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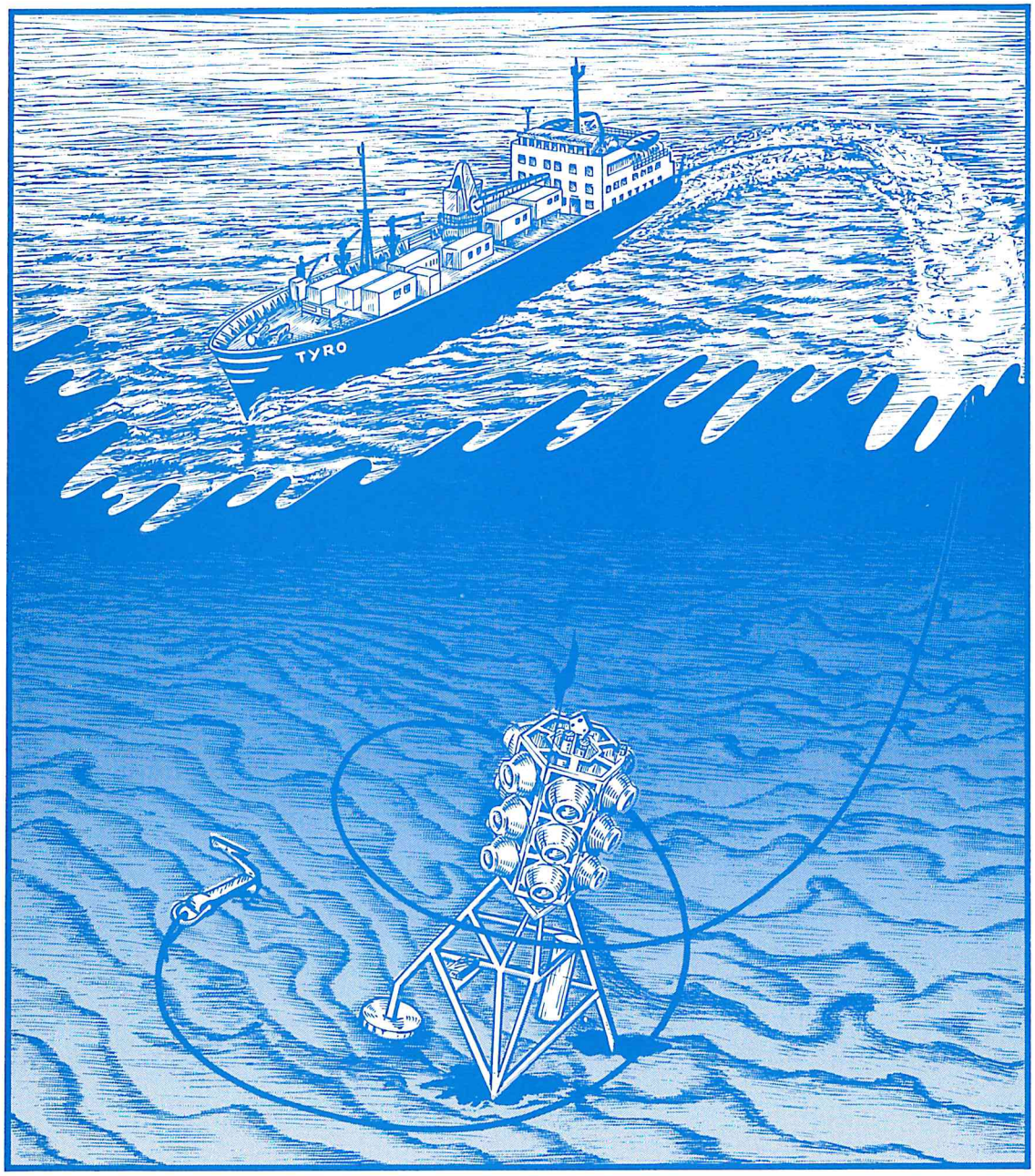

NETHERLANDS INSTITUTE FOR SEA RESEARCH (NIOZ)

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The NIOZ-harbour now has enough space for both RV Tyro and RV Pelagia.
(Photo: copyright 'Flying Focus' Archiefnr: 8108)

1.1. INTRODUCTION

The main event in 1991 was the coming into service of the RV Pelagia. This new NIOZ research vessel was launched and christened by Mrs. Zijlstra on January 26 at the Verolme shipyard at Oud-Leusden, witnessed by many officials and relatives. It was handed over on April 25 in the harbour of Oudeschild, Texel, and celebrated in a more sober sphere on board the Pelagia.

During the first cruises, the scientists and technicians have shown great enthusiasm concerning the ship's capacities and equipment as well as the skilful operation by the 10-man crew.

The handing over coincided with the start of the Integrated North Sea Programme, in which NIOZ is heavily involved. The importance of the INP was emphasized by the willingness of two cabinet ministers, Mrs. J.R.H. Maij Weggen and Dr.ir. J.M.M. Ritzen, to cast off the ropes of the Pelagia and the RV Holland of Rijkswaterstaat (Directorate General of Public Works and Water Management) on July 1. In 1992, a significant part of the Pelagia shiptime will be devoted to the INP, in collaboration with colleagues from Dutch and foreign institutions.

The NIOZ harbour was enlarged to accomodate the Pelagia as well as the RV Tyro. Loading/unloading and preparation for the various cruises has become much easier.

The organizational constraints dictated by a ship of essentially larger size and possibilities than the former RV Aurelia necessitated adjustments in the internal structure of the Technical Department of NIOZ.

After several years of intensive involvement with the ins and outs of NIOZ, Prof. Scharloo retired as chairman during late 1990 and was succeeded by Prof. Battjes. In 1991, the vacancy in the Executive Board was filled by Prof. Goos from the University of Utrecht.

As of 1 January, Dr. P.A.W.J. de Wilde was appointed as part-time professor of Marine Zoology at the University of Groningen. Procedures are in an advanced state for appointing a NIOZ scientist in chemical oceanography as part-time professor of General Oceanology at the same university to succeed dr. E.K. Duursma. With this appointment the number of part-time university professors at NIOZ will have risen to six.

The NIOZ Science Committee had two meetings at which Ph.D. project proposals were reviewed and one department was presented and discussed in detail. This year it was the Department of Coastal Systems. This department studies the ecosystem of the Wadden Sea in particular. The discussion contributed to an integration of long-term observations and the experimental approach.

The number of Ph.D. students increased to a total of 32, rather evenly distributed over the departments. Thanks to NWO and various other financial sources, the number of postdoctorates during 1992 is expected to rise from five to seven.

In 1991, the larger part of the new programmes and projects were associated with Global Change and environmental studies. NIOZ is involved in 4 out of the 9 themes of the NWO/NOP programme Global Change (Verstoring van Aardsystemen), and is coordinator for two (VvA-4: fluxes in the North Sea; VvA-9: carbon balance in the ocean mixed layer).

The number of NIOZ projects financed by the European Community increased to a total of 15. Together with another 8 (contract research) projects

the additional funds to NIOZ amount to about 7 million guilders over contract periods of 2 to 4 years.

The Integrated North Sea Programme was started in 1991 in collaboration with Rijkswaterstaat and a number of colleagues from other Dutch institutions, as well as colleagues from Great Britain, Sweden, Norway, Denmark, the United States and Belgium. Part of the expeditions were financially supported by the Netherlands Marine Research Foundation (SOZ). The programme will be continued in 1992 and the years to come.

Research on the open ocean was continued with the SOZ-supported DUTCH-WARP, a contribution to the WOCE programme on the North Atlantic.

Due to postponement of the Indian Ocean Programme to May 1992 because of political and military unrest in the area, the SOZ was able to organize expeditions in the Mediterranean Sea (MAST, EROS-2000) in which NIOZ participated.

NIOZ cooperated with institutes from the Sovjet Union, which resulted in a number of expeditions, *e.g.* to the Black Sea, the Barentsz Sea and the Lena estuaries.

During 1991, the number of employees at NIOZ grew to about 250, necessitating alterations and rearrangements within the buildings. These will continue in 1992.

The Netherlands Journal of Sea Research published two special volumes, apart from its regular issues, *viz.* the final part of the Proceedings of the International Symposium on the Ecology of the North Sea (held in 1988) and the first part of the International Flatfish Symposium (held in 1990).

In the course of the year, NIOZ was able to house and cater a considerable number of symposia, workshops and courses, thanks to the flexibility and cooperation of the staff involved.

The increasing scientific activities request heavy exertion from the technical and analytical staff. Moreover, with sea-going programmes, each year is entirely different from any other. However, NIOZ personnel have responded with great flexibility and dedication.

W.G. Mook

Integrated North Sea Programme (INP 1991-1992)

H.J. Lindeboom

In order to promote coordination between various (inter)national North Sea research programmes, NIOZ took the initiative to organize an integrated North Sea programme, together with the Netherlands Marine Research Foundation (SOZ), the Tidal Waters Division (DGW) of the Ministry of Transport and Public Works and the Policy-linked Ecological Research North Sea and Wadden Sea (BEON).

At present researchers and ships from several countries bordering the North Sea are participating in the programme. Central theme in the NIOZ contribution is the horizontal and vertical (short-term) transport of dissolved and particulate material, and the effect of transport phenomena on the ecology. Recently it has become clear that short-term transport phenomena may play an important role in the total ecology of the North Sea. Storms bring nutrient-rich water to the surface, where subsequently algal blooms may occur. Calcifying algae may transport inorganic carbon to the sediment, while flocculation may be an important mechanism in transporting organic material including microcontaminants to the sediment.

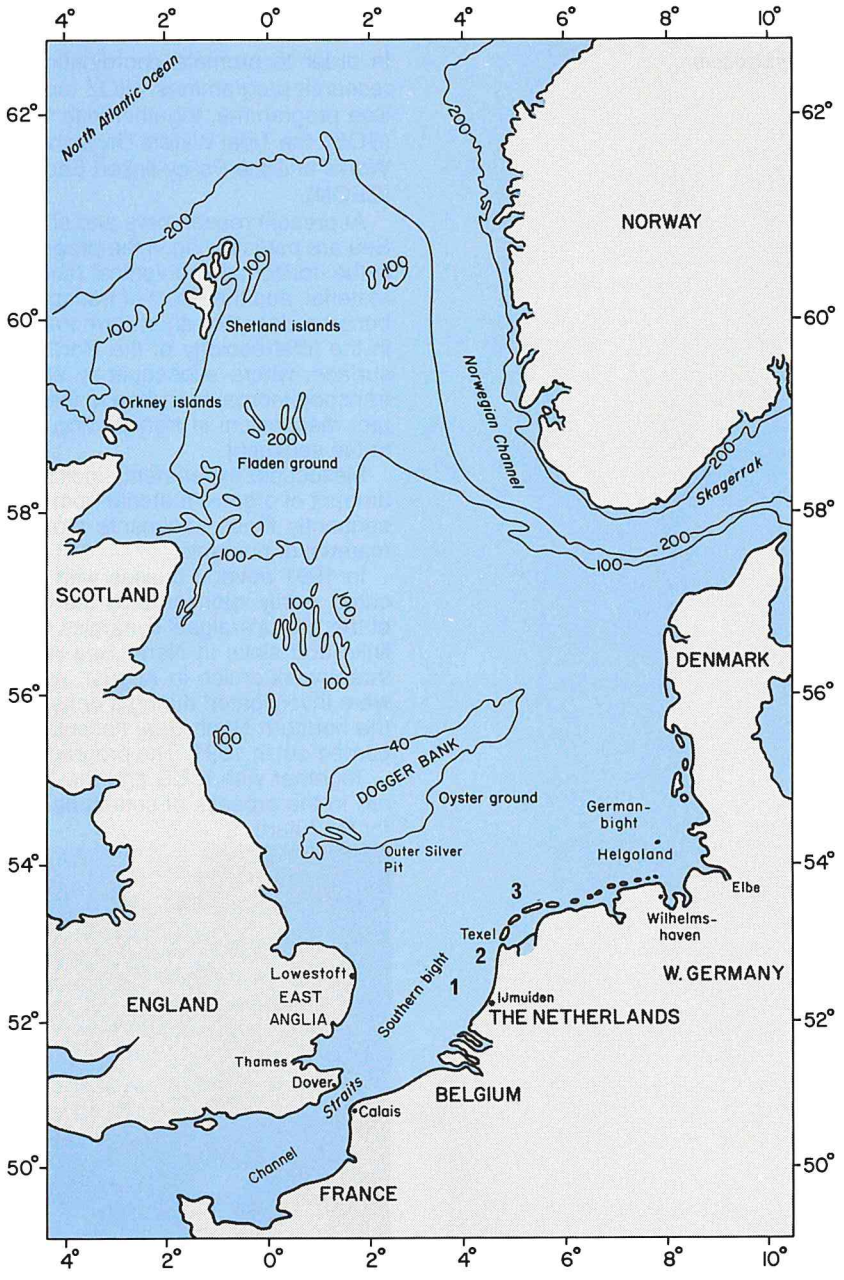
Mesocosm experiments indicate that the sediment is receiving a significant amount of organic material from the water phase throughout the year, and subsequently these sediments may act as sinks or as regenerators of organic material or nutrients.

In 1991 several cruises with the new research vessel 'Pelagia' were executed, partly sponsored by the SOZ. A mooring for the continuous monitoring of the 'physics-algae' dynamics was placed in the Oyster Ground area. Benthic links and sinks in North Sea nutrient cycling (BELS) were studied during a three-week cruise in August, while distribution and effects of micropollutants were investigated during a cruise in September. Research on sedimentation in the northern North Sea, flocculation processes and pelagic systems was also carried out in 1991. The programme will continue in 1992.

Together with ICES and the North Sea Task Force the initiators of the INP are in the process of setting up an extended North Sea research programme for the future.

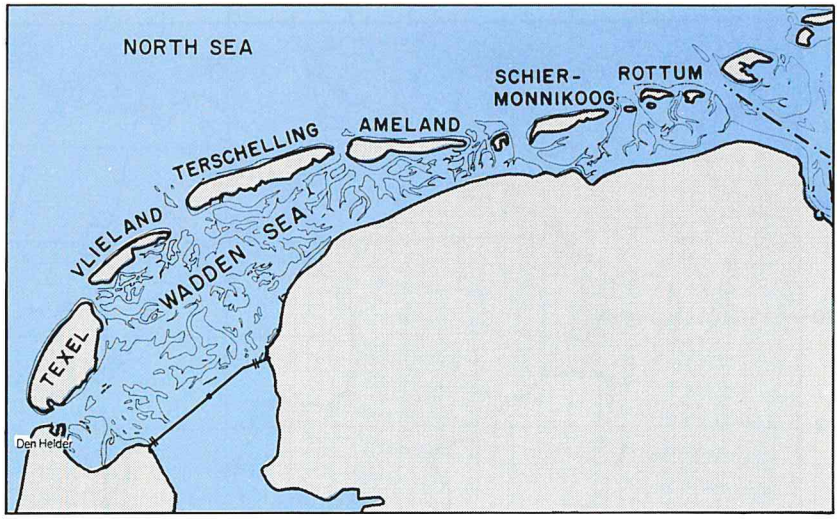
By casting off the rope of the Pelagia on 1 July, the Ministers of Transport and Public Works Mrs. J.R.H. Maij Weggen and of Education and Science Dr. ir. J.M.M. Ritzen officially started the Integrated North Sea Programme.

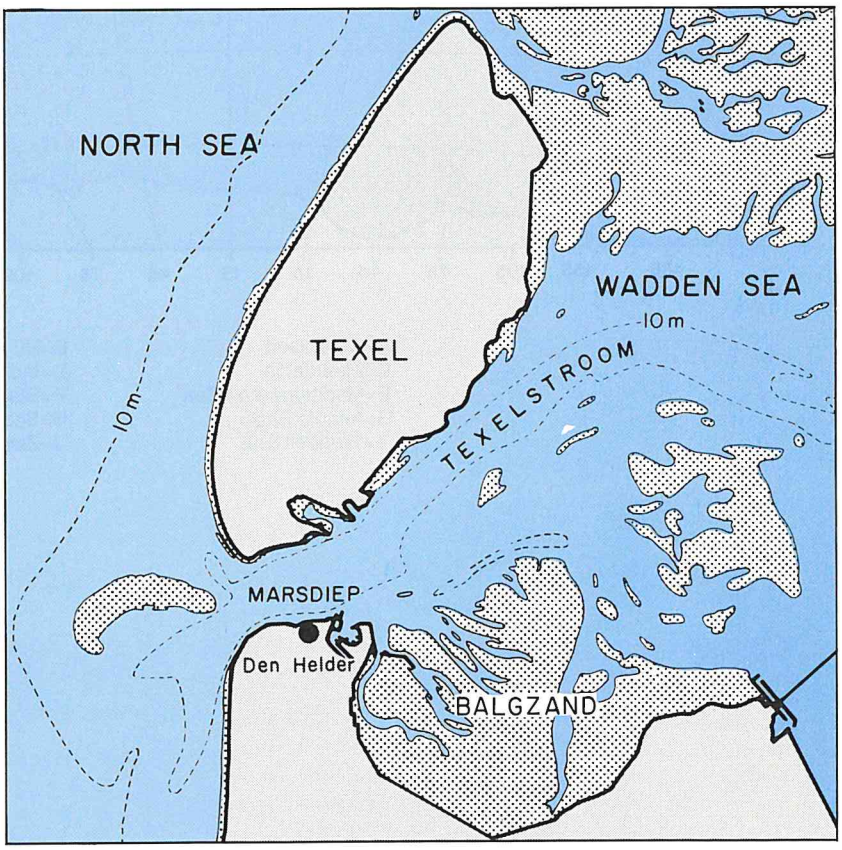
1.1.2. Maps



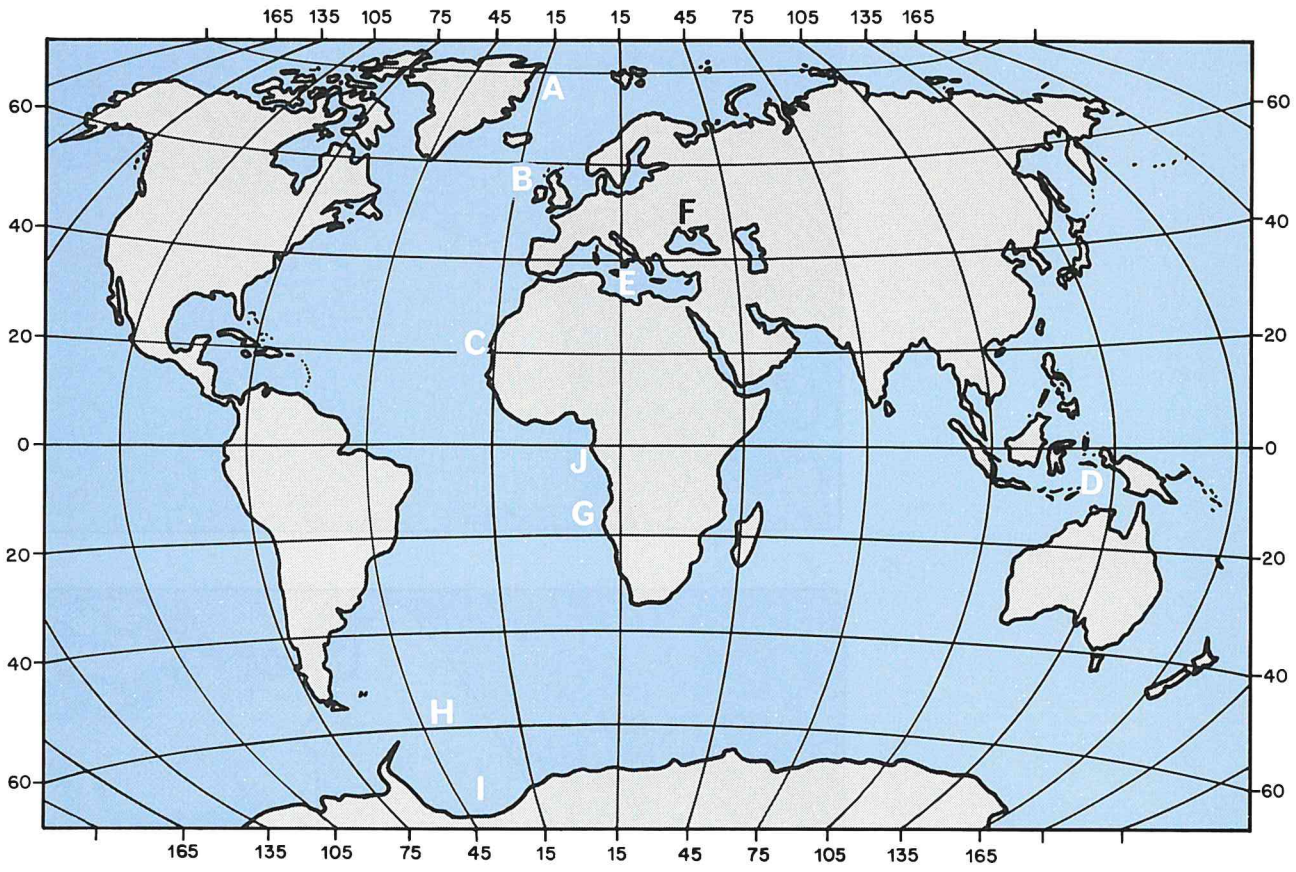
1=Brown Ridge
2=Breeveertien
3=Frisian Front

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=Mauritania
D=Indonesia
E=Mediterranean Sea
F=Black Sea
G=Angola Basin
H=Scotia Sea
I=Weddell Sea
J=Zaire Estuary

1.2. CHEMICAL OCEANOGRAPHY AND MARINE POLLUTION (H1)

INTRODUCTION

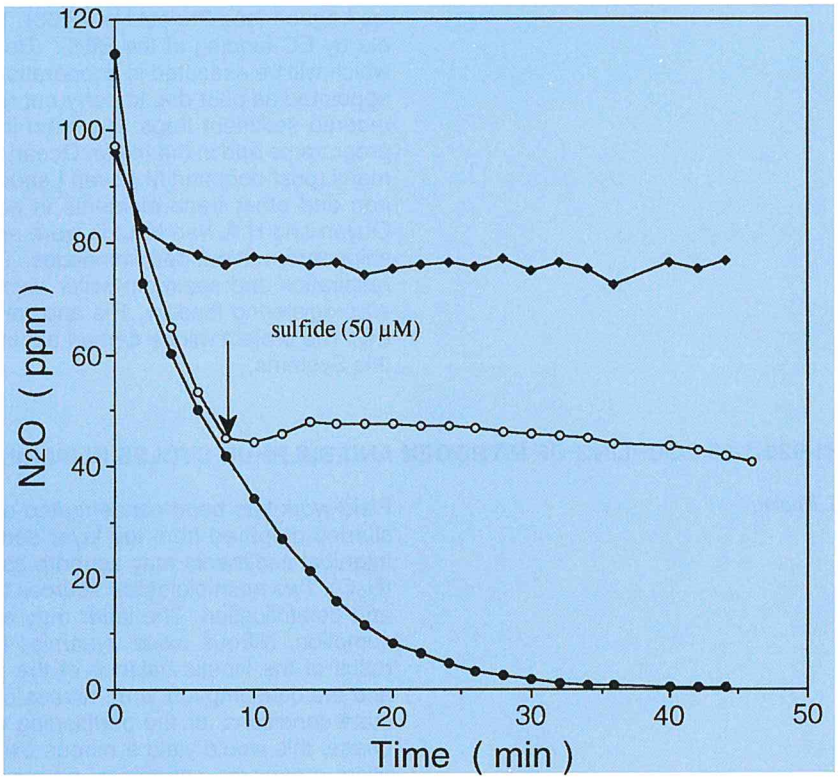
The Department of Chemical Oceanography continued its efforts in the various research projects reported on below. Some of the projects came to a temporary standstill (H1-01 and H1-05) by the departure of the scientists involved, while other projects were regrouped (H1-10, H1-11, and H1-13). This will in the near future lead to reformulation of project descriptions. Funding by the NOP made it possible to appoint new personnel to strengthen and/or start work on water-air exchange of greenhouse gases CO_2 (D.C.E. Bakker, project H1-17) and N_2O (H.P.J. de Wilde, project H1-02/03). H. de Hey, in cooperation with the Department of Benthic Systems, started to work on eutrophication of the Venice Lagoon (see Project H1-02/03). The appointment of De Hey became possible by EC funding of the BEST (Benthic Eutrophication Studies) programme, which will be executed in cooperation with IBN and TNO. G.J.A. Brummer was appointed as post-doc to carry out research on carbon fluxes by application of moored sediment traps. His main involvement will be in the ongoing JGOFS programme and in the Indian Ocean programme starting in 1992. K.R. Timmermans (post-doc) and M.A. van Leeuwe (OIO) started their project on the role of iron and other trace elements in oceanic systems (project H1-15). J.C. van Ooyen and H.A. van Koutrik were appointed as technicians for laboratory and shipboard nutrient determinations. T. Tahey (OIO) started his work on benthic respiration and sediment-water exchange (project H1-04) by application of *in situ* registering landers. His appointment became possible by funding by the EC. The project will be carried out in cooperation with the Department of Benthic Systems.

H1-02/H1-03 COUPLING OF NITROGEN AND SULPHUR CYCLES IN MARINE SEDIMENTS

E. Epping

Field work has been concentrated on nitrous oxide consumption by sediment slurries prepared from top layer sediment. Field data from 1990 showed that intertidal sediments may act both as a source, and as a sink for nitrous oxide (N_2O). Two main biological sources for nitrous oxide production are nitrification and denitrification. The latter may also be responsible for nitrous oxide consumption. Nitrous oxide dynamics in denitrification can be considered as a result of the kinetic balance of the production term, nitrite reductase activity, and the consumption term, nitrous oxide reductase activity. Assuming steady-state conditions for the partitioning of nitrous oxide between gas- and water-phase, this would yield a nitrous oxide concentration in seawater of 6-12 nM. Micro-organisms capable of nitrous oxide consumption at *in situ* concentrations have to deal with these low concentrations, implying a high affinity system for nitrous oxide. Mainly because of its oxygen lability, the information on nitrous oxide reductase is very limited. Although its activity may be affected by sulphide and oxygen, no precise data are available on the effective concentrations. Therefore nitrous oxide reductase activity was assayed in slurry experiments as a function of these antagonistic environmental parameters. Sediment slurry systems appeared to be very difficult for assaying specific nitrous oxide consumption rates, probably due to the activity of other functional groups of bacteria, such as sulphate-reducing bacteria, thereby changing the chemical environment during the course of the assay. The results obtained from these

experiments reveal a first order consumption rate and a very high sensitivity towards free sulphide. Fifty µM of free sulphide appear to block the nitrous oxide consumption completely, though earlier reports were in the order of 1-10 µM. To circumvent the complexity of sediment systems, denitrifying bacteria were enriched and cultivated in an anoxic, nitrate limited, pH and temperature controlled chemostat, with acetate as a carbon and energy source. In the early stages of selection (1-5 volume changes) these mixed populations of denitrifying organisms have been assayed for nitrous oxide consumption and the inhibitory effect of free sulphide, tri-sulphide and oxygen. Again free sulphide appeared to be effective in the micromolar range. Tri-sulphide and low initial concentrations of oxygen were found to be effective inhibitors as well. The level of exposure of denitrifying bacteria to these parameters *in situ* may play a key role in nitrous oxide dynamics in intertidal sediments.

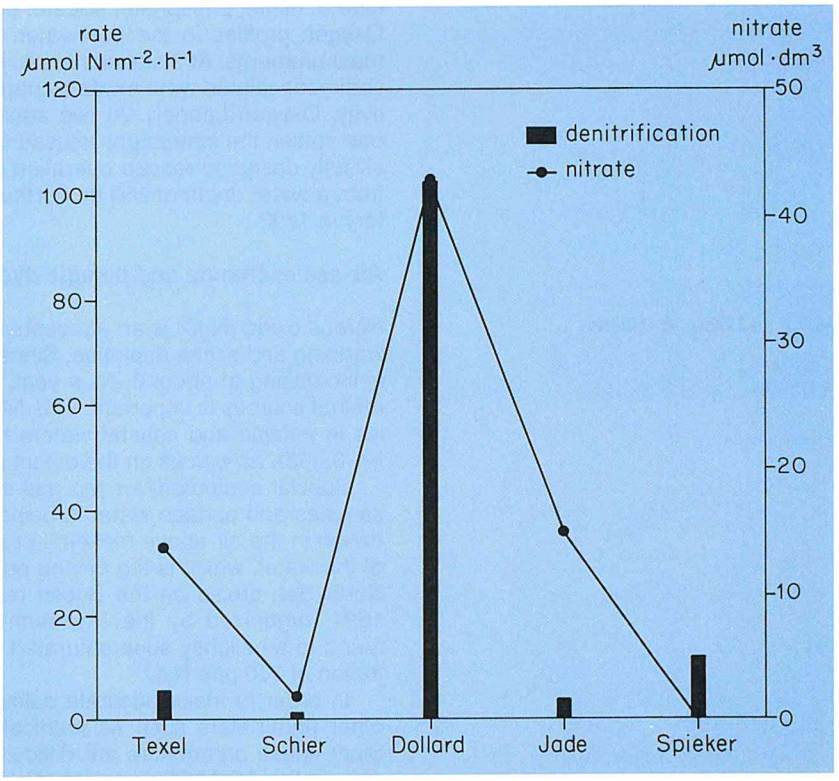


Effect of sulphide on nitrous oxide consumption rates.
● = bottle A/20 µl N_2O
◆ = control/20 µl N_2O
○ = bottle a/50 µl sulphide

L. Lohse, W. Helder

In February the second part of the comparative investigation on nitrogen cycling in different parts of the Dutch and German Wadden Sea took place. In August 1990 and February 1991 highest denitrification rates and nitrous oxide fluxes as well as nutrient concentrations were measured in the Ems-Dollard estuary. Results were obtained in collaboration with Michael Koeritz (Carl-von Ossietzki-University, Oldenburg, Germany). Main emphasis in 1991 was on investigations on 'Benthic sinks and links in North Sea nutrient cycling' (BELS). During a three-week cruise in the southern and central part of the North Sea all key processes in nitrogen cycling were determined: denitrification, nitrification,

ammonification, nutrient fluxes and oxygen profiles. First results indicate that large areas of anoxic sediments occur in the German Bight and along the Danish coast. These findings were confirmed by porewater nutrient data and a preliminary evaluation of denitrification rates.



Benthic denitrification rates and nitrate concentration in overlying water in different parts of the Wadden Sea.

Inorganic benthic nitrogen turnover was also studied in the Lagoon of Venice (L. Lohse, H. de Hey). These investigations were part of the Benthic Eutrophication Studies (BEST). The Venice lagoon is as a classic eutrophicated marine system. Elevated nutrient concentrations as well as high levels of heavy metals seemed to have a strong impact on nitrogen turnover in the sediments. Furthermore attempts were made to improve the technique of measuring denitrification, the microbial mediated reaction from oxidized inorganic nitrogen compounds to gaseous nitrogen. During the EROS-2000 cruise in the Mediterranean Sea (Gulf of Lions) a comparison between two conventional techniques was made. In cooperation with T.H. Blackburn (Institute for Ecology and Genetics, Aarhus, Denmark) denitrification rates were determined concurrently by the ^{15}N and the acetylene block-method to assess the order of magnitude of underestimation by the latter method. In view of the drawbacks of the acetylene block technique, we are now developing a gas-stripping device to measure the emission of gaseous nitrogen from the sediment directly (in cooperation with A. Devol, School of Oceanography, Washington).

H1-04 EARLY DIAGENETIC PROCESSES, ORGANIC CARBON MINERALIZATION AND SEDIMENT-WATER EXCHANGES

W. Helder, R. Kloosterhuis, L. Lohse, T. Tahey, K. Bakker, H.A. van Koutrik

Emphasis was on field work in the NW Mediterranean Sea, within the framework of the EC-sponsored EROS-2000 project.The research area was visited with the RV Tyro in the period 16 Nov.- 6 Dec. At 15 stations box-cores were taken and subsampled for assessment of porewater profiles of ammonia, nitrate, nitrite, phosphate, silicate, dissolved Mn, dissolved Fe, and for organic. Oxygen profiles in the porewater were made by shipboard micro-electrode measurements. At 3 stations *in situ* measurements of oxygen distribution in the sediment column were made by deployment of the TROL (Temperature, Resistivity, Oxygen Lander). At two stations TROL gave consistent results, but at one station the instrument refused to come back to the sea surface. Only by a skilfully designed rescue operation by dredging was the instrument recovered from a water depth of 950 m. Further analyses will be carried out in the laboratory in 1992.

Air-sea exchange and pelagic dynamics of N_2O

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 0.2% a year, a better understanding of aquatic and terrestrial sources is important. This NOP-funded project focuses on N_2O dynamics in pelagic and coastal waters resulting from microbiological activity (see H1-02/03), as well as on the extent of N_2O sea-air exchange.

Special equipment for the gas-chromatographical analysis of N_2O in CTD samples and surface water is being developed. Measurement of the concentration in the air above makes it possible to calculate the degree of saturation of the water, which is the driving potential for N_2O sea-air exchange. During a North Sea cruise on the British research vessel RRS Challenger in August 1991, organized by the Plymouth Marine Laboratory, surface waters were found to be slightly supersaturated, relative to an average marine air concentration of 300 ppb N_2O.

In order to make accurate calculations of the extent of air-sea exchange, other parameters such as (vertical) wind speed have to be known as well. Since these parameters are difficult to measure on shipboard, we will participate in the ASGASEX project (Air-Sea Gas Exchange experiment). In February 1992 measurements will be carried out on a stable platform close to the Dutch coast (Meetplatform Noordwijk) in cooperation with other NIOZ participants, the Royal Dutch Meteorological Institute and the Canadian Bedford Institute of Oceanography.

Future research will focus on dynamic areas such as the Indian Ocean. In July/August 1992 and January/February 1993 we will participate in the JGOFS Indian Ocean cruise 'Monsoons and pelagic systems'.

H1-06a ANALYTICAL ORGANIC CHEMISTRY

M.Th. J. Hillebrand, K. Booij

Continued efforts have been made in improving and maintaining the quality of the PCB analysis. Certified reference materials for PCBs in sediments were analysed regularly to monitor the quality of the analysis. A start has been made with analysing certified reference materials for biological samples.

The separation of PCBs in the gas chromatography analysis has been improved by the installation of a narrow bore capillary column and a hydrogen carrier-gas system.

The HPLC line for automated clean-up of sample extracts was equipped with a UV fluorescence detector and a programmable fraction collector.

Alternatives for soxhlet extraction of sediments and biological samples were tested and optimized: steam distillation, saponification and supercritical fluid extraction.

A new software package for the processing of the chromatographic data was optimized in collaboration with the software designer.

The department participated in the ICES intercalibration exercise for PCB analysis in sediments and biological samples. On the basis of the results further improvements of the analytical methods were made.

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

J.M. Everaarts, C.V. Fischer

In invertebrate organisms sampled from the edge of the Banc d'Arguin (Mauritania) during a survey with RV Tyro from 7 May through 29 May, 1988, actual baseline levels of selected cyclic organochlorine pesticides, some of their persistent metabolites and polychlorinated biphenyls (PCB) could be described. The macrobenthic invertebrate organisms represented the phyla Annelida (Polychaeta, bristle-worms), Arthropoda (Crustacea, Natantia [shrimps] and Reptantia [spider- and hermit-crabs]), Mollusca (bivalves) and cephalopods (Octopus and Sepia). In most of the samples analysed, no pesticides such as g-hexachlorocyclohexane (g-HCH), dieldrin, endrin, p,p'-DDT and its metabolites p,p'-DDE and p,p'-DDD could be detected and in only a few samples g-HCH, dieldrin and p,p'-DDE were identified but could not be quantified. Of the PCBs occurring as strictly separated single peaks and given in their sequence of appearance in the chromatogram, the CB-congeners # 52, 49, 44, 70, 84, 187, 183, 172, 180 and 194, generally could not be detected. Also CB-153 and CB-138 were in most chromatograms not detectable, and if identified certainly not quantified.

H1-07/S-02b BIOLOGICAL MARKERS OF ENVIRONMENTAL CONTAMINATION

J.M Everaarts

This research project focuses on the development, application and validation of biological markers in marine species either as indicators of exposure to toxic chemicals or as predictors of the adverse consequences of that exposure. Furthermore, biological markers may function as 'early warning signals' for the assessment of environmental contamination and may be included in monitoring programmes. Physiological responses to anthropogenic and naturally occurring contaminants involved in the present research are the haematological status and liver somatic index, induction of detoxifying systems (see S-02b) and genetic damage, such as DNA adduction and strand-breaks. A semi-chronic laboratory experiment was carried out with female dab (*Limanda limanda*) injected orally several times with the technical PCB-mixture Clophen A40. Haematological parameters (haematocrit, haemoglobin concentration and mean corpuscular hemoglobin concentration) and the liver somatic index were measured: the data need now to be evaluated statistically. From the livers of the specimens subsamples were taken to analyse the integrity of the DNA in terms of the number of strands-breaks. Processing of the samples applying the alkaline unwinding assay is still going on. The above mentioned biological markers together with measurement of the induction of the monooxygenase enzyme system (see also S-02b) are measured in samples of the dab and the seastar (*Asterias rubens*) collected during a cruise on the North Sea in August-September, in the framework of the 'Integrated North Sea Programme'.

H1-08 HEAVY METALS IN THE MARINE ENVIRONMENT

J.M. Everaarts, C.V. Fischer

Surface sediment samples, zooplankton and macrobenthic invertebrate organisms obtained from the area of the continental slope of the Banc d'Arguin (Mauritania) were analysed for heavy metals. Samples were taken during a cruise with RV Tyro (Netherlands Marine Research Foundation, NWO-SOZ) from 7 May through 29 May 1988. The concentrations of copper, zinc, lead and cadmium in the surface sediment (upper 5 mm) were generally higher in the silt fraction than in the bulk sediment. No significant geographical trend in the metal concentrations of the surface sediments was found, and no correlation could be established between concentrations in bulk sediment, the silt fraction and the % silt. In general, the metal concentrations in both bulk sediment and silt were lower than in marine environments in other climatological regions. In zooplankton, the heavy metal concentrations were relatively high: expressed in $\mu g \cdot g^{-1}$ on a dry weight (D.W.) basis, they ranged from 15-90 for copper, 70-580 for zinc, 12-55 for lead and 4-10 for cadmium. In epibenthic crustaceans and bivalve molluscs, the concentrations of copper, zinc, and lead were in the same order of magnitude as in corresponding species from other geographical latitudes. Cadmium concentrations were relatively low, ranging from 0.13-0.42 $\mu g \cdot g^{-1}$ D.W. in the bivalve mollusc *Pitaria tumens* and from 0.04-0.27 $\mu g \cdot g$ D.W. in the shrimp *Processa elegantula*. Also in the crab species *Ilia spinosa, Inachus* sp. and *Pagurus* sp., the cadmium concentrations were low, varying between 0.1 and 0.2 $\mu g \cdot g^{-1}$ D.W. No significant relation between the metal concentration in whole-body samples and sediment (either bulk or silt) was present. Also no gradient was apparent in concentrations in organisms sampled at different depths (5 to 200 m) along two offshore transects perpendicular to the Banc d'Arguin. Data indicated lower metal concentration in epibenthic organisms from sampling stations along a northern transect (southwest of Cap Blanc) than in the southern transect, at Cap Timiris. Evidence was obtained for a considerable atmospheric input of heavy metals, in particular zinc and lead, in a certain area along the continental slope of the Banc d'Arguin.

H1-09 EXCHANGE OF ORGANIC CONTAMINANTS BETWEEN SEDIMENT AND WATER

K. Booij

Previously, a technique has been established to separate PCBs that are dissolved in the water phase from PCBs that are bound to colloids. This technique has been applied successfully to the measurement of sediment-water partition coefficients for sediments from the southern North Sea. The sediment-water partition coefficients (K_d) are linearly proportional to the octanol-water partition coefficients (K_{ow}), at least up to $\log(K_{ow})=7.5$.

H1-12 EXTRACTION OF DISSOLVED PCBs FROM THE WATER PHASE

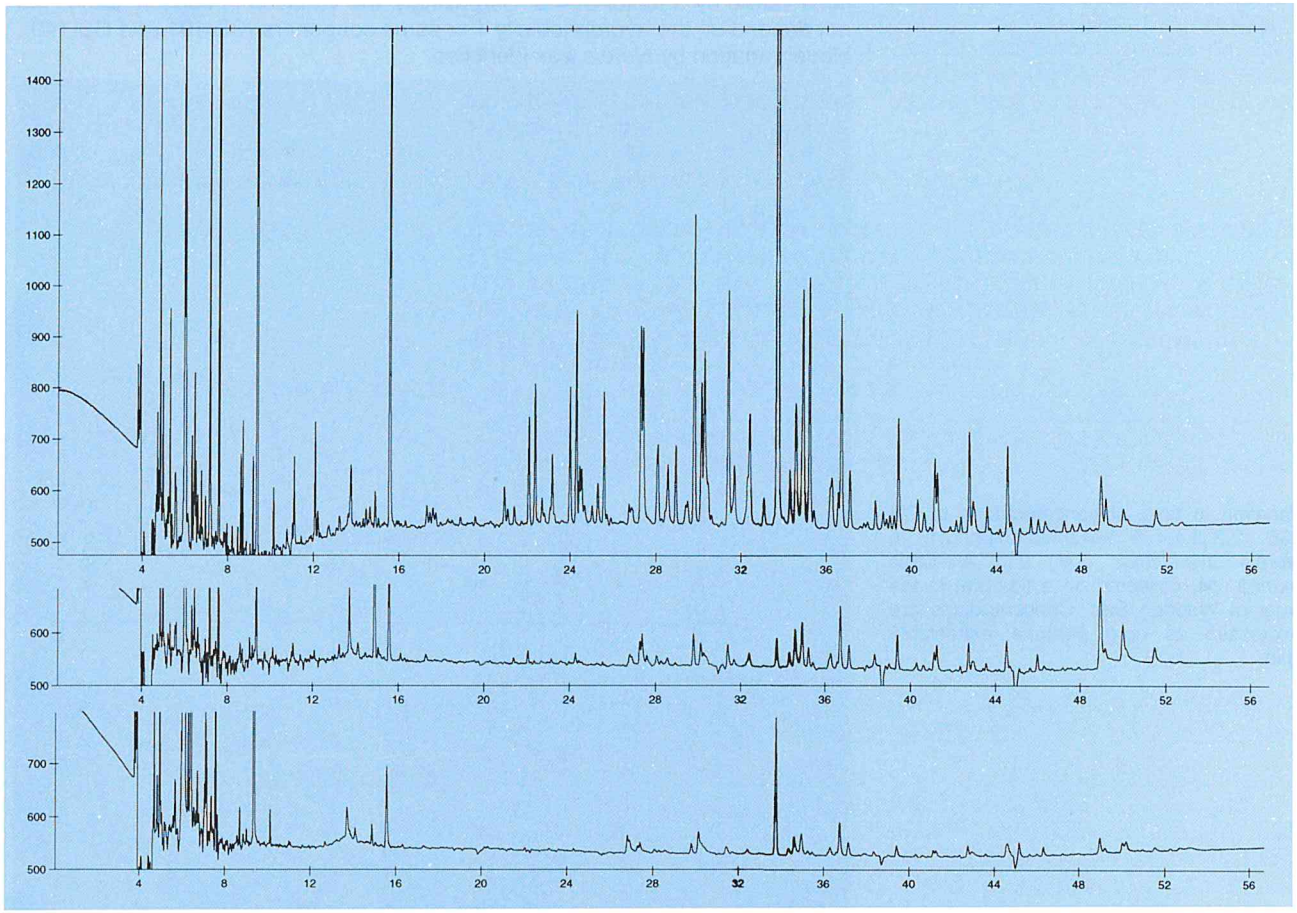
M.Th.J. Hillebrand, K. Booij

Previously, it was established that a water mass that passes a glass fibre filter contains two fractions of PCBs: a dissolved fraction that is readily extracted by either liquid-liquid extraction or solid phase adsorption, and a fraction that is bound to colloids, which is extremely resistant to extraction.

This year, the flow rate for the continuous liquid-liquid extractor was decreased to 3 litres per hour. For this flow rate the extraction efficiency was 85-90% for tetrachlorobiphenyls and 70-75% for hexachlorobiphenyls, as determined by repeated extractions.

Concentrations of PCBs with more than 6 chlorine atoms could not be determined with this technique, because of the low concentrations in the water phase compared to the procedure blank.

These results indicate that the continuous liquid-liquid extractor can be used to measure total PCB concentration in the water phase.



Upper chromatogram: 1st extract of 100 litre filtered seawater containing PCBs, water/solvent ratio 0.06.

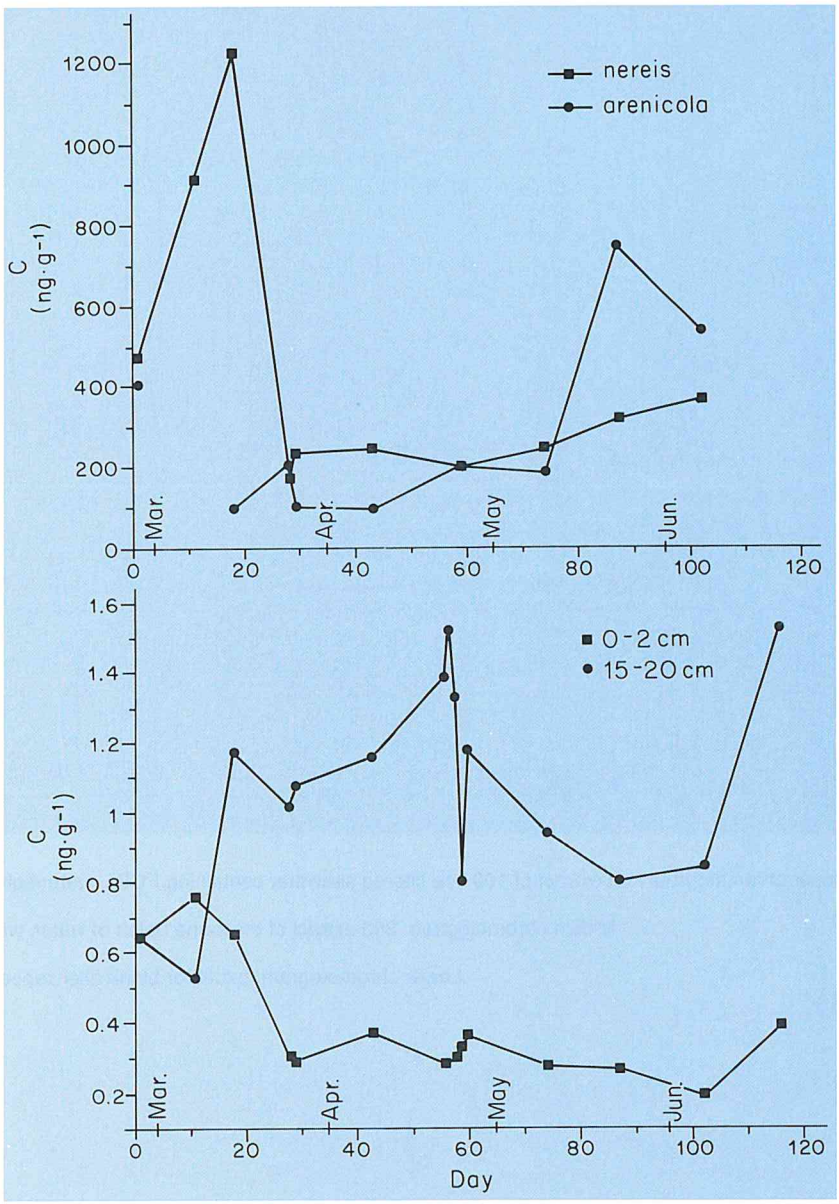
Middle chromatogram: 2nd extract of the same batch of water, water/solvent ratio 0.06.

Lower chromatogram: extractor blank after repeated extractions of demi water: 3 times 8 hours.

H1-14 VERTICAL AND HORIZONTAL PENETRATION OF POLLUTION FRONTS IN NORTH SEA SEDIMENTS

K. Booij, A. Sarkar

A time series measurement of PCB concentrations on a tidal flat near the island of Texel was started in February. Compartments sampled were sediment (0-2 cm and 15-20 cm), *Nereis diversicolor*, *Arenicola marina*, *Mytilus edulis*, and *Littorina littorina*. A preliminary analysis of the data showed that concentrations varied by a factor of 4-6. Surprisingly, the variation in concentrations did not depend on the hydrophobicity. For some congeners (CB 101 and CB 149), biodegradation by *Nereis* was identified.



Variation in time of concentrations of CB 138 (2,2',3,4,4',5 hexachlorobiphenyl) in *Nereis diversicolor* (●) and *Arenicola marina* (■) collected on a tidal flat in the western Wadden Sea. Concentrations are expressed as ng/g pentane extractable lipid.

Variation in time of concentrations of CB 138 (2,2',3,4,4',5 hexachlorobiphenyl) in sediments collected on a tidal flat in the western Wadden Sea at a depth of 0-2 cm (■) and 15-20 cm (●). Concentrations are expressed as ng/g dry weight.

H1-15 TRACE METALS IN THE OCEANS

Scientific Programme on Arctic and Siberian Aquatorium (SPASIBA)

R.F. Nolting, W. Helder

As a result of the cooperation between France, Russia and the Netherlands a programme was started (September) on the hydrographic, chemical and geological study of the Lena delta and adjacent Laptev Sea. Our contribution to this study was the investigation of diagenetic processes of trace metals in sediments supplied by the river Lena. Also the horizontal and vertical distribution of trace and major elements was studied. For this purpose, we collected grab samples in the Lena river and estuary and box-core samples in the Laptev Sea. The box-core samples were sliced and processed on board, so that interstitial water and sediments were separated directly after sampling.

Map of the northernmost cruise sailed by RV Jacob Smirnietsky, shown in the Siberian town of Tiksi.

Zaire estuary

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

In the Zaire estuary fresh water flows as a jet stream over the saline stagnant underlayer. Because of this, sedimentation of organic-rich material in the estuary and subsequent mineralization creates near-anoxic conditions in bottom water and in river sediments, resulting in very high dissolved iron and manganese concentrations in the porewaters.

Sediment, suspended-matter and water samples were collected in the Zaire river, estuary-canyon and adjacent ocean, during a survey with the RV Tyro in November and December 1989. The sediments were treated with 0.1 N HCl, to determine the easily leachable metal fraction, and the residue was totally destructed. For most metals this leachable fraction was rather constant, both in the sediment profile and in the longitudinal section in seaward direction. This fraction and total metal concentrations, however, changed considerably in the Atlantic Ocean (4000 m depth) some 200 miles from the Zairean coast.

Most of the sediment, with adsorbed metals supplied by the river, is probably trapped in the estuary and canyon, and only a small part of the very fine fraction escapes to the open ocean.

River inputs to the Mediterranean (EROS-2000)

R.F. Nolting, W. Helder

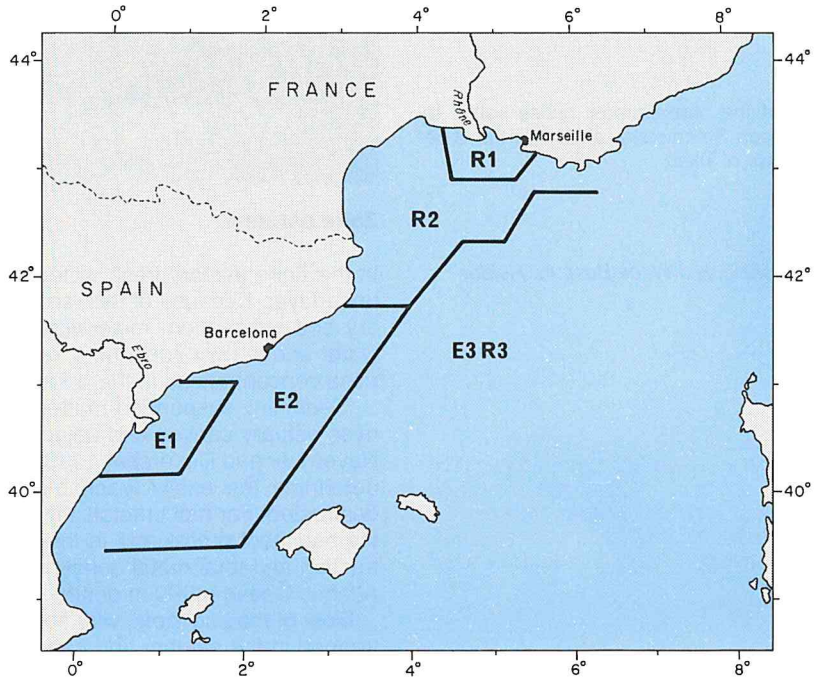
Sediment samples were collected in the North West basin of the Mediterranean Sea in May 1990. In these samples trace and major elements were determined to study sources and cycles of natural and anthropogenic constituents in coastal areas.

Three fractions were determined: the porewater fraction, which contains all dissolved elements, the leachable fraction of the sediment, which contains all easily exchangeable elements, and the residual fraction.

The area investigated can be divided into five 'subareas' which are different in element concentration, relative importance of leachable fraction and sedimentary composition. Highest concentrations of trace elements were found in sediments closest to the Rhône delta.

In summary, the Rhône is probably the major source for several (trace) elements to areas in the Gulf of Lions located close to the river mouth. The influence of the river Ebro on (trace) element concentrations in sediments close to this river mouth is minimal. Profiles of 0.1 N HCl leachable lead and zinc in the sediments of the Gulf indicate that, especially in the vicinity of the Rhône outflow and plume, the concentrations of these metals are determined by input from the river. Solid phase lead and zinc are more than three times higher than their pre-industrial background.

At the offshore, deep (>2000 m) stations in the Gulf of Lions, the surface concentrations of solid phase lead and zinc are about twice as high as background values. Due to the restricted mobility of lead and zinc and the lack of bioturbation in the sediment, the profiles from these deep stations preserve a historical record of the increased atmospheric deposition of these metals since 1890, similar to results from the North-East Atlantic.



The Northwestern basin of the Mediterranean Sea with the five proposed areas. The areas marked with $R_{1,2}$ are to some extent influenced by the Rhône and those marked with $E_{1,2}$ by the Ebro. The influence of these rivers on area E_3R_3 is minimal.

The decrease in the ratio solid phase Zn/Pb in offshore direction indicates that the distribution of zinc is mainly dependent on riverine input, whereas that of lead depends rather more on atmospheric deposition.

The Southern Ocean

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

Results of the 1988/1989 Polarstern expedition have now been completed. Preparations have started towards participation in the 1992 JGOFS Southern Ocean expedition. Throughout 1991 we have been upgrading the ultraclean laboratories both at the institute and in the dedicated shipboard laboratory van. In addition the sampling and filtration techniques were modified, whereas the final extractions and analyses in the laboratory were improved in such a way that overall analytical blanks are now lower again and also more reproducible. Consequently the detection limits for metals like Cd, Cu, Fe, Zn have been brought down five- to tenfold. During a cruise aboard RV Pelagia from 18 November through 4 December the new methods and equipment were used and tested at the North Sea.

Next to these commonly known metals, the distributions of Rare Earth Elements (REE) were determined along vertical profiles collected in 1988 at stations in the Weddell Sea and in the Scotia Sea. The REE such as Nd, Er, Yb, Lu were found to exhibit tight relationships with nutrient silicate. The deep water values of the ratio Nd/Si, Er/Si, Yb/Si and Lu/Si were virtually indistinguishable from those found in the deep waters of the Northwest Indian Ocean and the North Pacific Ocean. The global chemical cycling of the REE appears analogous to that of silicate, hinting at the role of settling biogenic particles in transporting REE from the surface waters to the deep ocean. Among the REE, the element Ce exhibits its own oxidation chemistry in seawater, akin to the oxidation of Mn and Fe. In the Antarctic waters the concentration of Ce is very low at 3-5 pM (3-5 x 10^{-12} mol/l) and Ce is strongly depleted compared to the other REE. (The research on REE is largely executed by A. Souren and J. Schijf at the Isotope Geology Laboratory, Amsterdam).

The role of iron and other trace elements in oceanic ecosystems

H.J.W. de Baar, J.T.F. de Jong, G.W. Kraay, M.A. van Leeuwe, R.F. Nolting, K.R. Timmermans, M.J.W. Veldhuis

This project is a joint venture between the Departments of Chemical Oceanography and Pelagic Systems, with collaboration of colleagues at the Alfred Wegener Institut, Bremerhaven. The second manuscript (Buma *et al.*, 1991) on our, first ever, study in 1988 of the biological role of Fe in an Antarctic ecosystem has been published. Herewith the first stage of this project as well as the Ph.D. thesis of collaborator A.G.J. Buma (formerly at NIOZ) has been completed.

In March K.R. Timmermans started a three-year postdoctoral research period with the design and construction of ultraclean continuous culture equipment. Two systems are now operational in the cold climate rooms and the assessment of growth characteristics as function of iron-availability of *Pyramimonas* sp. and other Antarctic phytoplankton species has started. In September M. van Leeuwe joined the team. She intends to combine the assessment of Fe-dependent growth parameters of algae with research on the likely effects of Fe on other (higher) trophic levels in the food chain. During a cruise aboard RV Pelagia from 18 November through 4 December enrichment experiments were executed by addition of both Fe and Co to the plankton community. In addition, preliminary grazing studies were performed.

The North Atlantic Ocean

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

Upon some final re-determinations to ensure overall quality control, the results of the 1989 and 1990 JGOFS expeditions are now completed and reported in the NIOZ Data Reports series. Two manuscripts are currently in preparation, in collaboration with P.M. Saager (Free University, Amsterdam).

The Indian Ocean

H.J.W. de Baar

With the publication of the second manuscript on Cd, Zn, Ni and Cu in the Indian Ocean (Saager *et al.*, 1991) this project is now completed. Based on this and other work, a data and literature review on the relation between cadmium and phosphate in the modern ocean was written and submitted for publication.

H1-16 RARE EARTHS AND OTHER METALS IN ANOXIC BASINS

H.J.W. de Baar

Our results for dissolved Rare Earth Elements (REE) in the anoxic waters of the Black Sea will be published in a special volume of Deep-Sea Research. Results for suspended particulate REE, as well as from mixing experiments between oxic and anoxic waters of the Black Sea, are now completed and written in chapters of the Ph.D. thesis of J. Schijf; manuscripts are in preparation.

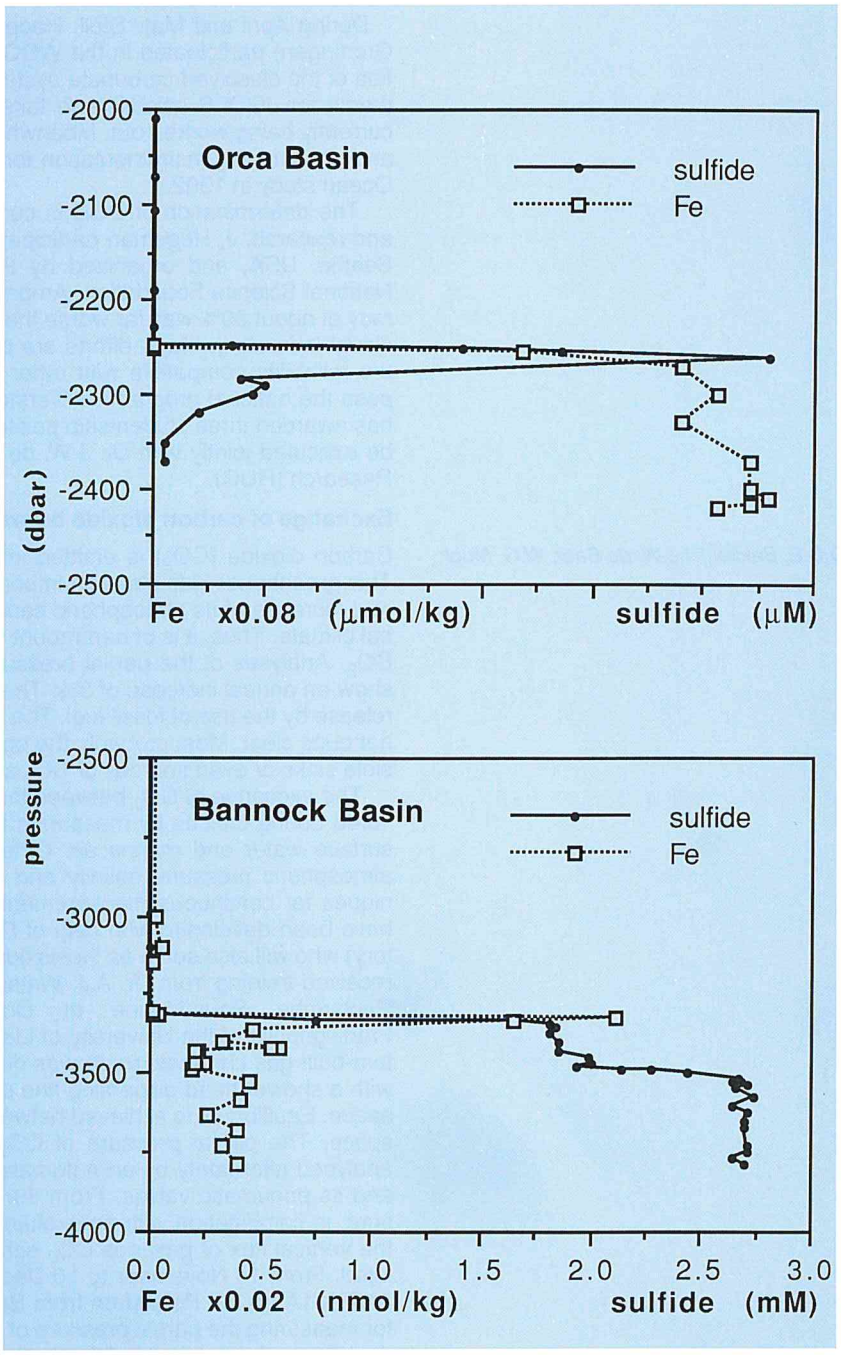
One manuscript on distributions of trace metals in seawater and anoxic brines of the East Mediterranean has been completed and submitted for publication. Among the various results, we observed for the first time depletion of Ni in anoxic waters, in contrast with anoxic basins with similar sulphide levels (*e.g.* Framvaren fjord) yet of normal salinity. Most probably the hypersaline conditions of Bannock and Tyro Basins cause removal of Ni as sulphides. The distributions of dissolved Fe and sulphide in hypersaline Bannock Basin have identical shape, yet exactly opposite concentrations as published previously for anoxic hypersaline Orca Basin in the Gulf of Mexico (See figures next page). However, at any given depth the concentration products [Fe][S] are virtually the same in both basins, suggesting solubility control by one and the same FeS phase in both basins. Apparently in Bannock Basin the excess sulphide causes FeS to precipitate, whereas in Orca basin it is the excess Fe causing FeS formation. The corresponding dataset for REE in Bannock Basin is complete and was described successfully with a model of the thermodynamic speciation of REE in hypersaline waters. This modelling was done in collaboration with Prof. F.M.M. Millero, University of Miami, also serving as adviser for the now completed Ph.D. thesis of J. Schijf.

H1-17 MASS BALANCE OF CARBON IN PELAGIC SURFACE WATERS

JGOFS North Atlantic Project

M.H.C. Stoll, H.J.W. de Baar, J. Rommets, J. Hegeman, J.M.J. Hoppema

The results of the JGOFS North Atlantic upper ocean cruises in 1989 and 1990 have been completed and are available as NIOZ Data Reports. Next to many physical, chemical and biological data of collaborators we produced a coherent dataset of the dissolved carbonate system as well as a modest preliminary dataset on Dissolved Organic Carbon (DOC). The carbonate system data were used as the basis for assessing the effect of different calculation routines and dissociation constants on the determination of total carbon dioxide in seawater.



Vertical distribution of dissolved Fe and H_2S in Orca basin (from Wiesenburg *et al.*, 1985) and Bannock Basin (Saager, Schijf and De Baar). Note the very similar vertical distributions, yet for opposite chemical species, in both basins.

During April and May, Stoll, Hoppema and M. Kraak (student, University of Groningen) participated in the WOCE North Atlantic cruise for the determination of the dissolved carbonate system, in accordance with international agreements for JGOFS scientists to take part in WOCE expeditions. Results are currently being worked out. Meanwhile preparations have started for preparing and constructing instrumentation for our participation in the JGOFS Southern Ocean study in 1992.

The determination of DOC is currently the subject of considerable debate and research. J. Hegeman participated in an intercalibration workshop held at Seattle, USA, and organized by Prof. Hedges under auspices of the US National Science Foundation. Among over thirty laboratories the overall accuracy of about 50% was far worse than the reproducibility reported by each individual laboratory. Major efforts are needed before analysis of DOC will reach the reliability compatible with other oceanographic parameters. For this purpose the national programme 'Verstoring van Aardsystemen' (Global Change) has awarded three studentship positions as of early 1992 for a study of DOC to be executed jointly with Dr. J.W. de Leeuw (TUD) and the Center for Isotope Research (RUG).

Exchange of carbon dioxide between oceans and the atmosphere

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

Carbon dioxide (CO_2) is emitted into the atmosphere by fossil fuel burning. This greenhouse gas plays an important role in the global climate and the current increase of its atmospheric concentration may trigger changes in the global climate. Thus, it is of paramount importance to know the fate of the emitted CO_2. Analyses of the partial pressure of CO_2 in the atmosphere since 1958 show an annual increase of 3%. This corresponds with about 60% of the CO_2-release by the use of fossil fuel. The fate of the remainder of the emitted CO_2 is not quite clear. Most probably the oceans have taken up most of it. Other possible sinks or even sources of CO_2 are the terrestrial vegetation and soils.

The exchange of CO_2 between the oceans and the atmosphere will be monitored during cruises by measuring the difference in partial pressure between surface water and marine air. Other important parameters are wind speed, atmospheric pressure, salinity and water temperature. Equipment and techniques for continuous measurement of CO_2 in surface water and marine air have been developed with help of Dr. A.J. Watson (Plymouth Marine Laboratory) who will also serve as thesis adviser. From 28 May to 5 June 1991 Bakker received training from Dr. A.J. Watson and his team at STARESO (Station de Recherche Sous-Marine et Océanographique), Corsica, where Dr. Frankignoulle of the University of Liège also participated. Upon return our custom-built gas chromatograph was delivered and combined with an equilibrator with a shower head dispersing fine seawater droplets in an atmospheric headspace. Equilibrium is achieved between CO_2 in seawater and in the finite headspace. The partial pressure of CO_2 in the headspace and in marine air is analysed alternately by an automated programme for the gas chromatograph and its pneumatic valves. From the thus determined gradient of partial pressure, in combination with an exchange coefficient as function of wind velocity, the vertical flux of gaseous CO_2 either into or out of the sea surface is calculated. From 14 November to 10 December 1991 Bakker participated in cruise ANT X/1A on RV Polarstern from Bremerhaven to Puerto Madryn (Argentina) for measuring the partial pressure of CO_2 in marine air and surface water along a north-south track in the Atlantic Ocean (50°N-40°S). At the 30-40°S latitudes the atmospheric CO_2 is well known to exhibit a minimum throughout years and seasons. This minimum suggests net removal of atmospheric CO_2, which may or may not take place in the South Atlantic Ocean.

Greenhouse gases and the North Sea

J.M.J. Hoppema, H.J.W. de Baar

This review study of emissions of gases CO_2, CH_4, N_2O and DMS was completed and is available as NIOZ Report 1991-4. The section on the North Sea carbon cycle and its concomitant gases CO_2 and CH_4 is currently written into a manuscript towards publication. This work led to a request for a now ongoing study on relations between the North Sea and the Atlantic Ocean (see S-4).

1.3. PHYSICAL OCEANOGRAPHY (H2)

INTRODUCTION

The study of non-linear dynamics in ocean circulation and tidal flows has been continued with emphasis on the interpretation of laboratory experiments in rotating tanks, on solitons, chaotic stirring and the relation between tidal dynamics and morphology.

A second cruise was carried out within DUTCH-WARP, the Dutch contribution to the international WOCE programme, in the Iceland Basin. Besides data obtained on board RV Tyro, also infra-red satellite pictures and trajectories of ARGOS-drifters were collected.

Based on data collected during the EPOS leg-1 and leg-2 cruises, the wind-mixed layer was modelled for the spring marginal ice zone. The results of this modelling have been used in a study of the phytoplankton blooms in this region and in the carbon budget.

A mooring deployed in the North Sea, within the framework of the INP, collected physical and biological data simultaneously to study the correlation between the evolution of the physical structure of the water column and phytoplankton during periods of brief atmospheric forcing in the summer.

A study was completed on the relationship between the colours of coastal waters and the inherent properties of the water. With the airborne radiometer CORSAIR, participation was established in the FLUXMANCHE project.

Within H2-09 Frisian Front Project and H2-11 Small-scale turbulence studies no activities were undertaken during 1991.

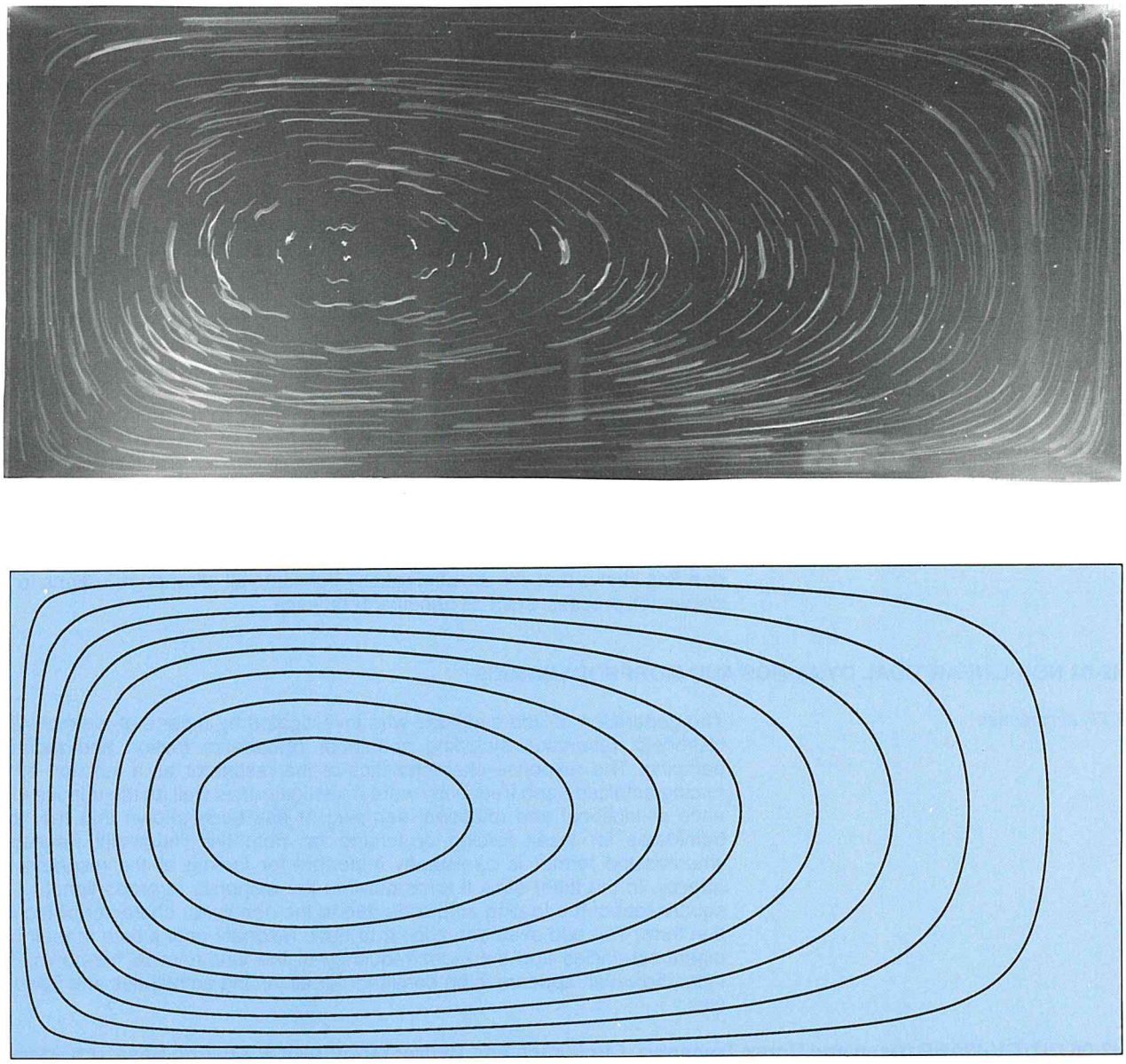
H2-01 NON-LINEAR DYNAMICS OF OCEAN CIRCULATION

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

Certain features of the fully non-linear, inertial circulation of the ocean can be modelled in the laboratory as the initial, inviscid response of a fluid in a non-axisymmetric tank which is impulsively set rotating. The experiments, carried out by the Technical University of Eindhoven in a rectangular tank with a sloping bottom, have been interpreted as yielding a vertically uniform flow characterized by a boundary layer at the deep side of the tank and a three-dimensional potential flow which ensures conservation of mass. The aspect ratio of the tank determines whether the observed flow at the surface is dominated by the vertically uniform part or not.

Other experiments, also carried out by the Technical University of Eindhoven, have been used to derive a model describing the decay of vortices. The spin-down of a vortex is determined by the non-linear effects (due to the secondary circulation produced by the Ekman pumping and suction at the top of the bottom boundary layer) and free-surface effects. The presence of a free-surface prolongs the decay-time in a radially non-uniform way. The non-linear feedback mechanism may lead to a 'breaking' azimuthal velocity profile, the dynamical condition of which turns out to be equivalent to Rayleigh's kinematically derived instability condition.

To model the dynamics of eddies in the ocean a systematic classification of the equations used in the literature has been set up. In order to gain insight into these equations, the basis of the traditional beta-plane model has been investigated. By applying general tensor calculus, a construction of this model is derived from first principles that is more transparent than the ones given in textbooks. (Cooperation with the Technical University Eindhoven, G.J.F. van Heist, C.W.M. Williams).



Particle displacements, visualized in a rotating tank with sloping bottom (top) and corresponding theoretical streamlines (bottom).

H2-02 NON-LINEAR TIDAL DYNAMICS

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

The influence on solitons of the dispersion due to the earth's rotation is investigated. In the 'deep-sea' regime the effects of the earth's rotation can be regarded as a perturbation. Furthermore, research has been carried out on the importance of the horizontal Coriolis term and on rotation-modified non-linear equations. It turns out that the horizontal term of the Coriolis force can be neglected for all practical purposes.

H2-03 NON-LINEAR TIDAL DYNAMICS: CHAOTIC STIRRING

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

A detailed investigation was performed of the occurrence of Lagrangean chaos in a numerical model of the western Dutch Wadden Sea. Chaos in particle trajectories can appear if hyperbolic fixed points are present in the residual circulation pattern. Chaotic trajectories are indicative of strong mixing and, therefore, important in transport processes in tidal areas. Indeed, strong mixing regions were identified in a two-dimensional numerical tidal model, as well as 'islands' of relative calm, possibly representative of long-lived patches in the region. In order to study the process more quantitatively a simple mathematical model, including superposition of tidal and residual currents, was investigated in detail. Chaotic behaviour sets in when two parameters —*viz.* the tidal excursion length relative to the residual eddy length scales and the tidal velocity amplitude relative to the residual velocity— surpass certain critical values. Chaos may either lead to strong internal mixing in the residual cells, to advective channels connecting the cells or to a chaotic web dispersing the particles all over the area. Application of these principles to the model of the real Wadden Sea shows that chaotic stirring may dominate all other contributions to the dispersion process, such as genuine turbulence.

H2-04 NON-LINEAR TIDAL DYNAMICS AND MORPHODYNAMICS

J.T.F. Zimmerman

The generation of odd overtides was investigated by means of a simple tidal Helmholtz resonator, including non-linear (quadratic) friction and radiation damping. The response characteristics of the resonator as a function of the forcing amplitude and frequency were investigated, as well as the relative influence of frictional and rotational damping. It has been shown that the latter dominates for weak forcing or forcing far from the Helmholtz frequency, whereas the former is particularly important for forcing at the resonant frequency. In the latter case it turns out that the response is proportional to the square root of the forcing amplitude due to the non-linear character of the friction term. The odd overtides appear to have resonant peaks both at their own eigenfrequencies and the eigenfrequency of the fundamental harmonic. The latter, however, appears to be dominant for all forcing amplitudes and frequencies.

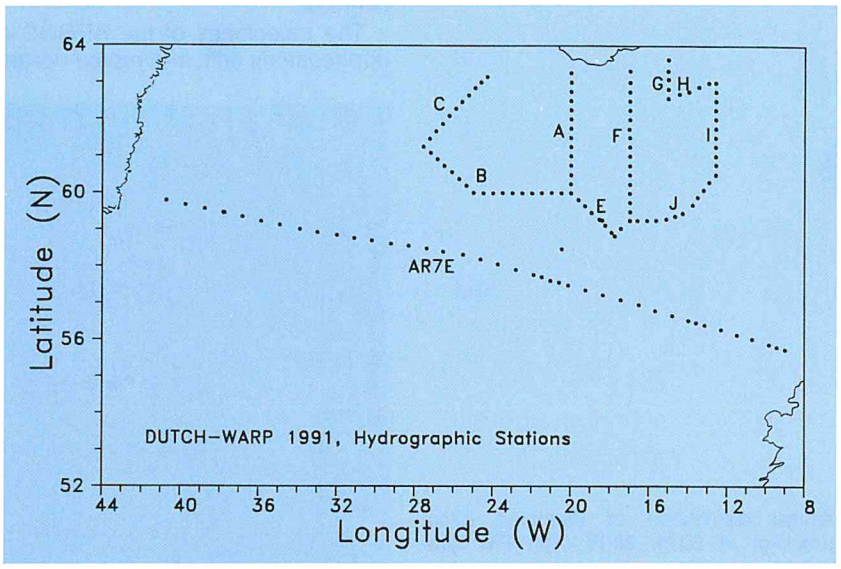
H2-05 DUTCH-WARP (Deep and Upper Transport, Circulation and Hydrography-WOCE Atlantic Research Progr.) H2-13 APPLICATION OF INFRARED REMOTE SENSING

H.M. van Aken, C. de Boer, T. de Bruin, J. de Munck, L. Otto, M. Hoppema, M. Stoll (the latter 2 from Chemical Oceanography), R.X. de Koster, R. Manuels, S. Ober

In the early spring of 1990 a second cruise was carried out within the framework of DUTCH-WARP. Firstly, WOCE Hydrographic Programme (WHP) section AR7E between Ireland and Greenland was surveyed. Thereafter a number of hydrographic sections, south of Iceland, were surveyed. In total, 144 hydro-

graphic stations were occupied. Additional XBT's (141) were launched as well as 4 ARGOS drifters. Four moorings, deployed during the 1990 cruise, were recovered.

At each hydrographic station a CTD downcast was recorded while during the upcast up to 24 water samples were taken. From these water samples determinations of salinity, nutrient content, oxygen concentration, total CO_2 (TCO_2) and alkalinity were made. The nutrient determinations were carried out by K. Bakker, H. Malschaert and R. de Vries of the Chemical Oceanography Department. A first inspection of the data has shown that the CTD data, oxygen data and TCO_2 data will meet the WHP quality requirements. The alkalinity data appear to contain errors due to malfunctioning of the titration system. The nutrient data still require some recalibration.



Hydrographic station of DUTCH-WARP 1991, South of Iceland.

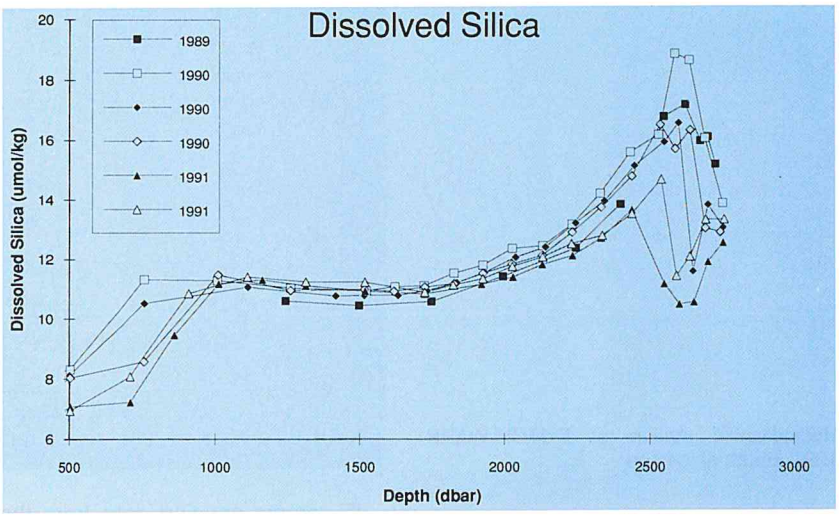
IR remote sensing data from the Iceland Basin will be obtained from the Royal Dutch Meteorological Institute (KNMI).

A first analysis of the data has confirmed the results from 1990 that the hydrography of the deep Iceland Basin is determined by the interaction of overflow water from the Norwegian Sea and cold waters from the Labrador Sea with intermediate waters (1000 m) and bottom water (2000-3000 m) of a southern origin. This southern water is characterized by a high nutrient content and a low oxygen content. The first part of the cruise showed the upper layer in the late winter situation with a thick layer (300-400 m) of homogeneous mode water formed in the preceding winter by convective cooling. Later on during the cruise, the seasonal stratification developed. In that period a diatom bloom in the upper 50 m caused a strong depletion of nutrients (especially silica) and TCO_2, while the surface oxygen content increased.

The processing of the 1990 data was finalized in spring. The data from the 1990 WHP AR7E section were sent to the WHP Project Office. Because of the cloudy weather in 1990, no complete individual IR remote sensing pictures of the Iceland Basin could be obtained. Thanks to occasional clear spells over the area KNMI was able to produce a composite picture of the sea surface temperature in the summer of 1990. This picture agrees with the large-scale tempera-

ture distribution observed in 1990 and will in more detail be compared with the observed hydrography of the 1990 surface layer. A simple mathematical model of the overflow plume in the Iceland Basin was developed and first sensitivity experiments were carried out. Further adaptations of this model to the observed density distribution will be made. An inverse model using the observed distributions of natural tracers in the Iceland Basin is under development. A provisional analysis of the current meter data has shown a near-bottom cyclonal circulation in the Iceland basin, transporting both southern water and overflow water. The overflow south of Iceland shows strong temporal variations with a typical period of 10 days. A principal component analysis of these current meter data has shown that most of the velocity variance is caused by a barotropic mode and by a baroclinic mode connected with variations in the overflow.

The trajectories of the ARGOS drifters deployed in 1990 show a general northeasterly drift, interrupted occasionally by eddies or meanders.



Vertical distribution of dissolved silica (µmol/kg) at 60°N, 20°W from RV Tyro cruises.

H2-06 GREENLAND SEA PROJECT

H.M. van Aken, S. Ober, F.P. Lam

The current meter data from the section between Jan Mayen and Greenland have been processed. In cooperation with scientists from Iceland and Denmark a data report has been prepared. In November 1991 analysis of the downward amplification of the diurnal tides over the Greenland slope has started. Both ray theory and vertical modes will be used in this analysis.

H2-07 JGOFS/SOUTHERN OCEAN - PHYSICAL PART AND MODELLING
H2-08 EPOS, PHYSICAL PART AND MODELLING

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

In 1991, during the EPOS-symposium in Bremerhaven, the EPOS project organized by the European Science Foundation came to an official end. In practice, research based on data collected during this project was continued, in particular in the field of modelling the Antarctic ecosystem. The model predictions provided fresh insight into the role the stratification of the water column

plays during the melting of the sea ice in the marginal ice zone and in the area outside the sea ice. The duration and the maximum of the phytoplankton bloom peak are partially generated by the stratification, but the decay of the bloom is not caused by changes in the structure of the water column outside the ice melt area, but by grazing. Also work has been done on the description of water masses and exchange of water between Scotia Sea and Weddell Sea. The physical data measured during the EPOS leg-2 cruise have been worked up to database quality and have been entered into the AWI database to be available for all participants.

NIOZ has been invited by the Alfred Wegener Institute (Bremerhaven) to coordinate a JGOFS/Southern Ocean cruise in October-November 1992 on board RV Polarstern. Preparatory meetings have taken place during 1991.

As a continuation of EPOS modelling activities and anticipating the planned JGOFS/Southern Ocean expedition, international cooperation has been started to exchange data and model information in order to make model validation possible. In a workshop in Cambridge (British Antarctic Survey) preparations have been made for an intercalibration of ecological models to be used in the Southern Ocean. Cooperation takes place with Alfred Wegener Institute (Bremerhaven), C. Lancelot (G.M.M.A. Univ. Libre Bruxelles), and U. Cederlöf (Univ. Gothenburg).

H2-10 INTEGRATED NORTH SEA PROJECT INP, PHYSICAL PART

C. Veth, H. Ridderinkhof, S. Ober

From 1 July to 9 October a multidisciplinary mooring in the framework of the INP was deployed in the Oyster Ground area of the North Sea (near 54°25' north, 4° east). Simultaneous measurements of the physical structure of the water column and chlorophyll concentrations were carried out with moored instruments such as current meters, thermistor strings, fluorometers and transmissometers. During the deployment and retrieval of the mooring with RV Pelagia, the fluorometers were calibrated against measurements from water samples and CTD-measurements. The mooring was serviced a number of times with RV Holland (Rijkswaterstaat). A preliminary analysis of the data shows variations of the chlorophyll concentration with the tidal cycle, probably caused by tidal motion in a chlorophyll gradient and by variation of the chlorophyll concentration with tidal variations in the structure of the water column.

Simultaneous measurements were also performed with sediment traps: One trap just below the thermocouple and another at a few metres from the bottom. Cooperation takes place with D. Mills (School of Ocean Sc. Univ. of North Wales), S. Floderus (Phys. Oc. Dept. Univ. of Uppsala) and several departments of Rijkswaterstaat.

H2-12 OPTICAL OCEANOGRAPHY AND REMOTE SENSING

G. Marees, M.R. Wernand

A new series of satellites dedicated to measuring the ocean colour is expected to be launched in the mid-nineties. Therefore it is of great importance better to understand the relationships between the radiance received at satellite sensor height, the upward radiance at sea level and the phytoplankton and sediment content of the sea.

By simulating the spectral bands of several satellites with an underwater irradiance meter, correlations were made between the signals of these bands and the water quality, *i.e.* the organic and inorganic materials in the seawater.

These semi-empirical relationships or so-called algorithms may change with

the seasons and therefore continuous tuning of these algorithms should be performed. A report was finished in which relationships applicable for coastal waters are presented for several satellite sensors (historical, present and future). Special attention was paid to the NASA supported SeaWIFS (Sea viewing Wide-Field-of-viewSensor) satellite instrument with its 8 spectral bands. This ocean colour remote sensing device will be launched at the end of 1993.

This research was carried out within the National Remote Sensing Programme (NRSP) and partly financed by the Netherlands Remote Sensing Board (BCRS).

To measure inherent optical properties a 22-channel optical transmissometer was built. Tests and calibrations were carried out.

Participation in the FLUXMANCHE project was established in cooperation with the oceanographic department of the University of Southampton. Investigations of the coastal boundary currents between Boulogne and Cap Griz-Nez, and the cross Channel variability of water quality from Cap Griz-Nez to Dover took place within this French-English programme, using spectral radiometric instruments. In April a field campaign was performed southwest of the Cap Griz-Nez area with a NERC research aircraft. Numerous ship overflights were made with our non-imaging multi-channel Coastal Remote Sensing Airborne Radiometer (CORSAIR) and seatruth was simultaneously sampled from RV Challenger.

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 (H3-05), Late-Quaternary and Recent sedimentary processes in the Skagerrak-Norwegian Channel (H3-07) and the adjacent sea areas of the Faeroe-Shetland Channel (H3-08).

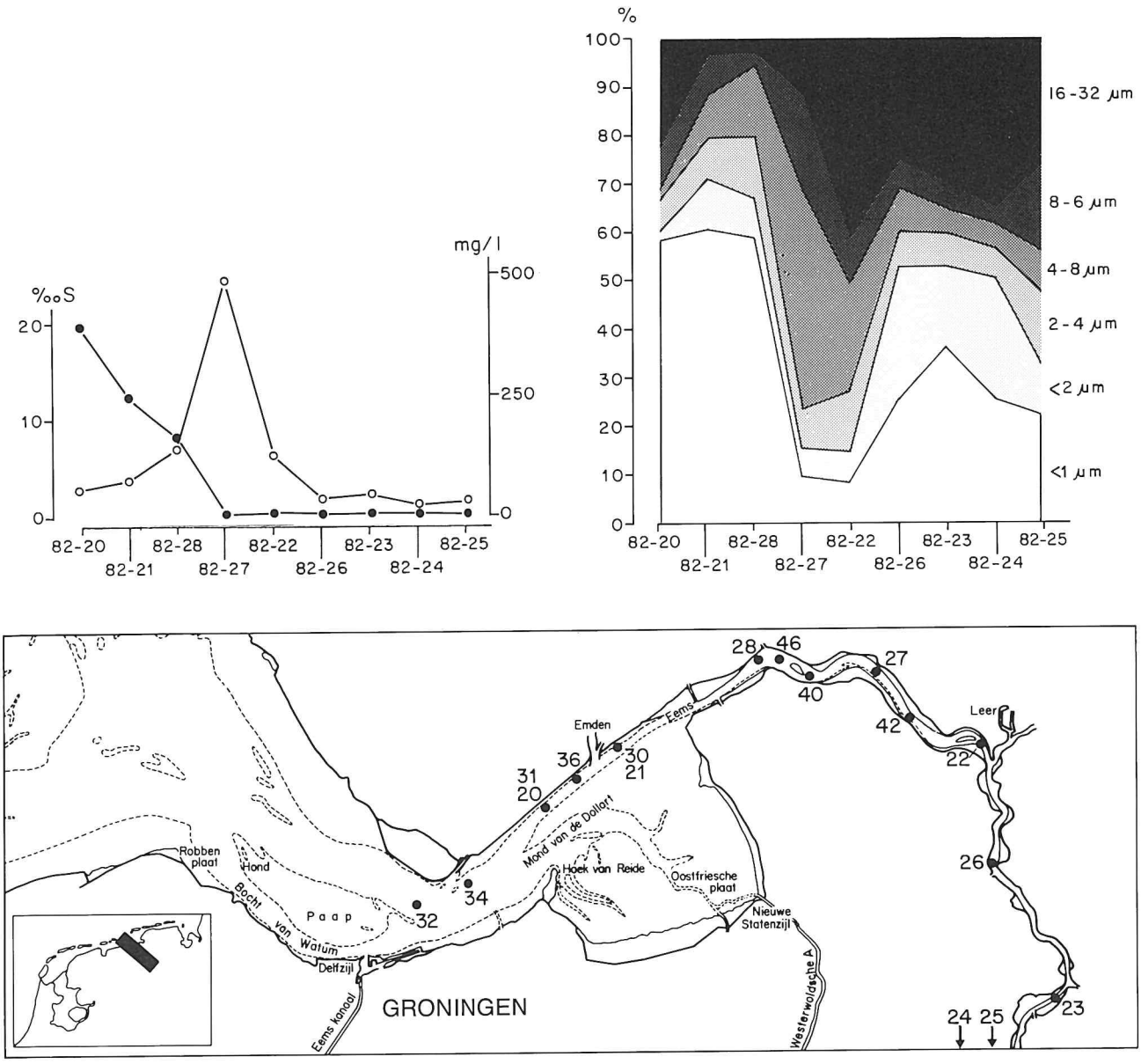
In Indonesia seismic and sedimentary studies were made in the Lombok and Savu basins (H3-10). In the Angola Basin palaeoceanography in relation to terrestrial climate is studied in a series of piston cores collected in 1989 (H3-13). Research in the Lena river mouth and the Laptev Sea was related to supply 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 (H3-14), while silica and nutrients were used to trace water masses in the Antarctic (H3-15). Tritium was used for this purpose in the eastern Atlantic (H3-16). 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 (H3-19). 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

Measurements were made with the *in situ* suspension camera in the Ems river estuary and at a number of tidal stations in the Dollard. This made it possible to study the finer *in situ* particle sizes, which had previously been impossible. In the Ems river estuary samples were also collected for determining the concentration of carbohydrates, fulvic acids and humic acids (by G. Fengler, Hamburg). In the Gironde (France) and in several canyons in the western Mediterranean and in the Bay of Biscay *in situ* suspended matter measurements were carried out. Because of bad weather conditions only a small part of the programme was completed. In June *in situ* suspended matter size and Coulter counter measurements were carried out in the Elbe river mouth as part of a research programme on the suspended matter behaviour in the Elbe river estuary. This is a joint programme of the University of Hamburg, the GKSS, Geesthacht and NIOZ. S. Chen worked out these measurements for a Ph.D. thesis.



Salinity (●), suspended matter concentrations (○; in $mg \cdot dm^{-3}$) and pipette particle sizes in the Ems estuary in November-December. The location of the sampling stations is indicated.

H3-02.1 SUSPENDED SEDIMENT ACCUMULATION IN THE DOLLARD

D. Eisma

For flocculation studies, a series of measurements was made in the Ems-Dollard in January (see H3-01). For 1992-1993 and subsequent years further research is planned on transport, deposition and resuspension under the combined influence of tidal currents and waves, which can be combined with the programme on suspended matter modelling carried out in this area by Rijkswaterstaat (Tidal Waters Division).

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

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

In April-May D. Eisma visited several institutes in Shanghai, Hangzhou and Nanjing that are investigating sediment transport along the Chinese coast, to discuss a programme for 1992. This programme will include studying suspended matter *in situ* as well as deposition and preservation of organic matter on a tidal flat on Chungmin Island in the Chang Jiang river mouth. The programme has been submitted to the China Commission of the Royal Netherlands Academy of Arts and Sciences for funding.

The research plans on the Wenzhou coast, initially projected for 1990, were now carried out during a two-week field campaign in May 1991. Surface sediments were collected along transects perpendicular to the coast in the tidal flat areas south of the city of Wenzhou. The samples will be studied during the forthcoming visit of the Chinese counterparts from the Second Institute of Oceanography, Hanghzhou.

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

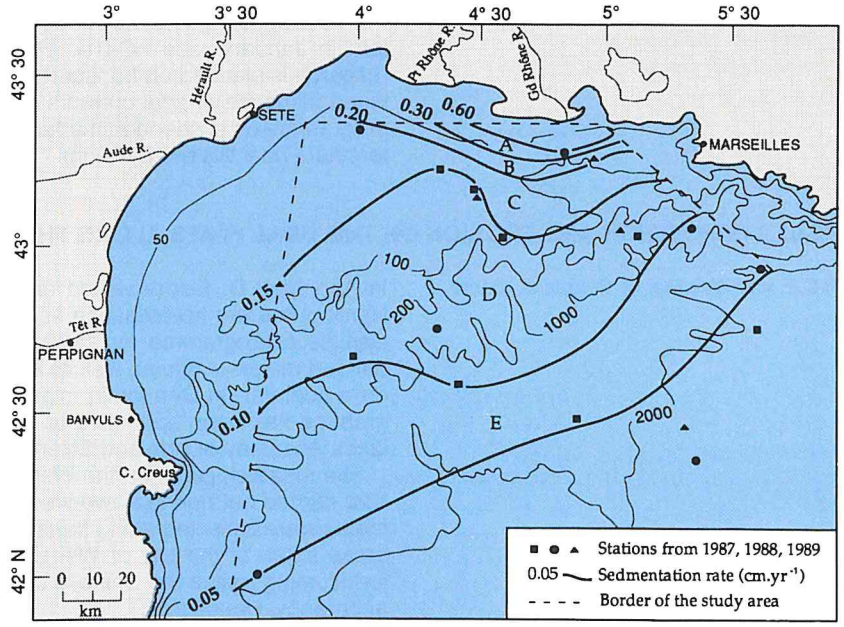
D. Eisma, Z. Zuo, G.W. Berger

Samples of suspended matter and water collected in the southern North Sea as well as the last series of rainwater samples were analysed for ^{210}Pb and ^{210}Po. For the bottom cores models were made to explain the ^{210}Pb curves including diffusion and resuspension as well as layering caused by burrowing organisms. For most of the mud in the deposition areas (Oyster Grounds, Outer Silver Pit) the ^{210}Pb profiles can be explained by reworking and resuspension, but those in the deposition area in the eastern part of the Oyster Ground (at the Frisian Front) cannot be explained in this way: here deposition is taking place, as was found earlier.

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

D. Eisma

Additional sediment cores from the Ebro river mouth area were analysed for ^{210}Pb and ^{137}Cs: these data have been worked out and the results presented at the EROS-2000 meeting in October in Texel. Samples from a number of cores from the NW Mediterranean were sent to the Dept. for Chemistry at Antwerpen University for analysis with automated microprobe. The results of the analyses (carried out by D. Wegrzynek) show a strong influx of sediment from the Rhône river and of biogenic carbonate, as was also clear from observation by the scanning electron microscope. Input of dust from the Sahara was hardly found, although such dust has a composition that differs significantly from that of the other sources. The dust analyses were done on three samples from dust traps on Corsica (obtained from G. Bergametti, Paris). Additional dust samples will be analysed.



Spatial distribution of accumulation rates ($cm \cdot yr^{-1}$) in Gulf of Lions.

H3-05 FORMATION OF SHORE-FACE CONNECTED SAND RIDGES OFF THE DUTCH COAST

Tj.C.E. van Weering

The study of the shore-face connected ridges was this year supported by interpretations of shallow seismic profiles obtained by IFREMER. The profiles clearly depict a number of probably meandering channels and filled river valleys that directly underlie the near-coastal offshore sand ridges. Oriented box-cores are being studied by Van der Meene (Dept. of Physical Geography, RUU) to establish the relationships between persistent wind, wave and current data with extant sedimentary structures and sedimentary characteristics.

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

Box-core samples collected in the eastern Skagerrak during 1990 were sub-sampled to measure sedimentation rates by means of ^{210}Pb and ^{137}Cs isotope determinations. The results confirm the earlier interpretation of sedimentation patterns in the Skagerrak, indicating that highest sedimentation (up to 44 cm/100 yr) occurs in the eastern Skagerrak. There is a marked difference in sedimentation rate between the Skagerrak and the Norwegian Channel; based on a limited number of samples, it appears that highest rates there are 10 cm/100 yr.

The transmissometer profiles of the water column measured during the 1988 and 1990 cruises with RV Aurelia show that in the eastern Skagerrak local reworking of bottom sediments results in redistribution and transport of silt-sized sediments to the deeper basin. Bottom nepheloid layers in the deep Skagerrak are either absent or at most up to 30 m, whereas in the shallower

eastern Skagerrak these are up to 80 m near the bottom and indicate an increase in turbidity of 35-50% compared with midwater minimum values. Rose-bengal-stained subsamples of box-cores were studied for comparison of living and dead foraminiferal assemblages. These data were compared with historical data of Petterson and possibly indicate eutrophication of parts of the Skagerrak.

Rare Earth Element (REE) distribution studies of the box-core samples show that LREE, MREE and K, Sc, Cr, Fe, Co, Rb, Cs, Ta and Th are 3-5 times enriched in clays compared with silts and sands, and that HREE is only 2 times enriched. Shale-normalized REE patterns provide evidence of extensive fractionation due to sediment sorting.

Initial results of the bottom lander for long-term sediment dynamic studies, which was lowered for test purposes in the Skagerrak at 315 m depth, show that (measured at 1 m from the bottom) short-period reversals in current direction and velocity changes coincide with periods of lower temperatures and increased transmission (measurements were done over a period of 118 hrs). In order to expand the data base for sediment budget studies a small number of box-cores and a few piston-cores were collected in the Norwegian Channel area north of Bergen. The piston-cores will also be used for palaeoclimatological studies in cooperation with the Dept. of Earth Sciences, Free University Amsterdam. Cooperation also takes place with Denmark's Geological Survey, Copenhagen, and the University of Göteborg.

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

Tj.C.E. van Weering

Results of the preliminary oxygen isotope analysis of core NA 87-25 from Feni Ridge were, in combination with an interpretation of penetrating echosounder profiles, summarized in a publication. Partially on the basis of this publication an ODP drilling proposal was formulated in cooperation with Lamont Doherty Geological Survey (LDGO) and Woods Hole Oceanographic Institution (WHOI).

In cooperation with L. Labeyrie, Lab. Faibles Radioactiv., Gif sur Yvette, France, a detailed oxygen isotope curve was established for core NA 87-22. Initial results show that this core reflects the highest sedimentation rates measured so far in NE Atlantic Ocean cores for the period 30000 Bp, thus enabling precise dating of glacial retreat and onset of effects of Norwegian Sea Deep Water Overflow into the Atlantic on sedimentation. Detailed subsampling of this core has been done for AMS dating. These studies are still in progress. Additional subsampling is also being carried out for Cd/Ca ratio determinations in cooperation with E. Boyle, Massachusetts Institute of Technology (MIT).

During a cruise with RV Pelagia in cooperation with Denmark's Geological Survey (DGS), high resolution seismic profiles of the eastern continental slope of the Faeroe Islands were recorded, simultaneously with multichannel recording by the DGS/University of Aarhus, Denmark. The profiles show a strong influence of the Norwegian Sea Deep Water current on sedimentation and shaping of the continental slope. A preliminary interpretation of the profiles indicates distinct erosion of part of the midslope section directly underneath the NSDW current axis. In addition this may have stimulated large-scale gravitational sliding. Some software problems were encountered during the testing of the benthic lander (see H3-07) which will be dealt with before the start of the Indian Ocean Expedition in 1993. The instrument recorded various parameters for a maximum of 138 hrs. A last test is scheduled for early spring.

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

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

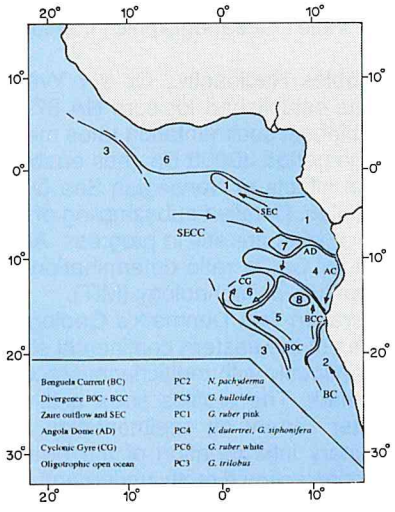
During 1991 a tectonic facies and a structural map were prepared of the Lombok and Savu forearc basins and adjacent areas, on the basis of re-interpretation of the Snellius II seismic lines and multichannel (Industrial) data. These results were combined with a number of interpretations derived from the Sumba 1989 and 1990 fieldwork.

Financial support of SOZ enabled W. van der Werff to pass a 6-month stage period in Bandung, to cooperate with MGI and especially with Hardi Prasetyo. In this period available seismic profiles were studied and a comparison of an oblique subduction system *versus* a normal system was made. In relation to the seismic stratigraphic position of Sumba, an analysis of the back-arc structure was made of the Bali and Flores basins, based on data provided by Hardi Prasetyo.

Selected core samples of the piston-cores collected during Snellius II were studied for their mineralogical content and for the distribution of ashes and turbidites, yielding a preliminary basin-wide correlation. Samples selected for REE studies to allow comparison with the Savu and other basin sediments of eastern Indonesia were sent to the Reactor Institute in Delft (IRI). Cooperation takes place with the Marine Geological Institute (MGI), Bandung; LIPI, Bandung; Free University, Amsterdam.

H3-13 PALAEOCEANOGRAPHY AND TERRESTRIAL CLIMATE

J.H.F. Jansen, E. Ufkes



The piston-cores taken during the expedition to the Angola Basin in late 1989 have been opened and described in the course of the last two years. Three frozen cores were cut with a diamond-saw at the Soil Survey Institute, Winand Staring Centre in Wageningen. The cores were scanned with the X-ray fluorescence (XRF) core scanner. This method produces Ca-intensity values which allow us to apply a provisional carbonate stratigraphy for all cores.

We started a close cooperation with colleagues at the Department of Earth Sciences of the University of Bremen, who are carrying out related programmes in the Angola and Cape Basins.

Counts of planktonic foraminifera collected from the surface water in the southeast Atlantic Ocean during October, November 1989 were subjected to principal component analyses. This yielded 8 principal components which reflect the hydrographical features of the region. The key areas of the 7th (*Globigerinella siphonifera* and *Neogloboquadrina dutertrei*) and the 8th (*Globorotalia inflata*) principal component were not related to major hydrographical features.

During the cruise physical and chemical parameters were measured. The relation between the principal components (PC) and the physical parameters was weak. Temperature-extreme species such as *Globigerinoides ruber* pink and *Neogloboquadrina pachyderma* correlate significantly with temperature (*G. ruber* positive and *N. pachyderma* negative). *G. ruber* pink is related to lowered salinities, whereas *Globigerinoides trilobus* prefers higher salinities, as found in the open ocean.

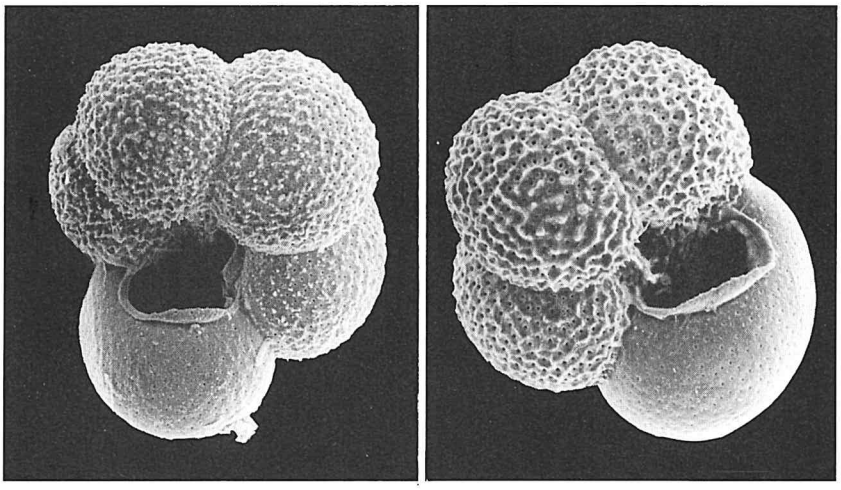
A few significant relations have been found between the principal components and the nutrients, NO_3, PO_4 and SiO_4. *N. pachyderma* (PC2) is highly related to NO_3 and PO_4. PC5 (*Globigerina bulloides*) and PC8 (*G. inflata*) are more restricted in relation to NO_3, whereas the factor loadings of PC1, *G. ruber* pink, increases concurrent with an increase in SiO_4 content.

Fertility can be expressed in a *Neogloboquadrina-Globigerinoides* (NG) ratio, a ratio of eutrophic *vs.* oligotrophic species. High NG-ratios have been found in regions with a high fertility and/or a shallow thermocline, containing a relatively small amount of oligotrophic species.

It is generally accepted that changes in coiling direction of *N. pachyderma* are generated by temperature and thus can be used as a palaeotemperature indicator. However, the difference in distribution of sinistrally and dextrally coiling *N. pachyderma* in Walvis Bay, off Namibia, South Atlantic, cannot be attributed to temperature differences alone. Here the change in coiling direction seems to be largely evoked by variations in phosphate content. The sinistrally coiled *N. pachyderma* at Walvis Bay is linked to maximum phosphate contents. The presence of these (sub)polar morphotypes of *N. pachyderma* at low latitudes can be explained by supply from elsewhere. Transport of South Atlantic Central Water into the area provides cool and nutrient-rich water, the habitat of N. pachyderma. Dependent on temperature and phosphate levels, a dextrally or a sinistrally coiling standing stock is evoked.

High numbers of benthic foraminifera are also found in the surface waters, mainly off the Zaire river in a south-southwest ward direction and off the coast at 20°S. The benthic foraminifera (up to 10%) are probably transported from the continental shelf into the area by upwelling and distributed by the southward deflecting branches of the South Equatorial Counter Current and the Benguela Current in the southern part.

There are distinct differences between the fauna assemblages of the core tops and the surface water samples. This can be attributed to the fact that the water samples were taken during spring, while the core tops represent the average environment over a number of years.



Left: Sinistrally coiling *Neogloboquadrina pachyderma.*

Right: Dextrally coiling *Neogloboquadrina pachyderma.*

H3-14 ACCUMULATION, DISSOLUTION, PRESERVATION AND TRANSFORMATION OF BIOGENIC OPAL RELATED TO THE PRESENCE OF ALUMINIUM

A.J. van Bennekom, S.J van der Gaast, J. van Iperen

As established in cultures, concentrations of <0.1% Al in biogenic silica markedly influence solubility and dissolution rate. Determination of these low amounts of Al was improved by application of wavelength dispersive microprobe techniques, available at Wageningen University. A surprising result was

that diatoms from the edge of the Zaire river plume (collected in 1989) had less Al than diatoms from outside this plume. This was contrary to qualitative suggestions obtained earlier with the less sensitive energy dispersive microprobe technique (available at NIOZ). Interesting was also that a fragment of *Ethmodiscus rex* (a diatom species known for its low dissolution rate) had a relatively high Al concentration of about 0.5%.

Silica uptake measured with ^{32}Si

At the height of the diatom spring bloom in the Marsdiep (end of March) a pilot study was carried out. At ambient concentrations of 0.5 $\mu mol \cdot dm^{-3}$ H_4SiO_4 the diatom populations actively took up silica, both in the dark and in the light. No uptake was measured after the addition of formalin, proving that exchange does not interfere. Preliminary results show the high sensitivity of the ^{32}Si technique; they also show that high specific activity is needed, but not always crucial. This project is carried out in cooperation with L. Lindner (RUU) and J. Hegeman (B3).

H3-15 THE SILICA CYCLE

The cycles of silica and aluminium in the Southern Ocean

A.J. van Bennekom

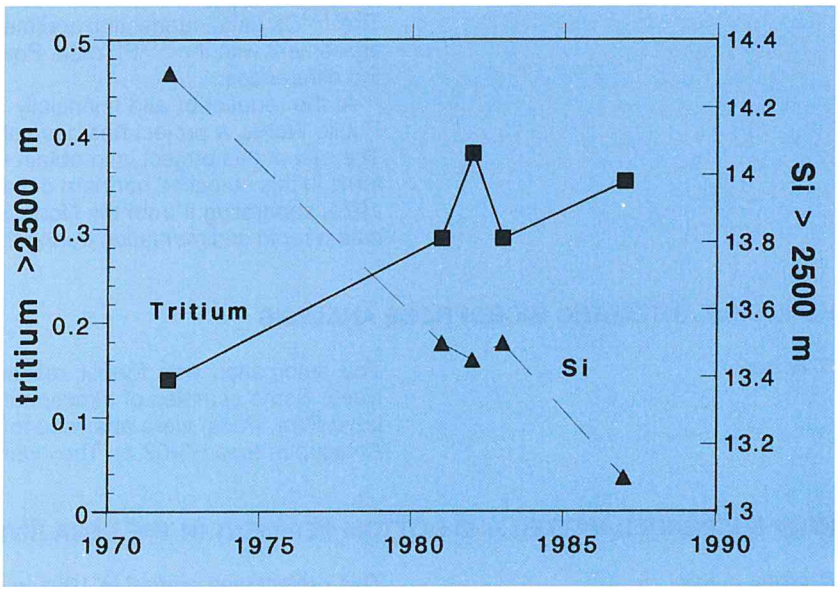
During the expedition to King George Island A. Sandee (DIHO) analysed water samples for silicic acid (H_4SiO_4). Meltwater from glaciers had 8-16 $\mu mo\ dm^{-3}$; small streams 47-50 $\mu mol \cdot dm^{-3}$, probably enhanced by contact with volcanic soils (warm water at Deception Island had up to 2100 $\mu mol\ dm^{-3}$!!). On King George Island H_4SiO_4 in streams was always lower than the 73-75 $\mu mol \cdot dm^{-3}$ found in the centre of Admiralty Bay. Streams and meltwater decreased the H_4SiO_4 concentration of sea water in the vicinity of their outlets, also when they were very turbid and the concentrations did not change upon storage. It is concluded that glacial weathering does not contribute to the high H_4SiO_4 concentrations in Antarctic surface water.

Intercalibration of nutrient data and extensive recalculations —together with the other EPOS participants— improved the comparison between EPOS legs 1 and 2. The use of nutrients as quantitative water-mass tracers met with some problems; apparently the parameters used as tracers (salinity, temperature, H_4SiO_4 and oxygen) are not sufficiently constant in the various contributing water masses. Qualitatively, the combination of these parameters was used to unravel the complicated mixing pattern in the Weddell-Scotia Confluence.

H3-16 DEEP-WATER MASSES IN THE EASTERN ATLANTIC

A.J. van Bennekom

Tritium concentrations in samples from the deep Norwegian Basin (taken in 1987) became available (RUG, Isotope Lab.). Combination with earlier data showed a regular increase of Tritium since 1972, concomitant with a decrease in H_4SiO_4. This points to an increase in the flushing rate of these waters and contrasts with a decrease in the flushing rate in the deep Greenland Basin since the early 80s. However, it may also mean a change in the composition of the inflowing waters. This project is carried out in cooperation with W. Helder (H1).



Time series of the concentration of Tritium (in T.U., ratio T/H*10^{18}) and Silicic Acid (in mmol m^{-3}(in bottom waters (>2500 m depth) of the Southern Norwegian Basin. Data sources: 1972 GEOSECS Expedition; 1981 TTO/NAS Expedition; 1982 METEOR cruise 61; 1983 and 1987 TYRO Expeditions, for which Tritium measurements were carried out by the Centre for Isotope Physics, Groningen University.

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

S.J. van der Gaast

X-ray diffraction studies of natural samples of ferrihydrite, which is a mineral that occurs abundantly in sediments and soils, indicate that crystalline domains are present within the ferrihydrite primary particles. The average diameter of the primary particles, determined from low-angle X-ray diffraction patterns, decreased from 4.1 to 2.5 nm, as the Si content increased from 4.1 to 6.1%. The main size, determined by applying the Scherrer equation to the broad (110) peak at 0.26-0.27 nm, also decreased, from 1.0 to 0.77 nm, as Si increased. For one sample of ferrihydrite, the smallest possible domain contained 36 oxygen atoms and 3 Si atoms. Si binds to and bridges the surface of the domains. The amount of silicate is probably a factor controlling domain size and particle size. Indications are found that P is absorbed in the same way as Si in ferrihydrite. This research is carried out in cooperation with R.L. Parfitt and C.W. Childs of the Dept. of Scientific and Industrial Research (DSIR) Land Resources, New Zealand.

H3-19 RADIONUCLIDES

G.W. Berger

^{210}Po, ^{210}Pb and ^{226}Ra analyses have been carried out on samples taken in the Western Scheldt as part of the EG project 'Behaviour of ^{210}Po and ^{210}Pb in European marine environments'. The average ^{210}Pb concentration in suspended matter is around 150 Bq·kg^{-1}, which is higher than found in the North Sea in previous studies. Sources are probably ore-processing plants along the Scheldt estuary.

Analyses of ^{210}Pb and ^{137}Cs in the framework of a project in the Eastern Scheldt (financially supported by the Ministry of Transport and Public Works) has been completed. The purpose of this project was to date three sediment

cores. ^{210}Pb profiles indicate sedimentation rates of 0.6, 0.6 and 1.8 $cm \cdot a^{-1}$. The ^{137}Cs data, suggesting sedimentation rates of around 5 $cm \cdot a^{-1}$, are not in agreement with the ^{210}Pb data. Post-depositional mobility of ^{137}Cs can explain the differences.

At the request of and financially supported by the Ministry of Transport and Public Works, a project has been started in the Haringvliet and Hollands Diep. The aim of this project is to obtain insight into the changed sedimentation patterns in this so-called northern delta basin after the closure of the Haringvliet in 1970, separating it from the North Sea. The first ^{210}Pb and ^{137}Cs profiles indicate a rapid sedimentation during the last decades (up to 50 $cm \cdot a^{-1}$).

H3-20 SEMI-AUTOMATIC MICROPROBE ANALYSIS

D. Eisma

The automation was further refined and more mineral standards were analysed. Some samples of atmospheric dust from the Sahara (obtained from M. Loye-Pilot, Paris) were analysed to compare the results with those obtained at Antwerpen (see H3-02.4). They were found to consist mainly of illite.

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

D. Eisma, J. Kalf

This project was started in 1991 in collaboration with the Shirshow Institute of Oceanology (Moscow) and the Institut de Biogéochimie Marine (Montrouge). In August/September, samples were collected in the Lena river mouth and the Laptev Sea (suspended matter and bottom core samples). These are being analysed for total concentration of suspended matter, organic content and composition by SEM/Microprobe. The cores will be analysed for ^{210}Pb and fall-out isotopes to estimate the deposition rate.

H3-22 BLACK SEA MUD DIAPIRISM

Tj.C.E. van Weering

In cooperation with Moscow State University, during July an international cruise was held on board RV Gelendzik in the USSR sector of the Black Sea and in the Mediterranean Sea. During the cruise box-core samples were collected extending from the NW Black Sea shelf edge to the central Black Sea Basin. These will be used to trace the distribution of radionuclides from the shelf to the deep basin, and establish its relationship to sediment transport patterns. Seismic profiles (sparker) were obtained across a series of mud volcanoes. The mud volcanoes appear related to the release of gas derived from the deeper underground rather than to compression due to tectonic conditions south of the Crimean peninsula. The seismic section is being studied and will be used to obtain a better interpretation of the profiles collected in the Indonesian region (see H3-10).

1.5. BENTHIC SYSTEMS (B1)

INTRODUCTION

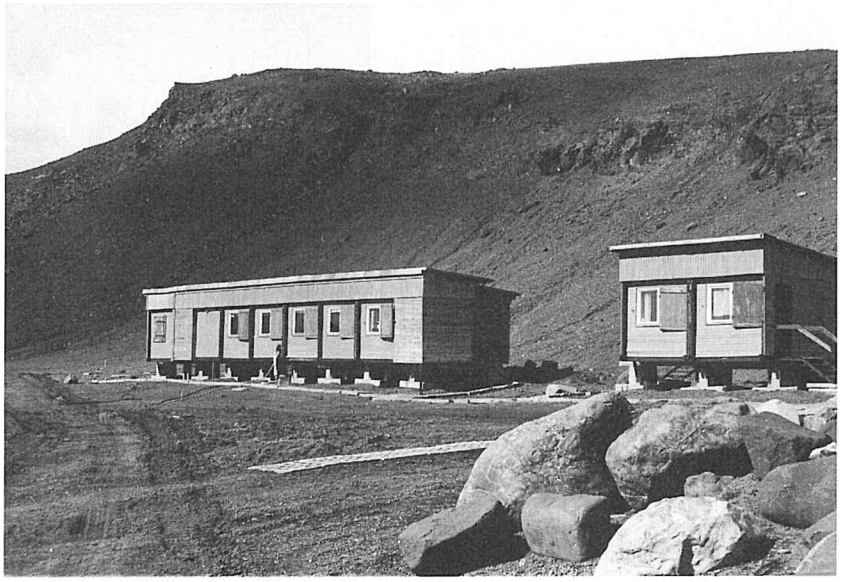
The Benthic Systems Department continued its research activities focused on the structure and functioning of marine benthic ecosystems.

Participation in a sea-going expedition (EROS-2000), laboratory and field studies in such diverse environments as the Southern Ocean and the Caribbean Sea and mesocosm studies in Texel, all formed part of our efforts.

In the period December 1990 -February 1991 Vosjan, Pauptit and Nieuwland stayed at the Arctowski Polar Station in King George Island (Antarctica)(B1-02), whereas in January and June Bak visited Carmabi (Netherlands Antilles) and Invemar (Colombia) (B1-05). De Wilde accepted a part-time professorship in Marine Ecology at the State University of Groningen (The Netherlands). Cramer (B1-11) obtained her Ph.D. and left our group; De Hey and Tahey as Ph.D. students now fill two new vacancies shared by the NIOZ Departments Benthic Systems and Chemical Oceanography. Jenness from David and Elkins College, West Virginia (USA) expressed his wish to spend part of his sabbatical in our Department, where he is involved in the development of techniques to measure RNA/DNA ratios in macrofauna organisms.

Considerable time and effort was devoted to the completion of the free-falling benthic lander, especially as to the realization of new types of sediment grabs, water samplers for the sampling of the contents of the bell jars and robust pressure-proof oxygen electrodes (B1-04).

With the major results of the Mauritania I expedition, May 1988, and the ICES sea-going workshop, March 1990, laid down in 4 papers (in press) and 1 paper (in press) respectively, the projects B1-07, B1-08 and B1-12 were completed. Project B1-13, higher trophic levels (see also S-01d), remains dormant as for the contribution of our Department



The summer lab of Arctowski station

B1-01 BENTHIC MESOCOSMS (see also S)

Marine benthic mesocosms

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

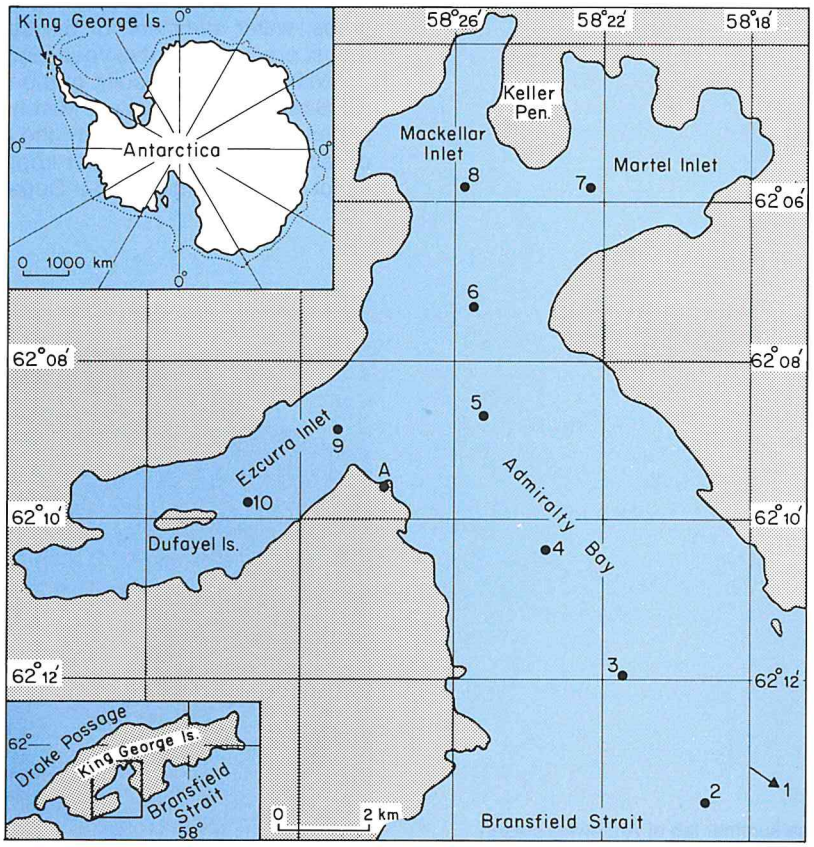
This year the Benthic Department was only indirectly involved in research in the North Sea mesocosms; BEWON and TNO Den Helder took the lead in this. For growth experiments in the bivalve *Arctica islandica* in mesocosms see B1-10 and for eutrophication experiments (BEST) in outdoor mesocosms B1-04.

Funded by EC/MAST Hans de Hey as a Ph.D. student was contracted for a 2-year period to participate in benthic eutrophication studies (BEST) aimed at understanding algal blooms in Venice Lagoon, Italy. A major part of the work will be carried out in the outdoor mesocosms in Texel; conjunctional fieldwork also in Venice Lagoon. This research project is also under the auspices of the NIOZ Department Chemical Oceanography. Cooperation occurs with TNO Den Helder, IBN Texel and the University of Venice.

B1-02 MICROBIAL BIOMASS AND ACTIVITY IN MARINE ECOSYSTEMS

J.H. Vosjan

During the Dutch Antarctic expedition to the Polish Polar Station 'Arctowski' the ETS-activity and the effect of temperature on respiratory activity of microorganisms from Admiralty Bay, King George Island, and Bransfield Strait, Antarctica, have been studied.



Position of the sampling stations in Admiralty Bay (King George Island, South Shetlands, Antarctica). A is Arctowski Station, where the coastal samples were taken.

Lower bacterial numbers, ATP and ETS-activities and turbidity were found in Admiralty Bay than in Bransfield Strait. This can be explained by an earlier start of primary production in the Strait. At some stations in the Bay, high turbidity was caused by suspended matter from the land. In Admiralty Bay the activity and biomass increased from December to January, while the opposite occurred in Bransfield Strait.

A temperature optimum in respiratory activity occurred between 20 and 25°C, and from the Arrhenius curve an activation energy was calculated of 75 KJ mol^{-1}. This means a strong response of microorganisms to small temperature changes.

In the warm marine crater lake of Deception Island (Antarctica) higher numbers of bacteria were counted than in the colder waters. This may be due to a higher organic matter input from primary production, related to a longer ice-free season.

The penetration of light (Photosynthetically Active Radiation (PAR), UV-A and UV-B) has been studied, because lowering of the ozone concentration in the stratosphere will cause an increase in UV-B irradiation on the earth surface and this will influence the ecosystems. In the Dutch Wadden Sea with a high load of suspended matter and yellow substances the light penetration is much lower than in coastal regions of the Antarctic. In Admiralty Bay the 1% level of UV-B was found at 9.9 m (range for all stations 7-14 m), of UV-A at 16.9 m and of PAR at 20.3 m. For comparison, in the Marsdiep we measured penetration down to 95, 150 and 380 cm, respectively.

B1-03 BIOTURBATION

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

Coloured sediment grains are used as tracers for bioturbation activity by macrobenthic organisms. This improved methodology is now employed in experiments with the sea urchin *Echinocardium cordatum*. This study is carried out in cooperation with R. Daan (S-02c).

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

P.A.W.J. de Wilde, G.C.A. Duineveld, T.M. Tahey

Funded by EC/STEP Tom Tahey entered the NIOZ Departments Benthic systems and Chemical Oceanography to assist in the further development of lander technology and to contribute in lander deployments and benthic boundary research. As stipulated by EC, part of the research will be carried out in the Adriatic Sea in cooperation with the Italian counterparts (University of Bologna). Other research areas will include the Gulf of Lions (Mediterranean), the Somalia and Kenya Shelf and continental slope in the Indian Ocean (1992-1993).

From 19 November to 5 December 1991 the Department of Benthic Systems participated in the EROS-2000 expedition in the Western Mediterranean. Our contribution, in which benthic lander deployments, *in situ* bell jar techniques and shipboard incubations of intact sediment cores took a prominent place, was mainly the measurement of benthic community respiration and organic matter demand, assessment of benthic community structure and composition of sedimentary phytopigment.

B1-05 CORAL REEFS

R.P.M. Bak

The presence of stony corals (Scleractinia) is a *sine qua non* for the existence of coral reefs and our studies concentrated on, 1. key processes in the mainte-

nance of these clonal organisms: damage, regeneration and partial mortality in relation with environmental characteristics, 2. a key organism: ecological characteristics of morphotypes of the dominant reef-building coral *Montastrea annularis*, 3. long-term changes in the composition and structure of the coral community.

Regeneration efficiency and capacity was assessed for eight coral species in different habitats (different sedimentation regimes) along the coast of Curaçao to identify sediment sensitive species and the impact of sedimentation on partial mortality. To investigate the influence of damage and regeneration on reproduction, tissue samples of four species are being sampled and processed. The distribution of naturally occurring lesions on the living colony surfaces was surveyed on two different reef locations. Preliminary analysis shows great variation in the importance of partial mortality between species.

Bleaching, loss of symbiotic algae from the coral tissue, is a process generally related to global change in temperature/radiation. Regeneration efficiencies of bleached colonies of three species tested were seriously impaired. Frequently, a regenerating lesion would suddenly enlarge, which resulted in total death of the coral colony.

The three morphotypes of the key organism *Montastrea annularis* have been studied for potential differences in reproductive patterns, linear growth increment, regeneration rates and photopigments. Preliminary results show that all morphs released gametes in population mass spawnings a week after full moon in autumn. The columnar morphotype appears to differ from the massive and bumpy morphotypes in photopigment characteristics and in the final stages of the regeneration process. Surveys of abiotic factors along the coast of Curaçao, to relate to distributions of the organisms, are initiated.

Photographing permanent quadrats along the slopes of the reefs of Curaçao and Bonaire (depths 10-40 m) was continued and the data from 1973 to present are being analysed.

Water quality is a direct parameter of a major anthropogenic environmental change along tropical coasts: eutrophication. Our first data for six stations along the coast of Curaçao, from virgin reefs to sites down-current of human activity, showed nutrient levels from normal to slightly enhanced. There were indications that heterotrophic activity of pelagic micro-organisms increased along the coast. Bacterial densities were high for reefal habitats and increased along the coast. Heterotrophic nanoflagellate densities have not been assessed for reefs but in Curaçao appeared to occur in densities comparable with temperate coastal seas. These studies will be continued to obtain a more complete picture of microbial characteristics and to eventually investigate possible links with the benthic communities. This research is carried out together with E. Meesters, M. van Veghel, stationed at Carmabi, Curaçao, Netherlands Antilles.

B1-06 PROTOZOANS

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

Heterotrophic nanoflagellates (2-20 µm) occur in high densities in marine sediments (200-400 x $10^3 \cdot cm^{-3}$). We studied their role in the functioning and structure of benthic small food webbs by, 1. assessing fluctuations in densities in the field, 2. manipulating densities in experimental bottoms, 3. investigating the relationship between flagellates and their bacterial prey.

An extensive survey of North Sea localities showed densities in the surface of the sediments to vary enormously between stations. Highest numbers ever

recorded were encountered off Esbjerg, ~800 x $10^3 \cdot cm^{-3}$. This contrasts with values normally ranging from 50-200 x $10^3 \cdot cm^{-3}$ in sixteen other stations. A general trend is that densities are higher in sandy than in silty sediments.

In our experimental sandy bottoms flagellates kept normal densities in the controls (no extra carbon input). Densities increased sharply to a peak (500 percent increase) in reaction to carbon input. A continuous supply of extra carbon supported continuously high population levels. The presence of macrofauna in such experimental systems clearly influenced the structure of the small food web in terms of the rate of density fluctuations and in density levels maintained. In conjunction with carbon input bioturbation dramatically increased flagellate numbers in deeper layers in the sediment.

To assess the role of heterotrophic nanoflagellates as bacterivores it is necessary to obtain data on grazing rates besides the flagellate enumerations. Grazing on bacteria in the sediment was studied with Fluorescently Labelled Bacteria (FLB) as tracers. Two methodological aspects of the FLB technique were investigated in the laboratory: 1. the effects of mixing FLB through sediment samples on flagellate densities, on flagellate grazing rates and on percentage of the flagellate community ingesting FLB (% consumers), 2. the ingestion of FLB by two benthic flagellate species (cultured after isolation from marine sediments) at different ratios in amounts of FLB *versus in situ* bacteria.

No significant differences were observed between six methods/intensities of mixing on the parameters investigated (above 1.). The percentages of consumers varied from 13-18% in all grazing experiments. FLB are suspended bacteria and most *in situ* bacteria may be attached to particles. The hypothesis that low percentages of consumers are related to a preference of surface-associated flagellates for attached bacteria will be investigated. In the experiments with cultured flagellates, the organisms discriminated against FLB in the grazing. The size of prey (natural bacteria and FLB) is likely to be responsible here and will be investigated.

Analysis of fluctuations in communities of bacteria, nanoflagellates and ciliates through spring/early summer in Marsdiep water showed beautiful patterns of predator-prey interactions between the groups. This year, these fluctuations were studied in a cooperative effort to relate the fluctuations more clearly to a lower trophic level, bacterial production, and to the higher trophic levels of metazoan predation.

B1-09 GROWTH AND PRODUCTION

G.C.A. Duineveld

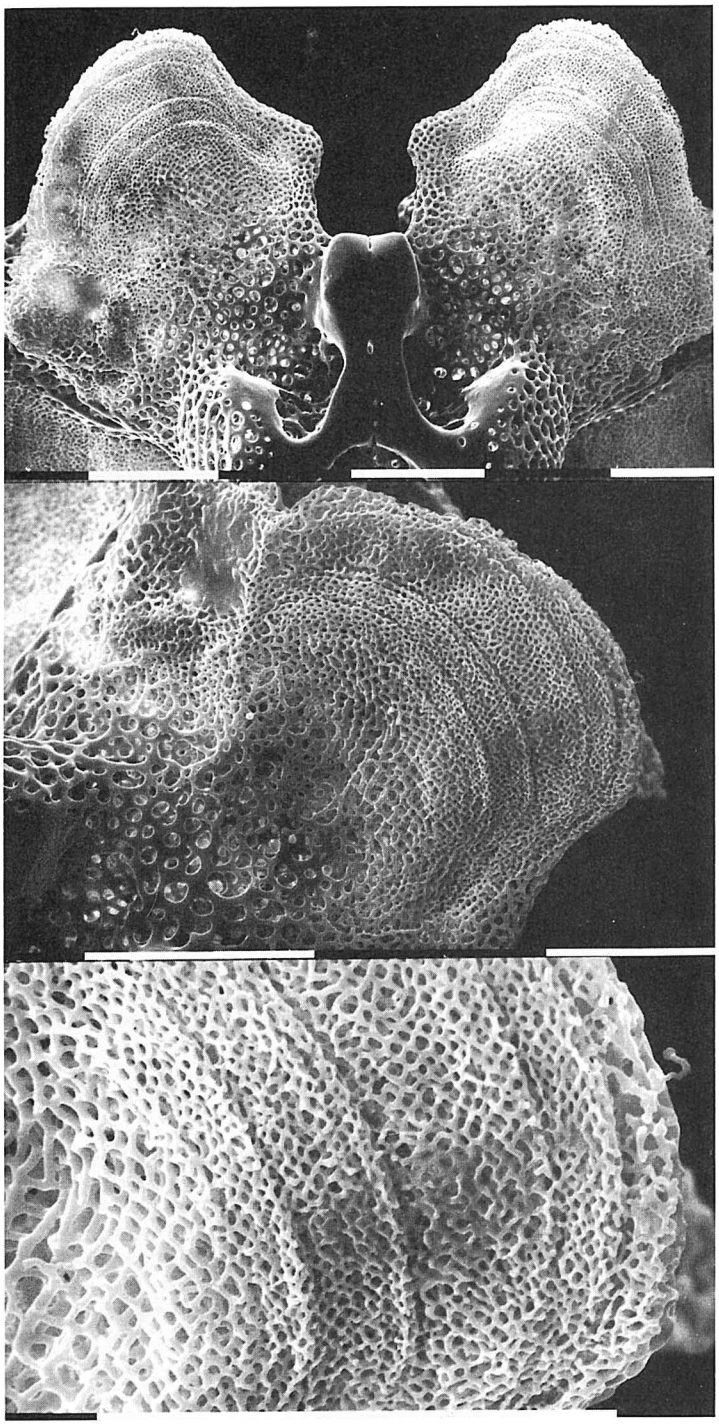
Fluorometric and spectrophotometric biochemical methods to determine the RNA/DNA ratio in tissues of marine organisms have recently been introduced and adopted as a measure for growth in selected key animals. So far the bivalve *Spisula* has been used as a test organism.

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

R. Witbaard, P.A.W.J. de Wilde, G.C.A. Duineveld, S. Holtmann, G. van Noort

Growth of *Arctica islandica* (Bivalvia) is studied to assess long-term changes in the subtidal North Sea. The first step to interpret such changes has been to evaluate natural growth differences.

Although the yearly periodicity of growth lines has been established for an American population, such a calibration for the North Sea was lacking. Checking the periodicity by means of oxygen and carbon isotopes has, however, corroborated the American work.



Annual growth rings in vertebral arm ossicles of the brittle-star *Amphiura filiformis* used to unravel the population structure. White bars: 0.1 mm.

Comparing growth of different localities shows that large variations exist. The yearly growth variations furthermore indicate that the processes affecting growth are on a smaller scale than expected.

Cooperative research with Uppsala University (Sweden) and Naturhistoriska Riksmuseet (Sweden) has been initiated to explore the chemical constitution of the growth increments.

A 3-year monitoring programme has been started in the North Sea, commissioned by the Tidal Waters Division of RWS. The main objective is a further assessment of the structure of the benthic community of the Dutch economic sector. In spite of the tedious sorting and identification work often involved in biological monitoring, we accepted this task because we are convinced it will provide more insight into the natural variations of macrobenthic stocks and hopefully also into underlying mechanisms. Complementary research in *in situ* installed mesocosms in selected key areas of the North Sea is considered.

For an extension of the MILZON-project (North Sea Directorate, RWS) our Department was contracted to work out and report on 78 macrobenthos samples collected in a wide zone north of the Frisian islands. For this work Mrs. Holtmann (T.H. Braunschweig, Germany) was appointed for a period of 1 year.

B1-13 HIGHER TROPHIC LEVELS

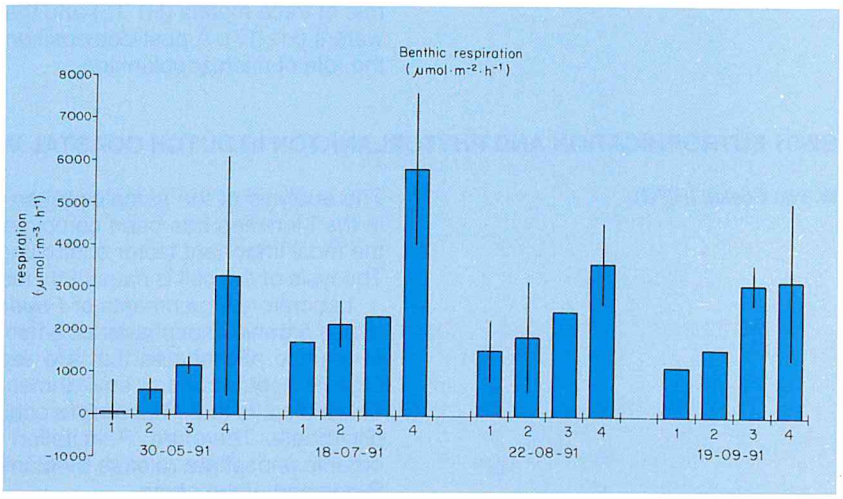
(See S-01d)

B1-14 BENTHIC EUTROPHICATION STUDIES - BEST

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

This cooperative research project, in which TNO/Den Helder, IBN (formerly RIN)/Texel, University of Venice/Italy and NIOZ participate, aims at the understanding of the responses of estuarine communities to eutrophication, comparing the Venice Lagoon and the Dutch Wadden Sea. The contribution of NIOZ in the project focuses on microbial and benthic respiration studies.

During the first year, mesocosm experiments were carried out in Texel and field studies in Italy; bell jars were used to study, 1. vertical oxygen profiles in the near-bottom water and sediment oxygen uptake; 2. vertical distribution of nutrients in the sediment and nutrient fluxes across the sediment-water interface.



Increase in benthic community respiration with increasing nutrient input.
I=no additions
II=25 µM nitrate+3,15 µM phosphate
III=50 µM nitrate+6.30 µM phosphate
IV=100 µM nitrate+12.60 µM phosphate

1.6. PELAGIC SYSTEMS (B2)

INTRODUCTION

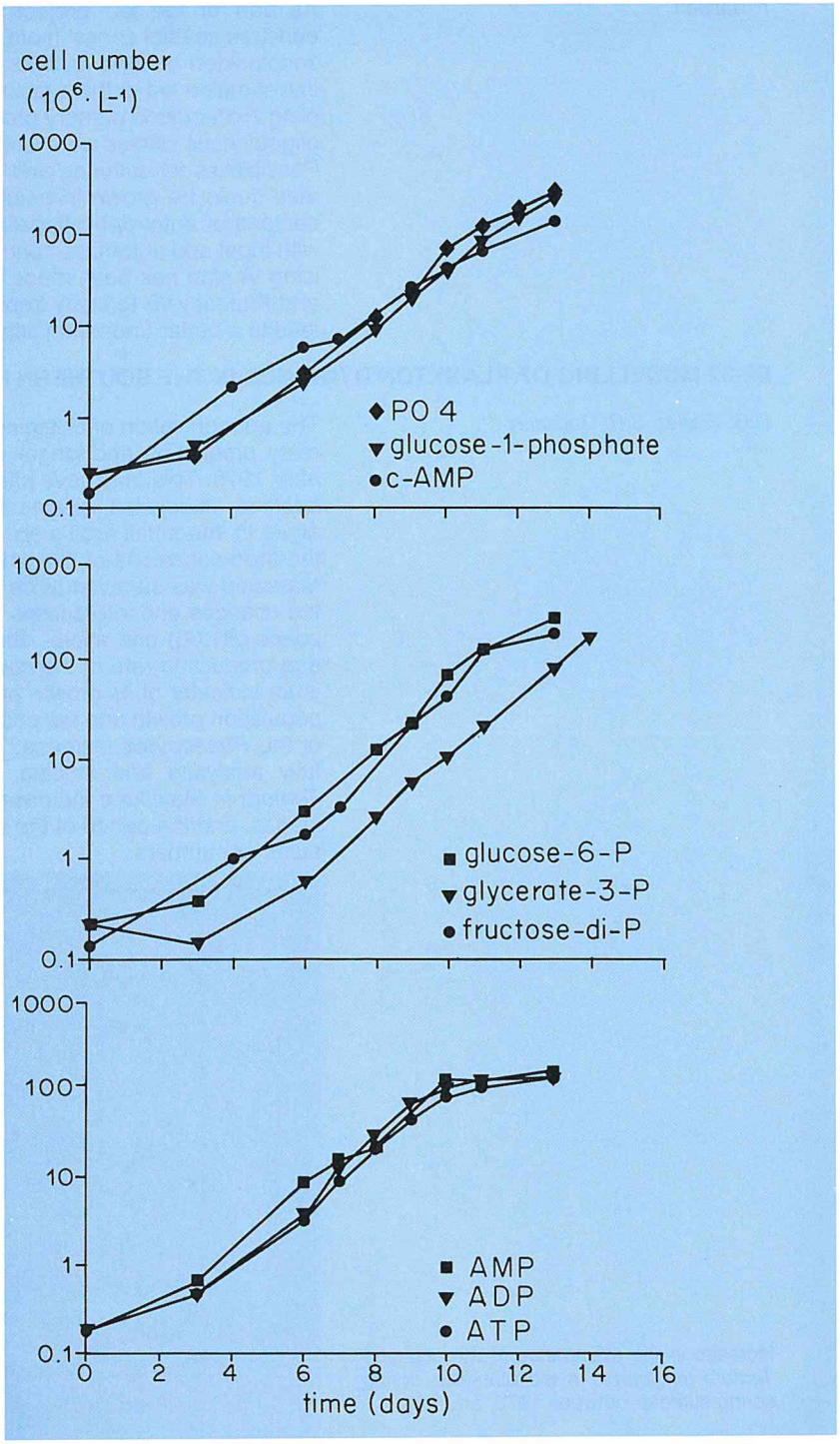
The Department of Pelagic Systems investigates the role of plankton in the productivity of the sea and the cycle of organic matter in the foodweb. This comprises a quantitative description of biomass, consumption, production and species composition at different trophic levels, in relation to physical 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 various experimental conditions. Special attention is directed to the phytoplankters *Phaeocystis* sp. (B2-01), *Emiliania huxleyi* (B2-13) and zooplanktonic 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, B2-02, B2-13). The projects B2-05 (Eastern Indonesian waters), B2-06 (Zooplankton in the coastal zone of Banc d'Arguin, Mauritania) and B2-12 (Ecophysiology of Antarctic phytoplankton) were completed, or are in the phase of final publication. A.G.J. Buma is expected to take her Ph.D. in March 1992. The project on the productivity of the deep chlorophyll maximum in the oligotrophic ocean was postponed by JGOFS cruises planned in the Indian and Southern Oceans in 1992/93. The analysis of zooplankton samples and data collected in 1989/90 during the JGOFS North Atlantic Pilot study (B2-04) and phytoplankton in the Zaire/Angola Basin (B2-07) was continued. Next year the involvement with the JGOFS programme will be continued by participation in the cruises to the Indian Ocean and Southern Ocean with RV Tyro and RV Polarstern. In cooperation with the Department of Chemical Oceanography special attention will be given to the role of trace metals (H1-15) and the mass balance of carbon in pelagic surface waters (H1-17). A post-doc position will be used to strengthen the research on the role of microzooplankton.

B2-01 EUTROPHICATION AND PHYTOPLANKTON IN DUTCH COASTAL WATERS

W. van Boekel (RUG)

The analysis of the samples taken during the 1990 *Phaeocystis* spring bloom in the Marsdiep has been completed. The results show that lysis of the cell is the most important factor controlling the breakdown of the *Phaeocystis* bloom. The lysis of the cell is caused by the depletion of inorganic nitrogen.

Laboratory experiments of *Phaeocystis* focused on the ability of the species to use organic phosphates as a nutrient source. It appeared that a whole range of organic phosphates that are expected to be constituents of the dissolved organic pool in natural environments could function as a phosphorus source. This indicates that *Phaeocystis* can postpone P-depletion by the use of organic phosphate. Therefore, P-limitation of *Phaeocystis* is unlikely in areas where organic phosphate release by plankton through lysis or excretion exceeds the P-demand of the algae.



Time series of cell numbers of *Phaeocystis* sp. in batch cultures with inorganic phosphate (PO_4), glucose-1-phosphate, cyclic-adenosine monophosphate (c-AMP), glucose-6-phosphate, glycerate-3-phosphate, fructose-1,6-diphosphate, adenosine monophosphate (AMP), adenosine diphosphate (ADO) and adenosine triphosphate (ATP) as single P-source.

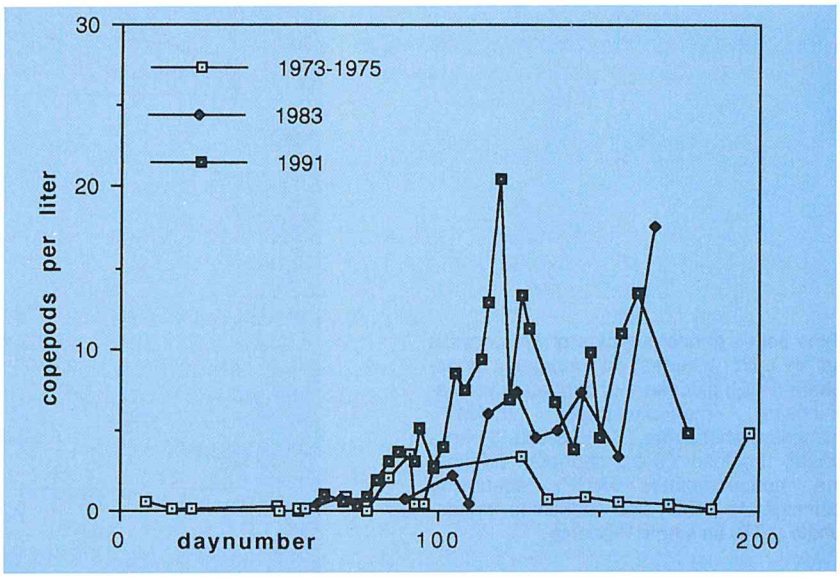
F. Hansen

As part of the EC project 'Dynamics of *Phaeocystis* blooms in nutrient-enriched coastal zones' more work has been performed to evaluate the role of zooplankton grazing as a loss factor for *Phaeocystis* stocks. Last year's field investigation led to the hypothesis that ciliates have an important function coupling *Phaeocystis* primary production to higher trophic levels. Three species of oligotrichous ciliates were isolated during the *Phaeocystis* spring bloom period. Possibilities for culturing and quantification of these ciliates were studied. Ciliates could be grown in batch cultures by using adequate concentrations of bacteria or autotrophic flagellates as food. Preliminary results on preservation with lugol and automatic counting (flow cytometer, coulter counter) were promising. A start has been made with grazing experiments with copepods, ciliates and *Phaeocystis* to study trophic interactions and selective grazing, which may lead to a better understanding of *Phaeocystis* bloom phenomena.

B2-02 MODELLING OF PLANKTON DYNAMICS IN THE SOUTHERN NORTH SEA

H.G. Fransz, S.R. Gonzalez

The eutrophication of Dutch coastal waters has led to an enhanced annual primary production and longer periods of *Phaeocystis* blooms in the Marsdiep after 1975. This may have effected the seasonal development of heterotrophic bacteria, flagellates, ciliates and other microzooplankton interacting with the algae in 'the small food web' or 'microbial loop'. This may also have changed the food conditions of the omnivorous mesozooplankton. The plankton in the Marsdiep was sampled twice a week between 5 March and 27 June to follow the changes and interactions in algae (B2-01, B3-01), bacteria (S-01c), protozoans (B1-06) and micro- and mesozooplankton. At the same frequency the egg production rate of the copepod *Temora longicornis* was measured, which is an indicator of its growth and ingestion rate. As in earlier years, the fastest population growth and the peak in egg production rate were found in the period of the *Phaeocystis* increase. The underlying food relationships must be carefully analysed and studied in experiments. The maximum abundance of *Temora* in May/June increased in the period 1974-1991 in all developmental stages, and the period of the spring increase became longer, leading to higher summer numbers.



Increase in the abundance of the copepod *Temora longicornis* in the Marsdiep during spring-summer between 1973 and 1991.

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

M.A. Baars, H.G. Fransz, S.R. Gonzalez, G.W. Kraay, B.R. Kuipers, S.S. Oosterhuis, H.J. Witte

Data from the transition area between the Southern Bight and the Oyster Ground have been summarized. The name 'Frisian Front' is especially dedicated to the benthic front in this area, an enriched zone of only 15 km width and *ca.* 100 km length in between the 30 and 40 m depth contour lines. Pelagic data from 1985-1990 show that the water column in spring is characterized by high chlorophyll concentrations and primary productions of up to 6-8 g $C \cdot m^{-2} \cdot d^{-1}$. The vigorous spring bloom is presumed to be due to the import of turbid waters from the British side of the Southern Bight, where phytoplankton growth is suppressed and nutrient levels are relatively high. When this water is transported to the northeast, and current velocity lowers, silt sinks out and the increased transparency induces blooming. On satellite photos, this is illustrated by the disappearance of the plume of Norfolk boulder clay in the area of the Frisian Front. In summer, high chlorophyll concentrations also regularly occur, but only in a narrow zone above the benthic front and with a uniform vertical distribution. The presence of this 'chlorophyll curtain' seems bound to periods of calm weather and it is independent of the location of the tidal front. Creutzberg has hypothesized that this chlorophyll front is mainly due to the flux of nutrients by mineralization of the organic material in the sediment. Actual measurements indeed show high fluxes of up to 2 $mmol \cdot m^{-2} \cdot d^{-1}$ of nitrogen components during May-August. Current meter data and subsurface drogues indicate that residual currents are predominantly parallel to the contour lines. Therefore, at low wind speeds, residence time of the water above the enriched zone will be several weeks up to more than one month. This will give a substantial accumulation of nutrients regenerated by the bottom, leading to a marked new production in the water column. If sedimentation of summer species of phytoplankton is negligible, primary production above the Frisian Front will be doubled in 10 days. Total primary production at the Frisian Front is estimated at 420 g $C \cdot m^{-2} \cdot y^{-1}$ compared with 240 g $C \cdot m^{-2} \cdot y^{-1}$ to the south and at the Oyster Ground. An amount of 120 g $C \cdot m^{-2}$ is attributed to the spring difference, and 60 g $C \cdot m^{-2}$ is caused by the chlorophyll curtain in summer.

The spring development of zooplankton is also more pronounced in the region of the Frisian Front than in surrounding areas, resulting in biomasses (50 mm net catches) of 10-20 g $C \cdot m^{-2}$ in early summer. Biomass levels thereafter decline; relatively high values sometimes re-occur, but extend over a broader north-south range rather than just in the zone above the Frisian Front. In summer, acoustic recordings show a high concentration of fish schools above the enriched zone. These schools mainly consist of adult sprat and young herring, as confirmed by catches and the diurnal vertical migration pattern.

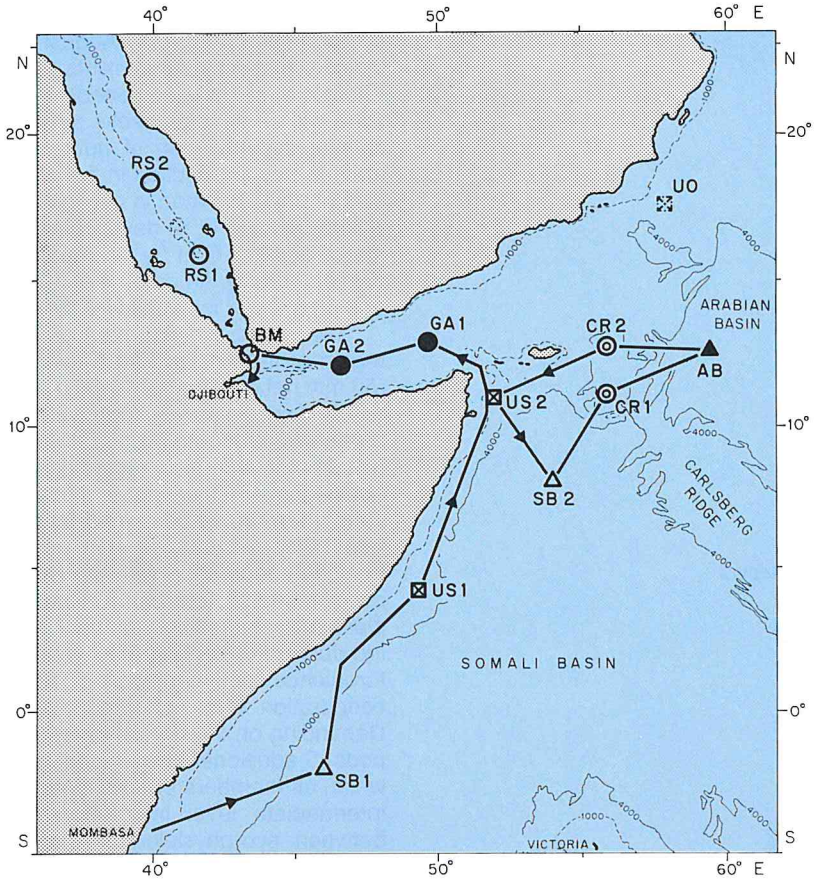
B.R. Kuipers

In close cooperation with the BEWON Department (Riegman), pelagic mesocosm research has been initiated: structure and functioning of experimental plankton communities as function of light and nutrient availability will be studied during the coming 5-10 years. After initial studies of water circulation and turbulence, sedimentation of particles and wall-effects in small set-ups (in cooperation with T.U. Eindhoven), a 1-m^3 mesocosm prototype was built. Depending on the results of test runs with algae, microzooplankton and copepods, 5 additional mesocosms will be built in 1992. This cooperative study, in which all members of the Department are involved, has been designed as an intermediate level integration of knowledge (by mathematical modelling) between eco-physiological study of single species in continuous cultures (B2-01/10/13, S-0b) and field studies in the stratified North Sea and the Atlantic Ocean (B2-01/02/04).

B2-08 MONSOONS AND PELAGIC SYSTEMS

M.A. Baars, G.W. Kraay, S.S. Oosterhuis, M.J.W. Veldhuis, J.IJ. Witte

Plans for a Netherlands Indian Ocean Programme in the northwestern part of the Indian Ocean took definite shape. The expedition is now scheduled from May 1992 up to April 1993, and comprises a series of 11 cruises covering 5 main themes. One is on the ecology and diversity of pelagic populations in an area with seasonal upwelling. In cooperation with S. van der Spoel and P.H. Schalk (Institute of Taxonomic Zoology, University of Amsterdam) plankton and micronekton will be sampled down to 1000/2000 m in the Red Sea, the Gulf of Aden and the Arabian Sea off Somalia, both during the SW monsoon (the upwelling season) and the NE monsoon. Work on carbon fluxes and stocks will cover almost all JGOFS core measurements, including studies on new production, CO_2 air-sea exchange, N_2O formation, and sedimentation up to and including the oxygen minimum zone. With participants from a number of JGOFS Working Groups (S.L. Smith, USA; B.A. Biddanda, India; P.H. Burkill, UK; B. Zeitzschel, Germany), the 1992/1993 cruises represent a pilot study for JGOFS Indian Ocean 1994/1995. Data collected in the cruises by the Dutch RV Tyro will form the base for the algorithms on chlorophyll and primary production in the Arabian Sea when the SeaWifs satellite will become operational at the end of 1993.



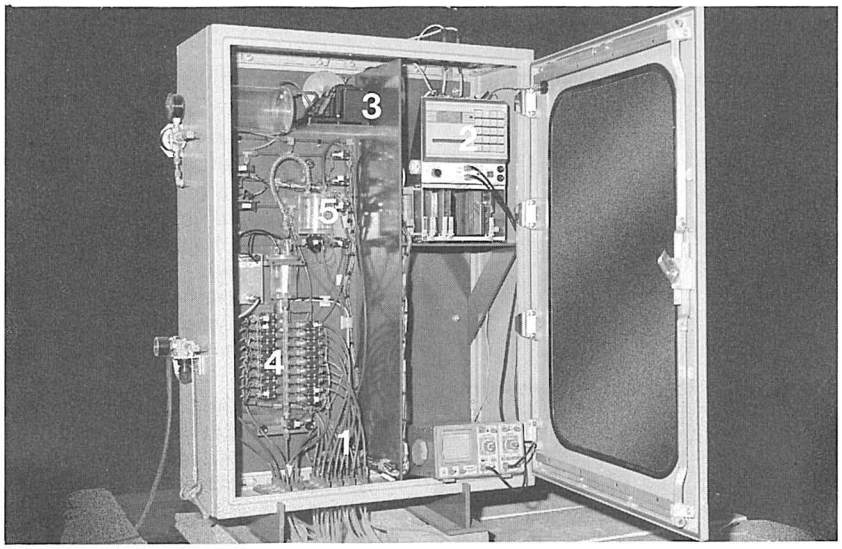
Proposed cruise for 1992.

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

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

The experimental research on zooplankton centres on how significant environmental variables influence the ecophysiology of marine zooplankton under controlled conditions in the laboratory. To this end various copepod species were bred in the laboratory from one generation to the next. For *Pseudocalanus elongatus* the 100th generation was reached this year.

Experiments with *Acartia clausi* and *Temora longicornis* were carried out to determine exactly the rate of development through the successive stages. This was necessary to check for the assumption of isochronal development and to correct development rates determined in former and recent experiments. Moreover, this accurate information on development rate is essential to develop a model of the age distribution and the duration of copepod life stages. Three generations of *Acartia clausi* were cultured at 16 different combinations of temperature and food quantity. After *Temora* and *Pseudocalanus* this is the third copepod species subjected to this set of conditions. Altogether these data constitute the basic information for modelling the development rate of North Sea copepods throughout the season. A newly developed automatic food control system (built in cooperation with the Electronics Department) has been used to monitor the food quantity in the copepod cultures. The system functioned quite well, and, after more experience has been acquired, it can also be used to control the density of food particles. In a joint project with I.A. McLaren (Canada) on the nucleus- and DNA content of copepods, we cultured the progeny of 'domestic' *Pseudocalanus* and that of freshly collected specimens. Preparations of the adults were made and sent to Canada for further analysis.



Particle-Control-System used to monitor and control the density of food-algae in copepod cultures.
Tubings (1) are connected to 16 different copepod cultures, to a culture with food and to a container with flush-water. A small computer (2) controls sucking-up of samples, flush-water or food by a vacuum-pump (3) and magnetic valves (4) from the appropriate culture or container. The concentration of particles in samples is measured electronically in an orifice-tube in a measuring-cell (5), according to the Coulter-principle. All operations are fully automatized, using vacuum and compressed air as the driving forces. Detection of possible technical troubles and restoring them automatically is part of the system, allowing it to run properly at a minimum of manual interference.

B2-11a ZOOPLANKTON DISTRIBUTION AND PRODUCTION IN THE ANTARCTIC WEDDELL AND SCOTIA SEA AND THE WEDDELL-SCOTIA CONFLUENCE

H.G Fransz, S.R. Gonzalez

Further analysis of samples and data collected during EPOS I in 1988/89 has given new information. The samples of copepod developmental stages taken for carbon estimation were analysed by wet oxidation. Carbon weight-length relationships were established for the common Antarctic copepod species. Bio-

mass estimates were obtained with these improved data. It was found that copepods formed 65% of total biomass in the Scotia Sea, 57% in the Weddell Sea and 61% in the confluence zone. The contribution of the numerous cyclopoid copepod *Oithona similis* to total biomass was 16%, 31% and 22%, respectively. In the Weddell Sea this small-sized species was very dominant, with 55% of copepod biomass. The weight classes 10-50 and 50-100 mg (smaller copepodite stages) dominated in biomass. The following table gives the estimated mean carbon biomass and daily production based on estimated development rate of *Oithona* in the Antarctic seas.

	Scotia Sea	Confluence	Weddell Sea
mean biomass $gC \cdot m^{-2}$ in upper 300 m	6.0	1.2	0.4
production mg $C \cdot m^{-2} \cdot d^{-1}$	45	9	3

Analysis of the combined zooplankton files obtained by AWI (Bremerhaven), IPO (Kiel) and NIOZ revealed that the decrease in biomass and species diversity from the Scotia Sea to the Weddell Sea coincided with a sharp decline in older juvenile stages. Recruitment is a major problem at extreme polar conditions due to a low survival rate of juveniles.

B2-11b ZOOPLANKTON DISTRIBUTION IN THE ARCTIC WATERS AROUND SPITSBERGEN

H.G. Fransz

To confirm general principles about species distribution and life cycles of polar zooplankton, samples were collected with a 50 mm-net from RV Polarstern during a cruise around Spitsbergen archipelago in Arctic waters. This EPOS II cruise was coordinated by ESF to stimulate the study of Arctic shelf seas and the cooperation between the West and East European countries. The preliminary results show:

1) The cyclopoid copepod *Oithona similis* is numerically the most abundant zooplankton species in high Antarctic and Arctic waters. It reproduces at locations even beyond 81°N, where the larger *Calanus* species occur only in inactive stages.

2) The dominant *Calanus finmarchicus* population of the northwards-flowing Atlantic west-Spitsbergen current declines in number from south to north, and reduces its reproduction rate.

3) In the southwards-flowing Arctic east-Spitsbergen current *Calanus glacialis* starts reproduction at the marginal ice zone, but the population disappears in the southern Barents Sea beyond the polar front. In the south *Oithona similis* is very common and has an extremely high egg/female ratio. But here the relatively low number of nauplii indicates a high mortality of juveniles.

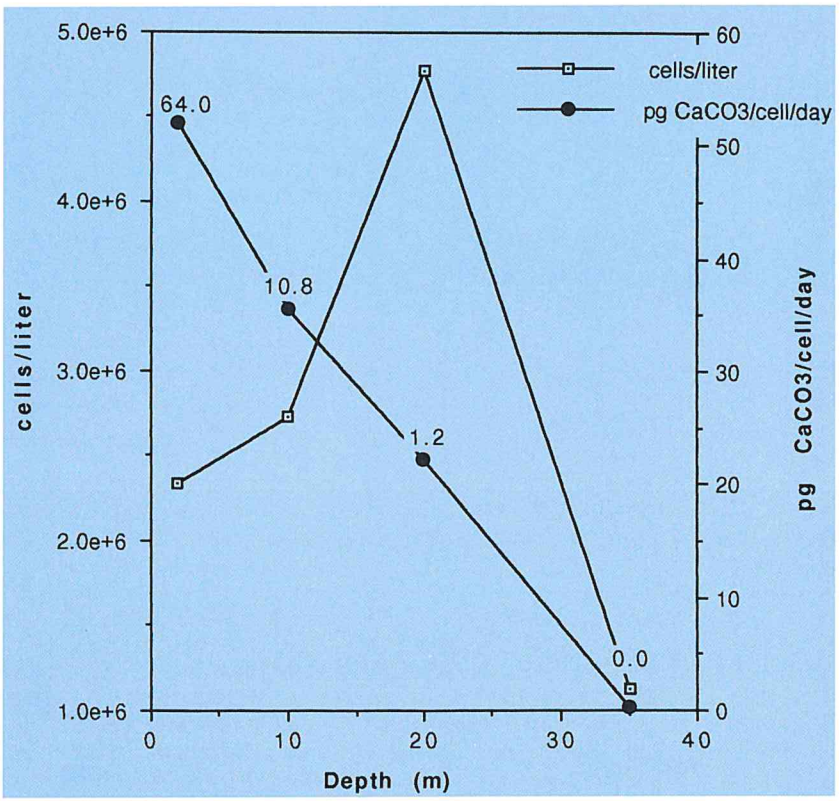
Persistence and life cycles very much depend on local primary production in relation to the marginal ice zone, but also on displacement by currents. The anticyclonic movement of water around Spitsbergen may provide necessary life conditions for typical polar species such as *Calanus glacialis*, because it transports adults towards a spawning area at the marginal ice zone, and the offspring back to polar waters for hibernation.

Ursus maritimus, top predator of the pelagic system in the high Arctic.
(Photo: H.G. Fransz)

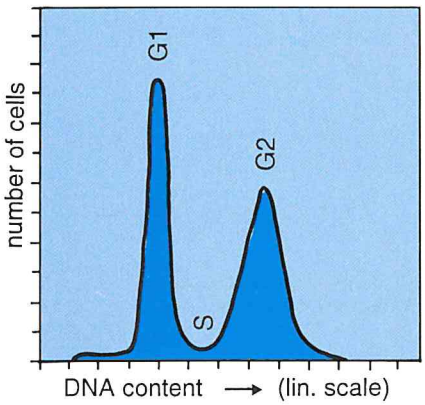
B2-13 LIFE CYCLE, PRODUCTION AND CALCIFICATION OF THE COCCOLITHOPHORE *EMILIANIA HUXLEYI*

P. van der Wal, J.D.L. van Bleijswijk Tierens Verhagen, R. Kempers, M.J.W. Veldhuis, G.W. Kraay

The coccolithophorid *Emiliania huxleyi* is used as a model organism for the study of calcifying algae. Especially the process of calcification is found to have a strong influence on the inorganic carbon pool of the seawater and therefore affects the alkalinity, pH and pCO_2. The research activities this year were focused on the organic and inorganic carbon fluxes, cell size, pigmentation and cellular DNA characteristics in relation with changes in growth rate.

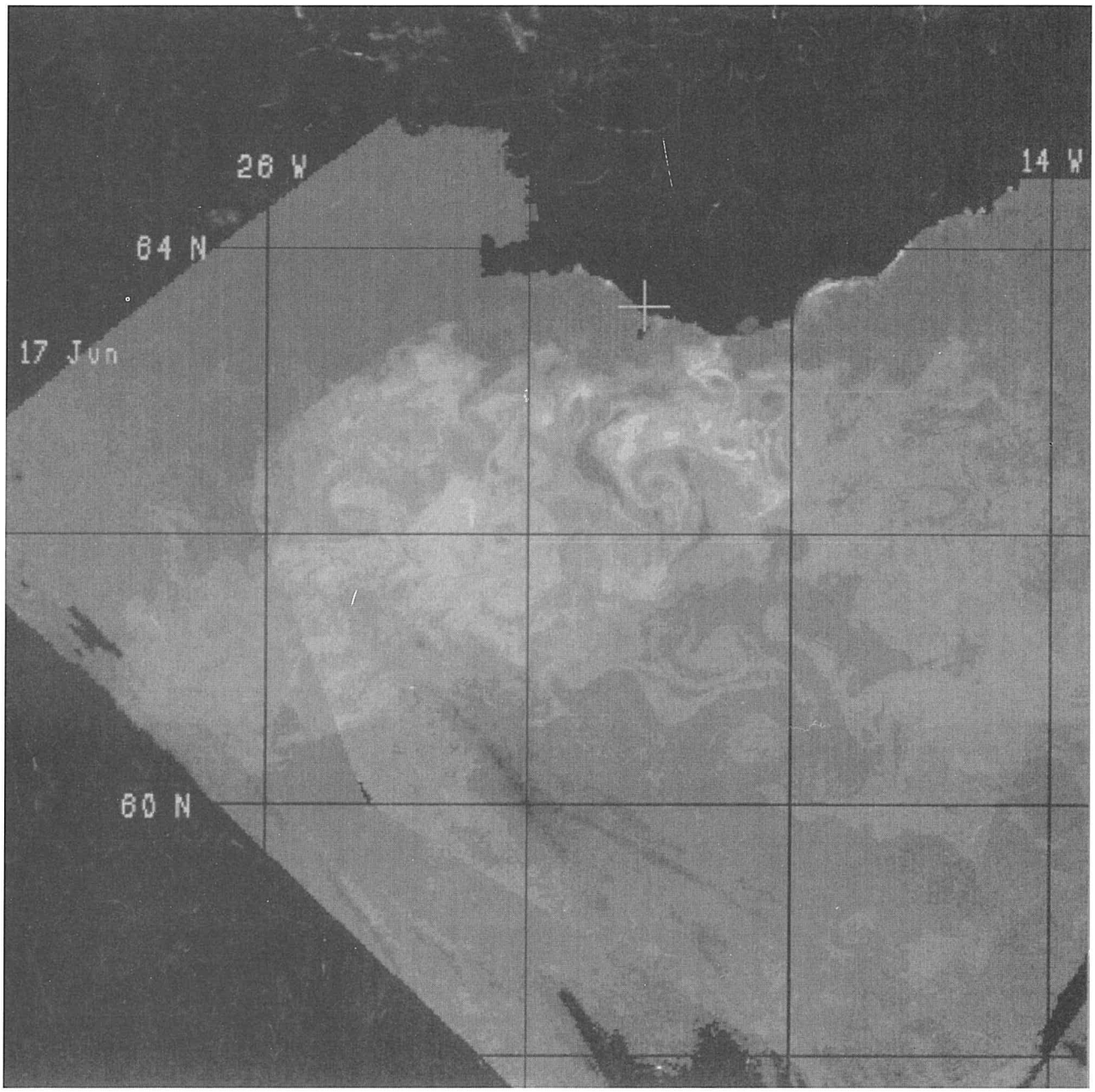


Cell numbers and $CaCO_3$ production per cell of *Emiliania huxleyi* at four depths in the coccolithophore bloom of June 1991 south of Iceland. Numbers indicate the percentages of the light intensity at the surface.



Cellular DNA distribution of *E. huxleyi* G1 and G2: single and double copy of cellular DNA, respectively. G: synthesis phase, stage where single copy of DNA is duplicated.

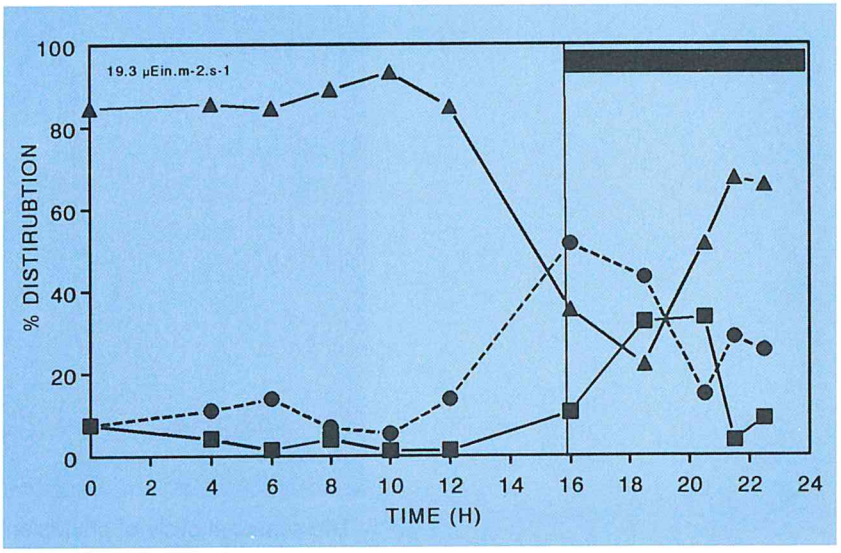
P. van der Wal participated in a UK cruise in the North Atlantic. In June and July RV Charles Darwin made two cruises to a region south of Iceland. The general theme of the research was: 'The environmental significance of coccolithophores'. During the first cruise NOAA-satellite images were received that revealed the existence of a very large bloom of the coccolithophore *Emiliania huxleyi*, judged by the high reflectance of the water. The bloom had an east-west orientation and roughly measured 800 by 200 km; its northern edge reached to within the southern coastal waters of Iceland. The satellite images were used as maps to select and find interesting sites within the bloom. In the bloom, cell numbers of *E. huxleyi* varied between 2000 and 20 000 per ml; the number of loose coccoliths, the particles responsible for the high reflectance of the water, maximally amounted to 368 000 per ml. The pCO_2 varied proportionally and the alkalinity inversely proportionally to the concentration of the coccoliths, apparently as an effect of the formation of $CaCO_3$. This massive bloom of



NOAA Channel 1 (580-680 nm), atmospherically corrected, image of the North Atlantic region south of Iceland showing the extension of a bloom of the coccolithophore *Emiliania huxleyi* on 17 June 1991. The high reflectance of the water is caused by the presence of loose coccoliths in concentrations of 10^8 to 4 x 10^8 per litre (image by courtesy of Steve Groom).

E. huxleyi had disappeared by the time of the second cruise to the area. Only aggregates containing remnants of the bloom were found below the photic zone. During the first cruise rates of calcification were measured by P. van der Wal with the radioactive tracer 45Ca. $CaCO_3$ production in the bloom was highest at the surface and was usually confined to the upper 10 or 20 m. The total production integrated over the first 35 m of the water column ranged from 0.6 to 2.9 g $CaCO_3 \cdot m^{-2} \cdot d^{-1}$ Strong indications have also been obtained that *E. huxleyi* thrives at a wide range of light intensities, an ability that may considerably attribute to the competitiveness of this successful species.

In the laboratory a number of growth experiments were carried out in order to assess various cell characteristics as a function of growth rate (light intensity) over a day/night cycle. The flow-cytometrically measured daily changes in size, scatter and chlorophyll fluorescence were equal to those observed for the various light intensities (7-160 $\mu Einstein \cdot m^{-2} \cdot s^{-1}$), which stresses the importance of the timing of the sampling procedures. In general cell size and scatter (the latter approximating number of coccoliths) increased with increasing growth irradiance. Cellular chlorophyll fluorescence reached maximal values at 20 $\mu Einstein \cdot m^{-2} \cdot s^{-1}$. The growth rate remained relatively high even at the lower light levels tested. Furthermore, a staining procedure (applying flow cytometry) was developed for the cellular DNA content of the cells. Cell counts revealed that cell division occurred mainly during the dark phase, but duplication of the DNA was at the end of the light period and early dark phase. Patterns for the DNA replication generally agreed with those described for eukaryotic algae. Changes in the growth rate corresponded mostly with the duration of the G1 phase.



Cellular DNA of *Emiliania huxleyi* over 24 h period (16 hours light, 8 hours dark), incubated at 19 $\mu Ein \cdot m^{-2} \cdot s^{-1}$. Distribution over/in cells with single copy DNA (G1), double copy of DNA (G2) and cells in DNA synthesis phase (S).

1.7. COASTAL SYSTEMS (B3)

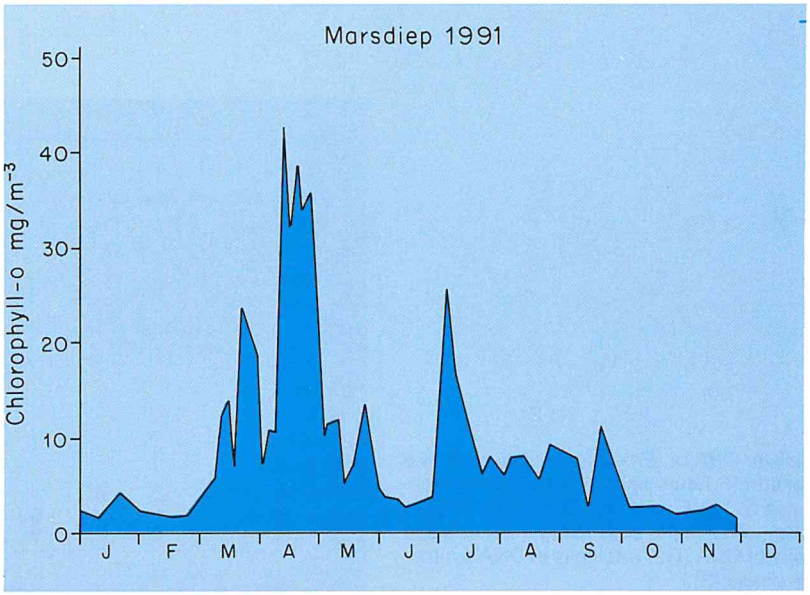
INTRODUCTION

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), energy transfer from algae to molluscs (B3-03), interactions between primary consumers (B3-04), dynamics and distribution patterns of secondary consumers (flatfish: B3-05; birds: B3-08 and B3-09), energy transfer from primary to secondary consumers (B3-06), and energy budgets in secondary consumers (B3-07). The only project not fitting into this scheme is on physiology of marine organisms (B3-10). Nevertheless, it is clear that a real insight into processes at the ecosystem level can be gained only by the inclusion of research at integration levels of populations and individuals. Therefore, studies in the fields of population biology (*e.g.* B3-02, B3-04, B3-08), autecology (*e.g.* B3-07, B3-09) and ecophysiology (*e.g.* B3-10) are indispensable parts of the programme of the Department.

B3-01 PRODUCTION AND TRANSPORT OF ORGANIC MATTER

G.C. Cadée, J. Hegeman

The Marsdiep sampling programme was synchronized in spring this year with a number of other sampling programmes including nutrients, zooplankton and bacteria (see B2-01, B2-02, S-01, H3-15, B1-06).



The seasonal cycle of phytoplankton in the Marsdiep tidal inlet in 1991 was characterised by the normal spring diatom peak followed by a *Phaeocystis* peak which reached relatively high cell numbers (maximum observed 125000 cells·cm^{-3}), the bloom (period with >1000 cells·cm^{-3}) consisted of 2 peaks and its total duration was about 5 months, comparable to the late 1980s. Net samples of phytoplankton indicated the presence of *Phaeocystis* colonies the year

round in the Marsdiep, suggesting that colonies overwinter. Formation of new colonies (attached to diatoms) was not confined to the spring but also observed in autumn.

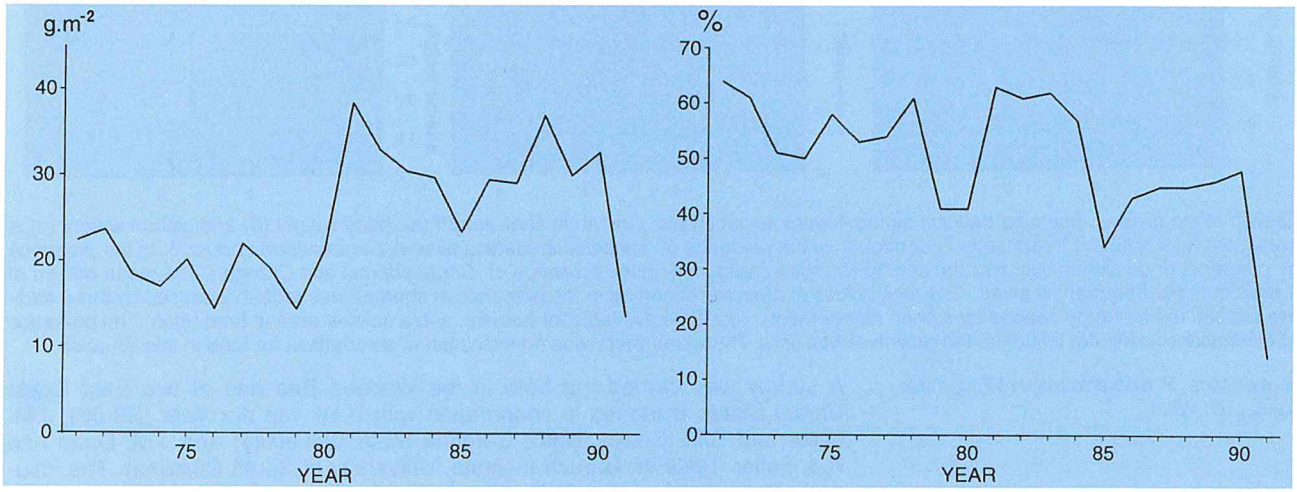
B3-02 SECONDARY PRODUCTION AND DYNAMICS OF TIDAL-FLAT MACROZOOBENTHOS

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. The now available data set of more than 20 years illustrates the effects of two important environmental conditions:

1. Eutrophication. The elevated levels of nutrients, primary production and chlorophyll during the 1980s (with doubled values compared with the 1970s) resulted in the following changes in the benthic fauna: roughly doubled values for biomass and production and even stronger increases in numbers and biomass in several species of small-sized deposit-feeding worms. About half of the species studied in detail showed a significant increase, whereas none was consistently handicapped.

2. Climate. Occasionally occurring severe winters seriously reduced numbers in about one third of the species, and slightly reduced species richness and biomass. The coldest winters were followed by higher-than-average reproductive success in several species of large bivalves (cockle, mussel, sand gaper). The mildest winters were followed by recruitment failure in these species. The chance occurrence of a series of such mild winters (1988, 1989, 1990) ultimately resulted in low stocks of these bivalves and low values for total biomass. This had serious consequences for cockle and mussel fisheries and for some bird species (see B3-08a).



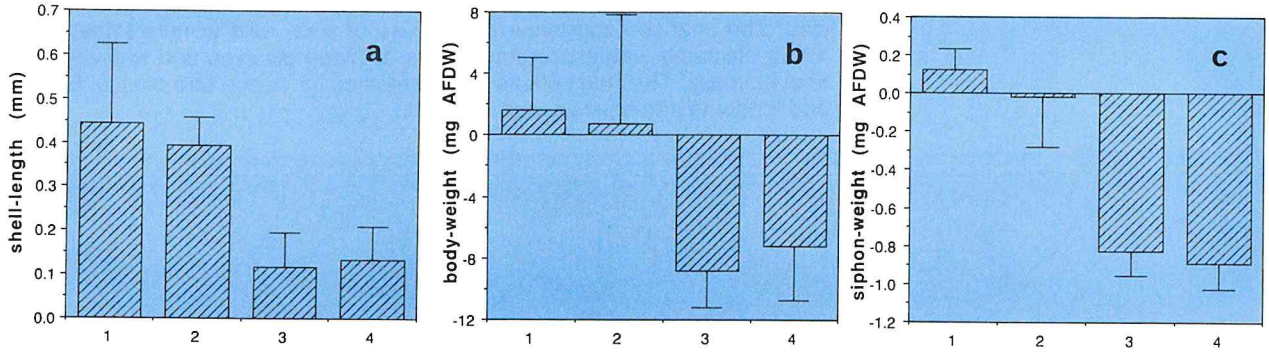
Long-term changes in biomass and composition of the stock of larger bottom animals in the westernmost part of the Wadden Sea: (left) total biomass in $g \cdot m^{-2}$ ash-free dry weight in early spring in each of the years 1971-1991, (right) share of large bivalves (mussel, cockle, sandgaper). In nearly all years large bivalves accounted for about half of the total benthic biomass, but this proportion was seriously reduced in early-1991, explaining the low value of total biomas in that year. Recruitment failure during three successive foregoing years (all characterized by very mild winters) and unrestricted fishery in 1990 for the few remaining cockles and mussels caused these low values. Consequences for mollusc-eating birds, such as oystercatchers and eiders, were serious (see B3-08b).

B3-03 COMPETITION FOR FOOD BETWEEN BIVALVE MOLLUSCS

P. Kamermans

In its final year, this project focused on *Macoma balthica*. Long-term investigations by Beukema & Cadée suggest that diatoms are more important as food for *Macoma* than the flagellate *Phaeocystis*. Nevertheless, experiments carried out in 1990 showed comparable growth of *Macoma* on diatom diets and on a diet of single cells of *Phaeocystis*. During the *Phaeocystis* bloom this spring, ingestion of *Phaeocystis* colonies and strings of diatom cells by *Macoma* was observed. Immediately after ingestion, the *Phaeocystis* colonies were expelled again, whereas the diatom cells were not. This indicates that *Phaeocystis* colonies, which are dominant during the growing season of *Macoma*, are indeed unsuitable food for *Macoma*.

Experiments were performed to study whether shortening of the feeding organs (siphons) by predators (flatfish, crabs, shrimp, etc.) could induce a shift from deposit feeding to suspension feeding in *Macoma*. Cutting off pieces of siphons did not result in a shift to suspension feeding, but decreased the deposit-feeding activity and reduced the deposit-feeding range. The presence of shrimp (*Crangon crangon*) suppressed the deposit-feeding activity. However, stomach content analysis of *Macoma* did not show evidence of a shift from deposit to suspension feeding in the presence of shrimp. Growth of *Macoma* decreased significantly in the presence of shrimp.

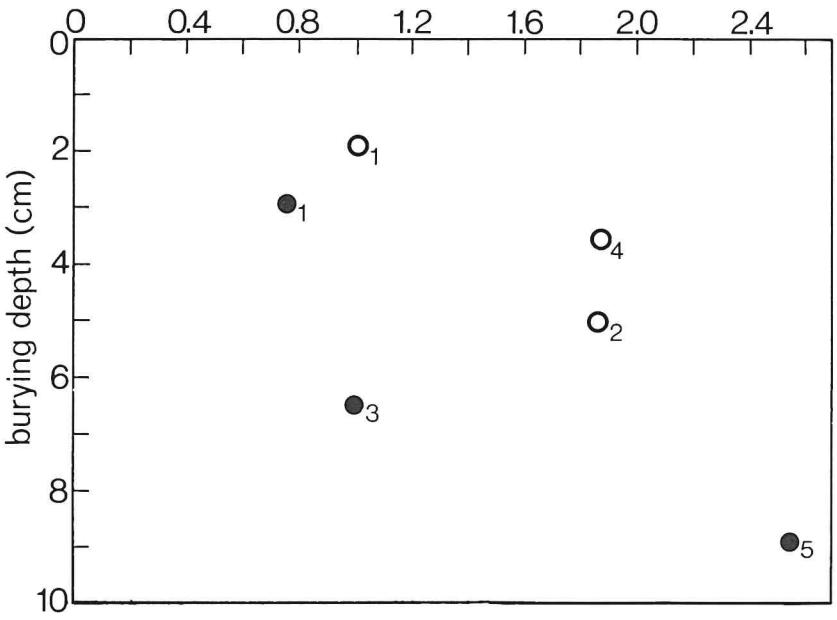


Growth of the bivalve *Macoma balthica* during 4-week experiments. Growth in shell length (a), body weight (b) and siphon weight (c) is presented for 4 different treatments: 1=control, 2=in the presence of suspension feeding bivalve *Cerastoderma edule*, 3=in the presence of predators upon siphon tips, *viz.* the shrimp *Crangon crangon*, 4=in the presence of *Cerastoderma* and *Crangon*. The mean with sd of 4 replicates per treatment is given. The weight loss of *Macoma* observed in the presence of shrimps was probably caused by three additive factors: extra energy needed for siphon regeneration, less time available for feeding, and a smaller area to feed upon. The presence of *Cerastoderma* did not influence the growth of *Macoma*. Therefore, there was no indication of competition for food in this situation.

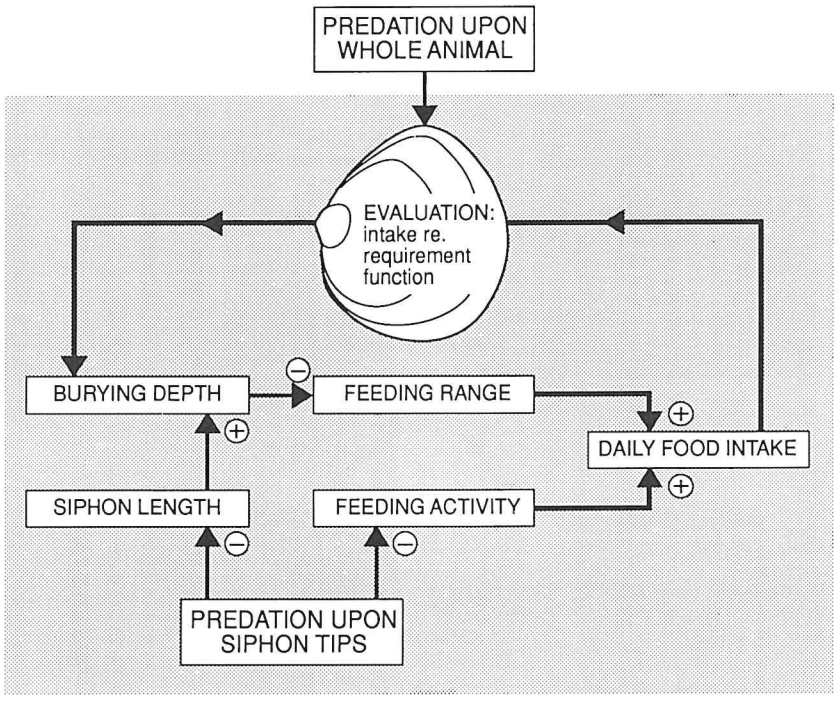
E. Adriaans, P. Kamermans, H.W. van der Veer, J.IJ. Witte

A survey was carried out both in the Wadden Sea and at two East Coast United States estuaries in cooperation with H.W. van der Veer (B3-06), J.M. Miller and B.M. Currin (North Carolina State University) and J.M. Dean and R.J. Feller (Belle W. Baruch Institute, University of South Carolina). The influence of predation upon siphon tips on the feeding behaviour of *Macoma* was studied in the field. At each site samples were taken along a transect with a gradient in predation pressure. Siphon weights and burying depths of *Macoma* showed a negative correlation with predation pressure. This indicates that deposit feeding would be impaired at high densities of predators. The relative weight of the soft parts of *Macoma* increased with increasing siphon weight, suggesting better feeding conditions at low predator densities. Stomach content analysis of *Macoma*, however, did not show evidence of a shift from deposit to suspension feeding at high predation pressure.

FEEDING OR BEING FED UPON; LIFE-HISTORY DECISIONS IN THE BIVALVE *MACOMA BALTHICA*



Macoma takes its food from the surface of the sediment with its feeding organs (siphons). There is a positive relation between the burying depth of the animal in the sediment and the size of the siphon.
○=growing season, ●=non-growing season.
1. Texel, Wadden Sea
2. Amsteldiep, Wadden Sea
3. Griend, Wadden Sea
4. Schleswig-Holstein, Wadden Sea
5. Pamlico River, North Carolina.



Causal netwerk of factors influencing the life-history decisions of *Macoma balthica* as far as feeding, growing and reproducing are concerned.

Shallow-living *Macoma* have more siphon length available to vacuum the surface of the sediment. However, the deeper the animal buries in the sediment, the safer it is from predation by birds and crabs. Predation upon siphon tips by fish, crabs and shrimp shortens the siphons and would lead to a lower burying depth if the same food intake is to be maintained. Additionally, predation upon siphon tips also disturbs the siphons, and it has been shown to lower the grazing activitiy. *Macoma* moves up in the sediment in the growing season because it needs more food. Predation by birds and crabs is apparently traded off against growth and reproduction. These ideas are illustrated in the diagram.

B3-04 INTERACTIONS BETWEEN MACROZOOBENTHOS SPECIES ON TIDAL FLATS

E.C. Flach

Results of field experiments performed in foregoing years showed that the presence of 'normal' numbers of the lugworm *Arenicola marina* and high densities of the cockle *Cerastoderma edule* exerted a strongly negative effect on the abundance of the amphipod *Corophium volutator*. The same kind of experiments with azoic and partly repopulated plots on the tidal flats at Balgzand were repeated to see whether the presence of *A. marina* and *C. edule* would also affect other macrozoobenthic species. These plots became occupied by the recruits of all common macrozoobenthic species and nearly all of these species showed a negative response to the presence of lugworms and cockles. The negative effect of the lugworm was stronger for nearly all species except for *Pygospio elegans*, which showed a stronger response to the cockle. This negative effect of adult cockles and lugworms on the recruitment of nearly all species might have quite some impact on the structure of the macrozoobenthic community.

The monthly sampling of a transect from the upper, muddy zone to a lower, sandy part of Balgzand was continued. Two remarkable phenomena were observed. Firstly, the normally high densities in the upper zone of the species *Corophium volutator* declined to zero in April/May. So far this species has not reappeared at Balgzand. Secondly, the middle part of the transect became colonized with very high densities of juvenile *A. marina*, up to 500·m^{-2} in June. In May densities of *A. marina* were still low and high densities of *Pygospio elegans* were found in this middle part, but in July after the colonization of juvenile lugworms hardly any *P. elegans* were found in this zone. A survey in the Dutch Frisian Wadden Sea showed that these events were not restricted to the Balgzand area. *C. volutator* had disappeared in the entire western Wadden Sea, whereas the other *Corophium* species (*C. arenarium*) could still be found at the same places as before. High densities of juvenile lugworms were found in many places where the density of adult lugworms was low.

Wim de Bruin and Jaap Zuidewind assist with the sampling of the experimental plots. (Photo: E. Flach).

B3-05a RECRUITMENT MECHANISMS IN FLATFISH POPULATIONS

H.W. van der Veer

Particular attention has been paid to the determination of year-class strength. Data on the population dynamics of 0-group flounder *Platichthys flesus* in the western Wadden Sea were analysed. Like in plaice, year-class strength in flounder is determined already during the pelagic stage before immigration of the larvae and settling on the tidal flats in the Wadden Sea. Also after settlement a period of density-dependent mortality was observed, most probably caused by predation by crustaceans. Overall, daily instantaneous mortality rates were about 0.08 d^{-1} higher than those observed in plaice in earlier years, most probably due to a combination of higher water temperatures and higher predator densities.

B3-05b LONG-TERM CHANGES IN FISH STOCKS IN THE COASTAL ZONE (see also S-08)

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

The fish trap catches recorded daily from 1960 onwards were analysed in detail. For most of the relatively abundant fish species, trends in all types of traps seemed to be similar, allowing an investigation on long-term changes. The first step will be a calibration of the long-term changes of commercial species, as abundance estimates of the stocks are available for these species.

B3-06 FISH-BENTHOS INTERACTIONS

H.W. van der Veer

The central theme has been the food intake of *Macoma balthica* under the influence of food availability and predation pressure. For further details see B3-03.

B3-07 ENERGY BUDGETS OF BENTHIC CARNIVORES

M. Fonds, P. van der Puyl

Investigations on populations of seastars (*Asterias rubens*) in the Wadden Sea (Vlieter) and North Sea coastal area (Petten) were continued. After a remarkable decline in mussel populations (*Mytilus edulis*) in the Wadden Sea in 1990-1991, the seastar population in the area of investigation also declined during the winter of 1990/91. A high production of 0-group seastars (1-2 cm diameter) was observed at the end of August 1991, with maximum densities between 50 and 100 individuals per m^2.

Daily food consumption was measured with juvenile and adult dab (*Limanda limanda*) in the period of January to July. Unlike adult plaice (*Pleuronectes platessa*), adult dab continue feeding in winter and they store food energy both in growth and in gonad production. Dab fed with mussel meat (*Mytilus edulis*) showed a higher daily food consumption, and they also produced better quality eggs than dab fed with shrimp (*Crangon crangon*).

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

C. Swennen, P. Duiven

The lack of cockles and mussels in the Wadden Sea caused by negligible spatfall (B3-02) and continuing fisheries on molluscs resulted in a dramatic decline in molluscivorous birds. The number (<90000) of wintering Eiders was 35% lower than the long-term average, and mortality was high. At least 15 000 bodies were found, most of them juveniles. Numbers of nests reported were 80% lower on Schiermonnikoog, 31% lower on Terschelling, and slightly lower on Vlieland and Texel. On the latter two islands, a significant number of nests were deserted or had been preyed upon. Total numbers of nests were about 3000, and they produced only 2 fledglings.

The number of wintering Oystercatchers was also over 30% lower than normal, while the number of non-breeding oversummering Oystercatchers on two counting sites Schiermonnikoog and Balgzand was 50% and 70% lower, respectively, than in the foregoing years.

From 3 June to 11 July, the ecology of the East Asian race of the Oystercatcher *Haematopus ostralegus osculans*, living in a coastal breeding area in South Korea, was studied in cooperation with the Institute of Ornithology, Seoul. The main prey of this bird is the crab *Macrophthalmus japonicus*, which hides in holes when disturbed. The bird finds them by probing into the soft mud. It removes the carapace of the crabs and eats only the gonads and livers, leaving all meat in the skeleton. Other bird species preying upon crabs normally swallow the whole crab. It was concluded that food for Oystercatchers is superabundant during summer, but there is a serious lack of safe breeding places, which makes this subspecies endangered.

B3-08b ANNUAL ENERGETICS OF KNOTS

Mollusc specialists on tropical mudflats

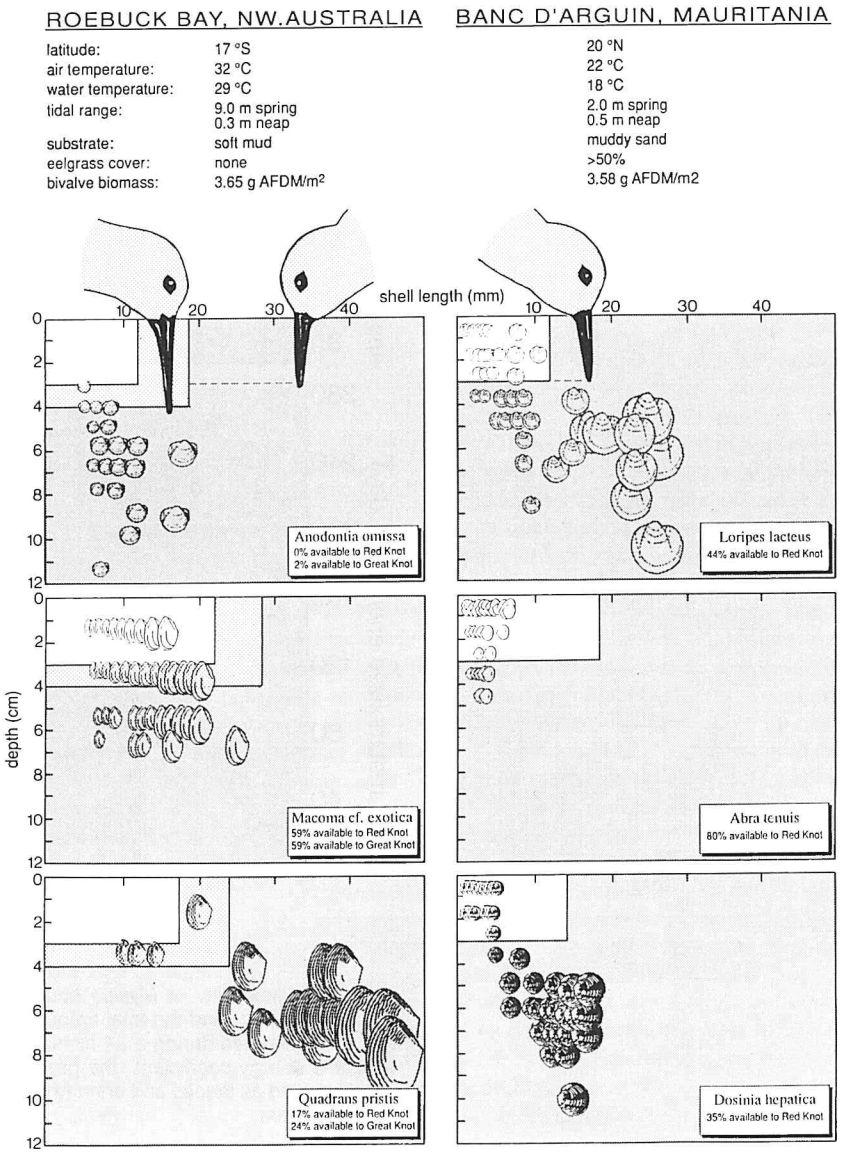
I. Tulp, P. de Goeij, T. Piersma

Three wader species, the Knot, the Great Knot and the Purple Sandpiper, stand out by their habit of mainly feeding on hard-shelled mollusc prey outside the breeding season. When locally abundant in coastal areas, these mollusc specialists might exert a significant impact on the population densities and life-history characteristics of their intertidal prey. However, the characterization of the three waders as mollusc feeders is mainly based on studies in the temperate coastal zones of North America, Europe, Asia and New Zealand. Does their preference for molluscs uphold in tropical areas, where both the birds' nutrient demands and their potential prey availability are very different?

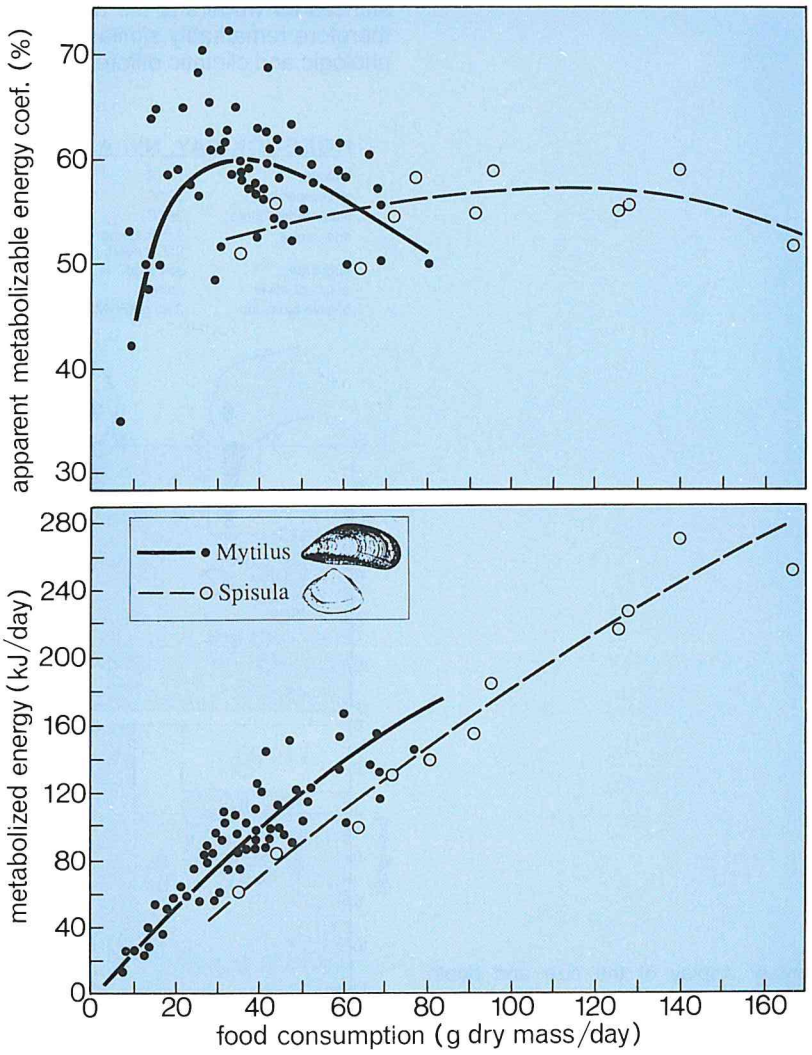
During March-May 1991 we studied the food and feeding of Knots, *Calidris canutus rogersi* and Great Knots *Calidris tenuirostris*, at Roebuck Bay, near Broome in northwest Australia (17°30'S, 122°30'E). This work allows a comparison with earlier studies in April-May 1988 on the tropical intertidal areas of the Banc d'Arguin, Mauritania (19°50'N, 16°17'W). Both in northwest Australia and in Mauritania the diet of the Knot was hard to assess, since it consisted for a large part of tiny prey such as (parts of) polychaete worms and crustaceans. In both areas small bivalves were taken as well, but without them likely to make up most of the diet. In northwest Australia, Great Knots were concentrating more on bivalve prey than Knots. Of the 100 prey which we observed being ingested, 18% consisted of bivalves. Small yellow-orange coloured seacucumbers, and worms, crabs and shrimps comprised the rest. Clearly, both mollusc specialists go for prey other than bivalves on these tropical mudflats. Their fondness for tropical alternatives might either stem from a local paucity of bivalves available to them, or from rich side-dishes. The total biomasses of bivalves present at the two tropical sites (~3.6 $g \cdot m^{-2}$ ash-free dry mass) compares unfavourably with the bivalve biomass in the Dutch Wadden Sea where Knots usually feed on bivalves (24 $g \cdot m^{-2}$ AFDW). The lower tropical biomass is not compensated by an enhanced availability of the bivalves present. Both in northwest Australia and in Mauritania the relative bivalve biomass available to Knots was about 10%, a percentage which comes close to the value for the Wadden Sea. We suggest that at the studied tropical intertidal flats mollusc specialists like Knots and Great Knots are forced to feed on other prey types, in view of the limited availability of their usual intertidal prey.

A diet of prey items smaller than the sizable molluscs taken in temperate estuaries probably leads to relatively low intake rates as well, both in northwest

Australia and in Mauritania. At both sites, birds storing the nutrient reserves required for the flights to the arctic breeding grounds make long hours, foraging for almost the entire period that mudflats were exposed. The ecological circumstances for waders at the two tropical spring staging sites examined here are therefore remarkably similar, in spite of the considerable geographic, geomorphologic and climatic differences between them.



Summary display of the size and depth related availability of three relevant bivalve species from Roebuck Bay, northwest Australia (left) and three from the Banc d'Arguin, Mauritania (right). The available prey (in terms of ingestible maximum gird and attainable depth) for Knots and Great Knots (the latter only for Roebuck Bay, left) are given in the unshaded left-hand upper corners. For the Australian examples, each depicted specimen stands for one measured individual, for Mauritania each depicted bivalve represents three.



Apparent digestibility of *Mytilus edulis* and *Spisula subtruncata* fed upon by Knots in small cages (top) and the total amount of metabolized energy (bottom) in relation to the dry mass ingested during a 24 hr trial. Digestibility is expressed as the 'apparent metabolizable energy coefficient', the proportion of the ingested energy in the food which is not discarded as faeces and urine (these two are almost inseparable in birds) during a 24 hr experiment.

Knots digesting bulky bivalves: the principle of diminishing returns

T. Piersma, J. van Gils, J. Samuels

Knots tend to feed on molluscs. Such prey provides high-quality meat, but has the disadvantage of possessing heavy calcareous shells. Stout-billed waders like Oystercatchers are able to pierce the flesh from the shells, but Knots, with soft bills, ingest the entire prey. This results in fifty percent or more of the ingested mass consisting of indigestible mineral matter. To find out if such a high proportion of shell material affects the digestibility of the meat contained in mollusc prey, we carried out a series of digestion experiments with two species of bivalves. Knots in small cages were offered a weighed amount of either *Mytilus edulis* or *Spisula subtruncata*, and the faeces produced during the 24-hr experiment was collected. The energy retention by the birds was then plotted against the total dry mass ingested. It appears that above a certain amount of ingested dry mass, the apparent metabolizable energy coefficient drops. (Note that the low coefficients at small food intake rates are probably due an enhanced endogenous production of nitrogen containing protein-breakdown products; an effect which we eventually hope to account for analytically.) Therefore, the relative yield from eating bulky bivalves gets lower as more is ingested. The food intake rate at which the energetic return begins to diminish, is likely to depend on prey species and on the birds' gut structure. The latter effects are currently being investigated.

Energy conservation in Knots: holding the heat

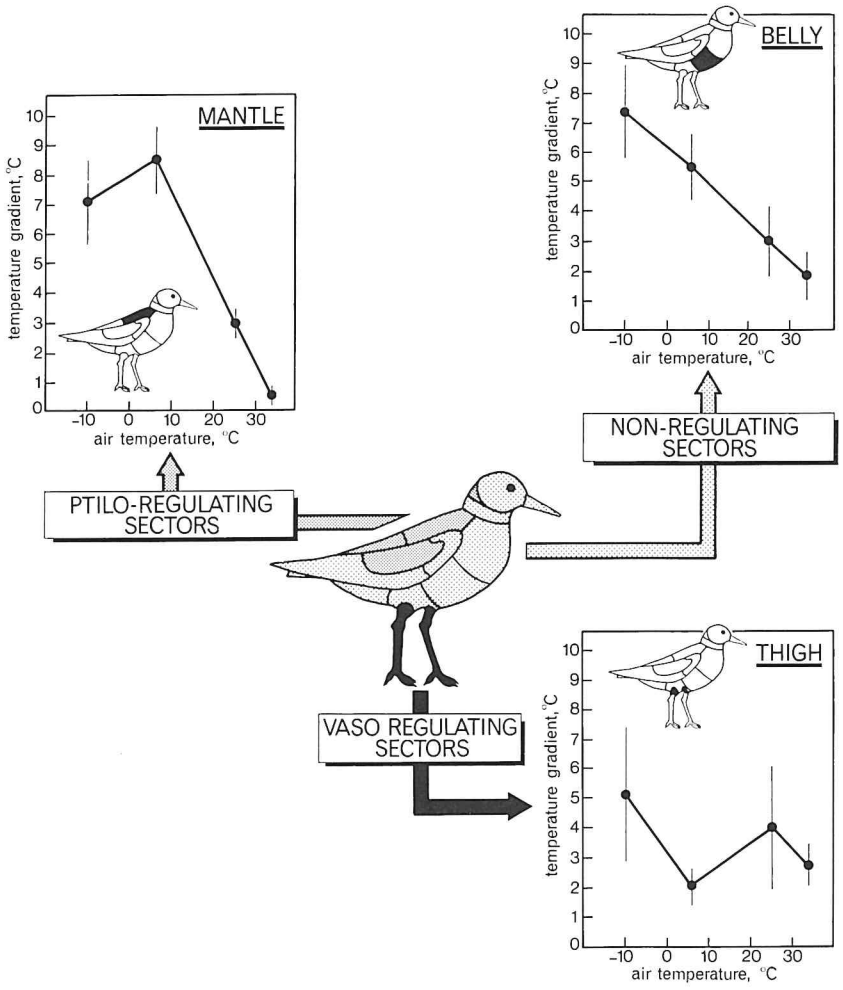
T. Piersma, L. Bruinzeel, P. Wiersma

Waders spending the non-breeding season at temperate latitudes such as in the Wadden Sea face low temperatures, strong winds and little sunlight. Yet, in some wader species, part of the population migrates much further south and may end up at tropical latitudes with high temperatures, little wind and a lot of sunshine. Knots provide a typical example of this pattern, with Siberian breeding birds 'wintering' in West Africa and their Greenland/Canadian conspecifics wintering in the Wadden Sea and on the British Isles. If we take into account that these small warm-blooded (40-43˚C) creatures breed in the Arctic and are therefore facing a wide range of climatic conditions with basically one type of insulating clothing (either a grey coloured winter or a red summer feather 'coat'), one wonders whether the birds are able to behaviourally adjust their insulative layer by adjustments to feather postures or subcutaneous blood flow in ways to either enhance the heat loss (in the tropics) or to conserve the body heat as much as possible (in the north). One avenue of finding this out was explored in 1991 in cooperation with Prof. G. Heldmaier of the University of Marburg, Germany, by the application of thermography of Knots under widely differing temperatures.

Thermography is the study of surface temperatures by infrared thermovision. We were able to use a video recording system connected to a personal computer and display unit, allowing the selection and digital storage of appropriate colour images. The system was mounted in a climate room to generate air temperatures between -10 and +35˚C. Knots were thermoscanned from above and from beside, and hard copies of selected images analysed afterwards.

The four experimental birds showed highly consistent patterns of body surface temperatures. Knots were not able to adjust the underparts of their plumage resulting in a constant linear increase of the gradient with decreasing temperature (we call this the non-regulating sectors of the bird's insulating layer). The upper parts of Knots showed a sudden decrease in the gradient at the lowest air temperature offered, suggesting an adjustment of the position of the feathers resulting in a reversed rate of heat loss (i.e. the ptilo-regulating

sectors). The legs and thighs showed the most variable response, with a decreasing gradient at decreasing air temperatures up to a point where the gradient increased again. This pattern might be explained by changes in the blood flow through the legs allowing loss of heat at high temperatures and conservation of heat at low temperatures, the latter without getting the legs frozen at very low temperatures (i.e. the vaso-regulating sectors). We suggest that these subtle adjustments in the positioning of the feathers and the 'strength' of the blood flow is one of the adaptations that helps Knots to survive under the widely differing set of climatic regimes they encounter, with only one set of clothes.



Gradient between the Knots' surface temperature and the air temperature in relation to the latter. Averages with standard deviations for measurements of selected sectors of the body surface in four different individuals are presented. A linear increase in the gradient with a decreasing air temperature indicates constant conductive properties of the relevant part of the plumage. The gradient's response to changing air temperatures allowed the distinction of three types of body surface sectors (see text).

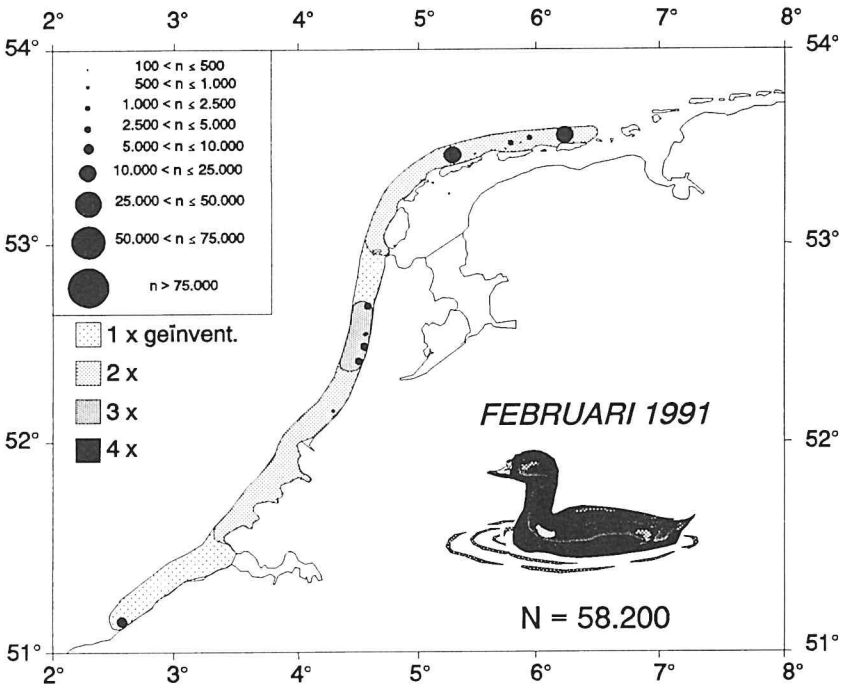
B3-09 SEA-BIRDS AND CETACEANS

M.F. Leopold

During the first Dutch Antarctic Expedition, the growth of chicks of Adelie Penguins was studied in relation to food delivery by the parents. In 6 weeks' time, the chicks grew from 65 g at hatching, to over 3 kg. The food consisted only of

krill. Besides krill, minute quantities of PCBs are unwittingly delivered to the chicks by their parents with every meal, and the increase of these toxic substances in chick bodies was followed. It is hoped that the PCBs can serve as a tracer of the total amount of food delivered to a chick during its life-time.

Seabird and cetacean work in the North Sea continued. The distribution of seaducks in Belgian and Dutch coastal waters was studied, and possible (benthic) food items were sampled. Some 100000 seaducks of the species *Melanitta nigra* were found wintering north of the Wadden Islands, over very rich banks of the bivalve *Spisula subtruncata*. *Spisula* was also found in masses at other localities where seaducks were present, and this bivalve was the main prey item found in stomachs of *Melanitta* that had died after an oil-incident in Zeeland. It is concluded that the distribution and density of *Spisula* is the main factor governing seaduck distribution in Dutch coastal waters. During the survey, on 12 March, a group of 48 Harbour Porpoises was encountered near Terschelling. This may well have been the largest group seen in Dutch waters during the last two decades.



Distribution of the Common Scoter (*Melanitta nigra*) in February 1991. Circles indicate group sizes (>100), hatchings the areas surveyed.

During the breeding season, in May and June, the distribution of the breeding seabirds of Heligoland was mapped at sea around this island. This work was a follow-up of last year's work on the food brought by parent birds to the colony. The birds were concentrated in waters west, north and east of the island, whereas the southern sector supported few seabirds. This project was carried out in cooperation with the 'Vogelwarte Helgoland', and also involved the training of German seabird workers. In August and September the waters off the British east coast were extensively sampled, during the young-fish and herring surveys of the Netherlands Institute for Fisheries Investigation (RIVO). This year's seabird and cetacean survey in this area and time of year was the

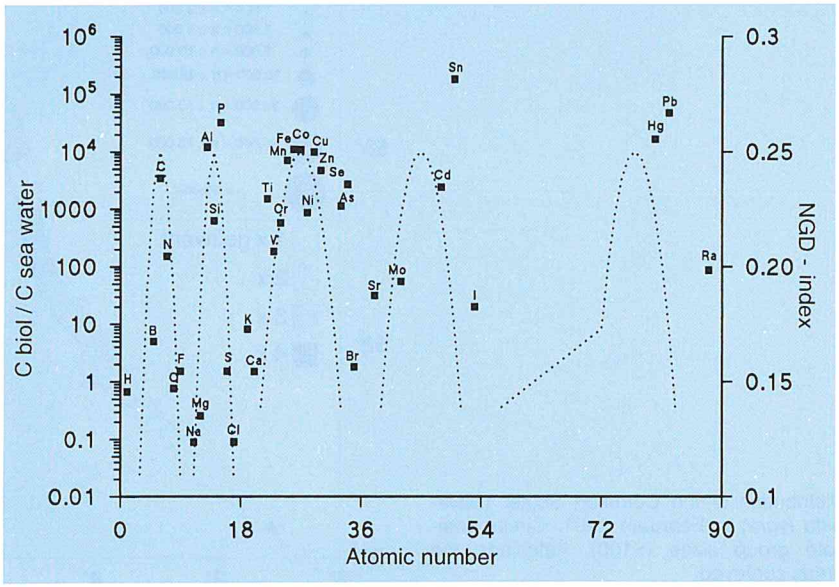
fifth in a row, and the resulting data-base now seems sufficient for a detailed analysis. Similarly, in December, the fifth RIVO-survey into the English Channel was joined for seabird counts in that area.

The seabird and cetacean work has attracted attention from the Dutch government and from the oil industry, and two reports on seabirds in relation to human interference with the marine environment have been produced to answer questions raised.

B3-10 CHEMICAL INTERACTIONS BETWEEN MARINE ANIMALS AND THEIR ENVIRONMENT

D.H. Spaargaren

The molal concentrations of 34 elements in various marine animals were compared with the availability of these elements in their natural environment and two physicochemical properties of the elements, *viz.* the charge/radius ratio or ionic potential and the 'Noble Gas Deviation' or NGD-index. The NGD-index is defined as a value which expresses the deviation of the electron configuration of an element from that of the previous and subsequent noble gas. A dimensionless value for the NDG-index can be obtained by taking the product of the number of electrons which must be lost and that which must be gained to obtain a noble gas configuration in the outer electron shell, divided by their squared sum.



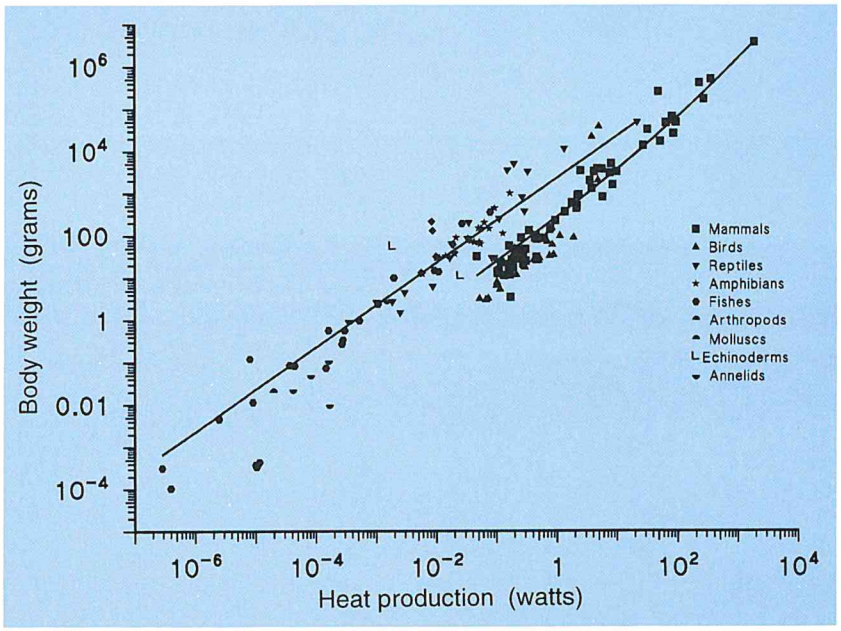
Concentration factors ($C_{biol}/C_{seawater}$: left-hand ordinate) and the Noble Gas Deviation index (right-hand ordinate) as a function of atomic number (abscissa).

The biological concentration factor (ratio of an element concentration in biological material and that in the environment) appears to be a periodic function of the element number, similar to the NGD-index. This close connection is most obvious when the composition of biological material is compared with that of sea water and becomes less clear if compared with river water or with the composition of crustal rocks. These results are in favour of a marine origin of life. The close fit between concentration factor and NGD-index offers a possibility to assess the concentration factors of elements for which up till now no data have been available.

A second study focused on the transport function of branching structures. In

larger animals a considerable part of the total body mass (*e.g.* body water, dissolved substances, mineral and organic deposits) does not consume, or hardly consumes, any oxygen. These materials can be considered to form a metabolically inert infrastructure which mainly serves three functions: (1) nutrient (building material and energy sources) storage, (2) transport and distribution of these materials and (3) structural support to the organism. Considering the transport and support function of the metabolically inert structures and their interconnections, it is likely that the infrastructure will basically show a tree-like, branching building plan. A method is described to determine the surface area (AQu) and the volume (VQu) of simple (dichotomal) branching structures in relation to a few parameters (*e.g.* the radius and the length of a primary branch; just as in the calculation of the surface area and volume of other geometrical objects, the obtained values are determined by the definition of the branching system). Experimental data concerning basic metabolic rate (P) in relation to body weight (W) fit very well the equation $W = k_1P + k_2P^{1.5}$, which can be derived considering the body to comprise a metabolically active part combined with a metabolically inert infrastructure. With increasing size of an organism the volume of its metabolically inert infrastructure increases disproportionally.

Just as with the 'power law' for basic metabolic rate, the theoretical equation requires the assessment of two parameters. Reasonable estimates have been derived.



Body weight associated with heat production. Curve fittings for poikilothermic and homoiothermic species.
Upper curve (poikilothermic animals): $W=9881\ P-1637\ P^{1.5}$; N=75, corr. coeff.=0.991.
Lower curve (homoiothermic animals): $W=779.6\ P+28.1\ P^{1.5}$; N=94, corr. coeff. =0.997.

B3-11 PALAEOBIOLOGY

G.C. Cadée

The main topic is the study of taphonomy i.e. the processes between death of an organism and its final embedding in the sediment. The study focuses on molluscs and processes studied include transport and fragmentation of shells. Eolian transport of shells was observed during gales. Particularly large flat

shells such as those of *Mya arenaria* were transported inland from the tidal flats. For the study of fragmentation of shells by predators we focused on Eiderducks in the Wadden Sea. Eiderducks feed mainly on bivalves which they ingest and crush in their gizzard. Due to low densities of living mussels and cockles (*Mytilus* and *Cerastoderma*) as a result of several years of recruitment failure (see also B3-08a) some eiders started to feed on periwinkles (*Littorina littorea*). In this way they added crushed periwinkles to the sediment. Although it is difficult to distinguish shell fragments produced by predators (birds, fish, crabs) from those produced by physical processes, data accumulate which indicate that predators are the main source of shell fragments (of all sizes including the smallest) in Wadden Sea sediments. (See also 1.9.1. under Shoichi Shimoyama.)

(Photo: NIOZ)

1.8. SPECIAL PROJECTS (S)

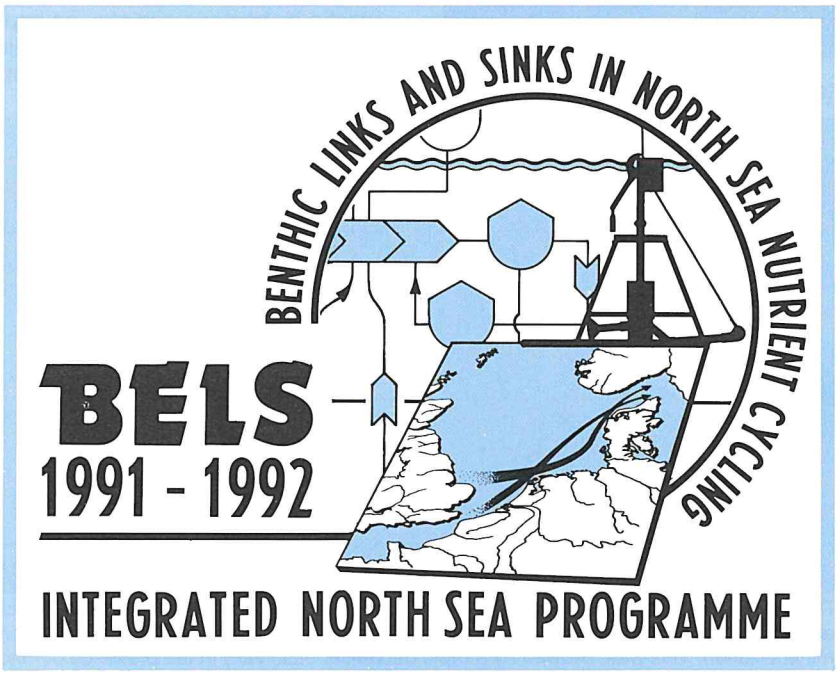
APPLIED SCIENTIFIC RESEARCH NIOZ (BEWON)

The BEWON group is part of the larger BEON-project (= Policy Linked Ecological Research North Sea and Wadden Sea), a cooperative effort between 9 Dutch institutes including NIOZ. The group executes a scientific research programme to improve the scientific basis for the management of the North Sea and the Wadden Sea. This research concerns politically sensitive problem areas: eutrophication, micropollutants and effects of fisheries on the marine ecosystem.

In close cooperation with other Dutch and foreign institutes, this year's programme focused on sediment-water interactions of nutrients, nutrient availability and *Phaeocystis* blooms, the biology of the small foodweb, physical modelling of the coastal zone, ecological modelling of the North Sea, pollution and higher trophic levels, and the effects of fisheries on the North Sea ecosystem.

Participation in several EC- and NOP-funded projects proceeded, and various cruises were made to study the effects of beam-trawl fishing. BEWON was co-organizer of the Integrated North Sea Programme (INP), and two major INP cruises were carried out. These focused on studies of the sediment as link or sink in nutrient cycles, as well as on the effects of micropollutants.

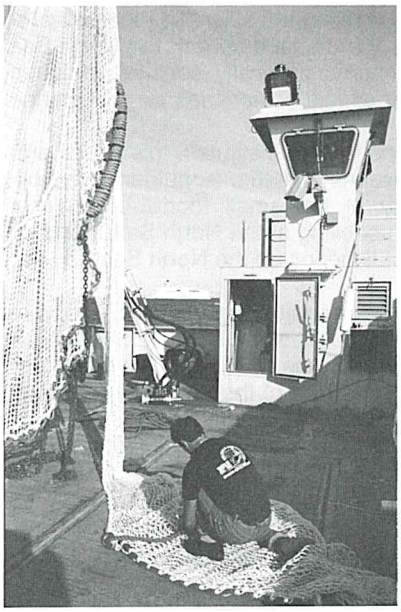
Various advisory reports written or supported by the group concerned the establishment of protected areas in the North Sea, the ecology of the coastal zone, the Frisian Front, the effect of drilling platforms on the ecosystem, the effect of beamtrawl fishery, and the cause of nuisance algal blooms.



S-01 EUTROPHICATION

S-01a NUTRIENT CHEMISTRY

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

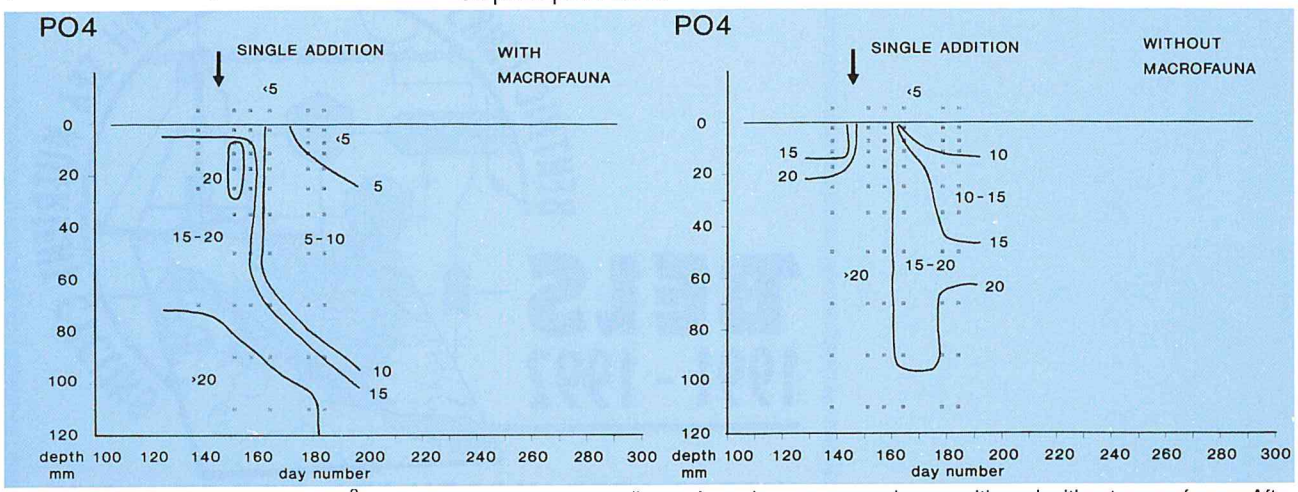


(Photo: G. Nieuwland)

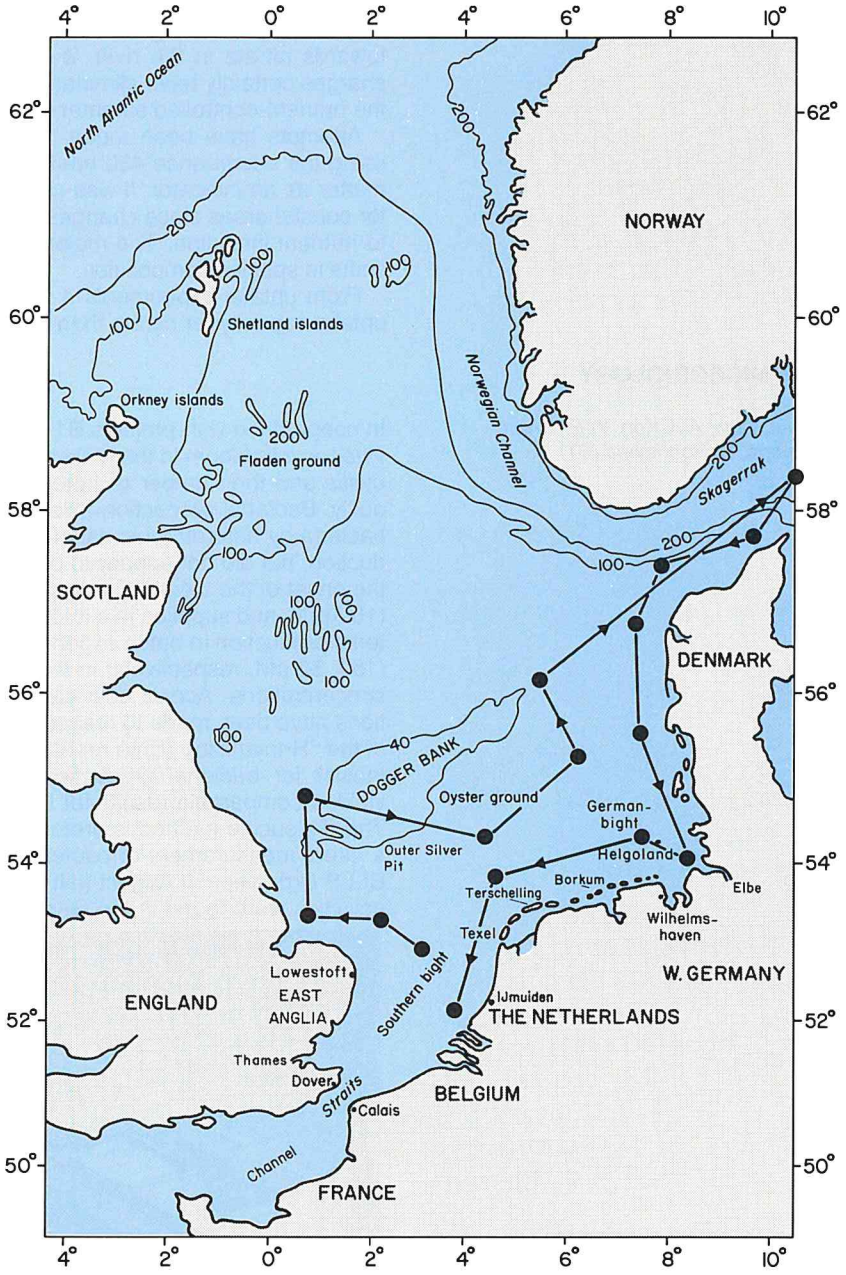
During 1991 the experimental work concentrated on sediment-water interactions of nutrients (N, P, Si) in the North Sea. The most important activity was the first leg of the programme Benthic Links and Sinks in North Sea Nutrient Cycling (BELS), which was carried out with *RV* Pelagia in August (chief scientist W. van Raaphorst). This cruise, funded by SOZ, was part of the Integrated North Sea Programme (INP) and visited 16 stations in the southern and eastern parts of the North Sea. Besides NIOZ, DIHO and the Free University of Brussels participated in BELS, while cooperation was established with a North Sea programme of Plymouth Marine Laboratory (PML, UK) and the British MAFF-JoNUS programme. During the cruise 14 scientists performed measurements on early diagenesis of nutrients in the upper 10-15 cm of North Sea sediments. To answer the question: how do benthic groups of organisms affect sedimentary nutrient cycling, measurements were also done on bacteria, protozoa, meio- and macrofauna, and demersal fish (see alsoH1-02,B1-06, S-01c, S-01d).

Work on sediment-water interactions of nitrogen were performed in close cooperation with H1-02 (L. Lohse, W. Helder). Results indicate that on an annual basis, from the biologically rich sediments of the Frisian Front almost all nitrogen mineralized in the sediment is returned to the water column. From the sandy sediments of the Broad Fourteens area, only 75% is regenerated to the pelagic system. It was demonstrated that differences in nitrogen releases from the sediments of the Frisian Front and Broad Fourteens can explain the relatively high chlorophyll concentrations at the Frisian Front during late summer.

Phosphorus binding to North Sea sediments was also studied. Results of the 1990-mesocosm project and North Sea field measurements indicate that P-uptake by bacteria can play an important role in the sediment-water exchange of phosphorus. Part of the organic phosphorus deposited on marine sandy sediments seems to be —at least temporarily— bound to the sediments by sorption processes.



Phosphate concentrations (mmol·m^{-3}) in the porewater of the sediment from the mesocosm boxes with and without macrofauna. After addition of organic matter (indicated by an arrow) the porewater phosphate concentration in the upper layer increased, presumably due to mineralization. This was followed by a rapid decrease, especially in the presence of macrofauna.



Cruise track of the INP-programme Benthic Links and Sinks in Benthic Nutrient Cycling in August 1991. In total 16 stations in the Southeastern North Sea were visited to study aspects of sediment-water interactions of nutrients.

S-01b PHYTOPLANKTON

R. Riegman, A.A.M. Noordeloos, W. Stolte, C. Brussaard, A. Rowe

The nuisance algal species *Phaeocystis* was studied in continuous cultures. Competition experiments at various nitrogen/phosphate (N/P) ratios indicated that *Phaeocystis* is a poor competitor under P-limitation and an excellent competitor under N-limitation. Colony formation was stimulated when *Phaeocystis*

was cultivated on nitrate rather than ammonium. Since improvement of waste water treatment along the Rhine has caused a dramatic shift from ammonium towards nitrate in the river, it was concluded that the increased nitrate discharges certainly have stimulated the blooming of *Phaeocystis* colonies during the nutrient-controlled summer period in the Dutch coastal areas.

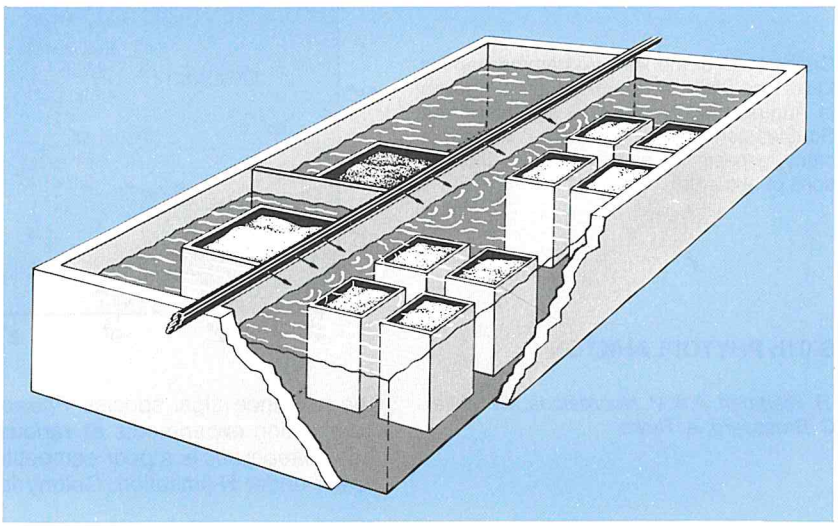
Attempts have been made to establish nutrient limitation in the Marsdiep using the absorbance 480 nm/665 nm ratio in acetone extracts of suspended matter as an indicator. It was concluded that this method may not be suitable for coastal areas since changes in this ratio could not exclusively be attributed to nutrient limitation. The majority of changes in absorption ratio were due to shifts in species composition.

From uptake experiments it was concluded that diatoms do have a higher uptake capacity for nitrate than non-diatoms.

S-01c MICROBIOLOGY

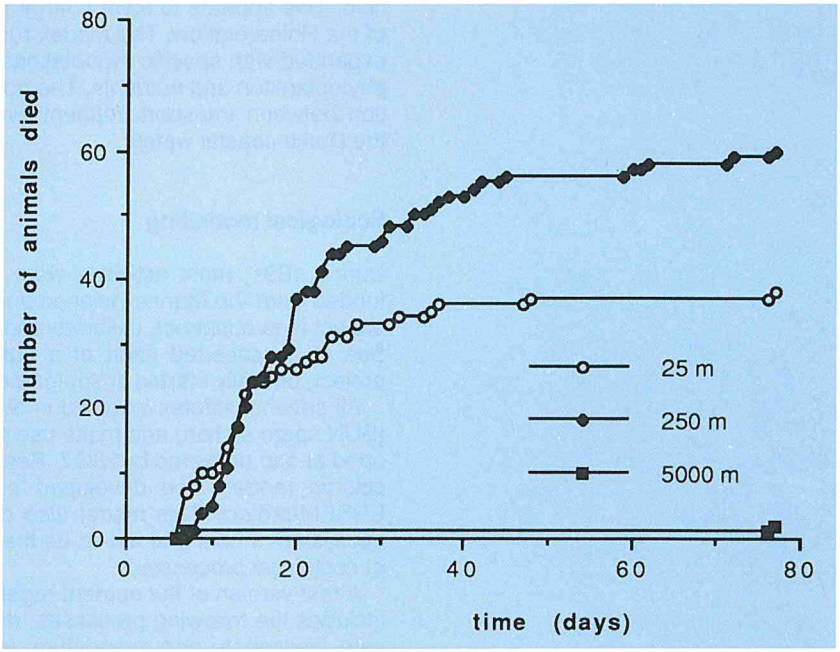
F.C. van Duyl, A.J. Kop, W.E. Lewis, R. Osinga, B. Hondeveld (B1)

In cooperation with projects B1-06, B2-01 and B3-01 the wax and wane of the *Phaeocystis* bloom in the Marsdiep was studied. Single cell numbers of *Phaeocystis* and the number of heterotrophic nanoflagellates increased simultaneously. Bacterial production followed with a time lag of 10-12 days. Grazing of bacteria by heterotrophic nanoflagellates may have retarded the bacterial production, but did not appear to play a regulating role on bacterial abundance at the onset of the bloom. *Phaeocystis* material collected in the wax of the bloom (15 April), and supplied in a thick suspension to seawater, initially inhibited bacterial production in batch experiments. High concentrations of DMSP and DMS (150, 50 μM, respectively) in these samples suggested high potential acrylate concentrations. Acrylic acid can act as a bacterial growth inhibitor. Preparations have been made to measure acrylic acid in marine samples. Comparison of the ^{3}H-thymidine (DNA replication rate) and ^{3}H-leucine method (protein synthesis) for bacterial production measurements showed that both methods yielded comparable results for bacterial production rates in marine sediments. The ^{3}H-leucine method is preferred above the thymidine method because it is a direct measurement of bacterial biomass production. During the North Sea BELS expedition in August (INP), the ^{3}H-leucine method was applied. Highest activities were found in the German Bight. In addition, the hypothesis 'benthic



Mesocosm set-up showing the two seawater-filled basins housing submerged sediment sections in containers. Each water basin has its own water circulation system. The inflow system in the right basin is shown. Basins are separated from each other by thermo-insulated walls (not shown).

heterotrophic nanoflagellates play a significant role in the N-regeneration' was investigated. Cycloheximide, an inhibitor of the protein synthesis in eukaryotes, inhibits grazing of bacteria by benthic nanoflagellates. Preliminary results suggest that under certain environmental conditions the efflux of DIN is reduced in the absence of grazing of protists.



Mortality in *Echinocardium* in sediment cores from 25 m (31-935 mg oil·kg^{-1} dry sediment), 250 m (28-215 mg·kg^{-1}) and 5000 m (2-3 mg·kg^{-1}).

S-01d HIGHER TROPHIC LEVELS

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

The main effort has been concentrated on the impact of micropollutants on the population dynamics of North Sea fish species, a project in cooperation with S-02d, B3-08 and the Netherlands Institute for Fishery Investigations (A.D. Rijnsdorp). Abundance, growth and reproduction of the dab *Limanda limanda* were determined for four North Sea sub-populations that were thought to differ in PCB content. Laboratory experiments were executed simultaneously to study the impact of PCB on the reproduction and growth of dab. First results indicate that under laboratory conditions even the treatment with the highest PCB concentration did not result in effects on egg and/or larval survival. A preliminary analysis of the field data shows large differences in mortality and growth between areas. However, at present the effect of PCBs (micropollutants) and the effect of differences in food availability (eutrophication) cannot be distinguished (see also B3-08).

S-01e MODELLING

Physical oceanography

H. Ridderinkhof, J.W. Baretta, P. Ruardij, A. van de Berg

A transport model for the southern part of the North Sea has been constructed. This model serves as the physical base for an interdisciplinary model to study the effects that changes in nutrient supply from the rivers have on phytoplank-

ton biomass and succession. One version of the model is based on velocity fields as computed by the Institut für Meeresforschung, Hamburg (IFM), whereas another is based on the velocity fields as computed in the ZUNOWAK-model (Rijkswaterstaat). The main difference between the two is that with the IFM-model daily variation, based on actual wind forcing, has been computed, whereas the ZUNOWAK-model calculates a stationary velocity field. This appears to have a large influence on the results, *e.g.* the spreading of the Rhine outflow. The model, running under the SESAME-package, will be expanded with specific formulations for non-conservative state variables, *e.g.* phytoplankton and nutrients. The goal of this model (FYFY) is to study the relation between transport, nutrient availability and phytoplankton succession in the Dutch coastal waters.

Ecological modelling

During 1991, most activities were concentrated on the EC-ERSEM project, funded from the Marine Science and Technology programme. The goal of this project is to construct, calibrate and validate an ecosystem model of the North Sea in a concerted effort of a number of marine institutes in the EC. The project, officially started in september 1990, has now passed its initial phase.

All seven institutes involved in the project have bought the same hardware (SUN sparc station) and make use of the simulation package SESAME, developed at and delivered by NIOZ. Besides this package a first version of a water-column model, also developed by NIOZ, is delivered for use within the ERSEM-project. This model also defines the overall logical structure of the ecosystem model and will so be the test bed for newly developed formulations of ecological processes.

A first version of the nutrient regeneration model was completed. This model includes the following processes: nitrification, denitrification, adsorption of silicate, phosphate and ammonium, immobilization of phosphate, vertical transport and exchange of nutrients between the water column and the sediment.

S-01f MODELLING PHYSICAL OCEANOGRAPHY OF THE WESTERN WADDEN SEA

H. Ridderinkhof, J.T.F. Zimmerman

See H2-03

S-01g WADDEN SEA ECOSYSTEM MODEL (EMOWAD)

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

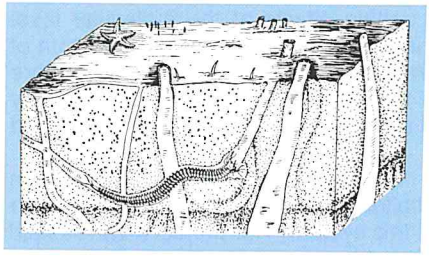
Together with IBN (formerly RIN) and German and Danish institutes the EC-MAST project on Wadden Sea modelling (WASP = Wadden Sea Project) was continued. Most emphasis was laid on the extension of the benthic submodel with proper nutrient dynamics (N, P, Si). To make this possible the entire existing version of the EMOWAD benthic submodel was changed, including the model structure. All work has been performed in close cooperation with the North Sea ERSEM project. Within WASP coupling between ecosystem models and physical models has a high priority. To develop strategies to actually perform such a coupling, a workshop was organized at NIOZ in January (22-25), which was attended by 25 scientists from Germany, Denmark and The Netherlands.

S-02 MICROPOLLUTANTS

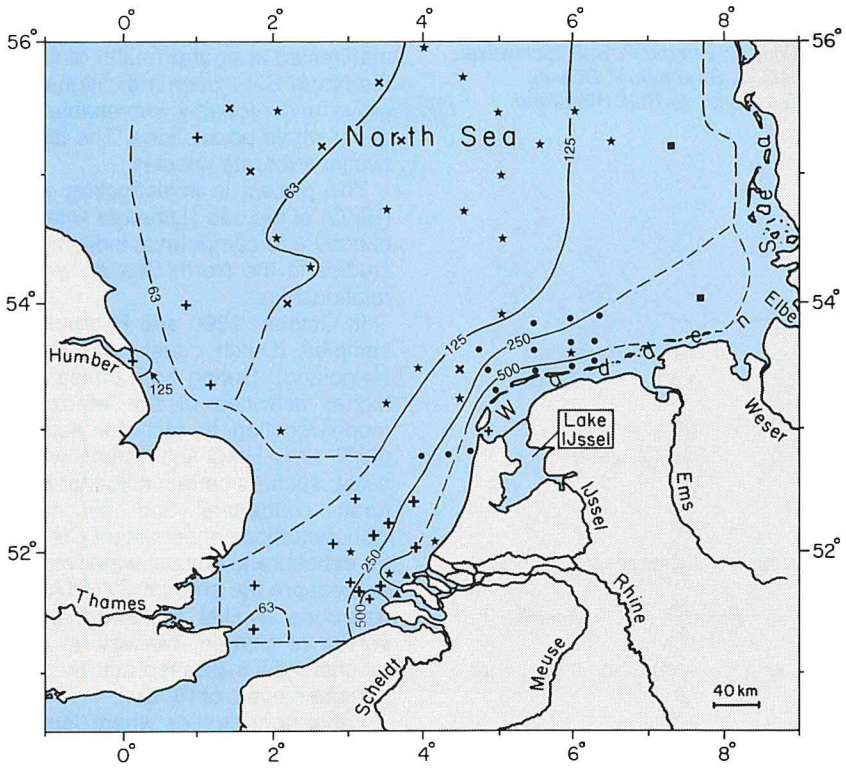
S-02a ENVIRONMENTAL FATE OF POLYAROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT

J.P. Boon, M.Th.J. Hillebrand,
J.M. Everaarts, J.M. Nieuwenhuize (DIHO)

All data on concentrations of 2,2',3,4,4',5'-hexachlorobiphenyl (CB-138) in the benthic polychaete worm *Nephtys* spp. from the North Sea were plotted in a single figure. 64 stations were sampled between 1981 and 1990. Since the concentrations of other CB-congeners largely co-varied with the concentrations of CB-138, data on total PCBs generally follow the same trend. Only in the area where the lowest concentrations occurred was the share of tri- and tetra-chloro-biphenyls larger than in other areas.



Nephtys spp. lives in (semi-permanent) tunnels in de bottom of the North Sea.



Isolines of concentrations of 2,2',3,4,4',5'-hexachlorobiphenyl (CB-138) in the benthic polychaete worm *Nephtys* spp. Values are in $ng \cdot g^{-1}$ pentane-extractable lipid (PEL). Each sample consisted of at least 5 specimens.
Broken lines: Insufficient data to indicate the border line between areas with different concentration levels accurately.
+: Sample taken between 28 September and 6 October 1981
●: Sample taken between 11 and 14 January 1982
■: Sample taken between 28 September and 6 October 1982
⁎: Sample taken between 16 April and 2 May 1986
X: Sample taken between 14 and 23 July1988
▲: Sample taken on 19 September 1988
The samples taken in 1988 were analysed by J. Nieuwenhuize and J.M. van Liere at the Delta Institute for Hydrobiological Research (DIHO).

A stable concentration gradient existed perpendicular to the Dutch coast. This is because Dutch coastal water mixes poorly with water of Atlantic origin entering the North Sea via the Channel and north of Scotland. The range of CB-concentrations in the southern North Sea amounts to a factor of about ten.

The background concentrations in the central part of the southern North Sea are determined mainly by interaction with the atmosphere, while riverine input is mainly responsible for the increase above these concentrations in the Dutch coastal area.

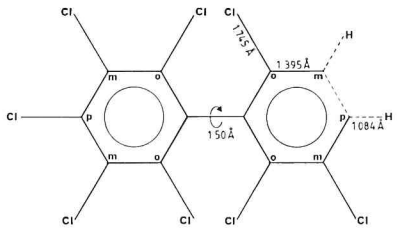
S-02b BIOCHEMICAL AND PHYSIOLOGICAL EFFECTS OF MICROCONTAMINANTS

J.P. Boon, H.M. Sleiderink, M.J.C. Rozemeijer, I. Oostingh, M. Fonds, J.IJ. Witte, P. van der Puyl, D. Schweizer, E. Casal, C. Swennen, P. Duiven, J.M. Everaarts, M.Th.J. Hillebrand

This part of the project tries to connect increased environmental concentrations of selected organic contaminants with certain effects at the molecular level manifested in poorer health of fish and invertebrates that live at the bottom of the North Sea. Such indications can serve as early-warning signals for more grave and probably irreversible effects that occur at a later stage and may affect whole populations. The biological effects will be studied in four fish and two invertebrate species.

The project is investigating whether the hepatic monooxygenase system (HMO) of the dab (*Limanda limanda*) is suitable as an indicator of effects upon exposure to compounds inducing part of this system. The project involves field studies in the North Sea as well as laboratory studies to investigate causal relationships.

In October 1990 and February 1991, four locations in the North Sea were sampled (Dutch coast near Callantsoog, Frisian Front, Dogger Bank and Helgoland). During both cruises, adult fish from the coastal location showed higher activities of the ethoxyresorafin-o-deethylase (EROD) reaction, a model-reaction to test the activity of the cytochrome P4501A1-dependent (CYP 1A1) HMO-subsystem, which is induced by planar polyaromatic molecules, such as certain chlorinated biphenyl (PCB), dibenzodioxin and dibenzofuran congeners and by certain polyaromatic hydrocarbons (PAHs). Concentrations of persistent CB-congeners in dab muscle are used as markers for exposure to coastal water masses. Immunochemical techniques were used to measure the amount CYP 1A1 present in the liver. This part of the research was done by H.M. Sleiderink at the Marine Molecular Biology Laboratory, University of Bergen, Norway, in cooperation with Dr. A Goksøyr. Preliminary results show increased activity of CYP1A1 at the coastal location in adult fish at higher levels of PCBs.



Vicinal H-atomes in meta (m) and Para (p) positions of a chlorobiphenyl molecule.

Laboratory studies where female dab were injected several times with the technical PCB-mixture Clophen A40 confirmed the induction of CYP1A1. However, this did not have any visible influence on their reproductive success.

In another laboratory experiment executed in cooperation with the Tidal waters Division of Rijkswaterstaat (DGW-RWS), the Free University of Amsterdam (VU) and the Dutch Organization for Applied Research (MT-TNO), flounder (*Platichthys flesus*) were injected with the carcinogenic compound benzo[a]pyrene (B[a]P). Exposure to B[a]P resulted in increased activity of CYP1A1, increased levels of B[a]P metabolites in bile and increased B[a]P-DNA adducts in liver, representing a point mutation that may lead to a malignant tumour at a later stage of development.

On the basis of these results and the results described in project S-02a, two SOZ-sponsored cruises in the Integrated North Sea Programme (INP) were planned. The first cruise with participants from 9 other Dutch and foreign institutes was executed in August-September 1991.

During 1990 and 1991, eider ducks (*Somateria mollissima*) severely suffered from mass mortality due to parasitic infections. Besides a lack of suitable food, contamination of the Wadden Sea with PCBs has also been mentioned as a possible cause of their deteriorated immune system. In cooperation with the Department of Toxicology of the Agricultural University of Wageningen, a laboratory experiment was carried out in 1990.

The HMO-system of eider ducklings was induced after injection with 3,3'4,4'-tetrachlorobiphenyl (CB-77), but not by the technical mixture Clophen A50. Of the latter, uptake rates were independent of the molecular structure while only congeners with vicinal H-atoms in the meta- and para-positions were metabolized, which appears to be the normal situation in seabirds and is in contrast to *e.g.* marine mammals. Eider ducklings appear to be only weakly sensitive to alterations in plasma levels of vitamin A and thyroid hormones (TT4 and TT3) caused by PCBs, probably because of the metabolic profile of the PCBs. Moreover, the PCB injections did not influence the sensitivity of the eider ducklings to artificial infections with the parasite *Polymorphus botulus*.

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

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

Research on the effects of waste discharges at offshore installations focused on oil-contaminated drill cuttings that were washed or thermally treated before discharge. Such techniques have recently been developed to remove as much oil as possible from the cuttings. The results of a field survey at a location where washed cuttings had been discharged showed that short-term effects (in terms of fauna abundance or diversity) in the close vicinity of the platform were evidently less severe than at similar locations where no washing procedure was applied. Boxcosm experiments performed with sediments collected at stations at 25 m, 250 m and 5000 m from the discharge point did not reveal a significant response of the natural infauna (in terms of mortality) to increased contamination levels. However, an introduced test species (*Echinocardium cordatum*) suffered considerable mortality in contaminated sediment of both the 25-m and the 250-m station, whereas in sediment of the 5000-m station mortality was almost nil. There is no indication that the extent of the area subjected to environmental stress is reduced by applying a washing procedure: Densities of some very sensitive species were low up to 1000 m from the platform. In 1991 a follow-up survey was carried out to investigate long-term effects.

Boxcosm experiments with sediment cores that were artificially contaminated by dosing different amounts of thermally treated cuttings showed hardly any effect of these simulated discharges, neither on test animals nor on the natural infauna. The only evident effect was a reduction in the thickness of the aerobic sediment layer.

Boxcosm experiments performed to study long-term effects at a location where unwashed oil-contaminated drill cuttings had been discharged 6 years before revealed a clear response of *Echinocardium cordatum* to contamination of the sediment. Oil concentrations in the sediment around the platform were still high and elevated mortality in *Echinocardium* appeared to occur up to 250 m from the location.

The investigations are carried out under contract with RWS (North Sea Directorate) and NOGEPA (oil companies) and performed in close cooperation with MT-TNO Den Helder.

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

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

The research that was carried out in 1990 on the penetration depth of beam trawls, on the survival rate of fauna caught in the trawl and on the long-term effects of beam trawling has now been worked out.

Results of the determination of parallel stratification, particle size distribution, reciprocal formation-factor, porosity and vertical distribution of foraminifers and meiofauna indicate that the commercial beam trawl disturbs the hard-sand sediment to a depth of at least 4-8 cm. Due to the absence of a reference stratum in the sediment the methods used in 1990 are not suited to determine exact penetration depths. Future research will need the assistance of divers or a remote-operated underwater system to insert special objects into the bottom to a given depth before trawling starts.

The composition of the catches and the survival rate of benthic species and fish after their treatment on board were studied on board a beam trawler fishing for sole (*Solea solea*) with 12 m-beams. The survival of living species collected from the catches was estimated in seawater tanks on board the ship, over a period of 2-3 days. The chance that fish caught in the trawl will survive is almost nil. The chance of benthos to survive depends on the species involved: 40% for molluscs and crabs, 70-80% for starfish and almost 100% for whelks and hermit crabs. Fish that escape through the meshes have a 80-90% chance of survival. Sole fishing produces dead fish and benthic animals which are returned to the sea: approximately 0.1-0.2 g ash-free dry weight per m^3 per haul. Part of this material is consumed by birds and starfish.

Comparison of the benthic fauna in an untrawled area with that of an adjacent trawled area may give information on long-term effects of beam trawling. The area in and around 'Borkum Riff' is one of the few suitable locations in the southern North Sea where —because of the presence of large stones— a scarcely trawled area is enclosed by a frequently trawled area. Species composition of meiobenthos, macrobenthos (infauna and epifauna) and fish was determined in both areas. Sediment characteristics (grainsize and silt content) appeared to be the dominant factor for the composition of macrobenthic infauna and to a lesser extent of macrobenthic epifauna and fish. In this study it was not possible to demonstrate any significant differences in species composition which could be attributed to long-term beam trawling. Differences —although not significant— indicated lower densities of species of molluscs (*Corbula gibba, Natica alderi, Ensis* spec., *Tellina fabula*), crustaceans (Corystes, Thia) and worms (*e.g.* Pectinaria) in the areas which had been fished.

In August 1991 species composition of macrobenthos in the area in and around 'Borkum Riff' was investigated in more detail. Sampling with the newly developed benthos-dredge was carried out at locations near the observed ridges of stones. During the period of investigation the area in 'Borkum Riff' that was considered barely to have been trawled was checked again by side-scan sonar. These recordings showed hundreds of beam-trawl tracks. Obviously also this area had been beam-trawled intensively and was useless to demonstrate long-term effects of trawling.

The studies were carried out in cooperation with Rijkswaterstaat-North Sea directorate (RWS-DNZ), Netherlands Institute for Fishery Research (RIVO), Netherlands Geological Survey Marine Geology Division (RGD/EZ) and Delta Institute for Hydrobiological Research of the Academy of Sciences (DIHO).

S-04 RELATIONS BETWEEN THE NORTH SEA AND THE ATLANTIC OCEAN

J.M.J. Hoppema, H.J.W. de Baar

Upon request from the Tidal Waters Division of Rijkswaterstaat, a literature survey investigating all possible relations between the North Sea and the North

Atlantic Ocean was performed. Emphasis was laid upon physical interactions. It was found that not only short-term influence of the North Atlantic is exerted on the North Sea (tides, storm surges, water import), but long-term influence as well. The latter is expressed by changes in the Gulf Stream-North Atlantic Current system, which recur in the temperature and salinity record of the North Sea. The North Atlantic also has an impact on the long-term variations of biological parameters on the North Sea: The variations of zooplankton and phytoplankton in the North Sea are very similar to those in the Northeast Atlantic, whereas these in turn correlate positively with hydrographic parameters of the Gulf Stream and with the sea surface temperature and salinity for the North Atlantic. Nowadays, it is generally accepted that long-term changes in hydrography and biology are caused by climatic fluctuations. The mechanism by which the large-scale biological variations are effectuated is still largely unknown.

S-08 LONG-TERM CHANGES IN THE OCCURRENCE OF RARE FISH SPECIES IN THE SOUTHERN PART OF THE NORTH SEA

C.G.N. de Vooys, H.W. van der Veer, J.IJ. Witte, J. van der Meer

The analysis of data on rare fish species collected by NIOZ from about 1930 till the present was completed. The occurrence of some of the species studied, especially rays (skare, stingray, smooth hound, angler and greater weever), was probably negatively influenced by fisheries. The changes in the occurrence of the other species (sturgeon, tadpole fish, electric ray, marbled electric ray, conger, basking shark and thresher shark) are probably caused by factors other than fishery.

The records of rare fish species by the commercial fish fleet from 1930 onwards show remarkable similarities between species. Of the 16 species analysed so far, 54% of the variation for all the species can be described by a common pattern, based on principal component analysis. Since the decrease in abundance of one of the species, the greater weever *Trachinus draco*, is assumed to be caused by increased beam-trawl fisheries, this pattern might reflect a general impact of beam-trawl fisheries on a group of species. The investigations will be continued with the analysis of the patterns of other species.

S-09 PROTECTED AREAS NORTH SEA

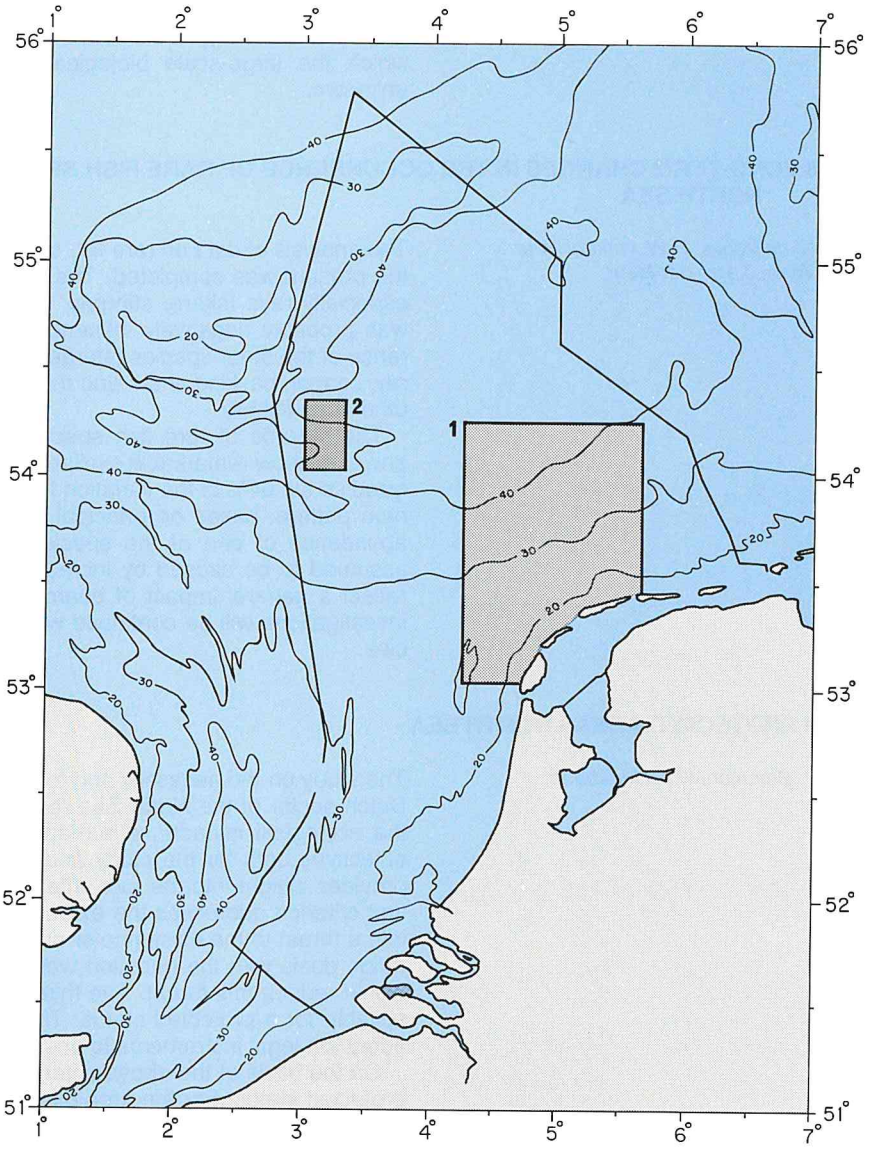
M.J.N. Bergman, H.J. Lindeboom

The study on the necessity and feasibility of designating protected areas in the Dutch sector of the North Sea reviews the knowledge on the ecosystem and the ecological impacts of human activities. The study also summarizes the objectives both for the study and for the designation of protected areas and provides insight into the four criteria that are used to come to a decision. The first criterion addresses the extent to which specific activities have developed into a threat to the existence or normal functioning of species. The second criterion deals with the question whether restriction of activities in certain areas would reduce this threat. The third criterion is used for identifying areas most suitable for a protected status. The last criterion deals with the availability of adequate legal instruments to ensure effective protection of these areas.

On the basis of the above criteria it is concluded that two areas qualify for a protected status. For the area directly northwest of the Frisian Islands (10000 $km^{2)}$ the following protective measures have been proposed: a) Closure of all types of fisheries throughout the year. b) Oil-containing discharges from off-

shore mining installations will be prevented (oil) or minimized (production water). c) Additional area-specific measures (offshore mining, shipping, military activities, sand extraction, dumping and laying of pipelines) can be considered whenever necessary. d) International conventions with respect to conservation will be applied. The Klaverbank (800 km^2) should be given a protected status under which gravel extraction is prohibited and oil-containing discharges from offshore mining will be prevented (OBM) or minimized (production water).

This study was carried out on request of the Ministry of Agriculture, Nature Management and Fisheries and executed in cooperation with Sea Use Management Studies, Education and Advice (SEA).



Areas within the Dutch sector of the North Sea qualifying for a protected status: 1. the area directly northwest of the Frisian Islands; 2. Klaverbank.

S-10 MONITORING MACROBENTHOS WADDEN SEA

R. Dekker

The monitoring programme for macrozoobenthos in the subtidal western Wadden Sea was extended with work on intertidal flats in the eastern part of the Dutch Wadden Sea. During 1991, three transects between Ameland and the mainland and three transects in the Dollard were sampled twice (in March and September). These six transects are part of the long-term programme 'Biological monitoring macrozoobenthos Wadden Sea and Ems-Dollard' (Biolmon) of the Ministry of Transport and Public Works, Tidal Waters Division (DGW). The work on the three subtidal transects in the western Wadden Sea was continued. Intertidal transects in this part of the Wadden Sea are monitored in the framework of B3-02.

Spring sampling indicated a dramatic mortality of several winter-sensitive species which had become established during the previous years with extremely mild winters. During summer, a number of macrobenthic species (*Ensis americanus, Lanice conchilega*) showed a very successful recruitment, especially on intertidal flats. In the Dollard, such conspicuous mortalities and recruitments were not observed since no winter-sensitive species inhabit this area, and species showing a successful recruitment elsewhere do not penetrate into the brackish waters of the Dollard.

1.9. ADDITIONAL RESEARCH

1.9.1. Research at NIOZ by guests

- S. Baskakov (Moscow State University) studied mud volcano sediments and structures.
- Phil Battley (Wanganui, New Zealand), from August to October, worked on feeding ecology of Knots and benthic food abundance in the western Wadden Sea.
- Dr. David Brew (University of East Anglia, Norwich, UK), on a grant from the British Council, worked on microfauna in fine sediment from the German Bight. The purpose of this work is to trace recent changes in the near-bottom environment of that area. To date the sediments, ^{14}C analyses will be carried out.
- Ir. W. ten Brinke (Rijkswaterstaat, Tidal Waters Division, Middelburg) studied suspended matter samples from the Oosterschelde in relation to flocculation.
- Dr. Th. Courp (Laboratoire de Sédimentologie et Géochimie Marine, Perpignan, France), on a grant from the French Government, continued his work on suspended matter transport in the Lacroze-Duthiers canyon in the Gulf of Lions, NW Mediterranean. He also worked on samples collected in the Bay of Biscay and the Gironde river. For training purposes, some XRD analyses were carried out on bottom sediment samples from the East China Sea.
- M. Gehlen (Free University of Brussels) worked together with W. van Raaphorst on the early diagenesis of silica in North Sea sediments and on the use of silica as tracer for bioturbation studies.
- Dr. A. Goksøyr and J. Beyer (Institute for Marine Molecular Biology, University of Bergen, Norway) participated in the Integrated North Sea Programme (INP), theme microcontaminants, cruise I (26 August to 14 September) on the North Sea for measurements of cytochrome P4501A with immunochemical techniques (ELISA) in dab (*Limanda limanda*).
- Dr. Richard S. Halbrook (Environmental Science Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA) participated in Integrated North Sea Programme (INP), Theme Microcontaminants, Cruise I (26 August - 14 September) on the North Sea, collecting samples of dab (*Limanda limanda*) and seastar (*Asterias rubens*) for the determination of DNA damage.
- F. Hansen (University of Kiel) studied grazing on *Phaeocystis* by copepods in the framework of the EC project 'Dynamics of *Phaeocystis* blooms in nutrient enriched coastal zones'.
- K. Ivanova (Moscow State University) studied benthic foraminifera in a piston-core from the Norwegian Channel.
- Dr. Amir Kahn (Dacca, Bangladesh) on a grant from UNESCO worked on sediment samples from the Dutch Wadden Sea and North Sea. The main purpose of this research was to study metal diagenesis and trace metal distributions in these sediments.
- Dr. J. Klungsøyr and S. Wilhelmsen (Institute for Marine Molecular Biology, University of Bergen, Norway) participated in the Integrated North Sea Programme (INP), theme microcontaminants, cruise I (26 August to 14 September) on the North Sea for measurements of polyaromatic hydrocarbons in sediments, dab (*Limanda limanda*), and seastars (*Asterias rubens*).
- Dr. Th. Leipe (Institut für Meereskunde, Warnemünde, Germany) studied particle composition and sedimentation rates in a core collected in the Baltic Sea (Arkona basin) to obtain a record of the post-Pleistocene deposition in that area.
- Ir. W. van Leussen (Rijkswaterstaat, Tidal Waters Division, The Hague) studied suspended matter samples from the Dollard with the SEM. These data were used in combination with *in situ* measurements to study flocculation of suspended matter in that area.
- X. Qinchung (Second Institute of Oceanography, Hanghzhou, China) studied tidal flat depositional systems along the Chinese coast from Hanghzhou to Wenzhou.
- Dr. A. Sandee, DIHO, Yerseke, worked at NIOZ, taking part in the preparations for INP.
- Dr. A. Sarkar (National Institute of Oceanography, Goa, India) on a grant from the Commission of the European Communities participated in the study of time variation of PCB concentrations in sediment and biota (See H1-14).

- Dr. Shoichi Shimoyama (Dept. Earth and Planetary Sciences, Kyushu University, Japan) visited our Institute from 13 June to 23 September partly paid by NWO in a cooperation programme with the Japanese Society for the Promotion of Science. His project fitted in the programme of the Palaeobiology project (Cadée, B3-11) and involved the recognition of allochthonous and autochthonous parts in mixed shell assemblages from the North Sea and Wadden Sea by using indexes for the left/right ratio of bivalve shells and the amount of fragmentation. The hypotheses that left/right ratio deviates from 1 and fragmentation increases away from the source spot where the bivalve lives were tested in a number of samples. First results seem to indicate the hypothesis is true, indicating that these indexes are useful in interpreting fossil shell assemblages.
- Dr. Lee R. Shugart (Environmental Science Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA) participated in Integrated North Sea Programme (INP), Theme Microcontaminants, Cruise I (26 August - 14 September) on the North Sea, collecting samples of dab (*Limanda limanda*) and seastar (*Asterias rubens*) for the determination of DNA damage.
- Dr. Roland Völz (Institut für Meereskunde, Warnemünde, Germany), worked on CTD data handling and transfer of oceanographic data to data banks.
- X. Xia Ming (Second Institute of Oceanography, Hanghzhou, China) studied tidal flat depositional systems along the Chinese coast from Hanghzhou to Wenzhou.

1.9.2. Participation in national and international programmes

- J.W. Baretta and P. Ruardij participated in the EC-MAST project for ERSEM, for which NIOZ is the leading institute.
- W. van Raaphorst was coordinator of the ecosystem modelling in the EC-MAST project WASP, a cooperation between German, Danish and Dutch institutes.
- M.J.W. Veldhuis (project leader), H.G. Fransz, G.W. Kraay, J.D.L. van Bleijswijk, P. van der Wal and R. Kempers participated in an international working group on the calcification by the coccolithophorid alga *Emiliania huxleyi*. This working group is a collaboration of NIOZ with the Departments of Biochemistry and Geobiochemistry of the University of Leiden, the CGA-Geomarine Centre, the Free University, Amsterdam, the ETH, Zürich, the Plymouth Marine Laboratory, the Marine Biology Department of the University of Groningen and the Natural History Museum, London.
- H.J. Lindeboom was co-organizer of the Integrated North Sea Programme (INP). J.P. Boon, H.M. Sleiderink, K. Booij, W. van Raaphorst, J.D.L. van Bleijswijk, P. van der Wal, J.M. Everaarts, C. Veth, H. Ridderinkhof, S. Ober participated in this programme.
- S.S. Oosterhuis, H. de Wilde and I. Flameling participated in a cruise by RRS Challenger in the North Sea from 4 August to 2 September. In this cruise, organized by N.J.P. Owens from the Plymouth Marine Laboratory, the spatial distribution of major nutrients in relation to phytoplankton abundance was investigated. Vertical net hauls were made to construct distribution maps of different zooplankton species, for interannual comparison with maps for August 1988 and 1989, made during the NERC North Sea Project.
- H.G. Fransz, from 20 June to 30 July, participated in the European Polarstern Study II (EPOS II). This study of the European Arctic Shelf (SEAS) was coordinated by the European Science Foundation (ESF).
- H.M. van Aken and L. Otto were principal investigators for the survey of section AR7E of the international World Ocean Circulation Experiment (WOCE).
- J.T.F. Zimmerman was a lecturer in tidal dynamics at the course of 'Oceanography of semi-enclosed seas' at the International Centre for Theoretical Physics in Trieste.
- T. Piersma, in cooperation with Dr. N.C. Davidson of the Joint Nature Conservation Committee, Peterborough, UK, continued editing the extended proceedings of an international workshop on 'Recent advances in understanding Knot migrations'.
- T. Piersma cooperated with M. Barter and D. Rogers of the Australasian Wader Studies Group and the Royal Australasian Ornithologists Union, Melbourne, Australia, in a programme aimed at analysing body condition in long-distance migrant waders from Australasia. This work should allow comparisons with the East Atlantic Flyway populations for which data are available.

- T. Piersma started a project with Dr. Henk Visser of the University of Groningen and Dr. Robert E. Ricklefs of the University of Pennsylvania, Philadelphia, USA, to investigate size related body composition in growing and adult waders from the Holarctic region.
- T. Piersma cooperated with Dr. Marilyn Ramenofsky of the University of Washington, Seattle, USA, to look at the production of stress hormones in staging waders in the Wadden Sea, and with Dr. Charles R. Blem of the Virginia Commonwealth University, Richmond, USA, to look at seasonal changes in the fatty acid composition in migrant waders.
- D. Eisma, J. Kalf and S. Chen participated in the Elbe Estuary programme of the University of Hamburg and the GKSS, Geesthacht, Germany.
- M. Leopold participated in the North Sea Task Force in cooperation with all other North Sea countries (chaired by Great Britain) to produce a seabird-vulnerability atlas for the North Sea.
- A.J. van Bennekom participated in ANTARES, a French programme in the southern Indian Ocean.
- J.H.F. Jansen participated in the national contribution to the Core Project PAGES (Past Global Changes) of the IGBP (International Geosphere-Biosphere Programme).
- R.F. Nolting and J. Kalf participated in the Russian SPASIBA (Sientific Programme on Arctic and Siberian Aquatorium) expedition. This expedition was held from 29 August to 28 September in the Lena Delta and Laptev Sea.

The Russian RV Jacob Smirnietsky in the harbour of Tiksi.
(Photo: R.F. Nolting)

- R.F. Nolting participated in the CEC programme (Bureau of Certification of Reference Material) for the certification of trace metals in seawater and estuarine reference material.
- G. Nieuwland, H.J. Lindeboom, J.H. Vosjan and E. Pauptit participated in Netherlands Antarctic Expedition to Arctowski (Antarctica) December 1990/January 1991.
- J.H. Vosjan and E. Pauptit participated in research on Antarctic freshwater lakes with Dr. K. Janiec, Polish Polar Institute, Dziekanow, Warsaw, Poland.
- J.H. Vosjan trained three scientists from KMFRI, Mombasa, Kenya, in microbiological methods.
- H.J.W. de Baar and C. Veth participated in two planning meetings for the JGOFS Southern ocean study, both held at Bremerhaven in May and 6-7 December, respectively; S.R. Gonzalez, M. van Leeuwe and K.R. Timmermans also attended the December meeting.

- M.J.W. Veldhuis represented The Netherlands at the SCOR/JGOFS Annual meeting at Bermuda, September 1991.
- C. Swennen participated in a cooperative project of the Institute of Ornithology, Seoul, Asian Wetland Bureau, Kuala Lumpur and NIOZ in research on the ecology of the endangered Chinese Egret, visiting the breeding colony in South Korea twice.
- Tj.C.E. van Weering and G.W. Berger participated in a Chinese-Dutch cooperative programme regarding tidal-flat research of the Chinese coast.
- Tj.C.E. van Weering, G.W. Berger and J. Schilling participated in a UNESCO Black Sea research programme.

1.9.3. Visitors from abroad

- Dr. A. Abarnou, Dept. of Chemistry, IFREMER, France.
- Dr. Th. Alerstam, University of Lund, Sweden
- J. Allen, J. Rennel Centre, IOS, Southampton, UK.
- S. Baskakov, Moscow State University, USSR.
- Dr. M. Baumann, University of Bremen, Germany.
- N. Broekhuizen, University of Strathclyde, UK.
- A.D. Bryant, University of Aberdeen, UK.
- Dr. K. Buck, Monterey Bay Aquarium Research Institute, Monterey, California, USA.
- Dr. J. Callaway, Louisiana State University, USA.
- Dr. U. Cederlöf, University of Góteborg, Sweden.
- Dr. A. Cruzado, CEAB, Blanes, Spain.
- Dr. N.C. Davidson, Nature Conservancy Council, Peterborough, UK.
- Dr. F. Dehairs, Free University Brussels, Belgium.
- R. Doerffer, GKSS Forschungszentrum Geesthacht, Germany.
- Prof. Dr. W. Ebenhöh, University Oldenburg, Germany.
- Dr. K. Estep, Institute of Marine Research, Bergen, Norway.
- Eun Mee Park, Institute of Ornithology, Kying Hee University, Seoul, Korea.
- Dr. J. Ferreira, University of Sao Paulo, Brazil.
- Dr. A. Figueiredo, Universidade Fluminense, Rio de Janeiro, Brazil.
- S. Floderus, Uppsala University, Sweden,
- Dr. A. van Geen, US Geological Survey, Menlo Park, California, USA.
- M. Gehlen, University of Oldenburg, Germany.
- Dr. S. Gordeev, Institute of Oceanology, Moscow, USSR.
- Dr. B. Gurney, University of Strathclyde, UK.
- Dr. S. Hall, MLA, Aberdeen, Scotland, UK.
- Dr. M. Heath, MLA, Aberdeen, Scotland, UK.
- Dr. R. Herman, Biologie, Universiteit Gent, Gent, Belgium.
- Dr. A. Höpner, Nat. Park Adm. Niedersachsen, Germany.
- Mr. Huang Zhiling, Ocean Bureau, Shantung Province, Commission of Science and Technology, Nanjing, China.
- Dr. H.Y. Inoue, Meteorological Research Institute, Ibaraki, Japan.
- Dr. M. Ivanov, Moscow State University, USSR.
- K. Ivanova, Moscow State University, USSR.
- K. Jansen, Water Quality Institute, Copenhagen, Denmark.
- Dr. A. Jones, University of Strathclyde, UK.
- R. Kaiser, NLWA Forschungsstelleküste, Germany.
- Dr. B. Karson, University of Göteborg, Sweden.
- Dr. N.H. Kenyon, Institute of Oceanographic Sciences, Deacon Laboratory, Wormley, UK.
- Dr. H. Kluser, Alfred Wegener Institute, Bremerhaven, Germany.
- C. Kohlmeier, University Oldenburg, Germany.
- J. Krohn, GKSS Forschungszentrum Geesthacht, Germany.
- Dr. B. Kruse, National Environmental Research Institute, Denmark.
- T. Larsen, University of Aalborg, Denmark.
- J.W.J.T. Lemmens, Marine Biological Laboratory, University of Western Australia, Australia.
- H. Lennart, IfM, Hamburg, Germany.

- Dr. A. Lindström, University of Lund, Sweden.
- Prof. Liu Jiaju, Nanjing Water Conservancy Institute, China.
- Prof. A. Lizitzin, Institute of Oceanology, Moscow, USSR.
- Mrs. V. Loizeau, Dept. of Chemistry, IFREMER, France.
- K. Madsen, Water Quality Institute, Copenhagen, Denmark.
- Dr. A. Malmgren-Hansen, Water Quality Institute, Copenhagen, Denmark.
- B. March, J. Rennel Centre, IOS, Southampton, UK.
- J. Marshall, Space and atmospheric physics group, Imperial College, London, UK.
- Dr. H. Maske, Dept. de Ecologia, CICECE, Mexico.
- Dr. D.K. Mills, University of Wales, Menai Bridge, UK.
- Dr. J. Mrazek, Greifswald, Germany.
- D. Murphy, GKSS Forschungszentrum Geesthacht, Germany.
- Dr. H. Mutvei, Naturhistoriske Riksmuseet, Stockholm, Sweden.
- Dr. S.N. Mwangi, Marine and Fisheries Research Inst., Mombasa, Kenya.
- Dr. M. Napata, Instituto de Investigaciones Marinas, Vigo, Spain.
- Dr. W. Overloop, Free University Brussels, Belgium.
- Dr. M.A. Owili, Marine and Fisheries Research Inst., Mombasa, Kenya.
- M.R. Penn, Michigan Technological University, Houghton, Michigan, USA.
- Dr. R. Pierce, Department of Conservation, Whangarei, New Zealand.
- X. Qinchun, Second Institute Oceanography, Hanghzhou, China.
- Dr. G. Radach, IfM, Hamburg, Germany.
- Dr. P. Radford, PML, Plymouth, UK.
- W. Rosenthal, GKSS Forschungszentrum Geesthacht, Germany.
- Dr. R. Scharek, AWI Bremerhaven, Germany.
- H. Siemoneit, University of Oldenburg, Germany.
- Dr. W.L. Silvert, Bedford Institute of Oceanography, Dartmouth, Canada.
- D. Smeed, J. Rennel Centre, IOS, Southampton, UK.
- Dr. M. Yu. Sokolov, Institute of Microbiology, Moscow, USSR.
- Dr. M. Tanaka, Kyoto University, Japan.
- Dr. L.G. Underhill, University of Cape Town, South Africa.
- Dr. C. Vale, Instituto Nacional de Investigaçao das Pescas, Lisboa, Portugal.
- Dr. U. Vietinghoff, Wilhelm Pieck Unversity, Germany.
- A.W. Visser, Universidad Autónomo de Baja California, Mexico.
- Dr. S.G. Wakeham, Skidaway Institute of Oceanography, Georgia, USA.
- Dr. E.M.S. Woodward, Plymouth Marine Laboratory, Plymouth, UK.
- X. Xia Ming, Second Institute Oceanography, Hanghzhou, China.
- Prof. Xie Jinzan, Hehai University, Nanjing, China.
- Prof. Ying Wang, University of Nanjing, China.
- Dr. J. Wijnant, Marine and Fisheries Research Inst., Mombasa, Kenya.

2.1. PUBLICATIONS

2.1.1. Netherlands Journal of Sea Research and other series issued

In 1991, the last three issues of vol. 27 and the first three issues of vol. 28 of the Netherlands Journal of Sea Research appeared. Only one issue was published of the NIOZ Publication Series (no. 18: the Annual Report 1990).

The publication of the Proceedings of the International Symposium on the Ecology of the North Sea was completed with a double issue (vol. 28, no. 1/2), containing three invited review papers, *viz.* on zooplankton, zoobenthos and modelling of the North Sea. These proceedings were edited by P. de Wolf, H.J. Lindeboom and R.W.P.M. Laane. They were issued with financial support of the Ministry of Transport and Public Works.

The publication of the Proceedings of the First International Symposium on Flatfish Ecology started with a double issue (vol. 27, no. 3/4), containing 23 papers. Another issue with a similar number of papers will appear in 1992. These proceedings are edited by R. Berghahn, A.D. Rijnsdorp and H.W. van der Veer with the assistance of J.G. Baretta-Bekker.

During 1991, two regular issues appeared, (edited by the permanent editors) *viz.* vol. 27, no. 2 (June 1991) with 7 papers and vol. 28, no. 3 (December 1991) with 10 papers. Of these 17 papers, 7 were on marine biology, 5 on marine geology, 4 on marine chemistry and 1 on physical oceanography.

2.1.2. Publications NIOZ 1991

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2.1.3. Internal reports NIOZ 1991

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- F.C. van Duyl, R.P.M. Bak, A.J. Kop & G. Nieuwland. Het microbiële voedselweb in het Friese Front: 43-48.
- W. van Raaphorst, H.T. Kloosterhuis & E.M. Berghuis. Stikstof regeneratie en verwijdering in het sediment van het Friese Front: 49-60.
- G.C.A. Duineveld & L. Moodley. Het zoöbenthos van het Friese Front: 61-74.
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Bergman, M.J.N., H.J. Lindeboom, G. Peet, P.H.M. Nelissen, H. Nijkamp & M.F. Leopold. Beschermde gebieden Noordzee. Noodzaak en mogelijkheden. NIOZ Report 1991-3.

Hoppema, J.M.J. & H.J.W. de Baar. Changes in the balance of non-fossil carbon nitrous oxide and dimethyl sulfide in the North Sea. NIOZ Report 1991-4.

Duyl, F.C. van. The applicability of mesocosms in North Sea eutrophication studies. NIOZ Report 1991-5.

- Duyl, F.C. van. Introduction: 1-4.
- W. van Raaphorst, H.T. Kloosterhuis, E.M. Berghuis, A.J.M. Gieles, J.F.P. Malschaert & G.J. van Noort. Nitrogen cycling in two sediments of the southern North Sea (Frisian Front and the Broad Fourteens): Field data, mesocosm results and mathematical modelling: 7-48.
- F.C. van Duyl, R.P.M. Bak, A.J. Kop, G. Nieuwland, E.M. Berghuis & A. Kok. Mesocosm experiments: mimicking seasonal developments of microbial variables in North Sea bottoms: 51-71.
- R.P.M. Bak, F.C. van Duyl, G. Nieuwland & A.J. Kop. Benthic heterotrophic nanoflagellates in North Sea field/mesocosm bottoms and their response to sedimentation: 75-83.
- G.C.A. Duineveld, P. Verburg, E.M. Berghuis, A. Kok, G.J. van Noort & P.A.W.J. de Wilde. Metabolic responses of soft-bottom benthic mesocosms to enrichment and food deprivation: 87-98.
- R. Witbaard. Measurement on burrows of *Callianassa subterranea* made in a mesocosm: 101-107.

Vooys, C.G.N. de, J.IJ Witte, R. Dapper, J.M. van der Meer & H.W. van der Veer. Lange termijn veranderingen in zeldzame vissoorten op het Nederlands Continentaal Plat van de Noordzee. NIOZ Report 1991-6.

Witte, J.IJ, R. Dapper, G.J. van Noort & H.W. van der Veer. De verspreiding van vissen op het Nederlands Continentaal Plat van de Noordzee. NIOZ Report 1991-7.

Daan, R., W.E. Lewis & M. Mulder. Biological effects of washed OBM drill cuttings discharged on the Dutch continental shelf. NIOZ Report 1991-8.

Riegman, R. Mechanisms behind eutrophication induced novel algal blooms. NIOZ Report 1991-9.

Hoogstraten, R.J. van & R.F. Nolting. Trace and major elements in sediments and in porewater from the north-western basin of the Mediterranean Sea. NIOZ Report 1991-10.

Otto, L. & T.F. de Bruin. Toepassing van infrarood remote sensing bij oceaanonderzoek (eerste resultaten van project OP-1.25). Fysische achtergronden en gebruik bij DUTCH-WARP 1. NIOZ Report 1991-11.

Bruin, T.F. de. Gebruik van de D.A.M.E. datalogger in een meterstation aan boord van de R.V. Tyro. NIOZ Report 1991-12.

Offringa, H. Verspreiding en Voedseloecologie van de Zwarte Zeeëend (*Melanitta nigra*) in Nederland. NIOZ-Rapport 1991-13.

2.1.4. Cruise reports 1991

Aken H.M. van, 1990. DUTCH-WARP 1990, R.V. TYRO cruise 90/3. Part I: WOCE section AR7E. (cruise report) NIOZ, Texel: pp. 17 + figs.

Aken, H.M. van. DUTCH-WARP 91, R.V. Tyro, cruise 91/1, Shipboard report. NIOZ, Texel: pp. 35 + appendix.

Boon, J.P. Cruise report INP-microcontaminants, RV Pelagia, October 1991. NIOZ, Texel: pp. 56 + figs + list of participants.

Raaphorst, W. van. Report of cruise BELS-INP, RV Pelagia, leg 1: August 5 - August 23, 1991. NIOZ, Texel: pp. 5 + 6 appendices + figs.

2.1.5. Data reports 1991

Aken, H.M. van & S. Ober. A compilation of moored current metter data from the Iceland Basin (DUTCH-WARP 89, mooring IB98/1). NIOZ Data Report 1991-2.

Rommets, J.W., R. Dapper & H.J.W. de Baar. Data Report JGOFS RV TYRO 1989 Leg 1. NIOZ Data Report 1991-1.

Rommets, J.W., R. Dapper & H.G. Fransz. Data Report JGOFS RV TYRO 1990 Leg 3. NIOZ Data Report 1991-3.

2.2. LECTURES, ETC.

2.2.1. Colloquia and workshops at the institute

(titles translated)

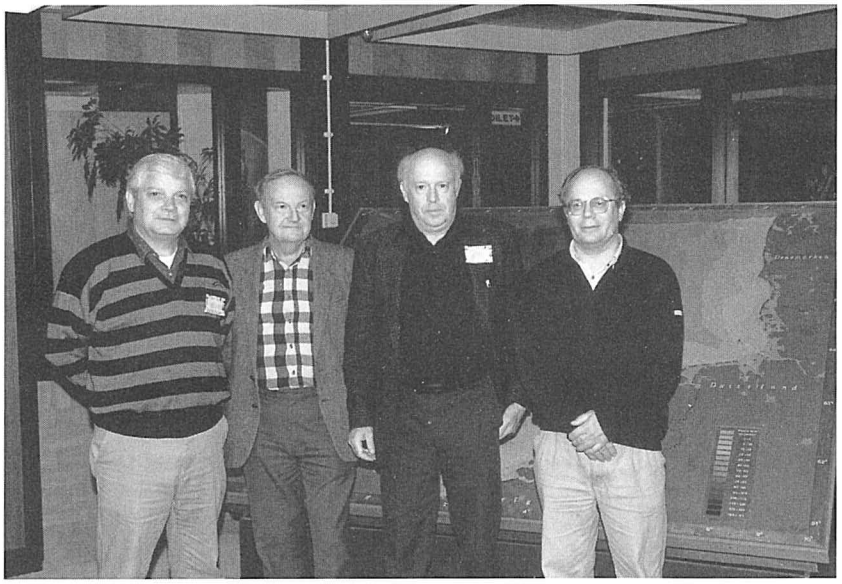
18 January	A. Visser (Universidad Autonóma de Baja California, Mexico): Formation and maintenance of linear sand banks by tidally rectified currents
	H. Ridderinkhof (NIOZ): Chaos in the Wadden Sea
25 January	T. Piersma (NIOZ): (Do Knots feed on *Macoma balthica* or not?)
	P. Kamermans (NIOZ): (Is *Macoma balthica* a suspension or deposit feeder?)
	M.J. Reichert (NIOZ): (Flatfish in a subtropical estuary: a comparison with the Wadden Sea)
8 February	T.F. de Bruin (NIOZ): (The use of satellites in the determination of ocean temperature)
	M.R. Wernand (NIOZ): (Systems to observe the earth for oceanographic purposes)
22 February	P. Westbroek (University of Leiden): (*Emiliania huxleyi* and global climate. From biochemistry to remote sensing)
	P. van der Wal (NIOZ): (Physiological and ecological aspects of calcification in *Emiliania huxleyi*)
8 March	J. Goudriaan (University of Wageningen): (Simulation of global carbon cycle)
	G. Klaver (DIHO, Yerseke): (Emission of CO_2, CH_4 and N_2O from mud flats and salt marshes along the salt gradient of the Scheldt-Western Scheldt estuary)
22 March	(20th anniversary of the Frisian Front research) P.A.W.J. de Wilde (NIOZ): (The benthic system) M.A. Baars (NIOZ): (The pelagic system)
5 April	A. Dickson (Scripps Institute of Oceanography, La Jolla, USA): The development of the alkalinity concept in marine chemistry
	W.G. Mook (NIOZ): ^{13}C and NIOZ
17 April	D.A. Smeed (DAMTP, Cambridge, UK): Observations of North Sea Fronts
19 April	R. Riegman (NIOZ): (An ecophysiological explanation of *Phaeocystis* blooms in Dutch coastal waters)
	W. van Boekel (NIOZ): (Organic phosphates: a bonus for *Phaeocystis*)
29 April	J. Marshall (Imperial College, London, UK): Open ocean deep convection
17 May	(Protected areas in the North Sea) H.J. Lindeboom (NIOZ): (The policy) M.J.N. Bergman (NIOZ): (Urgency and possibilities)

31 May	H.W. van der Veer (NIOZ): (Changes in the occurrence of some fish species on the Dutch continental shelf between 1930 and 1990)
	P. Reijnders (RIN, Texel): (Historical and future developments in seal populations in the Dutch Wadden Sea from 1900 into the 21st century)
7 June	S. Wakeham (Skidaway Institute of Oceanography, Georgia, USA): Particulate organic matter in the oceans
14 June	F. Hansen (NIOZ): Copepod grazing during the phytoplankton spring bloom: which grazer really controls *Phaeocystis*?
30 August	A. Buma (NIOZ): Photoadaptation in three Antarctic microalgal species
	K. Buck (Monterey Bay Aquarium Research Institute, USA): Unique protists inhabiting sea ice environments: morphology, ultrastructure and ecology
23 September	U. Cederlöf (University of Göteborg, Sweden): Experiences with ADCP (Acoustic The coastal upwelling system near Mauritania B.R. Kuipers (NIOZ): (Zooplankton in the coastal upwelling system) G.C. Duineveld (NIOZ): (Benthic structure and activity)
11 October	Effects of PCBs on dab E. Casal and D. Schweizer (E.T.H., Zürich): Effects of PCBs on eggs and larvae of dab J.P. Boon (NIOZ): (The effect of PCBs on mono-oxygenase enzyms in dab) J.M. Everaarts (NIOZ): (Effects of PCBs on some haematological parameters)
8 November	Flowcytometry
	H. Balfort (University of Amsterdam): (The application of flowcytometry in freshwater ecosystem research)
	M.J.W. Veldhuis (NIOZ): (An evaluation of possibilities for applying flowcytometry in marine biological research)
	Prof. Ying Wang (Nan Jing University, China): Tidal flats along the Chinese coast Prof. Liu Jia Ju (Nang Jing Hydraulic Research Institute, China): Siltation in harbour channels
22 November	The stability of the ocean at higher latitudes H. Dijkstra (IMOU, Utrecht): (Deep-water formation in the Greenland Sea) C. Veth (NIOZ): (The stability of the water column in the marginal ice zone)
6 December	Boxcosm experiments F.C. van Duyl (NIOZ): (Bacterial production and the influence of macrofaunal activity in North Sea boxcosms) W. van Raaphorst (NIOZ): (Nutrient regeneration and the influence of macrofaunal activity in North Sea boxcosms)
17 December	A. van Geen (US Geological Survey, Menlo Park, California, USA): Cadmium/calcium ratios in foraminiferal shells from San Francisco Bay: A Record of Estuarine Chemistry.

Nato Advanced Research Workshop on Biological Markers of Environmental Contamination

The workshop, held at NIOZ from 12 to 18 May, brought together 40 international experts on biological markers and biomonitoring in order to formulate a unified strategy for development and validation of biomarkers, as well as for application of biomarker measurements in assessing environmental health. The workshop discussions addressed the following critical topics: (1) Applications and objectives of (biomarker-based) biomonitoring, (2) Conceptual paradigms for evaluating biomarker responses, (3) Implementation of biomarker-based biomonitoring, (4) Interpretation of biological marker responses and (5) Research strategy for development and validation of biomarkers. The Organizing Committee consisted of L.R. Shugart (USA), D. Peakall (Canada), C.

Walker (UK) and J.M. Everaarts (NIOZ) (Photograph, from the left to the right). Thanks to the hospitality of the Institute, the workshop was a great success. The results of the scientific discussions will be summarized in 6 chapters of a book to be published in the NATO Advanced Science Institutes Series.



Annual Wader Study Group Conference and Symposium

On 5 and 6 October, NIOZ hosted the 1991 Annual Conference of the Wader Study Group, with an additional Symposium on 'Shorebirds and prey availability' on Monday 7 October. The meeting was organized on behalf of the Wader Study Group (WSG) by Petra de Goeij and Theunis Piersma (NIOZ) and Cor Smit (IBN-DLO). Over 155 people of 20 nationalities attended the meetings, during which 36 lectures were presented. Ten poster presentations were additionally offered. During the 3-day conference a number of special workshops were arranged, and in this way further progress in international cooperative wader migration research was made. Abstracts of talks and posters will be published in the Wader Study Group Bulletin. A special issue of the Netherlands Journal of Sea Research will be devoted to the proceedings of the symposium on 'Shorebirds and prey availability'.

EROS-2000 Workshop

From 20 to 25 October a general meeting of the EROS-2000 Programme of the EC was held at NIOZ, where the results of the past year were presented and discussed. It was attended by about 40 scientists from most of the EC countries.

2.2.2. Lectures and posters

2.2.2.1. Lectures by NIOZ scientists

(titles translated)

Aken, H.M. van. (Inversions, or: what can we learn from observations?) National Seminar on Climate Physics, IMAU, University of Utrecht, 13 September.

Baar, H.J.W. de. (Chemical Oceanography.) Lecture Series, Free University Amsterdam, 12-15 February.

——. The Role of Fe and Mn in the Antarctic Ecosystem. Massachusetts Institute of Technology, Cambridge, Mass., USA, 20 February (jointly with A.G.J. Buma).

——. Effects of iron and manganese on phytoplankton growth. Woods Hole Oceanographic Institution, Woods Hole, Mass. USA, 28 February.

——. (The role of the oceans in the CO_2-greenhouse effect.) League of Women of the South-Holland province, The Hague, 18 March.

——. (The oceans govern global climate.) Royal Physical Society Groningen, 19 March.

——. Comparison of observations by various national laboratories of the dissolved carbon dioxide system during the JGOFS North Atlantic Study. Second Session of the Joint JGOFS-CCCO Panel on Carbon Dioxide, UNESCO, Paris, 25 April.

——. The possible role of iron in the marine carbon cycle. Zentrum für Meeres- und Klimaforschung, Universität Hamburg, 25 June.

——. Geochemistry of rare earths and other metals at oxic-anoxic interfaces. Invited lecture, Gordon Research Conference in Chemical Oceanography, New Hampshire, USA, 15 August.

——. The possible role of iron in the marine carbon cycle Lamont- Doherty Geological Observatory of Columbia University, Palisades, New York, USA, 19 August.

——. Processes at the oxic-anoxic interface of the Black Sea. University of Groningen, 12 September.

Bak, R.P.M. (Tropical Marine Biology.) Lecture series, University of Amsterdam, February.

——. (Marine Biology.) Lecture series, University of Groningen, April, June.

——. Tropical Coastal Zone Management. Lecture series, Int. Inst. Hydraul. Environm. Eng., Delft, September.

——. Patterns in nanoflagellate and bacterial densities in sediments and water column along the Banc d'Arguin. Symposium on the ecosystem of the Banc d'Arguin region, Leiden 26 March.

——. A range of coral reef studies. Instituto Investigationes del Mar, Santa Marta, Colombia, 19 June.

——. Components of the microbial loop in the Curaçao coral reef system. Carmabi Ecological Institute, Curaçao, 27 June.

Bennekom, A.J. van. Estuarine processes, International Institute for Hydraulic and Environmental Engineering, Delft, 6-7 March.

——. Changes in the surface distribution patterns of nutrients near the Weddell-Scotia Confluence, Oct 1988 to Jan 1989, related to hydrography and phytoplankton blooms. EPOS symposium, Bremerhaven.

——. Watermass distribution in the Weddell-Scotia Confluence at about 49°W. EPOS symposium, Bremerhaven.

——. Comparison between the river plumes of the Zaire and the Amazon. Nutrients in the estuaries and river plumes of Rhine and Scheldt. Wadden Sea nutrients: A case for sediment/water interaction. The Surinam river estuary. Summer course: Biogeochemical processes in estuaries, Melreux, Belgium, 1-6 September.

Beukema, J.J. Long-term data sets at the Netherlands Institute for Sea Research. MARS Network Workshop, Blanes, Spain, 27-29 May.

——. Expected changes in the Wadden Sea benthos in a warmer world: lessons from periods with mild winters. 26th European Marine Biology Symposium, Middelburg, 17-21 September.

——. Variability in the macrozoobenthos living on tidal flats of the Wadden Sea. Symposium "Shorebirds and the variability of their benthic prey". Annual Wader Study Group Conference, Texel, 5-7 October.

——. Recent changes in the bottom fauna of the Dutch Wadden Sea. German-Dutch meeting on sea-level changes, Hengelo, 7-8 November.

Bleijswijk, J.D.L. van. (Study of distribution and physiology of two *Emiliania huxleyi* subspecies). Verwey-bijeenkomst, NIOZ, Texel, 25-27 February.

——. (*Emiliania huxleyi* strikes again). Gorlaeus Laboratory Symposium, Leiden, 22-23 May.

——. (Specific detection of algal cells with immunofluorescent labelling techniques). Cursus Mariene Oecosystemen, NIOZ, Texel, May.

——. Physiological parameters of *Emiliania huxleyi* grown under six different light intensities. Second GEM Workshop (Global Emiliania Modelling Initiative, Chateau de Blagnac, Cabarra, France, 21-26 September.

Boer, C.J. de. (Hydrographic variability of the overflow water in the Iceland Basin.) National Seminar on Climate Physics, IMAU, University of Utrecht, 13 September.

——. (Hydrography, dynamics and mixing characteristics of deep overflow water in the northeastern Atlantic Ocean.) MFO-dagen NIOZ, Texel, 11-12 March.

——. Hydrographical variability of the overflow water in the Iceland Basin. ICES statutory meeting (79th), La Rochelle, France, 28 September.

Booij, K. Time variation of PCB concentrations in sediment and biota. 4th Workshop sorption and bioavailability, NIOZ, Texel, 4 October.

Boon, J.P. (Behaviour and effects of polychlorinated biphenyls (PCBs) and related compounds in marine environments.) University of Groningen, 10 October.

——. (Interactions between cytochrome P450 and PCBs in marine organisms.) Delta Institute for Hydrobiological Research, Yerseke, 7 November.

——. (Ecotoxicological risks in marine ecosystems; interactions between research and policy.) Rijkswaterstaat, Den Haag, 12 December.

Bruin, T.F. de. (Dutch ocean research and the international programmes WOCE and JGOFS.) Themadag "Kring voor Remote Sensing" over "Global Change en Remote Sensing", Wageningen, 28 February.

Buma, A.G.J. The role of Fe and Mn in various plankton communities. American Society Limnology and Oceanography, Special Symposium, San Marcos, Calif., 23 February.

——. On the effect of Fe and Mn on plankton communities in Antarctic waters. EPOS Symposium Bremerhaven, 23 May 1991.

Cadée, G.C. *Phaeocystis* in the Marsdiep in 1990, wintering of colonies. EC *Phaeocystis* workshop Brussels, 30 January.

——. Bioturbation in the Wadden Sea. Workshop marine sedimentologists, NIOZ, Texel, 16 March.

—— (A geologist's view of the biology of the Wadden Sea.) Course Geology students Utrecht Univ., NIOZ, Texel, 13 May.

——. Phytoplankton variability in the Marsdiep, 1980-1990. ICES Variability symposium, Åland, Finland, 6 June.

——. Long-term changes in phytoplankton in marine coastal areas. 4th Intern. Phycology Conference, Durham NC, USA, 9 August.

Cadée, G.C., H. Gonzalez & S. Schnack-Schiel. Distribution, abundance, composition, and feeding rates on faecal pellets from the Scotia-Weddell Seas area, Southern Ocean. EPOS symposium, Bremerhaven, Germany, 25 May.

Cadée, N. Seasonal changes in metabolic rates of Knots in relation to migratory performance. Annual Conference of the Wader Study Group, NIOZ, Texel, 5 October.

Duineveld, G.C.A. Phytopigments in sediment traps and bottom deposits on the Mauritanian shelf. Symposium on the Ecosystem of the Banc d'Arguin region, Leiden, 26 March.

——. The benthic macrofauna and benthic respiration off the Banc d'Arguin, Mauritania. Symposium on the Ecosystem of the Banc d'Arguin region, Leiden, 26 March.

——. Mesocosms applicable to biodiversity studies. MARS Workshop on Biodiversity, Plymouth, UK, 7 October.

Eisma, D. (Sediment transport and deposition in the Wadden Sea.) Marine Biology course NIOZ, 11 February.

——. (Marine Sedimentology.) Lecture series University of Utrecht, March.

——. Flocculation of suspended matter. East China Normal University, Shanghai, China, 24 April.

——. Flocculation of suspended matter. Centre of Marine Science Nanjing University, China, 27 April.
——. Transport and deposition of cohesive sediment. Intensive course, Bordeaux, France, September.
——. Flocculation processes in estuaries. 6th Annual Meeting Aachen sedimentary group, Aachen, Germany, September.
——. (Sedimentation of mud in the North Sea.) NOC Meeting, Amsterdam, 10 October.
——. The geology of land-sea interaction under conditions of changing land use and sea level. NATO Advanced Research Workshop on the impact of global change on the coastal ocean, Chateau de Bonas, France, 14 October.
Epping, E. (Denitrification on intertidal sediments). University of Groningen, 23 April.
——. (Control of nitrous oxide consumption activity). University of Groningen, 27 September.
——. (Denitrification and nitrous oxide consumption). BION meeting, Dalfsen, The Netherlands, 16 May.
Everaarts, J.M. Micro-contaminants in surface sediment, plankton and benthic invertebrates of the coastal area of Mauritania (Banc d'Arguin) and the adjacent deep-sea area. Symposium on the Ecosystem of the Banc d'Arguin region, Leiden, 25 March.
——. Biological markers in fish: DNA integrity, hematological parameters and liver somatic index. Sixth International Symposium on Responses of Marine Organisms to Pollutants. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA, 26 April.
Flach, E.C. (The influence of the cockle and the lugworm on other macrozoobenthic species). Verwey-bijeenkomst, NIOZ, Texel, 25 February.
——. The influence of *Arenicola marina*, *Nereis diversicolor*, *Macoma balthica* and *Cerastoderma edule* on the numbers of *Corophium volutator*. Kristineberg Marine Biological Station, Sweden, 29 August.
——. Disturbance of benthic infauna by the sediment reworking activities of the lugworm *Arenicola marina*. 26th European Marine Biological Symposium, Middelburg, 18 September.
——. Disturbance of benthic infauna by sediment reworking activities of the lugworm *Arenicola marina*. Studenten-AIO-OIO-dag, NDV, University of Utrecht, 18 October.
Fransz, H.G. The spring-summer distribution, development and production of epipelagic copepod polulations in the Weddell-Scotia confluence. EPOS I symposium, Bremerhaven, Germany, 24 May.
——. Persistence in polar zooplankton populations at extreme fluctuations in food conditions. Polarstern, Barents Sea, 14 July.
——. The impact of eutrophication on *Temora longicornis* (Copepoda, Calanoida) abundance in a tidal inlet (Marsdiep). 26th EMBS, Middelburg, 17 September.
Helder, W. (The nitrogen cycle in the Wadden Sea.) Hydrobiologische Vereniging, KNAW, Amsterdam, 3 May.
——. (Production, transport and mineralization of organic matter in the open ocean.) Colloquium Dept. of Marine Biology, University of Groningen, 10 October.
Jansen, J.H.F. Results from the Angola Basin expedition, 1989. University of Bremen, Department of Earth Sciences, 25 February.
——. (Palaeoceanography of the South Atlantic and palaeoclimate of equatorial Africa during the Quaternary). University of Groningen, Department of Marine Biology, 15 April.
Kamermans, P. Growth of the bivalve mollusc *Macoma balthica* fed algal diets of diatoms and flagellates in the laboratory. European Community workshop on the ecology of *Phaeocystis*-dominated ecosystems. Brussels, 1 February.
——. (Food limitation and food competition of bivalve molluscs living in the Wadden Sea.) Verwey-dagen, NIOZ, Texel, 25 February.
——. Food intake of the bivalve mollusc *Macoma balthica* (L.); deposit- or suspension-feeding? Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina, Columbia, USA, 14 March.
——. Idem. Institute of Marine Sciences, University of North Carolina at Chapel Hill, Morehead City, USA, 19 March.
——. Idem. Virginia Institute of Marine Science, College of William and Mary, Gloucester

Point, USA, 20 March.
——. Idem. Smithsonian Environmental Research Center, Edgewater, USA, 22 March.
——. (The effect of resuspension on the food competition between molluscs in the Wadden Sea). Nederlandse Vereniging voor Aquatische Ecologie, Amsterdam, 31 October.
——. (The effect of resuspension of benthic diatoms on the food competition between molluscs in the Wadden Sea.) Nederlands - Vlaamse kring van diatomisten, Haarlem, 15 November.
Kuipers, B.R. Zooplankton distribution in the Banc d'Arguin. Symposium on the Ecosystem of the Banc d'Arguin region, Leiden, 25-27 March.
Lavaleye, M.S.S. The trawl fauna of the Mauritanian shelf. Symposium on the Ecosystem of the Banc d'Arguin region, Leiden, 26 March.
Leopold, M. (Is the Dutch continental shelf important to sea-birds?) Amsterdam, Ne-derlandse Ornithologische Unie, 20 April.
Lindeboom, H.J. Models and management, Oceanography Course TU Delft, NIOZ, Texel, 22 April.
——. (Protected areas in the North Sea - necessity and possibilities.) Presentation of the report 'Beschermde gebieden Noordzee' to the State Secretary, Den Haag, 15 May.
Maas, L.R.M. On the role of the Coriolis force on the density and current structure in a stratified sea. Erasmus-programme of the Techn. Univ. Delft, NIOZ, Texel, 23 March.
——. Non-linear and free-surface effects on the spin-down of axisymmetric laboratory vortices. 1st European Fluid Mech. Conference, Cambridge, UK, 19 September.
Nolting, R.F. Pathways of trace elements in the Zaire river and estuary. Second international symposium on the biogeochemistry of model estuaries: estuarine processes in global change. Jekyll Island, Georgia, USA, 16 April.
——. The occurrence of some distinct areas in the NW Mediterranean Sea based on the elemental properties of the sediment. (Horizontal and vertical distribution). 3rd EROS-2000 Workshop on research in the northwest Mediterranean Sea, NIOZ, Texel, 23 October.
Piersma, T. (Departure behaviour of waders migrating north from the Banc d'Arguin.) Landelijke dag Werkgroep Vogeltrektellen, Utrecht, 26 January.
——. (Why do many waders leave the productive Wadden Sea in autumn, only to return in spring?) EcoMare, Texel, 2 February.
——. (Energy expenditure and intake of Knots in the Wadden Sea and elsewhere.) Verweiy-dagen, NIOZ, Texel, 25 January.
——. (The contribution of thermostatic costs to the energy budgets of free-living birds.) Thematic day on thermoregulation, Zoological Laboratory, University of Groningen, 6 March.
——. Wind-related staging site use in an Afro-arctic migrant bird. Birmingham Meeting of the Society for Experimental Biology, Birmingham, 9 April.
——. The economics of wader migrations: conservation implications. Inter-agency Ornithology Seminar 1, Joint Nature Conservancy Committee, Peterborough, UK, 9 April.
——. Energetic constraints on the distribution of coastal shorebirds along the East Atlantic Flyway. IV Neotropical Ornithological Congress, Quito, Ecuador, 5 November.
——. (The lives of Knots.) Vogelwerkgroep Texel, Den Burg, 15 November
Piersma, T. & P. Battley. When and why are Knots *Macomaniacs*, and are *Macoma* too dumb to do anything about it? Wader Study Group Symposium on 'Shorebirds and prey availability', NIOZ, Texel, 7 October.
Raaphorst, W. van. Data availability and collection in the western Dutch Wadden Sea from a ecosystem modelling perspective. International WASP workshop on ecosystem modelling. NIOZ, Texel, 23 January.
—-. Extension of the EMOWAD ecosystem model and coupling to physical models. International WASP workshop on physical modelling. Delft Hydraulics, Delft, 12 March.
—-. Ecosystem modelling, case study Wadden Sea. EC-Erasmus network course on environmental modelling. NIOZ, Texel, 22 April.
Raaphorst, W. van, H.T. Kloosterhuis & A.J.M. Gieles. Sediment-water exchange of

phosphorus in Wadden Sea and North Sea. 3rd International workshop on Phosphorus in Sediments. Woudschoten/Zeist, 2 October.

Ridderinkhof, H. Residual currents in the Wadden Sea. Congress Sedimentology in the Wadden Sea, NIOZ, Texel, 16-17 March.

——. (Residual currents and mixing in the Wadden Sea.) WAQUA-gebruikersclub, ICIM BV, Rijswijk, 30 May.

——. (Chaotic mixing in the Wadden Sea.) KNMI, De Bilt, 4 June.

Riegman, R. (Community structure and functioning in aquatic ecosystems.) Jaarvergadering van de BION-werkgemeenschap Aquatische Oecologie, Dalfsen, 16-17 May.

——. (The origin of nuisance algal blooms.) BEON beleidspresentatie bijeenkomst, Den Haag, 20 June.

——. Evidence for eutrophication-induced *Phaeocystis* sp. blooms in the Marsdiep area (The Netherlands). Int. Conf. on Toxic Marine Phytoplankton, Rhode Island, USA, 28 Oct-1 Nov.

——. Evidence for eutrophication-induced *Phaeocystis* sp. blooms in the Marsdiep area (The Netherlands). Int. Conf. on Toxic Marine Phytoplankton, 26th European Marine Biology Symposium, Middelburg, The Netherlands, 17-21 Sept.

——. (Phytoplankton-bacteria interactions.) AIO/OIO course microbial ecologie, Dalfsen, 21-25 October.

——. (Nuisance algal blooms). MANS workshop on eutrophication models. WL, Delft, 10-12 September.

Ruardij, P. Modelling the benthic system of the western Wadden Sea. WASP-workshop, January.

Spaargaren, D.H. (communicated by Dr. G. Flik, University of Nijmegen). *In vivo* ion fluxes across the gills of shore crabs, *Carcinus maenas* (L.). Ruder Boskovic Institute, Center for marine Research, Rovinj, Yugoslavia, 26 June.

Swennen, C. (Eiderducks and mussel fishery in the Wadden Sea.) Visserijdagen, Volkshogeschool, Bakkeveen, 8 February.

Tulp, I. & P. de Goeij. Waders in an exotic place: feeding on exotic dishes? Wader Study Group Symposium on Shorebirds and prey availability, NIOZ, Texel, 7 October.

Veer, H.W. van der. Lecture series University of Zürich, Switzerland, 10-25 May.

——. The ecology of juvenile flatfish: impact of latitude. Lousiana State University, USA, 24 November.

Veldhuis, M.J.W. Ultraplankton, growth and production in the North Atlantic. Observatoire Oceanologique de Roscoff, France, 22 May.

——. Application of DNA staining techniques in marine phytoplankton research. GEM workshop, Chateau de Blagnac, Cabarra, France, 21- 26 September.

Veth, C. The structure of the upper part of the watercolumn in the spring marginal ice zone of the Weddell-Scotia Area of the Southern Ocean. EPOS-symposium, Bremerhaven, Germany, 24 May.

——. The stability of the watercolumn in the marginal ice zone. Workshop on modelling of the Antarctic sea-ice zone. University of Southern California, Los Angeles, USA, 24 April.

——. The stability of the watercolumn in the marginal ice zone. Modelling workshop on Processes determining primary production in the Southern Ocean. British Antarctic Survey, Cambridge, UK, 16 October.

Vosjan, J.H. Lecture series International Postgraduate Training course on Fundamental and Applied Marine Ecology of the Free University Brussels, Belgium.

——. Lecture series Marine Ecology. Nationale Fonds voor Wetenschappelijk Onderzoek, Oostend, Belgium.

Wal, P. van der. Calcification rates in a bloom of the coccolithophore *Emiliania huxleyi*. INA Conference, Praha, 8-15 September.

——. Measuring calcification rates with ^{45}Ca during the 1991 BOFS cruise to the North Atlantic. GEM workshop, Chateau de Blagnac, Cabarra, France, 21-26 September.

Weering, Tj.C.E. van. (Invited Lecturer) The Skagerrak revisited. Symposium University of Göteborg, Sweden, March 5-7.

——. Mud volcano distribution in the Black Sea. Workshop Unesco, Ville-franche-sur Mer, France, 26-28 September.

Werff, W. van der, Tj.C.E. van Weering, R.A. Fortuin & D. Kusnida. On the origin of the Sumba Forearc Basement. Silver Jubilee Mtg. LIPI, Yogjakarta, Indonesia, 17-19 September.

Werff, W. van der, Tj.C.E. van Weering & H. Prasetyo. The accretionary wedge south of Sumba-Timor: an accreted terrain in the process of slivering. Mtg. Indon. Ass. Geoph., Bandung, Indonesia, 15-17 October.

Wilde, P.A.W.J. de. Introduction into the hydrographical system of the Mauritanian offshore area. Symposium on the ecosystem of the Banc d'Arguin region, Leiden, 25 March.

——. (The ecosystem of the North Sea.) Workshop Protected Areas in the North Sea, Ministry of Agriculture and Fisheries, The Hague, 17 May.

——. (Lecture series marine ecosystems.) University of Groningen, 3-7 June.

——. The ecology of the Frisian Front. Statutory Meeting ICES, La Rochelle, France, 30 September.

Zimmerman, J.T.F. Dynamical Oceanography. Lecture series University of Utrecht, Jan.-June.

——. Physical Oceanography. Lecture series Int. Inst. Hydraul. Envir. Engin. Delft, June.

——. Cooscillation. Lecture series Int. Center Theor. Phys. Trieste, Italy, 15 April-3 May.

——. Topographic tidal rectification, Seminar Woods Hole Oceanogr. Inst., 9 July.

——. Mixing in tidal currents. Seminar Woods Hole Oceanogr. Inst., 10 July.

——. Tidal dynamics and morphodynamics. Seminar Woods Hole Oceanogr. Inst., 11 July.

Zuo, Z. ^{210}Pb distribution in NW Mediterranean sediments: mixing and deposition. EROS-2000 workshop, NIOZ, Texel, 23 October.

2.2.2.2. Posters

Baar, H.J.W. de & R.F. Nolting. Distribution of dissolved cadmium, copper and iron in the Weddell and Scotia Seas. American Society Limnology and Oceanography, Special Symposium, San Marcos, Calif., 21-23 February.

Baar, H.J.W. de, R.F. Nolting & P.M. Saager. The relation between Cadmium and Phosphate in the modern ocean. Gordon Research Conference on Chemical Oceanography, Kimball Union, New Hampshire, USA, 12-16 August.

Bak, R.P.M., A. Boldrin, G. Nieuwland & S. Rabitti. Differentiation of water masses over the Scotia-Weddell Confluence by living/non-living particle characteristics. EPOS Symposium, Bremerhaven 22-27 May.

Bennekom, A.J. van, A.G.J. Buma & R.F. Nolting. Effect of Al on the dissolution kinetics of Antarctic diatoms. EPOS symposium, Bremerhaven, 22-27 May.

Berger, G.W. & H.W. Köster. Sources, distribution and radiological effects of ^{210}Po, ^{210}Pb, ^{226}Ra and Th isotopes in Dutch rivers and coastal waters related to the discharges of ore processing plants. Intern. Symposium on Radionuclides in the Study of Marine Processes, Norwich, UK, 9-14 September.

Booij, K., A. Koopmans & J.L. de Boer. Equilibrium partitioning of trace organics between water, sediment and colloids. 3rd workshop on chemistry and fate of modern pesticides, Bilthoven, 4-6 September.

Duyl, F.C. van. Impact of macrozoobenthos on benthic bacterial production and consumption in North Sea boxcosms experiments. 26th European Marine Biology Symposium, Middelburg, 16-21 September.

Fortuin, A.R., P.A. Sumosusastro, Tj.C.E. van Weering & Th.B. Roep. Large-scale slumping and sliding in the Neogene of Sumba, E. Indonesia. Symposium on dynamics of subduction. Silver Jubilee LIPI, Yogjakarta, Indonesia, 17-19 September; and Mtg. Indon. Ass. Geoph. Bandung, Indonesia, 15-17 October.

Fortuin, A.R., Th.B. Roep, P.A. Sumosusastro & Tj.C.E. van Weering. Outline of the Neogene Forearc sedimentation in eastern Sumba, Indonesia. Symposium on the Dynamics of Subduction. Silver Jubilee LIPI, Yogjakarta, Indonesia, 17-19 September; and Mtg. Indon. Ass. Geoph. Bandung, Indonesia, 15-17 October.

Herman, R.L. & R.P.M. Bak. Nematode feeding guilds and the occurrence of nanobenthos. EPOS Symposium, Bremerhaven, 22-27 May.

Meesters, E. & R.P.M. Bak. Coral regeneration on Curaçao. Verwey-dagen, NIOZ, Texel, 25-27 February.

Nolting, R.F.& H.J.W. de Baar. Distribution of copper, cadmium, zinc, nickel and iron in the upper 300 meter of a transect in the Southern Ocean (57°-67°S, 49°W). EPOS symposium, Bremerhaven, 22-27 May.

Piersma, T. & B.J. Ens. Optimal migration schedules: nutrient dynamics as constraint. BOU/BTO/ICBP Conference on 'The ecology and conservation of Palearctic-African migrants', Norwich, UK, 4-7 April.

Poot, M. & B. Roelen. Food and feeding of Knots in autumn in the eastern Dutch Wadden Sea. Wader Study Group Annual Conference and Symposium, Texel, 4-7 October.

Rozemeijer, M.J.C., J.P. Boon, P. Duiven, J. van der Meer, J.S.J. van de Sant, C. Swennen, A.J. Murk, J.H.J. van den Berg, M. Fellinger, A. Brouwer & J.H. Koeman. The effect of 3,3',4,4'-tetrachlorobiphenyl and Clophen A50 on the monooxygenase system of eider ducklings (*Sommateria mollissima*) with indications for structure-related biotransformation of CB-congeners. NATO-advanced research Workshop: strategy for biomarker research and application in the assessment of environmental health, NIOZ, Texel, 11-17 mei.

Schijf, J., P.M. Saager & H.J.W. de Baar. Anoxic Brines in the Mediterranean Sea: Extreme Trace Metal Gradients at the Seawater-Brine Interface. Gordon Research Conference on Chemical Oceanography, Kimball Union, New Hampshire, USA, 12-16 August.

Sleiderink, H.M., J.P. Boon & J.M. Everaarts. Levels of EROD-activity and Σ450 in dab (*Limanda limanda*) from the southern North Sea. NATO-advanced research Workshop: strategy for biomarker research and application in the assessment of environmental health, NIOZ, Texel, 11-17 mei.

——. Levels of EROD and Σ450 in dab (*Limanda limanda*) in the North Sea. 6th International Symposium on Responses of Marine Organisms to Pollutants, Woods Hole, USA, 24-26 April.

Slomp, C.P., W. van Raaphorst & J.F.P. Malschaert. The effect of deposition of organic matter on phosphorus dynamics in sandy marine sediments. 3rd International workshop on Phosphorus in Sediments. Woudschoten/Zeist, 30 September - 3 October.

Souren, A.W.M.G., J. Schijf & H.J.W. de Baar. Rare earth element distributions in the Southern Ocean. EPOS Symposium Bremerhaven, 22-27 May.

——. Rare earth element distributions in the Southern Ocean. Gordon Research Conference on Chemical Oceanography, Kimball Union, New Hampshire, USA, 12-16 August.

Veer, H.W. van der, R. Dapper, J. van der Meer, J. Nieuwenhuizen, C.G.N. de Vooys & J.IJ. Witte. Long-term changes in rare fish species in the North Sea 1930-1991. 26th European Marine Biology Symposium. Middelburg 17-21 September.

Weering, Tj.C.E. van, A.R. Fortuin, H. Prasetyo & W. van der Werff. Late Cenozoic sedimentary patterns along uplifted forearc segments of the eastern Sunda forearc, Indonesia. Silver Jubilee LIPI, Yogjakarta, Indonesia, 17-19 September; and Mtg. Indon. Ass. Geoph. Bandung, Indonesia, 15-17 October.

2.2.3. Advice offered

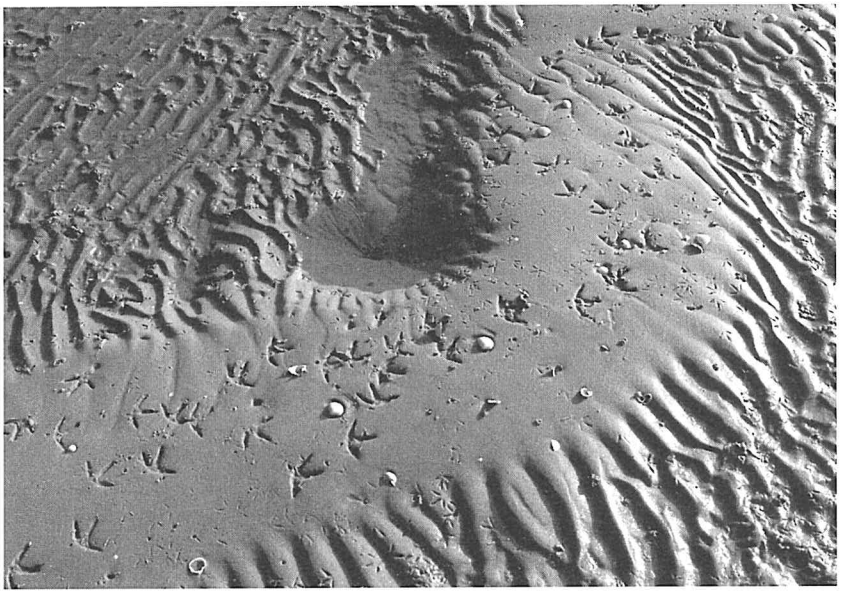
J.D.L. van Bleijswijk advised Quest International B.V. on the production of natural flavor compounds from *Emiliania huxleyi*.

On the request of Unesco/UNDP, Tj.C.E. van Weering paid a visit to Guyana to prepare a proposal for studies of the development, morphology and dynamics of mudbanks in the offshore zone and their possible relationship with coastal erosional/ accretionary cycles of the coast of Guyana.

H.J.W. de Baar gave advice to O. Klepper (RIVM) and H. van Huet (KUN) on improved oceanic carbon cycle module in the policy supporting Integrated Model to Assess the Greeenhouse Effect (IMAGE) of the RIVM.

C. Swennen gave advice to Ned. Ver. Behoud Waddenzee on negative effects of the mussel fisheries on birds.

C. Swennen gave advice to the US Department of Justice on the damage caused to birds by an oil spill.
W.G. Mook advised, as member of an international committee, the Canadian authorities about the necessity of installing a new accelerator mass spectrometry facility in Canada.
W.G. Mook acted as member of a Peer Review committee evaluating the Radioisotope laboratory of NERC in Glasgow.
W.G. Mook was panel member advising the International Atomic Energy Agency on isotopic standards for carbon 14.



(Photo: NIOZ)

2.3. ACRONYMS USED IN THIS ANNUAL REPORT

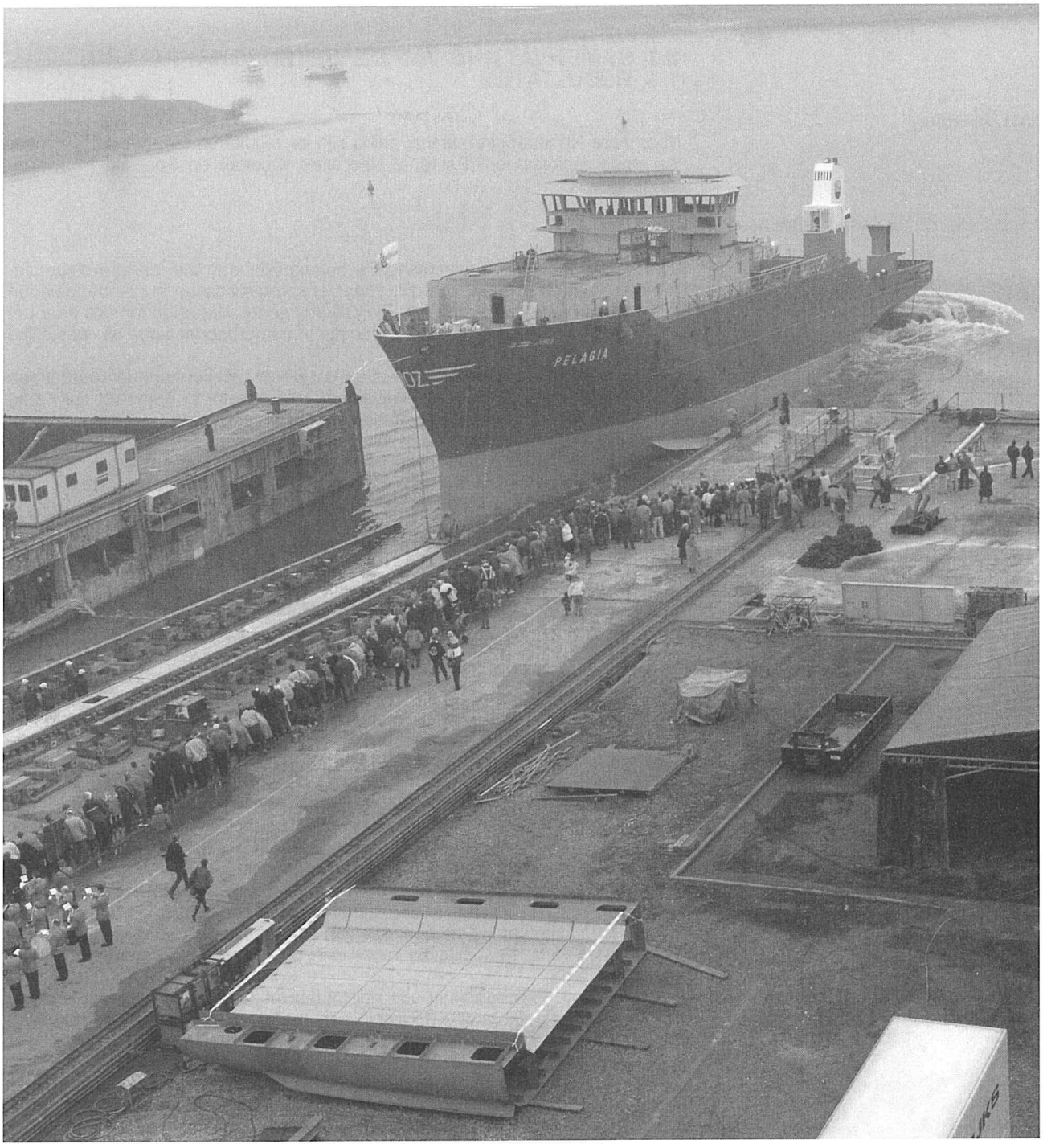
AFDW	Ash-Free Dry Weight
AMS	Accelerator Mass Spectrometry
ASGASEX	Air Sea Gas Exchange Experiment
ATP	Adenosine-Tri-Phosphate
AVHRR	Advanced Very High Resolution Radiometer
AWI	Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, FRG
BAH	Biologische Anstalt Helgoland, Helgoland, FRG
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
CORSAIR	Coastal Optical Remote Sensing Airborne Radiometer
CREST	Comité de la Recherche Scientifique et Technique (EC)
CTD	Conductivity Temperature Depth (probe)
DGS	Denmark's Geological Survey
DGW	(Dienst Getijdewateren RWS) Tidal Waters Division RWS
DIHO	(Delta Instituut Hydrobiologisch Onderzoek) Delta Institute for Hydrobiological Research
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
EMOWAD	(Ecologisch Model westelijke Waddenzee) Ecological Model western Wadden Sea
EON	(Ecologisch Onderzoek Noordzee en Waddenzee) Ecological Research North Sea and Wadden Sea
EPOS	European Polarstern Study
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, RW)
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)
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
OIO	(Onderzoeker in opleiding) Ph.D. student
OPEX	Oil Pollution Experiment
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
RIN	(Rijks Instituut voor Natuurbeheer) Research Institute for Nature Management
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
SEDEX	Sediment Experiments
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

Tewaterlating van de Pelagia op 26 januari 1991 op de Verolme werf te Oud Heusden.

Launching of RV Pelagia on 26 January, at the Verolme shipyard in Oud Heusden.


PELAGIA

3. Nederlandse samenvatting van de wetenschappelijke resultaten en andere activiteiten

3.1. SAMENVATTING VAN DE WETENSCHAPPELIJKE RESULTATEN

3.1.1. Inleiding

Voor deze Nederlandse 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)

Chaotische menging is waarschijnlijk belangrijker dan alle andere dispersieprocessen in de Waddenzee. Dit voor transportprocessen in getijdegebieden interessante resultaat werd verkregen bij een gedetailleerd onderzoek naar het voorkomen van chaos in het numerieke transportmodel voor de westelijke Waddenzee.

Hoge troebelheid maakt dat UV-A en UV-B licht niet ver kunnen doordringen in de Waddenzee, veel minder ver dan in helder water in Admiralty Bay, King George eiland, Antarctica. Een toename in UV-licht zal in Antarctische wateren dan ook grotere effecten hebben dan in de Waddenzee.

Evenals in 1990 werden in de Waddenzee de hoogste nutriëntengehaltes, denitrificatiesnelheid en N_2O flux uit het sediment aangetroffen in de Dollard. Laboratoriumexperimenten maken het aannemelijk dat de gevonden verschillen in N_2O fluxen van en naar wadsedimenten samenhangen met de mate waarin denitrificerende bacteriën blootgesteld zijn aan vrij sulfide, tri-sulfide en zuurstof. Tijdens onderzoek naar de eutrofiëring in de Lagune van Venetië (BEST) werd gevonden dat ook hoge gehaltes aan zware metalen de N-cyclus in sedimenten nadelig beïnvloeden. Naast veldwerk in de lagune wordt het grootste deel van dit onderzoek uitgevoerd in mesocosms op Texel.

Met de op het NIOZ vervaardigde *in situ*-suspensiecamera was het mogelijk ook de kleinere deeltjes te meten, hetgeen eerder nog niet kon. Metingen werden verricht in de estuaria van Eems, Elbe en Gironde en ook in open zee.

Het coöperatief onderzoek van sedimentatie en erosie op wadden langs de Chinese kust is, na een onderbreking, in 1991 weer op gang gekomen. In 1991 werd onderzoek gestart in het Lena estuarium (Siberië).

Een nieuwe methode om opname van Si door diatomeeën te meten (m.b.v. ^{32}Si) blijkt ook bruikbaar in het Marsdiep.

In gesuspendeerd materiaal in de Westerschelde werden relatief hoge gehaltes aan ^{210}Po gevonden, waarschijnlijk afkomstig van ertsverwerkende industrieën. In sedimentkernen van de Oosterschelde werd m.b.v. ^{210}Po een sedimentatiesnelheid van 0.6 - 1.8 cm/jaar gemeten, in het Haringvliet/Hollandsdiep werd tot 50 cm/jaar sediment afgezet sinds het afsluiten in 1970.

De verhouding van de concentratie van 34 onderzochte elementen in marine organismen vergeleken met die in zee wijst op een mariene oorsprong van het leven op aarde.

Bij toename in lichaamsgrootte neemt het metabolisch inerte deel van een organisme (gebruikt voor versteviging en transport en opslag van voedingsstoffen) een steeds groter deel in.

De voorjaarsbloei van de koloniale alg *Phaeocystis* in het Marsdiep is dit jaar uitgebreider onderzocht. De bloei duurde 5 maanden, met een piekhoogte van 125.000 cellen per cm^3, niet afwijkend van de situatie in de laatste jaren. Kolonies van *Phaeocystis* blijken het hele jaar aanwezig te zijn in de waterkolom,

de soort kan kennelijk als kolonie overwinteren. Nieuwe kolonies worden niet alleen in het voorjaar aangetroffen (vaak vastgehecht aan diatomeeën), maar ook in de herfst. Lysis van *Phaeocystis*-cellen ten gevolge van N-limitatie lijkt de belangrijkste factor voor het ineenstorten van de bloei. Doordat deze alg ook organische fosfaatverbindingen als P-bron kan gebruiken speelt P-limitatie minder snel een rol dan bij andere algen. Fluctuaties in bacteria, nanoflagellaten en ciliaten tijdens de voorjaarsbloei vertonen fraaie voorbeelden van predator-prooi interacties. Copepoden blijken geen belangrijke consument van *Phaeocystis*, tijdens de *Phaeocystis*-piek voeden zij zich waarschijnlijk met ciliaten. Veel aandacht is dit jaar besteed aan onderzoek in het laboratorium hiernaar.

De op het wad levende tweekleppige *Macoma* spuugt binnengekregen *Phaeocystis*-kolonies onmiddellijk weer uit. Eetactiviteit en groei van *Macoma* wordt negatief beïnvloed door de aanwezigheid van garnalen en het verkorten van de sifon (dit gebeurt buiten o.a. door platvissen). Met kortere sifonen bleek *Macoma* echter niet van sedimentivoor suspensivoor te worden zoals eerder werd verondersteld. Vergelijkbaar onderzoek uitgevoerd in twee estuaria in North Carolina toonde aan dat ook daar de aanwezigheid van predatoren *Macoma* beïnvloedde: hoe meer predatoren hoe kortere sifonen, hoe ondieper *Macoma* zich ingraaft en hoe slechter hij groeit.

De amphipode *Corophium volutator* komt gewoonlijk alleen voor op de hogere wadden. Experimenten buiten op het wad toonden aan dat de wadpier *Arenicola* en de kokkel een negatief effect hebben op het zich vestigen van *Corophium* (en ook op de worm *Pygospio*). Dit kan verklaren waarom *Corophium* alleen op de hoge wadden voorkomt waar dichtheden van kokkel en wadpier laag zijn. In afwijking van andere jaren bleek in 1991 echter *Corophium volutator* verdwenen te zijn uit de westelijke Waddenzee, er was bovendien een enorme vestiging van juveniele wadpiertjes.

Eutrofiëring en wintertemperatuur blijken de belangrijkste factoren in de veranderingen van de macrofauna op de wadden van de westelijke Waddenzee sinds 1969. Door eutrofiëring nam de hoeveelheid voedsel voor het macrobenthos toe en verdubbelden biomassa en productie, vooral kleine sedimentivore wormen namen sterk toe. Tijdens af en toe voorkomende strenge winters worden de aantallen van 1/3 van de soorten gedecimeerd, maar in de zomers na de koudste winters treedt een grote broedval op van schelpdieren als kokkel, mossel en strandgaper, waarvan dan jaren achtereen een sterke populatie op het wad voorkomt. Na drie zachte winters van 1988 tot 1990, met als gevolg een falende recrutering, is er door schelpdiervisserij en predatoren als de eidereend weinig meer over aan kokkels en mossels op het wad. Dit heeft geleid tot een sterke teruggang (35%) in het aantal overwinterende eidereenden in de Waddenzee in 1991, een grote mortaliteit (15.000 dode eiders spoelden aan), een sterke achteruitgang in de broedpopulatie en een broedsucces van slechts 2 jongen uit in totaal zo'n 3000 nesten. Ook de aantallen van de eveneens voornamelijk schelpetende overwinterende scholeksters waren ruim 50% lager. Ook de zeester *Asterias*, die vooral mossels eet, nam enorm af in aantal in 1990/1991. Eind Augustus hadden zich echter weer veel jonge zeesterren gevestigd.

In zijn broedgebied in Zuid Korea eet het Oost-Aziatische ras van de scholekster voornamelijk krabben; niet de voedselhoeveelheid maar de afwezigheid van veilige broedplaatsen bedreigt deze soort hier.

Ook dit jaar werd weer veel aandacht besteed aan de kanoet waarvan de Siberische populatie overwintert in West-Afrika en de Groenlands/Canadese populatie in West-Europa. Hoe handhaven deze vogels hun lichaamstemperatuur van 40-43°C onder zulke sterk verschillende omstandigheden? De tempe-

ratuur van de buitenkant, bestudeerd m.b.v. thermografie, geeft aan dat kanoeten zowel door variatie in doorstroming met bloed (poten) als door het al of niet opzetten van hun veren warmteuitwisseling met de omgeving kunnen reguleren. Kanoeten voeden zich voornamelijk met schelpdieren, die zij geheel inslikken en kraken in hun maag. Met hun voedsel krijgen zij dus veel onverteerbaar schelpmateriaal binnen. Uit proeven bleek dat de hoeveelheid opgenomen voedsel slechts tot een bepaalde grenswaarde toeneemt met de hoeveelheid gegeten schelpdieren, deze grenswaarde is afhankelijk van voedseltype en structuur van de maag. In tropisch NW Australië (Broome) overwinterende kanoeten bleken daar vooral andere prooien te eten dan schelpdieren, dit vermoedelijk omdat daar relatief weinig schelpdieren beschikbaar waren (slechts 3.6 g asvrij-drooggewicht per m^2 tegenover 24 g in de Waddenzee). Evenals in Mauretanië worden normaliter schelp-etende kanoeten in hun tropisch overwinteringsgebied gedwongen over te gaan op andere prooien.

Jaarklassesterkte van de bot wordt evenals die van de schol reeds bepaald in het pelagische larvale stadium, voordat de larven in de Waddenzee komen en daar de bodem opzoeken. Na vestiging op het wad treedt een dichtheidsafhankelijke mortaliteit op ten gevolge van predatie door krabben en garnalen.

Schelpeters als eider, kanoeten, platvissen zijn de belangrijkste leveranciers van schelpfragmenten aan het waddensediment. Het voorkomen van grote hoeveelheden schelpfragmenten in een sediment wordt door geologen vaak ten onrechte in verband gebracht met een turbulent afzettingsmilieu.

3.1.3. Noordzee

Een belangrijke ontwikkeling in 1991 was het Integrated Noordzee Programme (INP), waaraan werd deelgenomen door de Nederlands Raad voor Zeeonderzoek, de Dienst Getijdewateren van Rijkswaterstaat en de BEON groep, tesamen met een aantal onderzoekers en schepen van landen rondom de Noordzee.

Het centrale thema van dit onderzoek is het horizontale en vertikale korte-termijntransport van opgelost en particulair materiaal, en de effekten van deze transportverschijnselen op de oecologie. Zulke korte-termijntransporten spelen een belangrijke rol in de oecologie van de Noordzee; zo brengen stormen voedselrijk bodemwater naar het oppervlak, waar vervolgens algenbloeien kunnen ontstaan. Anderzijds transporteren kalkalgen anorganisch koolstof naar het bodemsediment, terwijl het uitvlokken van organisch materiaal een bijdrage levert aan het transport van organisch materiaal en verontreinigende microcontimanten naar het sediment. Met het nieuwe schip Pelagia werden in 1991 verschillende Noordzeetochten gevaren. Zo werd in de periode van 1 juli tot 9 oktober een instrument verankerd op de Oestergronden (54˚25'N, 4˚O) waarmee continu en simultaan de fysische structuur van de waterkolom en de chlorofylconcentraties werden gemeten met instrumenten zoals stroommeters, thermistors, fluorometers en transmissometers. Een voorlopige analyse toont aan dat de chlorofylconcentraties variëren met de getijdecyclus, zowel als gevolg van de getijdebeweging in een chlorofylgradiënt als door de variatie van de chlorofylconcentratie met de variatie in de structuur van de waterkolom.

Een oud probleem, namelijk de instromende hoeveelheid water vanuit de Atlantische Oceaan door de straat van Dover, werd opgepakt in het project Fluxmanche, tesamen met de Universiteit van Southampton. De kuststromen tussen Boulogne en Cap Gris Nez en de variabiliteit van de waterkwaliteit tussen Cap Gris Nez en Dover werden onderzocht in een Frans/Engels programma; de NIOZ-bijdrage bestond uit talrijke vluchten met de remote sensing

CORSAIR, de Coastal Remote Sensing Airborne Radiometer, aan boord van een NERC vliegtuig.

Met gebruikmaking van de isotopen ^{210}Pb en ^{210}Po werd aangetoond dat in de sedimentatiegebieden Oestergronden en Outer Silver Pit de profielen van deze isotopen in de bodem kunnen worden verklaard uit bioturbatie en resuspensie van het sediment, terwijl in het gebied van het Friese Front (Oostelijk deel van de Oestergronden) deze verklaring niet voldoet: daar vindt aktieve sedimentatie plaats.

Isotopenbepalingen (^{210}Pb en ^{137}Cs) aan boxcore-monsters uit het oostelijk Skagerrak bevestigen de eerder gevonden sedimentatiesnelheden (tot 44 cm/100 jaar), terwijl er een veel kleinere sedimentatie is in de Noorse Geul (tot 10 cm/100 jaar). Uit de studie van de foraminiferen uit de boxkernen van het Skagerrak volgen aanwijzingen, bij vergelijking met oude gegevens van Höglund, dat ook in het diepe Skagerrak eutrofiëring optreedt.

Uit de studie van ondiepe seismische profielen (van IFREMER) van 'shoreface connected sand ridges' blijkt dat onder deze ruggen een aantal, waarschijnlijk meanderende, geulen en opgevulde rivierdalen liggen.

De analyse van PCB's werd verder verbeterd door gebruikmaking van gegarandeerde standaardoplossingen, en van verbeterde instrumentatie. Het gebruik van biologische indicatoren voor de vroegtijdige waarschuwing voor milieuverontreiniging in zee werd verder ontwikkeld; het betreft hier niet alleen hele dieren, zoals de schar en de zeester, maar ook bloedonderzoek, leverfuncties, de vorming van ontgiftingsystemen door het organisme, en schade aan het genetisch materiaal, zoals DNA. Oriënterende proeven werden uitgevoerd met schar en zeesterren verzameld in de Noordzee.

N_2O is een in de atmosfeer vookomend sporegas dat zowel werkt als broeikasgas als bijdraagt aan de aantasting van de ozonlaag. De huidige concentratie van 310 ppb in de atmosfeer neemt met 0,2% per jaar toe; het gas wordt gevormd door microbiologische processen in water en op land. Teneinde een beter inzicht te krijgen in de uitwisseling van N_2O tussen zeewater en de atmosfeer werd in samenwerking met het Plymouth Marine Laboratory een Noordzeetocht uitgevoerd met het onderzoekschip Challenger.

(Foto: NIOZ)

De gegevens over de productie en het koolstofbudget, in relatie tot de hydrografische structuur in het gebied van het Friese Front werden samengevat en dragen bij tot een vergroot inzicht in dit stukje Noordzee.

Een inventarisatie van heterotrofe nanoflagellaten in het sediment van de Noordzee toonde enorme verschillen in aantallen op verschillende stations; het hoogste aantal ooit gevonden werd aangetroffen ten westen van Esbjerg (~800 x $10^3 \cdot cm^{-3}$); normale waarden variëren van 50-200 $10^3 \cdot cm^{-3}$. In het algemeen zijn de aantallen in zandige sedimenten hoger dan die in slik.

De eutrofiëring van het kustwater heeft geleid tot een verhoogde primaire produktie en een langer durende *Phaeocystis*-bloei. Het gevolg hiervan kan zijn dat er veranderingen optreden in de seizoensgebonden ontwikkeling van heterotrofe bacteriën, flagellaten, ciliaten en ander microplankton, terwijl ook de voedselcondities van het zooplankton veranderd zijn. Dat blijkt bv. ook uit de toename van de maximale talrijkheid van de copepode *Temora* voor alle ontwikkelingsstadia, terwijl bovendien de periode van toename van aantallen in het voorjaar langer van duur werd, wat op zijn beurt leidde tot een grotere zomerpopulatie.

De groei van de langlevende (150 jaar) Noordkromp wordt gebruikt om lange-termijnwijzigingen in de Noordzee te evalueren.

Een begin werd gemaakt met de studie van plankton in pelagische mesocosms, waarin de structuur en het functioneren van planktongemeenschappen als functie van licht en nutriënten zullen worden bestudeerd. Deze methodiek moet dienen als intermediair niveau van integratie tussen enerzijds de ecofysiologische studies van soorten in continue culturen, en anderzijds veldwerk in de Noordzee en mathematische modellen.

Bij het kweekwerk van copepoden ten behoeve van de populatiedynamica en bioenergetica, waarbij de soort *Pseudocalanus elongatus* de 100ste generatie bereikte, werden experimenten uitgevoerd met *Acartia clausii* en *Temora longicornis* om de ontwikkelingssnelheid van de soorten te meten bij 16 verschillende combinaties van temperatuur en voedseldichtheid. *Acartia* kwam daarbij in de plaats van de in 1990 minder succesvolle experimenten met *Centropages hamatus*.

Een voedselautomaat (gebouwd in samenwerking met de afdeling Electronica) werd gebruikt om de voedselconcentratie in de cultures constant te houden.

Het werk aan de zwarte zeeëend (*Melanitta nigra*) werd afgesloten; deze soort overwinterde voornamelijk ten noorden van de Nederlandse Waddeneilanden, en voornamelijk in gebieden waar de schelp *Spisula subtruncata* talrijk is.

Op 12 maart werd een groep van 48 bruinvissen waargenomen, nabij Terschelling: dit is de grootste groep die in de laatste 20 jaar gezien is.

3.1.4. Oceaanonderzoek

Op het NIOZ is in 1991 oceaanonderzoek uitgevoerd in het kader van verschillende (internationale) projecten. De afdeling Fysische Oceanografie voerde een tweede hydrografische opname uit in de Noord-Alantische Oceaan in het kader van het World Ocean Circulation Experiment (WOCE). Verschillende afdelingen namen deel aan de Nederlandse Antarctische Expeditie op de Poolse basis Arctowski, St. George Island, en aan onderzoek in de Middellandse Zee in het kader van het European River Ocean System (EROS-2000). Ook werd er deelgenomen aan het European Polarstern Study II (EPOS II) rond Spitsbergen. Het oceaanonderzoek werd uitgevoerd met verschillende

Nederlandse (Pelagia, Tyro) en buitenlandse (Charles Darwin, Polarstern, Gelendzik) schepen en vanaf walbases (Curaçao, Antarctica).

Watermonsters verzameld in de Weddellzee in 1988 zijn geanalyseerd op hun gehalte aan zeldzame aarden. Deze blijken in het algemeen een vaste relatie te hebben met het silicagehalte. Deze relatie is identiek aan de relaties gevonden voor de noordwestelijke Indische Oceaan en voor de noordelijke Stille Oceaan.

Met een numeriek model is de rol van de dichtheidsgelaagdheid t.g.v. zeeijs op de planktonbloei bij de Antarctische ijsrand onderzocht. De duur en het maximum van de planktonbloei blijken sterk bepaald door de gelaagdheid. Voor het einde van de bloei heeft echter begrazing een sterke invloed.

Analyse van het opgeloste silicaat in het smeltwater van gletsjers op St. George Island in Antarctica toont aan dat glaciale verwering niet bijdraagt aan de hoge silicaconcentraties die in de Antarctische zeeën worden gevonden. De fysische en chemische eigenschappen van de watertypen rond Antarctica blijken overigens niet voldoende constant om een kwantitatieve matermassa-analyse mogelijk te maken.

Vanuit het Antarctische station Arctowski werd microbiologisch onderzoek gedaan in Admiralty Bay en in Bransfield Strait. Vanwege de vroegere start van de primaire productie in Bransfield Strait bleek daar de bacteriële activiteit, zowel in aantallen als in ATP- en ETS-activiteit uitgedrukt, hoger dan in Admiralty Bay. De micro-organismen bleken een sterke respons te vertonen op kleine temperatuurveranderingen.

De totale biomassa van copepoden verzameld in 1988 met de Polarstern is bepaald met natte oxydatie. Copepoden blijken ongeveer 60% van de totale biomassa te vormen, zowel in de Scotiazee als in de Weddellzee. De biomassa en de diversiteit van zoöplankton neemt af van de Scotiazee naar de Weddellzee. Dit hangt waarschijnlijk samen met de beperkte overleving van juveniele stadia onder de extreem polaire omstandigheden in de Weddellzee.

Tijdens de Antarctische expeditie werd de groei bepaald van kuikens van de Adeliepinguin, en de relatie hiervan met het door de ouders aangevoerde voedsel. In 6 weken groeiden de kuikens van een gewicht van 65 g naar meer dan 3 kg. Het verorberde voedsel bestond uitsluitend uit krill. Mogelijk vormen de lage concentaties PCB in het krill een goede tracer voor de totale hoeveelheid gegeten krill.

Vanuit het NIOZ is deelgenomen aan de door de ESF gecoördineerde EPOS II-tocht met de Polarstern naar de wateren rond Spitsbergen. Hierbij zijn copepoden bestudeerd, zowel in de relatief warme West-Spitsbergenstroom als in de polaire Oost-Spitsbergenstroom. De anticyclonale circulatie rond Spitsbergen lijkt gunstig voor typisch polaire copepoden omdat deze volwassen exemplaren naar de paaigebieden brengt en copepodieten naar polaire wateren om te overwinteren.

Gegevens m.b.t. de concentraties van opgelost Silicaat en Tritium in het diepe Noorse Bekken suggereren dat de verversing van het diepe water in dit bekken de laatste 20 jaar aanzienlijk is versneld. Dit in tegenstelling met het diepe water in het naburige Groenlandbekken, dat lijkt te stagneren.

Een gedetailleerde curve voor zuurstofisotopen is bepaald voor een sedimentkern afkomstig uit het Faroer-Shetlandkanaal. Hiermee is een nauwkeurig datering mogelijk van het begin van de 'overflow' van diep water uit de Noorse Zee naar de Atlantische Oceaan. Dit begin hangt samen met het einde van de laatste ijstijd. De sedimentatiesnelheid van de kern bleek de hoogste ooit bepaald in de Atlantische Oceaan. Seismische profielen van de oostelijke con-

tinentale helling bij de Faroer tonen de sterke invloed van het diepe water uit de Noorse Zee op sedimentatie en erosie in het Faroer-Shetlandkanaal.

Een tweede tocht in het kader van DUTCH-WARP, de Nederlandse bijdrage aan het hydrografische programma van WOCE, vond plaats in april en mei in de Noord-Atlantische Oceaan. Naast fysische parameters werden door leden van de afdeling Chemische Oceanografie ook chemische parameters gemeten. Deze dienen voornamelijk als hydrografische tracer (nutriënten). De metingen aan het CO_2-systeem (TCO_2 en Alkaliniteit) vormen echter een bijdrage binnen WOCE aan het Joint Global Ocean Flux Study (JGOFS), waarvoor in voorgaande jaren al een aantal tochten is uitgevoerd. Een viertal stroommeterverankeringen, uitgezet in 1990, kon worden geborgen. De waargenomen hydrografie van het diepe water in het IJslandbekken blijkt bepaald te worden door interactie van watertypen van noordelijke oorsprong met water dat op verschillende niveaus vanuit het zuiden het IJslandbekken instroomt. In het oppervlaktewater werd in mei een diatomeeënbloei waargenomen met een duidelijk effect op de concentraties van zuurstof, koolzuurgas en voedingszouten. Een analyse van de registraties van de opgehaalde stroommeters toont een westwaarts baroklien transport van 'overflow'- water met een snelheid van ongeveer 20 $cm \cdot s^{-1}$. Sterke snelheidsfluctuaties met een karakteristieke periode van ongeveer 10 dagen, hebben een overwegend barotroop karakter. Een begin is gemaakt met het ontwikkelen van wiskundige modellen voor de gegevensassimilatie en voor de simulatie van de diepe circulatie in het IJslandbekken.

De coccolitoforide *Emiliania huxleyi* wordt zowel op zee bestudeerd als in het laboratorium. Gedurende een tocht met de Britse Charles Darwin zuid van IJsland werd een zeer grote bloei van *E. huxleyi* bemonsterd. Hierbij was de beschikbaarheid van optische satellietbeelden van groot nut. De losse coccolieten, verantwoordelijk voor de sterke lichtreflectie waarneembaar op satellietbeelden, kwamen voor in aantallen tot 368 000 per ml. De bloei had een sterke invloed op de partiële CO_2-spanning in het oppervlaktewater. In het laboratorium zijn groeiexperimenten uitgevoerd om de verschillende celkarakteristieken te bepalen als functie van de lichtintensiteit. Hierbij wordt uitgebreid gebruik gemaakt van de 'flow-cytometer'.

Een onderzoek is gestart naar de uitwisseling van CO_2 tussen oceaan en atmosfeer. Op de uitreis van de Polarstern van Bremerhaven naar Puerto Madryn in Argentinië is continu de partiële spanning van CO_2 in het oppervlaktewater en in de atmosfeer gemeten.

Van in 1988 bij de Banc d'Arguin (Mauretanië) verzamelde ongewervelden is de concentratie aan pesticiden en PCB's bepaald. Terwijl in de meeste organismen verschillende pesticiden en hun metabolieten konden worden bepaald, waren in het algemeen PCB's niet aantoonbaar aanwezig. Sediment, zooplankton en benthische ongewervelden, afkomstig van de Banc d'Arguin, zijn ook geanalyseerd op het gehalte aan zware metalen. In het sediment zijn de concentraties relatief laag en in de ongewervelden van vergelijkbare grootte als in andere gebieden. De concentraties aan zware metalen in het zooplankton zijn relatief hoog.

Planktonische foraminiferen, verzameld in het Angolabekken in 1989, zijn statistisch geanalyseerd m.b.v. hoofdcomponentenanalyse. De verschillende hoofdcomponenten die zijn gevonden, blijken gerelateerd aan verschillende hydrografische omstandigheden in het Angolabekken. De correlatie van de hoofdcomponenten met fysische parameters is echter zwak. De belangrijkste correlaties zijn die tussen de hoofdcomponenten en de verschillende voedingszouten.

Sedimentmonsters uit de noordwestelijke Middellandse Zee, verkregen tijdens het EROS-2000-programma, zijn geanalyseerd op hun gehalte aan spore-elementen en zware metalen. Uit de verdeling van de spore-elementen blijkt de Rhône de belangrijkste bron voor deze elementen. De invloed van de Ebro is hierbij verwaarloosbaar. De concentraties van lood en zink zijn 2 à 3 maal de waarden uit de voor-industriële tijd. Zink blijkt voornamelijk uit de Rhône afkomstig. Bij lood speelt atmosferische depositie een belangrijke rol. Sedimentkernen uit de noordwestelijke Middellandse Zee zijn geanalyseerd met behulp van een 'micro-probe'. De resultaten tonen een sterke influx van biogeen carbonaat en van sediment uit de Rhône. Stof uit de Sahara wordt nauwelijks waargenomen.

Bij de kringloop van spore-metalen in hypersaliene bekkens in de oostelijke Middellandse Zee blijken sulfiden een belangrijke rol te spelen. Nikkel zowel als ijzer worden verwijderd door neerslag in de vorm van sulfiden.

Tijdens een tocht met het Sovietschip Gelendzik in de Zwarte Zee zijn seismische profielen opgenomen over een reeks moddervulkanen. Deze moddervulkanen blijken verband te houden met het vrijkomen van gas uit de diepere ondergrond en niet met tectonische processen.

Theoretisch fysisch onderzoek is uitgevoerd naar aspecten van de niet-lineaire oceaancirculatie die worden gesimuleerd in roterende hydraulische modellen. Ook wervels in dergelijke modellen zijn bestudeerd. Het verval van deze wervels blijkt in belangrijke mate te worden bepaald door niet-lineaire effecten. Deze kunnen aanleiding geven tot het 'breken' van wervels, equivalent met de Rayleigh-instabiliteitsvoorwaarden. Een analyse van de rol van de aardrotatie voor inwendige golven en solitonen heeft aangetoond dat de horizontale Coriolis-component voor interne solitonen verwaarloosbaar is.

Sedimentmonsters die ferrihydriet bevatten zijn bestudeerd met behulp van Röntgendiffractie. Hiermee is aangetoond, dat siliciumatomen gebonden zijn aan het oppervlak van kleine kristallijne domeinen. Hierbij lijkt het aantal siliciumatomen de grootte van de domeinen te bepalen. Een soortgelijke binding lijkt te bestaan voor fosfor.

Langs de kust van Curaçao zijn steenkoralen bestudeerd. Grote verschillen in mortaliteit tussen verschillende soorten zijn vastgesteld. De ecologische karakteristieken van de dominante rif-bouwende *Montastrea annularis* zijn onderzocht. Alle drie de morfotypen van dit sleutelorganisme blijken zich in het najaar, een week na volle maan, massaal voort te planten. Verschillen tussen de morfotypen zijn vastgesteld in de fotopigmentkarakteristieken en in het regeneratieve proces. Bij de koraalriffen bleken de concentraties van nutriënten normaal tot licht verhoogd. De bacteriële dichtheden waren relatief hoog en namen langs de kust toe.

Seismische profielen van het Lombok- en Savoebekken, verzameld tijdens de Snellius II-expeditie, zijn opnieuw geïnterpreteerd aan de hand van industriële meerkanaalsgegevens. De resultaten van deze herinterpretatie zijn vervolgens gecombineerd met gegevens verzameld tijdens veldwerk op Soemba in 1989 en 1990.

3.1.5. Speciale Projecten

De BEWON-groep is een onderdeel van het Beleidsonderbouwend Ecologisch Onderzoek Noordzee (BEON), waarin 9 instituten samenwerken. De groep op het NIOZ houdt zich bezig met beleidskwesties betreffende eutrofiëring, verontreinigende stoffen en effecten van visserij op de bodemfauna. BEWON

besteedde veel tijd aan het organiseren en uitvoeren van het Integraal Noordzee Programma (INP), waarin de rol van het sediment in de nutriëntencycli en de effecten van verontreinigende stoffen centraal staan.

In het fysisch transportmodel voor de zuidelijke Noordzee maakt het groot verschil voor de verspreiding van het Rijnwater in zee of de actuele windkracht gebruikt wordt of een berekend stationair snelheidsveld.

Met de ontwikkeling van een ecosysteem-model voor de Noordzee —een samenwerkingsverband van 7 Europese instituten, gefinancierd uit het EG-MAST programma— zijn goede afspraken en vorderingen gemaakt. Alle instituten hebben nu dezelfde computerfaciliteiten en ieder instituut verzorgt een eigen deel van het model.

In het Friese-Frontgebied komt bijna alle stikstof die in de bodem gemineraliseerd wordt weer in de waterkolom, in het Bree-Veertiengebied geldt dat voor slechts 75%. Hogere chlorofylconcentraties in de nazomer in het Friese-Frontgebied zijn hiermee te verklaren. Bij de fosforcyclus speelt opname door bacteriën in de bodem een belangrijke rol.

In competitie-experimenten uitgevoerd in continu-cultures onder verschillende N/P verhoudingen blijkt *Phaeocystis* een uitstekende competitor onder N-limitatie. Kolonievorming bij deze alg trad op bij nitraat als N-bron en niet bij ammonia. Verbeteringen in rioolwaterzuivering langs de Rijn hebben gezorgd voor een sterke verschuiving van ammonium naar nitraat in het Rijnwater: hiermee is deze waterzuivering tevens de oorzaak van de toegenomen bloeien van *Phaeocystis*.

In het Marsdiep namen in het voorjaar heterotrofe flagellaten toe met de toename van het aantal vrijlevende *Phaeocystis*-cellen, bacteriële productie volgde hierop met een vertraging van 10-12 dagen. De ^{3}H-thymidine methode (die DNA-replicatiesnelheid meet) bleek vergelijkbare waarden voor bacteriële productie op te leveren als de ^{3}H-leucinemethode die een maat is voor eiwitsynthese. De leucine-methode geeft directer een maat voor bacteriële productie en werd daarom gebruikt tijdens het INP. De hoogste productiewaarden werden gevonden in de Duitse Bocht.

In de centrale Noordzee werden relatief lage gehaltes aan polyaromatische verbindingen aangetroffen in de worm *Nepthys*, de bron hier is de atmosfeer. In het Nederlandse kustwater werden 10 keer zo hoge concentraties aangetroffen, hier is de bron rivierwater.

Toxicologisch onderzoek richtte zich vooral op biochemische en fysiologische effecten die als vroegtijdig waarschuwingssignaal kunnen dienen voor aantastingen van het ecosysteem. Zowel toediening in het laboratorium van een technisch PCB-mengsel (Clophen A40) aan schar als de toediening van benzo[a]pyreen aan bot leidde tot inductie van het enzym cytochroom P450 1A in de lever, karakteristiek voor het 'dioxine-type' mechanisme van giftigheid. Ook in het veld werd bij schar uit Noordzee kustwater een verhoogde activiteit van P450 1A gevonden vergeleken met verder uit de kust gevangen exemplaren. Eidereendkuikens vertoonden een sterk verhoogde concentratie van P450 1A onder invloed van 3,3'.4.4'-tetrachloorbiphenyl, maar niet na blootstelling aan het PCB-mengsel Clophen A50. Eidereendkuikens bleken wel in staat bepaalde molecuultypen uit dit mengsel enzymatisch om te zetten.

De negatieve effecten van lozing van oliehoudende boorspoeling worden slechts gedeeltelijk verminderd als geprobeerd wordt de olie uit de boorspoeling te verwijderen. Wel was de fauna rond een platform waar dit gebeurt rijker en diverser, maar een test-organisme als de zeeklit *Echinocardium cordatum* vertoonde toch nog duidelijk mortaliteit in sediment verzameld op 25 en 250 m van het platform en de dichtheid van enkele zeer gevoelige soorten was toch nog laag in een gebied tot 1000 m rond het boorplatform. In een gebied waar 6

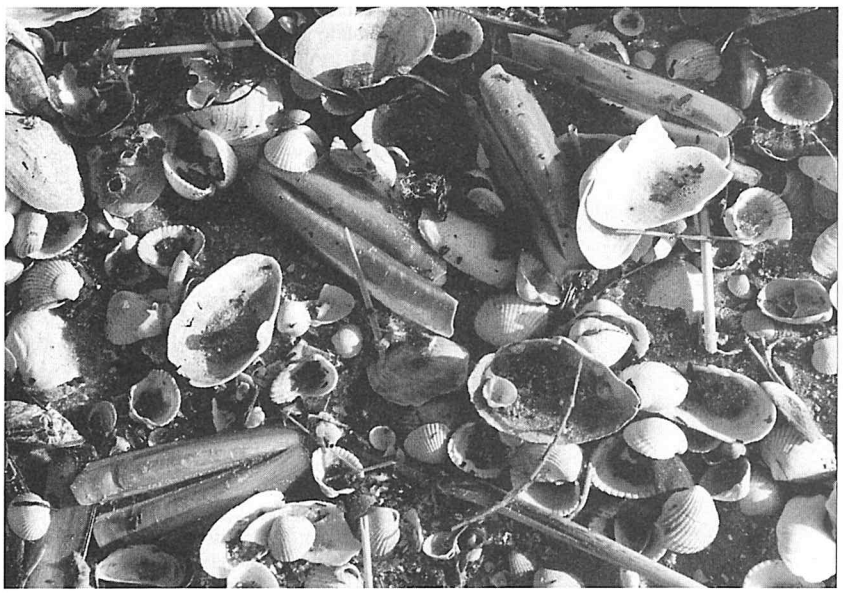
jaar geleden oliehoudende boorspoeling was geloosd was nog steeds olie in de bodem aanwezig en trad een verhoogde mortaliteit op bij de zeeklit.

De kans dat vissen overleven als ze in zee terug gezet worden na te is gevangen in een trawlnet van een tongvisser zijn praktisch nihil. Van de benthische organismen in de netten gevangen overleeft 40% van de mollusken, 70-80% van de zeesterren en bijna 100% van de wulken en heremietkreeften. Om effecten van visserij te bestuderen is gezocht naar een gebied waar niet gevist wordt. Het bleek onmogelijk zo'n gebied te vinden in de Noordzee. Ook het gebied rond Borkum Rif, rijk aan stenen en daardoor mogelijk minder bevist, bleek honderden bodemsporen van trawls te vertonen op de side-scan-sonarbeelden.

Op verzoek van het ministerie van Landbouw, Natuurbehoud en Visserij zijn twee gebieden aangewezen in de Noordzee die in aanmerking komen voor een volledige afsluiting voor visserij, lozing van oliehoudende boorspoeling, zandwinning, afvalstorten, pijplijnen en andere menselijke activiteiten: een gebied van 10000 km^2 ten noorden van de Waddeneilanden en een gebied van 800 km^2 bij de Klaverbank.

Het monitoringprogramma van Waddenzee-macrobenthos werd uitgebreid met transecten in het Eems-Dollard gebied. Veel wintergevoelige soorten bleken de winter niet overleefd te hebben. De tweekleppige *Ensis americanus* en de worm *Lanice conchilega* vestigden zich echter weer massaal op het wad in de zomer.

Uit een literatuuronderzoek bleek dat veranderingen in de Golfstroom doorwerken in temperatuur en saliniteit van de Noordzee. Lange-termijnklimaatseffecten veroorzaken fluctuaties in hydrografie en biologie.



(Foto: NIOZ)

3.2. BEZOCHTE CONGRESSEN

Meeting on the certification of trace elements in seawater (reference material), EG Brussel, 9 januari: R.F. Nolting.
International Symposium on the Oceanography of the Indian Ocean and JGOFS Indian Ocean Planning Group, first meeting, Goa, India, 14-18 januari: M.A. Baars, Tj.C.E. van Weering.
Workshop The Analysis and Characterization of Marine Particles, Honolulu, Hawaii, 20-26 januari: S.J. van der Gaast.
WASP-3 workshop 1991, NIOZ, Texel, 22-25 januari: W. van Raaphorst, P. Ruardij.
Workshop MARS (European Marine Research Stations), Parijs, 28-29 januari: P.A.W.J. de Wilde.
EC *Phaeocystis* workshop Brussel, 29 jan.-2 febr.: G.C. Cadée, P. Kamermans, R. Riegman.
Jaarvergadering van de ICES Marine Chemistry Working group, Brussel, 9-16 februari: J.P. Boon.
Workshop on North-East Water polynya project, Bremerhaven, 11-12 februari: H.G. Fransz.
Workshop on EPOS II, Bremerhaven, 13-15 februari: H.G. Fransz.
SEAS (Study of the European Arctic Shelf), Bremerhaven, 13-15 februari: G.C.A. Duineveld, H.G. Fransz.
Bijeenkomst van de oecologische kring en Nederlandse Vereniging voor Microbiologie in Amsterdam, 13 februari: F.C. van Duyl.
American Society Limnology and Oceanography, Special Symposium: What Controls Phytoplankton Production in Nutrient-Rich Areas of the Open Sea. San Marcos, Calif., 22-24 februari: A.G.J. Buma, H.J.W. de Baar, K. Timmermans.
Verwey-Bijeenkomst, NIOZ, Texel, 25-27 februari: R.P.M. Bak, F.C. van Duyl, E. Flach, B. Hondeveld, P. Kamermans, L. Moodley, T. Piersma, P.A.W.J. de Wilde.
IOC T.C. on ocean processes and climate, Parijs, 27 febr.- 1 maart: L. Otto
Meeting of the JGOFS Optics group, Palisades, New York, februari: M. Wernand.
Meeting on the European North Atlantic gyre dynamics experiment. James Rennell Centre for Ocean Circulation, Southampton. 4-6 maart: H.M. van Aken, L. Otto.
Skagerrak-Bedrock, Quaternary and Modern Environments, Göteborg, Zweden, 6-7 maart: G.W. Berger.
WASP 1, 2 workshop 1991, WL Delft, 11-13 maart: W. van Raaphorst.
ICES-workshop van de Study Group on Ecosystem Effects of Fishing Activities, Lowestoft, Engeland, 11-15 maart: M.J.N. Bergman.
Sedimentology in the Wadden Sea, NIOZ, Texel, 16-17 maart: G.C. Cadée, D. Eisma, H. Ridderinkhof.
Jaarvergadering van de Marine Chemistry Working Group ICES, Brussel, 18- 22 maart: J.P. Boon.
Meeting Working Group on Shelf Seas Hydrography, Lissabon, 23-28 maart: C. Veth.
Symposium on the ecosystem of the Banc d'Arguin, Leiden, 25-27 maart: R.P.M. Bak, G.C.A. Duineveld, J.M. Everaarts, S.R. Gonzalez, B.R. Kuipers, M.S.S. Lavaleye, P.A.W.J. de Wilde.
Workshop Optical taskteam JGOFS, Lamont-Doherty Geological Observatory, USA, maart: M.R. Wernand.
JONSMOD-meeting, Proudman Oceanographic Laboratory, Birkenhead, Engeland, 2-6 april: H. Ridderinkhof.
BEST Project Meeting, Bologna, Venezië, 2-7 april: P.A.W.J. de Wilde.
BOU/BTO/ICBP Conference on 'The ecology and conservation of Palearctic-African migrants', Norwich, Engeland, 4-7 april: T. Piersma.
Annual general meeting Society for Experimental Biology, Birmingham, Engeland, 6-14 april: T. Piersma, D.H. Spaargaren.
Second international symposium on the biogeochemistry of model estuaries; estuarine processes in global change, Jekyll Island, Georgia, USA, 14-19 april: R.F. Nolting
Course on 'Oceanography of semi-enclosed Seas', Int. Centre Theor. Phys., Trieste, 15 april-5 mei: J.T.F.Zimmerman.
Seabirds-at-sea Research in the North Sea, NIOZ, Texel, 17-18 april: M. Leopold.

Oil pollution, beached bird surveys and policy: towards a more effective approach of an old problem, Directoraat-Generaal van Scheepvaart en Maritieme zaken Rijswijk 19 april: M. Leopold.

Meeting on modelling of the Ecology of the Antarctic Sea-ice zone, University of Southern California, Los Angeles, USA, 19-27 april: C. Veth.

Joint JGOFS-CCCO Panel on Carbon Dioxide, UNESCO, Parijs, 24-26 april: H.J.W. de Baar.

Sixth International Symposium on Responses of Marine Organisms to Pollutants, Woods Hole, Massachusetts, USA, 24-26 april: J.P. Boon, J.M. Everaarts, M.C.J. Rozemeijer, H.M. Sleiderink.

Meeting of the JGOFS Bentic Processes Group, Bermuda, april: W. Helder.

NATO Advanced Research Workshop: strategy for biomarker research and application in the assessment of environmental health, NIOZ, Texel, 11-17 mei: J.P. Boon, J.M. Everaarts.

SCOR/JGOFS process studies task team, Banyuls sur Mer, Frankrijk, 14-17 mei: M.J.W. Veldhuis.

Workshop Beschermde Gebieden Noordzee, Ministerie van Landbouw en Visserij, Den Haag, 15 mei: M.J.N. Bergman, H.J. Lindeboom. P.A.W.J. de Wilde.

Jaarvergadering van de BION werkgemeenschap Aquatische Oecologie, Dalfsen, 16-17 mei: H.G. Fransz, R. Riegman.

14th International Radiocarbon Conference, Tucson, Arizona, USA, 20-24 mei: W.G. Mook.

Symposium 'Quality assurance of information from marine environmental monitoring in Europe (QUASIMEME)', Noordwijkerhout, 21-23 mei: J.P. Boon, M.Th.J. Hillebrand.

Meeting JGOFS/Southern Ocean planning group, Bremerhaven, 21 mei, en 28-29 mei: C. Veth.

EPOS I symposium, Bremerhaven, 22-27 mei: R.P.M. Bak, A.J. van Bennekom, H.J.W. de Baar, A.G.J. Buma, G.C. Cadée, H.G. Fransz, S.R. Gonzalez, R.F. Nolting, C. Veth, J.H. Vosjan.

ESTEC symposium over European Remote Sensing (ERS), Noordwijk, 30-31 mei: H.G. Fransz.

ERSEM-workshop, Texel, 1-6 juni: J.W. Baretta, P. Ruardij.

Primary production and biochemical processes in the sea, Brookhaven, USA, 2-6 juni: R. Riegman.

ICES Variability Symposium, Mariehamn, Åland, 5-7 juni: G.C. Cadée.

Fourth Intern. Phycology Conference, Durham NC, USA, 4-10 augustus: G.C. Cadée.

Gordon Research Conference on Chemical Oceanography, Kimball Union, New Hampshire, USA, 12-16 augustus: H.J.W. de Baar.

BEST Workshop, NIOZ, Texel, 15 augustus: P.A.W.J. de Wilde.

XXth General Assembly of IUGG, Wenen, 15-24 augustus: C.J. de Boer, J.T.F. Zimmerman.

Third Workshop on chemistry and fate of modern pesticides. Bilthoven 4-6 september: K. Booij.

Fourth INA Conference (International Nanoplankton Association), Praag, 8-15 september: P. van der Wal.

Intern. Symp. on Radionuclides in the Study of Marine Processes, Norwich, Engeland, 9-14 september: G.W. Berger.

MANS-workshop on ecological modelling of the North Sea, Delft, 11-13 september: A. van de Berg, P. Ruardij.

Ecology of Antarctic Sea Ice Zone, specialists' meeting, Bremerhaven, 14-16 september: C. Veth

First European Fluid Mechanics Conference, Cambridge, Engeland, 16-20 september: L.R.M. Maas.

Processes determining primary production in the Southern Ocean, modelling workshop, Cambridge, Engeland, 16-19 september: C. Veth.

EMBS, 26th European Marine Biology Symposium, Middelburg 17-21 september: J.J. Beukema, G.C. Cadée, R. Dekker, E. Flach, H.G. Fransz, P. Kamermans, R. Riegman, A.A.M. Noordeloos, F.C. van Duyl, H.W. van der Veer.

Second GEM Workshop (Global *Emiliania* Modelling Initiative), Chateau de Blagnac, Cabara, Frankrijk, 21-26 september: J.D.L. van Bleijswijk, M.J.W. Veldhuis, P. van der Wal.
Symposium Antarctic Science-Global Concerns, Bremen, 22-27 september: C. Veth.
ICES 79th Statutory meeting, La Rochelle, 26 september-1 oktober: H.M. van Aken, C.J. de Boer, J.M. Everaarts, W. Helder, P.A.W.J. de Wilde.
The third international workshop on Phosphorus in Sediments, Woudschoten/Zeist, 30 september-3 oktober: W. van Raaphorst, C.P. Slomp.
SCOR/JGOFS Scientific Steering Committee, 6th Meeting and JGOFS Indian Ocean Planning Group, second meeting, Bermuda, 30 september-5 oktober: M.A. Baars, M.J.W. Veldhuis.
SeaWIFS-workshop, NASA, Washington D.C., USA, September: M.R. Wernand.
Symposium "Biomonitoring van Toxische Stoffen: Meet- en Regeltechniek voor het Milieu?", Lelystad, 3 oktober: J.P. Boon, J.M. Everaarts.
Sixth Annual Meeting Aachen Sedimentary Group, Aachen, 3-5 oktober: D. Eisma.
MARS (European Marine Research Stations) network workshop on marine coastal biodiversity, Plymouth, Engeland, 7-9 oktober: G.C.A. Duineveld.
Wader Study Group Annual Conference and Symposium, NIOZ, Texel, 4-7 oktober: J.J. Beukema, T. Piersma, I. Tulp, P. de Goeij, M. Poot, B. Roelen, C. Swennen, P. Duiven, M. Leopold, A. Koolhaas, A. Dekinga, N. Verboven, Y. Verkuil, S. Visser, G. Boots, N. Cadée.
NOC Meeting, Amsterdam, 10 oktober: D. Eisma.
NATO Advanced Research Workshop on the Impact of Global Change on the Coastal Ocean, Chateau de Bonas, Frankrijk, 13-18 oktober: D. Eisma.
EROS-2000 Workshop, NIOZ, Texel, 21-15 oktober: D. Eisma, R.F. Nolting, Z. Zuo.
Meeting on the certification of trace elements in estuarine water, EG Brussel, 29 oktober: R.F. Nolting.
Symposium ökosystemforschung in der Paläontologie, Göttingen, 1-3 november: G.C. Cadée.
IV Neotropical Ornithological Congress, Quito, Ecuador, 4-9 november: T. Piersma.
Kluyver Symposium, Gent, 29 november: J.H. Vosjan.
EPOS-workshop, Bremerhaven, BRD, 6-11 december: C. Veth.
Symposium Evolutionary Marine Biology, Groningen, 2-4 december: R.P.M. Bak.

3.3. BESTUURSFUNCTIES

E. van Abs
- lid commissie zeegaand onderzoek Stichting Onderzoek der Zee (SOZ)
- lid Overlegorgaan Faciliteiten Zeeonderzoek (OFZ)

M.A. van Arkel
- lid werkgroep Monitoring rond Mijnbouwinstallaties

H.M. van Aken
- lid Arctic Oceans Sciences Board
- lid Working Group on Oceanic Hydrography ICES
- lid Hydrographic Committee ICES
- lid Scientific Steering Group Greenland Sea Project
- lid gebruikersgroep CTD-systemen van SOZ
- lid gebruikersgroep verankerde systemen van SOZ
- lid WOCE Hydrographic Programme Planning Committee

H.J.W. de Baar
- 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
- lid programmeringscommissie Nationaal Onderzoeks Programma Mondiale Biosfeer
- lid Scientific Program Committee 1990 JGOFS Symposium
- afgevaardigde internationale IGBP/SCOR/JGOFS vergadering
- lid NWO Platform Verstoring van Aardsystemen
- secretaris/penningmeester Tweede Fase Opleiding Mariene Aardwetenschappen (TOMA)
- lid MAB/SCOPE/IGBP Commissie (KNAW)
- lid JGOFS Southern Ocean Planning Group

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
- member International Association of Biological Oceanographers (IABO) Coral Reef Committee
- bestuurslid werkgroep Biologisch Aardwetenschappelijk Onderzoek Tropen
- lid redactieraad Marine Ecology Progress Series
- adviseur wetenschappelijke studiekring Nederlandse Antillen
- External Examiner, Dept. Biology, The University, Newcastle, England
- lid JGBP subcommissie LOICZ

J.W. Baretta
- lid MAST-commissie on Modelling Coordination
- lid MAST-commissie on Marine Data Requirements
- coordinator ERSEM-project

A.J. van Bennekom
- 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 Populatie biologie 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
- lid DORA commissie (diepzee opberging radioaktief afval)
- advisor Hydrobiological Bulletin
- associate editor Ichnos
- lid advisory council International Bryozoology Association
- lid redactie Netherlands Journal of Sea Research

G.C.A. Duineveld
- lid ICES Benthos Ecology Working Group

F.C. van Duyl
- lid protozoën werkgroep
- lid IPCC subgroup

D. Eisma
- hoogleraar Mariene Sedimentologie, Rijksuniversiteit Utrecht
- lid wetenschapscommissie Laboratorium voor Sedimentologie en Milieuonderzoek in Meren en Kustwateren, Nanjin, 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

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
- voorzitter BEON werkgroep voor remote sensing
- lid commissie mariene biologie SOZ
- lid stuurgroep Joint Global Ocean Flux Study Nederland
- voorzitter werkgemeenschap Aquatische Oecologie BION
- lid SCOR/JGOFS werkgroep Modelling
- lid commissie Nederlands Arctisch Onderzoeks Programma

W. Helder
- lid Commissie Chemische Oceanografie SOZ
- voorzitter Nederlandse Oceanografen Club
- lid committee on Marine Environmental Quality (ICES)
- 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 Commissie Zeegaand Onderzoek SOZ

J. van Iperen
- bestuurslid Nederlands-Vlaamse Kring van Diatomisten
- redakteur van het verenigingstijdschrift Diatomededelingen

J.H.F. Jansen
- penningmeester Sedimentologische Kring, Koninklijk Nederlands Geologisch Mijnbouwkundig Genootschap

W.C.M. Klein Breteler
- voorzitter/secretaris BION-discussiegroep Zoöplankton-FRIENDS

A.J. Kop
- lid van de Nederlandse Vereniging voor Stralingshygiëne

M. Leopold
- lid 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'

G. Marees
- lid werkgroep Optische Remote Sensing Water (ORWA)

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 KNAW
- lid INQUA-commissie KNAW
- lid IGBP/MAB/SCOPE commissie (KNAW)
- lid bestuur Stichting Onderzoek der Zee (NWO)
- lid commissie watersysteem verkenningen
- lid Raad van Overleg van het fysische oceanografisch onderzoek van de Noordzee
- lid Wetenschappelijk Begeleidingscommissie Mariene Biologie RUG
- voorzitter Curatorium van het Centrum voor Isotopen Geologisch Onderzoek, Vrije Universiteit Amsterdam
- lid PACT-commissie Raad van Europa
- lid Scientific Committee European Univ. Centre for the Cultural Heritage, Council of Europe at Ravello, Italy
- Chairman International Association of C^{14} Laboratories
- lid Scientific Steering Committee IGBP core project PAGES
- Associate Editor Radiocarbon
- lid Board of Advisors van het International Institute of Environmental studies and Disaster management, Bangladesh

M. Mulder
- lid werkgroep Monitoring rond Mijnbouwinstallaties

L. Otto
- lid Hydrography Committee ICES
- lid European Science Foundation Committee for WOCE
- lid Commissie voor Fysische Oceanografie SOZ
- lid Programmaraad NWO Werkgemeenschap MFO
- nominated member SCOR
- lid IOC Technical committee on ocean processes and climate

- voorzitter WOCE werkgroep
- voorzitter IOC/WMO Intergovernmental WOCE Panel

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
- 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 Kwantitatieve aspecten van uitwisseling en diffusieprocessen van fosforverbindingen over het grensvlak sediment-water in de Loosdrechtse Plassen (Limnologisch Instituut, Nieuwersluis)
- lid begeleidingscommissie Vastlegging van fosfaat in sedimenten (DBW/RIZA, Lelystad)
- lid organisatie 3rd International Workshop on Phosphorus in Sediments, 1991

R. Riegman
- secretaris BION WGM Aquatische Oecologie
- voorzitter Kontaktgroep Algenfysiologie (KAFEE)

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 werkgroep bijlage VEG-vogelrichtlijn
- lid Nederlandse sektie International Council of Bird Preservation (ICBP)
- nationaal kontaktpersoon sea duck branch, International Waterfowl Research Bureau (IWRB)

H.W. van der Veer
- lid Organizing Committee Second International Symposium on Flatfish Ecology, Texel 1993
- lid Editorial Board of Netherlands Journal of Sea Research of the Proceedings of the First International Symposium on Flatfish
- lid Organizing Committee 6th International Conference of Coelenterate Biology, Noord wijk, 1993
- lid Working Group on Larval Fish Ecology ICES
- lid redactie Hydrobiological Bulletin

M.J.W. Veldhuis
- lid stuurgroep Joint Global Ocean Flux Study Nederland
- lid Flow Cytometrie Werkgroep Nederlands
- lid Joint Global Ocean Flux Studies Process Studies Task Team
- Voortrekker Verstoring van Aardsystemen project no. 9: Koolstofbalans in de oceanische menglaag lucht-zee uitwisseling VvA 9

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
- lid redactie NIOZ encyclopedie
- lector Mariene Bacteriologie, Vrije Universiteit Brussel, België
- werkgroepleider Bion werkgemeenschap Algemene Microbiologie

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

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 natuurbeschermingsraad, Ministerie voor Landbouw en Visserij
- lid Benthos Ecology Working Group, ICES
- lid Euromar Mesocosm Working Group
- lid SCOR working group 85, mesocosms
- lid Biological Oceanography Committee, ICES

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
- lid van de subcommissie mariene geodesie van de RCG
- correspondent van Natuur en Techniek
- lid Commissie voor Milieueffectrapportage
- lid Nederlandse Commissie van Geodesie (KNAW)
- lid themacommissie 'Kustonderzoek' van BOA-NWO

3.4. STUDENTENONDERZOEK

T. Arp	Vrije Universiteit, Amsterdam	H3-06
A.L.H.H. van Balen	Int. Agrar. Hogeschool Wageningen	B1-02
J. de Boer	Bakhuis Roozeboom Instituut, Beverwijk	H1-09
G. Boots	Bakhuis Roozeboom Instituut, Beverwijk	B3-08b
N. Cadée	RU Leiden	B3-08b
E. Casal	ETH, Zürich, Zwitserland	S-01d/02a
M. van Dalen	Hogeschool Alkmaar	H1-15
A. Dekinga	Van Hall Instituut, Groningen	B3-08b
I. Flameling	RU Groningen	B2-03
G.J. Gast	Univ. Amsterdam	B1-06
J. van Gils	RU Groningen	B3-08b
B. Hofte	Hogeschool Oost Nederland	S-01c
R.J. van Hoogstraten	Hogeschool Alkmaar	H1-15
E. Huisman	Hogeschool Enschede	BEWON
A. Koolhaas	Van Hall Instituut, Groningen	B3-08b
A. Koopmans	Hogeschool Alkmaar	H1-09
D. Kwast	Bakhuis Roozeboom Instituut, Beverwijk	H1-09
F-P. Lam	RU Utrecht	H2-06
V. Langeberg	Univ. Amsterdam	B1-05
A. van Leeuwen	RU Groningen	S-02c (TECON)
J. Leloux	RU Utrecht	H3-13
J.D. Lont	Noorder Haaks, Den Helder	S-01c
E. van der Lubbe	Univ. Amsterdam	B1-05
W. Nijmeier	Hogeschool Oost Nederland	BEWON
H. Offringa	LU Wageningen	B3-09
C. Ott	Bakhuis Roozeboom Instituut, Beverwijk	B3-08b
A. Otten	Hogeschool Alkmaar	H1-15
P. Paffen	Univ. Amsterdam	B1-05
H.P.M. van de Pas	Hogeschool Enschede	BEWON
M. Poot	RU Utrecht	B3-08b
M. Prins	RU Utrecht	H3-10
A. Ramkema	Hogeschool Alkmaar	H1-15
B. Roelen	RU Utrecht	B3-08b
A. Rowe	Polytechnics, Hatfield, UK	BEWON
A. Scheele	Bakhuis Roozeboom Instituut, Beverwijk	B3-08b
E. Scholtens	RU Groningen	S-02a
D. Schweizer	ETH, Zürich, Zwitserland	S-01d/02a
F. Smedema	TU Eindhoven	B2-03
W. Serree	Hogeschool Midden Nederland	H1-14
M. Snelders	Univ. Amsterdam	B1-05
T. Tahey	KU Nijmegen	B1-06
I. Tulp	RU Utrecht	B3-08b
N. Verboven	RU Groningen	B3-08b
S. Visser	Bakhuis Roozeboom Instituut,Beverwijk	B3-08b
I.C. Vrauwdeunt	Reynevelt College, Delft	H1-07
J. Werger	Hogeschool Midden Nederland	S-01a
E. Wijs	Univ. Amsterdam	H2

3.5. CURSUSSEN, VERGADERINGEN EN EXCURSIES

3.5.1. NIOZ cursussen

De cursus Inleiding in de Oceanologie werd gegeven van 4 februari tot 1 maart. Er waren 28 deelnemers, van wie het grootste deel afkomstig was van de RU Groningen. Deze cursus is een onderdeel van het tweede jaars curruculum Mariene Biologie in Groningen, waarvan het college van 4 tot 8 februari gegeven werd en het praktische gedeelte van 11 tot 22 februari plaats vond op het NIOZ. 55 medewerkers waren min of meer bij deze cursus betrokken. Twee vaardagen werden met de onderzoekschepen Navicula en Aurelia uitgevoerd.

De cursus Mariene Oecosystemen 1991 begon met de gebruikelijke collegeweek te Haren (3-7 juni) verzorgd door Prof. P.A.W.J. de Wilde. Colleges en het daaropvolgende practicum op het NIOZ (10-26 juni) werden gevolgd door 30 studenten (80% van de RU Groningen). Aan het praktische gedeelte is medewerking verleend door vrijwel alle NIOZ medewerkers van de biologische werkgroepen. Met name de continue meetserie in het Marsdiep gedurende twee etmalen, waar fysische parameters, nutriënten, fytoplankton en heterotrofen werden bestudeerd, werd bijzonder gewaardeerd. Omdat de Pelagia niet kon worden gebruikt, is het varende veldwerk geheel vanaf de Navicula gedaan, die daarvoor zes dagen op de Waddenzee heeft gevaren. Verder werden op het NIOZ zes lezingen over bijzondere onderwerpen gehouden.

Aan het eind van de cursus waren alle meetresultaten —basis voor het 'cursusverslag' —vastgelegd in het 'Resultatenboek 1991' (twee delen), en was de nodige literatuur verstrekt, zodat op 27 juni schriftelijk tentamen kon worden afgenomen, waarbij tevens de verslagen konden worden ingeleverd. Nieuw was dit jaar een enquête onder de cursisten naar de kwaliteit van het gebodene. Men bleek algemeen tevreden. Enkele punten van overlap met Mariene Biologie Groningen zullen in overleg met de vakgroep worden bijgesteld.

3.5.2. Andere cursussen gehouden op NIOZ

25-27 februari	Verwey-dagen 1991; landelijke AIO-bijeenkomst mariene biologie
11-12 maart	MFO-dagen
22 april	Oceanography course TU Delft
3-7 juni	ERSEM-workshop

3.5.3. Ontvangen gezelschappen van instituten, overheidsinstellingen, e.d.

2 februari	Medewerkers Bezoekerscentrum Schiermonnikoog
14 februari	Deelnemers cursus Hydrografie
18 maart	Studenten Prof. van Hall Instituut, Groningen
18 april	Leerlingen Rijksscholengemeenschap Texel
24 april	Bewoners Jellinekcentrum, Texel
3 mei	Ned. Inst. v. Register Ingenieurs, Heerenveen
16 mei	Studenten Laboratoriumschool Oss
18 mei	Leden Schelpenwerkgroep Noord-Holland

23 mei	Technici Huybr. Lab., Utrecht
30 mei	Studenten Alcwaard College, Alkmaar
1 juni	Lions Opmeer
6 juni	Deelnemers Symposium Informatica
13 juni	Medewerkers Museon, Den Haag
26 juni	Vakgroep Fysiologie, Medische Faculteit, Rijksuniversiteit Groningen
27 juni	Onderwijzend personeel Alcwaard College, Alkmaar
2 september	Student Milieukunde, Wageningen
4 september	Kottenparkcollege, Enschede
21 september	Studenten Aardwetenschappen, Amsterdam
27 september	Alg. Hogeschool Amsterdam, sectie biologie
3 oktober	Personeel Wilhelmina MAVO, Den Helder
10 oktober	Studenten Pedagogische Akademie, Sittard
17 oktober	Deelnemers cursus Ecomare
25 oktober	Veterinaire Dienst Noord-Holland
28 oktober	Staf Natte Afd. RWS Noord-Holland
22 november	Veterinaire Dienst Noord-Holland
30 november	Leden Planten Werkgroep, Utrecht

4.1. TECHNISCHE HULPAFDELINGEN

Algemeen
Kenmerkend voor 1991 was de ingebruikname van ons nieuwe onderzoekschip 'Pelagia' en de vernieuwde NIOZ haven, waarin tevens de 'Tyro' van de SOZ kan afmeren. Bij de begeleiding van deze projecten was de gehele technische dienst betrokken. Gedurende deze tijd zijn alle medewerkers gedwongen geweest veel te improviseren om het normale werk doorgang te laten vinden. Een vacature, ontstaan door het in de VUT gaan van één van de medewerkers in de werktuigkundige afdeling, werd opgevuld.

Ontwikkelingen en activiteiten
- Het ontwikkelen, produceren, testen en optimaliseren van de bodemlanders voor de afdelingen benthische systemen, geologie en fysische oceanografie heeft zich ook dit jaar doorgezet.
- Voor de Guildline CTD's is een deckunit gemaakt die het mogelijk maakt om het software-pakket van Neil Brown voor inzamelen en verwerken van gegevens te gebruiken.
- Een krachtig CAD systeem is geïnstalleerd bij electronica om printboards en schema's te ontwerpen.
- De Transmisso-Advanced-Spectral-Irradiance-meter voor fysische oceanografie is gereedgekomen.
- Er zijn nog drie microprofilers gebouwd en voor chemische oceanografie is een coulometer-controlbox gedupliceerd.
- Voor de 'Pelagia' zijn liermonitoren gemaakt, gebaseerd op het 'Tyro' systeem.
- Onder toezicht en volgens eisen van het NIOZ zijn voor de 'Pelagia' vijf laboratoriumcontainers gebouwd, te weten een gekoeld lab, een organisch schoon-lab, een isotopenlab en twee auto-analyser labs.
- Voor de SOZ werd op dezelfde wijze een gekoeld lab gebouwd.
- In eigen beheer is de chemische schoon-labcontainer geheel gerenoveerd, evenals de wadtoren.
- In nauwe samenwerking met Research Vessel Services van de Natural Environment Research Council in Engeland is in september op de 'Pelagia' en de 'Tyro' data-acquisitie en -opslag apparatuur geïnstalleerd.
- De diepzee-traktielier is van kunststof traktieschijven met een grotere diameter voorzien en het hydraulische powerpack is van een dieselmotor met groter vermogen voorzien.
- Voorbereidend, gedeeltelijk uitvoerend en toezichthoudend werk werd verricht voor het electrisch-, gas- en waterleidingwerk op de nieuwe haven. Voor een nieuw te bouwen opslagloods op het haventerrein zijn offertes aangevraagd.
- Het onderzoek naar diverse data-netwerksystemen werd afgerond en de aanleg gegund. Alle kabelwerk in het gebouw is inmiddels geïnstalleerd.
- De personele groei vereiste aanpassingen en verhuizingen binnen het instituut. Diverse laboratoria zijn verbouwd, aangepast of heringericht, evenals meetruimten, werkkamers en kantoren.

Oceaanprogramma

Er werd voorbereidend werk gedaan en technische assistentie verleend op de door SOZ gefinancierde expedities voor:

- het DUTCH-WARP project, voor het NIOZ uitgevoerd in april en mei met de 'Tyro';
- het MAST-project, voor de RUU uitgevoerd in juni en juli met de 'Marion Dufresne'; en voor de projecten:
- MAST voor de RUU;
- Geophysics of the Alboran Sea Region voor de VU en
- EROS-2000 voor het NIOZ.

De laatste drie expedities zijn van oktober t/m december met de 'Tyro' uitgevoerd in de Middellandse Zee. In het kader van het Integraal Noordzee Programma werden in augustus en september de expedities BELS (Benthic Links and Sinks in North Sea Nutrient Cycling) en Microcontaminants in the North Sea met de 'Pelagia' uitgevoerd.

De voorbereidingen van al deze expedities heeft zeer veel inzet en improvisatievermogen van de betreffende medewerkers gevraagd, maar kan als geslaagd worden beschouwd. De aanvang van de Indische-Oceaan expeditie, oorspronkelijk gepland in november, werd, in verband met de Golfoorlog, uitgesteld tot mei 1992; de voorbereidingen hiervoor zijn inmiddels op gang gekomen. Gezien de hoeveelheid werk en de lange duur van dit programma zal de technische dienst met een drietal contractmedewerkers worden uitgebreid.

Haven en vaartuigen

Op zaterdag 26 januari werd in Heusden de 'Pelagia' feestelijk tewater gelaten door mevrouw Zijlstra, echtgenote van de in 1989 overleden directeur van het NIOZ die zich jarenlang sterk had gemaakt om de bouw van dit schip te realiseren.

Tot half maart werd nog onderzoek gedaan op de Noordzee met de 'Aurelia' die daarna, tijdens de afbouw van de 'Pelagia' in Dordrecht, als hotelschip dienst deed. De oplevering van de 'Pelagia' geschiedde op 1 mei, door omstandigheden van technische aard, zo'n zes weken te laat. Hierdoor kwam een gepland oefenprogramma grotendeels te vervallen en, door vastliggende afspraken gedwongen, maakte het schip op 6 juni haar maidentrip richting Denemarken. De eerste veertien dagen werd het programma geplaagd door enige kinderziekten. De expeditieleider kenschetste de trip dan ook meer als oefentocht dan als wetenschappelijke tocht.

Op 1 juli werd in Scheveningen het startsein voor het Integraal Noordzee Programma gegeven door het losgooien van de trossen van de 'Pelagia' door de ministers Ritzen van Onderwijs en Wetenschappen en Maij-Weggen van Verkeer en Waterstaat. Sindsdien is de 'Pelagia' operationeel en te oordelen naar de reacties van opstappers is zij een waardig opvolger van de 'Aurelia' die inmiddels is verkocht.

De 'Navicula' heeft dit jaar 177 vaardagen gemaakt met in totaal 804 opstappers. De 'Griend' heeft 98 vaardagen gemaakt met 228 opstappers. De fuikvisserij vond ook dit jaar plaats; tengevolge van kwallen en grote hoeveelheden groen moesten enkele vangsten worden onderbroken.

Eind 1990 werd een aanvang gemaakt met de wijziging van de bestaande NIOZ haven. De oude strekdam werd weggebaggerd en vervangen door een nieuwe, verder naar buiten gelegde strekdam waarin tevens een 170 meter lange kade is opgenomen. Dit was nodig om de havenmond te verbreden, zodat grotere schepen konden binnenlopen. Tevens is langs de toegangsweg naar de kade een terrein opgespoten waar een opslagloods voor grote apparatuur is gepland. Het havenwerk werd in september afgerond. De 'Pelagia' en de 'Tyro' kunnen gelijktijdig aan de kade afmeren voor laden en lossen, waardoor tijdrovende transporten naar en van Den Helder tot het verleden behoren.

4.2. ADMINISTRATIEVE HULPAFDELINGEN

Administratie.—Na het doorlichten van de administratieve organisatie door een extern buro, heeft de direktie besloten mevr. I. Wernand-Godee te bevorderen tot hoofd administratie. Per 1 januari valt de heer S.W. de Porto onder deze afdeling mede door zijn administratieve werkzaamheden m.b.t. het inventarisbeheer en de in aanbouw zijnde douaneloods. Mevr. C. Gerritsen is per 1 december in dienst getreden om de heer de Porto hierbij te assisteren. Deze aanstelling is voor één jaar en wordt betaald uit de post "decentrale werkgelegenheidsgelden".

4.3. WETENSCHAPPELIJKE HULPAFDELINGEN

Bibliotheek.—Er werden 120 boeken aangeschaft en 3 atlassen. Het tijdschriftenbestand is per 1 januari 1991 uitgebreid met de volgende tijdschriften:

- Circumpolar Journal Vol 5(1) 1990
- Physics of Fluids A: Fluid Dynamics Vol 3(1) 1991
- Environmental Toxicology and Chemistry Vol 10(2) 1991
- SCAR: (Scientific Committee of Arctic Research) Bulletin nr 88 1988-Report nr 5 1989
- NWO geknipt Vol 1(1) 1990
- Adviesraad voor Wetenschaps-en Technologiebeleid AWT Selectief Vol 1(1) 1991
- Prepress Computing Magazine Vol 2(1) 1991
- Journal of Atmospheric Sciences Vol 48(1) 1991
- Journal of Phycology Vol 27(1) 1991-

via ruil:

- Red Tide Newsletter Vol 1(1) 1988
- Jaarverslag Stichting Onderzoek der Zee 1988/1989
- 'Nuclear Science and Applications Vol 1(2) 1989
- Annual Report Atomic Energy Centre, Dhaka Bangladesh Atomic Energy Comm. 1988/1989-

Redactie. —Zie 2.1.1.

Audiovisuele afdeling.—Bij het NIOZ in Den Helder werd de speciale laboratorium-unit in gebruik genomen ten behoeve van de verdere afwerking van de Noordzeefilm. De omslagontwerpen van Hobbelink voor de BEWON- en NIOZ-rapporten oogstten alom veel bewondering. Voor het Netherlands Journal of Sea Research werd een brochure ontworpen die aan het eind van het jaar werd uitgebracht.

De afdeling heeft diverse malen overleg gehad met de VARA over mogelijkheden de 'Pelagia' met de bodemlander op te nemen in het TV-programma 'Jules Unlimited'.

Veel werk werd verricht ten behoeve van posterpresentaties, niet alleen voor de jonge onderzoekers, maar ook ten behoeve van de promotie van de bodemlanders.

Reprografische afdeling. —In dit verslagjaar is door de reprografische afdeling naast de gangbare opdrachten veel teken- en coyproofwerk verricht voor uitgaven van het Netherlands Journal of Sea Research, in- en externe rapporten en andere publicaties. Het vermenigvuldigen van deze rapporten door de repro-

grafische afdeling komt steeds vaker voor. De tekencomputer wordt nu dagelijks gebruikt. Hij zorgt voor een vlotte afhandeling en bewijst daar door zijn waarde.

Op het fotografische gedeelte werd dit jaar veelvuldig een beroep gedaan, o.a. voor het behandelen van films en het produceren van dia's.

Door de uitbreiding van de redactie, werd een verbouwing en reorganisatie bij de reprografische afdeling noodzakelijk. Deze is in 1991 uitgevoerd.

Centrum voor Informatieverwerking en Automatisering (CIA). —De naam van de afdeling Rekencentrum is vervangen door de naam Centrum voor Informatie verwerking en Automatisering, afgekort CIA.

Voor het ethernet-netwerk in het instituut is gekozen voor het thintap-systeem, waarbij storingen door loskoppeling minimaal zijn. Door segmentering in alle paviljoens is een netwerk ontworpen dat nagenoeg geen onderhoud nodig heeft. In de loop van het jaar zijn de server-machines (SUN's) aangeschaft om de nodige netwerk-ervaring op te bouwen. Aan het eind van het jaar is begonnen met de aanleg van kabels.

In september is het dataloggingssysteem ABC van Research Vessel Services op de Pelagia geïnstalleerd. Tevens is een ethernet-netwerk op de Pelagia aangebracht, dat identiek is aan het netwerk in het instituut. Verder is de afdeling met één persoon uitgebreid door interne verschuiving.

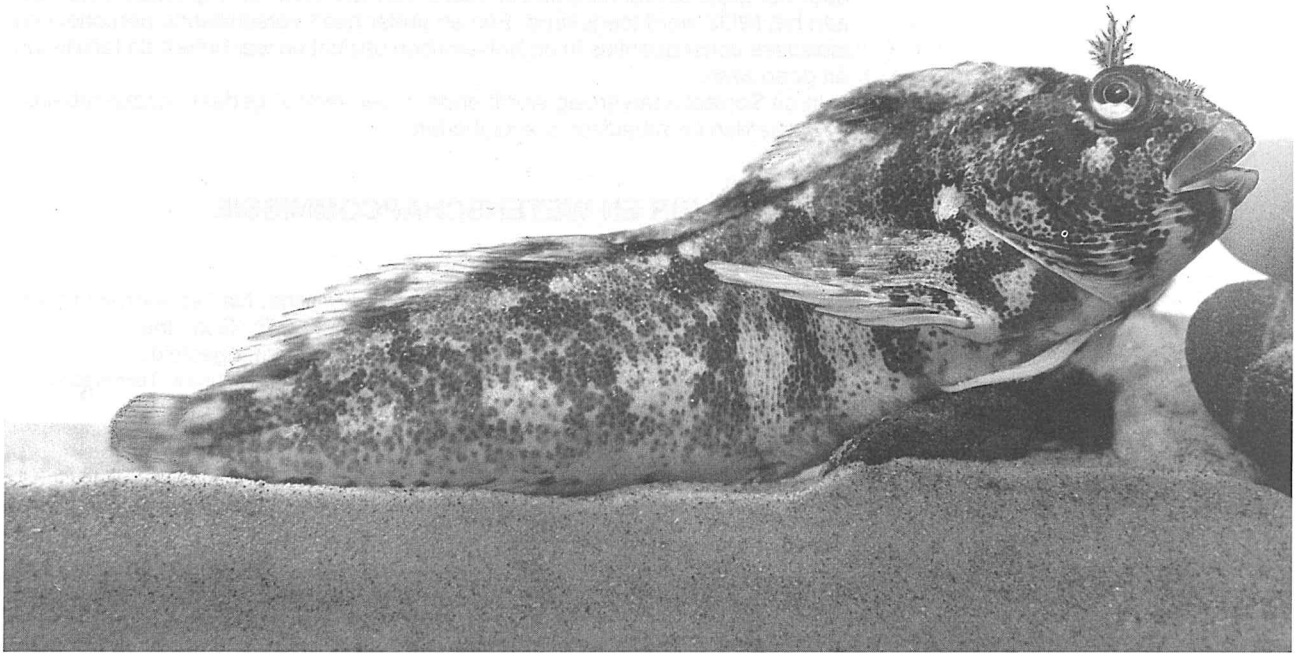
Er is besloten om de NorskData computer tot en met 1992 te laten functioneren om iedereen de gelegenheid te geven om te schakelen.

Biologisch Studiemateriaal. —De afdeling Studiemateriaal in Den Helder was veelal in staat aan de aanvragen voor gefixeerd en levend praktikamateriaal te voldoen.

De universiteitslaboratoria, scholen en educatieve instellingen bestellen tegenwoordig duidelijk nauwkeuriger, wat aantal praktikanten en tijdsbestek betreft. Vlotte levering en weinig materiaalverlies zijn daar waarschijnlijk debet aan. Aanvoer van haaien is problematisch gebleven. Was de afdeling in staat om 192 doornhaaien in 1990 aan te kopen, tot oktober 1991 waren er reeds 311 aangekocht, echter bij lange na niet voldoende om de wachtlijst weg te werken, laat staan weer een voorraadje op te bouwen. Oorzaken van de slechte haaienaanvoer zijn moeilijk te geven, doch de sensationeel opgeblazen dagbladpublicaties over het afsluiten van delen van de Noordzee als visgebied zullen de verstandhouding tussen vissers en de afdeling Studiemateriaal geen goed hebben gedaan. Gelukkig was de afdeling in staat wat tegengas te geven door via diezelfde dagbladen wat meer bekendheid aan het doen en laten van de afdeling studiemateriaal van het NIOZ te geven. Onder andere de vangst van een volwassen *Parablennius gattorugine* (gehoornde slijmvis; zie foto volgende pagina) in deze noordelijke contreien, bleek de moeite waard om de krant te halen.

Helaas moest per 1 juli, wegens pensioengerechtigde leeftijd, afscheid worden genomen van de heer P.F. de Vreede, die precies 15 jaar zijn krachten aan de afdeling Studiemateriaal heeft gegeven. Als nieuwe versterking mocht de afdeling de heer E. Eliveld verwelkomen.

Het geschikt maken van een computerprogramma voor de facturering en mailing van de afdeling bleek zonder de noodzakelijke steun van het CIA op Texel een flinke kluif te zijn. Nu is echter de eindfase bereikt en zal naar verwachting begin 1992 bij het uitgeven van een nieuwe catalogus gebruik worden gemaakt van de etikettering via de computer.



Op 26 augustus werd deze Gehoornde Slijmvis (*Parablennius gattorugine* Lin. 1758) in een fuik bij Den Helder gevangen. Deze soort werd de laatste 30 jaar in Nederland niet waargenomen.
(Foto: H. Hobbelink)

5.1. ALGEMEEN

Het verslagjaar werd gekenmerkt door groei en vernieuwing. Belangrijk vooral was de ingebruikneming van het nieuwe Noordzee-onderzoekschip Pelagia. De duur en frequentie van de vaartochten nam daardoor aanzienlijk toe. Ook steeg het aantal OIO's dat zijn promotie bij het NIOZ voorbereidt en konden enkele postdoc's worden aangesteld. Verdere groei werd vooral veroorzaakt door het grote aantal contracten, vooral van EG, NOP en Rijkswaterstaat, dat aan het NIOZ werd toegekend. Eén en ander heeft verschillende personele en logistieke consequenties in organisatorisch opzicht en wat betreft de faciliteiten en gebouwen.

In dit Sociaal Jaarverslag wordt onder meer verslag gedaan inzake arbeidsvoorwaarden en arbeidsomstandigheden.

5.2. BESTUUR EN WETENSCHAPCOMMISSIE

Bestuur Stichting NIOZ

De samenstelling van het bestuur is in 1991 gewijzigd. Na het vertrek in 1990 van Prof.dr. W. Scharloo trad per 19 april Prof.dr. H.J.Th. Goos toe.

Per 31 december 1991 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 vier maal met de directie in vergadering bijeen: op 19 april, 19 juni, 28 oktober en 11 november. De vergaderingen werden namens de algemeen directeur van NWO bijgewoond door Dr. H. van Dommelen. Genotuleerd werd door mevrouw J.W. Schröder-ter Avest (tot 1/9/91) en mevrouw C.S. Blaauboer-de Jong (vanaf 16/9/91).

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.

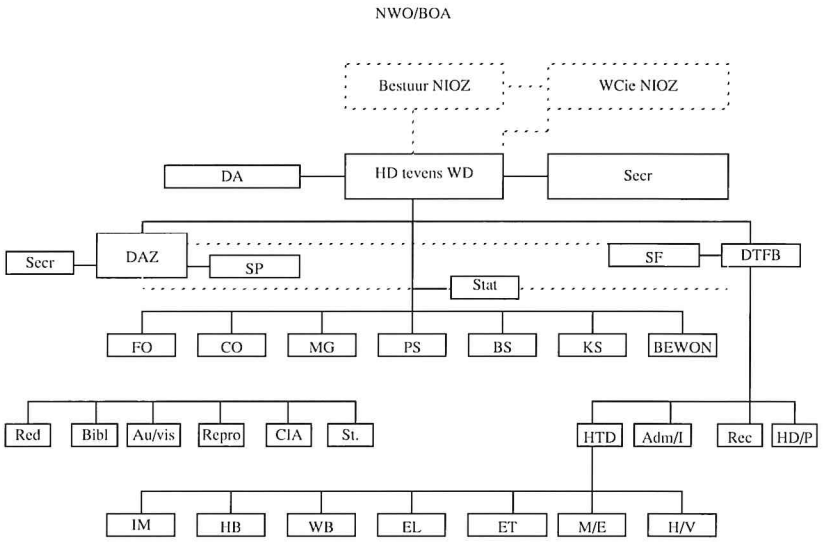
De Wetenschapcommissie NIOZ was per 31 december 1991 als volgt samengesteld:

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 Ecologie, Yerseke
Prof.dr. W.P.M. de Ruyter	Instituut voor Marien en Atmosferisch Onderzoek, (IMAU), Rijksuniversiteit Utrecht
Prof.dr. V. Smetacek	Alfred-Wegener-Institut für Polar- und Meeres-forschung, Bremerhaven, Duitsland
Prof.dr. W.J. de Wolff	Instituut voor Bosbouw en Natuurbeheer (het voormalige RIN), Leersum

De Wetenschapcommissie NIOZ kwam in 1991 tweemaal bijeen: op 3-4 juni en op 26-27 november. 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.

5.3. ORGANOGRAM NIOZ



Verklaring van afkortingen in schema taakverdeling directie NIOZ

NWO	: Nederlandse Organisatie voor Wetenschappelijk Onderzoek
BOA	: Gebiedsbestuur Biologische-, Oceanografische- en Aardwetenschappen
HD	: Hoofddirecteur
WD	: Wetenschappelijk directeur
DA	: Directie-assistent
Secr	: Secretaresse
FO	: Afdeling Fysische Oceanografie
CO	: Afdeling Chemische Oceanografie
MG	: Afdeling Mariene Geologie en Geochemie
PS	: Afdeling Pelagische Systemen

BS : Afdeling Benthische Systemen
KS : Afdeling Kustsystemen
BEWON : Beleidsgericht Wetenschappelijk Onderzoek NIOZ
Stat : Statisticus
DAZ : Directeur Algemene Zaken
SP : Staffunctionaris Personeelszaken
Red : Redactie
Bibl : Bibliotheek
Au/Vis : Audiovisuele Afdeling
Repro : Reprografische afdeling
CIA : Centrum voor Informatieverwerking en Automatisering
St Mat : Afdeling Studiemateriaal
DTFB : Directeur Technisch en Financieel Beheer
SF : Staffunctionaris Financiën
Adm/I : Administratie en Inventarisbeheer
Rec : Receptie/telefoniste
HTD : Hoofd Technische Diensten
HD/P : Huishoudelijke Dienst/Potvis
M : Instrumentmakerij
HB : Houtbewerking
WB : Werktuigbouw
EL : Electronica
ET : Energietechniek
M/E : Magazijn/Expeditie
H/V : Haven en Vaartuigendienst

5.4. PERSONEELSLIJST 31-12-91

In het onderstaande overzicht zijn zowel de vaste medewerkers van het instituut vermeld als degenen die ten behoeve van een project, op basis van een detachering of samenwerkingsovereenkomst of uit andere hoofde op het NIOZ werkzaam zijn.

	UREN	FUNCTIE	PERIODE
DIRECTIE			
Mook W.G.	34.60	hoofd directeur, tevens wetenschappelijk directeur	
Rietveld M.J.		directeur algemene zaken	
Abs van E.		directeur technisch en financieel beheer	
ALGEMENE DIENST			
Hart-Stam J.M.G.		dir. secretaresse	
Shröder-ter Avest J.W.	32.00	dir. secretaresse	tot 01-09-1991
Blaauboer-de Jong C.S.		dir. secretaresse	m.i.v. 16-09-1991
Rommets J.W.		wet. dir. ass.	
Witte J.IJ.		wet. dir. ass.	
Vooys P.C.		stafmed. pers.zaken	
Arkel van M.A.		stafmed. fin.zaken	
Meer v.d. J.		statisticus	
Heetvelt L.H.M.	7.60	formatiedeskundige	m.i.v. 01-07-1991
Wolf de P.		onderzoeker	

AFDELING BENTHISCHE SYSTEMEN

Wilde de P.A.W.J.		werkgroepleider	
Vosjan J.H.		senior onderzoeker	
Bak R.P.M.		senior onderzoeker	
Duineveld G.C.		onderzoeker	
Pauptit E.		lab. hfd. ass.	
Kok A.		1e lab. ass.	
Berghuis E.M.		1e lab. ass.	
Nieuwland G.		1e lab. ass	
Noort van G.J.		lab. ass.	
Hondeveld B.J.M.		oio NIOZ	
Witbaard R.		oio NIOZ	
Holtmann S.E.		onderzoeker (project-)	m.i.v. 15-05-1991
Tahey T.M.		oio (EG)	m.i.v. 15-10-1991

AFDELING PELAGISCHE SYSTEMEN

Fransz H.G.		werkgroepleider	
Klein Breteler W.C.M.	32.00	senior onderzoeker	
Baars M.A.		senior onderzoeker	
Kuipers B.R.		onderzoeker	
Veldhuis M.J.W.		onderzoeker	
Kraay G.V.		lab. hfd. ass.	
Oosterhuis S.S.		1e lab. ass.	
Gonzalez S.R.		lab. ass.	
Witte H.J.		analist	
Schogt N.		analist	
Wal P. van der		post-doc NWO	
Bleijswijk J.D.L. van		oio NIOZ	
Hansen F.		oio (EG-Kiel)	
Stolte W.		oio NIOZ	
Schut F.		oio RUG/NIOZ	
Kempers E.S.		analist	

AFDELING KUSTSYSTEMEN

Beukema J.J.		werkgroepleider/hoofdredacteur	
Swennen C.		senior onderzoeker	
Fonds M.		senior onderzoeker	
Spaargaren D.H.		senior onderzoeker	
Cadée G.C.		senior onderzoeker	
Hegeman J.		1e lab. ass.	
Duiven P.		1e lab. ass.	
Zuidewind J.		analist	
Puyl van der P.P.		analist	
Bruin de W.		analist	
Kamermans P.		oio NIOZ	tot 01-06-1991
Leopold M.F.		oio NIOZ	tot 15-11-1991
Flach E.C.		oio NIOZ	
Bolle L.J.		oio NIOZ	m.i.v. 01-08-1991
Piersma Th.		oio RUG/NIOZ	
Hoekstra R.C.	20.00	onderzoeker	van 15-07-1991 tot 15-09-1991

AFDELING CHEMISCHE OCEANOGRAFIE & ZEEVERONTREINIGING

Helder W.		werkgroepleider	
Everaarts J.M.		senior onderzoeker	
Baar de H.J.W.		senior onderzoeker	
Booij K.		onderzoeker	
Brummer G.J.A.		post-doc	m.i.v. 16-09-1991
Timmermans K.R.		post-doc NWO	m.i.v. 01-03-1991

Hillebrand M.T.J.		lab. hfd. ass.	
Nolting R.F.		lab. hfd. ass.	
Vries de R.T.D.		1e lab. ass.	tot 01-10-1991
Kloosterhuis H.T.		1e lab. ass.	
Ooijen J.C. van		lab. ass.	m.i.v. 01-12-1991
Bakker K.M.J.		lab. ass.	
Koutrik A. van		analist	m.i.v. 01-09-1991
Dekker M.H.A.	28.50	analist (EG)	
Jong J.T.M. de		analist (EG)	
Lohse L.		oio NIOZ	
Sleiderink H.M.		oio NIOZ	
Leeuwe M.A. van		oio NIOZ	m.i.v. 01-09-1991
Epping H.G.	32.00	oio (BION)	
Bakker D.C.E.		oio (NOP-project)	m.i.v. 01-05-1991
Wilde H.P.J. de		oio (NOP-project)	m.i.v. 01-05-1991
Stoll M.		oio (NWO)	
Hoppema J.M.J.		onderzoeker (project-)	
Hey H. de		onderzoeker (EG)	m.i.v. 18-03-1991

AFDELING FYSISCHE OCEANOGRAFIE

Veth C.		werkgroepleider	
Aken van H.M.		senior onderzoeker	
Otto L.		senior onderzoeker	
Zimmerman J.T.F.	26.60	senior onderzoeker	
Maas L.R.M.		onderzoeker	
Munck J.C. de		post-doc	m.i.v. 01-04-1991
Wernand M.R.		1e lab. ass.	
Manuels M.W.		1e lab. ass.	
Ober S.		fysisch ass.	
Koster R.X. de		data-analist	
Beerens S.P.		oio NIOZ	m.i.v. 08-07-1991
Toorn R. van der	32.00	oio NIOZ	
Bruin de T.F.		onderzoeker BCRS	
Marees G.		onderzoeker BCRS	tot 01-06-1991
Boer de C.		oio NWO	
Verkley W.T.M		post-doc NWO	
Gerkema Th.		oio NWO	

AFDELING MARIENE GEOLOGIE EN GEOCHEMIE

Eisma D.		werkgroepleider	
Jansen J.H.F.		senior onderzoeker	
Weering van T.C.E.		senior onderzoeker	
Bennekom van A.J.		onderzoeker	
Gaast van der S.J.		wet. assistent	
Berger G.W.		lab. hfd. ass.	
Kalf J.		lab. ass.	
Iperen van J.M.	N8.00	lab. ass.	
Schilling J.		lab. ass.	
Okkels E.	32.00	analist	
Zuo Z.		oio NIOZ	tot 01-12-1991
Moodley L.		oio NIOZ	
Ufkes E.		oio NIOZ	
Werff W. van der		oio (samenw.overeenk.UvA)	
Witte A.	20.00	analist (EG)	van 15-02-1991 tot 15-12-1991
Fischer C.V.	34.00	analist (EG)	tot 20-03-1991 van 01-05-1991 tot 23-11-1991
Beks J.		erk. gewetensbezwaarde	tot 03-09-1991

AFDELING BEWON

Lindeboom H.J.		werkgroepleider	
Bol-den Heijer A.C.	24.20	secretaresse	
Baretta J.W.		senior onderzoeker	m.i.v. 01-05-1991 buitengew. verlof
Berg A.J. van den		onderzoeker	m.i.v. 01-09-1991
Bergman M.J.N.		onderzoeker	
Boon J.P.		onderzoeker	
Duyl van F.C.		onderzoeker	
Raaphorst van W.		onderzoeker	
Ridderinkhof H.		onderzoeker	
Riegman R.		onderzoeker	
Ruardij P.		modelleur	
Veer van der H.W.		onderzoeker	
Kop A.J.		1e lab. ass.	
Malschaert H.		1e lab. ass.	
Mulder M.		1e lab. ass.	
Lewis W.E.	32.00	analist	
Noordeloos A.A.M.		analist	
Oostingh R.		analist	m.i.v. 01-02-1991
Embsen E.G.M.		techn.wet.progr. (EG)	
Smit J.P.C.		techn.wet.progr. (EG)	
Brussaard C.P.D.		oio (EG)	
Rozemeijer M.J.C.		onderzoeker (project-)	van 15-08-1991 tot 01-10-1991 van 11-11-1991 tot 02-12-1991
Marinus M.P.		assistent	van 01-07-1991 tot 01-09-1991
Daan R.		onderzoeker (project-)	
Reichert M.J.M.		onderzoeker (project-)	m.i.v. 16-10-1991
Hoek J. van der		analist	tot 01-03-1991 m.i.v. 01-10-1991
Boer J.L. de		analist	van 01-02-1991 tot 01-07-1991
Vooys C.G.N. de	20.00	onderzoeker (project-)	tot 01-03-1991
Heyman R.P.		onderzoeker (project-)	van 15-04-1991 tot 27-04-1991
Gee A. de		onderzoeker (project-)	van 01-04-1991 tot 01-05-1991
Nelissen P.H.M.		onderzoeker (project-)	van 14-02-1991 tot 01-03-1991
Hup M.		erk. gewetensbezwaarde	tot 22-03-1991
Boekel van W.H.M.	32.00	oio (EG)	
Dekker R.	30.00	onderzoeker (project-)	tot 01-02-1991 m.i.v. 04-03-1991
Osinga R.		oio (NOP-project)	m.i.v. 01-05-1991
Slomp C.P		oio (NOP-project)	m.i.v. 01-05-1991

WETENSCHAPPELIJKE & ADMINISTRATIEVE HULPAFDELINGEN

CENTRUM VOOR INFORMATIEVERWERKING EN AUTOMATISERING

Dapper R.		automatiseringsdeskundige.
Eijgenraam F.		automatiseringsdeskundige
Manshanden G.M	30.40	automatiseringsdeskundige

AUDIO-VISUELE/REPROGRAFISCHE AFDELING

Hobbelink H.		hoofd	
Hart W.	24.00	audio-visueel assistent	
Aggenbach R.P.D.		wnd. hoofd reprografie	
Verschuur B.	35.15	tekenaar	
Nichols R.C.		tekenaar	
Graaf A.C. de	20.00	reprografisch assistent	

REDACTIE

Bak-Gade B.	19.00	redaktie-assistente	
Mulder-Starreveld J.P.	28.50	redaktie-assistente	
Barten-Krijgsman N.	34.20	redaktie-assistente	
Lindeboom-Pollen P.R.	7.60	assistent-redacteur	m.i.v. 01-07-1991

BIBLIOTHEEK

Wal, v.d.-Doornekamp J.	33.25	hoofd bibliotheek	
Bruining-Porto du M	33.25	bibliotheekassistent	
Hashemi Saleh S.H.		vrijwilligster	

STUDIEMATERIAAL

Nieuwenhuizen J.M.		hoofd studiemateriaal	
Eliveld E.		med. afd. studiemateriaal	m.i.v. 08-07-1991

ADMINISTRATIE EN INVENTARISBEHEER

Wernand-Godee I.		hoofd administratie	
Bruin D.J.		adm. medewerker	
Keijser A.		adm. medewerkster	
Spel M.M.		adm. medewerkster	
Porto de S.W.		med. inventarisbeheer	
Gerritsen C.		adm.med. inventarisbeheer	m.i.v. 01-12-1991

RECEPTIE

Zonneberg M.	35.15	telefoniste/receptioniste	
Hin-Zoetelief J.M.M.	8.00	telefoniste/receptioniste	
Hillebrand-Kikkert A.	8.85	telefoniste/receptioniste	

HUISHOUDELIJKE DIENST/POTVISBEHEER

Steenhuizen G.H.		hoofd huish. dienst/beheerder Potvis	
Borkulo van T.C.	19.00	medewerkster Potvis	
Spigt H.		hoofd kantine	
Jourdan M.T.		medewerkster kantine	

TECHNISCHE HULPAFDELINGEN

Bakker C.L.		hoofd technische hulpafdelingen	

WERKTUIGBOUW

Buisman T.C.J.		hoofd werktuigbouw	
Porto de H.H.		1e technicus	
Groot S.P.		technicus	
Alkema P.R.		koeltechnicus	
Parlevliet F.J.		koeltechnicus	tot 01-07-1991
Gieles S.J.M.		technicus-chauffeur	
Blom J.J.		technicus vaarprogramma	
Bos E.B.M.		technicus vaarprogramma	
Persoon P.L.T.		technicus vaarprogramma	m.i.v. 01-04-1991
Polman W.		technicus vaarprogramma	
Boekel J.E.L.		technisch assistent	m.i.v. 11-09-1991

HAVEN- EN VAARTUIGENDIENST

Zwieten C. van	havenmeester	
Gerssen C.	gezagvoerder Pelagia	
Souwer A.J.	1e stuurman Pelagia	
Groot J.C.	2e stuurman Pelagia	
Pieterse J.M.	1e s.w.k. Pelagia	
Seepma J.	2e s.w.k. Pelagia	
Kalf J.J.	3e s.w.k. Pelagia	m.i.v. 18-11-1991
Mozes C.J.	bootsman Pelagia	
Koomen W.J.M.	kok Pelagia	
Grisnich P.W.	matroos Pelagia	m.i.v. 28-01-1991
Rebel R.	matroos Pelagia	
Eelman W.P.	matroos/motordr. Pelagia	tot 01-10-1991
Saalmink P.W.	matroos Pelagia	van 22-04-1991 tot 08-07-1991 m.i.v. 05-08-1991
Wisse C.H.	gezagvoerder Navicula	
Anthonijsz R.J.R.	machinist Navicula	
Tuntelder J.C.	matroos/kok Navicula	
Jongejan W.P.	komvisser	
Adriaans E.J.	schipper Griend	
Jong J. de	gezagvoerder Pelagia	van 05-06-1991 tot 12-07-1991

INSTRUMENTMAKERIJ

Boekel H.J.	hoofd instr./aquar.techn.afd	
Heerwaarden van J.	instrumentmaker	
Vaars A.J.	applicatietechnicus	
Keijzer E.J.H.	instrumentmaker	
Lakeman R.	aquariumtechn.	
Kuip T.	aquariumtechn.	
Kuip M.	assistent	van 20-06-1991 tot 19-08-1991

ELECTRONICA

Groenewegen R.L.	hoofd electronica	
Franken H.	elektronicus	
Laan M.	elektronicus	
Nieuwenhuis J.	technicus vaarprogramma	
Oost L.M.	electronicus vaarprogramma	
Koster B.	electronicus	tot 15-09-1991 m.i.v. 16-10-1991

HOUTBEWERKING

Heerschap L.	hoofd houtbewerking	
Daalder R.M.	houtbewerker	
Witte R.J.C.	technicus vaarprogramma	

ENERGIETECHNIEK

Schilling F.J.	hoofd energietechniek	
Bakker M.G.	electrotechnicus SOZ	

MAGAZIJN/EXPEDITIE

Ran A.	magazijnchef	
Visser A.J.	chauffeur	

5.5. STAGIAIRES

Ten opzichte van 1990 is het aantal stagiaires dat in het kader van de middelbare en hogere beroepsopleidingen stage bij het NIOZ heeft gelopen fors toegenomen. In 1991 is een stijging te constateren van ruim 40%. Dit wordt veroorzaakt door een toename van het aanbod van studenten en door het feit dat deze categorie goed inzetbaar is bij lopende projectonderzoeken, waarbij zowel de student als het instituut voordeel heeft. De volgende studenten zijn in dit jaar tewerkgesteld:

NAAM:	PERIODE:	AFDELING:	OPLEIDINGS INST.:
Y. van der Waaij (mw.)	05/08 - 31/12	Benthische Sys.	I.A.H. Larenstein
A.L.H. van Balen	02/08 - 31/12	Benthische Sys.	I.A.H. Larenstein
A.J.P. Hofte	01/01 - 01/04	Bewon	Hogesch.Enschede
W. Nijmeyer	01/04 - 01/07	Bewon	Hogesch.Enschede
J.D. Lont	02/09 - 02/12	Bewon	Hogesch. Noorderhaaks
P. Hurkmans	02/12 - 31/12	Bewon	Hogesch. Noorderhaaks
A.J.E. Otten (mw.)	01/01 - 01/06	Chem.Oceanogr.	Hogesch.Alkmaar
R.J. van Hoogstraten	01/01 - 01/06	Chem.Oceanogr.	Hogesch.Alkmaar
M. de Vringer (mw.)	07/01 - 20/04	Chem.Oceanogr.	Hogesch. Holland
J.L. de Boer	01/02 - 01/07	Chem.Oceanogr.	
P. Adema	01/09 - 31/12	Chem.Oceanogr.	H.L.O.- Alkmaar
S. Kofman (mw.)	01/09 - 31/12	Chem.Oceanogr.	H.L.O.- Alkmaar
A. Ramkema (mw.)	01/09 - 31/12	Chem.Oceanogr.	H.L.O.- Alkmaar
M. van Dalen	01/09 - 31/12	Chem.Oceanogr.	H.L.O.- Alkmaar
D. Kwast (mw.)	01/09 - 31/12	Chem.Oceanogr.	Bakhuis Roozeboom
I.C. Vrauwedeunt (mw.)	01/09 - 31/12	Chem.Oceanogr.	Reynevelt College
M.C. Witte	01/12 - 31/12	Fysische Oc.	T.H. Rijswijk
M.C. Vlaming	04/11 - 31/12	Geologie	Van Hall Instituut
A.A. Scheele (mw.)	01/01 - 01/02	Kustsystemen	B.R.I.
O. Wijker	01/01 - 01/03	Kustsystemen	B.R.I.
D. Jonkman (mw.)	07/01 - 01/05	Kustsystemen	L.H.S. Groningen
S. Ott	01/02 - 01/07	Kustsystemen	
S. Visser (mw.)	01/09 - 31/12	Kustsystemen	Bakhuis Roozeboom
G. Boots	01/09 - 31/12	Kustsystemen	Bakhuis Roozeboom
F.J. Smedema	08/07 - 01/10	Pelagische Sys.	Tech.Universiteit
S. Dijkstra (mw.)	29/04 - 14/06	Secretariaat	MEAO De Schalm
E. Bosch	01/01 - 11/01	Energietechn.	MTS-Noorderhaaks
D.N. Keppel	14/01 - 14/06	Energietechn.	MTS-Noorderhaaks
G.J. Drenth	01/01 - 12/01	Energietechn.	MTS A. & O.
A. Veltstra	14/01 - 15/06	Energietechn.	MTS A. & O.
R.C.J. Koenis	12/08 - 31/12	Energietechn.	MTS A. & O.
M. Bijker	12/08 - 31/12	Energietechn.	MTS-Noorder Hooft
S.A. Groot	01/01 - 11/01	Electronica	MTS-Noorderhaaks
M. van Ree	14/01 - 14/06	Electronica	MTS-Noorderhaaks
F. Doornweerd	01/02 - 01/08	Electronica	MTS- A. & O.
A. Bey	12/08 - 31/12	Electronica	MTS-Noorder Hooft
B.P. de Vries	12/08 - 31/12	Electronica	MTS- A. & O.
M. Hayma	01/01 - 01/03	Instrumentm.	MTS-Noorderhaaks
M. Kuip	04/03 - 15/06	Instrumentm.	MTS-Noorderhaaks
R. Witte	12/08 - 29/11	Instrumentm.	MTS-Noorder Hooft
T. de Jong	02/12 - 31/12	Instrumentm.	MTS-Noorder Hooft

5.6. ARBEIDSVOORWAARDEN

Algemene salarisverhoging

Per 1 april zijn de salarissen van het overheidspersoneel verhoogd met 3,4%. Deze maatregel heeft een algemeen karakter en werkt door naar een aantal specifieke toelagen die op sommige categorieën personeel van ons instituut van toepassing zijn.

Tijdelijke verlaging VUT-gerechtigde leeftijd

De tijdelijke verlaging van de VUT-gerechtigde leeftijd van 61 tot 60 jaar is verlengd tot april 1992. Onzeker is of deze regeling, die gezien moet worden als maatregel ter bevordering van de werkgelegenheid, in het komende jaar zal doorwerken. Gedacht wordt aan een verhoging van de VUT-leeftijd gekoppeld aan een systeem van flexibele pensionering. In verband hiermee kan nog vermeld worden dat degenen die gebruik maken van deeltijd-VUT (zie hieronder) in principe hiervan gebruik kunnen blijven maken tot de eerste mogelijkheid om volledig met VUT te gaan.

Decentrale arbeidsvoorwaardenregelingen

Deze maatregelen die ten behoeve van werkgelegenheidsdoeleinden in 1990 werden ingevoerd, zijn ook in dit verslagjaar van toepassing geweest. Het betreft:

1. verlenging van het bevallingsverlof;
2. ouderschapsverlof;
3. deeltijd-vut;
4. kinderopvang.

- ad 1) De totale duur van het zwangerschaps- en bevallingsverlof bedraagt 16 weken. De werkneemster kan in de periode van 6 tot 2 weken voor de vermoedelijke datum van bevalling met zwangerschapsverlof gaan. Het aantal dagen dat dit verlof korter is dan 6 weken wordt toegevoegd aan het bevallingsverlof, dat ingaat op de dag na de bevalling. Van deze regeling is in 1991 geen gebruik gemaakt.
- ad 2) Een ieder met een dienstverband van tenminste een jaar, een arbeidsduur van minimaal 16 uur per week en die een kind heeft dat de leeftijd van de basisschool nog niet heeft bereikt, kan in aanmerking komen voor ouderschapsverlof voor maximaal de helft van zijn/haar werktijd. Over de verlofuren wordt 75% van het salaris betaald. De maximumduur van het ouderschapsverlof bedraagt 6 maanden. Deze verlofregeling kan onder bepaalde voorwaarden flexibel worden toegepast door bijvoorbeeld binnen een periode van 12 maanden het verlof versnipperd op te nemen. Van deze regeling hebben dit jaar 4 medewerkers gebruik gemaakt.
- ad 3) Een jaar voor het bereiken van de VUT-gerechtigde leeftijd kan de werknemer die aangesteld is in een betrekking van tenminste 16 uur per week voor de helft van zijn/haar werktijd gedeeltelijk vervroegd uittreden. Over de tijd waarmee de arbeidsduur tot de helft van het oorspronkelijk aantal uren is teruggebracht, ontvangt de werknemer een (deeltijd-vut) uitkering van 80% van de laatst genoten bezoldiging. De deeltijd-VUT regeling is dit jaar op één medewerker van toepassing geweest. De regeling wordt per 1 april 1992 beëindigd.
- ad 4) Het NIOZ heeft aan het Kinderdagverblijf Texel een subsidie beschikbaar gesteld ter financiering van 1 'kindjaarplaats'.

Werktijden

Per 1 januari is een systeem van glijdende werktijden ingevoerd. Met inachtneming van de arbeidstijd, die van maandag t/m donderdag 8 1/4 uur en op vrijdag 7 1/4 uur bedraagt, kan men 's morgens tussen 7.00 uur en 9.00 uur met de werkzaamheden beginnen. Op vrijdag kan de dienst echter niet voor 15.45 uur beëindigd worden.

Schaal 93 - Kwestie

Tussen de werkgevers FOM, NWO, NIOZ en de werknemersorganisaties is in het kader van het arbeidsvoorwaardenoverleg 1991 de afspraak gemaakt om een bijzondere salaris(beleids)maatregel in te stellen voor de categorie personeelsleden die bezoldigd wordt op basis van (de tussen-) schaal 93. Deze maatregel vindt zijn grondslag in de bijzondere positie van deze groep, vormt geen precedent en laat onverlet de uitkomst van de functiewaardering. Op voorstel van het afdelingshoofd kan bij goed functioneren een structurele functioneringstoelage worden verleend die, in jaarlijkse stappen oplopend conform de opbouw van schaal 9, maximaal het verschil bedraagt tussen het maximumsalaris van schaal 93 en dat van schaal 9. De maatregel gaat in met terugwerkende kracht tot 1 januari 1991.

Formatie-onderzoek

In de jaren 1987 en 1988 zijn alle op het NIOZ voorkomende functies beschreven en, tezamen met het formatievoorstel, voorgelegd aan de Minister van O&W ter vaststelling van de NIOZ-formatie. Deze vaststelling heeft echter alleen m.b.t. de functieniveaus plaatsgevonden en niet in kwantitatief opzicht. Vervolgens is in 1989 door een ambtelijke werkgroep de overgang van het NIOZ naar NWO voorbereid. Punt van discussie was de nog niet vastgestelde formatie van het NIOZ. Het ministerie stelde dat de financieringswijze van het NIOZ-budget gebaseerd is op budget-lump sum-financiering in tegenstelling tot voorheen waarbij het ministerie in zijn verantwoordelijkheid als toezichthouder op de B-3 stichtingen zowel de maximaal toegestane functieniveaus als de aantallen functies vaststelde, m.a.w. de totale formatie bepaalde.

Nadat de overgang een feit was, is door NWO aan het NIOZ verzocht de formatie alsnog te doen vaststellen en hieraan gekoppeld het proces van functiewaardering opnieuw ter hand te nemen. Hiertoe is een extern deskundige aangetrokken die in de loop van het 2e kwartaal met zijn werkzaamheden is begonnen.Verwacht wordt dat de eerste fase van het formatie-onderzoek begin 1992 zal zijn afgerond.

Deeltijd

Het NIOZ stelt medewerkers onder bepaalde voorwaarden in de gelegenheid om op deeltijd-basis werkzaam te zijn. Ruim 15% van het personeelsbestand heeft een part-time aanstelling waarvan 20% een werktijd heeft van minder dan 20 uur per week.

5.7. ARBEIDSOMSTANDIGHEDEN

Bedrijfsgezondheidszorg

Bedrijfsgezondheidszorg beoogt de gezondheid, de veiligheid en het welzijn van mensen in werksituaties zo goed mogelijk te bevorderen. De bedrijfsgezondheidszorg heeft hierbij geen curatieve maar een preventieve en adviserende taak voor zowel de werkgever als de werknemer. Hiertoe wordt in een "pakket" maatregelen voorzien dat neerkomt op het verrichten van aanstellingskeuringen en periodieke keuringen voor specifieke categorieën personeel, het verrichten van onderzoek naar arbeidsomstandigheden, het houden van een bedrijfsgeneeskundig spreekuur, het uitvoeren van de ziekteverzuimbegeleiding en nog een aantal andere voorzieningen. In het 4e kwartaal zijn in dit kader besprekingen gevoerd met de Gewestelijke Gezondheidsdienst (GGD) te Den Helder. Er volgen nog besprekingen met de Bedrijfsgeneeskundige Dienst (BGD) in Alkmaar.

Ziekteverzuim

Het geregistreerde ziekteverzuim wordt uitgedrukt in een percentage van het totale aantal werkbare dagen. In 1990 bedroeg dit verzuim 4,5% en in 1991 4%. Procentueel is er een daling van het ziekteverzuim te constateren. Echter, in 1991 is door de toename van (tijdelijke project-) medewerkers het totale aantal ziektedagen toegenomen. (in 1990: 1794 en in 1991: 1995 ziektedagen). Het ziekteverzuim onder het niet wetenschappelijk personeel is hoger dan bij het wetenschappelijk personeel, namelijk 5,1% tegen 2% (in 1990 was dit respectievelijk 6% en 1,8%). Het relatief hoge percentage ziekteverzuim onder het niet wetenschappelijk personeel wordt voornamelijk veroorzaakt door een aantal langdurig zieken. In vergelijk met het landelijke percentage ziekteverzuim, te weten 8,4% steekt het verzuim bij het NIOZ gunstig af.

ARBO-wet

In 1988 is het ARBO-beleidsplan van het NIOZ voor de komende jaren tot stand gekomen. De beleidsvoornemens uit dit plan worden periodiek getoetst en besproken in de overlegvergaderingen van de directie en de ondernemingsraad. Dit jaar hebben negen personen een EHBO-herhalingscursus gevolgd terwijl drie leden van de bedrijfsbrandweer het diploma 'brandwacht 1e klas' behaalden en twee leden het diploma 'onderhoudsmonteur kleine blusmiddelen'. De jaarlijkse controle van de gehele brandmeldinstallatie en van de adembeschermingsapparaten is verricht. Met de gemeente Texel zijn regelingen getroffen voor de afvoer van schadelijke stoffen. Voor de opslag van oliën zijn twee containers aangeschaft en voor het stralen van werkstukken een gritkabine. Voor meer uitgebreide informatie wordt verwezen naar het ARBO-jaarverslag.

5.8. OVERLEG

Georganiseerd Overleg

In het GONWO (Georganiseerd Overleg - NWO) hebben zitting de vakorganisaties 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.

Overleg O.R. - Directie

Overleg tussen de O.R. en de Directie heeft dit jaar geregeld plaatsgevonden. Een belangrijk onderwerp vormde de overwerkregeling voor opstappers tijdens vaarexpedities. Vooralsnog is er voor een proefperiode van een jaar, ingaande 1 januari 1992, een regeling getroffen die neerkomt op maximaal 2 overwerkuren per werkdag. Hierbij kan het overwerk eerst financieel gecompenseerd worden als er meer dan 20 compensatiedagen zijn opgebouwd. De regeling heeft alleen betrekking op overwerk verricht aan boord van NIOZ schepen.

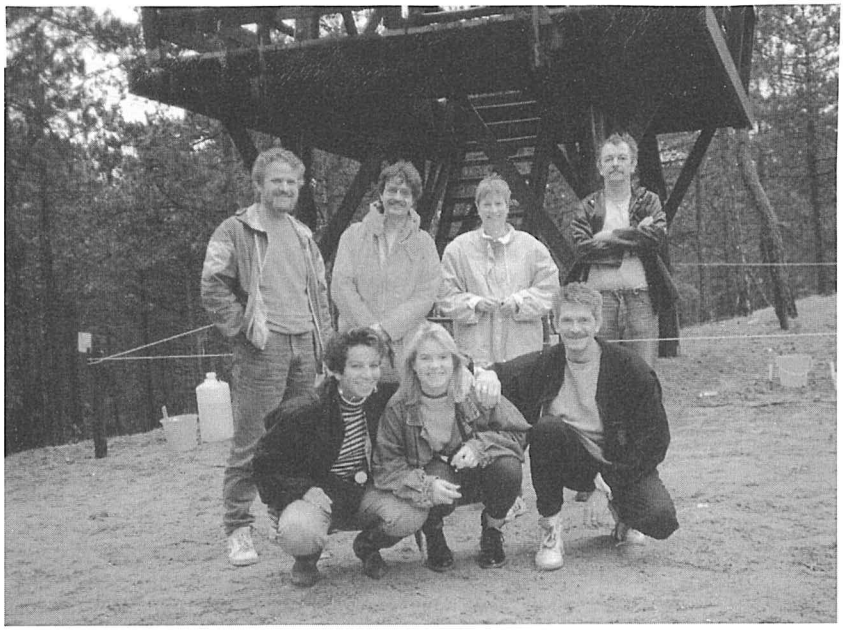
5.9. VERSLAG VAN DE PERSONEELSVERENIGING

Om een iets beter inzicht te krijgen in waar het NIOZ personeel zich buiten de werktijden om mee bezig houdt werd besloten om na de nieuwjaarstoespraak een hobby-dag te organiseren. Op 7 januari was het zover en kon men knutseltjes, plakboeken, archeologische vondsten, dichtwerk, timmerwerk etc. van de naaste collega's bewonderen. Muzikaal werd er ook flink uitgehaald, met

o.a. Ierse liederen van de NIOZ-band en pianorecitals zowel quatre-mains als deusx-mains. Gedegen werd het kunstwerkje van W.T. Schippers 'Waar gaat het over' door de toneelgroep 'Comedia de la NIOZ' gebracht. Hierna volgde een concert door het Amidius Trio waar hobo's, klarinetten en fagotten de oren deden suizen. Stukken van Mozart, Arden Taylor en de familie Haydn werden ten gehore gebracht. Volksdansen volgde, hierna kwamen de dichtende Bowema broertjes, en als afsluiter 'de kinderen van Jan en Zwaan', namelijk Wim Mook en Irene Wernand. Bij de NIOZ cultuur is het ondenkbaar het één en ander zonder borrel af te sluiten.

Vrijdag 8 maart was het voor de NIOZ kinderen zover en stond een optreden van de Helderse toneelgroep 'Julia' centraal met de kindervoorstelling 'Heksen kun je nooit vertrouwen ... maar kabouters .....' Voorafgaand was een kleurwedstrijd in de categorieën 0-3, 4-7 en 8-12 jaar. Het PV-bestuur kon zich uitleven bij het bakken van 500 pannekoeken. Vijf liter oploslimonade passeerde de kinderslokdarmpjes.

Met vorig jaar een PV-reisje was het dit jaar weer zover om een alternatieve sportdag te organiseren. Op donderdag 26 september, pijpestelen uit de lucht, kwam een ieder in plastic kostuum de routebeschrijving voor een fietstocht over Texel afhalen. Het lag in de bedoeling om 's middags enige sporten te beoefenen. Het weer noodzaakte het bestuur spelen als 'baardplakken', kogelwerpen en darts voorafgaande aan de fietstocht te laten plaatsvinden. Hierna sprongen de diverse teams vrolijk op de fiets voor het vervolgprogramma in het Texelse bos. Na 1 uur fietsen werd het droog. Via torenspel, estafette en trefbal leek er al een kandidaat voor de NIOZ wisseltrofee in zicht. Beoordeling van een te maken zandcreatie door een deskundige jury gaf uiteindelijk de doorslag. Team Electronica 1e plaats, team administratie, bibliotheek, redactie laatste plaats. Het één en ander werd afgesloten met een chinees etentje in Den Burg.



Het P.V. bestuur plus twee vrijwilligers na de regen, 26 september 1991.

De toneelgroep 'Comedia de la NIOZ' hield zich dit jaar bezig met 'De thuiskomst' van Harold Pinter. Er werd in eerste instantie gedacht aan een uitvoering begin van het jaar, door ziekte van één van de spelers, en uitstel van een tweede opvoeringsdatum in november werd besloten de opvoering te verschuiven naar 1992.

Het kunstbeleid van de PV richtte zich dit jaar in het bijzonder op de Texelse fotokunstenaar Piet de Wolf die twee exposities in de gangen van het NIOZ hoofdgebouw verzorgde.

Subsidies (f. 300,--) dit jaar gegeven aan de NIOZ voetbal- en volleybalploegen.

Diverse langdurig zieke PV-leden werden verrast met een fruitmandje, aangeboden door de personeelsvereniging.