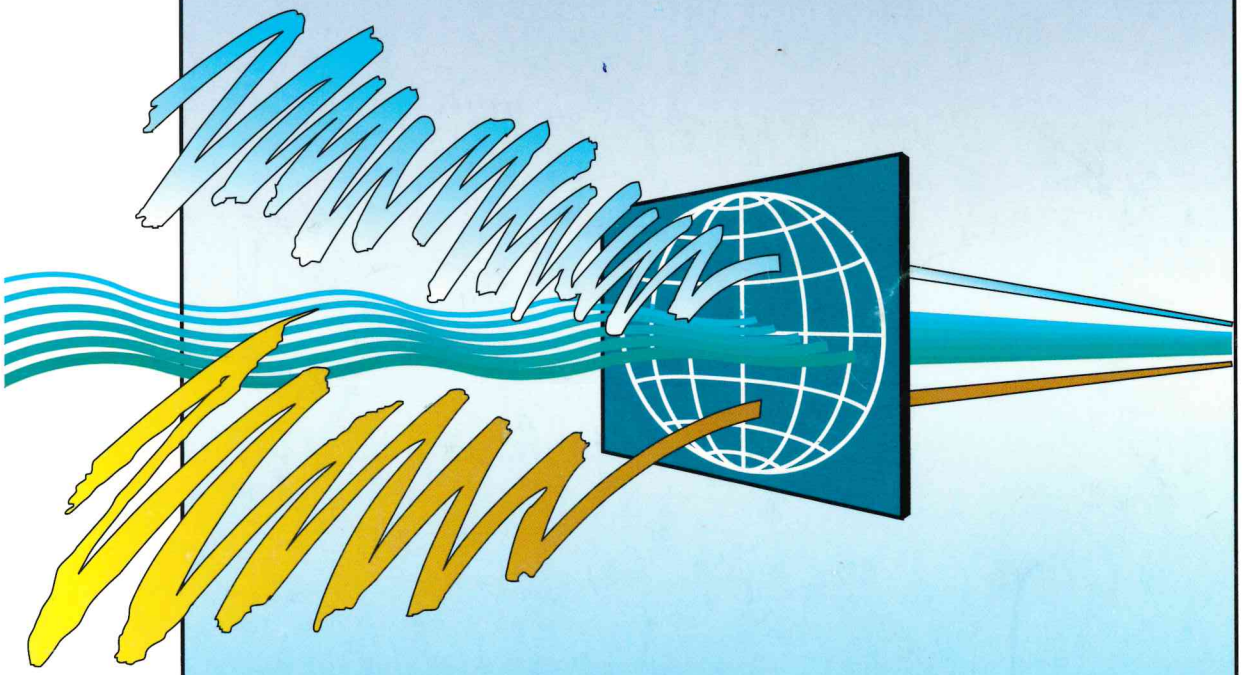
ANNUAL Report 1993



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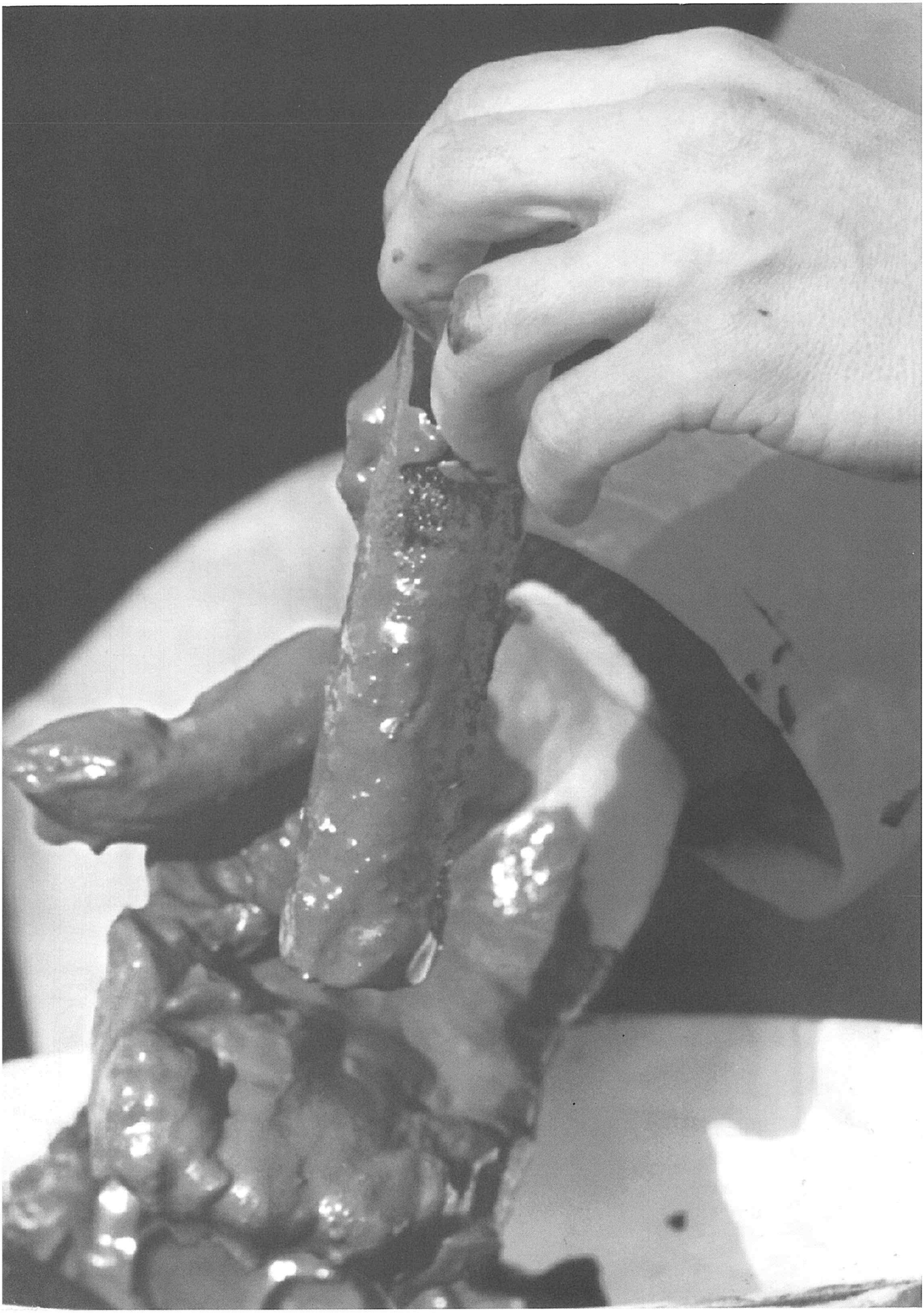
ANNUAL REPORT 1993

Het Zoölogisch Station op den Helderschen Zeedijk. (Naar een penneschets van G. V.)

NETHERLANDS INSTITUTE FOR SEA RESEARCH (NIOZ)



CONTENTS

INTRODUCTION

In 1993 NIOZ has continued to grow and flourish under the increasing interest in sea research, caused both by regional environmental concerns and the problems of global change. Also the main research programmes of the European Union have a strong and lasting impact on the activities of NIOZ.

Under these conditions the research atmosphere is healthy and stimulating, even to the extent that at times the Institute is felt to be 'bursting at the seams' as it were. It is difficult, if not impossible, to have technical and administrative support keep pace with the ever increasing scope of science. There can be no doubt that the flexibility and dedication demonstrated by NIOZ employees at all levels keep the Institute sailing.

The state of health of NIOZ was tested when an international multidisciplinary committee of experts visited NIOZ from 1 to 5 November. The former Peer Review goes back to November 1989. The open and profound discussions between NIOZ scientists and members of the Peer Review committee were generally appreciated by both sides. NIOZ is pleased that the report on both the research and the scientists themselves was generally very positive. Some of the recommendations were on time to be incorporated in the long-range Science Plan presented to the NWO Council of the Biological, Oceanographic and Earth Sciences (BOA) in December 1993. Some points are to be discussed in further detail in 1994, and also the introduction of the mainly organizational and financial changes, to a large extent already announced by the directorate, will require a great deal of time. In general, we may conclude that both the NIOZ directorate and scientists have found the lengthy preparations as well as the site visit very stimulating.

On 1 April RV 'Tyro' returned to the NIOZ harbour after a successful 11-month expedition to the Indian Ocean. A great number of official guests and cruise participants during the year were present at her arrival. The results of the mainly chemical, geological and biological research will be presented at various workshops in 1994. The participants agree that the success of the expedition is essentially due to the skill and motivation of the ship's technical staff.

NIOZ continued its scientific activities in the Antarctic aboard RV 'Polarstern' as part of the JGOFS programme and the research on the marginal ice zone. An agreement was concluded with the Alfred Wegener Institut für Polar- und Meeresforschung (AWI), Bremerhaven, involving close co-operation in years to come in the CO_2 research in the Southern Ocean, and providing support to AWI in the further development of the necessary analytical techniques.

The four Mast-II projects which were approved in 1992 started to operate this year. Of these four, OMEX is the most comprehensive, involving a great deal of international co-operation. This project is the first to be affected by the withdrawal of RV 'Tyro' from service (see below). Also, all projects of the NWO/NOP Global Change (Verstoring van Aardsystemen) programme became fully operational. The number of PhD students (OIO's) has now increased to 49.

Part of this increase was due to the coming of the Department of Marine Biogeochemistry, which was realized in July and officially marked on 10 September. With the support of NWO a semi-permanent laboratory has been built and equipped to meet the high standards required. This laboratory now houses a department of over 20 persons.

In December NWO's General Board took the decision that Dutch marine scientists had dreaded so much, *viz.* to do away with RV 'Tyro', the vessel for civilian ocean research. This has (temporarily?) deprived us of direct access to

a vessel for ocean research and consequently frustrated Dutch initiatives for major ocean expeditions. Also the participation in large-scale international programmes and related co-operation has been rendered more difficult. Ironically, NWO's negative decision ignores one of the recommendations made shortly before by the international Peer Review, *viz.* that NIOZ should have direct access to an ocean-going ship.

The troublesome co-operation over the last few years between the Marine Science Foundation (SOZ) and NIOZ in the joint execution of Dutch ocean research has caused NWO to revise the organization. In 1993 the definitive plans were presented. As of 1 January 1994 the national task of planning and executing Dutch sea-going research will rest with NIOZ, whereas the new Geoscience Foundation GOA will be responsible for assessment of and decision-making concerning the sea-going research that is not funded by NIOZ.

A source of increasing concern is the termination of the structural financing of the policy-linked research which the BEWON Department was set up in 1988 to execute in an agreement with other Dutch institutes. Although NIOZ remains committed to the continuation of the strategic and policy-linked research of the Wadden Sea and the North Sea, such a continuation is complicated by the replacement of the old long-term financial and thematic approach by a number of one-year projects. This endangers the continuity of the research. In contrast to expectations, it appears that NIOZ cannot derive any financial guarantees from the framework agreement, neither from the Ministries nor from NWO.

Arrangements were made with the Dutch universities concerning the new Graduate Schools to further mutual co-operation both in education and in research. Agreements were concluded for Biology and part of Chemistry, for Geology and another part of Chemistry, and for Physics with the Graduate Schools of respectively Functional Ecology, Sedimentary Geology and Meteorology and Physical Oceanography. Part of NIOZ's contribution consists in organizing a course in General Oceanography (Marine Sciences) and various sea-going courses.

The Herman Klomp Prize 1993 was awarded to Kees Camphuysen for his many and sound publications on bird life around the North Sea. Dr. Jan de Leeuw, head of the new Department of Marine Biogeochemistry, was awarded the Dr. P.H. Given Lecturership Award from the Pennsylvania State University, USA.

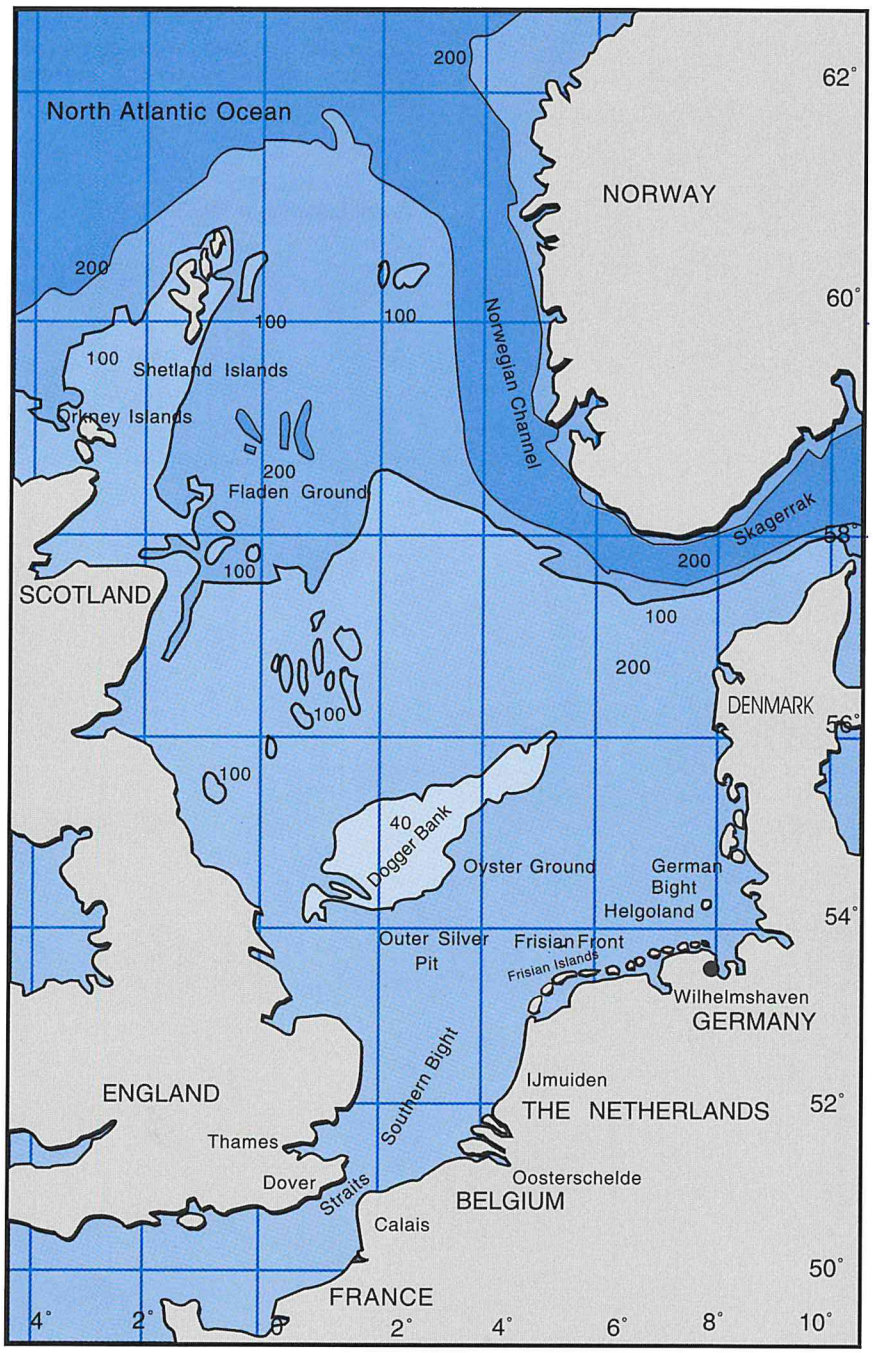
With the arrival of Project Manager Dr. John Pernetta on 1 November, the Core Project Office of the IGBP project LOICZ (Land-Ocean Interaction in the Coastal Zone) started to operate. The Office was officially opened on 9 December by Dr. John Marks of the Ministry of Education and Science, representing the funding ministries. On this occasion the Chairman of the LOICZ Scientific Steering Committee, Dr. Patrick Holligan, presented the scientific contents of the programme to official guests and to Dutch scientists interested in LOICZ activities. The presence of the CPO at NIOZ is certain to stimulate coastal research in the Netherlands and at NIOZ in particular.

The internal reorganization of the NIOZ Support Services was accomplished in 1993. Although the new job descriptions for all NIOZ positions, which are the realizations of the reorganization, have turned out to be a far greater operation than initially expected, they are nevertheless all but rounded off.

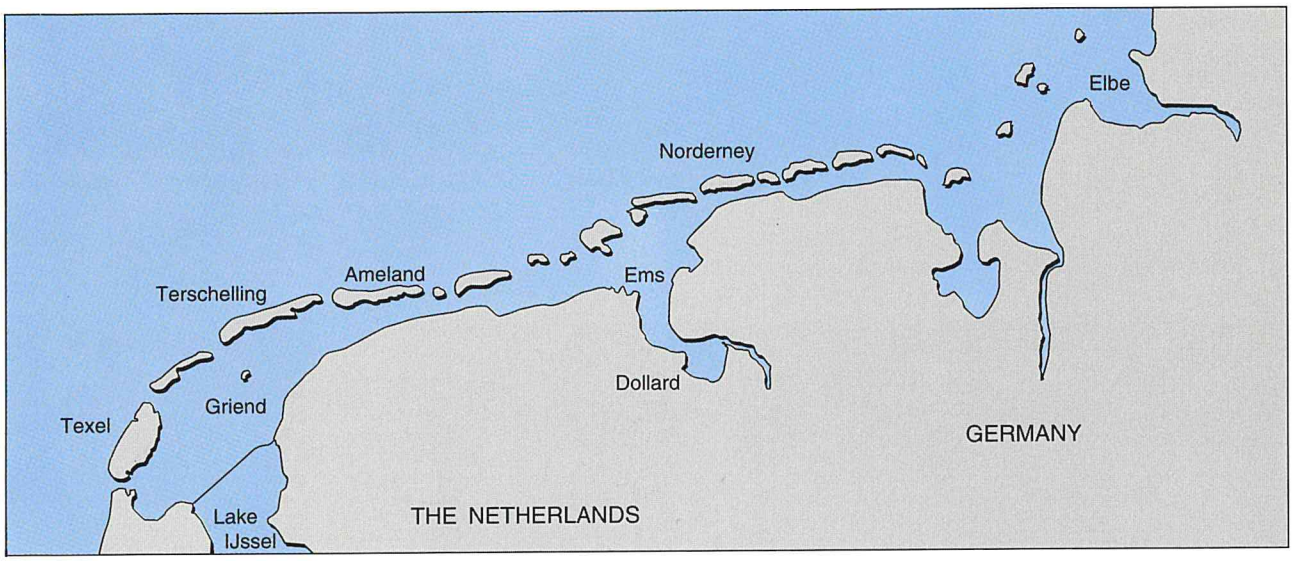
RV 'Pelagia' was mainly engaged in North Sea research in 1993. There were also expeditions to the Bay of Biscay (one for physical-oceanographic investigations along the shelf edge, another to mark the start of the OMEX programme), to a Norwegian fjord south of Bergen to study *Emiliania huxleyi* bloom conditions, and on behalf of Denmark's Geological Survey and the University of Århus to the east coast of Greenland. During the latter cruise hydrographic data were also collected for the DUTCH-WARP programme of NIOZ.

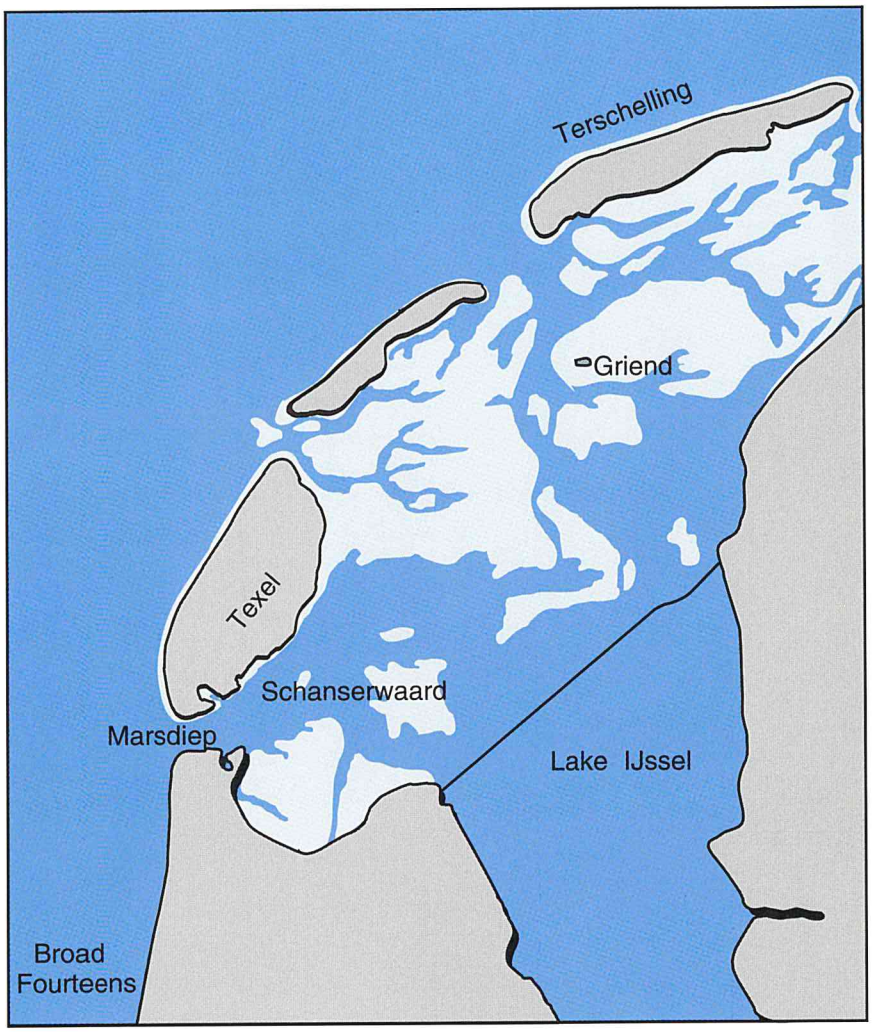
A group of about twenty Department heads and senior scientists spent a weekend together at Lhee near Dwingelo to discuss the scientific programme of NIOZ and suggest possible improvements in the organization and execution of the research. Although the general conclusions need further elaboration, the frank discussions in a friendly atmosphere were appreciated and found useful. As a result, in 1994 a restructuring will take place which can only enhance co-operation within the Institute, and help maximize effectiveness and efficiency of research.

Texel, December 1993 W.G. Mook



North Sea with geographical names mentioned in this report





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

1.1. MULTIDISCIPLINARY PROGRAMMES

Joint Global Ocean Flux Study (JGOFS)

H.J.W. de Baar

From the 1987 initiation NIOZ has contributed to the JGOFS core project of SCOR and IGBP. The national JGOFS committee with the aid of SOZ has this year completed a list of all publications resulting from the 1989-1990 RV 'Tyro' cruises in the Northeast Atlantic Ocean. The corresponding databases are available both on disk and in a printed report and have been exchanged with JGOFS datacentres of other countries (*e.g.* UK-BODC, US-JGOFS at Woods Hole). In June 1993 three NIOZ scientists (De Baar, Bakker, Majoor) participated in the annual workshop of the IOC/JGOFS CO_2 Panel. At the annual SCOR/JGOFS meeting in September 1993 national chairman De Baar represented The Netherlands.

JGOFS Antarctic Ocean

In 1993 results were worked out from the expedition in late 1992 aboard RV 'Polarstern' within the context of the Antarctic Ocean JGOFS Process Study. All data gathered by 51 scientists have been assembled into one database organized by J. Rommets (NIOZ) and given out to the participating institutes. This dataset served for supporting four workshops (two at NIOZ, two at AWI) where considerable progress was made towards synthesizing the vast variety of information into a coherent description of the processes occurring in the ecosystem during spring evolution.

Briefly the major finding was that Marginal Ice Zone (MIZ) blooms as described for neritic waters (Weddell Sea, Ross Sea) do not occur in truly open ocean Antarctic Circumpolar Current (ACC). Curiously enough the British programme in the Bellingshausen Sea also witnessed the absence of spring MIZ blooms. Reasons are manifold. In our region (6°W meridian) firstly the sea-ice was found to collapse and retreat in spring, but this does not necessarily imply *in situ* melting. Freshening of MIZ surface waters was not observed. Possibly the ice is flowing southwestward along with the Weddell gyre and actual melting takes place elsewhere. Also the very strong winds maintained a deep mixed layer (80-100 m), as opposed to the stratified regime deemed necessary to ensure adequate light conditions for photosynthesis. Any *in situ* melting of the 1-2 m thick sea-ice and snow would be obscured by dilution into the 80-100 m mixed layer. Seeding of the seawater by the in-ice community of algae as well as the higher amounts of Fe in the ice (30-60 nM as compared to 1-3 nM in seawater) would also be diluted 50-100 fold and thus hardly stimulate blooms.

Within the ACC proper the biological activity was always very low, except in the Polar Front where a spring bloom evolved during the two-month period. The physical forcing of such a bloom is currently being resolved from the very complex and dynamic eddy structures and interleaving surface waters in the Polar Front (~48-50°S) zone. The ongoing spring season and increasing chlorophyll were accompanied by a strong decrease of surface water pCO_2 to lowest values of about 300 µatm coinciding nicely with the blooms. This in combination with the general downward transport of water at the Polar Front

(formation of Antarctic Intermediate Water, AAIW) hints at the Polar Front serving as a net sink for atmospheric CO_2. However, this needs confirmation by additional data at other latitudes and/or seasons, currently being pursued in a three-year CO_2 programme (1993-1996, see below) set up between AWI (operator of RV 'Polarstern') and NIOZ.

Planning for 1996-1998 field programmes

Several options have been worked out by the Netherlands JGOFS committee. Firstly the SCOR-JGOFS Indian Ocean Planning Group has requested another Dutch field programme in the 1996 season. Secondly, the proposition of a North Atlantic field study in ~1998 (Dr. R. Lampitt) is seen as very suitable for a contribution also from The Netherlands. Thirdly, the important role of the Antarctic Polar Front as observed in the 1992 project has led to the concept of a field study in the Atlantic sector of the Polar Front. This being part of the permanently open ocean component of the Southern Ocean, it is possible to bring a regular (non-ice certified) ship in the region.

Netherlands Indian Ocean Programme 1992/1993 (NIOP)

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

The Netherlands Indian Ocean Programme, funded and organized by SOZ, comprised 5 main projects in various parts of the NW Indian Ocean and was executed in a series of 13 cruises by RV 'Tyro' from May 1992 up to and including March 1993. The field work of projects A 'Monsoons and coastal ecosystems in Kenya' and D 'Geological study of the Arabian Sea' was completed already in the autumn of 1992. NIOZ contributed in benthic studies of the Kenya project (see H1-06b, B1-04-3) and was responsible for the measurement of greenhouse gases in the Arabian Sea (see H1-04).

At the beginning of 1993, project E 'Biology of oceanic reefs' was concluded at the Seychelles. NIOZ participated in studies of the dynamics of reef communities (see B1-05). Subsequently, the cruises B2 and C2 of the projects B 'Monsoons and pelagic systems' and C 'Tracing a seasonal upwelling' were executed, with major NIOZ participation in collaboration with the Institute of Taxonomic Zoology (University of Amsterdam) and the Institute of Earth Sciences (Free University Amsterdam), respectively. These cruises visited the Somali Basin, Gulf of Aden and adjacent areas, to study pelagic and benthic variables in the northeast monsoon for comparison with similar observations during the southwest monsoon (the upwelling season) in summer 1992. During cruise B2 most of the JGOFS core measurements were done. The pelagic system was dominated by picoplankton, with a large grazing pressure by small heterotrophic flagellates. However, conditions were less oligotrophic than expected. Substantial levels of nutrients were observed in the mixed layer, associated with relatively high wind velocities. Consequently, primary production was high and not significantly lower than in the upwelling season. Zooplankton biomass was high as well, but species composition had changed. The typical upwelling copepod *Calanoides carinatus* now occurred only below 300 m, and diapausing populations were found at all stations where tows to depths of 1000 or 1500 m were done. Results from Project B are mentioned in H1-17, H2-13, H3-23, B2-08 and for Project C see also H1-04, H3-23, B1-04-4 and B1-06.

During cruise C2, in February 1993, emphasis was on the study of the Somali Basin transect at about 10°N. The surface mixed layer increased from 25 m near the coast to 90 m at the deepest station. Subsurface chlorophyll maximum deepened gradually from 25 m to 50 m at the deep stations. An oxygen Minimum Zone occurred between 200 and 1100 m, near-bottom oxygen increased regularly with depth.

Along the Socotra transect a subsurface chlorophyll maximum was almost absent. Oxygen values were lower than during the upwelling period, and also consistently lower than values from the literature.

The Oman and Yemen transects showed that off Yemen the oxygen values were similar, but off Oman the oxygen concentrations were markedly lower than during cruise C1. The contrasts between the two monsoonal periods were very marked in the upper 100 m of the water column, but hardly detectable

below 150 m depth. Chlorophyll maxima off Oman and Yemen were 1/10 of the values measured during upwelling.

Plankton concentrations and dissolved silica in the Somali Basin showed a strong N-S pattern with high near-shore values. Multi-net plankton tow results showed that plankton subsurface maxima rather than surface concentrations measured the upwelling effect.

Two strings of sediment trap moorings were recovered, deployed since June 1992, and consequently covering an entire upwelling and non-upwelling season. Particulate matter fluxes were twice as high at the shallow station (1533 m) in the NE Somali Basin, underneath the core of the upwelling, as at the deep station.

Pore-water studies showed that the sediments of the Somali Basin were almost completely anoxic. NH4+ pore-water concentrations suggest highest input of organic carbon at the shallowest stations. Pore-water profiles, however, suggest that even at the deepest stations the input of organic carbon is high compared with normal open ocean conditions. So far, no distinct seasonal trends in carbon mineralization could be indicated. Benthic oxygen consumption was high at all stations along the Somalia transect. No seasonal effects could be observed in the benthic fauna except a distinctly higher amount of flagellates in February than in August.

Limited seismic and acoustic recording off Somalia showed that the upper Somalia continental margin is cut by semi-vertical strike slip faults, also affecting recent sediments. This results in locally very irregular bottom topography with up to 300-m-deep incisions. The sedimentation pattern in these incisions indicates that sediment transport is mainly parallel to the coast.

Sediment cores indicate cyclic variations in carbonate content.

Overall, the success of the Netherlands Indian Ocean Programme was as large as that of her predecessor in 1984/1985, the Snellius-II Expedition. Due to the skill of NIOZ/SOZ technicians and the ship's crews, all major items of the programme were accomplished and most cruises executed according to schedule, with harbour stops of only 3 days in between cruises. The diverse programmes could not have been done so efficiently without such a flexible platform as 'Tyro', with the scientific crews benefiting enormously from the dedicated containers and winches, and the huge storage capacity. RV 'Tyro', loaded with geological and biological samples, returned to Texel at the end of March 1993. Results from projects B, C and D will be presented at an international workshop at NIOZ in January 1995. There is much interest from the USA, Canada, India, UK, Germany, and other countries involved in the JGOFS Arabian Sea Process Study 1994/1995. The Netherlands has been asked by the JGOFS Indian Ocean Planning Group to consider returning to the Indian Ocean in summer 1996, to add a third year of observations. Discussions about a possible Second Netherlands Indian Ocean Programme 1996/1997 have started, but realization will also depend on the feasibility of keeping RV 'Tyro', now 26 years old, in operation.

1.2. CHEMICAL OCEANOGRAPHY (H1)

INTRODUCTION

The department continued its work in the following main themes of research:
- biogeochemistry of carbon, nitrogen, phosphorus, sulphur, and oxygen, and early diagenesis in sediments.
- distribution and role of trace metals in the oceans.
- mass balance of carbon in pelagic surface waters.
- the behaviour and effects on organisms of metals and organic contaminants.

In 1993 a substantial amount of field work related to these themes was carried out in the north-west Indian Ocean (NIOP), the Southern Ocean (JGOFS), the Adriatic Sea (EC-STEP), the European shelf-slope-abyssal plain system of the Celtic Sea (OMEX; EC-MAST), and in the North Sea (BLOOM). In the coming years our participation in Southern Ocean cruises on board the German RV 'Porarstern' and the French 'Marion Dufresne' will continue, while also OMEX cruises are foreseen for the next three years. The participation in the NOP-VvA Theme 4 programme will be associated with cruises in the North Sea.

In collaboration with J. Gundersen, R. Glud and B.B. Jørgensen a European symposium was organized on the status and future of benthic lander technology. This meeting was held at the Max Planck Institute for Marine Microbiology, Bremen from 8 to 10 November. The meeting on benthic landers will be organized at NIOZ in 1995.

H1-01a NUTRIENT ANALYSES

K. Bakker, J. van Ooijen, A. van Koutrik, E. van Weerlee

On-board nutrient analyses were carried out during expeditions (NIOP, JGOFS, BLOOM, OMEX) and also for a great number of laboratory projects (*e.g.* BEWON, INP-mooring, Mesocosms). About 7500 samples were analysed. We participate in the intercomparison programme organized by the EC (QUASIMEME).

Applications of new analytical techniques for the TRAACS auto-analysers were development for sulphate, dissolved organic carbon (DOC), low level nitrate & nitrite, and for small sample volume (<100 µl) ΣCO_2.

H1-01b PHOTOLYSIS AND BIODEGRADATION OF FLUORESCENT XENOBIOTIC SUBSTANCES

J. den Das, M.H.A. Dekker, W. Helder

In this ongoing EC-MAST programme (in co-operation with Rijkswaterstaat-DGW), a new HPLC method based on direct injection of large volume (1-5 ml) samples and subsequent separation by ion-pair chromatography was initiated and validated. This technique will be applied in experiments on the photolytic degradation of rhodamines.

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

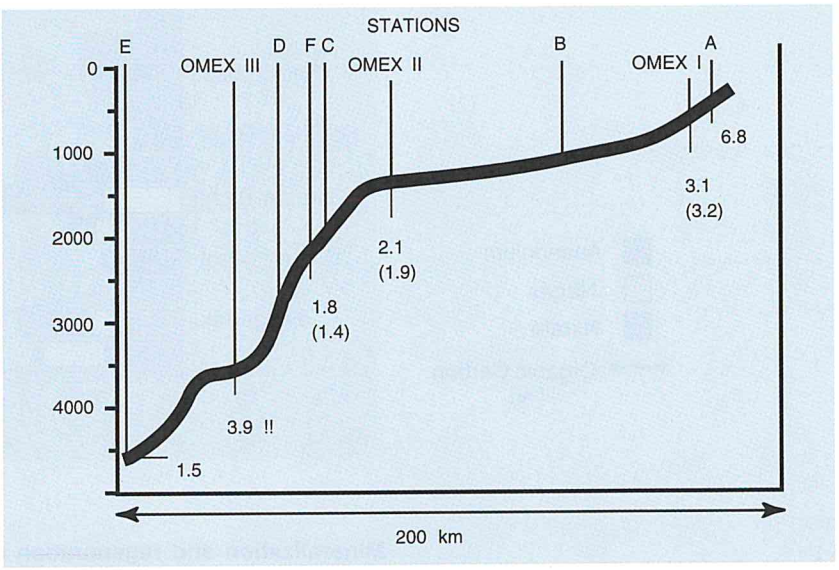
E. Epping, W. Helder

Research has focused on the improvement and application of the diagenetic model to describe the distribution of oxygen in photic sediments. The model provides a tool to estimate oxygen consumption and production from oxygen

profiles as measured *in situ*. By stoichiometric conversion carbon budgets can be calculated from these estimates. The model has been applied to a microbial mat on the island of Texel, an intertidal flat system and, in collaboration with K. Buis (NIOO-CL), to Lake Gooimeer. An interesting result is that light enhanced respiration can be observed in benthic primary production. Comparing results from the microbial mat with data obtained by B.B. Jørgensen (Max Planck Institute for Marine Microbiology, Bremen) from a microbial mat in Guerrero Negro (Mexico) reveals that the penetration depth may significantly increase, thus enlarging the volume of oxygen consuming sediment, or the volumetric oxygen consumption may be enhanced due to photosynthetic activity, without alteration of the penetration depth. These oxygen and carbon dynamics are important for proper interpretation of nitrogen and sulphur processes, as many of these are under redox control.

In February and May we participated in one-week North Sea cruises (see NECEM, R. Osinga) in order to calculate oxygen, nitrogen, sulphur and carbon budgets for three stations: Broad Fourteens, Frisian Front and Oyster Grounds.

From 11 to 31 October the Ocean Margin Exchange (OMEX) cruise at Goban Spur was attended (RV 'Pelagia'), to calculate carbon budgets along a transect perpendicular to the shelf edge, using standard techniques for pore-water analysis. This area can be qualified as a high energy benthic boundary area with near-bottom currents of up to 40 $cm \cdot s^{-1}$, and may constitute a hot spot for sediment carbon transport from the shelf to the abyssal. A new diffusion-reaction model was developed to fit oxygen profiles as measured *in situ* by application of TROL. Oxygen fluxes towards the sediment as calculated from the model were in good agreement with bell-jar and deck incubations. Oxygen fluxes decreased from 6.8 mmol O_2 $m^{-2} \cdot d^{-1}$ at 200 m water depth to 1.5 mmol O_2 m^{-2} d^{-1} at 4460 m. The OMEX III station, however, showed an increase in oxygen flux relative to this trend and was tentatively identified as a deposition area. At first glance, porewater data are at least in a qualitative way in accordance with the data on vertical oxygen distribution.



O_2 fluxes calculated from TROL profiles ($mm \cdot m^{-2} \cdot d^{-1}$); figures between brackets are values from *in situ* incubations.

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

Benthic nitrogen cycling in North Sea sediments

L. Lohse, W. Helder, W. van Raaphorst, R. Kloosterhuis, H. Malschaert

Results obtained from the BELS cruises in August 1990 and February 1991 (see also S-01a) were evaluated, and the study on the interaction of benthic denitrification and nitrification rates in coastal and offshore areas was completed.

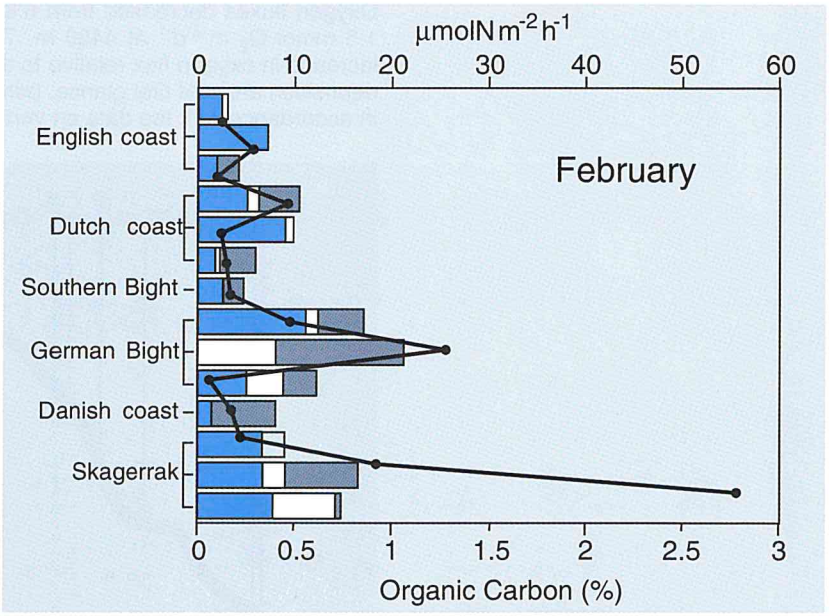
Estimates of the role of North Sea sediments in nutrient turnover indicate that on the basis of sediment-water exchange rates of dissolved inorganic nitrogen compounds, and porewater profiles, three areas can be distinguished:

—Areas characterized by permanent deposition of particulate organic matter from the water column (*e.g.* the German Bight). Here, depth integrated nitrogen mineralization rates correspond to 70% of the primary production occurring in the water column, indicating the important role of coastal sediments for nitrogen mineralization.

—Areas, where cycles of temporal deposition and resuspension take place (*e.g.* the Oyster Grounds). Here benthic nitrogen mineralization rates account for 5 to 15% of the primary production in the overlying water.

—Areas, where no obvious input of organic matter takes place; there is no indication of nitrogen mineralization.

Fluxes and profiles were correlated to the transport of suspended matter in the North Sea. From this the following scenario was derived: particulate material is transported with the residual currents from the south-western to the north-eastern North Sea. As long as the material stays in the southern North Sea only temporal deposition and subsequent resuspension occur. The first long-term sink for relatively fresh organic material represents the depositional area in the German Bight. However, also here, part of the material may be resuspended and will be transported along the German and Danish coast. The Skagerrak and the Norwegian Sea are the final sink. In contrast to organic material deposited in the German Bight, the bulk of material deposited in the Skagerrak is more refractory due to mineralization during transport.



Cumulative dissolved inorganic nitrogen fluxes (bars) in µmol $N \cdot m^{-2} \cdot h^{-1}$. The stations are plotted in a sequence which corresponds to the general transport of suspended matter in the North Sea.

Mineralization and regeneration of organic carbon in the coastal North Sea

H. de Heij, W. Helder

The aim of this VvA Theme 4 project is to study the mineralization of organic carbon in the sediments, particularly in deposition areas, the reduction of oxygen, nitrate, manganese, iron and sulphate and the influences of these reduction processes on the cycling of nutrients and trace metals.

Preparations have been made for three cruises on the North Sea in 1994.

A flow-injection method using a gas permeable membrane for measuring total carbon dioxide in small samples (20-100 µl) originating from pore waters and bell jars has been developed.

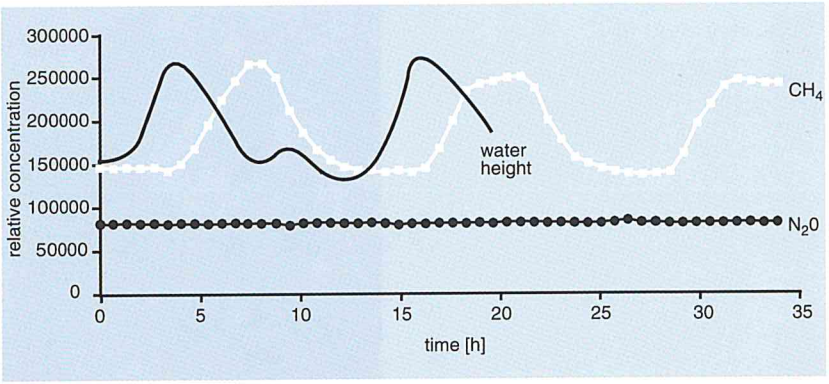
Water/atmosphere exchange of N_2O and CH_4 in marine systems

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

N_2O (nitrous oxide) and CH_4 (methane) contribute to global warming; nitrous oxide also contributes to ozone depletion. In order to understand the present, and predict atmospheric concentrations of these greenhouse gases, it is necessary to quantify all sources and sinks. This NOP-funded project focuses on the biochemical production and consumption of N_2O and CH_4 in the marine environment, as well as on the extent of N_2O and CH_4 air-sea exchange.

Within the framework of the international Air Sea Gas Exchange Experiment (ASGASEX) air-sea fluxes of N_2O and CH_4 were measured on a platform in the North Sea, 9 km west of Noordwijk. Concentrations in both surface water and atmosphere were monitored during September 1993. Generally surface waters were slightly supersaturated with N_2O while CH_4 was up to 60 times supersaturated. The resulting sea-to-air fluxes were calculated by multiplying the gas saturation data set with exchange coefficients based on wind-speeds registered by the Royal Netherlands Meteorological Institute (KNMI). Additionally CH_4 fluxes were determined independently from concentration gradients in the atmosphere above the sea surface.

A time series of the surface water CH_4 concentration shows a strong relation with tide, suggesting that the CH_4 originates from riverine input. This was confirmed by N_2O and CH_4 measurements on the Scheldt river and estuary made in collaboration with J. Middelburg, NIOO-CEMO Yerseke.



Relationship between dissolved gases and tide at Meetpost Noordwijk.

Carbon mineralization and oxygen consumption in northern Adriatic sediments

W. Helder, M.H.A. Dekker, R.F. Nolting, R. Kloosterhuis, A. van Koutrik, T. Tahey

This EC-STEP project is carried out in co-operation with NIOZ Department of Benthic Systems and the Marine Geology Department of the Italian Consiglio Nazionale delle Ricerche (CNR) in Bologna.

Following the first cruise in March 1992 a second cruise was carried out in August 1993. Emphasis was on *in situ* measurements of sediment-water oxygen profiles by the oxygen profiling lander (TROL), *in situ* measurement of sediment-water fluxes of oxygen and nutrients by the benthic chamber lander (BOLAS), and on pore-water profiles of redox indicators (nitrate, dissolved Fe, dissolved Mn). Analyses of solutes were carried out on board. Analyses of solid phase parameters (organic C, N, biogenic Si, particulate Mn, and particulate Fe) are now being done on Texel and in Bologna. A preliminary comparison of sediment oxygen consumption rates as calculated from oxygen profiles and from *in situ* and on-deck sediment incubations suggests that organic carbon mineralization rates were significantly higher in August 1993 than in March 1992.

Tracing a seasonal upwelling (NIOP leg C2)

Sediment biogeochemistry

W. Helder, R.F. Nolting, T. Tahey, G.J.A. Brummer, R. Kloosterhuis, J. van Ooijen, K. Bakker, A. van Koutrik

From 9 February to 7 March 1993 we participated in NIOP leg C2. Boxcores from three transects perpendicular to the coasts of repectively Yemen, Oman, and Somalia were analysed for porewater chemistry. All analyses were carried out on board. Solid phase samples were taken to the Texel laboratory and are currently being analysed for org. C/N, $\partial^{13}C$, and metal contents. At selected stations the oxygen profiling lander TROL was deployed for *in situ* measurement of oxygen porewater profiles.

Preliminary results indicate that despite the high organic carbon content of the sediment (up to 3%) mineralization of organic C is slow, probably because of the low oxygen concentrations in overlying bottom water. The sediment reveals relatively high values of $\partial^{13}C$, going from $-21^{0}/_{00}$ in coastal surface sediments to $-15^{0}/_{00}$ at depths of 5 cm. The enrichment with depth of C13 might be connected with fractionating diagenetic processes (methanogenesis). This hypothesis will be further elaborated in co-operation with the Department of Marine Biogeochemistry where analyses of specific organic molecules and their $\partial^{13}C$ content will be performed.

The comparison of porewater profiles and of calculated sediment-water fluxes from leg C1 (August 1992) and leg C2 (March 1993) indicates that there are no significant differences between an upwelling and a non-upwelling season.

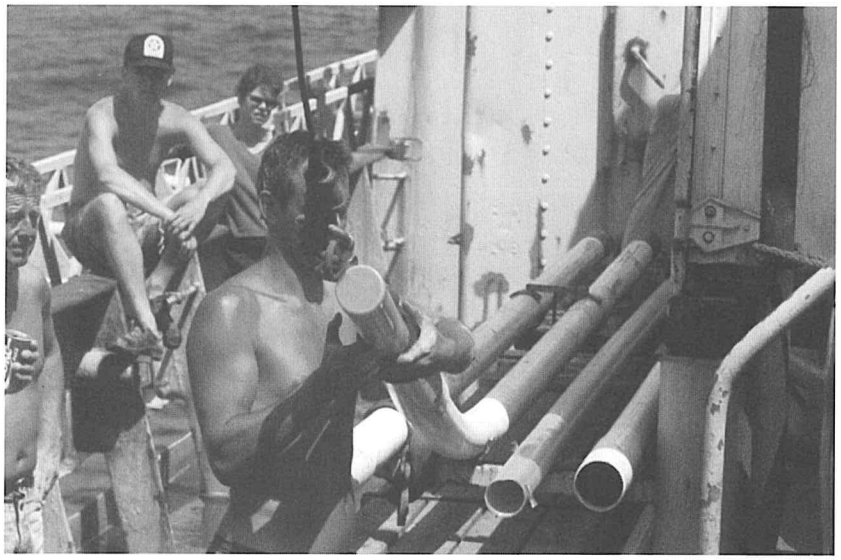


Photo: A. van Koutrik

A piston core should be straight ...!

Downward fluxes of particulate carbon

Particle fluxes intercepted by deep-moored sediment traps within the JGOFS North Atlantic programme at 47°N, 20°W allowed for tracing a pronounced flux maximum in the deep ocean (at 1025 m) to an earlier bloom of a calcareous coccolithophorid alga in surface waters. Apparently, the organic and carbonate carbon export production occurs in a single sharp pulse which settles out at a rate of about 170 m d^{-1}, while mineralization of the faecal pellet and aggregate material selectively takes its toll. Given a residence time *ca* 25 days in the water column at the 4000-m-deep-site, most of the organic bound phosphorus will have been released but the carbonate carbon appears unaffected before arriving at the sediment-water interface. Research was carried out jointly with M. Knappertsbusch (GCMA/ETH-Zürich), who did the coccolith work.

Two arrays with three sediment traps each have recently been recovered after an 8-month deployment in the northwestern Somali Basin as part of the NIOP-JGOFS effort. Current velocity, inclination and pressure measurements

collected quasi-continuously on the arrays during their deployment show that favourable conditions prevailed with respect to sediment trapping as a result of a modified array design. Nutrient and oxygen concentrations and pH measurements show that the newly applied pH-buffered biocide solution administered to the collecting cups prior to launching the traps has adequately minimized mineralization during deployment. During the SW monsoon period (July-October) massive fluxes were intercepted by the traps on the Somali continental margin that were within range of the coastal upwelling zone proper, whereas those moored in the deep Somali Basin outside that zone were lower by about a factor of two. During the NE monsoon period (November-March), fluxes were uniformly low at both sites, reflecting the low levels of new production that typify the non-upwelling situation. Preliminary results suggest that a substantial portion of the carbon fluxes produced by coastal upwelling are carried towards the deep Somali Basin while settling to the ocean floor. Water column and bottom sediment data collected at both sites during the five NIOP cruises within the B and C subprogrammes should allow for a comprehensive reconstruction of processes governing the (re)mineralization and burial of carbon and associated elements in the Somali upwelling area as a function of time.

H1-06a ANALYTICAL ORGANIC CHEMISTRY

M.Th.J. Hillebrand, K. Booij, E. van Weerlee, J.P. Boon (BEWON)

The quality assurance and quality control programme for the analysis of polychlorinated biphenyls (PCBs) has been extended to chlorinated pesticides. An increasing number of steps in the analysis have been formalized in Standard Operating Procedures (SOPs) that form a blueprint for future work on the analysis of other compounds. Validation of the methods applied was constantly controlled and maintained through the regular analysis of certified reference materials and the use of control charts. As a result of these efforts, the performance of the laboratory in intercomparison exercises (ICES/IOC/ OSPARCOM) has been greatly improved and the laboratory was invited to become a core laboratory for PCB/pesticide analysis in the European Community QUASIMEME programme.

The joint development and testing of the chromatography software Pandora is nearly finished. The programme includes simultaneous acquisition of 8 channels, integration, identification and quantification, reporting and the construction of control charts.

The existing problem of insufficient separation of co-planar CBs was tackled by the installation of a two-dimensional GC.

Preparations were made for the routine GC/HRMS analysis of PAHs.

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

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

The anthropogenic load on the world oceans impairs physiological functions of individual organisms and affects the ecological status of ecosystems. In particular, estuarine and coastal systems showing high biological activity are exposed to a high degree of contamination. Cyclic chlorinated hydrocarbons, such as industrially synthesized polychlorinated biphenyls (PCBs) are ubiquitous contaminants in the marine environment. Measuring the concentration of contaminants in water, sediment and biota gives information about the fate of contaminants once present in the aquatic system. In our studies, concentration levels of contaminants are analysed in relation with biological responses (biomarkers) measured in the same organisms (see also H1-07).

In the framework of the Integrated North Sea Programme (INP), theme Microcontaminants, samples were collected during two surveys with RV 'Pelagia' in the Southern Bight and the central North Sea in 1991 (26 August - 13 September) and 1992 (18 May - 6 June). The results of the analyses of selected toxic individual chlorinated biphenyl (CB) congeners in the pyloric caeca of seastars (*Asterias rubens*) indicate distinct gradients along transects radiating into the southern North Sea from the coastal areas of the Netherlands: Highest concentrations in specimens collected from near-coastal areas

in the Southern Bight and lowest concentrations in specimens from the open sea sampling locations.

The concentrations of tri-CB28, tetra-CB52, penta-CBs 101 and 118, hexa-CBs 153 and 138, and hepta-CB180, in the pyloric caeca of seastars from a number of coastal sampling locations were a factor of 2 higher during the second survey. In addition to the seven CB congeners mentioned and selected as indicators in several countries, a number of toxic congeners such as the non-ortho tetra-CB77 and penta-CB126, and mono-ortho penta-CB105 and hexa-CB156 were considered as well. Their concentrations are in proportion to the congener with highest concentration (CB153), and reflect the concentrations in the technical PCB mixtures.

Samples of benthic macro-invertebrates collected during two surveys along transects into the Indian Ocean perpendicular to the Kenyan coast are being processed and analysed for PCBs and pesticides. Surveys were made in the framework of the study of the coastal ecosystems of Kenya (Project A of the Netherlands Indian Ocean Programme 1990/1995), in order to distinguish the pathways of contaminants in the coastal zone and along the continental slope into the deep sea. Processing of the samples was partly done on board RV 'Tyro'.

H1-07 BIOLOGICAL MARKERS OF ENVIRONMENTAL CONTAMINATION

J.M. Everaarts, J. Oosthoek

To assess the quality of the (marine) environment it is crucial to evaluate the impact of chemical substances in terms of molecular toxicological responses that reflect the impairment of physiological and biological processes in organisms. If toxicological effects are to be used to asses environmental health or marine environmental risks, it is obvious that the research on biological markers is most relevant, since it includes the determination of the physiological status of organisms. Biological markers (or biomarkers) have been defined in many ways and the implementation of biomarker-based studies in ecotoxicological research and environmental monitoring programmes is increasing.

The objectives of recent ecotoxicological research are the development and application of selected molecular and biochemical responses in a number of marine animal species, in order to estimate the status of the system with respect to homeostasis or compensation phase, or to predict possible departures from health. Biomarkers involved in the present research are genetic damage (DNA integrity: number of double strand breaks in DNA) and induction of detoxifying systems (Cytochrome P450 dependent monooxygenase (MO) enzymes).

Samples collected in the framework of the Integrated North Sea - Microcontaminant Programme (1991 and 1992) were analysed (see also H1-06b). During the surveys, specimens of the flatfish *Limanda limanda* (dab) and the asteroid echinoderm *Asterias rubens* (seastar) were collected at sampling locations along transects radiating into the North Sea from the coastal zone of the Netherlands. In homogenates of liver tissue from male dab and the digestive gland (pyloric caeca) of female seastar DNA damage (strand-breaks) and MO induction were determined. Areas could be indicated with significantly increased strand-breaks (lower integrity) both in dab and seastar. However, enhanced DNA strand-breaks do not correspond with contamination gradients of polychlorinated biphenyls or polyaromatic hydrocarbons.

MO enzyme induction in the hepatic 13000×g fraction of male dab, measured as EROD activity, was significantly enhanced in response to low ambient temperatures. Some evidence was found for the facilitation of BPH activity expressing the enzyme induction in the microsomal fraction of pyloric caeca of seastars, at increasing PCB concentrations.

It can be concluded that there is some increase in DNA strand breaks (lower integrity) in specimens from coastal areas in the Southern Bight. However, so far no correlation has been found with the concentration of certain CB congeners with a dioxin type toxicity, such as the non-ortho CBs 77, 126 and 169 and the mono-ortho CBs 105 and 118.

DNA integrity and enzyme induction elucidate the physiological status and might be indicative of ambient impairment, within restricted areas, and not necessarily related to the presence of anthropogenic or xenobiotic substances.

H1-08 HEAVY METALS IN THE MARINE ENVIRONMENT

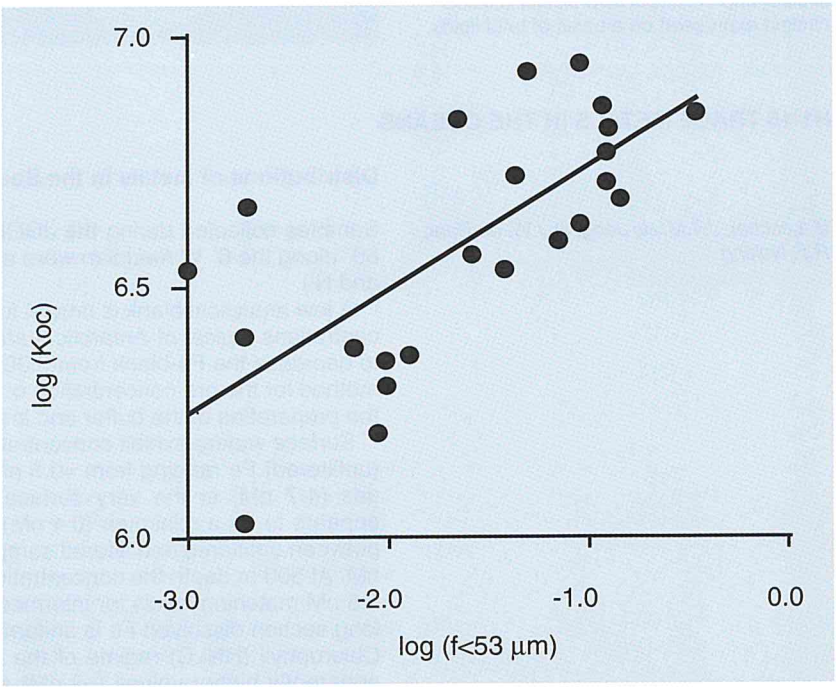
J.M. Everaarts, J. Nieuwenhuize (NIOO-CEMO)

Surface sediments and epibenthic invertebrates collected in the Kenyan coastal ecosystem and continental slope into the deeper parts of the Indian Ocean (Project A of the Netherlands Indian Ocean Programme 1990/1995) have been analysed for heavy metals (Cd, Pb, Cu, Fe, Mn, Zn). Evaluation and interpretation of the analytical data justify some preliminary conclusions. The concentrations of Cd (µg/g dry weight) in bulk surface sediment increases from 0.04 - 0.12 µg/g DW at most coastal stations (±20 m depth) to 0.18 - 0.28 µg/g DW at deep sea stations (±2000 m depth). These gradients (in the same concentration ranges) were found both during the south-east and north-east monsoon periods. For the other elements, except Pb, concentration gradients in opposite direction are evident. The concentration of Cd in organisms is significantly above baseline levels, varying from 1.0 - 31.1 µg/g DW in various species. Contrarily, Pb shows very low concentrations in all species investigated, varying from 0.2 - 2.2 µg/g dry weight. The concentrations of both Cu and Zn are at baseline levels or a little elevated, depending on species.

H1-09 EXCHANGE OF ORGANIC CONTAMINANTS BETWEEN SEDIMENT AND WATER

K. Booij

The mass fraction of organic carbon in sediments is commonly considered to be the factor that governs the sorption of hydrophobic contaminants between sediment and water. Thus, the sediment-water partition coefficient normalized on the fraction of organic carbon (Koc) is considered to be independent of sediment characteristics. The validity of the Koc concept was tested for sediments from the southern North Sea. It was shown that Koc values for fine-grained sediments are significantly higher than for coarse sediments. These results suggest that the composition of the organic fraction depends on the grain size of the sediment.



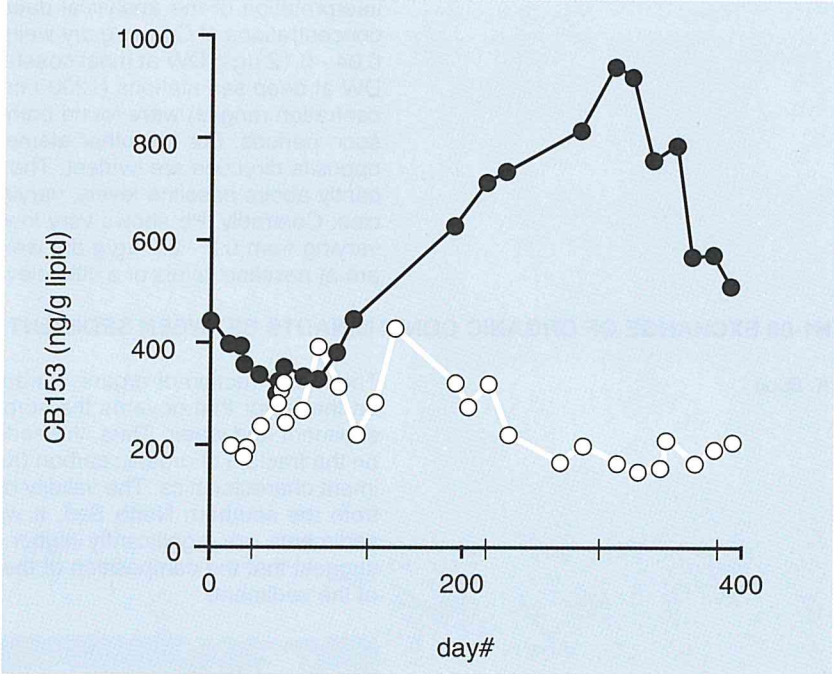
Sediment water partition coefficients normalized on organic carbon (Koc) for 2,2',4,4',5,5' hexachlorobiphenyl (CB153) *versus* the fraction smaller than 53 µm.

H1-14 DYNAMICS OF CONTAMINATION

K. Booij

The analysis of annual variation of PCB concentrations in sediments and in benthic invertebrates collected on the tidal flats in the western Wadden Sea was completed for two species. On a lipid basis, PCB concentrations in *Nereis diversicolor* were two times higher than in *Arenicola marina*. PCB levels in *N.*

diversicolor also showed a more distinct seasonal variation. Since both organisms were exposed to the same concentrations in the water phase, these differences probably reflect differences in lipid composition, feeding behaviour, and life cycle characteristics. The analysis of surface sediments and two other invertebrate species is under way.



Concentration of 2,2',4,4',5,5' hexachlorobiphenyl (CB153) in *Arenicola marina* (open circles) and in *Nereis diversicolor* (closed circles) expressed on a basis of total lipids.

H1-15 TRACE METALS IN THE OCEANS

Distributions of metals in the Southern Ocean

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

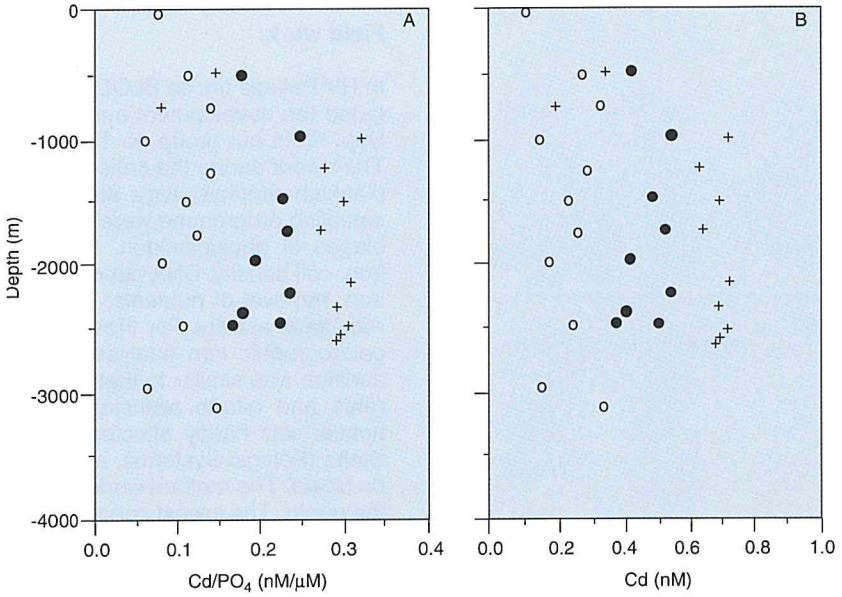
Samples collected during the JGOFS expedition 'Frühling im Eis' from 47° to 60° along the 6° W meridian were analysed for trace elements (Fe, Cd, Zn, Cu and Ni).

A low analytical blank is crucial for the determination of the very low Fe-concentrations typical of Antarctic surface waters. With great effort we were able to decrease the Fe-blank from 0.38 nM to 0.08 nM by improving the extraction method for the pre-concentration of the trace metals. This involved a change in the preparation of the buffer and leaving out the back extraction.

Surface waters exhibit concentrations of dissolved (0.4 µm filtered) and total (unfiltered) Fe ranging from ≈0.5 nM to ≈2.5 nM, with occasionally higher values (4-7 nM) in the very surface layer. At stations analysed so far there appears to be a minimum (0.4 nM) in the 50-100 m depth range. Differences between unfiltered and filtered samples suggest particulate Fe levels of 0.2-1.5 nM. At 300 m depth the concentrations tend to increase to values of about 1.5-2.5 nM matching levels for intermediate and deep water. Along the ≈1000-km-long section dissolved Fe is uniformly low at ≈0.5 nM in the High Nutrient Low Chlorophyll (HNLC) regime of the Antarctic Circumpolar Current (ACC), with apparently higher values (≈2 nM) at the Polar Front where plankton biomass was also higher. Similarly, total Fe increases from ≈1 nM in the barren ACC to ≈3.5 nM in the Polar Front. Apparently the faster eastward flow of the ACC at the Polar Front allows the higher total Fe values typical of the Scotia Sea to be maintained even east of the Sandwich Islands. Such high levels may be attributed to input from the Antarctic peninsula and the South American continent. The sea-ice does exhibit tenfold higher Fe concentrations (≈20nM) with even higher levels in the brine (≈65 nM) and surface snow (30-50 nM). However,

there is no indication of elevated Fe in seawater at the retreating ice-edge judging from the absence of low-salinity melt water lenses. The subnanomolar dissolved Fe concentrations may limit rates of phytoplankton growth, but this does not necessarily imply a direct relationship with algal biomass in this HNLC environment.

The Fe concentration in the deeper water masses increases from north to south beginning with about 1.0 nM at 50°S to about 2.8 nM at 58°S. This can be explained by input from the mid-ocean ridge and the shelves around Antarctica. Cd concentrations show the same trend, and increase from north to south from about 0.25 nM as reported for Atlantic waters to about 0.70 nM as reported for Pacific and Indian waters. The Cd/PO4 ratio increases in the same direction from about 0.1 nM/µM as found in Atlantic waters to about 0.3 nM/µM as found in Pacific and Indian waters. Thus Cd concentrations suggest that in the ACC at 6°W in the direction of the Antarctic continent, Atlantic water is gradually replaced by water of Pacific/Indian ocean origin. The Cu concentration shows no significant trend from north to south. It increases with depth, varying from 1.0 nM to 3.4 nM. The Cu/Si ratio remains constant at about 0.025 nM/µM. This is similar to ratios found in the Scotia Sea. The Zn and Ni concentrations vary from 6 to 8 nM and from 3.5 to 6.8 nM. The Zn/Si ratio is 0.053 nM/µM as also reported for the Pacific Ocean.



Cd/PO_4 ratio (A) and CD concentrations (B) along the 6° meridian.
o=48°41'S
●=50°01'S
+=53°58'S

The role of iron and other trace elements in oceanic ecosystems

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

Field studies performed in October/November 1992 (by M. van Leeuwe, R. Scharek (AWI), J. de Jong and H. de Baar) emphasized the importance of iron as a micro-nutrient for phytoplankton. Low concentrations of iron in the Southern Ocean (<2 nM) limit phytoplankton growth. The effect of iron on pigment synthesis was investigated in the laboratory by M. van Leeuwe, using cultures of *Pyramimonas* sp. (an Antarctic flagellate). Basic growth parameters (growth rates, cell yield) and additionally iron contents and pigment composition of the cell in response to different iron concentrations are being studied. Several changes occur as the cells are iron-depleted; growth rates decrease, resulting in a lower cell yield compared to algae growing under iron-sufficient conditions. Chlorophyll synthesis is inhibited and ratios between the different pigments shift. Future research involves the influence of iron on photosynthesis. Trainee D. Zuurbier under guidance of M. van Leeuwe prepared a literature study on the bioavailability of the various chemical forms of iron in seawater.

The laboratory research of K. Timmermans concentrated on effects of iron on phytoplankton ecophysiology, with emphasis on the nitrogen metabolism

and iron quota in several species of marine phytoplankton. The observations of reduced growth rates at low available iron concentrations were linked with reduced nitrate uptake rates. Reduced iron concentrations hardly affected ammonium uptake. The results confirm the hypothesis that iron, through its effects on the nitrogen metabolism, can affect the presence of new or regenerated production. To investigate the nitrate assimilation in greater detail, a nitrate reductase activity bioassay was developed and optimized. It was demonstrated with this bioassay that cells grown at low iron concentrations had reduced enzyme activity. By addition of iron, the nitrate reductase activity could be induced.

Considerable progress was made by trainee A. Buijs and K. Timmermans in the research on iron quota in marine phytoplankton. An ultraclean filtration method was developed. In addition, a washing procedure, in which the externally adsorbed metal was removed from the phytoplankton cells, was introduced as a standard method. Titanium (III) citrate EDTA proved to be a potent chelator, capable of removing all externally adsorbed metals and leaving the cells intact.

H. de Baar studied the impact of the Law of the Minimum (J. von Liebig, 1851) on the development of plankton ecology in the 19th and 20th centuries, with emphasis on all research ever done on limitation of marine productivity by iron or carbon dioxide.

Field work:

In RV Pelagia cruise BLOOM 1993, fifteen phytoplankton investigators investigated the development and senescence of algal bloom in the northern North Sea. From our group, K. Timmermans, A. Buijs and R.F. Nolting participated. Their work during the cruise focused on the effects of iron additions on phytoplankton ecophysiology. Short-term incubations (32 hours) with a very intense sampling programme were performed. Upon addition of iron to natural assemblages of phytoplankton, the following parameters were studied: dissolved iron, cell density, DNA per cell, externally adsorbed and internally incorporated iron, removal of nutrients, ^{15}N-nitrate and ^{15}N-ammonium uptake and nitrate reductase activity. For these cultures M. Gledhill (University of Liverpool) did polarographic iron analyses on board. The phytoplankton response to iron addition was similar to that seen in the laboratory experiments. Nitrate uptake rates and nitrate reductase activity were enhanced, whereas ammonium uptake was hardly affected after the iron additions. In co-operation with W. Stolte (Pelagic Systems), a new low-level ammonium analysis was performed on board. The method worked very well and resulted in consistent profiles over the depth. The lowest concentrations measured were 50 nM.

Seawater samples for trace metal determinations were collected by R.F. Nolting at 19 stations inside and outside the algal bloom. All samples were collected from a rubber boat with an especially designed Teflon coated winch with Teflon cable, at 6 depths, from the surface to 70 m. Small 1.7 dm^3 well-cleaned Go-Flo bottles and Teflon messengers were used. Iron (III) and labile iron were determined on board ship as soon as possible after sampling by Cathodic Striping Voltammetry, to avoid alteration in speciation. Other elements like Cu, Cd, Zn, Ni, Pb and again Fe are analysed at the institute with Atomic Absorption Spectrometry after an extraction procedure.

The possibility to analyse ambient iron concentrations in virtual real-time on board was very stimulating. Extremely low iron concentrations were found, between 0.3 and 2.5 nM. At all bloom stations iron profiles showed a significant minimum at 20 to 30 m where primary productivity was highest and nitrate and phosphate were depleted. Below the thermocline, where there was a strong increase in nutrients and decrease in fluorescence, the labile iron concentration also increased. Surface samples had higher labile iron concentrations, this may be due to lower biological activity in the upper few metres, but atmospheric input cannot be excluded. In contrast to the apparent correlation of iron with nutrients, the incoming Atlantic waters show a different pattern with high nutrient concentrations and low iron concentrations of less than 1 nM. Low salinity waters in the Norwegian Trench showed higher iron concentrations (1.5 to 2nM). The concentrations below the halocline were comparable

with those found in Atlantic waters. South of the bloom where the nutrient concentrations were still low, higher iron concentrations of 1-2 nM were observed and the distinct minimum at 20-30 m was absent. Iron (III) was found to have a similar distribution pattern to labile iron with lower concentrations sometimes being observed in the surface waters. In most cases iron (III) represents more than 90% of the labile iron. Iron does not seem to be a limiting element for primary production in the southern North Sea.

The copper concentration in the surface layer was around 1.5 nM and only at the station in the Norwegian Trench was a concentration of 3 nM found. Vertical copper profiles did not show any variation with depth or covariation with the nutrients. Concentrations are rather constant at 1.5 to 2.0 nM. Cadmium concentrations were rather low (10-25 pM) in the southern part of the research area contrary to the northern part (50 to 75 pM). In some profiles the cadmium concentrations showed a minimum at 20 to 30 m. Due to the very low cadmium concentrations (below 100 pM) significant trends could not be observed.

Global distributions

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

In collaboration with P.M. Saager (Free University, Amsterdam) a simulation model of the distributions of Cd (cadmium) and phosphate during modern (interglacial) and glacial times has been completed.

Scientific Programme on Arctic and Siberian Aquatorium (SPASIBA)

R.F. Nolting, W. Helder

Budget calculations, based on the solid discharge and trace metal content in the suspended particulate material, show that the yearly supply of trace elements by the Lena river is rather low: copper 460 $t \cdot y^{-1}$, lead 616 $t \cdot y^{-1}$, cadmium 23 $t \cdot y^{-1}$, nickel 422 $t \cdot y^{-1}$ and zinc 3168 $t \cdot y^{-1}$.

The rather high manganese concentrations (2500-5500 $\mu g g^{-1}$), which are found in the vicinity of Kotelny Island east north-east from the Lena mouth, can be explained by remobilization processes. Due to the existing bottom current direction, manganese reduced in sediments close to the river mouth can be oxidized again when it escapes to the water column. It is transported to another place where the process can start again. Finally the manganese is accumulated in the deeper part of the Laptev Sea, an area surrounded by islands and shallow waters.

The C/N ratio shows a clear decrease from a value of 13 in the river mouth to 9 in the more northern part of the Laptev Sea. Calculations with this C/N ratio show that 58% of the organic carbon in the sediment in the river mouth is of terrestrial origin, while this is 36% in the more marine part of the Laptev Sea.

River inputs to the Mediterranean Sea (EROS-2000)

R.F. Nolting, W. Helder

Sediment and interstitial water samples collected during the 1988 (RV 'Discovery') and 1991 (RV 'Tyro') cruises were analysed. Now the whole NW Mediterranean Sea research area is covered, with samples collected during 4 expeditions from 1987 to 1991. With respect to the horizontal distribution of solid phase trace metals in the upper layer of the sediment, the earlier presented division of the NW Mediterranean Sea into 5 different areas has proved to be correct. Sediments close to the Rhone river reflect input of cadmium, copper, zinc and lead by this river. Sediments further away from the Rhone still reflect the influence of this river but to a lesser extent. Sediments close to the Ebro river show the same trend, but trace metal concentrations here are significantly lower, which means that the influence of the Rhone on the NW Mediterranean Sea is higher than of the Ebro. Sediments far away from both rivers are probably not influenced by these rivers, but atmospheric input of trace metals may contribute considerably, as vertical profiles indicate. Changes in the horizontal distribution of trace metals are due to changes in sedimentary composition, which is confirmed by the major element composition in these sediments. There is a distinct change in the calcium carbonate and silicate concentration in the sediments from shallow to deeper open-sea stations. For this reason the trace metal concentrations have to be corrected and presented on a calcium carbonate free basis.

The vertical concentration-depth profiles of lead and zinc at the deep open-sea stations reflect anthropogenic inputs of these metals since the last century. In the top surface layer of these sediments the calcium carbonate content is very high (~60%), probably associated with biogenic material. If the lead and zinc concentrations in these surface sediments are corrected for their calcium carbonate content they indicate a stabilization in concentration. This suggests a reduced input, or at least a stabilization in the input of these elements to the NW Mediterranean Sea in the last few years.

Porewater profiles of the redox elements manganese and iron indicate sub-oxic conditions in coastal sediments, where the input of terrestrial organic material is high. The C/N ratio in these sediments is higher than in sediments from the deeper part of the area. Porewater profiles of cadmium, copper, zinc, nickel and lead reflect the diagenetic processes to which these elements are subjected. The porewater profiles of these metals at the stations in the deeper part of the NW Mediterranean Sea suggest that only oxic degradation of organic matter takes place. This is in contrast to the profiles found in the sediments in the shallow part of the area, where these metals are involved in manganese and iron reduction processes.

Sediment cores collected during all EROS cruises were shared with D. Cossa (IFREMER, Nantes, France), who determined mercury, R. Chester (University of Liverpool, England), for sequential extraction of metals and J.M. Martin (Montrouge, France) for arsenic and selenium determinations. DOC and DIC in the interstitial waters were determined by G. Cauwet (University Perpignan, France).

H1-17 MASS BALANCE OF CARBON IN PELAGIC SURFACE WATERS

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

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

The datasets obtained during 1989 and 1990 JGOFS cruises and 1990 and 1991 WOCE cruises, all aboard RV 'Tyro', have largely been worked out within the context of the Ph.D. thesis of Stoll. The accurate dataset for the Iceland basin allowed a first ever assignment of different TotalCO_2 concentration values for the different North Atlantic water masses. In collaboration with C. de Boer (Physical Oceanography) an estimate has been derived for the net southward transport of dissolved CO_2, presumably balanced by a net input of CO_2 from the atmosphere into northern North Atlantic surface waters. The implied net atmospheric transport from southern to northern hemisphere is thought to be representative of the pre-industrial era. This also suggests that in those days the atmospheric pressure of CO_2 was higher in the southern than in the northern hemisphere, as opposed to the modern industrial era. Understanding of these CO_2 transport terms is important towards unravelling the recent perturbations due to fossil fuel inputs.

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

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

The modern north-south atmospheric distribution of CO_2 always shows a minimum in the ~30-50 °S zone of the southern hemisphere. This led to the working hypothesis that currently the South Atlantic Ocean acts as a sink for atmospheric CO_2. The outbound and homebound cruises of RV 'Polarstern' each year to and from the Antarctic Ocean serve as an opportunity to test this hypothesis. The analogue hypotheses of the South Pacific and South Indian Oceans acting as a sink for CO_2 are just as valid but are not matched by a similar European ship of opportunity. D. Bakker and B. Majoor participated in an Atlantic traverse in January-February and another traverse was done in October-November by D. Bakker and E. de Jong. Until now 3 Atlantic traverses have been completed and the data appear to suggest the 20-40 °S zone of the Atlantic Ocean being a substantial sink of CO_2 indeed. Five more transects are scheduled till early 1995. A second phase (1995-2000) is envisioned. E. Koning (Univ. Utrecht) did a student project focusing on accurate intercalibrations

of both an Infrared CO_2 analyser and a Gas Chromatographic CO_2 analyser *versus* certified standard gases of the Netherlands Measurements Institute (NMI) as well as the US National Oceanographic and Atmospheric Administration (NOAA). E. Koning also studied the historic CO_2 data-sets of the 1928 Meteor expedition assembled by Wattenberg.

CO_2-system in the Antarctic Ocean

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

A joint research programme of the Alfred Wegener Institute and the Netherlands Institute for Sea Research has been set up by Dr. E. Fahrbach (AWI) and Prof. H. de Baar (NIOZ). NIOZ scientists will study the Antarctic CO_2 system in two cruises of RV 'Polarstern' each austral summer season. Objective is to quantify the function of the Antarctic Ocean as a source/sink of atmospheric CO_2. Each cruise typically amounts to 6-8 weeks at sea. Graduate student A.A.J. Majoor supported by one analyst will operate underway measurements of pCO_2, TotalCO_2 and ancillary data (nutrients, fluorescence, sea surface skin temperature) in surface waters. In addition pCO_2, TotalCO_2 and Alkalinity will be measured along vertical profiles at stations. As of September chemical analyst and data-handling expert E. de Jong joined our team, followed by E. Koning starting work as analyst in mid-October. B. Groenhout (University of Amsterdam) started a student project in September. The first season started with one cruise from December 1993 into January 1994 where Majoor, Groenhout and Koning participated, another cruise is scheduled in April-May 1994. Together with the CO_2 studies during the outbound and homebound cruises (see above South Atlantic CO_2) this assures that 4 out of typically 5-6 cruises of 'Polarstern' each Antarctic season will produce CO_2 data.

Dissolved Organic Matter

C.J. Wiebinga, H.J.W. de Baar, J. Hegeman

The special NWO programme Global Change has one theme JGOFS (VvA-9) where a sub-group of three graduate students investigate Dissolved Organic Matter in the oceans. C.J. Wiebinga studies the abundance and microbial turnover rates of Dissolved Organic Carbon. He took part in a cruise in the Indian Ocean (January 1993) in follow-up of participation in two cruises of this programme in 1992. During this cruise bacterial production was measured with incorporation of ^3H-labelled thymidine as well as leucine and bacterial biomass was estimated by epifluorescence microscopy. Together with J. Hegeman a data set was provided of DOC concentrations determined by three different methods. The remainder of the year was spent developing the DOC analytical methods and with the preparation of a France-JGOFS cruise in the Antarctic Ocean (ANTARES 2; February and March 1994). Therefore C.J. Wiebinga visited the Laboratoire Arago-CNRS (Banyuls-sur-Mer, France) in October to join in an intercalibration for bacterial production and biomass determinations to be carried out during the ANTARES 2 cruise. This work was done in a research team together with a Dr. J. Kuparinen (Finland) and Dr. D. Delille (France).

Parallel research of J. van Heemst and J.W. de Leeuw is focusing on the molecular composition of the organic matter. M. le Clercq, together with Van der Plicht and Meier at the Centre for Isotope Research of the University of Groningen assess the isotopic signature of the same material.

1.3. PHYSICAL OCEANOGRAPHY (H2)

INTRODUCTION

In 1993 the theoretical research in the field of non-linear dynamics of ocean circulation was continued. In particular research has been done on the dynamics of eddies on the beta-plane, stratified eddies, wind- and thermally driven ocean circulation and solitons. Mixing in tidal areas was studied as a chaotic non-linear system.

A new project was started on the study of physical and biodynamical behaviour of cohesive sediments.

The data collected during the DUTCH-WARP Programme have been analysed as well as the data collected from ARGOS drifters. The field work has shifted from the Iceland Basin towards the Bay of Biscay, where a short cruise took place. The study of processes near shelf edges has been extended from the Greenland shelf towards the shelf edge of the Bay of Biscay.

The Antarctic research is in the stage of processing the data of the JGOFS/ Southern Ocean cruise ANT X/6 (RV 'Polarstern').The data are used for modelling the structure of the water column in the marginal ice zone during the spring ice retreat. Special attention is paid to frontal features.

The participation in the Integrated North Sea project also in 1993 consisted of the operation of a mooring in the stratified water south of the Dogger Bank. Data from earlier years have been analysed and will be used in the modelling of brief interactions between stratification and biological processes.

Infrared remote sensing has been applied in the Indian Ocean Programme and the collected data have been worked out. In particular structures related to monsoons have been studied.

Optical remote sensing took place in several projects. In particular data have been collected in a project related to the future SeaWiFS satellite.

H2-01 NON-LINEAR DYNAMICS OF OCEAN CIRCULATION

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

We continued the research of the dynamics of eddies on a beta-plane, which is a local approximation of the rotating earth. New ways of constructing the beta-plane have been found. These have given deeper insight into its connection with the rotating earth. The rotational symmetry of the earth is connected with the translational symmetry of the beta-plane. Therefore it plays a part in the theory of the westward motion of eddies due to the dependence of the Coriolis force on the north-south co-ordinate. We have identified the transformation properties of the so-called beta-parameter. This has suggested the use of a new type of co-ordinate system which is to be investigated in the near future.

As a generalization to box models of the large-scale, thermally and wind-driven ocean circulation, non-linear equations describing the evolution of two vectors that characterize the state of the ocean are derived for a rectangular ocean on an f-plane. These state vectors represent the basin-averaged density gradient and the overall angular momentum vector of the ocean. Neglecting rotation, the so-called Howard-Malkus loop oscillation is retrieved, governed by Lorenz' (1963) equations. In a good approximation the resulting equations are exactly equivalent to a set Lorenz (1984) introduced to describe the 'simplest possible atmospheric general circulation model'. In contrast to the parameter

values suitable for the atmospheric general circulation, which allow for chaos to occur, those in the ocean are such that the circulation is in a steady, or at most simple periodic state.

On the basis of the formerly derived 'small beta' model of wind-driven ocean circulation, a spectral model has been devised by which a quick numerical evaluation of the stream function and the vorticity field can be accomplished. The analysis of the 'small beta' model has been further developed in order to investigate more thoroughly the inertial limit of the circulation. In this limit, which applies to small Ekman and Rossby numbers, but large Reynolds number, a unique relationship should exist between the absolute vorticity and the stream function. It has been shown that the model indeed leads to such a relation in the inertial limit, and moreover it can be proved analytically that the relationship is in general a non-linear one. (Co-operation with KNMI, W.T.M. Verkleij.)

H2-02 NON-LINEAR TIDAL DYNAMICS

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

A set of three coupled, non-linear, partial differential equations ('forced rotation-modified Boussinesq equations') was derived to provide a tool for the description of the generation and propagation of non-linear internal tides and their conditional disintegration into soliton sequences. These equations include density stratification, non-linearity, non-hydrostatic dispersion, Coriolis dispersion and forcing terms due to the interaction between the tidal flow and a (small) topography. Numerical solutions indicate that both the dispersion mechanisms can, if sufficiently strong, prevent the internal tide from disintegrating. Also, analytical expressions were derived which yield the critical values for the dispersion. For non-rotating systems a formula was derived which gives the number of emerging solitons directly in terms of the forcing characteristics and the geometry of the system. Furthermore, the numerical solutions revealed that the tidal flow need not be supercritical for solitons to be formed. As a natural sequel to the above-mentioned investigations, a slightly different set of forced evolution equations was derived, now omitting the restriction that the topography be small. Hence the generation of non-linear internal tides and solitons near the continental slope can now be studied. Comparisons are made with empirical observations.

H2-03 NON-LINEAR TIDAL DYNAMICS: CHAOTIC STIRRING

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

Mixing in tidal areas, such as the Wadden Sea, is very intense. This is probably due to chaotic motion of water particles. In a simplified model, the current field can be interpreted as a strongly perturbed Hamiltonian system, where the tidal flow acts as a perturbation of the residual flow, which is represented by a lattice of eddies. The motion of particles in this model is chaotic, which causes strong mixing in parts of the tidal area. Such mixing can be quantified by two coefficients: the rate of exchange between the eddies, and the fraction of area in which the chaotic advection takes place.

A theory for the analysis of strongly perturbed Hamiltonian systems was developed. Using the method of orbit expansion, analytical expressions for both mixing coefficients were derived. Application of this model to the Wadden Sea gives that 32% of the Wadden Sea is chaotic and that the dispersion coefficient is D=200 $m^2 \cdot s^{-1}$. This is (a little) less than a realistic numerical model of the area shows, most probably due to the (over)simplification of the current field.

During a stay at the Bedford Institute of Oceanography in 1992 the Lagrangian circulation on and around shallow banks in the Gulf of Maine was studied. It was shown that the application of methods from the dynamical systems theory can be used to obtain an overall picture of the Lagrangian flows in complex Eulerian current fields which are composed of periodic (tidal) and residual currents. Compared to the results obtained with the Wadden Sea model, a chaotic

spreading of particles appeared to be much less present in the models of the Gulf of Maine. This difference can be attributed to the difference in the ratio between the tidal excursion length and the length scale of the tidal residual eddies. This ratio is very small in the model of the Gulf of Maine so that, in correspondence with the theory, the area of chaotic spreading is very limited.

H2-04 BOA RESEARCH THEME ON TIDAL AREAS

H. Ridderinkhof

In 1993 a project was started which studies the physical and biodynamical behaviour of cohesive sediments in the Ems-Dollard estuary. Various Dutch institutes participate in this project which is financed as a specific theme by NWO/BOA. The participation of NIOZ is in the development and application of numerical models. During 1993 the project was defined in detail by a definition of several separate PhD and PostDoc research proposals. First experiments with a numerical tidal model of the area have been performed.

H2-05 EXPERIMENTAL OCEAN RESEARCH IN THE NORTH ATLANTIC

DUTCH-WARP

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

All data from the WOCE Hydrographic Programme (WHP) section AR7E now have passed the Data Quality Evaluation and in their final form have been submitted to the WHP Special Analysis Centre (WHP-SAC) in Hamburg.

The hydrographic data of the DUTCH-WARP Programme have been analysed by means of a classic tracer distribution analysis as well as by means of more advanced methods like the Water Mass Census and the Optimal Parameter Analysis. The results reveal that Labrador Sea Water is in volume the most important water type of the Iceland Basin. This water type mainly circulates in a cyclonic manner through the Iceland Basin. The Deep Northern Boundary Current in the Iceland Basin consists of Iceland Scotland Overflow Water (ISOW), diluted With Lower Deep Water (LDW). The LDW contains considerable quantities of Antarctic Bottom Water (AABW). Due to its long transit time to the north the bio-geochemical properties of AABW have changed (low O_2 and high TCO_2) and form a strong contrast with the ISOW properties. This is also confirmed by the Tritium data from the 1990 'Tyro' cruise. Due to strong mixing and entrainment during the overflow of ISOW, recirculating Sub-Polar Mode Water is brought from the upper ocean layers to a depth of about 2000 m in the Iceland Basin, while considerable amounts of ISOW are brought to shallower levels. The latter water mass is found especially along the South Icelandic slope. By means of a simplified inverse geostrophic model the total transport in the DNBC along the Icelandic slope is estimated to be of the order of 3.5 Sv ($=3.5 \times 10^6 \cdot m^3 \cdot s^{-1}$). The current pattern from the geostrophic calculations confirms the results from the current meter arrays, with an overall anticyclonic circulation in the deep layers and strong local topographic steering of the deep baroclinic current.

For the study of the surface layers above the permanent thermocline a box-model is being developed on the basis of an integrated evaluation of literature data, combined with DUTCH-WARP data. A full balance of the model can only be obtained if additional (westward) transport is assumed, which, however, cannot be demonstrated from the (scant) actual observations. For a further study of the circulation in the surface layer another 12 ARGOS drifters were deployed with the assistance of the OWS 'Cumulus' of the UK Meteorological Office at station LIMA in the centre of the research area. The data obtained so far show a marked difference between the conditions over the Iceland Basin and those over the adjoining Rockall Plateau, with a northeast current along the intermediate slope.

An advanced inverse modelling technique has been applied to the DUTCH-WARP hydrographic data set in order to compute the barotropic component of the velocity field, without assuming a level of no motion. It has been found that the solution of the inverse procedure is particularly sensitive to small variations in parameters such as layer thickness, truncation level and the number of boxes included in the analysis.

Interannual changes in the main hydrographic features are studied using XBT sectors. This year east-west sections were made with RV 'Pelagia' (crossing to Greenland) and along the AX-5 section in co-operation with the Royal Navy.

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

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

The CTD-data collected during the JGOFS/SO project on board RV 'Polarstern' have been worked up to data bank standard. The JGOFS quality requirements have been met. The 6° west section from 47° to 60° south shows strong frontal regions, the Antarctic Polar Front and the Antarctic Circumpolar Current-Weddell Sea Front. Geostrophic velocity field shows eddy motion near the fronts. Phytoplankton species distribution and pigment distribution coincide with the spatial physical structures near the fronts. During the period that the retreating ice-edge coincided with the ACC-Weddell Front, the ice edge was highly irregular due to eddy motion. The one-dimensional wind-mixed layer model developed during the EPOS project was applied and showed deep wind-mixed layers, mainly caused by strong winds. This open ocean area showed stronger winds on average, and more cloud cover, and consequently much lower plankton blooms than in the EPOS area. The physical model predictions are used as forcing functions in an ecophysiological model, established by C. Lancelot (Univ. Libre de Bruxelles) to predict the factors controlling the phytoplankton development in the marginal ice-zone. The plankton blooms near the frontal zones, in particular near the Polar Front, cannot simply be modelled using a one-dimensional wind-mixed layer model. Comparison of model predictions with the EPOS one-dimensional model and measured values of the wind-mixed layer in different parts of a frontal zone gives information on upwelling or downwelling motions. An attempt will be made to correct the one-dimensional model with estimates of vertical velocities by secondary currents near fronts.

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

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

The aim of this project is the study of simultaneous measurements of physical and biological data from a (seasonally) stratified shelf sea under atmospheric forcing. The time series obtained from a fixed mooring provide the adequate means for the study of diapycnal mixing events between light-limited and nutrient-limited parts of the water column. The results from the field experiment and the data will be used in a coupled one-dimensional model for the lower trophic levels. Preliminary analysis of the 1991 and 1992 (late summer) data shows the expected significant correlations between stratification rate, convective overturn rate and chlorophyll *a* contents at synoptic frequencies. In 1993 the mooring site, located in the central North Sea (54°25'N, 4°02'E), was occupied between March and August, to study the spring bloom period. Although most current meters, a thermistor string, a sediment trap and (for a short period) a transmissometer returned useful data, none of the fluorometers worked adequately. Tests with *in situ* nutrient auto-analysers were successful. Starting in November 1993 a whole year round experiment is scheduled, with mooring service planned every month. (Co-operation with D. Mills (MAFF Fisheries Laboratory, Lowestoft, UK, and several departments of Rijkswaterstaat.)

H2-12 OPTICAL OCEANOGRAPHY AND REMOTE SENSING

M.R. Wernand, S. Shimwell (Pel. Systems)

With the forthcoming optical satellite sensor mounted on the SeaStar satellite and to be launched mid-1994, the real-time application of ocean colour algorithms comes closer. A start was made with the data collection for the project 'Relation between particulate matter and North Sea colour' to be used in relation to SeaWiFS. This project operated within other projects of the institute: PMNS (B2-06) and OCEAN (S-01a). Determination of particulate matter concentrations in the North Sea from satellite data is the main purpose of this project.

The development of site-specific case-2 water quality algorithms takes place within the PMNS project. Airborne remote sensing techniques were used for the verification of earlier found algorithms for total suspended matter, chlorophyll and yellow substance with *in situ* bio-chemical measurements.

Within the PMNS project, TRASIR was used to measure the upwelling diffuse attenuation coefficient (k) and the beam attenuation coefficient (c). A newly bought 9-channel absorption meter was used for underway sampling to determine, together with TRASIR, scatter-dominated or absorption-dominated water masses.

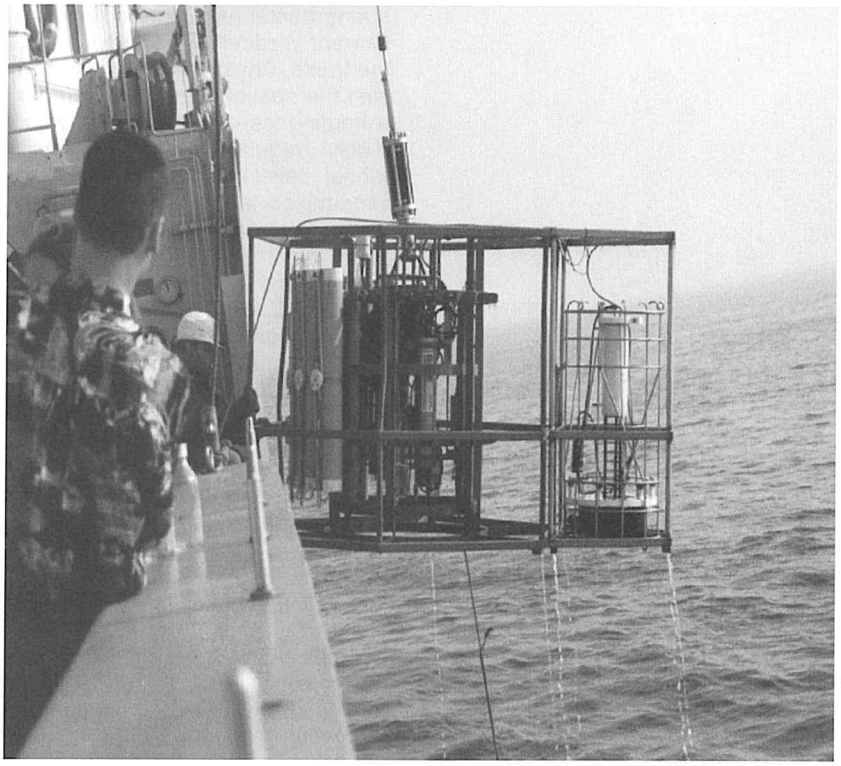


Photo: C. Blaauwboer

The exterior of the TRansmissometer/ Advanced Spectral IRradiance meter (TRASIR) developed at the Netherlands Institute for Sea Research. The instrument is used for the development of ocean-colour algorithms and channels (BW=12 nm) between 400 and 720 nm, measuring upwelling irradiance and beam attenuation.

H2-13 APPLICATION OF INFRARED REMOTE SENSING

L. Otto, T.F. de Bruin; A.J. van Bennekom (Dept. Mar. Geology and Geochemistry); M.A. Baars (Dept. Pelagic Systems)

This year RS was used for the study of the hydrographic conditions during the Indian Ocean expedition. The development of marked structures connected with fronts and upwelling in the course of the SW monsoon was detected.

A series of RS images south of Iceland was used to investigate the possibilities of 'feature tracking' in studies of surface currents.

H2-14 SHELF EDGE PROCESSES

H.M. van Aken, L.R.M. Maas, C. Veth, J.T.F. Zimmerman, F.-P. Lam, J.C. de Munck, Th. Gerkema, S. Ober, R.X. de Koster

Bay of Biscay

The field experiment of 1992 in the Bay of Biscay was repeated in June 1993 with a 12-day cruise of RV 'Pelagia' to the northern Bay of Biscay. Along 3 sections perpendicular to the continental slope, CTD surveys were carried out. Along the shallower parts of these sections (160-800 m) repeat surveys with a towed Acoustic Doppler Current Profiler system were carried out for over 24 hours each. For each section 14 to 16 velocity sections were obtained in this way, which will be used to construct the spatial structure of the semi-diurnal tides over the shelf edge.

A preliminary analysis of the CTD data has revealed that directly along the continental slope the deep water mass below 1000 m is characterized by direct mixing of Mediterranean water and Lower Deep water. At 15-20 km from the slope a salinity minimum is observed at a depth of about 1800 m, connected with the presence of Labrador Sea Water.

In co-operation with RIVO (IJmuiden) shallow hydrographic data from the Bay of Biscay from cruises of RV 'Tridens' in 1992 have been analysed. In the summer of 1992 a large plume of relatively fresh water near the sea surface was observed to spread north-eastward along the continental edge.

Shelf waves along the Greenland shelf edge

Tidal analysis has been done with current meter measurements from the shelf edge east of Greenland (71°N). The current records were available as part of the Greenland Sea Project in 1988/1989.

Earlier it was shown that the semi-diurnal tides showed some remarkable features in a vertical direction, supplying evidence for the presence of internal tides. The diurnal tides on the other hand, were amplified just at the shelf break. Together with other hints the manifestation of the diurnal tides could therefore be explained by so-called 'continental shelf waves', travelling along the Greenland shelf edge from north to south.

The research on this subject is continued with a somewhat wider scope: the vertical structure (caused by stratification) and the generation of these (extremely long) shelf waves are taken into account with several analytical models. To implement a better and more realistic bottom topography a numerical model is developed to solve the derived equations.

Photo: T. de Bruin

View from Reykjavik harbour.

1.4. MARINE GEOLOGY AND GEOCHEMISTRY (H3)

INTRODUCTION

The research carried out in the Marine Geology and Geochemistry Department concerned transport, deposition and particle properties of marine sediments, and palaeoceanography, in particular of the South Atlantic region.

Flocculation of suspended matter in relation to the tides and estuarine mixing was studied in the Elbe river estuary, as part of the (EC) MATURE project and the *in situ* measurement intercalibration project (also EC). Flocculation in relation to season and the water-mass distribution was studied on the North Sea and, as part of the PEGASUS project, to provide basic data for the interpretation of remote sensing (SeaWiFS) data. The *in situ* measurements were done with the suspension camera system developed at NIOZ; its speed is limited by the speed by which the negatives can be measured by the image analysis system. A second *in situ* system, based on video, is being developed to measure *in situ* settling velocity of suspended particles.

Fine-grained sediments and suspended matter were also studied in Lake Erhai (southwestern China) on the tidal flats of the Chang Jiang river mouth, and on a mangrove channel in Hainan, as part of the co-operation programme with China. Deposition rates of fine-grained material were studied with ^{210}Pb and ^{137}Cs. The influence of bioturbation, sediment mixing and diffusion of the sediment profile was studied in North Sea sediments. The $^{210}Pb/^{210}Po$ system in the North Sea is being studied in relation to transport and concentration processes and the influence of suspended organic matter.

Coarse-grained sediment transport and deposition and the sediment framework were studied with shallow seismics and coring in the Skagerrak, Norwegian Channel and Faroe-Shetland Channel as part of the ENAM project, in the Bay of Biscay as part of the OMEX project, and in the Lombok and Savu basins in Indonesia. Sediment structure and composition were studied, including foraminifera, stable oxygen isotopes and total organic matter. Shallow seismics and coring were also used to study mud diapirs in the Black Sea.

Biogenic silica was studied in the Arabian Sea as part of the Indian Ocean Project (NIOP), and in the Angola Basin sediment together with kaolinite structures. Hydrography, oxygen content and nutrient concentrations (including dissolved silica) were studied in the northwestern Indian Ocean (also a NIOP project).

The palaeoceanographic work in the Angola Basin included a study of foraminifera in two cores covering about 900 000 years and more than 100 000 years, respectively. Besides foraminifera, smectite crystallinity, and the contents of mica, chlorite and feldspar could be used as indicators of the climate (desert conditions). Zeolites could be used as an indicator of sediment source.

H3-01 FLOCCULATION OF SUSPENDED MATTER

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

Data on *in situ* floc size obtained in 1991 in the Dollard and the Elbe river mouth show variations of *in situ* floc size with the tidal phase (flow velocity) and particle concentration. In the Dollard the influence of the tidal flats can be seen in the maximum floc size: floc size increased during the flood tide when the flats are submerged, while during the ebb tide when the flats are emerged and flow velocities along the flats may reach 50 to 100 $cm \cdot s^{-1}$ floc size was reduced. Salinity variations and the total organic matter content of the flocs did

not influence floc size, confirming earlier observations in the Ems, Rhine, Schelde and Gironde estuaries.

In situ floc size was measured in the estuaries of the Elbe, Schelde and Gironde. This research was carried out as part of the (EC) MATURE project, which is concentrated on the turbidity maximum in these estuaries. A new *in situ* video camera is being constructed that will give better results at high particle concentrations than the present system, which was developed four years ago. This new system will also allow *in situ* measurement of floc settling velocity.

To study the influence of the *in situ* floc size on optical remote sensing measurements, participation took place in four short cruises of the PEGASUS programme with the *in situ* camera. Measurements were made simultaneously with the measurement of optical spectra (by M. Wernand and S. Shimwell) and plankton measurements (by G. Fransz).

In June an intercalibration programme for *in situ* measurements on suspended matter (settling velocity, floc size) was carried out in the Elbe estuary, supported by the EC. It was attended by 15 groups from five EC countries and one group from the US. D. Eisma and J. Kalf carried out *in situ* floc size measurements from an anchored pontoon and from a floating ship (RV 'Ludwig Prandtle' of the GKSS in Geesthacht). D. Eisma had the organization of the exercise.

In the North Sea, several cruises were made to study the seasonal variations in floc size. In the summer only part of the North Sea could be reached because of limited ship time and during spring some measurements were lost because of difficulties with film transport in the camera system. D. Lardinois (University of Liège, Belgium) and B. Everts (Terramare, Wilhelmshaven, Germany) participated in the cruises to carry out analysis of organic components in the suspended matter (lipids, proteins, some polysaccharides, humic compounds).

H3-02.2 CO-OPERATION WITH CHINA

D. Eisma, J. Kalf

The programme carried out in (October/November) 1993 consisted of three parts: 1. Sedimentation in Erhai Lake (Yunnan), a continuation of work on suspended matter in 1992, in co-operation with the Institute of Limnology and Geography, Academia Sinica, Nanjing. 2. Organic-matter accumulation on tidal flats at the Chang Jiang river mouth in co-operation with the Institute of Estuarine and Coastal Studies ECNU, Shanghai. 3. Organic and suspended-matter transport in mangrove channels in Hainan in co-operation with the Institute of Geo and Ocean Sciences, University of Nanjing.

In Erhai Lake ten bottom cores were taken and transported to NIOZ for analysis of sediment structure (X-ray radiograms), particle composition and deposition rate (with ^{210}Pb). At the sampling stations also suspended matter samples were collected and filtered for total suspended matter concentration and SEM analysis. On the tidal flats along the east coast of Chongming Island in the Chang Jiang river mouth, eight sediment cores were collected that are being analysed at the East China Normal University for sediment structure, particle composition and organic compounds. On the basis of the results, subsamples will be taken for determination of accumulation rate with ^{210}Pb at NIOZ. In Hainan only one 13-hour sampling series of suspended matter could be done in a mangrove channel. Water samples were filtered for total suspended matter content and SEM Analysis at NIOZ.

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

Results of Wenzhou Bay and Oujiang estuary samples collected during 1991 indicate that the Holocene development of the tidal flats is reflected in three stages (0-4000 BP, 4000-8000 BP and 8000-10000 BP). This result has been combined with the distribution of surface sediments and ^{210}Pb measurements of the accumulation areas.

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

J.P. Beks

In continuation of earlier work, dissolved and particulate samples for ^{210}Pb and ^{210}Po measurements were taken in spring and summer in the entire North Sea. ^{210}Pb has not yet been measured.

In spring 1993 total ^{210}Po ranged from 0.3 mBq·kg^{-1} south of the Dogger Bank to 2.2. mBq·kg^{-1} in bottom waters of the Thames area. Surface waters showed high values north of the Netherlands, along the Danish coast and along the southwestern slope of the Norwegian trench. Bottom waters showed high values especially in the Thames area and the Skagerrak. Bottom waters were richer in ^{210}Po than surface waters.

Summer ^{210}Po values ranged from 0.4 mBq·kg^{-1} south of the Dogger Bank to 2.4 mBq·kg^{-1} in bottom waters on the west slope of the Norwegian trench. Summer and spring distributions of ^{210}Po were similar.

In summer most ^{210}Po is in the dissolved phase; the particulate contribution increases during autumn and winter, and in spring most ^{210}Po is from the particulate phase.

H3-02.5 SEDIMENT MIXING, BIOTURBATION AND DIFFUSION IN THE NORTH SEA

J.P. Beks, B.M. van Oijen

The process of redistribution of isotopes and fine-grained particles in the top layer of sediments in the North Sea is studied with ^{210}Pb. Boxcores from the Oyster Ground and the Skagerrak were analysed at 1-cm intervals.

The silty core from the Oyster Ground showed accumulation of mud at 3 to 5 cm depth, due to bioturbation (probably deposit feeders). Total ^{210}Pb showed virtually no decay downcore and a high concentration at 3 to 5 cm depth. Taking only the fraction <20 mm into account, the profile showed a mixed layer of about 20 cm and decay of excess ^{210}Pb below this zone.

For sedimentation rate determination in this region, cores longer than 30 cm are necessary.

The muddy core from the Skagerrak (off Norway) was slightly depleted in mud around 6 and 15 cm depth. The mud corrected ^{210}Pb profile showed a mixed surface layer of 15 cm and decay of excess ^{210}Pb below this zone. A rough estimation gives a sedimentation rate of 0.3 to 0.4 cm·y^{-1} for this core.

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, H. de Haas, E. Okkels

Box-core and piston-core samples were collected with RV 'Pelagia' in the northern Norwegian Channel in the framework of the VVA-4/ENAM project. Their locations were selected on the basis of an acoustic and seismic survey held in collaboration with DGS (Copenhagen). The samples are presently being measured to determine accumulation/sedimentation rates, and to establish the relationship between grain size and the distribution of organic matter in the surface sediments. Downcore organic carbon analyses have been done to study the total storage of carbon in the Norwegian Channel and Skagerrak on a 10-100 year scale. Initial results show significantly lower amounts of organic carbon in the Norwegian Channel surface sediments and sedimentation rates that are overall considerably lower than those in the Skagerrak.

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

Tj.C.E. van Weering

In the framework of the EC supported ENAM project, a number of seismic lines were collected east of the Faroe Islands, where the 1991 seismic data indicated the presence of NSDW current influenced contourite deposits. A preliminary seismic stratigraphic analysis by a student (Yvo Kok, Utrecht University) has shown that the seismic sequences allow identification of four major units on top of the Palaeocene basaltic underground. These indicate that NSDW flow along the margin was initiated in the mid-Miocene, and since then had a number of stronger and weaker pulses.

Planktic and benthic foraminifera in core NA 81-10 have been studied by Tine Rasmussen (Postdoc, Carlsberg Foundation, Denmark).These foraminifera allow a high resolution distinction of oceanographic changes and variability in the SW Norwegian Sea across the last glacial/interglacial boundary. Oxygen isotopes are being measured in Gif-sur-Yvette in collaboration with L. Labeyrie and J.C. Duplessy to establish sea surface anomalies and temperature changes in the SW Norwegian Sea.

Feni ridge cores NA 87-22 and 25 have been sampled at 5 cm intervals for oxygen isotope analysis, which allows a detailed definition of surface and bottom watermass characteristics in the NE Atlantic Ocean during and after the last glacial (isotope stages 2 and 1). These are being compared with the similar parameters at the previous glacial/interglacial cycle, in order to compare the magnitude of changes and the time scales involved.

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

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

On the basis of both single- and multi-channel (industrial) seismic profiles the forearc basin structure was further outlined.

A seismo-stratigraphic analysis of the Lombok fore-arc Basin showed that this basin developed and evolved after the Late Oligocene and is still in an early stage of forearc basin evolution. Probably it is built on rifted Asian crust of continental origin. The Lombok accretionary ridge was a major source of sediments that were deposited in the Lombok Basin by a system of submarine fans.

A similar study on and near the coast of Sumba and in the Savu Basin recorded the effects of arc continent collision on forearc basin development and the sedimentological response to these processes.

The Sumba microcontinent, which is trapped in the Savu and Lombok Basins, presently acts as a barrier to compression, which introduces a rapid uplift of the island and ongoing deformation of the accretionary sediments to the south of Sumba.

Diatoms in surface sediments collected during the Snellius II expedition were studied to asses their relationship with water masses in the region. Pacific Ocean and Indian Ocean influences defined by a PO/IO ratio reflect fluctuations of water masses during the late Quaternary. It was shown that absolute diatom abundances and diatom accumulation rates of autochthonous species do not correspond to daily rates of primary production in the photic zone and thus cannot be used directly as palaeoproductivity estimates.

H3-13 PALAEOCEANOGRAPHY OF THE ANGOLA BASIN AND TERRESTRIAL CLIMATE

Planktonic Foraminifera

J.H.F. Jansen, E. Ufkes, S.J. van der Gaast

Two piston cores have been studied, core T89-40 (21°36'S, 6°47'E; 3070 m water depth) north of Walvis Ridge and core T89-24 (8°55'S, 12°03'E; 2140 m water depth) just south of the Zaire River plume.

Cluster analysis of planktonic foraminifera of core T89-40 yields 2 groups, one marked by typically subtropical species, *e.g. Globorotalia menardii*, and a second group marked by more temperate species, *e.g. Globorotalia scitula* and *Globigerina bulloides*. Downcore variations of these two groups provide a basis for the preliminary stratigraphy of the core, together with two datum levels (^{14}C and the last appearance of the coccolith *Pseudoemiliania lacunosa*). It appears that the core probably reflects the palaeoceanography of the last 900 000 y and has an average sedimentation rate of 1.7 cm/1000 y. There is a downcore wax and wane of the subtropical and temperate (Benguela Current) groups, which indicate shifts of the Benguela Current to the north during glacial times. Besides these glacial-interglacial shifts, which occur in (orbital eccentricity) cycles of 100 000 y, the core shows long-term variations. The amplitudes of the contributions of the subtropical group are particularly large

between *c* 450 000 and 300 000 y and after *c* 130 000 y ago. During these two periods, large abundances are observed of left-coiled neogloboquadrinids which could reflect increased seasonal variations.

Cluster analyses of the data of core T89-24 yield three groups comprising all major species except *Globorotalia inflata*. The first is a subtropical assemblage nearly identical to the first group in T89-40. The second group is marked by eutrophic and deeper dwelling species. The third group is attributed to the influence of the Benguela Current, because of the contribution of *G. scitula* and left-coiled *Neogloboquadrina dutertrei* and *N. pachyderma*. ^{14}C dating and biostratigraphic information show that the 18-m-long core represents the last 100 000 y. The last 15 000 y of this period were very warm, as is indicated by maximum abundances (up to 50%) of the subtropical species. Before, they reached <30%. Group 3 is generally low abundant, but peak occurrences are noticed around *c* 50 000 y, 65 000 y and 87 000 y ago), pointing to northward excursions of the Benguela Current.

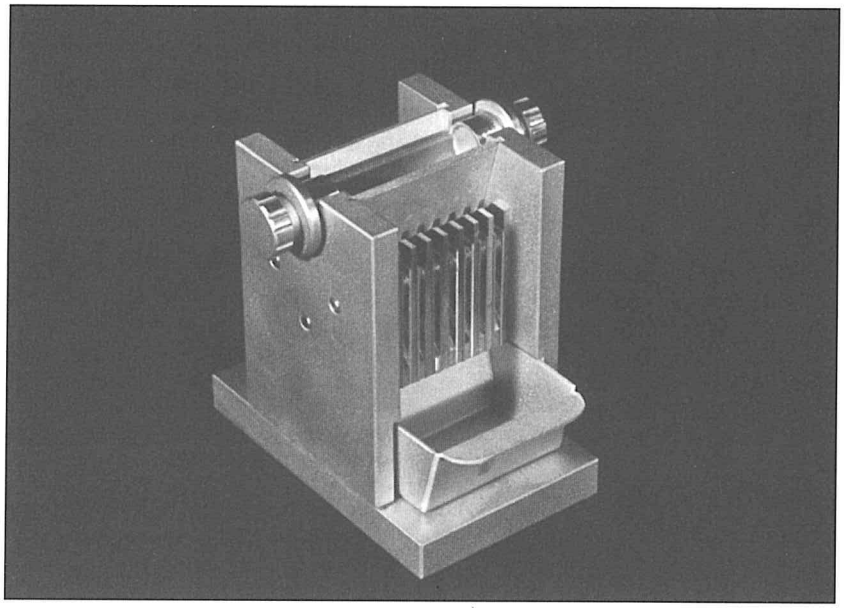


Photo: B. Aggenbach

Microsplitter constructed by H. Boekel and co-workers after a copy of an 'Otto Microsplitter'. The 8-cm-high device is used to split a sediment sample into 2 aliquots. This procedure can be repeated until a required amount of material is obtained. The microsplitter is used for foraminiferal studies.

Clay minerals

Previous work on sediments from the Zaire deep-sea fan has shown that the crystallinity of smectite can be used as an indicator of glacial cycles. The crystallinity is mainly controlled by the contribution of poorly crystallized smectite which was largest during interglacials. New measurements were carried out on recent samples from box cores and piston-core tops (0 to 1000 years old) from a large area of the Angola Basin. These measurements show that the smectite crystallinity increases strongly to the southern part of the basin. This is probably caused by a wind supply of well-crystallized smectite originating from the Namib Desert. The desert is also a source of mica, chlorite, and feldspar. Together, these minerals are markers of the desert as a sediment source.

Zeolite minerals are found in the slope sediments of the entire basin, which indicates that old shelf deposits are eroded; in smaller quantities, however, than in glacial times.

H3-15 THE GEOCHEMICAL CYCLES OF SI AND AL

A.J. van Bennekom, J.H.F. Jansen, S.J. van der Gaast

Biogenic silica content was determined in a piston core from the Arabian Sea, obtained during NIOP C2. The surface content of about 5% decreases steeply downcore to a minimum of about 0.5% at the last Glacial Maximum, comparable with literature data. At the deeper levels of the previous interglacial, biogenic silica increases again.

In the framework of the Dutch Antarctic program, J.E.E van Beusekom determined dissolved Al in the Southern Indian Ocean during April-May on board RV 'Marion Dufresne'. Concentrations in surface and bottom waters were about 0.4 nM, the lowest reported so far for the Southern Ocean. Intermediate maxima of about 2 nM indicated the possibility of Al as tracer of waters from the Atlantic or the northern Indian Ocean.

Determination of biogenic opal

Opal, derived from diatom-remains, phytoliths, *etc.*, is a major component of the Angola basin sediments. With X-ray powder diffraction (XRD) measurements, concentrations ranging from 35 to 65% are found. Wet-chemical methods, however, reveal concentrations which are 20 to 40% lower. This difference is probably caused by the high concentrations of aluminium (6-7%) in the opal of the Angola Basin. In the first place, this high Al content causes a shift in the maximum of the opal band in the XRD patterns which complicates the measurements. Secondly, high Al concentrations cause a decrease in the solubility of opal and, consequently, an underestimation of the concentrations by wet-chemical methods. This suggests that the XRD values might be correct. To obtain a method that provides good results a study has been started with R. Schneider and P. Muller, the University of Bremen.

We also joined an interlab comparison for opal determination in sediments initiated by D. Conley from Horn Point Environmental Laboratory, Cambridge. Two samples from the Chesapeake Bay and four samples from lakes in volcanic areas were used. It appeared that the XRD concentrations are 10 to 20% higher than the wet-chemical values. However, volcanic material shows up in an XRD band which interferes with the opal band. But it easily releases silicon in wet-chemical methods. Consequently, both methods produce too high concentrations if volcanic material is involved.

H3-17 CRYPTO-CRYSTALLINE CLAY MINERALS

S.J. Van der Gaast

Kaolinite is a clay mineral present in most sediments. Upon heating, cage-like structures are found with a maximum size of 7.7 nm. Such cages probably also exist in unheated kaolinite. They are probably important for absorption processes of inorganic and organic materials. Moreover, they may act as active positions for 'cracking' reactions of organic molecules and act as cages for trapped chemical elements. Such trapped elements can be used to detect changes in the geochemical environment.

Upon heating, the 1:1 structure of kaolinite transforms into a 2:1 structure with a dehydroxylated 'brucite' interlayer. A zig-zag structure is proposed for this interlayer material with a variable thickness. The XRD patterns of the heated kaolinite show phenomena similar to those of heated allophanes. Because of its very high specific surface area and absorptive capacity, allophanes can profoundly influence soil and sediment properties, even if present in only low concentrations. Probably, the structure of allophane is of the 2:1 type and not of the 1:1 type as generally accepted. This new structure for allophane may explain the wide range in the Al/Si ratio and the uniformity of the size of the allophane spheres.

H3-22 BLACK SEA MUD DIAPIRISM

Tj. C.E. van Weering

On the basis of the 1991 seismic data, a number of additional seismic lines were recorded in 1993 and subsequently covered by deep tow side scan sonar and underwater TV recording in the mud volcano area southeast of the Crimean peninsula. The mud volcanoes were apparently formed by repeated and irregular overflow of muds associated with the venting of gas.

A preliminary analysis of the gas content in two cores collected at the rim of a mud volcano showed a non-thermogenic origin. Selected sediment samples collected in 1993 have been sent to the University of Utrecht for AMS dating.

H3-23 WATER MASSES IN THE NW INDIAN OCEAN

A.J. van Bennekom, M.A. Hiehle, G.W. Kraay, S. Ober

In February and March, during Leg C2 of the NIOP programme, relations between hydrography, oxygen and nutrients were studied and compared with the results obtained in August 1992 (NIOP C1).

The Winkler procedure was slightly adapted to give better results for the very low oxygen concentrations (down to 3 M) in this region and in turbid waters from near-bottom samples. Correction factors for Winklers during earlier legs were determined.

Calibration of CTD data took much time. The same procedures were applied to all NIOP cruises. Slight changes with time of the CTD calibration constants were determined, resulting in good salinity and temperature statistics that meet the JGOFS demands for deep waters.

In the oxygen minimum zone (OMZ), the oxygen concentration was lower than reported in the literature, especially in the NW Somali Basin. Surprisingly, off Yemen and Oman, corrected oxygen concentrations in the OMZ were lower in February (non-upwelling season) than in August (upwelling season).

The deep (~3000 m) silica maximum was more pronounced in the extreme NE Somali Basin, than in the NW and central parts. This indicates a so far unknown inflow from the Arabian Sea at this depth. Fine-structure in oxygen profiles also shows intrusions of low-oxygen waters at >1500 m, apparently from the Arabian Sea. The quick changes in deep currents, registered by current meters and landers could be related to these intrusions.

H3-24 OMEX, BENTHIC PROCESSES

Tj.C.E. van Weering, J. Kalf, E. Okkels

Within the EC-supported Ocean Margin Exchange (OMEX), co-ordination is provided for the benthic processes subproject (in co-operation with the departments of Chemical Oceanography and Benthic Systems).

A cruise was held with RV 'Pelagia' in October to the OMEX study area in the northern part of the Bay of Biscay. During this cruise high resolution penetrating echo sounder profiles of the seabed were recorded. Subsequent sampling of the water column and surface sediments was carried out along the OMEX transect 1. Nine stations were sampled extensively, boxcoring included.

1.5. MARINE BIOGEOCHEMISTRY (H4)

INTRODUCTION

The Department of Marine Biogeochemistry started its activities at NIOZ January 1, 1993. As a consequence, the contribution of the Department to the annual report is the first one. Therefore this longer introduction also gives the history of the group and the long-term research plans.

History of the Department of Marine Biogeochemistry

The Department of Marine Biogeochemistry was added to NIOZ as a result of a 'group transfer' of the Organic Geochemistry Unit of the Technical University Delft. This Unit was founded in 1969 and started its teaching and research activities under the direction of Prof. P.A. Schenck and Dr. J.W. de Leeuw. Over the years a strong research team and appropriate analytical equipment were obtained. The first fifteen years of research at Delft were mainly dedicated to the isolation, structural identification and application of 'biomarkers', sedimentary compounds which can be considered as fossils on a (organic) molecular scale and used to reconstruct palaeo-environments and diagenetic processes. Later, the very rapid development of advanced analytical chemical instrumentation allowed for studies of the major part of sedimentary organic carbon, kerogen, a high-molecular-weight very complex material. The last seven years an important part of the research was dedicated to the formation and significance of sedimentary organic sulphur compounds. At a major reorganisation of the Department of Chemical Engineering of the Delft University it was decided that research in Organic Geochemistry was too fundamental within the Delft framework and the Unit was told to stop its activities in five years' time. During these last five years in Delft the Unit was, however, fully supported in all aspects. The transfer to NIOZ has been realized thanks to substantial financial and instrumental support of the Delft University, NIOZ and NWO. Organic Geochemistry will be continued within the Dutch University system because the two staff scientists, J.W. de Leeuw and J.S. Sinninghe Damsté, are part-time associated with the Faculty of Earth Sciences at the University of Utrecht.

Summary research plan 1993-1998

A considerable part of the fundamental research will be a continuation of the three main streams of research elaborated for many years by the Organic Geochemistry Unit of the Technical University Delft. These research items, dealing with sedimentary Organic Sulphur Compounds (OSC), Resistant Biomacromolecules (RBM) and Biomarkers in sediments and nature, are highly relevant to the long-term research strategy of NIOZ concentrating on 'Cycles in the Marine Environment'. It is foreseen that continuous research efforts in these three research areas will substantially improve applications in marine research concerning food-chain chemistry, mineralization, transformation and preservation of organic matter in the marine environment and in the reconstruction of palaeo-environments. Two other research items, molecular mechanics of geochemically relevant compounds and quantitative aspects of

GC-MS analysis, will also be continued because both are considered important tools to improve the quality of biogeochemical data.

Apart from these three research items more specific research projects are planned in direct collaboration with the NIOZ Departments Chemical Oceanography, Marine Geology and Geochemistry, Benthic Systems, Pelagic Systems and Coastal Systems.
The following research items will be addressed:
—Molecular characterization of dissolved and particulate organic matter (DOM and POM) in seawater.
—Molecular characterization of key organic compounds in phytoplankton and planktonic debris.
—Interactions of anthropogenic organic compounds with organic matter in sediments and biota.
—Molecular characterization of organic matter in suspended material and shelf sediments.
—Mineralization and preservation of organic matter in surface sediments.
—Fluxes of methane in the photic zone of the water column.

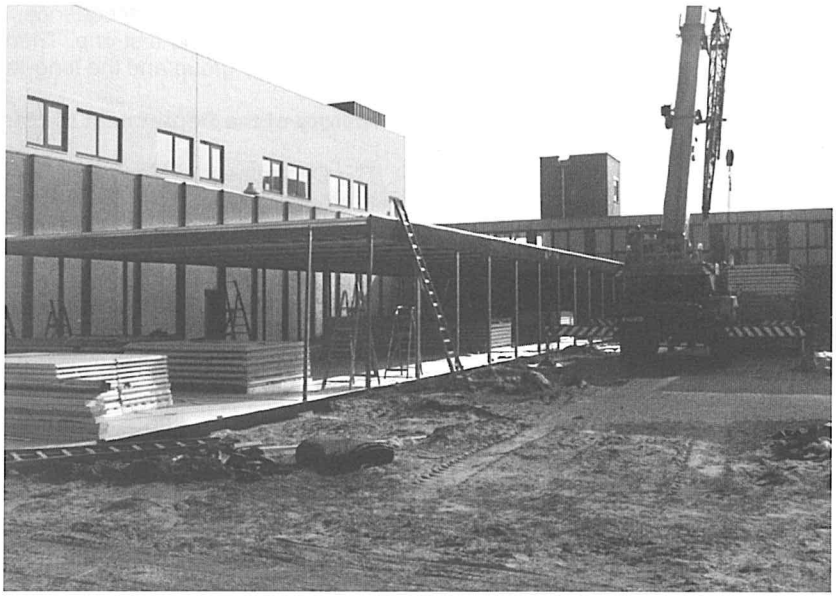


Photo: B. Aggenbach

The new laboratory under construction.

H4-1.1. FREE- AND SULPHUR-BOUND CARBON SKELETONS IN THE IMMATURE EVAPORITES OF A MESSINIAN BASIN (VENA DEL GESSO, ITALY)

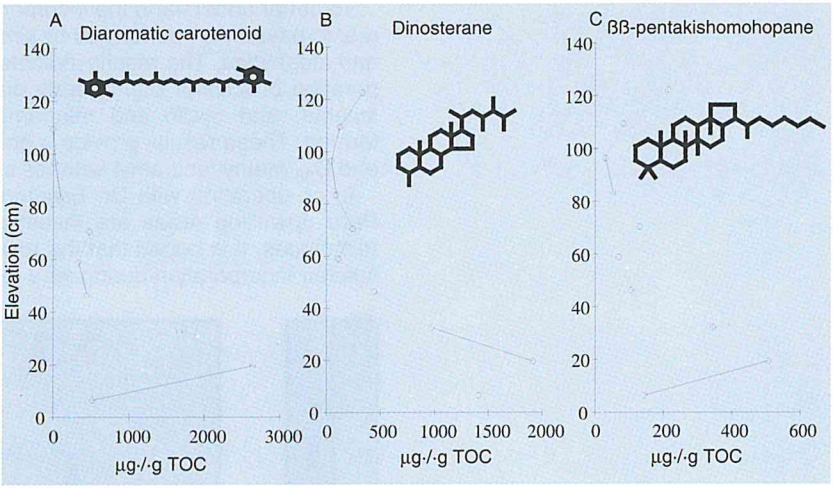
F. Kenig, N. Frewin, J.S. Sinninghe Damsté, J W. de Leeuw, I. Peleanu, D. Miggins

The objective of this project is the definition and evolution of palaeo-environmental conditions of deposition of the organic-rich marls of the evaporite cycles of the Vena del Gesso formation (Messinian, Italy), through identification and quantification of extractable free and sulphur-bound carbon skeletons. Screening of 35 marl samples from 11 different evaporitic cycles, through analyses of total extracts desulphurized with nickel boride, gave an overview of the variations in sources of organic material and degree of sulphurization present throughout deposition of the entire formation. Broad cyclic variations were determined in each bed in addition to bed-to-bed variations.

Abundance of hydrocarbons released through desulphurization decreases from bottom to top. The presence of certain biomarkers such as diaromatic carotenoids, which derive from the pelagic photosynthetic obligate anaerobe Chlorobiaceae, indicates that anoxia was occurring in the photic zone, favouring the natural sulphurization of organic compounds. Absolute quantity variations of these biomarkers demonstrated, in most marl beds, the upward decreasing quantities of sulphur-bound moieties and were related to progressive disappearance of the anoxic stratification of the basin.

The last cycle of the formation exhibits continued favourable conditions of sulphurization throughout the entire bed, possibly due to evolution of environmental conditions. From this screening, a type sequence was identified and studied in further detail. The marl bed of this cycle was subdivided into ten samples over 10 cm divisions. This allowed improved resolution of the above described variations of conditions of deposition and sulphurization and demonstrated that the basin evolved progressively from a stratified water column to a more shallow homogeneous water column while microbial mats developed.

Separate analyses of free and sulphur-bound hydrocarbons also added information about the variability of sources of organic material in the sediment and explained the effect of variations of input versus variations in the degree of sulphurization.



Absolute amount of hydrocarbon (in microgram per gram of total organic carbon) released by desulphurization of the polar fraction of 10 samples of the marl bed of cycle IV.
A) Diaromatic carotenoid (see text).
B) Dinosterane, which derives exclusively from dinoflagellates.
C) bb-pentakishomohopane, which derives from a cyanobacterial source.

H4-1.2. MOLECULAR PALAEONTOLOGY OF MARINE SEDIMENTS

J.S. Sinninghe Damsté, S. Schouten, H.M.E. van Kaam-Peters, M. Yamamoto, J.W. de Leeuw, J. Jellema, S.G. Wakeham, J.M. Hayes, R.E. Summons, M. Schoell, D. Hollander

By the combined use of sulphur and isotope geochemistry in analysing sedimentary organic matter it is possible to reconstruct palaeo-biochemicals which can provide detailed palaeo-environmental information. This new approach is now applied on a number of both recent and ancient sediments.

Analysis of a set of Black Sea sediment samples covering Unit I and II indicated that sulphur-bound isorenieratene (a diaromatic carotenoid characteristic of Chlorobiaceae) occurs not only in surface sediments but also in older ones. This demonstrates that anthropogenic influences are not a prerequisite for a shallow chemocline. The identification of series of thiophene and thiolane aryl isoprenoids derived from sulphur-bound isorenieratene in the Jurassic Orbagnoux Formation indicates that the present situation in the Black Sea, in which shoaling of the chemocline into the photic zone allowed a prolific growth of green photosynthetic sulphur bacteria, has also occurred in the past. A suite of novel polymethylhentricosenes with an unknown origin has been identified in surface Black Sea sediments. These components suggest the existence of an alternative biosynthetic pathway for 'isoprenoid-like' components. Presently, the work on the Black Sea sediments focuses on determination of $\delta^{13}C$ values for individual components and characterization of the high-molecular-weight organic matter to explain the apparent loss of C_{25} highly branched isoprenoid alkenes which are the major lipids of the upper 1 cm sediment but rapidly disappear in deeper sediments.

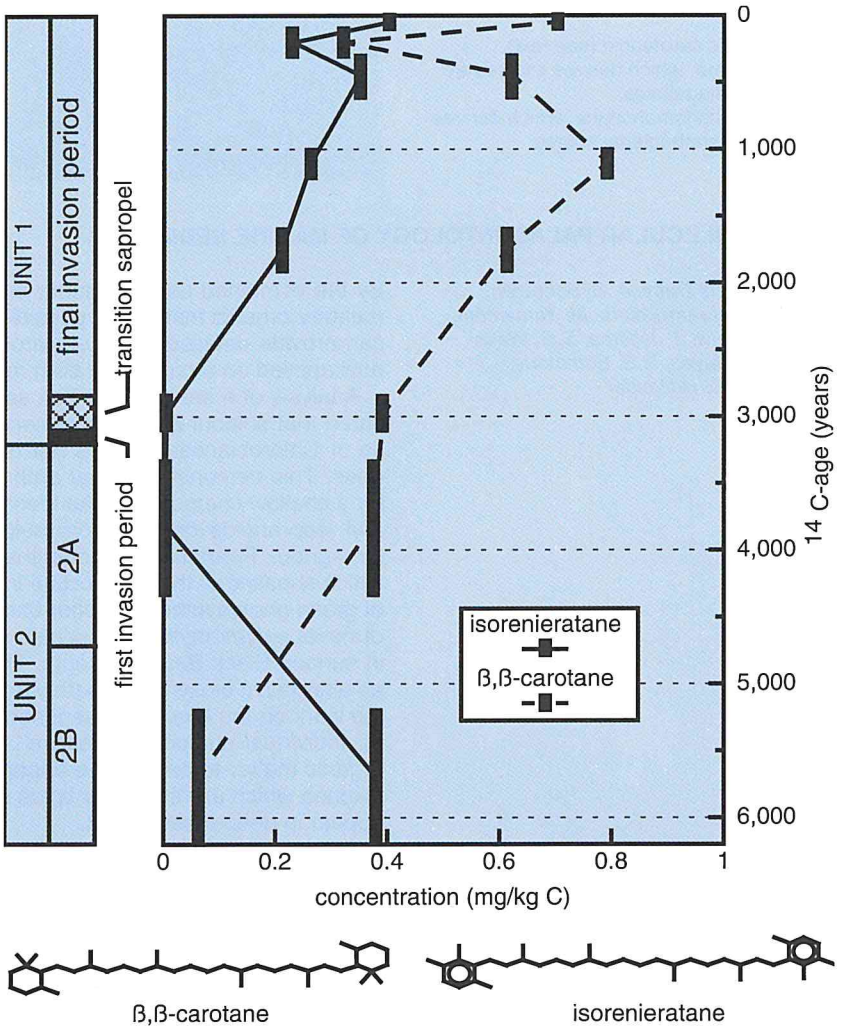
As a continuation of the work in co-operation with Dr. Schoell at Chevron, samples from the Miocene Monterey Formation at Shell Beach (California, USA) have been analysed for free and sulphur-bound hydrocarbons. Their carbon isotopic compositions have been measured during a stay of Ir. Schouten at the laboratories of Chevron in La Habra (USA). First results indicate that carbon isotopic compositions of dinorhopane and sulphur-bound cholestane and pentakishomohopane in Shell Beach sediments are similar to $\delta^{13}C$ values of

these components in stratigraphically related sediments at Naples Beach. This provides further evidence for the use of $\Delta\delta^{13}C_{chol/hop}$ in determining the stratification of oceans in the past.

Organic sulphur compounds and other organic species were also investigated in more mature and more ancient organic-rich sediments deposited in a stratified sea with warm saline bottom water represented by six core samples from the Late Jurassic Kimmeridge Clay in a North Sea well. Free hydrocarbons, sulphur compounds and sequestered hydrocarbons released by NiB desulphurization from high-molecular-weight fractions were analysed. A regular stratigraphic variation is found in relative abundances of some hydrocarbon biomarkers, both free and sulphur-bound. It was also noted that these samples contain relatively high amounts of Gymnosperm-derived biomarkers as well as dinoflagellate-derived biomarkers.

To better understand the incorporation of sulphur into organic matter, experiments have been performed to simulate the natural sulphurization of ketones and aldehydes. The results indicate that these compounds are prone to incorporation of sulphur during early diagenesis. The oxo-group is substituted by sulphur, and cyclic and macromolecular organic sulphur compounds are formed. These results provide a good explanation for the sulphurization of C_{37} and C_{38} methyl and ethyl ketones in sediments.

In co-operation with Dr. Eglinton (WHOI) samples from the Monterey and Peru upwelling areas are investigated using several chemical degradation techniques. It is hoped that the results will shed further light on the process of sulphur incorporation during very early diagenesis.



Concentrations of sulphur-bound ß,ß-carotane and isorenieratane from the carotenoids ß,ß-carotene and isorenieratene in surface sediments of the Black Sea. Isorenieratene is a specific carotenoid of photosynthetic green sulphur bacteria. And, therefore, sulphur-bound isorenieratane can be used to trace shoaling of the chemocline into the photic zone in the past.

H4-1.3. DIAGENETIC PATHWAYS OF ORGANIC SULPHUR COMPOUNDS AND SULPHUR-CONTAINING GEOMACROMOLECULES

M.P. Koopmans, J.S. Sinninghe Damsté, J.W. de Leeuw, R.A.A. van Malderen, M.D. Lewan

In recent years, research activities in the field of organic sulphur geochemistry have increased enormously. For instance, much attention has been given to the incorporation of sulphur into organic matter at a molecular level. In the course of these investigations, it was discovered that some types of organic sulphur compounds (OSC) are omnipresent in immature sedimentary rocks and crude oils, albeit with different distribution patterns. Therefore, it was proposed that OSC could be used as molecular indicators for biological and physical properties of the depositional environment. This has been successfully demonstrated in the case of immature sediments. However, it is presently unclear at what level of thermal maturity OSC can still be used for palaeo-environmental reconstructions.

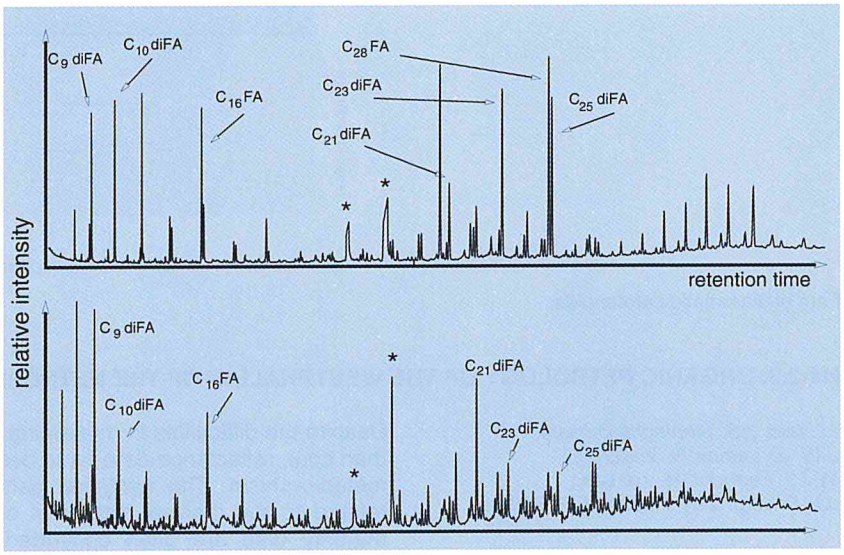
To elucidate this matter, an immature sulphur-rich sedimentary rock sample from the Messinian Gessoso-Solfifera formation in the Vena del Gesso basin (Italy) was artificially matured at different conditions by means of hydrous pyrolysis. These maturation experiments were carried out in collaboration with Dr. M.D. Lewan of the US Geological Survey, Denver, USA. Analysis of the produced maturation series indicates that relatively mild maturation conditions (200 ° C-300 ° C; 72h) already have a large impact on the abundance and distribution of OSC in this low-TOC rock. The sulphur-containing geomacromolecules break down into smaller molecules, probably due to cleavage of weak sulphide bridges.

Also, a second maturation series has been prepared from an immature sulphur-rich high-TOC sedimentary rock sample from the upper Cretaceous Ghareb formation (Jordan). The extended maturity interval (200 °C-365 ° C; 72h) will enable us to follow the abundance and distribution of OSC well into the oil window.

H4-1.5. CHEMICAL DEGRADATION OF MACROMOLECULES IN SULPHUR-RICH SEDIMENTS

S. Schouten, J.S. Sinninghe Damsté, J.W. de Leeuw, W.I.C. Rijpstra, P. Moerkerken, M. Ahmed, G.B. van Driel, R.A.A. van Malderen

The purpose of this project is to improve retrieval of palaeo-environmental information sequestered in macromolecules of S-rich sediments. In collaboration with Newcastle Research Group (Univ. of Newcastle, England), M. Ahmed has tested RuO_4 oxidation on model compounds, biopolymers and kerogens. Initial results indicate a large potential of this method. Biopolymers isolated from algae and cuticles of leaves were depolymerized to specific carboxylic acids. The 50 My old Messel kerogen degradation products show a similar distribution of mono- and dicarboxylic acids as those of the algaenan (see H4-3.2.) cell wall biopolymer of the green microalga *Tetraedron minimum*.



Gas chromatograms of product mixtures from RuO_4-degradation of algaenan from *T. minimum* (top), and Eocene Messel kerogen (bottom). *=contamination.

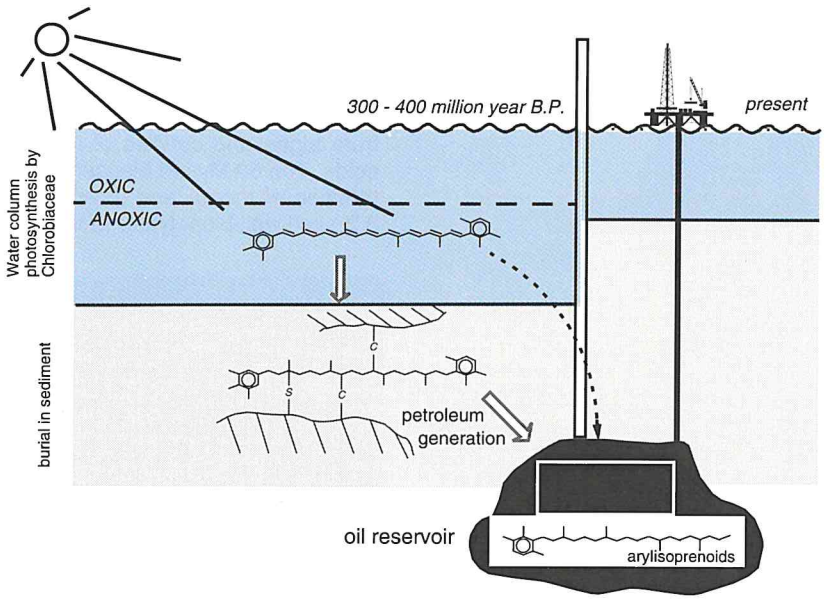
Selective chemical degradation reagents for sulphur-rich macromolecules have been further developed. The Nickel boride methods shows some promise and is further investigated by R.A.A. van Malderen to optimize the parameters for quantitative desulphurizations.

H4-2.2. ORIGIN AND FATE OF AROMATIC CONSTITUENTS IN MACROMOLECULAR MATTER

W.A. Hartgers, J.W. de Leeuw, J.S. Sinninghe Damsté, A.G. Requejo, J.M. Hayes, J.C. Crelling, G.R. Dyrkacz

The research has focused on pyrolysates of high-molecular-weight sedimentary fractions and oils from the Duvernay Formation (Western Canada Basin; 350 My), which are characterized by a high abundance of one specific compound: 1,2,3,4-tetramethylbenzene. To elucidate its origin, a combined molecular and stable carbon isotopic study has been performed. It was found that macromolecularly-bound diaromatic carotenoids account for this specific component. Isolation by HPLC and characterization by ^{1}H NMR revealed the structure of a diaromatic carotenoid with an unprecedented 2,3,6-/3,4,5-trimethyl aromatic substitution pattern. In addition to these specific molecular features, distinct isotopic compositions of these compounds indicate an origin from the photosynthetic green sulphur bacteria (Chlorobiaceae). The presence of these obligate anoxic bacteria reveals a penetration of anoxic water layers into the photic zone during time of deposition.

Pyrolytic studies performed on synthesized benzene and thiophene model compounds revealed a preference for cleavage of the carbon-carbon bond ß and, to a lesser extent, γ to the aromatic nucleus. This mechanistic information was applied to analyse the aromatic pyrolysis products generated upon flash pyrolysis of density fractions of the Posidonia kerogen (Type II; Germany, 180 My). These fractions were obtained by the density centrifugation technique. It was found that small amounts of pyrite (iron sulphide) associated to the organic matter in the sediment sample dramatically disturbed the result of the density separation, because of the high density of this mineral. The objective of current efforts, therefore, is a selective removal of this mineral from the organic matrix.



Fate of diaromatic carotenoids.

H4-2.3. ORGANIC PETROLOGY OF THE WESTPHALIAN OF THE NETHERLANDS

H. Veld, J.S. Sinninghe Damsté, J.W. de Leeuw, H. Visscher, W.J.J. Fermont, H. v.d. Laar, J.H.F. Kerp, J.-N. Rouzaud, R. Wilkins

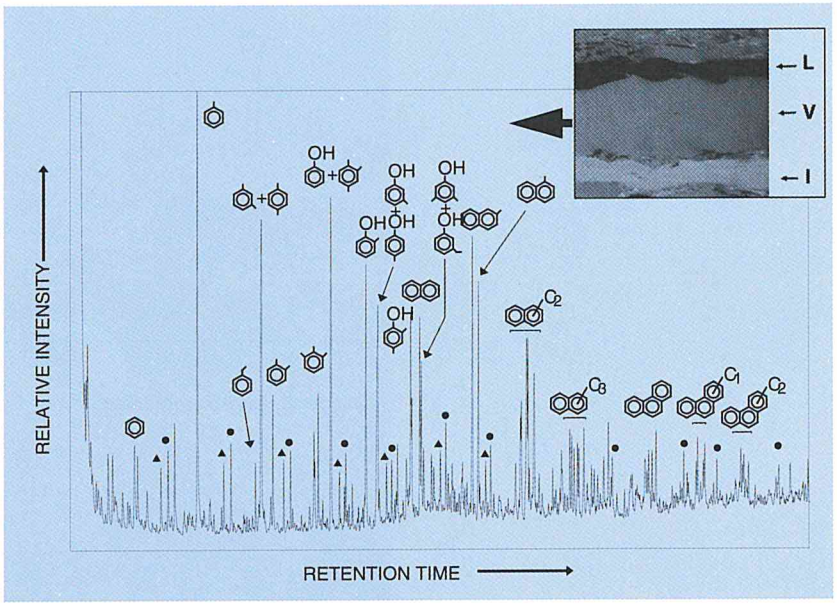
Despite the difficulties in measuring the vitrinite reflectance in sediments other than coal, reflectance data have become a standard for the degree of organic metamorphism. The evolution pattern of vitrinite reflectance is intrinsically related to the thermal history of organic matter. Therefore, other observed maturity data are often converted into vitrinite reflectance equivalents by

means of empirical calibration curves. Vitrinite reflectance is by definition measured on one specific coal maceral, whereas chemical rank parameters are often obtained from representative bulk samples of coal and rarely on pure maceral concentrates. In the present project the combined use of optical, photometric and organic geochemical methods allowed for the characterization of a set of isolated vitrinites of different rank.

Curie-point pyrolysis-gas chromatography (Py-GC) and Curie-point pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS) were performed on four selected vitrinite concentrates of maturity levels ranging from 0.96%Rmax to 1.93%Rmax to study possible relationships between the molecular structure of organic material and vitrinite reflectance. With increasing maturity the amount and number of pyrolysis products decrease significantly. The most obvious trends are decreases in n-alkane and n-alkenes, alkylphenols, and C_2 alkylated naphtalenes upon increasing maturity.

Alkylbenzenes and C_1 alkylated naphtalenes remain prominent pyrolysis products throughout the maturity interval investigated. Furthermore, a significant increase in alkylphenanthrenes and alkylbiphenyls with increasing maturity is noted. There is a substantial overlap between the compositions of the 'thermal extracts' (Cu-temperatures of 358°C) and the pyrolysates (Cu-temperatures of 770°C) indicating that the trends observed are mainly due to changes in distributions of low-molecular-weight compounds.

Vitrinite reflectance measurements carried out on the unextracted and extracted vitrinite concentrates generally did not reveal significant differences. For one sample, however, the reflectance value of the extracted fraction was significantly higher than for the unextracted fraction. Because the maturity of this sample falls within the transition-interval from the 'oil window' to the 'gas window', these reflectance differences have been related to hydrocarbon generation and subsequent expulsion from coals.



Microscopical and chemical appearance of coal. Microphotograph in normal reflected light (approx. 400x) showing the three groups of coal constituents, L=Liptinite; V=Vitrinite; I=Inertinite. The gas chromatogram gives the major pyrolysis products of a vitrinite concentrate with a vitrinite reflectance value of 1.0%Rmax.

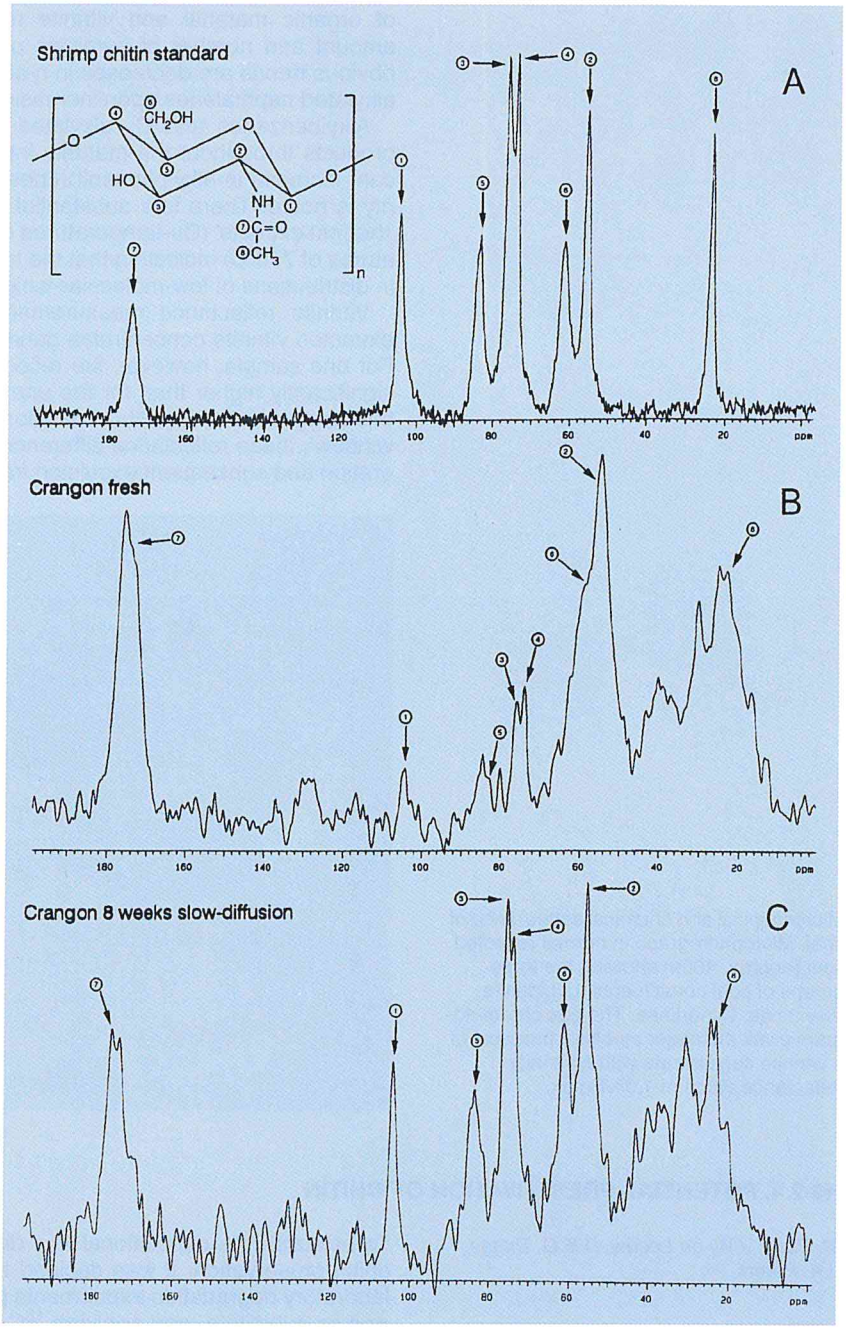
H4-2.4. POTENTIAL PRESERVATION OF CHITIN

M. Baas, J.W. de Leeuw, D.E.G. Briggs, J.A. Peters

To establish the depositional and diagenetic conditions resulting in long-term chitin preservation, it was decided to explore chitin behaviour during 8-week laboratory degradation experiments performed using the shrimp *Crangon crangon* as substitute, and applying ^{13}C-NMR and pyrolysis-gas chromatography-mass spectrometry. Since chitin represents one of the most abundant organic constituents in biomass on Earth, an investigation of its potential survival in sediments is justified. Moreover, results of investigations performed on sedi-

ment samples so far are troublesome in that no straightforward answers concerning the preservation of chitin in the sedimentary environment were found.

These analytical methods demonstrated that chitin represents the major component of the remaining biomass after only 8 weeks. This selective preservation confirms that the resistance of chitin to decay is a major factor in accounting for the extensive fossil record of arthropods lacking a biomineralized skeleton. It also suggests that chitin is likely to be an important contributor to the organic content of marine sediments.



Solid state ^{13}C-NMR spectra of shrimp chitin standard, the fresh shrimp *Crangon* and *Crangon* after 8 weeks of slow-diffusion.

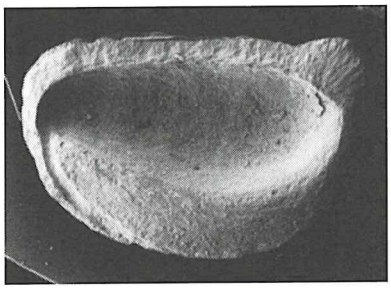
H4-3.1. MOLECULAR PALAEOBOTANY OF PROPAGULES (*i.e.* SEEDS, FRUITS, SPORES): PALAEO-ENVIRONMENTAL, ORGANIC GEOCHEMICAL AND SYSTEMATIC IMPLICATIONS

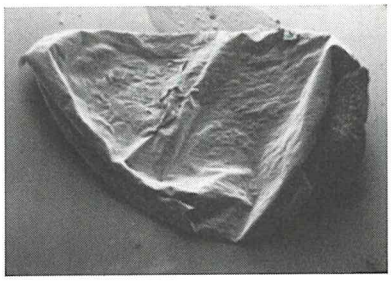
P.F. van Bergen, J.W. de Leeuw, J.S. Sinninghe Damsté, M.E. Collinson, A.C. Scott, P.J. Barrie, M. Goñi, G.P. Hatcher

Resistant constituents of fossil and extant propagules (*i.e.* seeds, fruits and spores) have been analysed by flash pyrolysis, NMR and (light- and electron-) microscopy to elucidate the relationship between distinct morphological entities or tissues and their chemistry. The results obtained have been used 1) in palaeo-environmental interpretations, 2) to establish organic geochemical pathways of macromolecules and their possible contribution to kerogen and 3) to recognize systematic relationships between different propagules. In addition, fossil Carboniferous pteridosperm cuticles have been analysed to determine their potential contribution to the formation of hydrocarbons in crude oils.

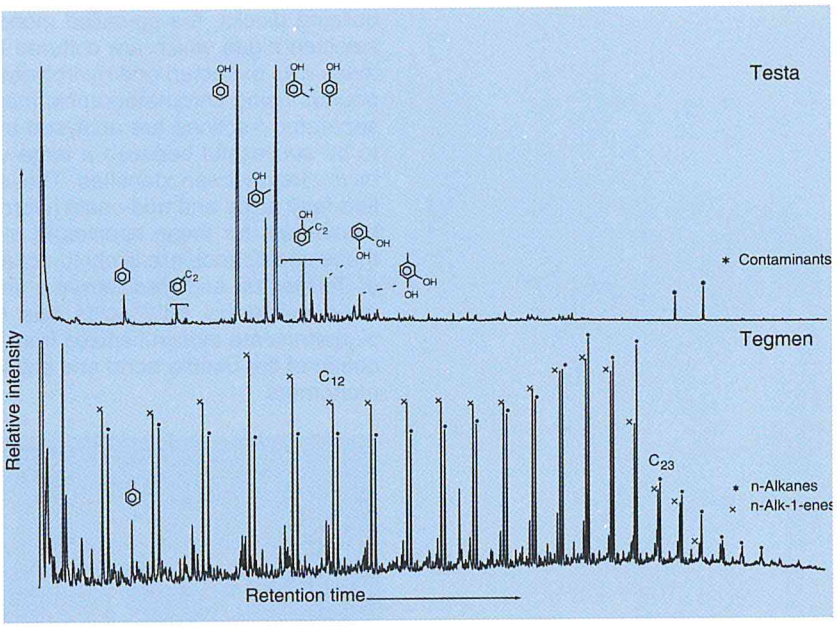
The results obtained with seed coat materials show that the two morphologically distinct seed coat layers (testa and tegmen) are composed of different resistant macromolecules (lignin in the testa and 'cutan' in the tegmen) both with different preservation potentials. Furthermore, seed coat material from different depositional settings revealed that the micromorphology was best preserved in fine-grained sediments whereas the insoluble chemical constituents were best preserved in the coarse-grained sediments.

Based on these results it was concluded that the seed coats of the water plants studied are composed of two different resistant biomacromolecules, each with a different preservation potential which may partly depend on lithologies.





Py (610°C)-GC-FID of fossil seed coat of *Stratiotes* cf. *headonesis*



H4-3.2. NOVEL AND SPECIFIC LOW- AND HIGH-MOLECULAR-WEIGHT SUBSTANCES OF GREEN MICROALGAE

J.W. de Leeuw, M. Baas, W.I.C. Rijpstra, F. Gelin, H. van den Ende, P. Metzger, C. Largeau, S. Derenne

A relatively large number of green microalgae such as *Botryococcus, Pediastrum, Scenedesmus, Tetraedron* and *Nannochloris* biosynthesize highly resistant, highly aliphatic cell wall component, recently termed algaenans. These algaenans are geochemically important substances because they are selectively enriched during diagenesis and act in many cases as the organic matter in source rocks generating oil. Because of their geochemical relevance a better understanding of the algaenan structures is required and several studies in our department are dedicated to this.

A detailed study using Curie point pyrolysis-gas chromatography (Py-GC) and Curie point pyrolysis-gas chromatography-mass spectroscopy (Py-GC-MS) of several high-molecular-weight (HMW) lipids biosynthesized by the

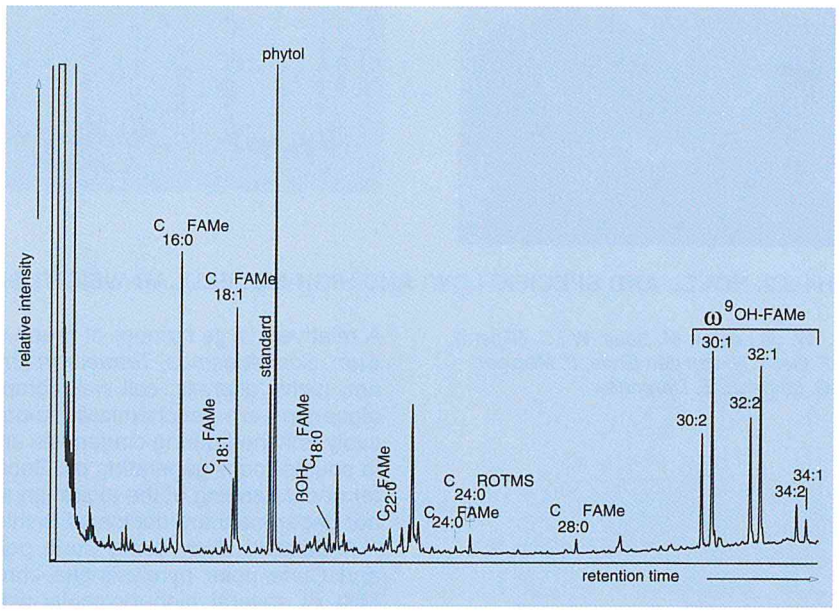
green microalga *Botryococcus braunii* was performed. These lipids were isolated and structurally identified by P. Metzger at Ecole Nationale Supérieure de Chimie de Paris (ENSCP). This investigation provided data that allow a better understanding of complex pyrolysis mechanisms associated with the flash pyrolysis of biomacromolecular structures corresponding to alkyl groups linked by ether bonds. The presence of alkenes, alkadienes, alk-9-ones and alk-10-ones with chain lengths corresponding to those of the ether bond alkyl chains indicated that the cleavage of the C-O bond is an important first step in the pyrolysis process.

In addition, some HMW lipids (up to C_{64}) were analysed by GC-MS using high-temperature capillary columns.

These studies allowed for the structural reconstruction of the main biopolymer that composes the outer cell walls of *B. braunii* race L. This biomacromolecule was found to be composed of C_{40} isoprenoid (lycopene) units cross-linked via ether bridges at C14 and C15.

A detailed comparison of two macromolecular materials, a soluble aliphatic polyaldehyde and an insoluble biopolymer termed Bb(A) algaenan, both isolated from *B. braunii* race A was performed. Comparisons of specific mass chromatograms and compositions of three clusters of pyrolysis products with different chain lengths show major similarities in their chemical structures. According to these results, the molecular structure of the insoluble Bb(A) algaenan is thought to be a more condensed and/or a reticulated form of the soluble polyaldehyde.

Furthermore, attempts are made to establish the structures of potential building blocks, the so-called monomers, of these algaenans in a number of selected algae which are cultured for this purpose. To this end the algal biomass was extracted and hydrolysed and separated in several classes of compounds using chromatographic methods. After appropriate derivatisation, the separated fractions are analysed by GC and GC-MS. This approach appears to be successful because a large variety of highly specific novel compounds have already been identified. These compounds (Δ^7-sterols, long-chain esterified fatty acids and mid-chain hydroxy fatty acids) can serve as highly specific biomarkers for these species of algae when present in sediments. Some of these compounds are likely to act as monomers of the algaenans. In the case of *Tetraedron* and *Pediastrum* a series of long-chain (C_{30}-C_{34}) mono-unsaturated ω-hydroxy fatty acids has been encountered. It is likely that these algaenans are biosynthesized from these unsaturated hydroxy acids via epoxidation of the double bond and subsequent ether bond formations between the monomers.



Specific gas chromatogram of the ester bound lipids of a *Pediastrum* species.

H4-3.3. VARIATIONS OF ORGANIC CONSTITUENTS AT THE K/T BOUNDARY

M. Yamamoto, M. Baas, J.W. de Leeuw, H. Brinkhuis, H. Visscher, J. Smit

The recently discovered excellent sediment sequence of the K/T boundary of the Geulhemmerberg near Maastricht has been preliminarily investigated for low-molecular-weight organic compounds. Unusual distributions of n-alkane, fatty acids, alcohols have been encountered. The major compound in the extracts was tentatively identified as a diunsaturated C_{40}-ethylketone, a compound never observed before.

Because palynological studies by Utrecht University reveal the presence of only dinoflagellate cysts and abundant spores of mosses, a detailed study of organic matter in such spores has started.

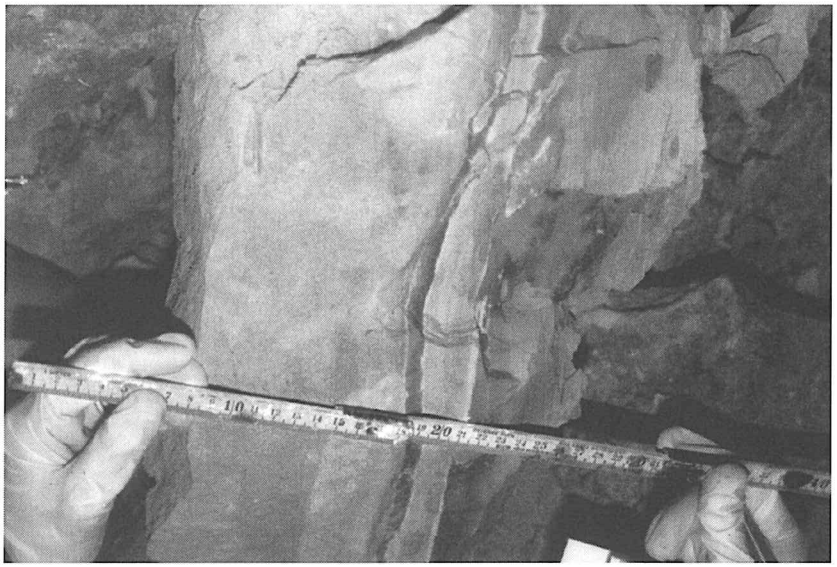


Photo: M. Baas

The K/T boundary of the Geulhemmerberg.

H4-4.1. MOLECULAR CHARACTERIZATION OF PARTICULATE ORGANIC MATTER IN ESTUARIES AND COASTAL SEAS

S. Peulvé, J.W. de Leeuw, M. Baas, M.-A. Sicre, A. Saliot

Very little is known about the way riverine dissolved and particulate organic matter is affected by the physical and the physico-chemical properties of mixing fresh and marine waters. It is assumed, however, that macromolecular organic compounds may play an important role, since they represent at least 80% of the total organic carbon. The knowledge of the role of organic bio- and geomacromolecules in carbon cycling within sediments is poor. Such macromolecules are not well-characterized. The recognition of the organic carbon cycle in recent marine environments, coastal as well as offshore, was accomplished using traditional low-molecular-weight biomarkers. Characterization and application of the macromolecular fraction has become possible through Curie point pyrolysis-gas chromatography and Curie point pyrolysis-gas chromatography-mass spectrometry (CuPy-GC and CuPy-GC-MS respectively). These methods involve thermolytic processes producing fragments (pyrolysis products) which can be related to the original macromolecules. Hence, it is possible to analyse the composition of complex organic carbon. CuPy-GC and CuPy-GC-MS were applied to characterize the macromolecular organic constituents of the suspended material of the surface and bottom waters and to investigate their role in the formation of the benthic nepheloid layer developing in the microtidal estuary of the Rhone River (France). We were able to characterize the complex organic matter in the surface waters of the Rhone Delta in terms of allochthonous and autochthonous inputs. We also followed the evolution of the Rhone River organic matter during flocculation and coagulation processes occurring in the salinity gradient of the Rhone estuary.

Macromolecular indicators were also applied to characterize water masses in an Arctic Delta: the Lena River and adjacent Laptev Sea, Siberia, Russia. As

well as in the previous study, we can characterize the different allochthonous and autochthonous inputs to the Laptev Sea. Our data also allowed us to differentiate between the surface waters, essentially consisting of relatively warm fresh waters from the Lena River, and the bottom Arctic waters, characterized by a higher salinity and a near freezing point temperature. We thus concluded that algal organic matter, abundantly present in the surface layers, is very efficiently reworked by heterotrophic microorganisms in the water column at intermediate depth.

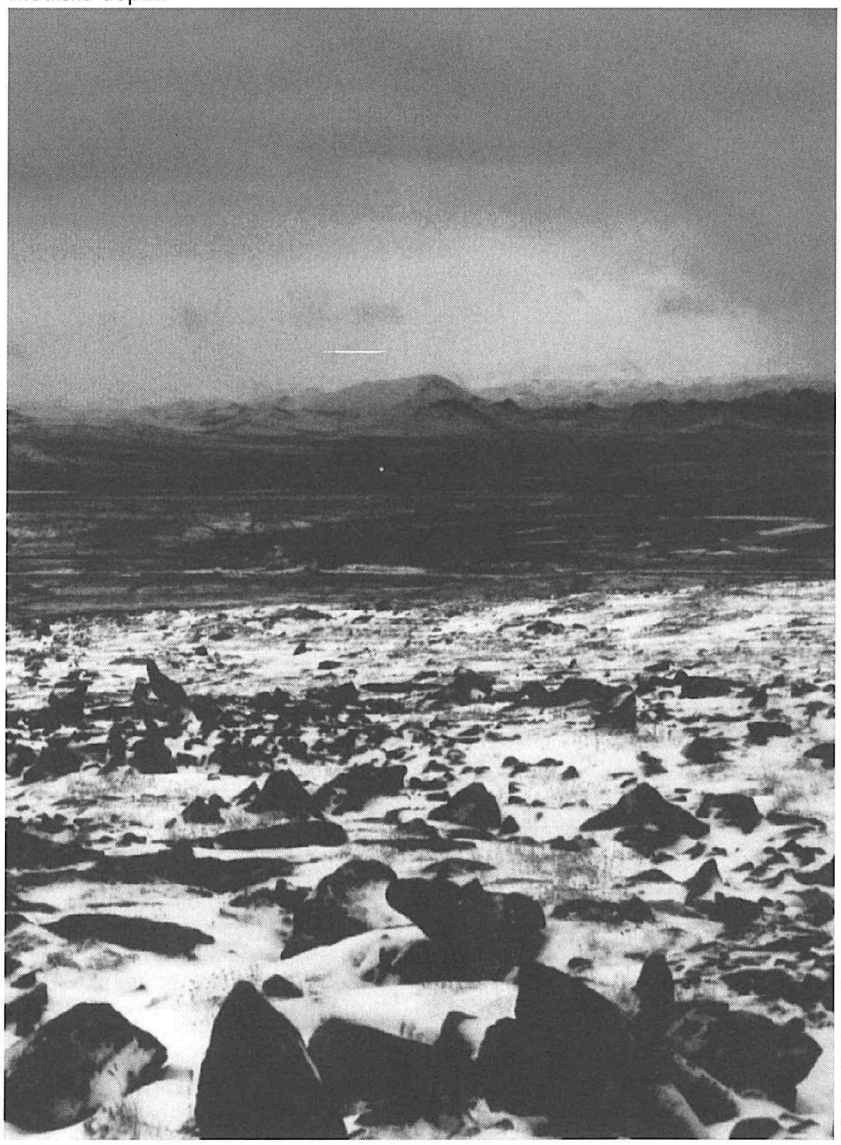


Photo: S. Peulvé

Delta of the Lena river.

H4-4.2. MOLECULAR CHARACTERIZATION OF DISSOLVED ORGANIC MATTER

J.D.H. van Heemst, J.W. de Leeuw, M. Baas, C.J. Wiebinga, H.J.W. de Baar, J. Hegeman, M. le Clercq, J. van der Plicht, V. Klap, F. Schut, R. Benner, P.G. Hatcher

This project involves the analysis of dissolved organic matter (DOM) at the molecular level in the ocean, including the analysis of colloids and small particles. Until now three samples have been analysed from Aloha Station (22°45.0'N 158° 00.0'W) from three diferent depths. These samples have been analysed by Curie-point pyrolysis-gas chromatography-mass spectroscopy (Py-GC-MS). Also standard compounds have been analysed by Py-GC-MS in order to produce reference chromatograms and mass spectra which can be used in identifying the source of unknown pyrolysis products and their origin. These compounds were chitin and peptidoglycan isolated from bacterial cell

walls. The cell wall sample was derived from *Pseudomonas* sp. Strain RB2256 (ultramicrobacteria). A number of pyrolysis compounds of the DOM-samples may indeed have been derived from aminopolysaccharides originating from bacterial cell walls, but the source of most of the pyrolysis products is still unknown. It can, however, already be concluded that the organic nitrogen in DOM is very unlikely to have derived from proteins as commonly thought.

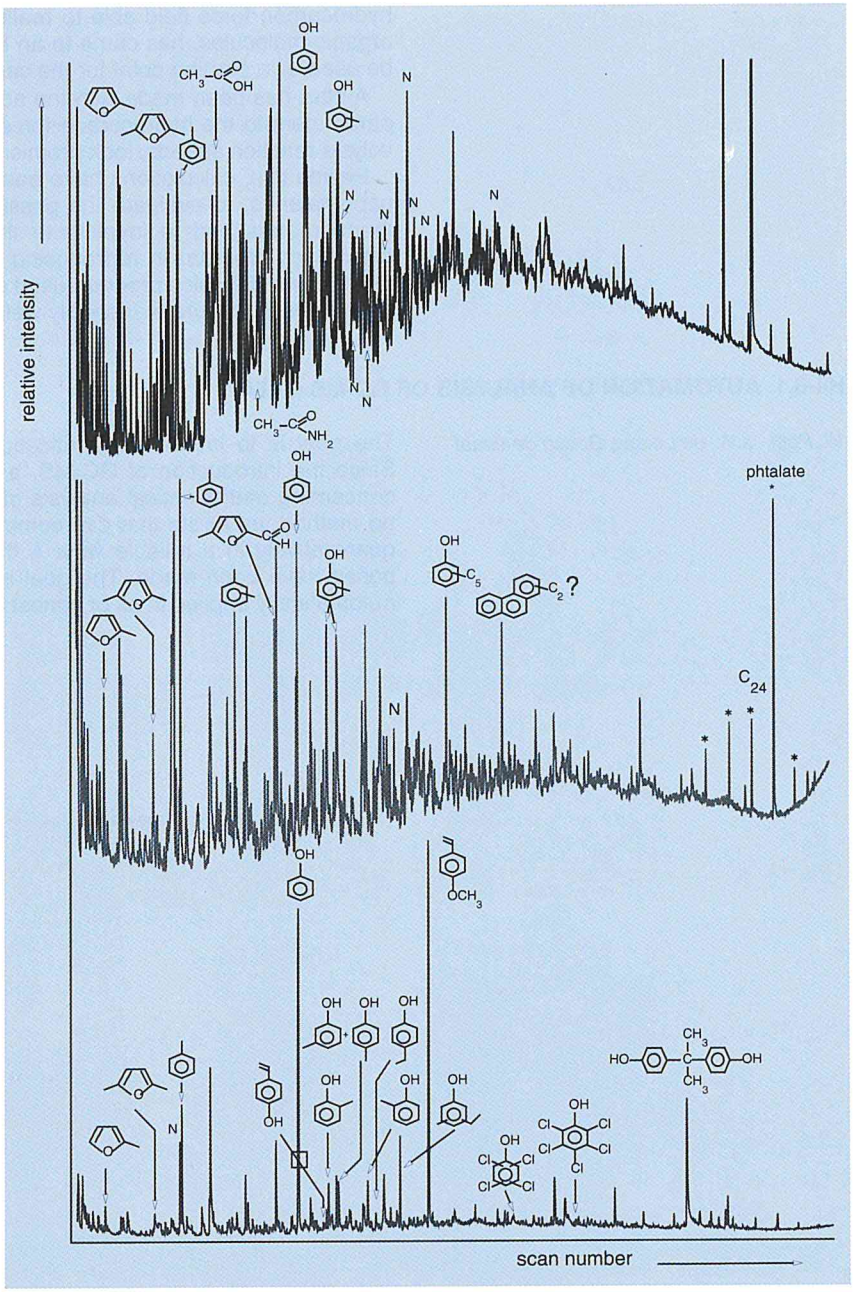
ALOHA STATION
10 m
Py-GC-MS (610°C)

N = N-cont. prod.

ALOHA STATION
765 m
Py-GC-MS (610°C)

* n-alkanes

ALOHA STATION
4000 m
Py-GC-MS (610°C)



H4-5.1. MOLECULAR MECHANICS CALCULATIONS OF GEOCHEMICALLY RELEVANT COMPOUNDS AND CARBO-CATIONS

A.C.T. van Duin, J.M.A. Baas, B. van de Graaf, J.W. de Leeuw, T.P. Bastow, R. Alexander

Force field calculations of energy contents and free Gibbs energies of biogeochemically relevant molecules open the possibility to predict and check the isomerization of organic molecules in sediments. Such isomerizations give

detailed insight into subtle changes in maturity of sediments. This research is performed in close collaboration with the Molecular Mechanics research unit of the Delft University of Technology. To be able to predict the kinetics of isomerization reactions, thermodynamic data on the proposed intermediate, the carbo-cation, are vital. To obtain this information we try to develop a molecular mechanics force field for these carbo-cations. In this year the first stage in the development of this carbo-cation force field, the creation of a new type of hydrocarbon force field able to realistically deal with pole-pole interactions in organic molecules, has come to an end. This new hydrocarbon force field will be used as a starting point for the carbocation force field.

A start has been made with the adding and optimization of the carbo-cation parameters to the hydrocarbon force field. First results, mainly based on solvolysis reaction speeds, look promising.

Beside this, calculations have been performed on a mixture of tetramethylnaphthalenes, to evaluate the possible use of these compounds as palaeothermometers and to investigate the capabilities of the modern molecular mechanics program in reproducing experimental mixture compositions. The molecular mechanics program used (MM3) proved to be able to reproduce the experimental mixture reasonably well.

H4-6.1. AUTOMATION OF ANALYSIS OF GC-MS DATA

W. Pool, J.W. de Leeuw, B. van de Graaf

The goal is to improve quantification of GC-MS data of complex mixtures. Since the introduction of GC-MS, a great many publications have appeared concerning mathematical analysis of two dimensional data. In spite of those, no method yet exists that can commonly be applied to process GC-MS data quantitatively in a reliable way. A thorough comparison of the routines proposed have been made. The goal is to develop a good method that can be automatically applied in all or almost all situations.

1.6. BENTHIC SYSTEMS (B1)

INTRODUCTION

Research in the Department of Benthic Systems in 1993 concerns the structure and functioning of marine benthic ecosystems in shelf sea areas, on the continental slope and in the deep sea.

The current research projects are divisible into two major themes, *viz.*:

- Structure and dynamics of benthic systems.

Research deals with the composition and structural properties of selected benthic communities in terms of biodiversity, size spectra, numerical density and biomass. Attention is paid to the forcing factors, including the effects of natural and man-induced perturbations. Comparative studies in areas that offer a wide range of extremes (*e.g.* high *versus* low altitude, neritic-oceanic, shallow-deep, soft-hard bottom, oligotrophic-eutrophic) will further our understanding of the structure of the ecosystem, its maintenance/resilience capacities and long-term alterations.

A new project studies the relationship between phenotypical properties and life-supporting characteristics of marine invertebrates and its possible contribution to the fitness of species in specific environments.

- Supply, quality and utilization of organic matter in benthic communities.

Research deals with the origin, supply, quality and utilization of organic matter in benthic ecosystems. Subjects studied are pelagic-benthic coupling, metabolic activity of major groups of organisms and decomposition/mineralization. Relevant studies include benthic boundary interactions and processes in shelf sea and deep sea, metabolic activity and growth of single species, community metabolism, partitioning of food over major groups of organisms, mineralization.

Studies range from particle interception in the water column to sedimentation and burial; from single species activity to community metabolism and from shallow areas to the deep sea environment.

Earlier projects Benthic Mesocosms (B1-01), EROS (B1-04-01) and BEST (B1-14) have been completed. Three new projects: Differentiations in marine invertebrates (B1-1.4), OMEX (B1-2.2) and small food web nutrient dynamics (B1-2.7), have been added.

In 1993 the Department of Benthic Systems again participated in a great number of sea-going expeditions and activities:

—North Sea: Biomonitoring, Milzon, *Arctica* projects and Disturbance of Global Systems
—Weddell Sea: UV Research
—Somalia/Oman: NIOP
—Adriatic Sea: EC/STEP
—Celtic Sea: EC/MAST-OMEX

Good news from the Bottom Landing System (BOLAS): It has been deployed 15 times in the Indian Ocean, Adriatic Sea and the Celtic Sea, and its numerous functions have proved 100% successful.

B1-02 MICROBIAL BIOMASS AND ACTIVITY IN MARINE ECOSYSTEMS

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

Distribution of microbial biomass and activity has been studied in selected marine ecosystems in various climatic regions.

During a cruise in the Weddell Sea (Antarctica) the distribution of microbial activity was studied. The vertical profiles of biomass and activity showed the highest values in the upper 50 m of the water column, *viz.* in an algae bloom at the ice shelf. A horizontal distribution of the micro-organisms shows a high correlation with the ice situation along the cruise transect across the Weddell Sea: high values in the open water of the polynya, lower values in the ice-covered area, again higher values in the central Weddell Sea, where more open water was observed, and after that a region with ice cover and lower microbial activity. At the end of the cruise again in open water higher values were found.

In the Dutch Wadden Sea microbial biomass, respiration activity and bacterial numbers were measured during two cruises and near the NIOZ harbour. Even in winter high biomass of micro-organisms was observed and the percentage of bacterial carbon to the total microbial carbon was highest during the winter (30-60%) and lowest when the total biomass was highest. In winter a significant fraction of the bacterial population remained active (16-23%). In September during a cruise to the mussel culture areas, the effect of these cultures on the microbial population in the water column was studied.

Photo: J.H. Vosjan

In Kenyan coastal areas the effect of oyster cultures on microorganisms in the water-phase was studied and compared with similar situations in the Dutch Wadden Sea. (Cooperation with the Belgian-Kenyan Programme and Fame, Free University Brussels.)

Role of UV-b in microbial ecology

There is clear evidence that the stratospheric ozone layer has decreased in recent years. Consequently, the UV-b radiation reaching the earth's surface has increased. It has long been known that UV radiation is harmful to living organisms, but we are far from predicting the effect of an increase of UV-b on the marine ecosystem. Therefore we studied the attenuation of PAR, UV-a and UV-b over a transect in the clear waters of the Weddell Sea and in the turbid waters of the Dutch Wadden Sea. In the Weddell Sea the 1% level of PAR, UV-a and UV-b was maximal at depths of 70, 45 and 25 m, respectively. There was a clear relation between the light penetration and the microbial biomass concentration in the water.

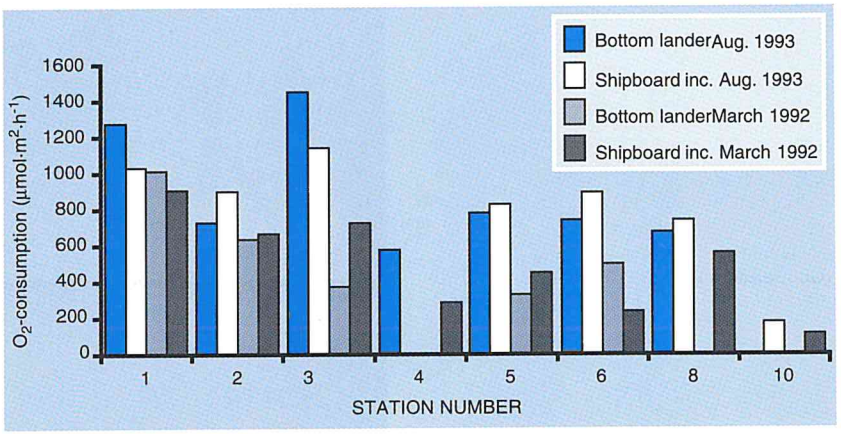
To predict a change in microbial species composition after UV-b irradiation, we have to know if there is a natural variability in the UV-b sensitivity. Therefore we studied the variability of marine bacteria to UV-b sensitivity. So far pure cultures of Wadden Sea bacteria have proved very sensitive, and show only a small range of variability. The question why some bacteria are more sensitive than others requires more study.

B1-04-2/B1-04-4 BENTHIC BOUNDARY PROCESSES AT CONTINENTAL SHELVES AND DEEP SEA SLOPES, SOMALIA/OMAN, ADRIATIC SEA

T.M. Tahey, J. Belgers, P.A.W.J. de Wilde, A. Kok, H. Witte, G. Wijnsma

The benthic boundary contribution to the NIOP programme was completed with the second cruise (C2-leg) in February/March to the Somalian/Oman upwelling area. Shipboard incubations were performed at 9 stations along three transects, from shallow to 4000 m depth. Simultaneously with the shipboard incubations, the bottom lander BOLAS was deployed at 4 stations. Both types of experiments measured the oxygen consumption of the sediment with the faunal community included. Water samples from these incubations were taken in order to study the fluxes of nutrients (Si, PO_4^{3-}, NO_3^-, NO_2^-, NH_4^+) at the sediment-water interface. The sediment of the shipboard incubated cores was sieved afterwards to collect the macrofauna. Samples of sediment, bottom water, surface water and small sediment traps mounted on top of the bottom lander were taken for later analysis of phytopigments.

In August the second cruise in the framework of the EG-STEP programme took place in the Adriatic Sea. Italian and Dutch scientists aboard the Italian RV 'Urania', sampled at 8 shallow (<250 m) stations along the Italian coast off the river Po. The benthic contribution existed of similar measurements as described above. Progress was made by applying new oxygen sensors in the benthic lander, which proved to work well under these conditions. The first results show a generally higher sediment oxygen consumption than in the March 1992 cruise. The macrofauna of both the August and the March cruises has been counted and identified to higher taxonomic levels. Phytopigment measurements show lower concentrations and a narrower range of plant pigments at southern stations than at northern.



Benthic oxygen consumption at 8 stations along a north-south transect off the Italian Adriatic coast for March 1992 and August 1993. Values are derived from shipboard and *in situ* bottom lander incubations. The stations 1 to 8 have water depths between 25 and 50 m, whereas station 10 has a depth of 250 m. Stations 1 and 2 lie off the river Po, and station numbers are increasing southwards.

B1-04-3 BENTHIC BOUNDARY PROCESSES AT CONTINENTAL SHELVES AND DEEP SEA SLOPES KENYA (NIOP)

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

In collaboration with NIOO (Yerseke), monsoonal effects on the carbon flux in the coastal waters of Kenya were studied during two cruises in 1992. As part of this project, sediment respiration was measured along 3 transects perpendicular to the coast.

Comparison of the results from the two cruises did not reveal great differences between the benthic respiratory activity in the two periods. Sediment respiration at corresponding depths (range 50-2000 m) was invariably highest on the northernmost transect and lowest on the southernmost one. On all transects, sediment respiration rapidly decreased with increasing depth, with a distinct minimum at the depth of the oxygen minimum layer (*ca.* 1000 m). The pattern of respiratory activity on the 3 transects suggests that there is no substantial terrestrial food input to benthic communities along the transects near the river mouths. The lack of a monsoonal signal in benthic respiration may have been due to the fact that the current direction in December had not yet switched to the pattern typical for the NE monsoon. Water column characteristics such as depth of euphotic layer, nutrient levels and primary productivity,

however, did show considerable changes when compared to June. Further analysis of the organic carbon and chlorophyll content of sediment samples will show whether these changes in the pelagic had any effect on the sediment.

B1-05 CORAL REEF ECOLOGY

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

Ecological strategies of stony corals, key organisms on coral reefs, are determinant in reef community composition and biodiversity. The main focus in the project is on processes, such as interaction, between dominant benthic organisms in relation with long-term studies to understand coral reef community dynamics. Investigations include assessment of the roles of damage regeneration, interspecific interaction and intraspecific variation. Damage (the occurrence of lesions on coral colony surfaces) appears to be a common phenomenon in different zones of the reef, but location and size of lesions vary significantly. Regeneration efficiency and growth form (*e.g.* hemispherical, branched) are determining factors in coral survival. Intraspecific variation in the main Caribbean reef builder *Montastrea annularis* showed differences in fecundity, skeletal linear growth and regeneration efficiency.

Analysis of long-term records (1973 to 1992) of coral community composi-

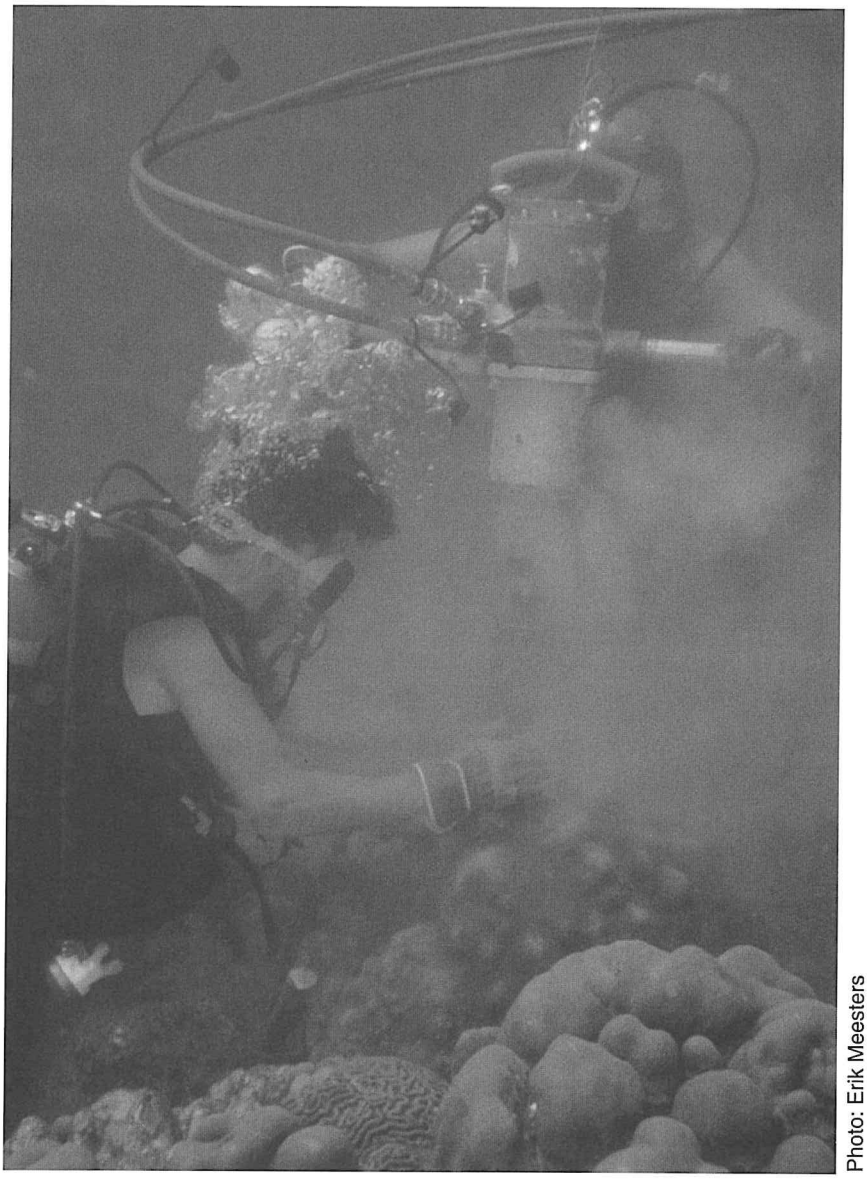


Photo: Erik Meesters

To investigate differences in growth rate within the polymorphic coral *Montastrea annularis*, cores are drilled in coral colonies at the reef of Curaçao (depth 10 m).

tion over the reefs in Curaçao and Bonaire showed numbers of species to have dropped in all permanent quadrates (n=16, each 3x3 m) at all depths (10-40 m). There is a significant decrease in coral cover at 10 and 20 m. Abundance of coral colonies decreased. Because largest changes occur in the shallowest depths and because preliminary observations of shallow water column characteristics are also indicative of change, we have started to investigate the linkage between coral reef water column and reef benthos.

B1-06 SMALL FOOD WEB STUDIES (PROTOZOANS)

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

At the base of the marine heterotrophic food web, nanoflagellates (2-20 m) can be voracious consumers of bacteria. It appears that quantities in excess of actual bacterial production can be consumed. Such situations are not limited to the pelagial but similar flagellate impact can be observed in the benthos.

Data on benthic nanoflagellates obtained during two seasons in North Sea bottoms (August 1991/February 1992) showed different effects of season on flagellate densities. At 10 out of 15 stations summer values where significantly higher than winter values. Flagellate densities in the surface layer of the sediment were 2 to 4 times higher than in deeper layers. Bacterial biomass and abundance probably determined minimum flagellate densities during winter. Increase in bacterial production was probably responsible for generally higher summer densities although grain size may be a limiting factor in silty sediments during summer.

Grazing experiments, performed concurrently with the density determinations, showed grazing rates to be the same in winter and summer, ranging from 1 to 44 bacteria $flag^{-1}hour^{-1}$. The percentages of flagellates consuming fluorescently labelled bacteria were higher in sandy sediments than in silty sediments and were lower in winter than in summer. The percentage bacterial production consumed by flagellates varied between 0.2 and 23.5% in summer and 1.0 and 415% in winter. The higher impact of flagellate bacterivory in winter is probably due to low bacterial production in that season.

Growth experiments were performed with two benthic flagellate species to study grazing activity during exponential and stationary growth. Grazing was measured using fluorescently labelled bacteria (FLB). Grazing behaviour was species specific: during stationary growth *Bodo saliens* showed a doubling of the percentage of flagellates ingesting marked bacteria and an increase in individual grazing rates, whereas *Bodo designis* showed no differences in grazing activity between the two growth phases. This phenomenon of non-continuous feeding during growth can explain variations in community feeding activity.

B1-09 GROWTH AND PRODUCTION OF MACROBENTHOS

RNA:DNA ratios

G.C.A. Duineveld, D. van Meerten, H.A. Visser, A. Kok

Determining biomass and growth rate of marine organisms by stock assessment and measuring changes in dimensions over time can be a slow, tedious and often imprecise process. Furthermore, this method does not allow the determination of 'instantaneous' growth rates which are useful for comparisons of spatial or temporal growth rates.

The majority of the cellular DNA is chromosomal. The DNA concentration represents an index of cell numbers since cellular DNA content is insensitive to changes in environmental conditions. Thus DNA contents in sediments may serve as a bulk measure for 'small food web' biomass in sediments.

The processes of cellular growth and division require the synthesis of nucleic acids and proteins. The RNA concentration is a parameter to determine the growth rate of an organism, because it serves as the machinery required for protein synthesis.

The ratio of RNA and DNA is, therefore, a more accurate index of metabolic activity than RNA concentration alone, because this ratio is not affected by the number or size of cells in a tissue sample. Given that growth (cell division and increase in size) is a metabolically active process, it is expected that RNA lev-

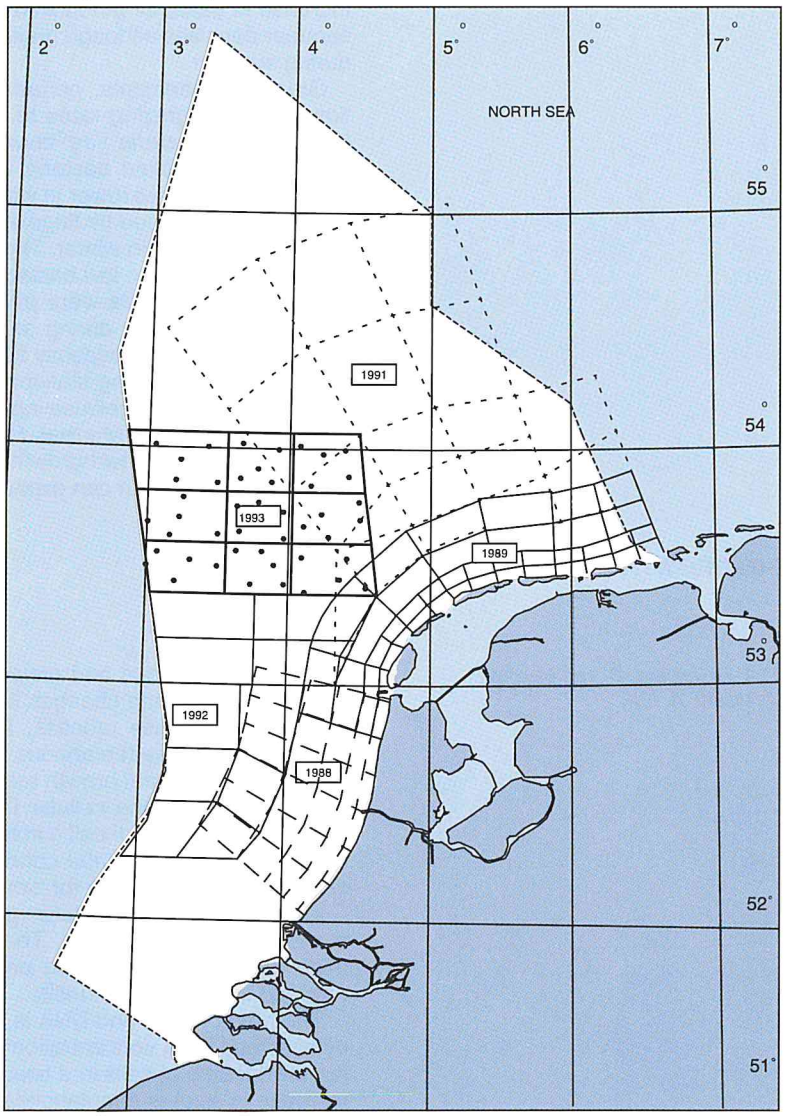
els would be much higher in actively growing tissues than in those at rest or growing only slowly. Variations in RNA:DNA ratios thus may prove to be a good measure of growth rates.

The RNA:DNA ratios can be determined fluorometrically after staining one or both types of nucleic acids with a fluorescent dye. The method used consisted of differentially staining DNA with BIS (bisbenziimidazole) and total nucleic acid with EB (ethidium bromide). On the basis of encouraging results, more experiments will be carried out in order to establish the RNA:DNA ratios of a bivalve and other benthic organisms.

B1-10-1 STRUCTURE AND DYNAMICS OF BENTHIC ECOSYSTEMS, BIOMONITORING NORTH SEA

G.C.A Duineveld, J. Belgers

The third inventory of the macrofauna in the North Sea was made as part of a 3-year monitoring programme commissioned by the Tidal Waters Division of RWS. The results of the first survey in 1991 showed that the 25 stations cover all infaunal communities in the southern North Sea. The data from the 1992 survey were compared with those of 1991 in order to assess changes in species and community. Only few species showed a coherent change over a wider geographical area. In all cases these changes were limited to the area along the Dutch coast. Community diversity and total biomass did not show a significant change within any of these areas



MILZON-BENTHOS I (1988-1989) ANDII (1991-1993) SURVEY AREAS
(See project B1-10-2)

B1-10-2 STRUCTURE AND DYNAMICS OF BENTHIC ECOSYSTEMS, MILZON-BENTHOS II PROJECT

S. Holtmann

The MILZON-BENTHOS II (MILieuZONering/Environmental Zonation) project (1991-1993) was carried out under commission of the North Sea Directorate (RWS) as a continuation of the MILZON-BENTHOS I project (1988-1989). The aim of the project is to study the spatial distribution of the zoobenthos in the Dutch part of the North Sea.

In spring 1992 and 1993, the area of the Broad Fourteens and Brown Bank (1992) and western Frisian Front area (1993) were divided into 19 compartments, based on a presumed homogeneous sediment composition. According to the 'stratified random sampling' method, in each compartment 3 to 5 stations were selected. Boxcore samples were collected at 85 stations to study the benthic fauna and to analyse sediment parameters.

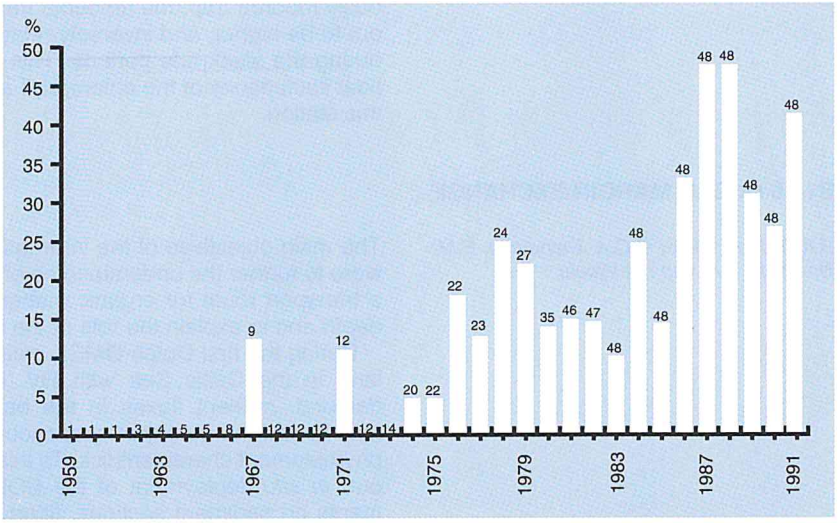
In the northern part of the area, the macrobenthos shows higher biomass and density, dominated by Echinodermata (*Amphiura filiformis, Echinocardium cordatum*) and Mollusca (*Mysella bidentata*).

B1-10-3 LONG-TERM STUDIES USING *ARCTICA ISLANDICA* (BIVALVIA)

R. Witbaard

Bivalves grow by deposition of annual increments. The longevity (>100 years) of *Arctica islandica* and its wide distribution in the North Atlantic shelf seas make it a potentially valuable indicator species for environmental changes.

Large variations in growth rate have been observed. Differences have been found both between years and between populations over the same period. Comparisons of populations give some idea of the factors controlling growth, but more knowledge of these factors is needed to warrant a retrospective study of the benthic environment based on the shell growth of *Arctica*. Therefore two growth experiments have been carried out in the laboratory to investigate the effect of temperature and food quantity on growth. They showed that shell growth increases with temperature between 1 °C and 12 °C as long as food is present in an optimum concentration. However, the temperature range used so far was too small to find the optimum temperature for growth. At a constant temperature of 9 °C an increasing availability of food resulted in increasing shell growth.



Occurrence of damage in *Arctica* shells for the period 1959-1991. Each bar represents the relative occurrence of scars (damaged increments) per year. The number of shells with a scar in a certain year is given as a percentage of all shells studied for that year. The total number of shells is given above each bar.

B1-10-4 THE APPEARANCE OF SCARS ON THE SHELL OF *ARCTICA ISLANDICA* AND THEIR RELATION TO BOTTOM TRAWL FISHERY

R. Klein, R. Witbaard

Field observations and literature data show that 70-90 percent of the bivalve *Arctica islandica* were damaged after being caught by a commercial beam-trawler. Since many shells of *Arctica* have signs of earlier breakage, visible as scars on the outside of the shell, *Arctica* can be used as an indicator of bottom

fishery. In 1992 a pilot study was conducted to study the possible relationship between the occurrence of scars on *Arctica* and bottom fishery. Of 48 shells all visible scars were dated by means of the animal's annual growth lines. The oldest animal found was 33 years old, offering the possibility of back-dating to 1959. Plotting the relative occurrence of scars per year from the whole sample showed that the sample site has been disturbed at least once a year since 1974. The pattern observed could be a reflection of changes in fishing intensity and fishing efficiency on this particular spot. This method might be a valuable tool to measure actual fishing intensities on very local scales.

B1-15 THE NORTH SEA AS A SINK FOR CARBON, VvA/NOP (GLOBAL CHANGE)

A. Boon, G.C.A Duineveld, E.M. Berghuis, J.A. van der Weele

This project focuses on the variations in quality and quantity of the benthic food supply in the North Sea and the response of the benthic infauna to these variations.

As a pilot study, bi-monthly samples from the sediment and near-bottom water were collected at 3 locations in the southern North Sea, *viz.* Frisian Front, Broad Fourteens and INP-mooring. The C, N, and phytopigment contents were taken as a measure of the quality of the seston and the sediment. First results from the pigment analysis of the sediment (10 cm cores) show distinct spring peaks in chlorophyll *a* at all stations. During this period, *Phaeocystis* is probably one of the important algae in the boundary layer. This spring pulse of phytodetritus is, however, rapidly broken down. After one month, *i.e.* by June, chlorophyll *a* levels were at a minimum at all locations. This fast degradation of labile phytodetritus agrees with earlier observations in North Sea mesocosms. Only the August samples from the Frisian Front revealed increased levels of chlorophyll *a*, now probably derived from a diatom bloom, accompanied by a set of accessory pigments different from the bloom in May and June.

To measure particulate benthic fluxes, a sedimentation recorder was tested that was designed to trap also horizontally moving particles which come into reach of the sediment. The collection made by the recorder is thought to be a better reflection of the potential food to surface-feeding animals than that of a classic sediment trap. Compared to the almost constant flux in a simultaneously moored trap, the amounts trapped by the sedimentation recorder turned out to be higher, and inversely related to the current speed with highest fluxes during the slack tide periods. This result agrees with earlier observations on tidal fluctuations of the chlorophyll *a* content in the top layer of the sediment of this station.

B1-16 OCEAN MARGIN EXCHANGE

P.A.W.J. de Wilde, G.C.A. Duineveld, E.M. Berghuis, J.A. van der Weele

The main objectives of the international OMEX-EC benthic biology subproject were to further the understanding of the significance of the continental slope as a transport route for organic matter from the shelf downwards to the abyssal depth and to explain the role of the biota in this.

During the first Dutch OMEX cruise in October, carried out southwest of Ireland in the Celtic Sea with RV 'Pelagia', we measured sediment oxygen demand, nutrient fluxes in the benthic boundary layer, benthic community activity and the quality of suspended and deposited organic matter in terms of phytopigment characteristics. To this end the following techniques were carried out: *in situ* deployment of the BOLAS Lander, shipboard incubation experiments on sediment sections, filtration of suspended matter from surface and bottom water, and boxcoring. Seven stations along an E-W transect projected over the Goban Spur area were visited. Water depths ranged from 200 m at the shelf to 3600 m at the westernmost station.

The measured sediment oxygen demand was about 130 mol $O_2 \cdot m^{-2} \cdot h^{-1}$ at the upper part of the slope and about half of this value at the lower end of the slope below 2000 m. In general the observed deep water values are relatively high and thus point to the enhanced or accelerated transport of organic matter along the slope.

B1-17 SMALL FOOD WEB NUTRIENT DYNAMICS

F.C. van Duyl, R.P.M. Bak,
G.C.A. Duineveld, R. Osinga, B. Hondeveld

This project focuses on two processes: 1. the relation between the source/dosage of organic matter and benthic bacterial production, and 2. the regeneration of N and P by the benthic small food web.

The key factors determining short-term variations in benthic heterotrophic bacterial production are still poorly understood. There are indications that variations in sedimentation of fresh algal material dictate the magnitude of changes in bacterial production in sediments. The project aims to investigate relations between bacterial production and the composition/ageing characteristics of phytopigments. The next step is to study the effect of such a burst in bacterial production through bottoms in relation with macrobenthos activity.

Our recent findings cast doubt upon the supposedly fundamental role of benthic bacteria as mineralizers of organic matter. In surface layers of oligotrophic sediments bacterial production was inversely related to inorganic N and P regeneration. This suggests that bacteria are sinks of N and P, possibly only releasing nutrients upon death. The role of benthic nanoflagellates in nutrient regeneration will be examined. Experimental approaches, such as addition of eukaryotic inhibitors, and ^{15}N tracer studies, are adopted to explain the role of heterotrophic benthic bacteria and nanoflagellates in mineralization.

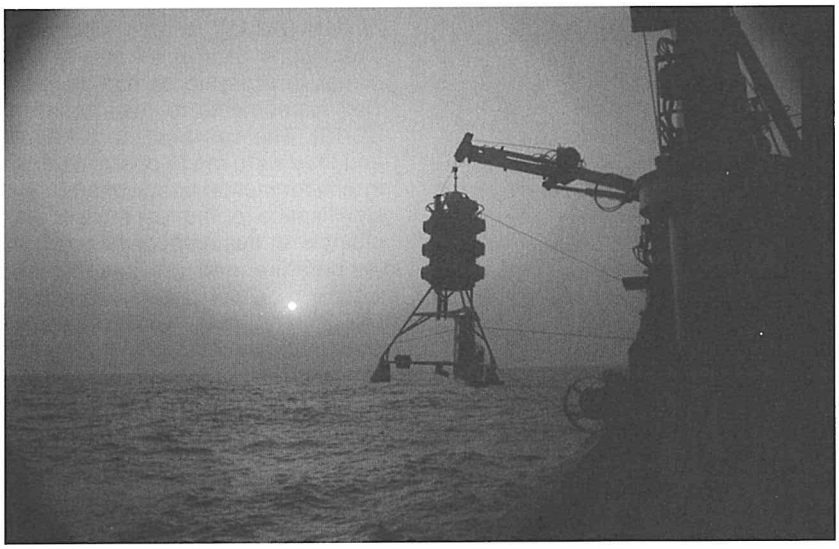


Photo: G. Nieuwland

1.7. 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 food web. 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 (projects B2-01, B2-03, B2-06), 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 at different experimental conditions. Special attention is given to phytoplankton species (B2-01), *Emiliania huxleyi* (B2-13), zooplanktonic ciliates (B2-03) and copepods (B2-10). The interactions of species and trophic levels, and ultimately the functioning of complete ecosystems, can be related to environmental conditions in multi-species experiments or mesocosms (B2-03) and mathematical models (B2-03, B2-13). The construction of four pelagic mesocosm systems was completed and they were made operational. Adaptation of life cycles to seasonal variation in environmental conditions receives more and more attention, to study their significance for the response of plankton systems and carbon fluxes to climatic change. In this respect we study the response of *E. huxleyi* to nutrients, light, temperature and grazing (B2-13); the recolonization of tropical upwelling waters by *Calanoides carinatus* after resting periods in deeper water layers (B2-08) and the survival and even increase in biomass of polar copepod species during long periods of low algal density (B2-11).

B2-01 EUTROPHICATION AND PHYTOPLANKTON IN DUTCH COASTAL WATERS

W. Stolte (in co-operation with BEWON)

Size distribution of phytoplankton affects the structure of the food web and the sinking rate of organic matter. To study the effect of fluctuating nutrient concentrations on the species composition and size distribution of phytoplankton, competition experiments were done. Mixtures of thirteen species of algae from different taxonomic and size classes were cultured in continuous cultures with either nitrate or ammonium as the only nitrogen source supplied (10 μM) every three days. In such discontinuously nitrogen-limited cultures, the growth of larger species is favoured when nitrate is the only nitrogen source available. Especially the diatom *Ditylum brightwellii* (±15 X 50 μm) was very successful under these circumstances. With ammonium as the only nitrogen source other species, small as well as large, became dominant. Experiments with single species cultures showed that the initial biomass-specific nitrate uptake (10 μm) of larger algae is higher than that of smaller algae. This probably accounts for the selection towards larger species in the nitrate competition experiments. The biomass specific-ammonium uptake of the single species did not relate to cell size.

During the Bloom '93 cruise in July to the upwelling area in the northern North Sea, the uptake of nitrogen compounds by different size classes of phytoplankton was measured in the field. Nitrate, nitrite and ammonium uptake rates were determined by adding ^{15}N labelled nutrient in trace amounts fol-

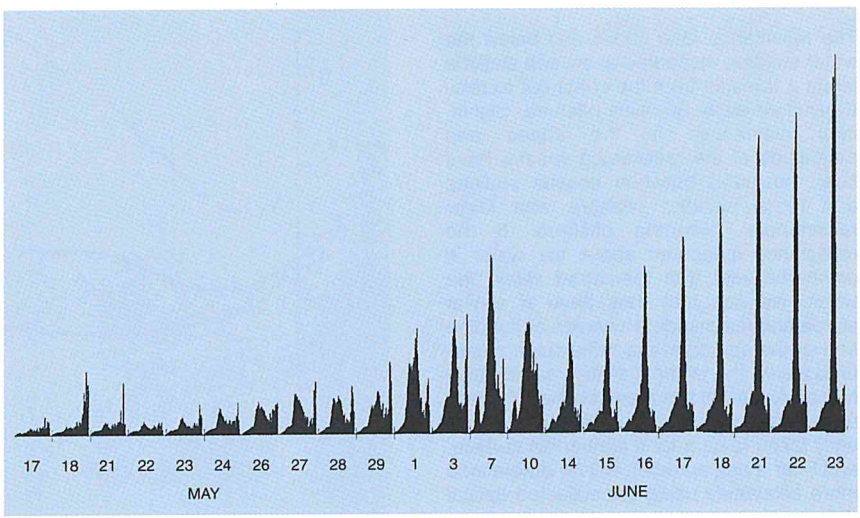
lowed by incubation for 2 to 6 hours at *in situ* light levels. $^{15}N/^{14}N$ ratios were measured at the institute with a mass spectrometer. The results were not in contradiction with the laboratory experiments. Specific nitrate uptake in the small size fraction (<3 μm) was lower than in the total population at all stations. Nitrogen assimilation rates of the total population varied from 3 μg N $dm^{-3}.d^{-1}$ at the oligotrophic stations in the north to 20 μg N $dm^{-3}.d^{-1}$ at the centre of a bloom of *Emiliania huxleyi.* The 'f-ratio' (the fraction of nitrate uptake from the total nitrogen uptake) was highest (*ca.* 50%) at the onset of the bloom, while it was almost 0 in stratified waters and in the area where the Atlantic Ocean water entered the North Sea.

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

B.R. Kuipers, R. Riegman, F.C. Hansen, H.J. Witte and A.A.M. Noordeloos

Started in 1991 with scale model tests, this project concentrated in 1992 on the realization of a prototype 850-litre mesocosm system with controllable temperature, light and turbulence for initial experimentation with natural water during 1993. Because of the good survival and growth of different algae and ciliate populations over several months, three identical systems could be ordered at the end of 1992, becoming fully operational in October 1993. All four mesocosms were filled with double GF/F filtered low nutrient northern North Sea water and stocked equally with an artificial low nutrient retention community of cultured pico- and nanoplankton, some larger flagellated algal species and ciliates for a four-month eutrophication experiment in co-operation with BEWON and Benthic Systems.

Test runs with the prototype in 1993 were made with natural Dutch coastal water collected in February, following the evolution of phytoplankton and heterotrophs. The experiment showed surprisingly well the developments predicted by a model steady state analysis and observed in the field in the spring of 1992: In response to increasing light input nutrient levels decreased, and microzooplankton biomass increased. Diatoms showed a steady exponential biomass growth which raised the chlorophyll level correspondingly; nano- and picoplankton responses were suppressed by the heavily grazing protozooplankton. After the 'new-production' bloom phase ended due to the depletion of silicate, the system switched to a regeneration mode, stimulated by increased regeneration of dead bloom material quantitatively enclosed in the system. While microzooplankton grazing control went on, the niche offered by regenerated N and P for non-grazable algal growth by other species than diatoms was occupied by slightly poisonous dinoflagellates.



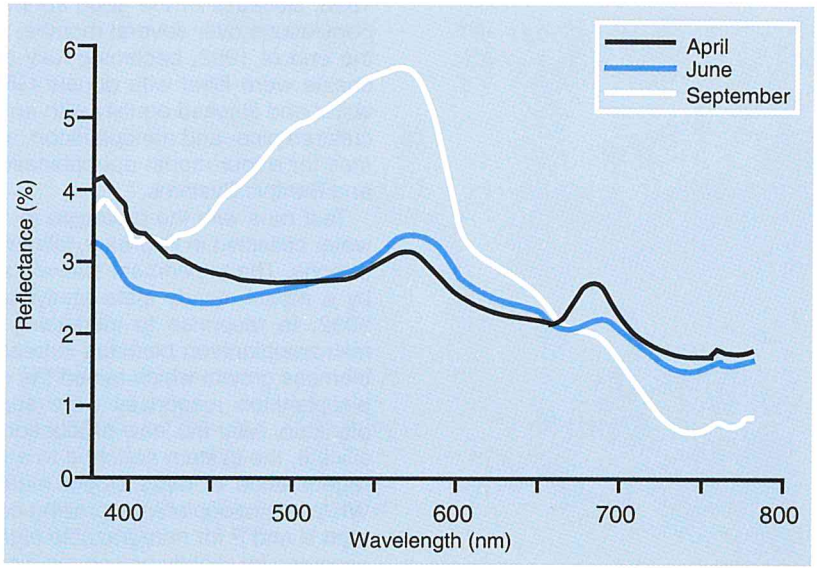
Elzone particle counter spectra illustrate how from 15 to 23 June a natural and healthy algal community can be overgrown by a poisonous species as a result of nutrient competition under strong microzooplankton grazing pressure.

B2-06 PARTICULATE MATTER NORTH SEA: SEMI-EMPIRICAL ALGORITHM DEVELOPMENT

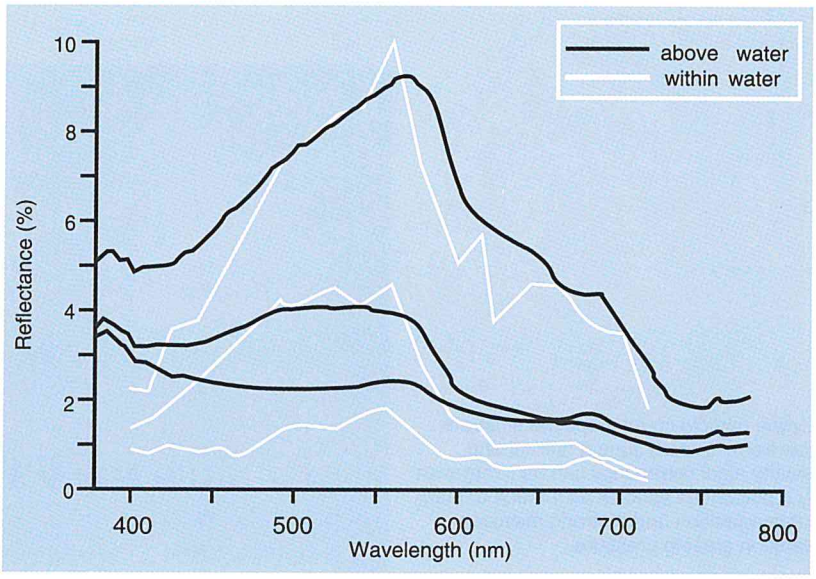
S.J. Shimwell, H.G. Fransz, S.R. Gonzalez, N. Schogt

This year four PEGASUS (Pelagic Geographic study of the Abundance of Suspended matter) cruises were performed to develop semi-empirical algorithms to obtain accurate information on the concentration and composition of suspended particulate matter from airborne and spaceborne multi-channel optical instruments (see also H2-12 and H3-01). Cruises were timed to coincide with seasonal variation in water quality.

Measurements with the newly developed multi-channel transmissometer TRASIR have shown that the beam attenuation coefficient 'c', in these waters, is dominated by particle scattering and hence the absorption is of minor importance. Experiments in the laboratory in water containing increasing amounts of white clay in suspension indicated that the beam attenuation coefficient - 'c' varies linearly with sediment concentration at all wavelengths. However, attenuation is greater in the blue wavelengths, especially as the sediment concentration increases.



The seasonal variation in the reflectance measured above the water at a station near Texel. The peak in reflectance at 685 nm in April corresponds to the fluorescence of chlorophyll and indicates a large population of phytoplankton. In June the fluorescence peak is still apparent but somewhat smaller and has shifted slightly to 689 nm. In September we see little absorption by chlorophyll in the blue region of the spectrum, no fluorescence in the red, and much higher reflectance at 550 nm due to scattering by an increased number of inorganic particles.

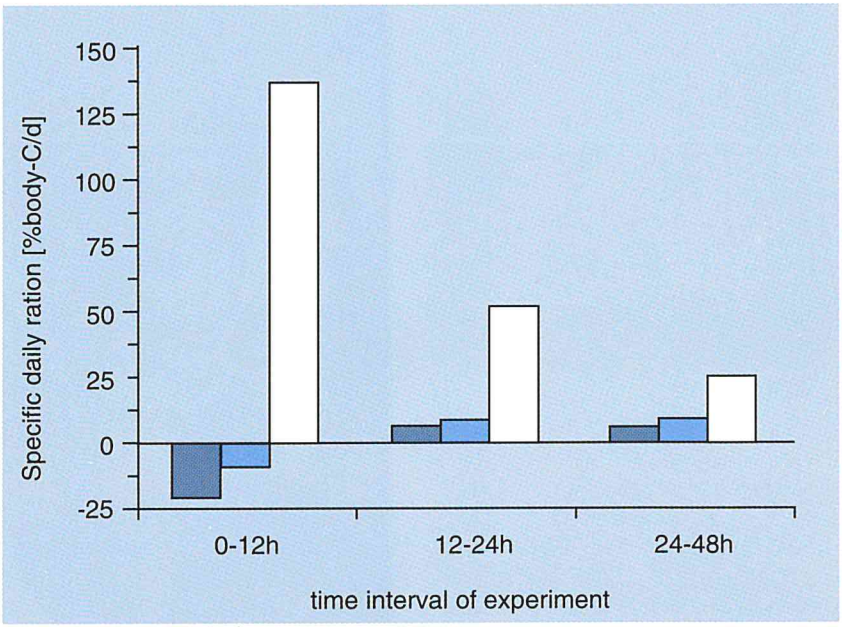


The reflectance ratio above and below the water surface, measured at several stations along a transect from the coast out to relatively clear water 30 miles offshore. Significant differences in the shape and magnitude of the reflectance spectra have been observed between coastal stations and those situated offshore with lower reflectances occurring offshore. If the reflectance measured above the water is compared with that measured within the water, we see that they have a similar shape and magnitude. However, at the blue end of the spectrum the reflectance measured above the water is always significantly higher. As part of this research the 'Q' factor used in the derivation of reflectance, (presently taken to be π for a lambertian surface, and 5 for a sea surface), will be determined more accurately using the collected optical data.

In coastal waters also a high density of certain zooplankters can influence the optical properties of the water. Moreover, it is valuable to relate zooplankton distribution to remotely sensed patterns of physical and algological conditions. The surface samples have been analysed. In comparison with 1973 high biomasses (>100 mg AFDW·m^{-3} in spring, >200 in summer) were now found to occur also beyond 20 miles offshore, and the measured egg production rate of the copepod *Temora longicornis* was equally high in a zone of 50-60 miles. This is a first indication that eutrophication may have extended the coastal zone of enhanced plankton production between 1973 and 1993, instead of an increase in local production. This extension is in agreement with our prediction in the SEAWAQ model.

F.C. Hansen, J. Passarge

Feeding relationships were studied by using different bacteria and algae as food for five different protozoan species (*Oxyrrhis marina*, *Ancistrumina* sp., *Uronema* sp., *Diophrys* sp., *Euplotes mutagens*) and the rotifer *Brachionus* sp. The heterotrophic dinoflagellate *Oxyrrhis marina* (Equivalent Spherical Diameter: 18 µm) was offered a food mixture of three algal species of different size: *Micromonas pusilla* (ESD: 2 µm), *Emiliania huxleyi*, (calcified, ESD: 4 µm) and *Tetraselmis* sp. (ESD: 7 µm). Grazing by *O. marina* was moderate to strong on *Tetraselmis* sp. and weak on the smaller algal species. Comparing the algal biomasses ingested with the respective biomass compositions of the food available revealed selective feeding on *Tetraselmis* sp. No grazing on the other algae occurred during the first 12 h of the experiment, while *Tetraselmis* sp. biomass was high (200-400 µg C/l). Later on, however, while *Tetraselmis* sp. biomass decreased to 80 µg C/l, *O. marina* fed on *M. pusilla* according to its biomass fraction in the food mixture, but discriminated against *E. huxleyi*.



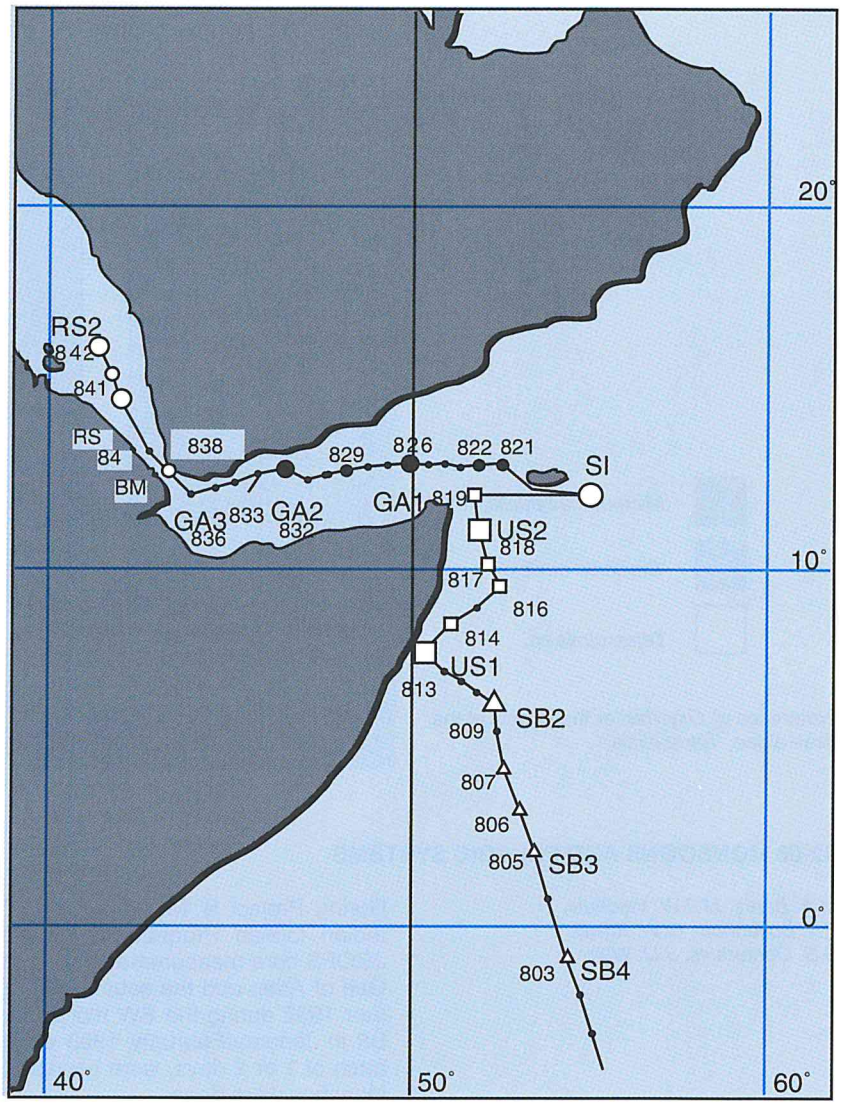
Preference of *Oxyrrhis* for the largest of the three algae, *Tetraselmis*.

B2-08 MONSOONS AND PELAGIC SYSTEMS

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

During Project B 'Monsoons and Pelagic Systems', part of the Netherlands Indian Ocean Programme 1992/1993 (see 1.1. in Annual Report 1992), JGOFS core measurements were done in the area of the Somali Current, the Gulf of Aden and the southern Red Sea. After the cruises B0 and B1 in summer 1992 during the SW monsoon, the field work was completed with cruise B2 in January/February 1993 during the NW monsoon. Eight main stations, each of 1 or 2 days, were occupied and in between shorter stations and XBT launches were done

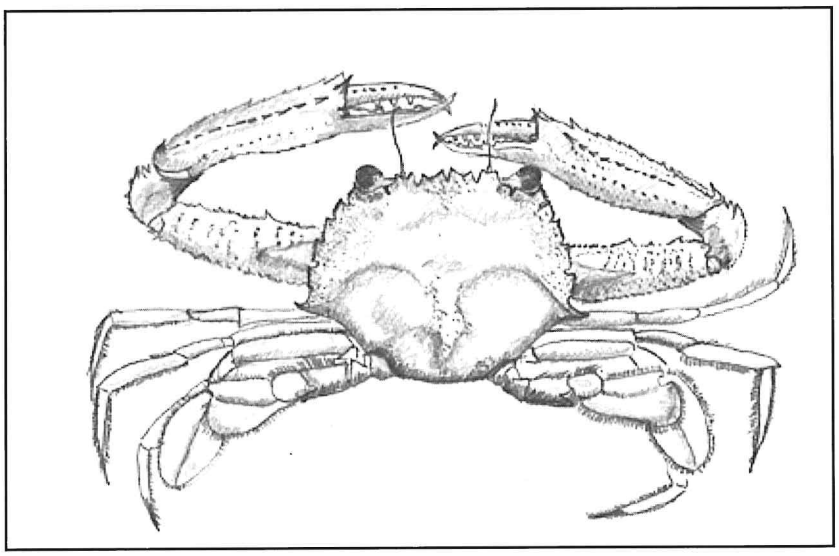
The B2 cruise encountered less oligotrophic conditions than expected. Only at the southernmost stations was the typical tropical structure observed, with a nitrate-depleted mixed layer and a deep chlorophyll maximum at the beginning of the thermocline. During a 54-hour stay at the station SB 2, the NE wind increased from Bft 4 to 6, corresponding with a deepening of the mixed layer and a rise of the nitrate concentration in the upper waters from 0.1 to 0.4 µM. Wind velocities remained high on average thereafter — Bft 5 compared with the normal 3-4 according to the climatological atlases — and mean nitrate concentrations in the surface layer amounted to 0.5 in the Somali Current and to even over 1 µM in the Gulf of Aden. Only on the shallow plateau (35 m) of Socotra, not deep enough for thermocline waters, was nitrate-depleted water found, supporting the hypothesis of wind-induced enrichment of non-shelf areas. As a consequence, mean primary production was not much lower than during the upwelling season, and the contribution of new production — measured by the ^{15}N technique in collaboration with the Bedford Institute of Oceanography — again very high. However, compared with the upwelling season, the phytoplankton composition was different, with a large predominance of picoplankton. Blooms of diatoms were only found in the southern Red Sea, corroborating the high chlorophyll concentrations observed by the CZCS satellite in this area through most of the year.



In the Somali Current and the Gulf of Aden, the 'microbial loop' dominated the pelagic system in January. Bacterial productivity was as high as during the upwelling season. Flow-cytometry was applied in serial dilution experiments to measure the grazing pressure by microzooplankton on the picoplankton groups prochlorophytes, cyanobacteria and pico-eukaryotes. Grazing on the latter two equalled or surpassed daily production, and experiments showed that the highest grazing impact was exerted by the fraction <10 mm, with grazers <3 mm significantly contributing, showing the role of heterotrophic nano- and dinoflagellates in the 'small food web'. The main predators on these flagellates were ciliates, of which strombiids 15-20 mm in size seemed by far the most abundant. The ciliates, in turn, may have formed the basic food for a large part of the zooplankton. Mean mesozooplankton biomass during the B2 cruise was surprisingly large. This confirmed earlier observations during the International Indian Ocean Expedition and during INDEX that the zooplankton stock remains relatively high after the SW monsoon. Compared with the 1984/1985 results from the seasonal upwelling area in the eastern Banda Sea, there was much less decline in primary productivity and zooplankton stock in the Somali Current area from the upwelling to the non-upwelling season. Earlier data on the primary productivity during the NE monsoon were much lower, which may point to large intra- and interannual fluctuations depending on weather conditions. However, a large part of the difference should be attributed to the development of ultra clean-incubation techniques since the early eighties, especially because of the vulnerability of oceanic picoplankton to contamination.

During the SW monsoon the typical upwelling copepod *Calanoides carinatus* dominated the upwelling centres in the Somali Current. During the NE monsoon, *C. carinatus* was virtually absent in the upper waters, but the pre-adult stage V was caught at all nine stations where plankton hauls were done below a depth of 500 m. The diapausing populations of this species at intermediate depths were widespread, even more than 500 km away from the upwelling centres near Somalia and Yemen/Oman.

Acoustic observations by a 30 kHz echo sounder (by participants from the Institute of Taxonomic Zoology, University of Amsterdam) revealed a pronounced scattering layer by day at the beginning of the thermocline. This layer, also found in July 1992, rose sharply to the surface early in the evening. Sea charts of the western Indian Ocean warn of this layer, and many false bottom soundings in this area in the past can be attributed to the phenomenon. Fishing with the Rectangular Midwater Trawl in the scattering layer revealed large numbers of the crab *Charybdis smithii*, which swarm at the surface at night; they could be responsible for the 'false' bottom echo. As numerous juveniles were caught in July 1992, the species seems to have a pronounced seasonal cycle.



Charybdis smithii

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

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

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

Together with J. van der Meer, a new method was developed to calculate the development rate of larval stages from the stage frequency observed in cultured cohorts of copepods. The method is a significant improvement of current methods. It was tested with experimental data collected specifically for this purpose during the past few years. It was also successfully applied to former data sets and to data on *Calanoides carinatus* and *Calanus australis*.

Temora longicornis was used for various experimental purposes. At regular time intervals this species was supplied to L. van Duren (Univ. Groningen) for behavioural studies on copepods. It was used in mesocosm experiments (B2-03) to represent the upper trophic level. Unfortunately eggs and young larvae did not survive in the mesocosm. Probably they were killed mechanically due to the circulation device. For this reason it was attempted to collect *Pseudocalanus elongatus* from the field and to cultivate it in the laboratory. This species carries its eggs in egg-sacs, and is therefore more likely to survive in the mesocosm.

B2-11 ZOOPLANKTON LIFE CYCLE IN ANTARCTIC SEAS

H.G. Fransz, S.R. Gonzalez, B.R. Kuipers

The vertical occurrence of the mesozooplanktonic community, larger than 200 µm, was studied on transects along 6° W during the Southern Ocean-JGOFS cruise of RV 'Polarstern' (ANT X/6) in austral spring 1992. Zooplankton density and biomass were high north of the Polar Front and increased within 3 weeks from about 5 to 12 x 10^3 organisms and 65 to 105 mg AFDW·m^{-3}. Zooplankton in the Antarctic Circumpolar Current and near the ice edge showed lower values (about 1 x 10^3 organisms and 8 mg AFDW·m^{-3}). The cyclopoid copepod *Oithona similis* formed almost 60% of the total zooplankton biomass. Egg production rates of the 6 most abundant copepod species, as measured in shipboard experiments, were in general highest (in the range of 15 to 20 eggs per female per day) in the northernmost part of the study area.

Water samples of 100 cm^3 were collected at all CTD stations from 20, 40, 80, 200 and 300 m depth and preserved in 2% lugol for microzooplankton counting by settlement microscopy using newly developed sedimentation chambers (H.J. Witte). The results for the transects analysed so far show a remarkably rich ciliated protozoan community in the Antarctic Circumpolar Current (ACC) water. While chlorophyll *a* concentrations are 10-100 times lower than in the North Sea, microzooplankton carbon shows comparable values of up to 200 µgr C·dm^{-3}, which in view of the grazing impact on system structure demonstrated by project B2-03, means a potential grazing control on small phytoplankton in bloom situations explaining the recorded domination of large diatoms. Microzooplankton in the ACC appears to be concentrated in one layer at 20-40 m depth, which seems important information for bio-essay studies on growth limiting factors (Fe-studies). Depending on the collection depth, the experimental jars will contain much or little microzooplankton, strongly influencing the result of such incubations firstly because of grazing control itself, and secondly because grazing produces chelators changing the colloid-ion equilibrium of dissolved trace metals in favour of availability.

Further analysis of the time series of zooplankton data from the Admiralty Bay collection studied in Warsaw, Poland, revealed that the seasonal increase of biomass and number of the oldest copepodite stages is during austral fall and early winter (March to June) at low algal density. The seasonal evolution of developmental stage distribution indicates a one-year life cycle as most dominant in all species.

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

P. van der Wal, J.D.L. van Bleijswijk, R. Kempers, M.J.W. Veldhuis, G.W. Kraay, S.R. Gonzalez, H.E. Gonzalez (AWI), M. Stoll, D. Bakker, G.J. Brummer, P. Westbroek (RUL)

During May this year, 36 scientists from Norway, UK, Germany, Spain, Canada and the Netherlands monitored the physical, chemical and biological properties of 10 seawater enclosures (volume 11 m^3) located in a fjord, 20 km south of Bergen. The phytoplankton community was dominated by diatoms at the onset of the experiment, while *Emiliania huxleyi* had a concentration of $2 \cdot 10^5 \cdot m^{-3}$. The water temperature ranged between 9 and 12°C, and the irradiance was high (max. PAR: 1200 mmol photons$\cdot m^{-2} \cdot s^{-1}$) during the major part of the experiment.

E. huxleyi grew well from 10 to 17 May and reached maximum densities of 2-7 mill. cells$\cdot dm^{-3}$; the growth rate was as observed in 1992. After 17 May, a very cold and stormy day, cell numbers decreased in all enclosures. High concentrations of large viruses were observed a few days after the maximum in *E. huxleyi.* This suggests that viral activity caused (part of) the algal mortality.

Outside the enclosures, in a nearby fjord (Nordas vannet), *E. huxleyi* was present in high numbers (13-27 mill. cells$\cdot dm^{-3}$) making up 65-87% of the total phytoplankton biomass.

For zooplankton no large changes in abundance and vertical distribution were observed throughout the study period. For the upper 50 m mean biomasses of the most abundant organisms, the copepods *Oithona similis, Calanus finmarchicus* and *Temora longicornis* were 6.5, 7.2 and 2.3 mg AFDW$\cdot dm^{-3}$, respectively. The horizontal distribution of most species showed a gradient in longitudinal direction of the Hardanger fjord, with calanoid copepods and larvaceans diminishing and cladocerans and cyclopoid copepods increasing inshore. The vertical distribution of the mesozooplankton showed the same pattern as the distribution of chlorophyll (87% of the total plankton was found in the upper 50 m). The estimated total daily grazing rate of the two dominant calanoid copepods was about 1/3 of the daily primary production.

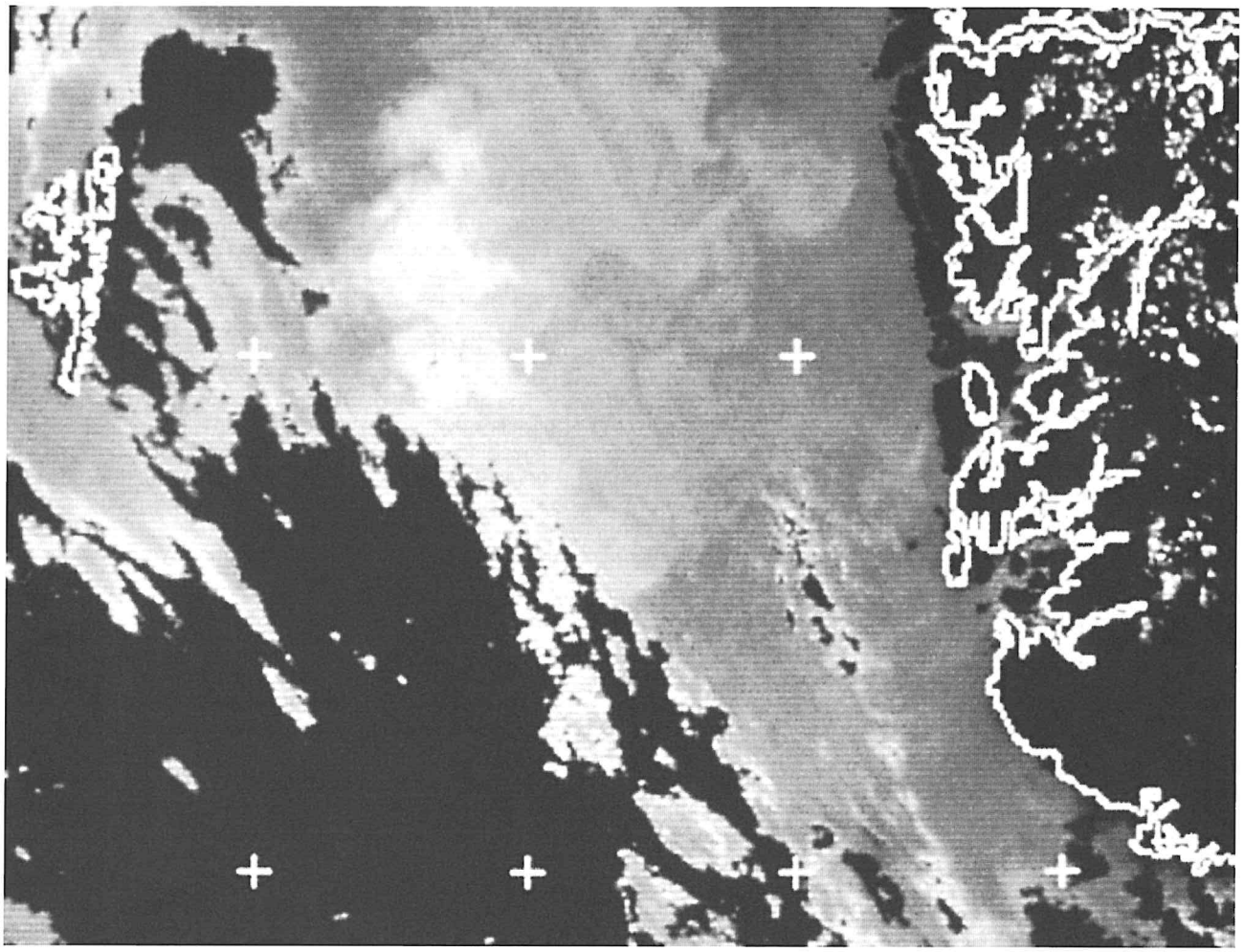
Prior to cruise Bloom 93 with RV 'Pelagia', a dense coccolithophorid bloom was detected by satellite images east of the Shetland Islands extending towards the Norwegian coast. When RV 'Pelagia' arrived the waters with the highest reflectance appeared to have a whitish-turquoise coloration with an extension of 100 by 50 km containing coccospheres and numerous loose coccoliths of *Emiliania huxleyi.* Within the white waters, nitrate concentrations amounted to about 0.1 µM; north of the whitish area nitrate concentrations were present in non-limiting concentrations. For all water types nitrate concentrations increased with depth, in particular below the euphotic zone (*ca.* 50 m). Highest chlorophyll concentrations were found close to the northern edge of the white waters with maximal values of over 2 µg Chl*a*$\cdot dm^{-3}$. Forty miles more to the north chlorophyll concentrations were at least a factor of three lower and in the white, coccolith-dominated waters concentrations amounted to only 0.2 µg Chl*a*$\cdot dm^{-3}$.

Production ranged from 1.3 g C$\cdot m^{-2} \cdot d^{-1}$ outside the bloom to half that value in the white waters, where calcite production was four times higher (~0.8 g calcite$\cdot m^{-2} \cdot d^{-1}$).

Flow-cytometry indicated dominance of: chroococcoid cyanobacteria of the *Synechococcus* type (*ca* 1 µm), a small unidentified pico-eukaryote (*c*a 1.2-1.5 µm) and a group of *Emiliania huxleyi* (6-10 µm). Larger phytoplankton species were present (a few hundred per cm^3). In the coccolith-dominated waters, numbers of living *E. huxleyi* cells did not exceed 5000 cells$\cdot cm^{-3}$, whereas *Synechococcus* here attained concentrations of up to 120 000 cells$\cdot cm^{-3}$. The unidentified pico-eukaryote attained highest concentrations of 50000 cells$\cdot cm^{-3}$ just north of the white waters.

The dissolved inorganic carbon (DIC) concentration in the white waters showed an increase with depth larger than observed in waters north of that area. Lowest pCO_2aq values of about 280 µatm were recorded in surface waters where chlorophyll concentrations were maximal. In the coccolith-dominated area surface values were at least 20 µatm higher but still they were undersaturated as compared to the atmosphere. These low values are the result of photosynthetic CO_2 fixation. The slightly higher CO_2 concentration in

the *E. huxleyi* bloom than outside the bloom is possibly due to the fact that during calcification CO_2 is formed, which would have diminished the demand for CO_2 used in photosynthesis. On the other hand, CO_2 is consumed due to dissolution of calcite. Experiments showed that 20% of the calcite standing stock was dissolved within 24 h.



NOAA satellite image of the North Sea (580-680 nm, atmospherically corrected) showing the extension of a large *Emiliania huxleyi* bloom between Shetland and Norway on 27 June. This bloom was visited during RV Pelagia's cruise BLOOM 93 held from 28 June to 16 July 1993. The waters with high reflectance on the image appeared to have a whitish-turquoise coloration and were characterized by the presence of large numbers of loose *E. huxleyi* coccoliths. The black areas on the picture are clouds (image by courtesy of Steve Groom, PML).

1.8. COASTAL SYSTEMS (B3)

INTRODUCTION

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

B3-01 PRODUCTION AND TRANSPORT OF ORGANIC MATTER

G.C. Cadée, J. Hegeman

After a relatively poor *Phaeocystis* year in 1992, phytoplankton development in the Marsdiep in 1993 was again 'normal' with a large bloom of *Phaeocystis*: about 2 months with cell numbers above 10000·cm^{-3}, a total period of *Phaeocystis* cells exceeding 1000·cm^{-3} of >100 days and a peak value of 178000 cells·cm^{-3} on 29 April. Only once since 1973 have we encountered a higher value (190000 on 10 May 1985). Primary production remained high in 1991 and 1992 (values for 1993 not yet available). This together suggests that lowering of phosphate inputs from the Rhine still has no effect on phytoplankton in the Marsdiep and counters speculations that lower P inputs from the Rhine should have decreased yields of shrimps and plaice in the coastal area. If these speculations were true, it would also be visible in the first step of the food chain, the phytoplankton.

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

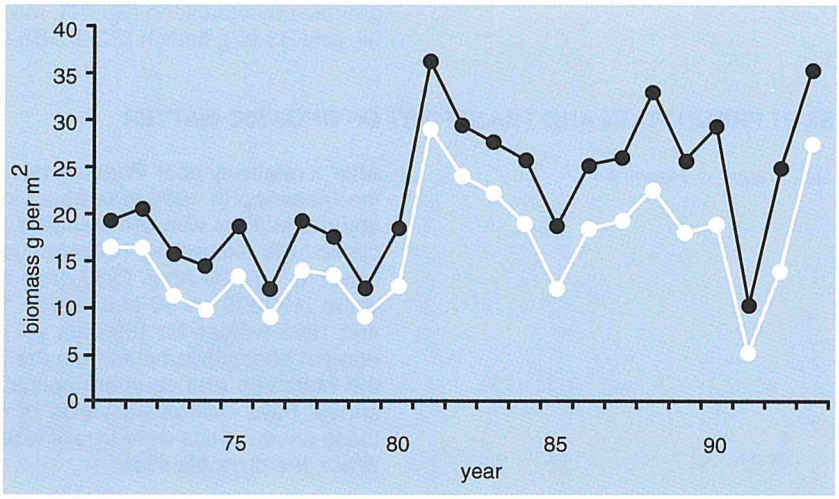
J.J. Beukema, W. de Bruin, J. Zuidewind

The long-term investigations (started in 1969) of the intertidal benthic macrofauna in the western part of the Wadden Sea have been continued. A data set of more than 20 years is now available. This year again a part of it was worked out. Special attention was given to the effects that changes in the abundance of various species of benthic animals have on foraging birds.

In most zoobenthic species, the abundance fluctuates strongly from year to year as a consequence of heavy mortality (*e.g.* during a cold winter) and irregular recruitment. Comparisons with similar long-term data sets obtained in other parts of the Wadden Sea showed that some benthic species are characterized by heavy fluctuations all over the Wadden Sea, whereas others show moderate fluctuations. The co-operation with L. Zwarts (Friesland), K. Essink (Groningen) and H. Michaelis (Norderney) also revealed that periods of scarcity in several species occurred in the same years over vast areas. Severe winters are indeed synchronized over areas even larger than the Wadden Sea. This limits the feasibility for birds to switch to other areas when their preferred food is scarce in their usual foraging area. The alternative, switching to other prey types, is limited to their ability to cope efficiently with less-preferred species, as most birds have specialized feeding habits. Another limitation to the

success of switching to alternative prey is the phenomenon of synchronized fluctuation patterns in different species of benthic animals. In the Wadden Sea, several species are sensitive to low winter temperatures or fail to reproduce after very mild winters (compare B3-03). Therefore they are scarce in the same years.

A striking example with far-reaching consequences was the simultaneous recruitment failure in all important species of bivalves in the Dutch Wadden Sea during three successive years: 1988, 1989, and 1990. As a consequence, mussels and cockles became scarce in the course of 1990, when unrestricted fishing for these species accelerated their decline. Virtually all mussel banks and most cockles were removed from the tidal flats of the Dutch Wadden Sea in the course of the summer of 1990. Food scarcity for birds specialized in bivalves became evident in the winter 1990/91. Ten thousands of eiders died for lack of food and oystercatchers also showed increased rates of mortality. Effects on alternative food sources included significantly enhanced mortality rates in the bivalves *Macoma balthica* and *Mya arenaria*. At the end of that winter, the Balgzand stocks of all bivalves together had declined to unprecedentedly low levels and would have been sufficient for only one more month of bird feeding at the same level. Such a precarious feeding situation would not have developed if the tidal flats of the Dutch Wadden Sea had in time been closed to fishery. Fortunately, at present Balgzand and some other areas are safeguarded against fishery for mussels and cockles.



Year-to-year changes in the biomass of the bottom animals on the Balgzand tidal flats during the 1971-1993 period. Late-winter averages of 15 sampling stations, expressed in grams ash-free dry weight per m^2, separately for biomass (solid points) and the group of bivalves (open points). Note:
1) The elevated level during the 1980's as compared to the 1970's; the difference is attributed to local eutrophication.
2) The sudden dip in 1991, caused by temporarily low stocks of bivalves as a consequence of (a) recruitment failure after extraordinarily mild winters in the 1988-1990 period and (b) intensive fishery on tidal flats for mussels and cockles in 1990.
3) The rapid recovery after early 1991, due to rapid growth and high reproductive success in several species in spring and summer of 1991 and a ban on fishery on Balgzand.
4) The high values observed in early 1993, which are inconsistent with any supposed de-eutrophication of the area.

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

P.J.C. Honkoop, D. Kwast

This project is part of the National Research Programme on Atmospheric Pollution and Climate Change (NOP), and deals with the problem of the generally low reproductive success of bivalves in the Wadden Sea after mild winters.

Three groups of the bivalves *Macoma balthica, Cerastoderma edule* and *Mytilus edulis* were kept in large basins in the open air, at different temperatures during the winter months. The goal was to get three groups of animals with different weights at the same length. Such differences in 'condition index' are expected to be caused by differences in winter temperature and to lead to differences in egg size, egg number and larval survival.

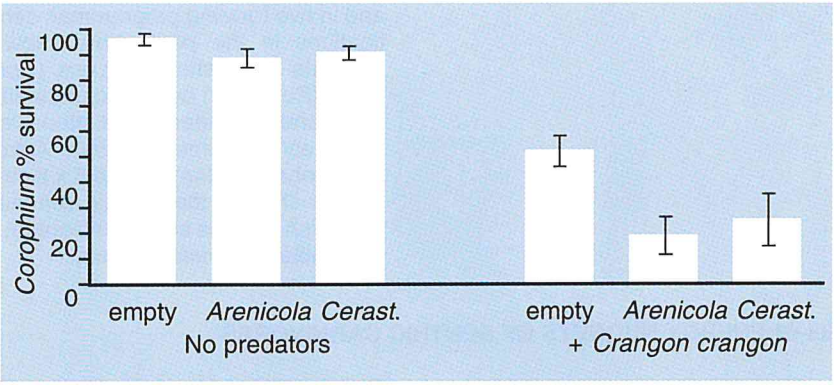
The animals in our experimental set-up grew very fast due to the high chlorophyll content of the seawater used in the flow-through basins, and no differences in condition were measured in the three groups of animals. Neither were there differences in egg size and egg number. Animals collected at the same time in the field showed a lower condition index and also had smaller and fewer eggs. These results corroborate the expected relation between condition index and egg size: the better the condition, the bigger the eggs.

B3-04 INTERACTIONS BETWEEN MACROZOOBENTHIC SPECIES ON TIDAL FLATS

E.C. Flach, W. de Bruin, J. Zuidewind

The last year of this project was devoted to a study of the processes underlying the strongly negative effects of cockles *Cerastoderma edule* and lugworms *Arenicola marina* on the abundance of the amphipod *Corophium volutator*, found in previous years. In aquarium experiments no direct effect on mortality was found, but a higher migration rate in the presence of cockles and lugworms was observed. However, this higher migration rate could not fully explain the strong reductions in *Corophium* densities found in the field, suggesting other effects in addition to enhanced migration. Because it is known that *Corophium* is an important prey for epibenthic predators (especially the shrimp *Crangon crangon*), aquarium experiments with *Crangon* in the presence and absence of cockles and lugworms were performed. Significantly lower survival rates of *Corophium* were found in the presence of cockles and lugworms.

To study the effect of predation on *Corophium* in the presence of cockles and lugworms in the field, cage experiments were carried out in two shallow bays in the Gullmarsfjord (Sweden). This was done in co-operation with R. Rosenberg and L. Pihl (University of Gothenburg) at Kristineberg Marine Biological Station during June and July. The usual negative effect of cockles and lugworms was found, but the *Corophium* densities inside the cages (excluding predators) were significantly higher. During the experiment the densities of epibenthic predators were estimated at high tide by catching them with a drop trap of 0.5 m^2. *Crangon crangon* was the most abundant predator (mean number ~5.3 per m^2, mean length ~3 cm).



The survival of *Corophium volutator* in aquarium experiments in the presence of lugworms and cockles compared to the survival without these species in the presence and absence of shrimps.

B3-05a RECRUITMENT MECHANISMS IN FLATFISH POPULATIONS

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

The data on the recruitment of dab (*Limanda limanda*) in North Sea waters were analysed in co-operation with the Netherlands Institute for Fisheries Research (DLO-RIVO). In this species the year-class strength appears to be determined at a relatively late stage as compared with other flatfish species, *viz.* not before the end of their second year of life.

Results of flatfish research carried out in tropical areas in Guinea-Bissau in 1992 and in Puerto Rico in 1992/1993 were analysed in relation to trends in flatfish population parameters with latitude. Results of both studies indicated that in tropical nursery areas especially the densities of settling juveniles is much lower than in temperate areas. Subsequent growth, corrected for temperature, and mortality rates are in accordance with those observed in subtropical areas (Georgia, USA) and temperate areas such as the Wadden Sea. The hypothesis has been postulated that in tropical areas less energy is available for reproduction, and consequently egg, larval and juvenile densities will be relatively low.

During the Netherlands Indian Ocean Programme (NIOP), samples were obtained with the RMT (Rectangular Midwater Trawl). The collected fishes of

these cruises are processed by NIOZ in co-operation with ITZ, Amsterdam, and University of Charleston, USA. Special attention will be given to the flatfish larvae. They were relatively abundant, both in the coastal areas and at the open ocean stations.

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

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

During spring and autumn the standard fyke programme was carried out with a kom-fyke at the location Schanserwaard. Input of the data is progressing and the results will become available at the beginning of 1994. Last year, a number of species were selected (based on a statistical analysis) for an analysis of long-term trends. In co-operation with A.D. Rijnsdorp (Netherlands Institute for Fishery Research, DLO-RIVO), the trends in the fyke catches of these species were compared with two other series containing long-term records: the NIOZ records of rare fish species from 1930 to 1990, and the by-catch data of the demersal young fish survey from 1972 onwards. A first analysis illustrated the complexity of these time series. Special statistical techniques will be developed to filter the variability from the 'signal' in the series.

B3-06 FISH-BENTHOS INTERACTIONS

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

Effects of intensive beamtrawl fishery on the benthic fauna in the southern North Sea were studied by a special working group in an EC-funded international FAR-project (IMPACT, see S-03).

A considerable amount of time and effort was put into testing of equipment and in two trawling programmes carried out in April and September. The investigations in the past years show that beamtrawl fishery produces large amounts of crushed molluscs (*Spisula, Mactra, Cardium, Arctica*), crushed crabs (Portunids) and dead undersized discard fish.

In general, it seems that intensive beamtrawl fishery particularly favours the hardy echinoderms (*Asterias, Astropecten* and *Ophiura*) and small fish that pass unharmed through the 8 x 8 cm meshes of the commercial nets. This may lead to shifts in the benthic community towards a dominance of starfish and small fish species such as solenette (*Buglossidium*), weever (*Trachinus vipera*) and gobies (*Pomatoschistus*).

B3-07 ENERGY BUDGETS OF BENTHIC CARNIVORES

M. Fonds, H. van der Veer, M. Tanaka, C. Costopoulos, P. van der Puyl

Growth rate and food conversion efficiency have been measured with O-group Japanese flounder (*Paralichthys olivaceus*) at different temperatures in the laboratory. A growth-rate model has been developed, which can be used for the analysis of the growth conditions for newly settled fish in the coastal nurseries in Japan.

The maximum growth rate of O-group plaice (*Pleuronectes platessa*) has been measured in the laboratory at temperatures from 2 to 26°C. Maximum daily length increment (dL, mm per day) was described as a function of temperature (T, °C) by the empirical equation:

$$dL = 0.014 * T^{1.5} - 6 \cdot 10^{-9} * T^{6}$$

Growth rate of O-group plaice in the Wadden Sea closely follows this temperature-growth rate model until the end of June, indicating that food is not limited and that the fish grow as fast as temperature allows. In July-August, however, growth rate is much lower than the maximum growth rate predicted for the high summer temperatures. In mid-summer the food supply appears to be limited, probably due to competition by the shrimp *Crangon crangon*. Young shrimp settle on the tidal flats in spring (April-June). They grow fast and become very abundant in summer and largely eat the same kind of prey as O-group plaice: polychaetes, small molluscs (or their siphons) and small crustaceans. Interspecific food competition between shrimp and O-group flatfish may be an

important factor for growth and recruitment of the flatfish. Plaice larvae enter and settle in the Wadden Sea early (March-April) and avoid this competition. Flounder (*Platichthys flesus*) larvae that settle later (May-June) may avoid competition by migrating to low-salinity areas where the shrimp cannot follow. With increasing size young flounder also start feeding on small shrimp: eating the food competitor is another way to reduce food competition.

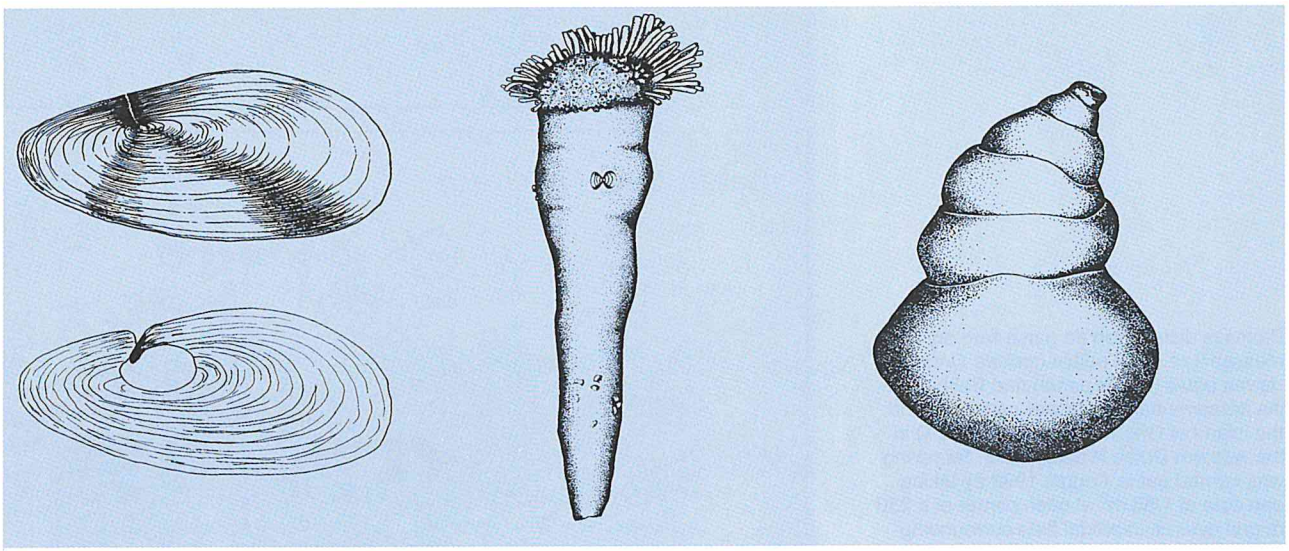
B3-08a DYNAMICS AND FEEDING OF SEABIRDS IN THE WADDEN SEA AND TROPICAL TIDAL-FLAT AREAS

C. Swennen, P. Duiven

Studies of eiders (*Somateria mollissima*) in the Vlieland feeding area were continued. Analyses showed that the amount of energy the females spend on their eggs is related to egg size. This year, a rearing experiment was conducted with incubator-hatched ducklings to study the survival of ducklings hatched from the largest and the smallest eggs of a clutch. It appeared that ducklings hatched from the largest egg (usually the second in the laying sequence) had better chances of survival than the duckling hatched from the smallest egg (usually the last in the laying sequence). The question is now why a female favours some of her progeny.

The growth of our experimental ducklings showed that the food density was locally sufficient for small ducklings. Later in the season the food situation deteriorated. Wild ducklings starved within a week of hatch because they and the accompanying females could not find back the feeding places on the intertidal flats, which still appear as deserts since the destruction of the natural mussel beds by the shellfish industry. We could orient our ducklings towards good feeding sites, whereas the wild female eiders strayed. This probably caused the great discrepancy between the low mortality among our ducklings and the extremely high mortality among the wild ones both feeding in the same area.

Swennen participated in a survey of the mollusc fauna in the Gulf of Thailand off Pattani by the Prince of Songkla University in April and October 1993. The first results indicate that the malacofauna of the Gulf of Thailand is poorer in species than the Andaman Sea at the other side of the Peninsula. However, the area is still extremely rich in forms, among which *Gastrochaena (Cucurbitula) cymbium, Brechites penis*, and *Enigmonia aenigmatica*, species that are not immediately recognized as bivalves.



Enigmonia aenigmatica (Iredale, 1918) *Brechites penis* (Linné, 1758) *Gastrochaena* (*Cururbitula*) *cymbium* (Sprenglers, 1783)

B3-08b DISTRIBUTIONAL ECOLOGY OF WADERS

Energetics and feeding of knots in Guinea-Bissau

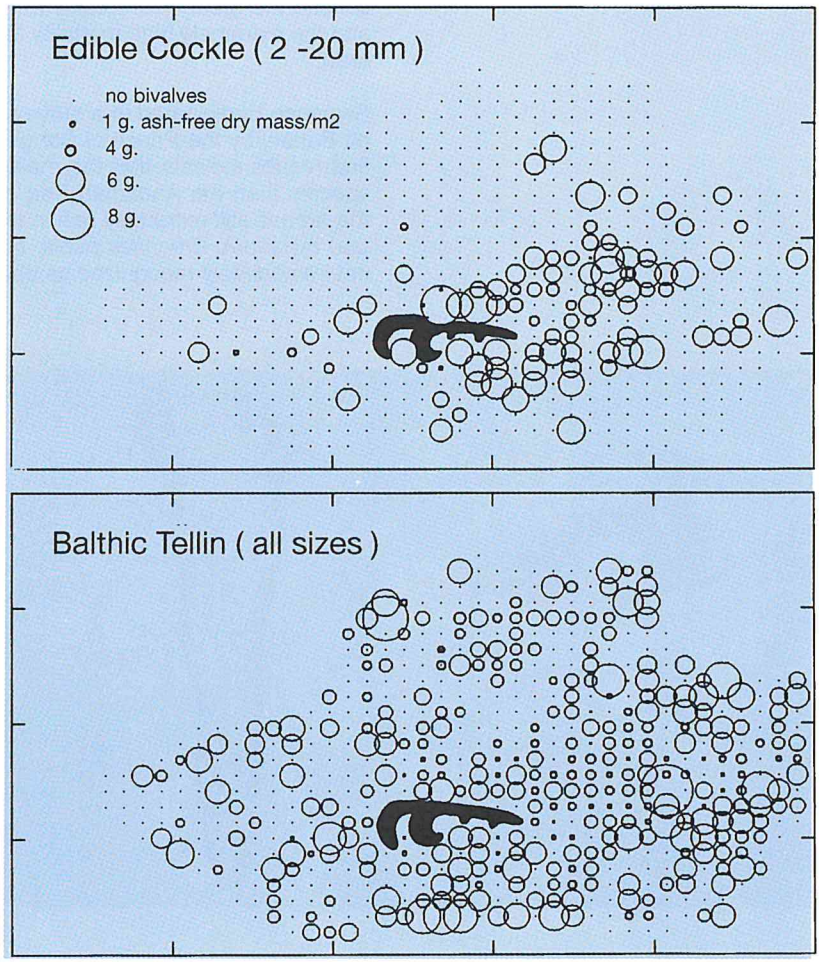
T. Piersma, M. Kersten

In March 1993 the Archipelago dos Bijagos in Guinea-Bissau was visited on board the MS 'Knud W'. We measured energy expenditure of resting waders freshly captured on their high-tide roost to collect comparative data on the energy patterns at tropical latitudes. Our observations supported the hypothesis that wintering waders show climate-related adaptations in metabolic rate, with those of tropically wintering birds being lower than those of the north temperate wintering conspecifics.

Knots in the western Wadden Sea in 1993

T. Piersma, J.van Gils, A. Koolhaas, A. Dekinga

In 1993 we have started to develop new work to unravel space use by shorebirds in relation to the information in their environment, and the extent to which they (are able to) use knowledge obtained in earlier seasons, by continuing our series of detailed studies on the distribution, diet and food availability of knots around Griend. We have evaluated the benthic sampling programme used for the last five years (1988-1992). By making some important adjustments, with rather similar sampling effort we are now able to make detailed maps of benthic food abundance around the island of Griend. In addition, we used the 'tjalk' MS 'Antilope' to follow in detail the knots during their movements in the western Wadden Sea for six weeks in July and August. Probably as a response to the continuing food scarcity (*Macoma balthica* is virtually absent from large



Biomass distribution (in g ash-free dry mass/m^2) of small edible cockels *Cerastoderma edule* (upper panel) and Balthic tellins *Macoma balthica* (lower panel) around the island of Griend (indicated in black) in the western Dutch Wadden Sea. Sampling was carried out in August 1993 by taking one core of 1/56 m^2 at each corner of a 250 m grid over all intertidal flats surrounding the island.

areas, and there was little spatfall of *Cerastoderma edule*), knot flocks ranged very widely, rarely occurring on the same flats on consecutive days. The permanent availability of an 'expedition ship' was therefore of great help to interpret the wizzy patterns of occurrence.

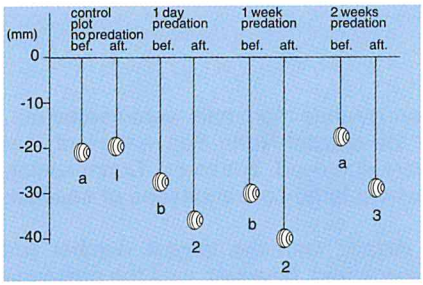
B3-08c LIFE HISTORY DECISIONS IN *MACOMA BALTHICA*, WITH A FOCUS ON BURYING DEPTH AND THE EFFECTS OF AVIAN AND EPIBENTHIC PREDATION

P. de Goeij

In an attempt to disentangle aspects of the foodweb of the Wadden Sea, we have studied the life history of the bivalve *Macoma balthica,* following up the work of Pauline Kamermans. The mean depth of *Macoma* in the European estuaries varies between 10 cm in winter and 2.5 cm in early spring, the reproductive and growing season. One of the factors which can influence the depth distribution throughout the year is nibbling of siphons by epibenthic predators.

Experiments were carried out to show the nibbler effect of 0-group plaice *Pleuronectes platessa* on the depth of *Macoma*. The expectation was that after its siphon has been nibbled *Macoma* would come up to the surface to feed at the same rate with a shorter siphon. Experimental plots with *Macoma* were exposed to predation by plaice. Burying depth of *Macoma* was measured before and after the experiment. After the experiment *Macoma*'s in plots that were exposed to predation buried on average significantly deeper than *Macoma*'s in the control plots.

The presence of plaice did have a significant effect on burying depth of *Macoma*, but in the opposite direction of what we expected. Even in the plots exposed to plaice for one day *Macoma* buried deeper. It is unlikely that all siphons have been nibbled in one day, which implies that *Macoma* stopped feeding and that burying deeper probably indicates an escape from the predator.



Depth of *Macoma balthica* in experimental plots before (bef.) and after (aft.) predation by plaice. Different letters indicate significant differences in mean depth before the experiment. Different numbers indicate significant differences after the experiment.

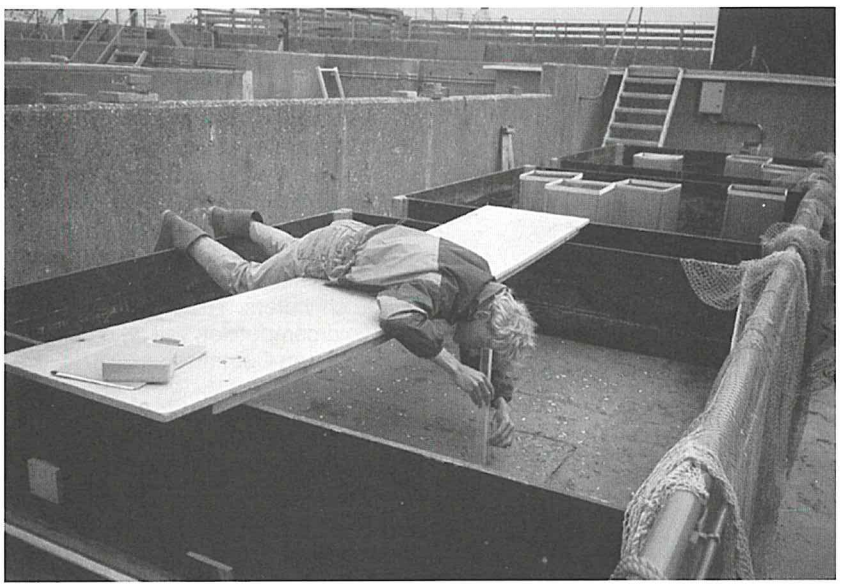


Photo: P. de Goeij

Experimental tidal basins at the IBN/DLO used for siphon nibbling experiments. Measuring depth of *Macoma balthica* is sometimes an up-side-down affair.

B3-08d FEEDING ECOLOGY OF BROAD-BILLED SANDPIPERS

Y. Verkuil, A. Dekinga, A. Koolhaas

In co-operation with the Black Sea-Azov Sea Ornithological Station in Melitopol (Ukraine), in May and June we studied the feeding ecology of broad-billed sandpipers, which use the Sivash area during their migration to the breeding areas in Scandinavia. Some of the broad-billed sandpipers captured each day were colour-marked to estimate the turnover rate. Most birds arrived between 10 and 16 May and left between 27 and 30 May, suggesting a staging period of about three weeks.

On the windflats the feeding activity, intake rates and defaecation rates of individuals feeding on *Nereis diversicolor* or individuals feeding on amphipods and isopods (resp. *Gammarus insensiblis* and *Sphaeroma serratum*) were recorded. After the birds had left, faeces samples were collected for diet analyses and reconstruction of size classes eaten, and for estimation of the energy content of the faeces. Experiments with captured birds were carried out 1) to measure and compare the assimilation efficiency of these three prey species, and *Artemia salina,* an abundant prey species in the hypersaline lagoons where large numbers of waders were foraging, but which were evidently ignored by broad-billed sandpipers, 2) to compare the energy content of faeces with the faeces from free-living birds, 3) to compare the remains found in the faeces of the captured birds fed with *Nereis* and *Gammarus* of measured size classes, and 4) to compare the defaection rate of birds feeding on *Nereis* and *Gammarus* as recorded in the field with the defaecation rate of captured birds fed with the same prey species.

B3-09 SEABIRDS AND MARINE MAMMALS

A. Seabirds

M.F. Leopold

In 1993, two major surveys of seabirds and marine mammals were carried out. In January/February and again in May the coastal North Sea waters of The Netherlands, Germany and Denmark were surveyed. Within the Dutch sector, the most interesting areas were those where large concentrations of seaduck had spent the previous winter.

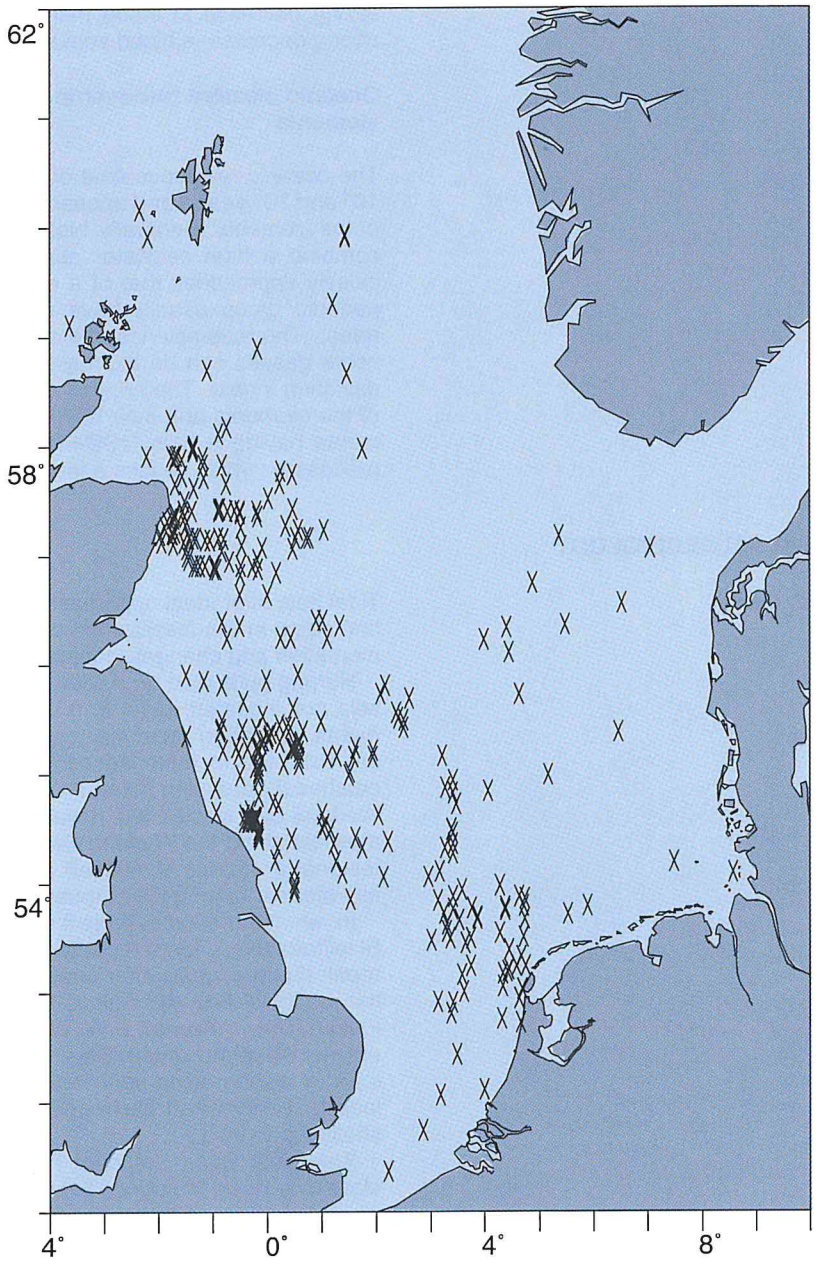
These areas appeared unchanged initially, with the largest number (*ca* 200000) present off Terschelling. Unprecedented, however, was the presence of nearly 60000 eiders *Somateria mollissima* among these ducks. Such numbers have never before been recorded in the Dutch North Sea, or, for that matter, anywhere in the German Bight. The ducks had apparently left the Wadden Sea in response to the collapse in food stocks there. In the North Sea they joined the wintering flock of common (125000) and velvet (12000) scoters, *Melanitta nigra* and *M. fusca*, over a rich bank of the bivalve *Spisula subtruncata.* This unusual concentration of seaduck was also detected by Dutch cockle fishermen, who promptly started fishing for the clams, for want of something better, *viz.* cockles *Cerastoderma edule* in the Wadden Sea. The fishery by a fleet of at least 7 ships caused a major disturbance and the ducks left the area and moved to another location off the Dutch mainland coast. The spring survey showed that, unlike the previous year, no scoters spent the summer in Dutch waters. The need to regulate shell fisheries in coastal waters in order to avoid competition with wintering seaduck is stipulated in the final report to the European Commission.

Around the Wadden Sea several cormorant *Phalacrocorax carbo* roosts were visited and regurgitated pellets were collected for diet analysis. These birds' food consists of a wide variety of fish, with juvenile flatfishes predominating. In order to determine the fish remains in the pellets a reference collection of fish otoliths has been set up.

B. Marine mammals

C.J. Camphuysen, M.F. Leopold

Sightings of cetaceans in the North Sea, as collected during surveys for seabirds at sea and during seawatching from coastal sites in and around the North Sea (NIOZ, IBN-DLO, NZG, CvZ/NZG, RIVO and various sources) between 1972 and 1993 were stored in one database. For most of the data, observer effort is known and relative abundance can be worked out. New sightings are published quarterly in *Sula*. The database is separate from the NIOZ and IBN-DLO database on seabirds and marine mammals at sea, because it includes information on accidental sightings, and is kept up to date.



Records of *Lagenorhynchus* dolphins in the North Sea (1982-1993), not corrected for observer effort.

B3-10 CHEMICAL INTERACTIONS BETWEEN MARINE ANIMALS AND THEIR ENVIRONMENT

Evolution of the ion composition of extracellular fluids in Metazoa

D.H. Spaargaren

Concentrations of the major ions (sodium, potassium, calcium, magnesium, chloride and sulphate) in the blood of large numbers (147) of marine and non-marine (brackish water, freshwater and terrestrial) animal species were analysed in relation to the evolutionary position of the species. Concurrent with the evolutionary development of the species, the complexity of their nervous system increases. The latter is associated with an increase of the 'irritability' of the tissues which can be correlated with a change in the ionic composition of the extracellular fluids, showing higher (Na + K) /(Ca + Mg) ratios and an

increased cation excess. The increase in irritability is mainly caused by a strong decrease in blood magnesium concentration, concurrent with a less strong decrease in blood sodium and chloride concentrations.

Oceanic element turnover in relation to the electron configuration of the elements

The oceanic residence time of chemical elements is highly variable (between 10^2 and 10^8 years) and appears to be a periodic function of the atomic number of the elements. Generally, high values are observed for those elements which combine a high seawater abundance and an electron configuration which closely approaches that of a noble gas; elements located in the middle of a periodic group usually have much lower residence times (higher turnover rates). The resemblance of the electron configuration of elements with that of noble gasses can be expressed by the so-called NGD-index (the noble gas deviation index). The relation observed between the oceanic residence times of the elements and their NGD-index is explained by the assumption that elements having a high NGD-index are more easily incorporated in biological processes, which causes a faster recycling of these elements.

B3-11 PALAEOBIOLOGY

G.C. Cadée

Tidal flats offer ideal opportunities to study the fate of bivalve shells during the first steps in the fossilization process. Two processes are studied: shell fragmentation and changes in metal content.

Herring gulls feed on a wide size range of mussels. Up to 40-mm-long mussels are ingested intact and crushed in their gizzard. Of the resulting fragments, the larger ones are regurgitated in pellets, whereas smaller fragments are excreted in their faeces. Mussels >40 mm are taken into the air and crushed by dropping them. As large mussels are scarce in the intertidal of the Wadden Sea since 1990, it was a surprise to find again herring gulls dropping mussels along the Wadden Sea coast on Texel in mid-September. They were feeding on clumps of mussels eroded from a subtidal mussel bed during easterly storms. Among these mussels they selected for the larger ones.

In an international project CRUSH (Co-operative Research Unravelling SHellfracturing), funded partly by NATO and KNAW, shell fracturing and shell repair (in gastropods after unsuccessful crab predation) were studied on a tidal flat in Cholla Bay (N. Gulf of California, Sonora, Mexico), together with K.W Flessa (Univ. Arizona), S.W. Walker (Univ. Georgia) and G. Hertweck (Senckenberg Wilhelmshaven). Shell repair — used as a measure of predation pressure — appeared to vary from species to species and also from locality to locality. Long-spired gastropods showed the highest percentages of repaired shells: up to 90%.

Arjan van Doorn (student Free University Amsterdam) continued studies started by Bram Majoor on the use of *Macoma* shells as an archive for environmental changes in metal concentrations. Concentrations proved to be too low to use the EDAX method: peaks found earlier by this method appeared to be artefacts. Using entire (cleaned) shells and an AAS method gave more reliable results. Experiments on changes in metal concentrations in shells buried for 3 months in an intertidal sandflat indicated changes: concentrations of some metals increased whereas other decreased during this early diagenesis. This indicates that *Macoma* shells probably cannot be used as an archive.

1.9. APPLIED MARINE ECOLOGY

INTRODUCTION

The Department of Applied Marine Ecology executes project research to improve the scientific basis for the management of the North Sea and the Wadden Sea. Short- and long-term changes in the ecosystem, and the possible anthropogenic or natural causes of these changes are the major research topics. The multidisciplinary research is carried out in co-operation with many different institutes all over Europe.

With the ending of the guaranteed financing by the government at the beginning of 1993, the department now works even more in a project-oriented way than in the past. In 1993 finances for these projects were obtained from various Dutch ministries, the EC and industry. Several new EC grants were obtained and new projects started.

This year's programme focused on the development of pelagic mesocosms to study the biology of the small food web, the relationship between algal blooms and dimethylsulphide (DMS) production, the effects of changing nutrient loads and of pollutants on higher trophic levels, ecological modelling of the North Sea, long-term changes in the North Sea ecosystem, the direct effects of fisheries on the benthic ecosystem, and the role of fishery discards as a food source for marine animals and birds.

BEWON was co-organizer of the Integrated North Sea Programme (INP). In September a public discussion on the effects of sediment subsidence by gas extraction in the Wadden Sea was organized.

The Department gave advice concerning scientific research to be carried out in protected areas in the North Sea, the drafting of the Quality Status Report, the effects of manure dumping in the North Sea or the Atlantic Ocean, effects of drilling platforms on the ecosystem, and the ecology of the coastal zone.

S-01a NUTRIENT CHEMISTRY

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

This project aims to quantify sediment uptake and release of the macro nutrients P, N and Si in co-operation with the Department of Chemical Oceanography (H1-04). The focus was on permanent binding and burial in the North Sea sediments as well as removal from the ecosystem by *e.g.* denitrification, and on the role of particulate suspended matter (SPM) in North Sea nutrient cycling.

Phosphate adsorption to iron (oxyhydr-)oxides was shown to have a large *in situ* effect on pore water phosphate concentrations in North Sea surface sediments. Both pore water and solid phase profiles of iron and phosphate indicate that this process results in a trapping of phosphate diffusing upwards from deeper layers, thus modifying the flux to the overlying water. Combination of these results with differential XRD measurements (S.J. van der Gaast, H3-17) suggests that the iron minerals ferrihydrite and akageneite are responsible for the adsorption of phosphate in these surface sediments.

Nitrification-denitrification coupling was investigated by L. Lohse (see H1-04). The study of diagenesis of Si in North Sea sediments (in co-operation with M. Gehlen, the Free University of Brussels, Laboratoire d'Oceanographie) indicates that biologically derived opal is not controlling the Si chemistry in most North Sea upper sediment layers (0-10 cm). A combination of sorption to Fe

oxides and dissolution of not well identified minerals to concentrations typically <400 µm seems to be more important.

Much effort was put in the optimization of techniques to measure different pools of nutrients in SPM. We are now able to quantify sorbed phosphate and ammonium, Fe- and Ca-bound phosphate, and organic N and P. Together with the measurement of dissolved organic and inorganic components this will give a full picture of the distribution of N and P in the water column. Preliminary results indicate that dissolved inorganic P is the largest fraction in the Marsdiep during winter at concentrations controlled by the adsorption equilibrium with suspended solids.

The project is complemented by studying transport and sedimentation of SPM and associated nutrients in the North Sea. This part is carried out within NOWESP (North West European Shelf Programme) funded by the EC-MAST II programme.

S-01b PHYTOPLANKTON

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

Size-differential control of phytoplankton and its impact on the structure of plankton communities were studied in co-operation with colleagues from the Department of Pelagic Systems. For this purpose a prototype of a pelagic mesocosm was tested. This indicated that microzooplankton might play a crucial role in controlling the biomass of smaller algae, creating the possibility for larger algae to bloom.

During a cruise to the central North Sea in June (BLOOM expedition) size-selective grazing was determined according to the Landry & Hasset dilution method. Although some indication for size-selective grazing was recognizable, the results were rather disappointing due to large variations probably caused by methodological artefacts. Therefore attempts are now made to develop an alternative method to estimate the grazing pressure on individual algal species in mixed communities in co-operation with Prof. dr. T. Fenchel (University of Copenhagen).

C. Brussaard continued her research on loss factors of algal blooms with special emphasis on the *Phaeocystis* blooms in the Marsdiep area (Dutch coastal waters). In 1993 the spring bloom of *Phaeocystis* was substantial and lasted for several weeks. During the collapse of the bloom, autolysis rates of up to .8 d^{-1} were measured. This indicated that a large part of the *Phaeocystis* bloom disappeared due to nutrient depletion induced autolysis, rather than by herbivoric grazing activity.

Axenic nitrogen-limited continuous cultures of the diatom *Ditylum brightwellii* were used to demonstrate that autolysis rates increase at lower growth rates. Even in the absence of bacteria, *Ditylum brightwellii* was found to be able to maintain a small population of healthy cells, growing on the lysis products of dying cells.

S-01c MICROBIAL ECOLOGY

Benthic small food web in North Sea sediments

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

Temperature accounted for more than 65% of the seasonal variations (summer and winter) and more than 55% of the spatial variations (summer) in bacterial production in North Sea sediments. Regressions between bacterial production and temperature rendered Q_{10} values exceeding realistic values for bacterial growth (average around 3). This implies that the (indirect) effect of temperature on substrate availability is considerable. Particularly in summer in temperature stratified regions of the North Sea a slight increase in bottom water temperature (mixing event) may be followed by an increase in sedimentation. Fresh algal detritus appears to form the major food source for the benthic system. After adding phaeopigment content in the sediment to multiple regression equations up to 88% of the variance in benthic bacterial production in North Sea sediments could be accounted for. Benthic bacterial biomass did not show seasonality (summer and winter) in North Sea sediments but showed significant correlations with sediment phaeopigment and chlorophyll *a* content in

summer as well as in winter. The phytopigment content of the sediment was 30-40% lower in winter than in summer.

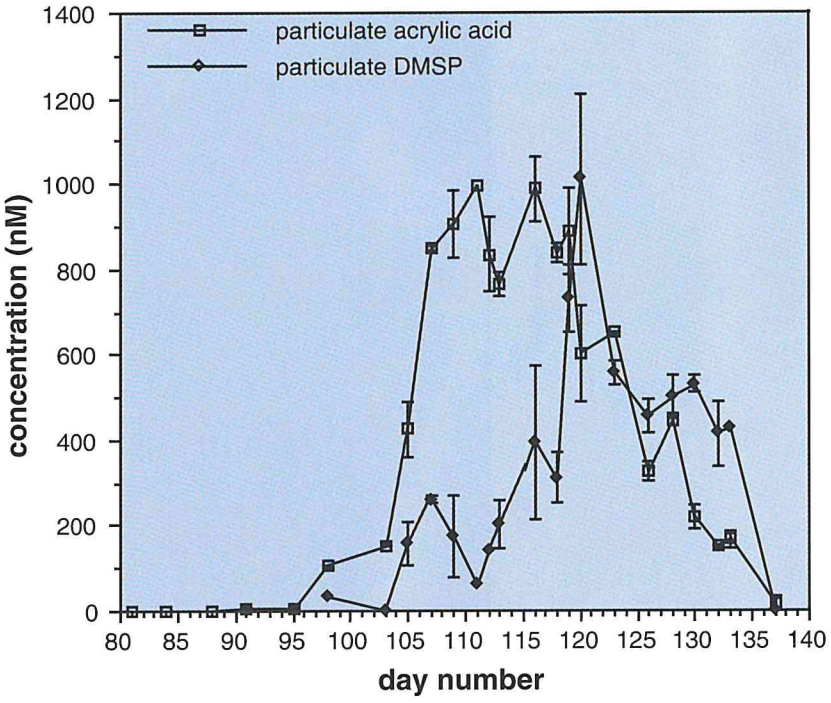
For most stations visited during the BELS expeditions in 1991 and 1992, sediment organic matter was a reasonable predictor of spatial variations in benthic bacterial production in summer. Exceptions were sandy stations located in eutrophic turbulent coastal regions, less than 25 m deep, and stations located in areas where allochthonous refractory material settles on the bottom such as in the deep Skagerrak and in the Silverpit (UK).

Pelagic mesocosms

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

Within the framework of the dimethylsulphide (DMS) project of the National Research Programme (NOP), a mesocosm experiment was carried out in co-operation with TNO to explain the role of sedimentation of algae in marine DMS production. The mesocosms (plastic bags) were filled with water from the Marsdiep, collected during the *Phaeocystis* spring bloom. This bloom was further stimulated in the mesocosms by adding nutrients in a ratio that favours growth of this species. The bloom was monitored for 35 days. Chlorophyll *a*, DMS, sedimentation and several other parameters were measured daily. Sedimentation rates were determined with sediment traps. These rates, however must be considered as gross sedimentation rates, since sediment traps do not measure resuspension. On most days, no depth gradient in chlorophyll *a* was observed. This indicates that resuspension rates were low. It was therefore assumed that the measured sedimentation was nearly equivalent to the real net sedimentation rates.

The measured rates showed that a considerable part of the primary production sinks to the bottom of the mesocosm. Therefore sedimentation may be an important factor involved in marine DMS production.



The concentrations of acrylic acid and DMSP in particulate organic matter during th *Phaeocystis* spring bloom in the Marsdiep (1993).

Spring blooms in coastal waters

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

Phaeocystis reached full bloom in the Marsdiep in the second half of April, one month earlier than in 1992. The interannual variations in the wax and wane of the *Phaeocystis* bloom and the coupled bacterial bloom in the Marsdiep may be related to weather conditions (wind direction, force and rain) and fluctua-

tions in the discharge of freshwater into the Wadden Sea (via Lake IJssel). The salinity was significantly lower in 1992 than in 1991 and in 1993.

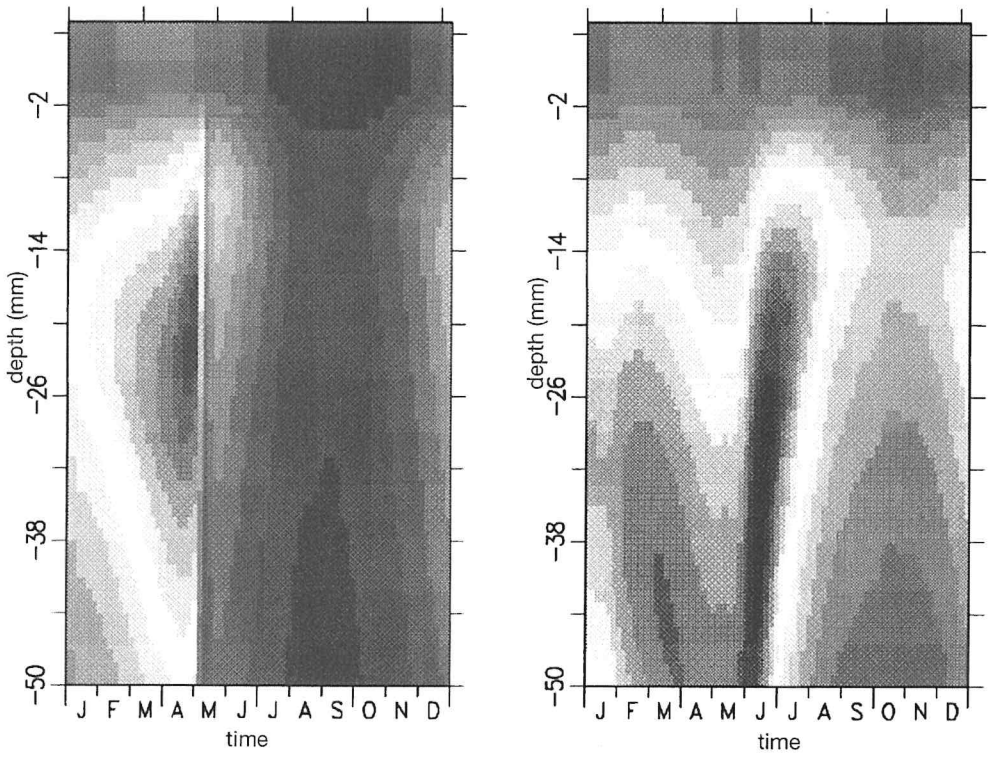
During the *Phaeocystis* bloom we measured bacterial production, acrylic acid, dimethylsulphoniopropionate (DMSP) and dimethylsulphide (DMS). Comparison of these data with numbers of *Phaeocystis* colonies and cells (S-01b and B3-01) gave remarkable results. The acrylic acid concentration in particulate material closely co-varied with the number of *Phaeocystis* colonies. The DMSP content in particulate material co-varied with the number of colony associated *Phaeocystis* cells. The strong increase in DMSP coincides with the decrease in acrylic acid. The first steep increase in bacterial production coincided with the decrease in acrylic acid and the steep increase and decrease in particulate DMSP. The second steep peak in bacterial production occurred 15 days after the peak in total *Phaeocystis* cells. The analysis of the sequence in changes in concentrations of variables and fluxes is the first step towards explaining the processes that control DMS release and consumption in the water column.

S-01e MODELLING

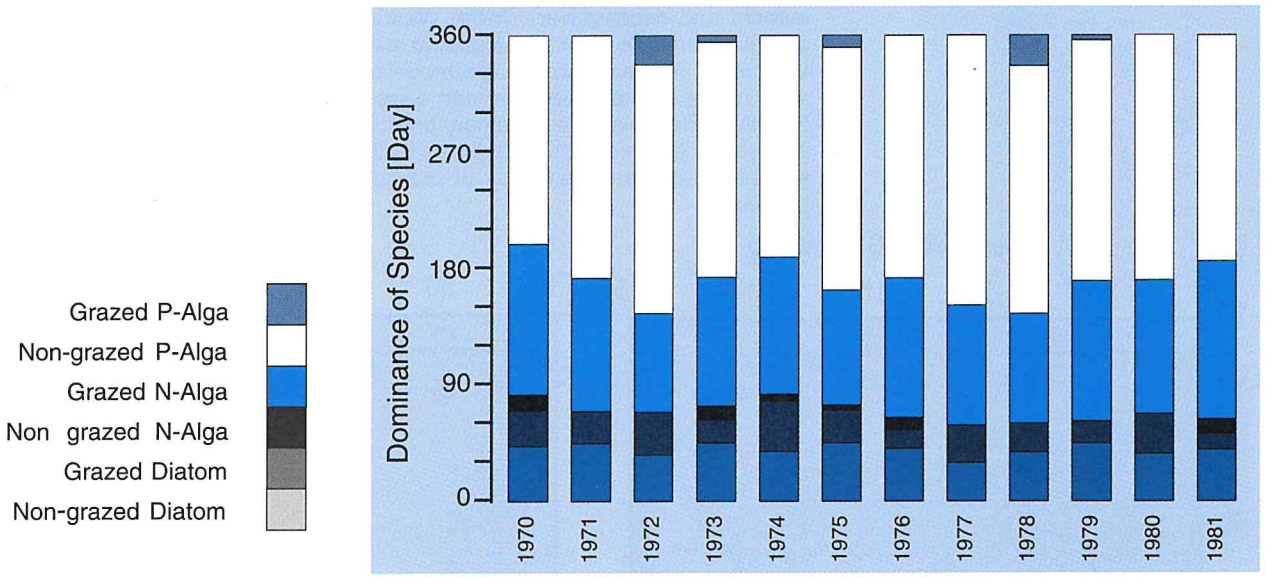
P. Ruardij, A. van den Berg, J.P.C. Smit, W. van Raaphorst, E. Embsen

ERSEM (European Regional Sea Ecosystem Model)

ERSEM, a joint project of 7 institutes and subsidized by the EC MAST I programme will be continued as a MAST II programme. The original goal of this project was the construction of an ecosystem model of the North Sea. Therefore the North Sea was divided into 10 areas, roughly corresponding with the ICES boxes. There are 5 coastal boxes (boxes 6 to 10). The deep areas are divided into upper boxes of 30 m depth and lower boxes from 30 m down to the bottom (boxes 11 to 15).



Example of profiles of nitrate as simulated with the ERSEM model for a coastal box (left) and an offshore box (right). In coastal areas, due to the large sedimentation of organic material, the thickness of the oxygenated layer will decrease to a few mm. Therefore the nitrification rate, *i.e.* the transformation from ammonium to nitrate, which takes place only in this layer, decreases and results in a lower nitrate concentration in the sediment. In offshore areas, the sedimentation is less and hence oxygenation depth is greater. Thus nitrification is not limited and the offshore box shows increasing nitrification after input of fresh sedimented material.



The results show that the model, despite using large boxes, can reproduce the general pattern as observed, especially for the lower trophic levels and the nutrients.

One of the major tasks of the NIOZ within ERSEM is the construction of a benthic nutrient model. For this purpose a new and efficient approximation method has been developed to solve sets of partial differential equations. It has been proved that by this method the dynamical behaviour of nutrients in the pore water of the sediment can be modelled in an appropriate way. The whole model with the benthic nutrient model shows an adequate response to different environmental conditions in both the North Sea water column and the sediment. A future objective will be to test and improve our understanding of long-term and large-scale dynamics.

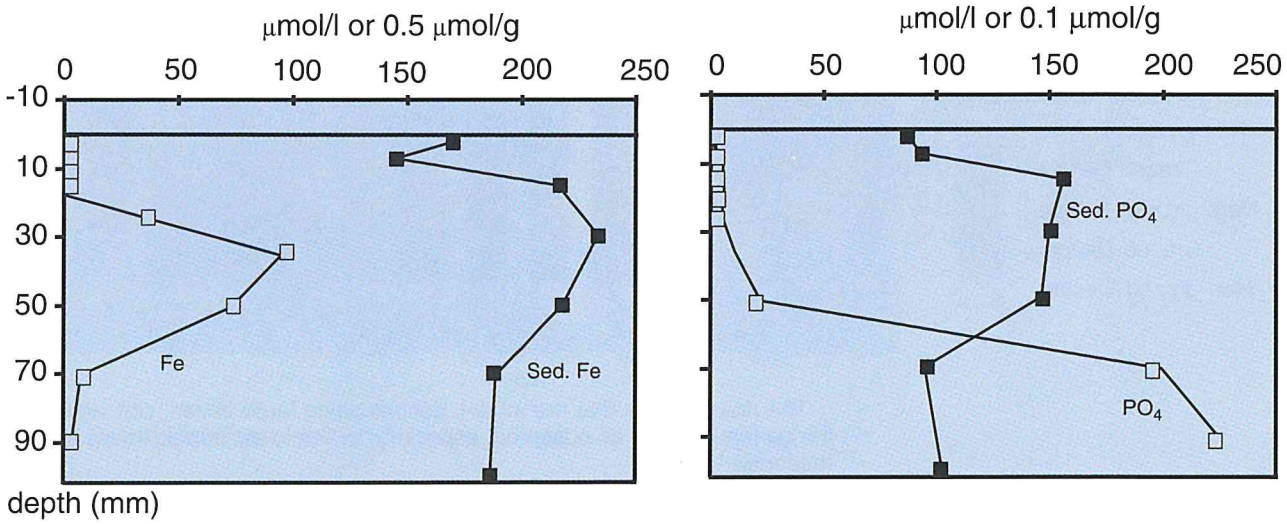
FYFY

FYFY is a model of the algal succession in the southern North Sea. It explains the diversity of algal species and assesses the influence of wind-forced water transport on the selecting factors which determine the algal composition in time and space. This transport has been calculated from realistic meteorological data on a daily basis over twelve years. The model results show that inter-annual variations of weather conditions can significantly change the algal biomass and composition. A seven-year trend of biomass increase near the Dutch coast can be attributed to transport processes. The period of dominance of a species within a year may almost double dependent on the wind direction and weather conditions. This means that part of the diversity and variability in the phytoplankton is caused by weather variability. The model also shows that the algal composition is influenced by the input of nutrients from the rivers, especially the Rhine. An increase of these nutrients as in the past decades causes a selective increase in biomass of non-grazed algae in the FYFY model. A change in the ratio of the nutrients in the river water also leads to a different algal composition through a change in the limiting nutrient. This means that reduction of phosphorus and nitrogen components in the river water in different ratios will cause a shift in species composition which might be harmful to the ecosystem.

ECOWASP

ECOWASP was developed together with IBN/DLO within the EC-MAST I project WASP. The model calculates the dynamics of primary producers, con-

sumers and decomposers in the Wadden Sea, and includes and extensive benthic submodel to calculate uptake and release of nutrients (N, P, Si) by the sediments. All fauna groups are modelled according to population dynamics, allowing for different size and age classes. Compared to available field data ECOWASP simulates *e.g.* primary production, nutrient concentrations and the production and biomass of mussels in the Wadden Sea. The model demonstrates the direct dependency of mussels and food provided by the primary producers.



Evidence for the role of iron (oxyhydr-) oxides in the trapping of phosphate is provided by the S-shaped pore-water profile of phosphate, indicating phosphate removal from solution and the concomitant patterns of ammonium-oxalate extractable sediment phosphate and iron. The observed decoupling of pore-water iron and phosphate is attributed to the re-oxidation of iron sulphides. The figure shows data from a station in the German Bight. The sediment samples were obtained during the INP-BELS cruise in February 1992.

S-02 MICROPOLLUTANTS

S-02a ENVIRONMENTAL FATE OF PCBs

J.P. Boon, A. van Schanke, M.T.J. Hillebrand

Differences in the chlorobiphenyl patterns between marine mammals and fish can be explained with the structure-biotransformation relationship developed in a former experimental study. This means that in seals only congeners belonging to the following groups bio-accumulate via the food chain:
I- Congeners without any vicinal hydrogen (H-) atoms.
II- Congeners with vicinal H-atoms in the *ortho*- and *meta*-positions in combination with ≤2 *ortho*-Cl atoms.

The following chlorobiphenyls were apparently enzymatically metabolized by the cytochrome P450-dependent mono-oxygenase system in seals:
III- Congeners with vicinal H-atoms in the *ortho*- and *meta*-positions in combination with 1 *ortho*-Cl atom.
IV- Congeners with vicinal H-atoms in the *meta*- and *para*-positions in combination with 2 *ortho*-Cl atoms.
V- Congeners with vicinal H-atoms in the *meta*- and *para*-positions in combination with ≤3 *ortho*-Cl atoms.

Harbour porpoise (*Phocoena phocoena*) seemed unable to metabolize chlorobiphenyl congeners belonging to group V.

Direct proof of the occurrence of biotransformation was obtained from *in vitro* studies in co-operation with D. Morse and A.J. Murk (Department of Toxicology, Agricultural University of Wageningen). The cytochrome P450 system is present in the liver and can be studied *in vitro* by grinding tissue and purifying the enzyme-containing fraction by centrifugation. This procedure results in the formation of 'microsomes', which retain their enzymic activity. The assay was tested with microsomes of a harbour porpoise (*Phocoena phocoena*) and a harbour seal (*Phoca vitulina*). A comparison of the patterns of individual CB

congeners in active batches with inactive batches led to structure activity relationships similar to those found in the *in vivo* experiments. Thus, the assay developed in this study seems to be a good model for *in vivo* phase I metabolism of organohalogen compounds and could therefore partially replace time-consuming and expensive animal experiments.

S-02b BIOMARKERS OF TOXIC EFFECTS OF MICROCONTAMINANTS

J.P. Boon, H.M. Sleiderink, J. Sewsaran, B.P. Mensink, C.V. Fischer, C.C. ten Hallers-Tjabbes, H. Kralt, J. Kraayenoord, J.M. Everaarts, M.T.J. Hillebrand

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

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

The main objective of the work on the cytochrome P450-dependent monooxygenase (MO) enzyme system is to investigate whether its inducibility in dab can serve as an indicator of exposure to planar contaminants for the North Sea environment. In fish, the iso-enzyme cytochrome P4501A can be induced by a large variety of planar aromatic compounds such as chlorinated biphenyls (PCBs), chlorinated dibenzodioxins (PCDDs) and chlorinated dibenzofurans (PCDFs). The induction can be measured catalytically (as EROD activity) and immunochemically by enzyme linked immunosorbent assay (ELISA).

As a follow-up of the Integrated North Sea Programme, EROD and ELISA data on PCB concentrations in muscle tissue from the two surveys in 1991 and 1992 were further interpreted. A positive correlation between PCB concentration and enzyme induction was found, but a strongly negative correlation between enzyme induction and water temperature, which masked the effect of contaminants. An additional laboratory study with dab from the Dogger Bank proved the inverse relationship between EROD induction and water temperature, but the concentrations of CYP1A measured by ELISA were not significantly different. In a laboratory study, CYP1A of dab could be induced by the technical PCB mixture Clophen A40.

C.C. ten Hallers-Tjabbes, B.P. Mensink

Imposex (or pseudohermaphroditism) is the development of male sexual characteristics in female gastropods. In the literature tributyltin (TBT), used in antifouling paints, was suspected of causing imposex in *Nucella lapillus*. Whelks (*Buccinum undatum* L) from the Dogger Bank were exposed to different TBT concentrations in the laboratory. No imposex occurred during the water exposure experiment, despite high TBT concentrations. Exposure to contaminated food and sediment has yet to be tested. However, only the control group produced egg masses with developing juveniles: TBT might also affect reproduction.

For whelks, sensory perception of chemical stimuli is the most important guidance in functional behaviour. In a pilot study with young and adult whelks, chemoreception responses to sediments contaminated with PAHs and to clean sediments were tested as well as the chemoreception acuity for food odour after exposure. The variation in individual behaviour in this first study only allowed for recognition of trends, and did not provide consistent results. The whelks tended to avoid sediment contaminated with benzo(a)pyrene (B[a]P, but not in the presence of fluoranthene (Flu). The recognition responses to food odour were sometimes, but not consistently, retarded after exposure to B[a]P.

The whelks caught in 1992 reproduced successfully and their offspring is still alive, as well as the offspring of the whelks hatched in 1991.

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

R. Daan, M. Mulder

Studies on the environmental impact of offshore drill cutting discharges concentrated on the long-term effects of oil-based mud (OBM) cuttings and the short-term effects of water-based mud (WBM) cuttings.

Photo: M. Mulder

The results of a field survey carried out in 1992 around a production platform where OBM drilling took place in 1984 became available this year. The location has been studied since 1985. Clearly elevated concentrations of oil in the sediment were still found up to 250 m from the platform, especially in the deeper sediment layers. Within 250 m no substantial fraction of the oil has degraded since 1984. No concentrations above background level were found at 500 m and farther away from the platform, but traces of oil were visually observed up to 1000 m away. At 100 m from the platform, the benthic fauna was still substantially impoverished compared to the stations farther away. At 250 m only the absence or reduced abundance of some OBM-sensitive species, *e.g.* adult *Echinocardium cordatum*, indicated a persistent effect, while at 500 m and farther away no significant effects could be detected. Particularly the re-appearance of adult *Echinocardium cordatum* at stations between 500 and 1000 m from the platform indicated recovery in this zone.

A study on the short-term effects of WBM cutting discharges was completed, including 2 post-drilling field surveys around a location in the Frisian Front area, 2 and 14 months after completion of the drilling. Results indicate no gradient in the benthic fauna composition around the well site. Even as close as 25 m from the discharge site no anomalies were found. Dumping of WBM with

a chemical composition such as used has no demonstrable effects on the benthic community.

In 1993 two new field programmes were started: a study of long-term effects of OBM cutting discharges in the shallow sandy area of the southern North Sea and a monitoring programme around a well site where drilling muds based on esters were dumped.

The OBM studies were commissioned by RWS (North Sea Directorate) and carried out in co-operation with MT-TNO Den Helder. The WBM study was performed by order of NOGEPA and the study on ester-based muds was commissioned by NAM.

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

H.W. van der Veer, P.A. Walker

Special attention has been paid to the impact of human activities on the productivity of the higher trophic levels, and in particular on the population dynamics of the shrimp *Crangon crangon* in the coastal zone. The main factors that influence the productivity and population dynamics of this species are thought to be eutrophication via the increased availability of food and the fishery on adult shrimp, reducing the adult stock and therefore potentially the size of recruitment. Although nutrient loadings have decreased in the coastal area and into the western Wadden Sea over the last years, so far this has not resulted in a reduction of the primary production in the area (B3-01). Also the benthic production seems to have been the same over the last years (B3-02). There is no relationship between reduced nutrient loading and settlement of juvenile shrimp on the tidal flats. The reduced abundance of adult shrimp is more likely to be caused by overfishing of the adult population.

The second topic concerns the biology of a number of ray species, in order to address the hypothesis that anthropogenic factors, in particular fisheries and pollution, have caused a decline in abundance and distribution of rays in the North Sea.

In contrast to the teleosts, which expend large amounts of energy on high rates of reproduction and growth, rays produce relatively few, well-developed eggs, have a slow growth rate and, in general, a high age and length at first maturity. This life-history pattern makes them particularly susceptible to overfishing. However, the situation regarding exploitation is complex and a literature review will serve to help interpret the long-term data series.

An extensive three-year tagging programme in the North Sea was started in 1992, in co-operation with RIVO in IJmuiden. Tagging data from the North Sea from the 1960s and 1970s collected by the Fisheries Laboratory in Lowestoft, UK, are being analysed at NIOZ for comparison.

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

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

Fieldwork was carried out on direct effects of 4-m beamtrawls on bottom fauna in the sandy coastal area and on effects of 12-m beamtrawls on a soft bottom community in the Oyster Grounds. Side-scan sonar recordings of both research areas showed tracks of recent commercial trawling on the seabed.

Grab and dredge samples, taken before and after a study site was trawled twice with commercial beamtrawls, showed that mean densities of a number of invertebrate species (molluscs, echinoderms, crustaceans, polychaetes) had significantly decreased after trawling.

Survival experiments were carried out with animals collected with a beamtrawl covered with a fine-meshed outer net, collecting fish that escaped through the 8 x 8 cm meshes of the sole net. Survival of fish from very short hauls was high, approximately 80-100%, indicating that fish escaping through the meshes suffer little damage from the nets or the tickler chains. Survival of fish in catches of the 4-m beamtrawl (hauls of 1-2 hours) was 10-40% and higher than the survival estimated earlier for fish in catches of (much heavier) 12-m beamtrawls. Remarkable was the high survival of undersized sole (40-60%) and turbot (50-80%).

Mean densities of a number of mobile invertebrate and fish species had significantly increased 24 hours after trawling with commercial beamtrawls. Stom-

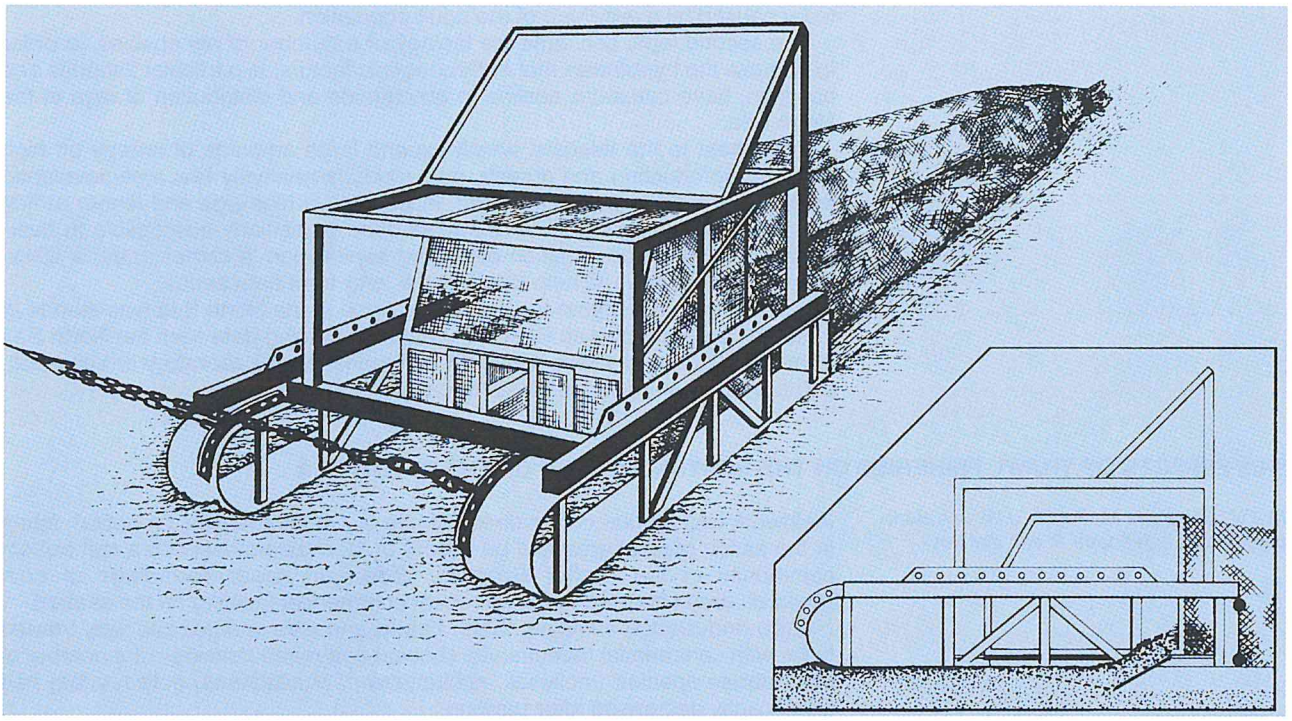
ach contents indicated, that particularly dab (*Limanda limanda*) acts as scavenger on bivalves, dug out by the passage of the trawl.

Repeated fishing with 4-m-beamtrawls over the same line showed a rapid decline in numbers of dab and plaice in the first four hauls. The numbers in catches increased again after trawling had been stopped for about 3 h, indicating a rapid immigration of the fish. This was also evident for sole and shrimp, showing increasing numbers in catches with 3-m-beamtrawl and TRIPLE-D after the line had been trawled with commercial beamtrawls. The main reason for this immigration was obvious: the fish were feeding on *Spisula* damaged by the commercial trawls.

Preliminary studies on survival of the bycatch in shrimp fishery carried out in the Wadden Sea showed considerable mortality in young flatfish: dab (70%), sole (50%) and plaice (30%). Such mortality is likely to depend on the treatment of the catch on board. To reduce mortality, young flatfish should be washed overboard immediately after passage of the sieve.

The fine-meshed 3-m beamtrawl appeared to be far more effective during the evening and at night. Therefore macrofauna sampling with the fine-meshed beamtrawl should be carried out only in the evening or at night.

In 1992-1993 these BEON-studies were incorporated in the EC-project IMPACT, a joint programme with German, English and Belgian partners. BEWON-field studies were carried out in co-operation with Rijkswaterstaat-North Sea Directorate (RWS/DNZ) and Netherlands Institute for Fishery Investigations (DLO-RIVO); both institutes supplied a research vessel.



In 1993 a prototype was developed of a new Deep Digging Dredge (TRIPLE-D) to catch low-abundant or clustered infauna. The dredge was successfully tested on *Macoma balthica* in the upper 10 cm of soft sticky sediments. The TRIPLE-D appeared to be a practical and reliable device to sample infauna (molluscs, crustaceans, echinoderms) as well as sole, and was indispensable in the studies on direct effects of trawl fishery on bottom fauna.

Weight about 500 kg
Towing speed 3 knots
Interchangeable blades
Max. depth blade 10 cm (width 20 cm)
Mesh size 2 cm stretched
Sample size about 10-100 m^2

S-04 SCAVENGING SEABIRDS IN DUTCH BEAMTRAWL FISHERIES

C.J. Camphuysen

In co-operation with Glasgow University, Hamburg University, Ornis Consult (Copenhagen), Joint Nature Conservation Committee (JNCC, Aberdeen) and Inselstation 'Vogelwarte Helgoland' (Helgoland & Wilhelmshaven), an EC-funded project was launched, aiming at an assessment of distribution, numbers, behaviour, and feeding efficiency of scavenging seabirds in winter in 7 subregions in the North Sea. The fieldwork for this project was carried out in January and February, and comprised an intercalibration cruise aboard RV 'Pelagia' and actual field studies during the International Bottom Trawl Survey (IBTS) aboard the fisheries research vessels 'Tridens', 'Dana', 'Scotia', 'Argos', and 'Walter Herwig'. This gave information on the species, numbers and distribution of scavenging seabirds in winter, on co-occurrence of seabirds and commercial trawlers, on dominance hierarchies among scavengers in areas differing in species composition and relative abundance of seabirds.

More detailed studies aboard commercial beamtrawlers commenced in summer. Detailed studies could be made of consumption rates of experimentally discarded fish and offal (mainly intestines of gutted fish). Several thousands of fish were discarded during these experiments, using samples of fish and offal from each haul. Numbers of fish consumed during these experiments were compared with expected consumption rates, based on the relative abundance of different species of seabirds at the trawl.

The distribution of scavenging seabirds at trawlers was studied using old data collected at NIOZ, IBN-DLO and by the Dutch Seabird Group (NZG) aboard sea-going vessels during 1987-1992, and during similar cruises in 1993. The network of seawatchers along the Dutch coast (working group CvZ of the Dutch Seabird Group; CvZ/NZG) was asked to record birds associated with commercial trawlers as seen from coastal sites. It appeared that adult Lesser Black-backed Gulls are numerically dominant offshore in the southern North Sea at trawlers, but that Herring Gulls are higher up in the dominance hierarchy at the trawl. Large numbers of adult Herring and Lesser Black-backed Gulls at over 80 km from the nearest colonies were probably part of a non-breeding contingent which, at such scale, was not known to exist in these waters.

S-10 MONITORING MACROZOOBENTHOS WADDEN SEA

R. Dekker, D. Kwast

Two times per year, macrozoobenthos is monitored along nine transects in the Wadden Sea. Three are in the subtidal parts of the western Dutch Wadden Sea; three at Piet Scheveplaat, south of Ameland, and three on a tidal flat in the Dollard. This work, financed by the Tidal Waters Division, Rijkswaterstaat, forms an addition to the project B3-02, carried out at Balgzand.

The good local 1992 spatfall at subtidal transects of the bivalve species *Mytilus edulis* and *Cerastoderma edule* survived well during the 1992/93 winter. The resulting high densities of these bivalves accounted for high total biomass values of over 200 $g \cdot m^{-2}$ ash-free dry weight. During the summer of 1993, recruitment in most macrozoobenthic species was relatively poor, except for subtidal *Mytilus edulis* and the tube-building polychaete *Lanice conchilega* locally on intertidal transects. In the Dollard the populations of *Corophium volutator* fully recovered after exceptionally low densities for some years.

1.10. BIOMETRICS AND STATISTICS

J. van der Meer

Optimal design for temporal and spatial biological sampling was our main subject this year.

Sampling design in temporal variation studies usually consists of taking 3 to 5 samples each time at a number of non-randomly chosen stations. Alternatives are sampling new randomly selected stations each time, or sampling at the same randomly selected stations each time. Optimal sampling, checked with results from Beukema's long-term sampling programme on Balgzand (B1-02), appears to be: revisit (each time) many randomly selected stations and make little effort per station.

Optimal sampling for spatial variation was studied using macrobenthos surveys in the ebb-tidal delta of the Rhine, Meuse, and Scheldt. Subsampling within a (few) station(s) resulted in lower precision of abundance estimates, detection of fewer species, and less reliable estimates of species-environment relations. Taking one sample at a larger number of randomly selected stations gave better results.

The long-term NIOZ sampling programme of the fish fauna in the Wadden Sea started in the early 1960s with a single kom-fyke trap still in use. Between 1966 and 1973 two more kom-fykes, and a fyke and a kom were used at adjacent localities. Time-trend analysis of the catches requires the assumption of a constant sampling fraction for all devices; patterns for the five devices should be parallel. For plaice and saithe the traps showed such parallel fluctuations, for other species such as garfish, the assumption was invalidated by distinct trends over years.

Finally work on statistical models of the nutrient stores in birds (estimated from carcass data on body mass, fat mass and body size) revealed that prevailing methods regressing fat mass on body mass and size, or regressing fat mass on condition indices like body mass divided by size, are based on questionable assumptions and should be abandoned.

2.1. PUBLICATIONS

2.1.1. Netherlands Journal of Sea Research and other series issued

In 1993, volume 31 of the Netherlands Journal of Sea Research appeared in four issues with a total of 512 pages. The first three issues were edited by the permanent editors, the fourth by T. Piersma. In the NIOZ Publication Series no 21 appeared: the Annual Report 1992. It was edited by H.A. van Aken, G.C. Cadée and P. de Wolf.

Among the 28 papers published in the three regular issues of the Netherlands Journal of Sea Research, 19 were on marine biology, 6 on marine geology, 2 on physical oceanography and 1 on marine chemistry. The one special issue contained the proceedings of a Wader Study Group symposium on 'Shorebirds and the availability of their benthic prey'. In addition to 13 papers on the theme 'Trophic interactions between shorebirds and their invertebrate prey', it contained a bibliography of a retiring staff member of NIOZ: C. Swennen.

2.1.2. Publications NIOZ 1993

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15 CADÉE, G.C. Persisting high levels of primary production at declining phosphate concentrations in the Dutch coastal area (Marsdiep).—Neth. J. Sea Res. **31:** 147-152.
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50 VAN DER MEER, J. Statistical methods for the analysis of long-term wader counts in the Oosterschelde and Westerschelde, SW-Netherlands. Rijkswaterstaat DG-466.
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52 VAN KATWIJK, Q. & C.J. CAMPHUYSEN. Post-breeding dispersal of Guillemots *Uria aalge* in the North Sea, late summer 1993.—Sula **7:** 133-141..
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2.1.3. Internal reports NIOZ 1993

54 CAMPHUYSEN, C.J. Scavenging seabirds behind fishing vessels in the northeast Atlantic, with emphasis on the southern North Sea. NIOZ report 1993-1, BEON report 20.

55 BALTHUS, C.A.M. De invloed van de wadpier *A. marina* op het macrobenthos op het Balgzand, een wadplaat in het westelijke deel van de Nederlandse Waddenzee. NIOZ Report 1993-2.

56 DEKKER, R. Het macrozoobenthos op 9 raaien in de Waddenzee en de Eems-Dollard in 1992. Monitoring bodemfauna Waddenzee en Eems-Dollard. NIOZ Report 1993-3.

57 DE BRUIN, T.F., L. OTTO, J. VAN BENNEKOM & M.A. BAARS. Toepassing van remote sensing technieken tijdens het Nederlands Indische Oceaan Programma. NIOZ Report 1993-4.

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59 VERKUIL, Y. & I. TULP. Premigratory fattening in Knots: food condition, feeding time and intake rate. NIOZ Report 1993-6.

60 POOT, M. & B. ROELEN. Feeding ecology of Knots at Schiermonnikoog in autumn 1990: deep *Macoma*: Knots foraging efforts to great hights. NIOZ Report 1993-7.

61 CAMPHUYSEN, C.J., K. ENSOR, R.W. FURNESS, S. GARTHE, O. HÜPPOP, G. LEAPER, H. OFFRINGA & M.L. TASKER. Seabirds feeding on discards in winter in the North Sea. Final report to the European Comm., study contr. 92/3505, NIOZ Report 1993-8.

62 RAAPHORST, W. VAN & J.P. BOON. The integrated North Sea Programme (INP) 1991-1992. NIOZ Report 1993-9.

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64 DUINEVELD, G.C.A. & J.J.M. BELGERS. The macrobenthic fauna in the Dutch sector of the North Sea in 1992. NIOZ Report 1993-11.

65 KLEIN, R. & R. WITBAARD. Long-term trends in the effect of beamtrawl fishery on the bivalve mollusc *Arctica islandica* L. (Mollusca, Bivalvia). NIOZ Report 1993-12.

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67 LINDEBOOM, H.J. (ed.). Openbare discussiedag 'Bodemdaling Waddenzee'. NIOZ Report 1993-14.

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70 VOOYS, C.G.N. DE, J.IJ. WITTE, R. DAPPER, J. VAN DER MEER & H.W. VAN DER VEER. Lange termijn veranderingen op het Nederlands continentaal plat van de Noordzee: trends in evertebraten van 1931-1990. NIOZ Report 1993-17.

71 TEN HALLERS-TJABBES, C., J. BOON, H.J. LINDEBOOM & C.G.N. DE VOOYS. Ecoprofile of the whelk, *Buccinum undatum*. NIOZ Report 1993-18.

2.1.4. Cruise Reports 1993

1 BAARS, M.A. & P.H. SCHALK. Shipboard Report of the NE monsoon cruise by RV 'Tyro'; Victoria-Djibouti, January 11 - February 6, 1993; 'Monsoons and pelagic systems': 1-135.

2 CAMPHUYSEN, C.J. De exploitatie van op zee overboord geworpen vis en snijafval door zeevogels, een verkennend onderzoek. Reisverslag RV Tridens 9-11 november 1992: 1-19.

3 CAMPHUYSEN, C.J. Foerageermogelijkheden voor zeevogels in de boomkorvisserij: een verkennend onderzoek. Reisverslag HD 7 '6 Gebroeders' 28 juni-2 juli 1993: 1-23.

4 FRANSZ, H.G. PEGASUS cruise 1 (13-16 April), cruise 2 (21-25 June), cruise 3 (29 September-1 October) and cruise 4 (8-11 December) with RV Pelagia.

5 VAN BENNEKOM, A.J. & J.E.E. VAN BEUSEKOM. Aluminium content of biogenic silica in sediments.

6 VAN WEERING, TJ.C.E., G. GANSSEN & W. HELDER. Shipboard report cruise C2, NW Indian Ocean: 1-104.

7 VELDHUIS, M.J.W. & K. TIMMERMANS. Bloom93, vaarverslag van vaartocht in de noordelijke Noordzee tijdens een bloei van *Emiliania huxleyi*.

2.2. LECTURES, ETC.

2.2.1. Colloquia and workshops at the institute

(titles translated)

12 February	H. van Haren (NIOZ): (Bottom boundary layer mixing above a slope; flux measurements from ADCP and thermistor-string data)
05 March	S.J. van der Gaast (NIOZ): (The influence of 'marine minerals' on some nutrients in pore water) W. van Raaphorst (NIOZ): Sorption of nutrients on marine minerals
12 March	R. Riegman & B. Kuipers (NIOZ): (Food-web relationships in the North Sea)
19 March	E. Epping (NIOZ): (Oxygen dynamics in Wadden Sea bottoms) W. van Raaphorst (NIOZ): (Phosphorus cycling in Wadden Sea sediments)
25 March	S. de Rijk (University of Amsterdam): (Salt-marsh foraminifera: an indication of sea-level fluctuations over the past 3 000 years?) E. Ufkes (NIOZ): (Spring distribution of planktic foraminifera in surface waters of the SE Atlantic Ocean)
26 March	P. Bos (RWS-DGW): (Processes in coastal areas with freshwater influx: the Rhine outflow (EC-MAST project PROFILE))
02 April	K. Phillipart (IBN), R. Jak (TNO), H. de Heij (NIOZ): (Effects of eutrophication on benthic systems)
07 April	Workshop colloquium 'The effects of fisheries on seabirds and marine mammals' R.F. Furness (Glasgow University): Preliminary estimates of the long-term changes in scavenging seabird numbers in the North Sea as a consequence of changing fisheries management S. Garthe (Vogelwarte Helgoland, Germany): Utilization of discards by seabirds in the central and southeastern North Sea P. van Damme (Catholic University, Louvain, Belgium): Parasitic diseases of fish A.S. Couperus (RIVO): Marine mammals as scavengers at trawlers C.J. Camphuysen (NIOZ): Herring Gull and Lesser Black-backed Gull feeding at trawlers during the breeding season: competitive scavenging *versus* efficient flying F. van Beek (RIVO): Discards/Beamtrawl
16 April	C. Zonneveld (VU): (A dynamic-model approach to animal energy budgets) A. van den Berg (NIOZ): (Algal succession in time and space)
23 April	G.J. Brummer (NIOZ): (Particle transport to the ocean floor as measured by sediment traps)
07 May	P. de Wolf (NIOZ): (Is *Pleurobrachia* plankton?)
14 May	Netherlands Indian Ocean Programme; preliminary impressions M.A. Baars (NIOZ): (Project B 'Monsoons and Pelagic Systems' of the Netherlands Indian Ocean Programme; plankton biomass and primary production in the seasonal upwelling zone near Somalia, June/July 1992 and January 1993) Tj.C.E. van Weering (NIOZ): (Preliminary results of NIOP project C 'Tracing a seasonal upwelling system') A.J. van Bennekom (NIOZ): (Deep water masses at NIOP stations B and C. a. Effects of the monsoon regime; b. Bottom water in the Somali Basin)
29 October	L.R.M. Maas (NIOZ): (Ocean circulation in a nutshell)

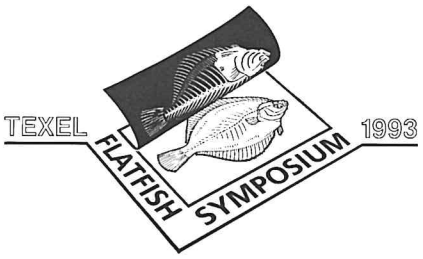
06 November	S. McChesney (University of Hongkong): Superabundance of invertebrate food for migrating waders in Hong Kong?
12 November	F. Kenig (NIOZ): Productivity *versus* heterotrophy: effects on the ^{13}C content of sedimentary organic matter
19 November	M.T.J. Hillebrand (NIOZ): (Should the NIOZ laboratories also apply for STERLAB accreditation?)
26 November	H.J. Lindeboom (NIOZ): (Long-term changes: a new hypothesis for the functioning of marine ecosystems) W. van Raaphorst (NIOZ): (The role of N and P in long-term changes in the North Sea) H.M. van Aken (NIOZ): (Climate variability in the exchange between ocean and North Sea)
10 December	Bill Hay (University of Utrecht): Studies of ocean colour in the tropical Atlantic and the Arabian Sea
17 December	C. Wiebinga (NIOZ): Methods for determination of dissolved organic carbon (DOC) J. van Heemst (NIOZ): (Molecular characterization of dissolved organic matter (DOM) in seawater) K. Booij (NIOZ): (Sorption of organic contaminants to sediments and colloids)

Workshop Towards predictive models of Bird migration

An international workshop 'Towards predictive models of bird migration: theoretical and empirical bottlenecks', convened by Bruno Ens (IBN-Texel) and Theunis Piersma was held at NIOZ from 5 to 8 July. The conference aimed at identifying the relationships between empirical and theoretical studies on the ecophysiology of migration, studies of evolution and studies on the population dynamics of migratory species. About 80 scientists of nine nationalities took part in the intensive lecture sessions and discussion meetings. Apart from all bilateral contact established during the meeting, a progress report on migration studies and a review paper for a major behavioural ecological journal are in preparation. There was wide concensus that this kind of meeting should be repeated some time in the future, and the group from Lund, Sweden, has taken up this challenge.

Second International Symposium on Flatfish Ecology

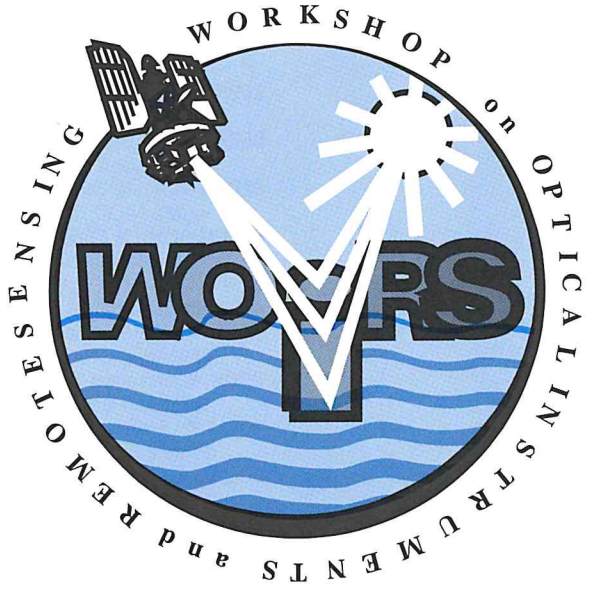
As a sequel to the successful First International Symposium on Flatfish Ecology (NIOZ, 1990) the Second International Symposium on Flatfish Ecology was held from 30 September to 6 October, organized by members of the NIOZ Department of Coastal Systems, together with colleagues from the Netherlands Institute for Fisheries Research (DLO-RIVO). The Organizing Committee consisted of members from both institutes (A.D. Rijnsdorp, H.W. van der Veer) and experts from UK (R.J.H. Beverton), Germany (R. Berghahn) and the USA (J.M. Miller). The main goal of these Flatfish Symposia is to converge research on specific important topics. The central theme of this symposium was 'Recruitment'. The presentations were grouped according to the various periods in the life cycle, such as egg and larval stage, juvenile stage and adult stage. The structure of the symposium was a combination of key-note addresses followed by oral and poster presentations and closed by a round-up exercise in workshops. In total 80 participants visited the symposium. About 60 papers were submitted for publication in the Netherlands Journal of Sea Research. At the symposium it was decided to dedicate the proceedings to R.J.H. Beverton for his contribution to our understanding of flatfish recruitment during his long career as fishery biologist.



Workshop On Optical Ground Truth Instrumentation

A European Workshop On Optical Ground Truth Instrumentation For The Validation Of Space Borne Optical Remote Sensing Data Of The Marine Environment (WOIRS) was held from 23 to 25 November. The workshop was organized by M. Wernand and M.A. van Arkel and sponsored by DGXII-CEC.

Thirty experts in the field of optical oceanography from various European institutes attended the workshop. Topics were the design of a multi-channel optical radiometer and the definition of optical parameters to be measured on sea-going expeditions in relation to remote sensing. Definitions on standard calibration of optical underwater instruments and intercalibration techniques of satellite sensors were stated, and the maintenance of a close coordination with the European OCTOPUS programme was recommended.



Contact-day of the Royal Dutch Geological and Mining Society

On 29 January, the annual contact-day of the Royal Geological and Mining Society of the Netherlands (KNGMG) was held at the Institute, organized by the department of Geology and Geochemistry. There were about 70 attendants. After a speech of welcome and introduction to the scientific activities of the NIOZ and the department, the visitors split into two groups. One group followed a partner programme and visited Ecomare on Texel. For the other group, lectures were given by NIOZ geologists.

2.2.2. Lectures and posters

2.2.2.1. Lectures by NIOZ scientists

(titles translated)

BAARS, M.A. Plankton biomass and primary production in the seasonal upwelling area of the Somali Current, SW monsoon 1992/NE monsoon 1993. Large Marine Ecosystems of the Indian Ocean Symposium, Mombasa, 29 March.

BAARS, M.A. Results from the Netherlands Indian Ocean Programme 1992/1993: the pelagic system in the Somali Current and adjacent areas in relation to the monsoons. JGOFS Training Course, Mombasa, 19 November.

BAK, R.P.M. (Tropical Marine Biology) Lecture series, University of Amsterdam, January.

BAK, R.P.M. (Marine Biogeography) Lecture series, RUG, January.

BAK, R.P.M. (Disturbance and dynamics in benthic coral reef communities.) Symposium Marien Onderzoek in Tropische Kustgebieden, KNAW, Amsterdam, 5 March.

BAK, R.P.M. (Marine Biology) Lecture series, RUG, June.

BAK, R.P.M. Twenty years of change in coral communities over deep reef slopes along leeward coasts in the Netherlands Antilles. Colloquium Global Aspects of Coral Reefs, Health, Hazards and History, RSMAS, Miami, 9 June.

BEERENS, S.P. Chaotic mixing in tidal areas. European Geophysical Society XVIII General Assembly, Wiesbaden, 3-7 May.

BEERENS, S.P. Orientation and wavelength of sandbanks in the North Sea. (EC/Mast summer school) Renesse, 8 July.

BERGMAN, M.J.N. Studies on the effects of fisheries. Lecture for students of Univ. of Groningen, NIOZ, Texel, 26 February.

BERGMAN, M.J.N. Direct effects of beamtrawl fishery on the benthic system of the North Sea. Lecture for students' course Biology, NIOZ, Texel, 11 March.

BERGMAN, M.J.N. Experimental studies on the impact of beamtrawl fishery. RWS-DGW, Middelburg, 10 June.

BOOIJ, K. PCBs: analytical chemistry and distribution between marine compartments. University of Amsterdam, 19 March.

BOOIJ, K. Sorption of PCBs to North Sea sediments. Symposium on Contaminants in Soils and Sediments. Ede, The Netherlands, 29 April.

BOOIJ, K. Erroneous flux measurements due to rotating water columns. Seminar Max Planck Institute for Marine Microbiology, Bremen, Germany, 3 June.

BOON, J.P. (Risk assessment model for toxic compounds in lung-breathing top predators.) Wintercongress KNCV, 8 January.

BOON, J.P. Concentrations of PCBs and PAHs in dab muscle. Workshop Integraal Noordzee Programma, NIOZ, 11-14 January.

BOON, J.P. The influence of Equilibrium Partitioning, Biotransformation and Lipid Depletion on PCB-patterns in Marine Mammals. ICES Marine Chemistry Working Group, Ottawa, Canada, 8-12 February.

BOON, J.P. The Integrated North Sea Programme 1991-1992; Theme Microcontaminants. An Overview of the Preliminary Results. 7th Symposium on the Responses of Marine Organisms to Pollutants, Gothenburg, Sweden, 20-22 April.

BOON, J.P. (Behaviour and effects of organic micro-contaminants in the marine environment.) Students' course Marine Environment, RUG, 17 May.

BOON, J.P. A Model for the Interpretation of Chlorinated Biphenyl Concentrations in Marine Mammals, SETAC Workshop 'Mechanisms of Uptake and Bioaccumulation of Micropollutants', Veldhoven, 24-26 May.

BOON, J.P. (Environmental chemistry.) Lecture RUG, 23 September.

BOON, J.P. The results of the Integrated North Sea Programme (microcontaminants). EERO Symposium European Coastal Seas: From Science to Management, Barcelona, Spain, 4-6 October.

CADÉE, G.C. (Has lowering of the PO_4 input from the Rhine affected primary production in Dutch coastal waters? The Marsdiep data.) CEMO/DGW colloquia, Yerseke, 21 October.

CAMPHUYSEN, C.J. (Herring Gulls and Lesser Black-backed Gulls feeding at trawlers during the breeding season: competitive scavenging *versus* efficient flying.) NZG/NOU themadag Meeuwen in Nederland: veranderingen in een tot voor kort sterk toenemende populatie, Leiden, 3 April.

CAMPHUYSEN, C.J. (Seabird research in the North Sea: the consequences of chronical oil contamination and changing fish stocks.) Kustasielhoudersdag Vogelbescherming Nederland, Rotterdam, 20 November.

CAMPHUYSEN, C.J. (Victims of oil contamination among seabirds in the North Sea: recomendations for European monitoring research). Lezing natuurorganisatie De Windbreker, Petten, 10 December.

CAMPHUYSEN, C.J. (The importance of fish offal to seabirds in the southern North Sea.) BEON beleidspresentatie, Den Haag, 10 December.

DAAN, R. (Short- and long-term effects of pollution around North Sea platforms.) Studiedag Ecotoxicologische risico-evaluatie: Een ecologische visie, Ede, 1 December.

DE BAAR, H.J.W. Lecture series Introductory Oceanography, Department of Marine Biology, RUG, 8-12 February.

DE BAAR, H.J.W. Ocean Carbon Cycle and Climate Change. Rotary Service Club, Bergen, the Netherlands, 23 March.

DE BAAR, H.J.W. An Introduction to the Symposium Ocean Carbon Cycle and Climate Change. European Union of Geosciences Conference, Strasbourg, France, 8 April.

DE BAAR, H.J.W. First results of the JGOFS Southern Ocean Study. Antarctica symposium, SCAR/KNAW, Amsterdam, 23 April.

DE BAAR, H.J.W. Waarom is de Wereldzee niet Groener. Inaugural lecture, RUG, Groningen, 11 May.

DE BAAR, H.J.W. Pollutant metals; Greenhouse gases. Lecture series in course Marine Environment, RUG, 18-19 May.

DE BAAR, H.J.W. Marine carbon dioxide research in The Netherlands. Annual meeting IOC-JGOFS Panel on CO_2, Plymouth, 14 June.

DE BOER, C.J. Deep water in the Iceland Basin. MFO symposium, Veldhoven, 11 May.

DE BOER, C.J. Deep water in the Iceland Basin. Institute of Oceanic Sciences, Deacon Laboratory, Wormley, Godalming, Surrey, UK, 27 May.

DE BOER, J. & J. VAN DER MEER. External quality assessment of chlorobiphenyl analysis. ICES/Helsinki Committee workshop, Hamburg, FRG.

DE GRAAF, W., J.S. SINNINGHE DAMSTÉ, G.B. VAN DRIEL, S. SCHOUTEN & J.W. DE LEEUW. Laboratory simulation of natural sulphurization: formation of polymeric and cyclic sulphides by a low-temperature reaction of hydrogenpolysulphides with alkenes, ketones and aldehydes. 16th International Meeting on Organic Geochemistry, Stavanger, 20-24 September.

DE LEEUW, J.W. The molecular structure of coal based on the analysis of resistant biomacromolecules in extant and fossil plant tissues. 4th Annual Peter H. Given Lectureship in Coal Science, Penn State, College of Earth and Mineral Sciences, 30 August.

DE LEEUW, J.W. Structure, origin and fate of organic sulphur in coal. 4th Annual Peter H. Given Lectureship in Coal Science, Penn State, College of Earth and Mineral Sciences, 1 September.

DE LEEUW, J.W. (From Organic Geochemistry to Marine Biogeochemistry.) Address at the opening of the Department of Marine Biogeochemistry, NIOZ, Texel, 10 September.

DE LEEUW, J.W., J.S. SINNINGHE DAMSTÉ, P.F. VAN BERGEN, N.L. FREWIN & M.E. COLLINSON. Organic carbon as a palaeoenvironmental indicator in the marine realm. 1993 Lyell meeting, London, 18 February.

DE LEEUW, J.W., M. BAAS, H. BRINKHUIS & J.S. SINNINGHE DAMSTÉ. Cyst cell wall biomacromolecules and dinosterol derivatives: molecular fossils of dinoflagellates. Fifth International Conference on Modern and Fossil Dinoflagellates, Zeist, 18-24 April.

DE LEEUW, J.W., S. SCHOUTEN & J.S. SINNINGHE DAMSTÉ. Solid-phase extraction of carboxylic acids from Irati oil shale bitumen: Sequestered carbon skeletons in polar and asphaltene fractions of petroleum. American Chemical Society Meeting, Chicago, 22-27 August.

DE MUNCK, J.C. Problems and preliminary results on the comparison of GEOSAT data with ARGOS drifters. ERS-1 coordination team, Delft, 14-15 June.

DE MUNCK, J.C. Principles of inverse modeling of hydrographic data. ICES 81st Statutory meeting, Dublin, 23-28 October.

DE WILDE, H.P.J. Air-sea exchange of N_2O and CH_4 in the Indian Ocean. Verwey-meeting, NIOZ, 1-3 February.

DE WILDE, H.P.J. N_2O and CH_4 in the Indian Ocean. Lecture given at the SCOR meeting, NIOZ, 31 March.

DE WILDE, H.P.J. Air-sea exchange of N_2O and CH_4 in the Indian Ocean. ASLO & SWS Annual Meeting 1993, Edmonton, Canada, 3 June.

DE WILDE, H.P.J. Production and consumption of N_2O and CH_4 in the northwestern Indian Ocean. Department of Ecology and Genetics, University of Aarhus, Denmark, 1 July.

DE WILDE, H.P.J. Water-atmosphere exchange of N_2O in marine systems. Nitrogen-study group meeting, Lelystad, 6 October.

DE WILDE, P.A.W.J. Benthic biological processes. OMEX Workshop Texel, 19 April.

DE WILDE, P.A.W.J. The Frisian Front System, Pelagic-benthic coupling. Course Kristineberg Marine Biological Station, Sweden, NIOZ Texel, 14 May.

DE WILDE, P.A.W.J. Benthic community metabolism. Advanced Course Estuarine Ecology. Yerseke, 25 May.

DE WILDE, P.A.W.J. Marine ecosystems. Series of 16 lectures, RUG, 7-11 June.

DE WILDE, P.A.W.J. Benthic boundary studies. EC Workshop, Iraklion, Crete, 30 September.

DE WILDE, P.A.W.J. The NIOZ Bottom Lander System (BOLAS). Benthic lander workshop, Max Planck Institut Bremen, 8 November.

EGLINTON, T.I., J. IRVINE, J.S. SINNINGHE DAMSTÉ, S. SCHOUTEN, J.W. DE LEEUW, A. VAIRAVAMURTHY & B. MANOWITZ. Formation and diagenesis of macromolecular organic sulfur in Peru margin sediments. 16th International Meeting on Organic Geochemistry, Stavanger, 20-24 September.

EGLINTON, T.I., J. IRVINE, J.S. SINNINGHE DAMSTÉ, S. SCHOUTEN, J.W. DE LEEUW, A. VAIRAVAMURTHY & B. MANOWITZ. Early diagenetic transformations of organically-bound sulfur in Peru margin sediments. Annual Symposium of the Organic Geochemistry Division of the Geological Society of America, Boston, 24 October.

EISMA, D. Introduction on NIOZ. KNGMG Contactdag, 29 January.

EISMA, D. Sedimentology of the Wadden Sea. Ecology Course NIOZ, 1 March.

EISMA, D. Changes in suspended matter floc size during the tidal cycle in the Elbe and Ems estuaries. ECSA 23 Symposium, Haren, 2 September.

EISMA, D. Floc size in the estuaries of the Zaire river and the Elbe and Ems rivers. AmasSeds Meeting, Niteroi, Brazil, 30 September.

EISMA, D. Water pollution in the Netherlands. Environment Service, Xiaguan, Yunnam, China, 28 October.

EPPING, E. Modelling oxygen profiles in photic sediments. UvA, 9 March.

EPPING, E. Benthic production in coastal sediments. NIOZ, 19 March.

EPPING, E. The effect of reduced sulphur species on nitrous oxide dynamics in a chemolithotrophic denitrifying bacterium. BION, Dalfsen, 26 March.

EPPING, E. Diurnal oxygen dynamics in a microbial mat. Univ. Groningen, 30 March.

EPPING, E. Nitrous oxide dynamics in *Thiomicrospira denitrificans*. Univ. Groningen, 17 May.

EPPING, E. A diagenetic model for production and consumption of oxygen in photic sediments. Max Planck Inst., Bremen, 10 June.

EPPING, E. Benthic primary production: a comparison of two methods. UvA, 26 November.

EVERAARTS, J.M. (Chemical Oceanography and Marine Pollution) DNA strand-breaks and chlorinated biphenyl congeners in the pyloric caeca of the marine invertebrate *Asterias rubens*: Preliminary results. Workshop INP-MICON Programme 1991-1992, Texel, 12-15 January.

EVERAARTS, J.M. Hematological parameters and Liver Somatic index in dab (*Limanda limanda*) during the INP cruises 1991 and 1992. Workshop INP-MICON Programme 1991-1992, Texel, 12-15 January.

EVERAARTS, J.M. Biomarkers of DNA damage. First SETAC World Congress, Lisbon, Portugal, 28-31 March.

EVERAARTS, J.M. Biomarkers in dab (*Limanda limanda*): DNA strand-breaks, hematological parameters and hepatic somatic index. Flatfish Toxicology Symposium, Utrecht, 4 June.

EVERAARTS, J.M. Biomarkers as indicators of marine pollution: DNA damage and enzyme induction in two marine animal species. Napa Conference on Genetic and Molecular Ecotoxicology, Yountville, California, USA, 12-15 October.

FLACH, E.C. (Lugworms and cockles as suppressors of the macrozoobenthos on tidal flats.) AIO-dag werkgemeenschap Populatiebiologie, BION, Utrecht, 5 March.

FLACH, E.C. The benthic community in the Wadden Sea. PhD course of the University of Gothenburg on the ecosystem of the Wadden Sea, NIOZ, Texel, 10 May.

FLACH, E.C. The influence of *Arenicola marina* and *Cerastoderma edule* on the numbers of *Corophium volutator* in shallow-water bays in the Gullmarsfjord compared to the situation in the Dutch Wadden Sea. Husö Biological Station, Åland, Finland, 9 June.

FLACH, E.C. (The effects of cockles and lugworms on the macrozoobenthic community.) CEMO/NIOO, Yerseke, 29 September.

FLACH, E.C. The effects of cockles and lugworms on the macrozoobenthic community. Fjordbiologisk Laboratorium, Odense Universitet, Denmark, 19 October.

FONDS, M., M. TANAKA & H. VAN DER VEER. Experiments on feeding and growth of Japanese flounder *Paralichthys olivaceus*. Flatfish Symposium, NIOZ, Texel, 1-6 October.

FONDS, M., E. CASAL, D. SCHWEITZER & H. VAN DER VEER. The effect of PCB contamination on the reproduction of dab (*Limanda limanda*) in the laboratory. Flatfish Symposium, NIOZ, Texel, 1-6 October.

FONDS, M., C. COSTOPOULOS & H. VAN DER VEER. The growth rate of juvenile plaice (*Pleuronectes platessa*) in the Wadden Sea in Summer. Flatfish Symposium, NIOZ, Texel, 1-6 October.

FRANSZ, H.G. Zooplankton, structure and function. Advanced course on Estuarine Ecology, NIOO-CEMO, Yerseke, 24 May.

FRANSZ, H.G. Identification of functional units for zooplankton and its food. Workshop of the GLOBEC international working group on numerical modelling. Villefranche-surmer, France, 12 July.

FRANSZ, H.G. Nutrient cycles in ecological models of the North Sea. Summer school on dynamics of nutrient cycling and food webs. Texel, 25 August.

FRANSZ, H.G. (A comparison beween Arctic and Antarctic plankton.) Arctisch Weekend, Soest, 13 November.

FREWIN, N., F. KENIG, J.S. SINNINGHE DAMSTÉ & J.W. DE LEEUW. Screening of free and sulphur-bound carbon skeletons present in 11 evaporite cycles of the Vena del Gesso. ENOG-II Meeting, Barcelona, 12-14 October.

GELIN, F., J.W. DE LEEUW, J.S. SINNINGHE DAMSTÉ, S. DERENNE, C. LARGEAU & P. METZGER. Pitfalls of Py-GC-MS illustrated by the thermal behaviour of complex natural lipids. Gordon Research Conference on Analytical Pyrolysis and Oxidative Degradation of materials, Plymouth, New Hampshire, 14-18 June.

GELIN, F., M. BAAS & J.W. DE LEEUW. Differences in chemical structures of algaenans derived from common-fresh water green algae as revealed by flash pyrolysis methods. 206th American Chemical Society Meeting, Chicago, 22-27 August.

GERKEMA, TH. The generation of nonlinear internal tides and solitons. EGS XVIII General Assembly, Wiesbaden, 3-7 May.

GERKEMA, TH. The generation of nonlinear internal tides and solitons. Technische Hochschule Darmstadt, 8-13 May.

GERKEMA, TH. Nonlinear internal tides and solitons. EC/MAST summer course (Modelling and prediction of physical processes in coastal seas and estuaries). Renesse, 27 June-9 July.

HARTGERS, W.A., Y. LING, A.G. REQUEJO, J. ALLAN, T.-M. XIE, J.M. HAYES, J.S. SINNINGHE DAMSTÉ & J.W. DE LEEUW. Macromoleculary-bound carotenoids in kerogen: Indicators of photic zone anoxia; 16th International Meeting on Organic Geochemistry, Stavanger, 20-24 September.

HELDER, W. Geochemical sensors in marine science. EC-MAST-days, Brussels 15 March.

HELDER, W. Biogeochemical Processes: Cycles of N and P. Advanced course in Marine Ecology, NIOO-CEMO, Yerseke, 26 May.

HELDER, W. In-situ measurement of oxygen profiles and comparison of calculated and measured sediment-water oxygen fluxes. Max Planck Institute for Marine Microbiology, Bremen, 10 June.

HELDER, W. Chemical characteristics of sediments in European estuarine and coastal areas. EERO, La Rochelle, 20 June.

HELDER, W. In-situ measurements of oxygen profiles and of sediment-water fluxes of solutes in the Adriatic Sea. EC commission MAST-II. Mediterranian Targeted Project: Euromarge-AS, Cesenatico, Italy, 7 October.

HELDER, W. The Temperature, Resistivity, Oxygen Lander (TROL). Construction and results. First European Lander Symposium, Max Planck Institute for Marine Microbiology, Bremen, 8 November.

HELDER, W. & R. KLOOSTERHUIS. Organic carbon in sediments and its mineralisation and burial. Workshop NIOP: Project C, Texel, 15 November.

HOFMAN, P., D. LEYTHAEUSER, A.Y. HUC, B. CARPENTIER, P. SCHAEFFER, P. ALBRECHT, B.J. KEELY, J.R. MAXWELL, J.S. SINNINGHE DAMSTÉ & J.W. DE LEEUW. Sedimentology of organic matter in an evaporitic basin (Mulhouse basin, Oligocene): A multidisciplinary approach. 16th International Meeting on Organic Geochemistry, Stavanger, 20-24 September.

HONKOOP, P.J.C. The influence of winter temperatures on the reproductive success of the marine bivalves *Macoma balthica, Cerastoderma edule* and *Mytilus edulis*. An introduction. Verwey dagen, NIOZ, Texel, 1-3 February.

HONKOOP, P.J.C. The influence of winter temperatures on the reproductive success of the marine bivalves *Macoma balthica, Cerastoderma edule* and *Mytilus edulis*. Workshop spatfall and Recruitment of mussels and cockles, Yerseke, 11-12 March.

JANSEN, J.H.F. (Deep-sea sediments; archive of the marine and terrestrial climate.) Contact-day KNGMG, Texel, 29 January.

JANSEN, J.H.F. & S.J. VAN DER GAAST. (X-ray diffraction of lowcrystalline minerals in deep-sea sediments and soils.) Contact-day KNGMG, Texel, 29 January.

JANSEN, J.H.F. Results from the Angola Basin expedition. University of Bremen, Dept of Geology, 2 September.

KEELY, B.J., S.E. BETTS, Y. LING, J.S. SINNINGHE DAMSTÉ, J.W. DE LEEUW & J.R. MAXWELL. A molecular and stratigraphic approach to the recognition of organic matter source inputs in marls of the Mulhouse basin (Alsace, France) and to Palaeoenvironmental assessment. 16th EAOG-meeting on Organic Geochemistry, Stavanger, 20-24 September.

KENIG, F., N. FREWIN, J.S. SINNINGHE DAMSTÉ & J.W. DE LEEUW. Variations of high-and low-molecular weight biomarkers from one evaporite cycle of the Vena del Gesso sediment sample. ENOG-II Meeting, Barcelona, 12-14 October.

KOOPMANS, M.P. Geochemistry of organic sulphur compounds. United States Geological Survey, Denver, 19 March.

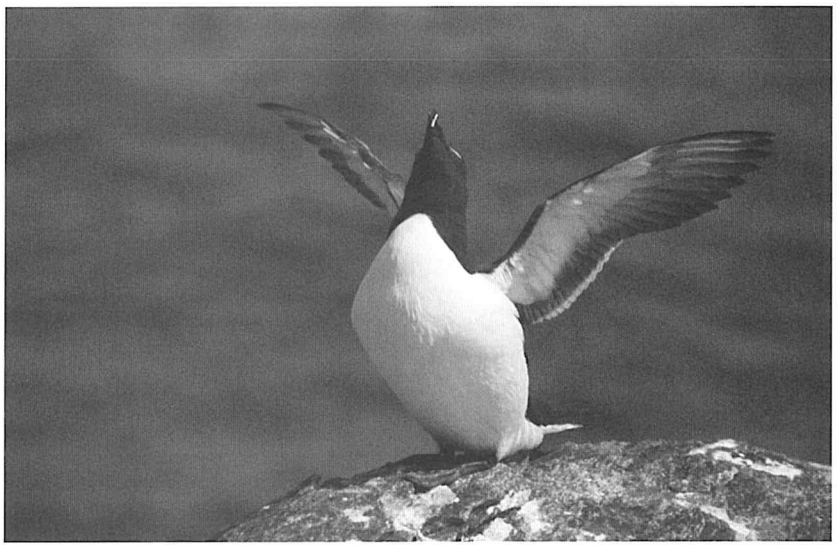


Photo: C.J. Camphuysen

KOOPMANS, M.P., M.D. LEWAN, J.S. SINNINGHE DAMSTÉ & J.W. DE LEEUW. Formation and destruction of sedimentary organically-bound sulphur: Implications for palaeoenvironmental reconstruction. Annual Symposium of the Organic Geochemistry Division of the Geological Society of America, Boston, 24 October.

KOOPMANS, M.P., M.D. LEWAN, W.I.C. RIJPSTRA, J.S. SINNINGHE DAMSTÉ & J.W. DE LEEUW. Artificially induced maturity-related changes of organic sulphur in a Vena del Gesso sediment sample. ENOG-II Meeting, Barcelona, 12-14 October.

KÖGEL-KNABNER, I., J.W. DE LEEUW & P. HATCHER. A ligin-like polymer in the cuticle of spruce needles: implications for the humification of spruce litter. American Chemical Society Meeting, Chicago, 22-27 August.

KRAAY, G.W. Some impressions of the picoplankton community in the Indian Ocean. Prochlorophyte workshop, Station Biologique de Roscoff, France, 19-29 May.

LABEYRIE, L. & TJ.C.E VAN WEERING. Implications of the Heinrich events and their record in the planktic and benthic foraminifera $\delta\,^{18}O$ on the relations between the evolution of the ice margins and deep water formation during the last glacial period. EUG VII, Strasbourg, 4-8 April.

LEOPOLD, M.F. (Effects of fishery on birds.) Studiedag 'Visserij in natuurrijke kustwateren', Waddenvereniging, Amsterdam, 5 April.

LINDEBOOM, H.J. The future of the North Sea: a scientific perspective. Forum-discussie over de toekomst van de Noordzee, Rotterdam, 19 May.

LINDEBOOM, H.J. (Applied research on eutrophication, micropollutants and disturbance of benthic ecosystems.) NIOO-CEMO, Yerseke, 26 May.

LOHSE, L. North Sea nutrient cycling: The benthic inorganic nitrogen cycle - preliminary results. INP Workshop, NIOZ, Texel, 11-14 January.

LOHSE, L. Benthic nitrogen cycling in North Sea sediments. Verwey Symposium, NIOZ, Texel, 1-3 February.

LOHSE, L. Nitrogen cycling in North Sea sediments: interaction of denitrification and nitrification in offshore and coastal areas. Annual meeting ASLO, Edmonton, Canada, 30 May-3 June.

LOHSE, L. Nitrogen cycling in North Sea sediments: interaction of denitrification and nitrification in offshore and coastal areas. Academy of Natural Sciences, Philadelphia, USA, 15 June.

LOHSE, L. Mineralisation of organic material in different depositional areas of the North Sea: Evidence for eutrophication? Institute for Microbial Ecology, Aarhus, Denmark, 1 July.

LOHSE, L. North Sea nutrient cycling: Nitrification and denitrification in sediments and sediment-water exchange of dissolved inorganic nitrogen compounds. International symposium on nutrient dynamics in coastal and estuarine environments. Helsingør, Denmark, 13-16 October.

MAAS, L.R.M. On self-sustained oscillations in a two-box model of the thermohaline circulation. University of Victoria, School of Earth and Ocean Sciences, 28 April.

MAAS, L.R.M. A point model of the 3D ocean circulation and its relation to an exact, stratified eddy solution. University of Victoria, School of Earth and Ocean Sciences, 25 June.

MAAS, L.R.M. 3D ocean cirulation in a nutshell. University of Washington (Seattle), Joint Institute for the Study of the Atmosphere and the Ocean, 19 July.

MALSCHAERT, J.F.P & W. VAN RAAPHORST. North sea nutrient cycling: benthic pools of ammonium. INP workshop, NIOZ, 12-14 January.

NIEUWLAND, G. Bacterivory by benthic heterotrophic nanoflagellates. INP workshop, NIOZ, 12-14 January.

NOLTING, R.F. Trace and major elements in sediments and porewaters of the Lena delta and Laptev Sea. The Third International Symposium. The Arctic Estuaries and Adjacent Seas: Biogeochemical Processes and Interaction with Global Change. Kaliningrad, Russia, 19-25 April.

OSINGA, R. Effects of macrozoobenthos on mineralization rates in experimental benthic systems. International Symposium on Nutrient Dynamics in Coastal and Estuarine Environments. Helsingør, Denmark, 14 October.

PIERSMA, T. Knots and Macoma. 'Swedish course on Wadden Sea ecosystem', NIOZ, Texel, 12 May.

PIERSMA, T. Metabolic rates of Knots. Colloquium Zoological Laboratory, RUG, 24 June.

PIERSMA, T. A mechanistic study of migration: annual energetics of Knots. International migration workshop, NIOZ, Texel, 6 July.

PIERSMA, T. Distributional studies of Knots in the Wadden Sea in relation to food resources. 8th International Scientific Wadden Sea Symposium, Esbjerg, Denmark, 1 October.

RIDDERINKHOF, H. (Chaotic mixing in tidal areas.) Bijeenkomst van het samenwerkingsverband Nonlinear dynamics and pattern formation, Univ. of Utrecht, 10 February.

RIDDERINKHOF, H. Chaotic advection: a mechanism for tidal mixing. Workshop Averaging methods, Den Haag, 15-16 March.

RIDDERINKHOF, H. Chaotic advection: a mechanism for tidal mixing. AGU-Chapman Conference: Fractals, Chaos and Predictability in Oceanography and Meteorology. Galway, Ireland, 20-22 September.

RIEGMAN, R. The impact of eutrophication on planktonic foodwebs in marine environments. Department of Microbiology, UvA, 26 January.

RIEGMAN, R. The impact of eutrophication on phytoplankton in marine environments. Laboratory for Marine Biology, University of Copenhagen, Helsingør, 22 March.

RIEGMAN, R. Possible impacts of eutrophication on plankton communities. NIOZ summer course 1993: Dynamics of nutrient cycling and foodwebs, NIOZ, Texel, 23-28 August.

RUARDIJ, P. Marine ecosystem modelling, a necessary tool for science and for management: an introduction. PhD course 'Dynamics of Nutrient Cycling and Food-webs'. NIOZ, August.

RUARDIJ, P. The assessment of benthic nutrient regeneration in the ERSEM North Sea ecosystem model at International Symposium on Nutrient Dynamics in Coastal and Estuarine Environments. Helsingør, Denmark, 13-16 October.

SCHOELL, M., S. SCHOUTEN, J.S. SINNINGHE DAMSTÉ, J.W. DE LEEUW & R.E. SUMMONS. A molecular organic carbon isotope record of Miocene climate changes. Annual Symposium of the Organic Geochemistry Division of the Geological Society of America, Boston, 24 October.

SCHOUTEN, S., M. SCHOELL, R.E. SUMMONS, J.S. SINNINGHE DAMSTÉ, M. AHMED & J.W. DE LEEUW. An isotopic and geochemical study of free and sequestered carbon skeletons in organic matter from the Monterey Formation. American Chemical Society Meeting, Chicago, 22-27 August.

SCHOUTEN, S., M. SCHOELL, R.E. SUMMONS, J.S. SINNINGHE DAMSTÉ, M. AHMED & J.W. DE LEEUW. Reconstruction of the depositional paleoenvironment of the Monterey Formation by a combined molecular and isotope geochemical study. 16th International Meeting on Organic Geochemistry, Stavanger, 20-24 September.

SINNINGHE DAMSTÉ, J.S. Molecular fossils as information carriers of the history of the earth. NWO-PIONIER symposium, Den Haag, 7 June.

SINNINGHE DAMSTÉ, J.S. (Pioneer research.) Address at the opening of the Department of Marine Biogeochemistry, NIOZ, Texel, 10 September.

SINNINGHE DAMSTÉ, J.S., S.G. WAKEHAM, M.E.L. KOHNEN, J.M. HAYES & J.W. DE LEEUW. A Holocene sedimentary record of anoxygenic photosynthesis in the Black Sea. 16th International Meeting on Organic Geochemistry, Stavanger, 20-24 September.

SLEIDERINK, H.M. Influence of temperature on EROD activity in dab (*Limanda limanda*) from the North Sea. INP Workshop, NIOZ, 11-14 January.

SLEIDERINK, H.M. Influence of temperature on cytochrome P4SO1A induction in dab. Flatfish toxicology symposium, University of Utrecht, 4 June.

SLOMP, C.P. Phosphorus dynamics and fluxes across the sediment-water interface. INP workshop, NIOZ, 12-14 January.

SLOMP, C.P. Phosphorus cycling in North Sea sediments: the role of adsorption processes. WHOI, Woods Hole, USA, 11 August.

SLOMP, C.P. Forms of phosphorus in North Sea sediments and fluxes across the sediment-water interface. Symposium on nutrient dynamics in coastal and estuarine environments. Helsingør, Denmark, 13-16 October.

STOLTE, W. Ammonium and nitrate uptake by marine phytoplankton. BION Annual meeting, Dalfsen, 25 March.

STOLTE, W. Ammonium and nitrate uptake by marine phytoplankton. Department of Microbiology, RUG, 16 March.

TEN HALLERS-TJABBES, C.C. Imposex in whelks (*Buccinum undatum*) from the open North Sea: relation to shipping activities. Workshop INP, NIOZ, 12-14 January.

TEN HALLERS-TJABBES, C.C. Navigation by sensory cues; guidance by odours and sound and sensitivity to disturbance. 'Orientation and navigation: birds, humans and other animals', the 1993 Conference of the Royal Institute of Navigation, Oxford, 15-17 April.

TEN HALLERS-TJABBES, C.C. (Sexual changes in whelks in relation to commercial shipping.) Rijkswaterstaat, Den Haag, 19 November.

TIMMERMANS, K.R. Iron-nitrogen interactions in marine phytoplankton. Annual ASLO-SWS meeting, Edmonton, Canada, 30 May-3 June.

UFKES, E. Recent surface water distribution of planktonic foraminifera in the southeast Atlantic during springtime. University of Georgia, Athens, USA, 9 February; University of South Carolina, Columbia, USA, 11 February; North Carolina State University, Raleigh, USA, 16 February; Lamont Doherty Earth Observatory, Palisades, NY, USA, 19 February; Brown University, Providence, RI, USA, 23 February; Woods Hole Oceanographic Institution, USA, 25 February; RSMAS University of Miami, Miami, USA, 1 March.

UFKES, E. Planktonic foraminifera in late Quaternary sediments of the Angola Basin. University of Bremen, Dept of Geology, 2 September.

VAN AKEN, H.M. DUTCH-WARP, research on a part of the oceanic conveyor belt. MFO symposium, Veldhoven, 11 May.

VAN BENNEKOM, A.J. (The silica cycle in the marine environment.) Contact-day KNGMG, Texel, 29 January.

VAN BENNEKOM, A.J. The role of aluminium in the dissolution kinetics of biogenic silica. GeorgiaTech University, Atlanta, USA, 4 October, and Horn Point Environmental Laboratory, Cambridge, MD, USA, 11 October.

VAN BERGEN, P.F. Resistant biochemicals and the bias in the fossil record. Linnaean Soc. Palaeobot. Specialist Group, London, UK, 31 March.

VAN BERGEN, P.F. Combining microscopy and chemistry: the key to the formation of kerogen and fossil fuels, Research Open day 1993, Department of Geology, Royal Holloway, University of London, London, 14 May.

VAN BERGEN, P.F., M.E. COLLINSON, S.J. SINNINGHE DAMSTÉ & J.W. DE LEEUW. Recognition of resistant aliphatic and aromatic biomacromolecules in recent and fossil seed coats. 16th International Meeting on Organic Geochemistry, Stavanger, 20-24 September.

VAN BERGEN P.F., M.E. COLLINSON & J.W. DE LEEUW. Chemical and microscopical aspects of preservation potential and taphonomy of fossil seeds. Botanical Society of America/Canadian Botanical Association, Ames, Iowa, USA, 1-5 August.

VAN DEN BERG, A. (The influence of variable transport on phytoplankton bloom and succession in the southern North Sea.) Najaarsvergadering Nederlandse Oceanografen Club, Modellen in de Oceanografie, 17 June.

VAN DER GAAST, S.J. Clay minerals in surface sediments of the Angola Basin. University of Bremen, Dept of Geology, 2 September.

VAN DER GAAST, S.J. A 2:1:1 structure for metakaolinite and metadickite; an XRD and TEM study. 10th International Clay Conference, Adelaide, Australia, 18-23 July.

VAN DER MEER, J. & T. PIERSMA. Scaling of Migration. International Workshop 'Towards predictive models of bird migration: theoretical and empirical bottlenecks', Texel, 7 July.

VAN DER TOORN, R. On the beta- and gamma-plane approximations. European Geophysical Society XVIII General Assembly, Wiesbaden, 3-7 May.

VAN LEEUWE, M.A. Iron-enrichment experiments in the Southern Ocean. Annual ASLO-SWS meeting, Edmonton, Canada, 30 May-3 June.

VAN RAAPHORST, W. Overview of the results of the BELS-INP programme. INP workshop, NIOZ, 12-14 January.

VAN RAAPHORST, W. Phosphorus cycling in intertidal sediments. UvA, 25 January.

VAN RAAPHORST, W. (The role of the sediments in North Sea nutrient cycling.) BEON symposium, The Hague, 28 April.

VAN RAAPHORST, W. Nutrient dynamics in the western Dutch Wadden Sea. Lecture series for the University of Gothenburg, NIOZ, 10 May.

VAN RAAPHORST, W., P. RUARDIJ, J.F.P. MALSCHAERT, L. LOHSE & C.P. SLOMP. North Sea nutrient cycling: experimental data of benthic processes and the ERSEM ecosystem model. Symposium on nutrient dynamics in coastal and estuarine environments. Helsingør, Denmark, 13-16 October .

VAN WEERING, TJ.C.E. Contourites and palaeoceanography in the northeastern Atlantic Ocean. Contact-day KNGMG, NIOZ, Texel, 29 January.

VAN WEERING, TJ.C.E. What are mudvolcanoes? Lecture at Workshop Mediterranean marine Geosciences, Izmir, June 22-24.

VAN WEERING, TJ.C.E. More on Gas in sediments. Lecture series on board RV Gelendzhik, June.

VAN WEERING, TJ.C.E. A lander for long-term measurements in the benthic boundary layer. Benthic lander Meeting, Max Planck Institute, Bremen, 8-9 November.

VELD, H., J.W. DE LEEUW & J.S. SINNINGHE DAMSTÉ. Molecular characterization of vitrinite maturation as revealed by flash pyrolysis methods. American Chemical Society Meeting, Chicago, 22-27 August.

VELDHUIS, M.J.W. Some impressions of the picoplankton community in the Indian Ocean. Prochlorophyte workshop Station Biologique de Roscoff, France,19-29 May.

VELDHUIS, M.J.W. Bloom 93, the presence of coccolithophorids in the North Sea. 4e GEM, *Emiliania* workshop, Blagnac, France, 18-22 September.

VOSJAN, J.H. Penetration of PAR, UV-a and UV-b radiation in Antarctic waters. Symposium on the Effects of UV-b on Aquatic Ecosystems, Ned. Ver. Aquat. Ecology, Amsterdam, 4 February.

VOSJAN, J.H. Lecture series International Postgraduate Training course on Fundamental and Applied Marine Ecology of the Free University Brussels, Belgium, 8-12 November.

VOSJAN, J.H. Antarctic research. Lecture to Van Hall Institute, NIOZ, Texel, 17 December.

WAKEHAM, S., M.E.L. KOHNEN, J.S. SINNINGHE DAMSTÉ & J.W. DE LEEUW. Organic sulfur compounds formed during early diagenesis in Black Sea sediments. Annual Symposium of the Organic Geochemistry Division of the Geological Society of America, Boston, 24 October.

WITBAARD, R. (Studying the growth of *Arctica islandica*.) Van Hall Instituut, Groningen, 26 April.

WITBAARD, R. & R. KLEIN. A method to estimate the bottom trawl intensity independently of fisheries by using internal molluscan growth lines. ICES Statutory Meeting, Dublin, 23-28 September.

YAMAMOTO, M., M. BAAS & J.W. DE LEEUW. Biogeochemistry of the K/T boundary at Geulhemerberg, Maastricht, The Netherlands; Preliminary results. K/T-boundary Symposium, Utrecht, 9 November.

ZIMMERMAN, J.T.F. (Chaotic mixing in the Wadden Sea.) Alg. Fysisch Colloquium, RUG, 8 April.

ZIMMERMAN, J.T.F. Physical characteristics of European estuarine and coastal areas. EERO Course on Estuarine Ecology and Coastal Management, La Rochelle, 20 April.

ZIMMERMAN, J.T.F. Tidal cooscillation. EC/MAST Course on Modelling and Prediction of Physical Processes in Coastal Seas and Estuaries, Renesse, 28-30 June.

ZIMMERMAN, J.T.F. (Variability in ocean circulation.) KNAW/RAW Symposium Variabiliteit in de Aardwetenschappen, Amsterdam, 5 November.

2.2.2.2. Posters

ALIAUME, C., H.W. VAN DER VEER, J.M. MILLER, E.J. ADRIAANS, J.IJ. WITTE, A. ZERBI. Ecological observations on juvenile flatfish in a tropical estuarine system, Puerto Rico. Second International Symposium on Flatfish Ecology, NIOZ, Texel 30 September-6 October.

BAKKER, D.C.E., H.J.W. DE BAAR, M.H.C. STOLL & J.W. ROMMETS. Carbon dioxide at 6° West during a Southern Ocean spring. Fourth international conference on CO2, Carquierannes, France, September.

BEETS, K., TJ.C.E. VAN WEERING, L. LABEYRIE *et al.* High resolution stratigraphy and Heinrich layers in a core from Feni drift, NE Atlantic Ocean. EUG VII, Strasbourg, 4-8 April.

BEN KHELIFA, L. & J.H.F. JANSEN. Allochthonous diatoms as tool for climate reconstruction: Continental diatoms in marine sediments of the Angola Basin (SE Atlantic). British Diatomists' Autumn Meeting, Bristol, 29-31 October.

BERGMAN, M.J.N. (Direct effects of beamtrawl fishery on bottomfauna.) BEON Symposium North Sea ecology, The Hague, 28 April.

BERGMAN, M.J.N. & J.W. VAN SANTBRINK. Early life history of a Deep Digging Dredge. Second International Symposium on Flatfish Ecology, NIOZ, Texel, 30 September-6 October.

BERGMAN, M.J.N., J.W. VAN SANTBRINK & M. FONDS. Direct effects of beamtrawl fishery on bottomfauna. Second International Symposium on Flatfish Ecology, NIOZ, Texel, 30 September-6 October.

BEYER, J., H.M. SLEIDERINK & A. GOKSØYR. P450 1A1 ELISA measurements in dab (*Limanda limanda*). INP-MICON cruises 1991-1992. 7th Symposium on the Responses of Marine Organisms to Pollutants (PRIMO-7), Gothenburg, Sweden, 20-22 April.

BOLLE, L.J., R. DAPPER, J.IJ. WITTE, H.W. VAN DER VEER. Nursery grounds of dab (*Limanda limanda*) in the southern North Sea. Second International Symposium on Flatfish Ecology, NIOZ, Texel, 30 September-6 October.

BOLLE, L.J. & A.D. RIJNSDORP. Recruitment of dab (*Limanda limanda*) in North Sea continental coastal waters. Second International Symposium on Flatfish Ecology, NIOZ, Texel, 30 September-6 October.

BOON, J.P., J. NIEUWENHUIZE, J.M. VAN LIERE, S. WILHELMSEN & J. KLUNGSØYR. INP-MICON Programme 1991-1992: Concentrations of PCBs and PAHs in dab muscle. 7th Symposium on the Responses of Marine Organisms to Pollutants, Gothenburg, Sweden, 20-22 April.

BOON, J.P., I. OOSTINGH, J. VAN DER MEER & M.T.J. HILLEBRAND. Kinetics of polychlorinated biphenyls (PCBs) in marine mammals: Investigating the possibilities for trend monitoring in living populations and influence of biotransformation. 7th Symposium on the Responses of Marine Organisms to Pollutants, Gothenburg, Sweden, 20-22 April.

BOON, J.P., J. NIEUWENHUIZE, J.M. VAN LIERE, S. WILHELMSEN & J. KLUNGSØYR. INP-MICON Programme 1991-1992: Concentrations of PCBs and PAHs in dab muscle. BEON-Symposium, Scheveningen, 28 April.

BOON, J.P., I. OOSTINGH, J. VAN DER MEER & M.T.J. HILLEBRAND. Kinetics of polychlorinated biphenyls (PCBs) in marine mammals: Investigating the possibilities for trend monitoring in living populations. BEON-Symposium, Scheveningen, 28 April.

CADÉE, G.C. Fragmentation of shells by birds in the Dutch Wadden Sea. 1st Eur. Paleont. Conf., Lyon, 6-12 July; ECSA-23, Haren, 30 August-3 September; 8th Wadden Symp. Esbjerg, Denmark, 29 September-2 October, and 5th Taphonomy workshop, Liège, Belgium, 18-19 November.

CAMPHUYSEN, C.J. (Birds and fishery.) BEON Symposium, The Hague, 28 April.

DE BOER, C.J. Water mass distribution in the Iceland Basin calculated with an optimal parameter analysis. ICES Statutory Meeting, Dublin, 23-28 October.

DE GOEIJ, P. Life history decisions in *Macoma balthica*, with a focus on burying depth and the effects of avian and epibenthic predation. 8th International Scientific Wadden Sea Symposium, Esbjerg, Denmark, 29 September-2 October.

DE GOEIJ, P. Do epibenthic predators increase prey-availability for knots by nibbling the siphons of the bivalve *Macoma balthica*? Second International Symposium on Flatfish Ecology, Texel, 31 September-6 October.

DE MUNCK, J.C. & H.M. VAN AKEN. Principles of inverse modeling of hydrographic data. MFO symposium, Veldhoven, 11 May.

EISMA, D. (ed.). EROS 2000 MAST II programme. MAST days and Euromarket, Brussels, March.

FLACH, E.C. Cockles and lugworms make *Corophium* vulnerable to epibenthic predators such as shrimps. ECSA-23 Symposium, Haren, 30 August-3 September.

FONDS, M., E. CASAL, D. SCHWEIZER, H.W. VAN DER VEER. Effects of PCB contamination on the reproduction of the dab *Limanda limanda* L. under laboratory conditions. Second International Symposium on Flatfish Ecology, NIOZ, Texel, 30 September-6 October.

FONDS, M., C.G. COSTOPOULIS, H.W. VAN DER VEER. The effect of temperature on growth of young plaice (*Pleuronectes platessa*) in the Wadden Sea, with evidence of food limitation in late summer. Second International Symposium on Flatfish Ecology, NIOZ, Texel, 30 September-6 October.

FREWIN, N.L., S.D. KILLOPS, P.F. VAN BERGEN, J.W. DE LEEUW & M.E. COLLINSON. Preservation potential of biomacromolecules of higher plant cuticles in Florida Bay. 16th International Meeting on Organic Geochemistry, Stavanger, Norway, 20-24 September.

GELIN, F., J.W. DE LEEUW, J.S. SINNINGHE DAMSTÉ, S. DERENNE, C. LARGEAU & P. METZGER. Contribution of the aliphatic polyaldehyde of *Botryococcus braunii.* A race to the formation of algal kerogens. 16th International Meeting on Organic Geochemistry, Stavanger, Norway, 20-24 September.

HANSEN, F.R., M. RECKERMANN, W.C.M. KLEIN BRETELER & R. RIEGMAN. Copepod grazing on Protozoa: a mechanism enhancing *Phaeocystis* blooms? Implications from combined incubation experiments. PEG workshop on protozooplankton ecology, Mondsee, Austria, 13-18 April.

KNAPPERTSBUSCH, M. & G.J.A. BRUMMER. A sediment trap investigation of a sinking coccolithophorid bloom in the North Atlantic. EUG, Strassbourg, Fourth GEM Workshop, Blagnac, September.

KOOPMANS, M.P., M.D. LEWAN, J.S. SINNINGHE DAMSTÉ & J.W. DE LEEUW. Maturity-related changes in abundance and composition of organic sulphur compounds and sulphur-containing geomacromolecules studied by hydrous pyrolysis. 16th International Meeting on Organic Geochemistry, Stavanger, 20-24 September.

KÖSTER, J., S. SCHOUTEN, J.W. DE LEEUW & J.S. SINNINGHE DAMSTÉ. Palaeoenvironmental and maturity related variations in compositions of macromolecular organic matter and distributions of sulphur and non-sulphur biomarkers in Triassic organic-rich carbonate rocks. 16th International meeting on Organic Geochemistry, Stavanger, Norway, 20-24 September.

MIDDELBURG, J.J., M. BAAS, H.L. TEN HAVEN & J.W. DE LEEUW. Organic geochemical characteristics of sediments from Kau Bay. 16th International Meeting on Organic Geochemistry, Stavanger, Norway, 20-24 September.

OSINGA, R., W.E. LEWIS & F.C. VAN DUYL. Effects of bioturbation on mineralization rates in experimental benthic systems. International Symposium on Nutrient Dynamics in Coastal and Estuarine Environments. Helsingør, Denmark, 13-16 October.

PEULVÉ, S., M.-A. SICRE, I. BOULOUBASSI, A. LORRE, A. SALIOT, J.W. DE LEEUW & M. BAAS. Characterization of the organic matter in an Arctic delta (Lena River) using biomarkers and macromolecular indicators. 16th International Meeting on Organic Geochemistry, Stavanger, Norway, 20-24 September.

RASMUSSEN, T.L. & TJ.C.E. VAN WEERING. Distribution of benthic and planktic foraminifera in a pistoncore from the Faroe Shetland Channel. EUG VII, Strasbourg, 4-8 April.

SCHOUTEN, S., M. SCHOELL, R.E. SUMMONS, J.S. SINNINGHE DAMSTÉ, M. AHMED & J.W. DE LEEUW. An isotopic and geochemical study of free and sulphur-bound carbon skeletons in Naples Beach sediment samples; Cooperative Monterey Organic Geochemistry Study workshop, New Orleans, 25-28 April.

SCHOUTEN, S., M. SCHOELL, R.E. SUMMONS, J.S. SINNINGHE DAMSTÉ, M. AHMED & J.W. DE LEEUW. Analysis of sequestered carbon skeletons in sulphur-rich geomacromolecules in polar and asphaltene fractions by multiple selective chemical degradation techniques. 16th International Meeting on Organic Geochemistry, Stavanger, Norway, 20-24 September.

SICRE, M.-A., S. PEULVÉ, A. SALIOT, J.W. DE LEEUW & M. BAAS. Pyrolysis techniques applied to the study of estuarine processes. Gordon Research Conference, Estuarine Processes, New Hampshire, August.

SICRE, M.-A., S. PEULVÉ, I. BOULOUBASSI, A. SALIOT, J.W. DE LEEUW & M. BAAS. Chemical characterization of macromolecular organic constituents and PAHs in the suspended matter from the surface waters and benthic nepheloid layer of the Rhone delta. 16th International meeting on Organic Geochemistry, Stavanger, Norway, 20-24 September.

SINNINGHE DAMSTÉ, J.S., A.-E.W.E.P. ERKES, W.I.C. RIJPSTRA, M.E.L. KOHNEN, J.W. DE LEEUW & S.G. WAKEHAM. Identification of highly unsaturated hydrocarbons with unprecedented carbon skeletons in surface sediments of the Black Sea. 16th International Meeting on Organic Geochemistry, Stavanger, Norway, 20-24 September.

SLEIDERINK, H.M., J. BEYER, J.M. EVERAARTS & J.P. BOON. Influence of temperature on EROD activity in dab (*Limanda limanda*) from the North Sea. 7th Symposium on the Responses of Marine Organisms to Pollutants, Gothenburg, Sweden, 20-22 April.

SLEIDERINK, H.M., J.M. EVERAARTS, A. GOKSØYR & J.P. BOON. Cyp 1A induction in dab (*Limanda limanda*) after multiple administration of a technical PCB mixture (Clophen A40). 7th Symposium on the Responses of Marine Organisms to Pollutants, Gothenburg, Sweden, 20-22 April.

SLEIDERINK, H.M., J. BEYER, J.M. EVERAARTS & J.P. BOON. Influence of temperature on EROD activity in dab (*Limanda limanda*) from the North Sea. BEON-Symposium, Scheveningen, 28 April.

SLOMP, C.P. & W. VAN RAAPHORST. Phosphate adsorption in oxidized marine sediments. Symposium on the Geochemistry of the Earth Surface, Penn. State University, USA, 1-6 August.

TEN HALLERS-TJABBES, C.C., J. KEMP & J.P. BOON. Imposex in Whelks (*Buccinum undatum*) from the open North Sea: Relation to Shipping Activities. 7th Symposium on the Responses of Marine Organisms to Pollutants, Gothenburg, Sweden, 20-22 April.

TEN HALLERS-TJABBES, C.C., J. KEMP & J.P. BOON. Imposex in Whelks (*Buccinum undatum*) from the open North Sea: Relation to Shipping Activities. BEON-Symposium, Scheveningen, 28 April.

VAN BLEIJSWIJK, J. Cell and growth characteristics of *Emiliania huxleyi* type A and B. The biology of the Prymnesiophyta, Plymouth, U.K., 29 March-1 April.

VAN BLEIJSWIJK, J. Light dependent calcium carbonate and organic carbon content of *Emiliania huxleyi* type A and B. 4th GEM workshop, Blagnac, France, 18-22 September.

VAN BLEIJSWIJK, J. Particulate inorganic carbon during development and decline of *Emiliania huxleyi* blooms in sea water enclosures. 4th GEM workshop, Blagnac, France, 18-22 September.

VAN BLEIJSWIJK, J. Calcium carbonate standing stock and cell characteristics in an *Emiliania huxleyi* bloom in the northern North Sea. 4th GEM workshop, Blagnac, France, 18-22 September.

VAN DE GRAAF, B., A.C.T. VAN DUIN, J.M.A. BAAS & J.W. DE LEEUW. The Next Hydrocarbon Force Field. Third World Congress of Theoretical Organic Chemists, Toyahashi, Japan, 18-24 July.

VAN DER VEER, H.W., E.J. ADRIAANS, L.J. BOLLE, N. DANKERS, L. MALABA DA FONSECA, P.A. WALKER, J.IJ. WITTE. Ecological observations on juvenile flatfish in a tropical estuary: Arquipélago dos Bijagos, Guinea-Bissau. Second International Symposium on Flatfish Ecology, NIOZ, Texel, 30 September-6 October.

VAN DER WAL, P. Primary production and rates of calcification in and around a bloom of the coccolithophore *Emiliania huxleyi*. 4th GEM workshop, Blagnac, France, 18-22 September.

VAN DUIN, A.C.T., J.M.A. BAAS, B. VAN DER GRAAF, J.W. DE LEEUW, T.P. BASTOW & R. ALEXANDER. Comparison of experimental and calculated thermodynamic values of alkylnaphthalenes; An approach to recognize maturity changes in source rocks and crude oils. 16th International Meeting on Organic Geochemistry, Stavanger, Norway, 20-24 September.

VAN DUYL, F.C. & A.J. KOP. Bacterial production in North Sea sediments: clues to seasonal and spatial variations. International Symposium on Nutrient Dynamics in Coastal and Estuarine Environments. Helsingør, Denmark, 13-16 October.

VAN HEEMST, J.D.H., M. BAAS, J.W. DE LEEUW & R. BENNER. Molecular characterization of marine dissolved organic matter (DOM). 16th International Meeting on Organic Geochemistry, Stavanger, Norway, 20-24 September.

VAN RAAPHORST, W., S.J. VAN DER GAAST, J.F.P. MALSCHAERT & C.P. SLOMP. North Sea nutrient cycling: sorption of nutrients onto marine minerals. ECSA symposium on particles in estuaries and coastal waters, Groningen, 30 August-3 September.

WITBAARD, R. Fisheries and *Arctica*. Verweydagen, NIOZ, Texel, 1-3 February.

2.2.3. Advice offered

L. Otto reviewed and advised, in a meeting in Bonn, on WOCE proposals to the German Science and Technology Ministry (BMFT).

C.G.N. de Vooys gave advice to Mr C.N. Baan (Bouwdienst Rijkswaterstaat, Voorburg) on the control of mussel settlement in the Krammer sluices.

T. Piersma was hired by BBC-Natural History Unit, Bristol, as a consultant for and player in their film on the biology and migration of Knots, entitled 'Unravelling the Knot' due out in late 1993/early 1994 and directed by Richard Brock.

C.J. Camphuysen and M.F. Leopold advised the Centre for Information and Knowledge of the Directorate Nature, Forest, Landscape and Fauna in Wageningen (IKC/NBLF) with respect to the current status of Harbour Porpoise in the southern North Sea.

C.J. Camphuysen and M.F. Leopold advised M.L. Tasker for the Dispersed Species Project of Birdlife International in Cambridge (UK), providing information on seabirds in The Netherlands and Belgium and at Jan Mayen, during a workshop on Helgoland (28 October-3 November).

C.J. Camphuysen advised Birdlife International on distribution and status of, and (possible) threats to, Ivory Gull *Pagophila eburnea* in the Arctic.

C.J. Camphuysen advised the Belgian Institute of Nature Conservation (Hasselt), the Norddeutsche Naturschutzakademie (Schneverdingen), Ornis Consult (Copenhagen), Eesti Teaduste Akadeemia (Tartu, Estonia), EcoNum (Bailleul, France), Latvian Ornithological Society (Riga), Lithuanian Institute of Ecology (Vilnius), Stavanger Museum (Stavanger), Bundesamt für Seeschiffahrt und Hydrographie (Hamburg, Germany), Royal Society for the Protection of Birds (Orkney and Sandy), Polish Department of Vertebrate Ecology and Zoology (Gdansk), Serviço Nacional de Parques (Lisbon), Kandalaksha Nature Reserve (Kandalaksha, Russia), Grupo Iberico de Aves Marinas (Vigo), Stockholm University, and the British Trust for Ornithology (Thetford) on methods and design of an international monitoring programme for stranded oiled birds, the 'European Beached Bird Survey'.

C.J. Camphuysen advised World Wildlife Fund International on oil pollution, fisheries and seabird mortality at the presentation of the status report 'An Assessment of Human Hazards to Seabirds in the North Sea' in London in March.

C.J. Camphuysen, H. Offringa and M.F. Leopold advised Jan Seijs of the Belgian Institute of Nature Conservation on database structure of seabirds at sea counts in September.

M.F. Leopold advised the ministry of Agriculture, Nature Management and Fisheries on the implementation of the EC Habitat Directive, with respect to the outer border of the Wadden Sea, as a special area.

J.S. Sinninghe Damsté offered advice to TNO in a report entitled Pyrolysis of epichloorhydrine rubber.

S. Schouten, M. Schoell, W.I.C. Rijpstra, J.S. Sinninghe Damsté and J.W. de Leeuw offered advice to Chevron in a report entitled Molecular Biogeochemistry of Monterey Sediments III: Distribution and stable carbon isotopic compositions of free and sulphur-bound carbon skeletons in sediment extracts from Shell Beach (Pismo Basin).

J.W. de Leeuw and M. Baas offered advice to the Geological Survey of the Netherlands in a report entitled Molecular characterization of North Sea Saale and Weichsel samples.

J.D.H. van Heemst, C.J. Wiebinga offered advice to Amicon on filter efficiency in a report entitled The efficiency of Amicon 500 Dalton tangential-flow ultrafiltration membranes in concentrating Dissolved Organic Carbon (DOC) from seawater.

J.D.H. van Heemst, C.J. Wiebinga offered advice to Filtron on filter efficiency in a report entitled The efficiency of a Filtron 500 Dalton tangential-flow ultrafiltration membranes in concentrating Dissolved Organic Carbon (DOC) from seawater.

2.3. ACRONYMS USED IN THIS ANNUAL REPORT

AAS	Atomic Adsorption Spectrometry
ADCP	Acoustic Doppler Current Profile
AFDW	Ash-Free Dry Weight
AMS	Accelerator Mass Spectrometry
ARGOS	a satellite location and data collection system
ASGASEX	Air Sea Gas Exchange Experiment
ASLO	American Society of Limnology and Oceanography
AVHRR	Advanced Very High Resolution Radiometer
AWI	Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
BAH	Biologische Anstalt Helgoland, Helgoland, Germany
BCRS	(Beleids Commissie Remote Sensing) Netherlands Remote Sensing Board
BELS	Benthic Links and Sinks in North Sea Nutrient Cycling
BEON	(Beleidsgericht Ecologisch Onderzoek Noordzee en Waddenzee) Applied Ecological Research North Sea and Wadden Sea
BEST	Benthic Eutrophication Studies
BEWON	(Beleidsgericht Wetenschappelijk Onderzoek NIOZ) Applied Scientific Research NIOZ
BIOLMON	Biological Monitoring
BION	(Biologisch Onderzoek Nederland) Biological Research of the Netherlands
BOA	(Biologie, Oceanografie en Aardwetenschappen) Foundation for Biological, Oceanographic and Earth Sciences
BOLAS	Bottom Lander System
CARMABI	Caribbean Marine Biological Institute
CB	Chlorobiphenyl
CEAB	Centre d'Etudis Avancals de Blanes
CMCA	GeoMarine Centre Amsterdam
CNR	Consiglio Nazionale delle Richerche (Italia)
CNRS	Centre National de la Recherche Scientifique
CORSAIR	Coastal Optical Remote Sensing Airborne Radiometer
CREST	Comité de la Recherche Scientifique et Technique (EC)
CRUSH	Cooperative Research Unravelling Shellfracturing
CTD	Conductivity Temperature Depth (probe)
CvZ	Club van Zeetrekwaarnemers
CZCS	Coastal Zone Colour Scanner
DGS	Denmark's Geological Survey
DGSP	Differential Global Positioning System
DGW	(Dienst Getijdewateren RWS) Tidal Waters Division RWS
DGXII-CEC	Directorate General XII of the Commission of the European Communities
DIC	Dissolved Inorganic Carbon
DIN	Dissolved Inorganic Nitrogen
DNZ-RWS	Directorate North Sea, Ministry of Transport and Public Works
DOC	Dissolved Organic Carbon
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
ECOWASP	Ecosysteem Model Waddenzee
ECSA	Estuarine and Coastal Sciences Association
EDAX	Energy Dispersal Analysis by X-rays
EERO	European Environmental Research Organisation
EGS	European Geophysical Society
ELISA	Enzyme Linked Immunosorbent Assay
ENAM	European North Atlantic Margin
EPOS	European Polarstern Study
EROD	Ethoxy Resorafin-o-de ethylase
EROS-2000	European River Ocean System-2000
ERS	Earth Resources Satellite
ERSEM	European Regional Seas Ecosystem Model
ESF	European Science Foundation
ETS	Electron Transport System
EUG	European Union of Geosciences
FAR	Fisheries and Aquaculture Research

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
GC/HRMS	Gaschromatography/High Resolution Mass Spectrometry
GEM	Global *Emiliania* Modelling
GEOSAT	Geodetic Satellite
GKSS	Forschungszentrum Geesthacht
GLOBEC	Global Ocean Ecosystem Dynamics
HPLC	High Pressure Liquid Chromatography
HREE	Heavy Rare Earth Elements
HRTEM	High Resolution Transmission Electron Microscope
IAPSO	International Association for the Physical Sciences of the Ocean
IBN-DLO	Instituut voor Bos en Natuuronderzoek, formerly RIN Dienst Landbouwkundig Onderzoek
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)
IMPACT II	The effects of different types of fisheries on the North Sea and Irish Sea ecosystem (EC-project proposal)
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)
IOC	Intergovernmental Oceanographic Commission
IPO	International Planning Office WOCE
IRI	Interuniversitair Reactor Institute, Delft
ITZ	Institute of Taxonomic Zoology Univ. Amsterdam
JGOFS	Joint Global Ocean Flux Study
JNCC	Joint Nature Conservation Committee, Aberdeen
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
MATURE	Biogeochemistry of the maximum turbidity zone in estuaries
MFO	Project group Meteorology Physical Oceanography
MGI	Marine Geological Institute, Bandung
MILZON	Inventariserend Macrobenthos Onderzoek in de Milieu Zonering op het Nederlands Continentaal Plat (Dir. Noordzee, RWS)
MREE	Medium Rare Earth Elements
MT-TNO	(Afdeling Maatschappelijke Technologie TNO) Division of Technology for Society TNO
NAM	(Nederlandse Aardolie Maatschappij) Dutch Oil Company
NASA	National Aeronautics and Space Administration USA
NATO	North Atlantic Treaty Organization
NECEM	(Noordzee expeditie Chemie en Microbiologie) North Sea Expedition Chemistry and Microbiology
NERC	Natural Environment Research Council (UK)
NIOP	Netherlands Indian Ocean Programme
NIOO-CEMO	(Nederlands Instituut voor Oecologisch Onderzoek-Centrum voor Estuariene en Mariene Oecologie) Netherlands Institute of Ecology-Centre for Estuarine and Coastal Ecology
NIOO-CL	(Nederlands Instituut voor Oecologisch Onderzoek-Centrum voor Limnologie) Netherlands Institute of Ecology-Centre for Limnology
NMI	Netherlands Measurements Institute
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
NOU	(Nederlandse Ornithologische Unie) Netherlands Ornithologists' Union
NOWESP	Northwest European Shelf Programme
NRSP	National Remote Sensing Programme
NSDW	North Sea Deep Water
NSO	(Nederlands Stookolieslachtoffer-Onderzoek) Dutch beached bird survey programme, working group of Dutch Seabird Group (NSO/NZG)
NSTF	North Sea Task Force
NWO	(Nederlandse Organisatie voor Wetenschappelijk Onderzoek) Netherlands Organization for the Advancement of Scientific Research
NZG	Nederlandse Zeevogelgroep
OBM	Oil Based (drilling) Muds
OCEAN	Ocean Colour European Archiving Network
OCTOPUS	Ocean Colour Technique for Observation, Processing and Utilization Systems
OIO	(Onderzoeker in opleiding) Ph.D. student
OMEX	Ocean Margins Exchange
OSPARCOM	Oslo & Paris Commission
OWS	Ocean Weather Ship
PACT	Committee on the Application of Physical and Chemical Techniques in Archaeology
PAGES	Past Global Changes
PAH	Polyazometric Hydrocarbons
PAR	Photosynthetic Available Radiation
PCB	Polychlorinated biphenyls
PEGASUS	PElagic Geographic Study of the Abundance of SUSpend matter
POM	Particulate Organic Matter
QUASIMEME	Quality Assurance of Information for Marine Environmental Monitoring in Europe
RCG	(Rijks-commissie voor Geodesie) State commission for Geodesy
REE	Rare Earth Elements
RENA	project Reguleerbare vormen van Natuurlijke Achtergrondstraling
RGD	(Rijks Geologische Dienst) National Geological Service
RIVO-DLO	(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
SCAR	Scientific Committee on Antarctic Research
SCOR	Scientific Committee on Oceanic Research
SEAWAQ	Seawater Quality model
SETAC	Society of Environmental Toxicology and Chemistry
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
STERLAB	Stichting Erkenning Laboratoria
SWS	Society of Wetland Scientists
TECON	(Toegepast Ecologisch Onderzoek Noordzee) Applied Ecological Research North Sea
TNO	(Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek) Netherlands Organization for Applied Scientific Research
TRASIR	Transmissometer/Spectral Irradiance Meter
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
VU	(Vrije Universiteit) Free University Amsterdam
VVA	(Verstoring van Aardsystemen) Netherlands Research Programme on changes of earth systems
WASP	Wadden Sea Project
WBM	Water Based (drilling) Muds
WCRP	World Climate Research Programme
WHOI	Woods Hole Oceanographic Institute
WHP	WOCE Hydrographic Programme
WOCE	World Ocean Circulation Experiment
WOIRS	Workshop on optical groundtruth instrumentation for the validation of spaceborne optical remote sensing data of the marine environment
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

3.1. RESEARCH AT NIOZ BY GUESTS

- Dr. M. Ahmed (Bangladesh) investigated the effect of RuO_4 on biopolymers and kerogen.
- Mrs Wilairat Cheewasettum spent two months (April and May) at the Department of Chemical Oceanography and Marine Pollution (Organic Micro-contaminants section) for introduction into ecotoxicology and short training in the analysis of heavy metals, chlorinated pesticides, and polychlorinated biphenyls.
- Chen Xiging (East China Normal University, Shanghai, China) carried out floc size analysis, and studied α- and γ-spectrometry and clay minerals.
- N.V. Druzhkov (Murmansk Marine Biological Institute, Murmansk, Russia), on an NWO grant for a one-year visit, in September started to compare the role of heterotrophic microplankton in the Barents Sea and the North Sea.
- M. Gehlen (Free University of Brussels) worked on the early diagenesis of silica in North Sea sediments.
- F. Gelin (Ecole Nationale Supérieure de Chimie, Paris) investigated biopolymers from strains of *Botryococcus braunii* by flash pyrolysis methods.
- Martha Gledhill (University of Liverpool) participated in the BLOOM 93 expedition aboard RV Pelagia to study chemical forms of iron in seawater.
- S. Groenewold (University of Hamburg) has started investigations on fish, crabs and starfish feeding on fishery discards.
- Dr. Richard S. Halbrook (Environmental Science Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA.) co-operated in the Workshop of the Integrated North Sea Programme (INP), Theme Microcontaminants, from 12 to 15 January.
- J.-L. d'Hondt (Muséum National d'Histoire Naturelle, Paris) stayed at our institute from 15 to 21 October in order to collect Bryozoa (*Alcyonidium polyoum, Electra pilosa*) for his comparative electrophoretic enzyme studies of European bryozoan populations.
- Dr. Ian Jenness, with 12 students from Davis and Elkins College, Elkins, West Virginia, USA, participated in the Mesocosm Bloom Experiment from 18 May to 1 June.
- Dr. J. Köster investigated samples from the northern Alps on organic sulphur compounds.
- Li Jufa (East China Normal University, Shanghai, China) did floc size analysis of the North Sea and studied estuarine transport processes.
- Dr. Anatoly Limonov (Moscow State University, Faculty of Geology) participated in the study of Black Sea mud diapirism for one month.
- C. Lohmann (Johannes Gutenberg University Mainz, Germany) worked on the analysis of algal pigments by HPLC techniques from March to October.
- D. Miggens (Guyana Natural Resource Agency, Georgetown, Guyana) investigates organic sulphur compounds in sediments from the Vena Del Gesso Basin and hydrocarbons in core samples from Guyana.
- Dr. A. Noor (Hasanudin University, Ujung Pandang, Indonesia) studied the impact of hydrocarbons on corals and coral reefs.
- S. Peulvé (Université Pierre et Marie Curie, Paris) investigates particulate matter by flash-pyrolysis methods.
- Dr. Tine Rasmussen (post doc, University of Aarhus, Denmark) spent twelve months at NIOZ to study downcore foraminiferal distribution in pistoncores of the Faroer-Shetland Channel area as indicator of paleo water-mass variations. She has obtained high resolution core data and expanded the work by studying samples obtained during the ENAM 1993 cruise with RV 'Pelagia'.
- Dr. Renate Scharek (Alfred Wegener Institut, Bremerhaven) stayed at the institute during August and again during November, working out findings on iron/phytoplankton in Antarctica in collaboration with Maria van Leeuwe, Jeroen de Jong and Hein de Baar.
- Karen Smyth (University of Hertfordshire, Hatfield, England) worked on the early diagenesis of silica in North Sea sediments from 1 March to 1 September.

- J. Tassarge (University of Braunschweig, Germany) worked on the size differentiated grazing by heterotrophic flagellates from 20 July to 1 September.
- M. Yamamoto (Geological Survey of Japan) investigates Jurassic samples from the North Sea and participates in the K/T Boundary project.
- Dr. S. Zea (Instituto Investigationes del Mar, Santa Marta, Colombia) studied change in benthic communities with special reference to reef sponges.
- Zhang Chen (Academica Sinica, Nanjing, China) analysed suspended sediment from Erhai Lake, China, and the North Sea.
- A.G. Zykalov (Moscow State University) participated in leg C2 of NIOP (6 February to 7 March) and continued his training in sedimentological techniques at the Department of Geology until July, working with Van Weering and Van Bennekom. He determined contents of carbonate and biogenic silica in a piston core obtained during NIOP C2 and gave a preliminary sedimentological interpretation in a report entitled 'Upwelling induced sedimentation in the northwest Indian Ocean'

Photo: T. de Bruin

3.2. PARTICIPATION IN NATIONAL AND INTERNATIONAL PROGRAMMES

- D. Eisma, J. Kalf: MATURE programme (EC): cruises in the estuaries of the Elbe (19-25 April), Schelde (3-8 May) and Gironde (17-22 May).
- D. Eisma, J. Kalf: Intercalibration programme particulate matter (WIMS programme), Elbe estuary (7-14 June).
- D. Eisma, J. Kalf: PEGASUS programme (optical remote sensing) (BCRS); four five-day cruises in the North Sea.
- D. Eisma, J. Kalf, R.F. Nolting, S. Peulvé participated in the EC programme EROS 2000 (Rhone River, northwest Mediterranean).
- D. Eisma, S. Chen, J. Beks: NWO/NOP Global Change Programme, North Sea.
- A.J. van Bennekom participated in the ANTARES 1 programme (ANTArctic RESearch) by determining Al/Si ratios in diatom cores obtained by J.E.E. van Beusekom (University of Hamburg) during the ANTARES 1 cruise (27 March to 18 May) to the southern Indian Ocean.
- M.A. Baars, R.P.M. Bak, K.M.J. Bakker, E.T. Buitenhuis, G.J. Brummer, G.C. Cadée, J.M. Everaarts, J. Hegeman, W. Helder, M.A. Hiehle, R. Kloosterhuis, G.W. Kraay, G. Nieuwland, R.F. Nolting, S.S. Oosterhuis, A. van Koutrik, Tj.C.E. van Weering, E. van Weerlee, M.J.W. Veldhuis, C.J. Wiebinga & J.IJ. Witte participated in the Netherlands Indian Ocean Programme (NIOP), co-ordinated by SOZ and carried out aboard RV 'Tyro'.
- H.G. Fransz, D. Eisma, S. Shimwell and M. Wernand participated in a project on the study of the composition of particulate matter in the North Sea by optical remote sensing. This project is a co-operation between NIOZ, RWS, RUG, NIO-CEMO from the Netherlands and the University of Southampton.
- B.R. Kuipers, S.R. Gonzalez and H.G. Fransz participated in workshops at NIOZ and AWI (Bremerhaven) about the JGOFS Southern Ocean program in 1992.
- S. Schouten, J.W. de Leeuw and J.S. Sinninghe Damsté participated in the Cooperative Monterey Organic Geochemistry Study (CMOGS) group, which studies the organic matter present in samples from the Monterey Formation.
- E. Buitenhuis, J.D.H. van Heemst, J.W. de Leeuw, M. Baas, C.J. Wiebinga, H.J.W de Baar, J. Hegeman, M. le Clercq, J. van der Plicht, Tj.C.E. van Weering, M.J.W. Veldhuis participated in the special NWO programme Global Change (VvA). The objective of this programme is to gain a deeper understanding of the carbon budget and the organic carbon fluxes in the ocean.
- F. Kenig, N. Frewin, J.S. Sinninghe Damsté and J.W. de Leeuw are participating in the EC-funded project of the European Network of Organic Geochemists (ENOG) investigating sulphur-rich immature hypersaline sediments.
- J.S. Sinninghe Damsté participates in the PIONIER programme of NWO.
- S. Peulvé participates in the DBT programme for the work on the Lena River.
- W. van Raaphorst co-ordinated the ecosystem modelling in the EC-MAST project WASP, in which German, Danish and Dutch institutes co-operate. P. Ruardij and J.P.C. Smit participated in this project.
- W. van Raaphorst was board member of the EC-MAST project NOWESP and co-ordinated the NOWESP task group on suspended particulate matter. H.J. Lindeboom and D. Eisma participated in this project.
- P. Ruardij and E. Embsen participate in the EC-MAST projects for ERSEM, for which NIOZ in the leading institute.
- C. Brussaard and R. Riegman participate in the EC-STEP programme *'Phaeocystis'*.
- M. Bergman, M. Fonds, J.W. van Santbrink and P. van der Puyl participated in field cruises of the EC-IMPACT project on the effects of beamtrawling in the North Sea.
- C.J. Camphuysen and M.F. Leopold participate in Project Ornis: Seabirds and marine mammals surveys in the German Bight (MFL).
- T. Piersma co-operated with Dr. M. Ramenofsky of the University of Washington, Seattle, USA, and Dr. S. Jenni-Eiermann of the Swiss Ornithological Institute to look at the seasonally varying hormone and metabolite levels in staging waders in the Wadden Sea.

- T. Piersma co-operated with Dr. Th. Alerstam, D. Lindström and S. Hedenström of the Department of Animal Ecology at the University of Lund, Sweden, on the analysis of wader migration data and the development of new research in this area.
- T. Piersma co-operated with Dr. H. Boyd and Dr. R.I. Guy Morrison of the Canadian Wildlife Service and Dr. N.C. Davidson of the Joint Nature Conservancy Committee, Peterborough, England, in an analysis of patterns and recent changes in the climatological conditions affecting long-distance migrants upon arrival in the Canadian Arctic.
- J.H. Vosjan and T. van Balen participated in the ANT/7 expedition to the Weddell Sea with the RV 'Polarstern', AWI, Bremerhaven, Germany.
- Tj.C.E. van Weering participated in the ESF Network on Mediterranean Marine Geosciences, OMEX (MAST II), ENAM (MAST II).
- R.F. Nolting participated in the EC Brussels programme (Bureau of Certification of Reference Material) for the certification of trace metals in estuarine water, which will be used as reference material.
- R.F. Nolting participated in the ICES programme, intercomparison exercise on trace metals in suspended particulate material (Phase II).
- R.F. Nolting participated in QUASIMEME (quality assurance of information for marine environmental monitoring in Europe) organized by the measurement and testing programme (BCR), CEC.
- J.T.M. de Jong, R.F. Nolting and H.J.W. de Baar participated in the IOC baseline study of trace metals in the North Atlantic Ocean with C.S.S. (Canadian Scientific Ship) Hudson. J.T.M. de Jong joined the cruise from 6 August until 1 September.
- C.J. Wiebinga participated in an intercomparison exercise for the determination of bacterial production and biomass with a European research group (Finland, France, The Netherlands). The work was carried out in Banyuls-sur-Mer (France) from 24 to 29 October.
- C.J. Wiebinga participated in the broad community DOC methods comparison-stage 1 organized by J. Sharp (University of Delaware).
- D.C.E. Bakker and H.J.W. de Baar participated in the NWO/NOP climate change programme with a multiyear study of CO_2 exchange between air and sea.
- D.C.E. Bakker. A.A.J. Majoor, and H.P.J. de Wilde participated in an air/sea exchange experiment ASGASEX at the offshore platform MEETPOST NOORDWIJK, September 1993.
- J.P. Boon and K. Booij participated in the BENTOX programme on the effect of organic contaminants on the reproduction success of benthic invertebrates.
- J.M. Everaarts participated in the Integrated North Sea Programme (INP), Theme Microcontaminants.
- W. Helder, A. van Koutrik, R.F. Nolting, J. van Heerwaarden, M. Laan, T.M. Tahey, P.A.W.J. de Wilde, A. Kok and H.J. Witte participated in the EC-STEP programme in the Adriatic Sea on board RV 'Urania' (9-20 August).
- W. Helder, E. Epping, M.H.A. Dekker, J. van Ooijen, A. van Koutrik, E.M. Berghuis, J. van der Weele, H. Visser participated in the OMEX-Benthic Processes cruise on board RV 'Pelagia' (11-29 October)

3.3. Visitors from abroad

- Dr. F. Abrantes, Serviços Geologicos de Portugal, Lisboa, Portugal.
- Dr. E.S. Acuña, Universidad catolica del norte, Coquimbo, Chile.
- J.W. Baretta, WKI, Hørsholm, Denmark.
- R. Billones, Philippines (temp. Free University Brussels) .
- Dr. K.R. Björklund, Universitetet i Oslo, Norway.
- Dr. S. Boxal, Univ. of Southampton, UK.
- Dr. D. Brew, British Geological Survey, UK.
- Prof. Dr. D.E.G. Briggs, Department of Geology, University of Bristol, England.
- Dr. F. Carlotti, Station Zoologique, Villefranche-sur-mer, France.
- Dr. M.E. Collinson, Department of Geology, Royal Holloway, University of London, Egham, Surrey, UK.
- Dr. B. Dale, Universitet i Oslo, Norway.
- Elisabeth Dillmann, Department of Zoology, University of Zürich, Switzerland.
- Dr. J. Fenner, Bundesanstalt für Geowissenschaften und Rohstoffe, Hanover, Germany.
- Dr. M. Gehlen, Free University of Brussels, Belgium.
- Dr. M. Goñi, Department of Chemistry and Geochemistry, Woods Hole Oceanographic Institution, Woods Hole, USA.
- Dr. F. Guichard, Centre des Faibles Radioactivités, Gif-sur-Yvette, France.
- K. Hata, Meteorological & Oceanographical consultant, Tokyo, Japan.
- Prof. Dr. J.M. Hayes, Biogeochemical Laboratories, Indiana University, Bloomington, Indiana, USA.
- Dr. A. Jelinowska, Université Paris-Sud, Orsay, France.
- Dr. M. Knappertsbusch, GCMA/ETH Zürich, Switzerland.
- Dr. T. Komatsu, Ocean Research Institute, University of Tokyo, Japan.
- Dr. D. Kroon, University of Edinburgh, UK.
- Dr G. Kuhne, Alfred Wegener Institut, Bremerhaven, Germany.
- Dj. Kunarso, Centre Oceanological Research and Development LIPI, Jakarta, Indonesia.
- Dr. C. Lancelot, Université Libre, Bruxelles, Belgium.
- S. McChesney, Dept Zoology, University of Hongkong, Hongkong.
- S. Mwangi, Kenyan Marine Fisheries Research Institute, Mombasa, Kenya.
- Dr. K. Nakata, National Institute for Resource and Environment, Tsukuba, Ibaraki, Japan.
- T. Nakane, Marine Biological Research Institue of Japan, Tokyo, Japan.
- Dr. H. Oberhänsli, Max-Planck-Institut für Chemie, Mainz, Germany.
- Dr. W. Orr, Earth & Energy Science Advisors, Dallas, USA.
- Dr. E.S. Rasmussen, Geological Survey of Denmark, Copenhagen, Denmark.
- Dr. Pavel Tomkovich, Zoological Museum, Moscow University, Russia.
- Dr. L. Pihl, University of Gothenburg, Sweden.
- Dr. N.B. Price, University of Edinburgh, UK.
- Dr. R. Requejo, Geochemical & Environmental Research Group, Texas A&M University, Texas, USA.
- Dr. C.S. Rocha, IPIMAR, Lisbon, Portugal.
- Prof. Dr. R. Rosenberg, University of Gothenburg, Sweden.
- Dr. N. Scheele, Alfred Wegener Institut, Bremerhaven, Germany
- Dr. G. Schmiedl, Alfred Wegener Institut, Bremerhaven, Germany.
- Dr. R. Schneider, Universität Bremen, Germany.
- Prof. H. Shen, ECNU, Shanghai, China.
- Dr. M.-A. Sicre, Laboratoire de Physique et Chimie Marines, Université Pierre et Marie Curie, Paris, France.
- P. Solberg, Dept. of Fisheries and Marine Biology, Bergen, High Technology Center, Norway.
- Dr. F. Stuer-Lauridsen, National Environmental Research Institute, Roskilde, Denmark.
- Dr. E.W. Tegelaar, ARCO Oil company, Dallas, Texas, USA.
- Dr. P. Tucholka, Centre des Faibles Radioactivités, Gif-sur-Yvette, France.
- Dr. A. Uchmann, Dept. Geology Univ. Krakow, Poland.
- Prof. Dr. J. Wattendorf, Institut für Botanische Biologie, Universität Freiburg, Fribourg, Switzerland.
- Dr. E.M.S. Woodward, PML, Plymouth, UK.
- Prof. Ch. Wu, Institute for Coastal and Estuarine Studies, Zhongshau University, Guangzhou, China.
- Prof Ron C. Ydenberg, Simon Fraser University, Vancouver, Canada.

3.4. Research by students

Adema, E.	Van Hall Inst. Groningen	B3-08c
Borgert, K.	Free Univ. Amsterdam	B1-05
Borsje, F.	Van Hall Inst. Groningen	B3-08c
Bouma, H.	Univ. Groningen	B3-08c
Buijs, A	Hogeschool Alkmaar	H1-15
De Jong, I.	Univ. Utrecht	B1-05/06
De Vries, K.	Univ. Groningen	S-01a,c,e
Den Das, J.	Hogeschool Alkmaar	H1-15
Den Hollander, N.	Hogeschool West-Brabant	B3
Drent, J.	Univ. Groningen	H1-02/03
Engelmann, N.	Univ. Groningen	B1-05
Franken, R.	Rijkshogeschool IJsselland	B1-10
Groenhout, B.	Univ. Amsterdam	H1-17
Happee, T.	Hogeschool Alkmaar	H1-15
Jellema, J.	H.L.O. Leiderdorp	H4
Joenje, M.	Univ. Amsterdam	B1-05/06
Klaas, J.W.	Hogeschool Enschede	S-01a
Koldewijn, J.	Hogeschool Enschede	S-01a
Koning, E.	Univ. Utrecht	H1-17
Koster, L.	Univ. Utrecht	B3-08c
Kraayenoord, J.	MBO	S-02b
Kralt, H.	MBO	S-02b
Lambrechts, D.	Univ. Amsterdam	B1-05/06
Lont, J.D.	HS Noorderhaaks	BEWON
Loonstra, I.	IJmond College, Beverwijk	H1-06b
Mets, A.	Bakhuis Roozeboom	B1-06
Moerkerken, P.	H.L.O. Delft	H4
Nagelkerken, I.	Univ. Groningen	B1-05
Noordeloos, M.	Univ. Amsterdam	B1-05
Oosthoek, J.	Hogeschool IJsselland, Deventer	H1-07
Oijen, B.M.	Univ. Utrecht	H3
Pauchli, W.	Univ. Utrecht	B1-05
Sewsaran, J.	Free Univ. Amsterdam	S-02b/ H1-07
Slot, A.E.M.	Hogeschool Midden Nederland	S-01a
Van Damme, C.	Hogeschool West-Brabant	B3
Van den Berg, J.	Hogeschool Amsterdam	B3-
Van Doorn, A.	Free Univ. Amsterdam	B3-11
Van Driel, G.B.	H.L.O. Delft	H4
Van Ek, Ch.	Univ. Groningen	B3-08c
Van Gils, J.	Univ. Groningen	B3-08c
Van Katwijk, Q.	Univ. Groningen	B3
Van Malderen, R.A.A.	H.L.O. Delft	H4
Van Schanke, A.	Univ. Wageningen	S-02a
Van Schie, A.	Univ. Groningen	B1-05
Vriezen, C.	I.A.H. Larenstein	BEWON
Wesseling, I.	Univ. Wageningen	B1-05
Wopereis, J.	I.A.H. Larenstein	BEWON
Zuurbier, D.	Hogeschool Alkmaar	H1-15

3.5. CONGRESSES *ETC.* VISITED BY NIOZ SCIENTISTS

International INP Workshop Preliminary Results of the Microcontaminant Surveys, NIOZ, 11-14 January: J.M. Everaarts, J.F.P. Malschaert, W. van Raaphorst, C.P. Slomp, H.J. Lindeboom, J.P. Boon, C.C. ten Hallers-Tjabbes, H.M. Sleiderink.

Norwegian RHUX Meeting, Department of Fisheries and Marine Biology, University of Bergen, Norway, 12-14 January: J. van Bleijswijk, P. van der Wal.

Verwey-days, NIOZ, Texel, 1-3 February: R.PM. Bak, H.J. Lindeboom, B. Hondeveld, P. de Goeij, M.A. van Leeuwe, T. Tahey, H.G. Fransz.

Effects of UV-b on Aquatic Ecosystems, Amsterdam, 4 February: J.H. Vosjan.

ICES Shelf Seas Working Group, Charleston USA, 9-13 February: C. Veth.

Meeting of the cooperative association 'Nonlinear dynamics and pattern formation', Utrecht, 10 February: H. Ridderinkhof.

E.C. *Phaeocystis* workshop, Brussels, 17-18 February: C. Brussaard, G.C. Cadée, F. Hansen, R. Riegman, W. Stolte.

Organisms as palaeoenvironmental indicators within the marine realm, Geol. Soc., 1993 Lyell meeting, London, UK, 18 February: P.F. van Bergen.

Discussion meeting on Palaeoclimates and their modelling with special reference to the mesozoic era, The Royal Society, London, UK, 24-25 February: P.F. van Bergen.

Workshop on the analysis of dioxins and pcbs, AMC, Amsterdam, 25 February: M.Th.J Hillebrand.

Meeting on Climate Physics, KNMI, De Bilt, 26 February: L. Otto, H.M. van Aken, F.P. Lam, J.C. de Munck, T.F. de Bruin, P. Beerens, C. Veth, C.J. de Boer.

Inaugurative meeting QUASIMEME-(Quality Assurance of Information for Marine Environmental Monitoring in Europe) programme, Noordwijkerhout, 26-27 February: J.P. Boon, M.Th.J. Hillebrand.

Symposium Marine Research in Tropical Coastal Zones, KNAW, Amsterdam, 5 March: R.P.M. Bak, F.C. van Duyl.

Antarctica Symposium, Royal Palace, Amsterdam, 5 March: W.G. Mook, J.H. Vosjan, C. Veth, H.J.W. de Baar, J. Rommets, H.J. Lindeboom, H.G. Fransz, D.C.E. Bakker.

Workshop Polarstern, Ant X/6, AWI, Bremerhaven, 8-10 March: M.A. van Leeuwe.

Second workshop on recruitment of mussels and cockles, RIVO, Yerseke, 11-12 March: C.G.N. de Vooys, P. Honkoop.

Workshop 'Averaging methods', The Hague, 15-16 March: H. Ridderinkhof.

MAST days and EUROMAR market, Brussels, 15-17 March: D. Eisma, W. Helder, W. van Raaphorst, H.J. Lindeboom.

Meeting of EROS-2000 Inorganic Processes Group, Southampton, England, 20-23 March: R.F. Nolting.

BEON-Workshop Risicoanalyse, The Hague, 25 March: J.P. Boon.

First SETAC World Congress, Lisbon, Portugal, 27 March-1 April: J.M. Everaarts.

International Symposium Large Marine Ecosystems of the Indian Ocean, Mombasa, 28 March-2 April: M.A. Baars.

Congress on the biology of the Prymnesiophyta, Plymouth UK, 29 March-1 April: M.J.W. Veldhuis, J. van Bleijswijk.

General annual meeting of the Society for Experimental Biology, Canterbury, UK, 29 March-3 April: D. H. Spaargaren.

Evolution and diversification in the history of plant life, Linnaean Soc. Palaeobot. Specialist Group London, UK, 31 March: P.F. van Bergen.

Resistant biochemicals and the bias in the fossil record. Linnaean Soc. Palaeobot. Specialist Group, London, UK, 31 March: J.W. de Leeuw.

NZG/NOU theme meeting Gulls in the Netherlands: changes in a recently increased population, Leiden, 3 April: C.J. Camphuysen, M.F. Leopold.

European Union Geosciences VII, Strasbourg, 4-8 April: Tj.C.E. van Weering.

Workshop 'Seabirds feeding on discards in winter in the North Sea', Texel, 5-6 April: C.J. Camphuysen, G. Leaper, M.F. Leopold, H.R. Offringa.

European Seabirds At Sea Database workshop, Helgoland, 15-16 April: C.J. Camphuysen, M.F. Leopold, H.R. Offringa.

Fifth International Conference on Modern and Fossil Dinoflagellates, Zeist, 18-24 April: J.W. de Leeuw.

OMEX Workshop Benthic Processes, NIOZ, Texel, 19-20 April: W. Helder, Tj.C.E. van Weering, P.A.W.J. de Wilde, H. de Haas.
LOICZ-workshop Human Impacts, NIOZ, Texel, 19-20 April: H.J. Lindeboom.
International Symposium on the Operationalization of Remote Sensing, ITC, Enschede, The Netherlands, 19-23 April: T.F. de Bruin.
The Third International Symposium The Arctic Estuaries and Adjacent Seas: Biogeochemical Processes and Interaction with Global Change, Kaliningrad, Russia, 19-25 April: R.F. Nolting.
EERO Course on Estuarine Ecology and Coastal Management, La Rochelle, France, 20-24 April: J.T.F. Zimmerman.
Workshop Cooperative Monterey Organic Geochemistry Study Group, New Orleans, 22-27 April: J.W. de Leeuw, S. Schouten.
Antarctica Symposium, KNAW, Amsterdam, 23 April: H.J.W. de Baar, W.G. Mook, J.H. Vosjan.
Meeting of the Working Group on Statistical Aspects of Environmental Monitoring (ICES), Copenhagen, 27-30 April: J. van der Meer.
BEON symposium, The Hague, 28 April: W. van Raaphorst, P. Ruardij, J.F.P. Malschaert, A. Kop, A. van den Berg, J.P. Boon, C.C. ten Hallers-Tjabbes.
Symposium on Contaminants in Soils and Sediments, Ede, The Netherlands, 29 April: J.M. Everaarts, K. Booij.
Demi-annual ERSEM-workshop, Hamburg, May: P. Ruardij.
European Geophysical Society XVIII General Assembly Wiesbaden, 3-7 May: R. van der Toorn, P. Beerens, Th. Gerkema.
UNESO-EC Meeting on the Venice Lagoon, Paris, 4-6 May: W. Helder.
MFO-Symposium, 10-12 May, Veldhoven: H.M. van Aken, C. de Boer, J.C. de Munck, L. Otto, C. Veth.
Vortices in the Ocean, KNAW, Amsterdam, 11-13 May: F.P. Lam, P. Beerens, J.T.F. Zimmerman.
Research Open day 1993, Department of Geology, Royal Hollway, University of London, London, 14 May: P.F. van Bergen.
Workshop Research in the European Coastal Zone (ECOPS), The Hague, 14 May: H.J. Lindeboom.
Chromatography course, Utrecht, 18 May: J.M. Everaarts, M.Th.J. Hillebrand.
Forum discussion on the future on the North Sea, Rotterdam, 19 May: H.J. Lindeboom.
Prochlorophyte workshop Station Biologique de Roscoff, France, 19-29 May: M.J.W. Veldhuis, G.W. Kraay.
Dynamical System tools, CWI, Amsterdam, 24 May: P. Beerens.
Workshop Polarstern, Ant X/6, NIOZ, 25-27 May: M.A. van Leeuwe.
Symposium Highlights in Microbiology, Groningen, 28 May: J.H. Vosjan.
Annual ASLO-SWS meeting, Edmonton, Canada, 30 May-3 June: K.R. Timmermans.
Symposium Flatfish Toxicology, Utrecht, 4 June: J.M. Everaarts, H.M. Sleiderink.
5th International Conference on Copepoda, Baltimore, USA, 6-12 June: W.C.M. Klein Breteler.
First European Paleontological Congres Lyon, 6-12 July: G.C. Cadée.
Colloquium Global Aspects of Coral Reefs, Health, Hazards and History, RSMAS, Miami, June 7-11: R.P.M. Bak.
Meeting on the second intercomparison on trace elements in estuarine water, CEC, Brussels, 8-9 June: R.F. Nolting.
Symposium ERS-1 coordination team, Delft, 14-15 June: J.C. de Munck.
Annual Meeting IOC-JGOFS Panel on CO_2, Plymouth, 14-17 June: H.J.W. de Baar, D.C.E. Bakker, A.A.J. Majoor.
ECOPS meeting predictions of change in coastal seas, Port d'Albret, France, 19-24 June: R. Riegman.
Nansen Centennial Symposium 'The role of the Polar oceans in shaping the Global Environment', Bergen, Norway, 21-25 June: J.H. Vosjan.
EC/MAST Summer Course Modelling and prediction of physical processes in coastal seas and estuaries, Renesse, 27 June-9 July: Th. Gerkema, P. Beerens, J.T.F. Zimmerman.
International workshop: Towards predictive models of bird migration: theoretical and empirical bottlenecks, NIOZ, Texel, 5-8 July: J. van der Meer, T. Piersma.
Workshop of the GLOBEC international working group on numerical modelling, Villefranche-sur-mer, France, 12-15 July: H.G. Fransz.
Symposium on the Geochemistry of the Earth Surface, Penn State University, USA, 1-6 August: C.P. Slomp.
Semi-annual meeting of the American Chemical Society, Chicago, 22-27 August: J.W. de Leeuw, S. Schouten, H. Veld.
EIASO Advanced Course: Biogeochemical Processes in Estuaries and Coastal Seas, Plymouth, 29 August-10 September: R. Osinga.
4th Annual Peter H. Given Lectureship in Coal Science, Penn State, College of Earth and Mineral Sciences, 30 August-2 September: J.W. de Leeuw.

ECSA-23 Particles in Estuaries and Coastal Waters, Haren, 30 August-3 September: G.C. Cadée, C. Brussaard, D. Eisma, J.F.P. Malschaert, W. Stolte, E.C. Flach.

JGOFS/Southern Ocean Workshop, Bremerhaven, 30 August-2 September: C. Veth, H. de Baar, S. Ober, B. Kuipers, S. Gonzalez, B. Löscher, D.C.E. Bakker.

JGOFS/Southern Ocean Planning Group, Bremerhaven BRD, 2 September: C. Veth.

Meeting 'Biodiversity and ecosystem function in the pelagic', Institute of Taxonomic Zoology, University of Amsterdam, 2 September: M.A. Baars.

NOWESP kick-off workshop, Hamburg, 3-4 September: W. van Raaphorst.

4th GEM, *Emiliania* workshop in Blagnac, France, 18-22 September: M.J.W. Veldhuis, J. van Bleijswijk, P. van der Wal, E.S. Kempers.

AGU-Chapman Conference: 'Fractals, Chaos and Predictability in Oceanography and Meteorology', Galway, Ireland, 20-22 September: H. Ridderinkhof.

16th International meeting on Organic Geochemistry, Stavanger, Norway, 20-24 September: P.F. van Bergen, J.W. de Leeuw, J.S. Sinninghe Damsté, M.P. Koopmans, H. van Kaam-Peters, S. Schouten, W.A. Hartgers, J. van Heemst, N. Frewin.

Lustrum symposium Netherlands Remote Sensing Society, 23 September, Schiphol-Amsterdam: T.F. de Bruin.

8th Intern. Wadden Sea Symposium, Esbjerg, Denmark, 28 September-2 October: J.J. Beukema, G.C. Cadée, P. de Goeij, T. Piersma.

EC Workshop CINCS, Iraklion, Crete, 29 September-2 October: P.A.W.J. de Wilde.

The Second International Symposium on Flatfish Ecology, NIOZ, Texel, 30 September-6 October: M. Bergman, L. Bolle, M. Fonds, P. de Goeij, H.W. van der Veer.

AmasSeds Meeting, Niteroi, Brazil, Sept./Oct.: D. Eisma.

Annual meeting Scientific Steering Committee JGOFS (under SCOR and IGBP), Carquireanne, France, September: H.J.W. de Baar.

Fourth international conference on CO2, Carquireanne, France, September: H.J.W. de Baar.

Modeling workshop IPCC Scenario Intercalibrations, Carquireanne, France: H.J.W. de Baar.

Workshop on EC-Mediterranean Targeted Project-Euromarge-Adriatic Sea, Cesenatico, Italy, 5-7 October: W. Helder.

Napa Conference on Genetic and Molecular Ecotoxicology, Yountville, Napa Valley, California, USA, 11-16 October: J.M. Everaarts.

Meeting ENOG-project group, Barcelona, 12-14 October: F. Kenig, N. Frewin, J.W. de Leeuw.

Symposium on nutrient dynamics in coastal and estuarine environments, Helsingør, Denmark, 13-16 October: C.P. Slomp, W. van Raaphorst, P. Ruardij, F.C. van Duyl, R. Osinga, E.C. Flach.

American Association of Petroleum Geologists International Conference, The Hague, 17-20 October: J.H.F. Jansen.

5th Intern. workshop on plant taphonomy, Liège, 18-19 November: G.C. Cadée.

ICES 81st Statutory Meeting, Dublin, 23-28 September: H.M. van Aken, J.C. de Munck, P.A.W.J. de Wilde, K. Booij, R. Witbaard.

Annual symposium of the Organic Geochemistry Division of the Geological Society of America, Boston, 24 October: M.P. Koopmans.

QUASIMEME workshop, Faro, Portugal, 26-31 October: M.Th.J. Hillebrand.

Birdlife International workshop on dispersed species at sea, Helgoland, 28 October-3 November: M.F. Leopold.

British Diatomists' Autumn Meeting, Bristol, 29-31 October: L. Ben Khelifa.

Wader Study Group Annual Conference and Symposium, Ipswich, Great Britain, 29-31 October: P. de Goeij, T. Piersma.

International Workshop on Dunlin migration, Ipswich, Great Britain, 1 November: P. de Goeij, T. Piersma.

Symposium Variability in and on the Earth, Council for Earth Sciences, KNAW, Amsterdam, 5 November: J.H.F. Jansen.

First European Lander Symposium, Bremen, 8-10 November: W. Helder, T. Tahey, P.A.W.J. de Wilde.

Meeting of the Inorganic Group of the EROS-2000 Programme, Brussels, 12-13 November: R.F. Nolting.

Fourth Meeting JGOFS Indian Ocean Planning Group, Mombasa, 20-21 November: M.A. Baars.

Final Manifestation Toxicology Research, Amsterdam, 25 November: J.M. Everaarts.

Third EMINar, European Inderdisciplinary Marine Network, University of Southampton, UK, 15-17 December: F.C. Hansen.

ANTARES/Southern Ocean JGOFS Workshop, Brest, 16-17 December: A.J. van Bennekom.

3.6. EXTERNAL PROFESSIONAL FUNCTIONS

M.A. Baars
- member Indian Ocean Committee (SOZ)
- member JGOFS Indian Ocean Planning Group
- member Working group Joint Global Ocean Flux Study Nederland

R.P.M. Bak
- professor Tropical Marine Biology, University of Amsterdam
- external examiner, Dept. of Marine Biology, University of Newcastle, England
- member International Association of Biological Oceanographers (IABO) Coral Reef Committee
- board member Working group 'Biologisch Aardwetenschappelijk Onderzoek Tropen'
- Senior Editorial Advisor Marine Ecology Progress Series
- Associate Editor Proceedings Colloquium Global Aspects on Coral Reefs. Health, Hazards and History, June 7-11, RSMAS, Miami
- board member 'Natuurwetenschappelijke studiekring voor het Caraïbisch gebied'
- member Neth. SCOR Committee (KNAW)

M.J.N. Bergman
- member Working Group on Ecosystem Effects of Fishing Activities ICES

J.J. Beukema
- editor-in-chief Netherlands Journal of Sea Research
- board member Working group Populatiebiologie BION

J.P. Boon
- member 'Wetenschappelijke commissie voor Chemische Oceanografie' NWO/SOZ
- member Marine Chemistry Working Group ICES
- member Working Group on the Biological Effects of Contaminants ICES
- member 'Wetenschappelijke begeleidingscommissie van het project Stresspar. MT'
- member Working group 'Regeling lozing oliehoudende mengsels vanaf mijnbouwinstallaties op zee van de Commissie voor de Milieueffectrapportage'
- member Editorial Board The Science of the Total Environment
- member Committee Increased risk of food-chain poisoning of lung-breathing top-predators of the National Health Council

G.J.A. Brummer
- member 'SOZ gebruikers-adviesgroep Verankerde Systemen'

G.C. Cadée
- member 'Commissie voor buitenlandse marien-biologische stations KNAW'
- advisor Netherlands Journal of Aquatic Ecology
- associate editor Ichnos
- member Advisory council International Bryozoology Association
- editor Netherlands Journal of Sea Research
- board member 'Nederlands Vlaamse Kring van Diatomisten'
- member Working group Antarctica IUCN

C.J. Camphuysen
- board member 'Nederlandse Ornithologische Unie' (NOU)
- chairman 'Nederlands Zeevogelgroep' (NZG)
- editor Sula
- co-ordinator 'Nederlands Stookolieslachtoffer-Onderzoek' (NSO)
- secretary BEON working group 'Effecten van visserij op vogels en zeezoogdieren'

R. Daan
- member Working group 'Monitoring rond Mijnbouwinstallaties'

H.J.W. de Baar
- Professor General Oceanography, Rijksuniversiteit Groningen
- interim-chairman 'Vakgroep mariene biologie, Rijksuniversiteit Groningen'
- chairman 'Wetenschappelijke Commissie voor Chemische Oceanografie NWO/SOZ'
- chairman Working group Joint Global Ocean Flux Study NWO/SOZ
- lecturer Chemical Oceanography, Dept. Earth Sciences, Free University, Amsterdam
- representative international IGBP/SCOR/JGOFS meetings

- member 'NWO Platform Verstoring van Aardsystemen'
- member MAB/SCOPE/IGBP Committee (KNAW)
- member JGOFS Southern Ocean Working Group
- associate editor Marine Chemistry
- convenor symposium Ocean Carbon Cycle, European Union of Geosciences, 1993
- convenor symposium 'Process Studies during Spring in the Southern Ocean' at Ocean Sciences Conference jointly organized by American Geophysical Union/American Society Limnology & Oceanography, San Diego, February 1994

P. de Goeij
- general secretary International Wader Study Group

J.W. de Leeuw
- lecturer Organic Geochemistry University of Utrecht, fac. Earth Sciences
- board member AWON-NWO
- board member LPP, University of Utrecht, Biology faculty
- board member Inst. für Chem. und Biologie des Meeres, Univ. Oldeburg
- board member EAOG (European Association Org. Geochem.)
- board member working group Mol. Mech. and Anal. Chem. NIOZ-TUD
- Professor Geochemistry, Univ. Barcelona

J.C. de Munck
- member Dutch Alti Meter Team
- member Working group remote sensing

P.A.W.J. de Wilde
- Professor Marine Zoology, University of Groningen
- member 'Programma Commissie Open Universiteit,' Heerlen
- member 'Curatorium Forschungszentrum Terramare,' Wilhelmshaven, Germany
- member Benthos Ecology Working Group, ICES
- member Biological Oceanography Committee, ICES
- board member 'Onderzoekschool Functionele Oecologie'

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

D. Eisma
- Professor Marine Sedimentology, University of Utrecht
- member Scientific Council Laboratory for Sedimentology and Environmental Research in Lakes and Waste Waters, Nanjing, China
- member Working group on marine sediments in relation to pollution ICES
- member 'projektgroep slibeigenschappen en coördinatiecommissie slib, Raad van Overleg fysisch oceanografisch onderzoek Noordzee'
- member Steering Committee EROS-2000 Program
- advisory Professor East China Normal University, Shanghai
- member Committee 'Mariene Aardwetenschappen SOZ'
- member Aquatic and Atmospheric Physical Sciences Research Grants and Training Awards Committee (AAPS RG & TA) NERC
- member BRIDGE Steering Committee (NERC)

J.M. Everaarts
- member 'Kontaktgroep ecotoxicologie van de commissie TNO/CNB voor onderzoek inzake nevenwerkingen van bestrijdingsmiddelen'
- member 'BION werkgemeenschap Biologische Toxicologie'
- member Working Group on biological effects of contaminants ICES
- member Marine Environmental Quality Committee ICES
- member Editorial Board of the Bulletin of Environmental Contamination and Toxicology: Aquatic Toxicology - Metals

M. Fonds
- member Mariculture Committee ICES

H.G. Fransz
- member Committee marine biology SOZ
- member 'Stuurgroep Joint Global Ocean Flux Study Nederland'
- member Committee 'Nederlands Arctisch Onderzoeks Programma'
- member 'GLOBEC werkgroep voor numerieke modellering' (NMWG)

W. Helder
- member Committee 'Chemische Oceanografie' SOZ
- chairman 'Nederlandse Oceanografen Club'
- chairman 'Beheers-adviesgroep auto-analysers' (SOZ)
- member Advisory Board Netherlands Journal of Sea Research
- member Neth. SCOR committee
- member 'Sectorcommissie Paleo- en Endogene Processen' AWON
- member Neth. LOICZ committee

J.H.F. Jansen
- member 'Nederlandse Ocean Drilling Project (ODP) Werkgroep'
- member Organizing committee Symposium The South Atlantic: present and past circulation, Bremen, 1994

W.C.M. Klein Breteler
- member 'BION-discussiegroep Zoöplankton-FRIENDS'
- representative GLOBEC for the Netherlands
- member 'Nederlandse werkgroep deeltjes-karakterisering'

G.W. Kraay
- member flow-cytometer working group

M. Leopold
- board member 'Nederlandse Zeevogelgroep' (working group offshore)

H.J. Lindeboom
- member 'Commissie voor Milieueffectrapportage'
- member 'Stuurgroep SEDEX'
- member 'Coördinatiegroep ecologie Noordzee en Waddenzee'
- member Committee mariene biologie SOZ
- external examiner Hogeschool 'Noorderhaaks' environmental sciences
- member 'MER-werkgroep nieuwbouw Aldel-Delfzijl'
- member 'MER-werkgroep gaspijpleiding door de Waddenzee'
- editor NSTF 'sub-regional assessments'
- chairman 'BEON werkgroep effecten van visserij op vogels en zeezoogdieren'
- member ICES study group on Ecosystem Effects of Fishing Activities

W.G. Mook
- Professor of Isotope-Fysics, University of Groningen
- Professor Application of Isotopes in Earth Sciences, Free University, Amsterdam
- member 'Koninklijke Nederlandse Academie van Wetenschappen'
- member Academia Europaea
- member 'Sectie Aardwetenschappen' (KNAW)
- member 'Academie Raad voor de Aardwetenschappen' (KNAW)
- member ICSU-committee
- member 'Klimaatcommissie/nationale WCRP-commissie' (KNAW)
- member INQUA-committeee/national PAGES-committee (KNAW)
- member IGBP/MAB/SCOPE committee (KNAW)
- chairman/nominated member SCOR Nederland (KNAW)
- board member 'Stichting Onderzoek der Zee' (NWO)
- member Committee 'Watersysteem Verkenningen'
- member 'Raad van Overleg van het fysische oceanografisch onderzoek van de Noordzee'
- chairman 'Curatorium van het Centrum voor Isotopen Geologisch Onderzoek, Vrije Universiteit Amsterdam'
- member PACT-committee Raad van Europa
- member Scientific Steering Committee IGBP core project PAGES
- Associate Editor Radiocarbon

M. Mulder
- member Working group 'Monitoring rond Mijnbouwinstallaties'

R.F. Nolting
- member EC commission certification of sea- and estuarine water for trace metals
- member 'Gebruikersgroep CTD-systemen' (SOZ)

S. Ober
- chairman 'Gebruikers-adviesgroep CTD-systemen' (SOZ)

L. Otto
- member Hydrography Committee ICES
- member European Science Foundation Committee for WOCE
- member Committee 'Fysische Oceanografie' SOZ
- member 'Programmaraad NWO Werkgemeenschap' MFO
- member Neth. SCOR Committee
- chairman Neth. WOCE working group
- chairman IOC/WMO Intergovernmental WOCE Panel
- co-ordinator subthema 'Water' NOP
- member Comité scientifique d'Oceanologica Acta

T. Piersma
- vice-chairman International Wader Study Group
- member Grebe Specialist Group of the International Waterfowl and Wetland Research Bureau (IWRB, Slimbridge) and the International Council for Bird Preservation (ICBP, Cambridge)
- member Estuaries Unit Consultative Committee, British trust for Ornithology, Thetford, England
- member 'Adviesraad voor het Ringwerk, Nederlandse Ringcentrale, Instituut voor Oecologisch Onderzoek, Heteren'

R. Riegman
- secretary BION 'WGM Aquatische Oecologie'

M.J. Rietveld
- member 'Directeuren Overleg Beleidsgericht Ecologisch Onderzoek Noordzee/Waddenzee' (BEON)

J.S. Sinninghe Damsté
- associate scientist University of Utrecht, faculty of Earth Sciences
- assistant editor Organic Geochemistry

D.H. Spaargaren
- secretary 'Commissie voor buitenlandse marien-biologische instituten KNAW'
- member Board of Advisory Editors of Crustaceana
- member Council of European Working Group on Chemical Evolution, Early Biological Evolution and Exobiology, Strassbourg
- member Groupement pour l'Avancement de la Biochemie Marine, Gif sur Yvette, Frankrijk
- member Society for Experimental Biology, London

C. Swennen
- member Stork specialist Group, ICBP
- member 'jury Heimans & Thysse prijs'
- member Dutch section International Council of Bird Preservation (ICBP)

E. van Abs
- member Committee 'Zeegaand onderzoek Stichting Onderzoek der Zee' (SOZ)
- member 'Overlegorgaan Faciliteiten Zeeonderzoek' (OFZ)

H.M. van Aken
- member Arctic Oceans Sciences Board
- member Working Group on Oceanic Hydrography ICES
- member Hydrography Committee ICES
- member 'SOZ gebruikers-adviesgroep CTD-systemen'
- member 'SOZ gebruikers-adviesgroep Verankerde Systemen'
- member WOCE Hydrographic Programme Planning Committee
- WOCE Hydrographic Programme Data Quality Evaluator

M.A. van Arkel
- member Working group 'Monitoring rond Mijnbouwinstallaties'

A.J. van Bennekom
- deputy member Antarctica-committee SOZ
- editor Circumpolar Journal

S.J. van der Gaast
- editorial board Applied Clay Science

J. van der Meer
- member Working Group on the statistical aspects of environmental monitoring (ICES)

H.W. van der Veer
- member Organizing Committee Second International Symposium on Flatfish Ecology, Texel 1993
- special editor Proceedings Second International Symposium on Flatfish Ecology, Texel 1993
- member Organizing Committee Third International Symposium on Flatfish Ecology, Texel 1996
- member Organizing Committee 6th International Conference of Coelenterate Biology, Noordwijk, 1993
- member Working Group on Larval Fish Ecology ICES
- editor Netherlands Journal of Aquatic Science
- adjunct associate-professor Zoology Department, North Carolina State University, Raleigh U.S.A.
- adjunct associate-professor of Marine Science, University of South Carolina, Columbia U.S.A.

F.C. van Duyl
- member 'Protozoën werkgroep'
- member IPCC subgroup
- member NVAE
- member Treub-Mij

W. van Raaphorst
- member 'Begeleidingscommissie Vastlegging van fosfaat in sedimenten' (DBW/RIZA, Lelystad)
- member 'Begeleidingscommissie Denitrificatie-onderzoek in de Randmeren' (DBW/RIZA, Lelystad)
- member Steering committee WASP (ECMAST I)
- member Steering committee NOWESP (ECMAST II)

Tj.C.E. van Weering
- member 'Beheersgroep OPI van SOZ'
- associate lecturer 'tweede fase onderwijs Mariene Aardwetenschappen,' Free University, Amsterdam

- member Committee Marine Earth Sciences SOZ
- member Steering Group ESF Network on Mediterranean Marine GeoSciences
- member Steering Committee OMEX (MAST II)

M.J.W. Veldhuis
- member Dutch JGOFS committee
- co-ordinator NWO/NOP 'Verstoring van Aardsystemen project no. 9'
- projectleider NOP project *Emiliania huxleyi*

C. Veth
- member 'Programmaraad van de werkgemeenschap MFO-NWO'
- member Committee 'Fysische Oceanografie'
- member 'Overleggroep waterstanden en getijden van de Raad van Overleg voor het fysisch oceanografisch onderzoek van de Noordzee'
- member EPOS management group ESF
- member European Science Foundation's WOCE Committee's group of experts on calibrations
- member Southern Ocean Planning Group for JGOFS
- member Committee Antarctic Research

J.H. Vosjan
- lecturer Marine Bacteriology, Free University Brussels, Belgium
- werkgroepleider Bion werkgemeenschap Algemene Microbiologie
- member committee 'Risico's UV straling van de Gezondheidsraad'
- member organizing committee 'Interuniversitaire derde cyclus Mariene Ecologie, Instituut voor Zeewetenschappelijk Onderzoek, Oostende, België'

M.R. Wernand
- member Optics task Team JGOFS
- member Sea WiFS Scientific Team

J.T.F. Zimmerman
- Professor Fysische Oceanografie, Rijksuniversiteit Utrecht
- editor Netherlands Journal of Sea Research
- member editorial board Continental Shelf Research
- IAPSO representative national UGGI comité (ARA-KNAW)
- member Sub-committee Marine Geodesy RCG
- member Committee 'Milieueffectrapportage'
- member Neth. Committee Geodesy (ARA-KNAW)
- member 'Themacommissie Kustonderzoek' van BOA-NWO
- member New York Academy of Sciences

3.7. COURSES, MEETINGS *ETC.*

3.7.1. NIOZ Courses

The course **Introduction to Oceanology,** given from 8 to 19 March, was attended by 18 students, mainly from the University of Groningen. This course is part of the second year's curriculum Marine Biology in Groningen. The theory was given at the University of Groningen from 8 to 12 February. About 50 NIOZ staff members contributed to the practical part of the course, which was held at NIOZ. Two days were spent on board RV 'Navicula' and one day on RV 'Pelagia'.

For the first time in many years a course **Physical Oceanography** was again held at NIOZ (26 July-5 August). The course was organized in co-operation with IMAU (University of Utrecht). The aim was to teach students how to carry out physico-oceanographical observations on board RV 'Pelagia' in the North Sea and on board RV 'Navicula' in the Wadden Sea. Attention was also paid to the processing of physico-oceanographical data such as the analysis of time series, the study of frequency spectra, and producing sections of temperature and salinity by hand and by computer. There were 15 participants from various institutes (mainly students from IMAU and the technical universities).

The course **Marine Ecosystems**, which is part of the Marine Biology programme of the University of Groningen, was held from 7 June to 2 July. The course was attended by 20 students an began with a series of introductory lectures by Prof. De Wilde given in the Biology Centre at Haren. From 14 to 25 June, members of the NIOZ biology staff gave the practical training programme at NIOZ, partly on board RV 'Pelagia', where different methods for fishing and sampling the benthos were compared (4 days). More time and energy were needed to carry out the other part of the practical work, a pelagic mesocosm experiment at the Department of Pelagic Systems, where changes in an algal community under size-selective grazing were studied. For 10 days the students took care of the daily sampling, grazing incubations and all the analyses involved. The results were compiled in the usual 'Result Book' (see also: Mesocosms B2-03). The remaining week (25 June to 2 July) was for preparation of the final reports and concluding examination at Haren.

3.7.2. Workshops, meetings, courses *etc.* held at NIOZ

25 January	Remote Sensing, part of the Tropical Marine Biology course UvA (org. R.P.M. Bak, M. Wernand)
19-20 April	OMEX Benthic Processes Workshop (org. Tj.C. E. van Weering)
10-14 May	course for biologists of the University of Gothenburg, Sweden, on the ecosystem of the Wadden Sea (org. E. Flach)
25-27 May	JGOFS/SO workshop (Org. C. Veth, B. Kuipers, H. De Baar)
18-19 November	International workshop 'Palaeoceanography of the Angola Basin and terrestrial climate' was held with all participants in the project and 5 external specialists. There were 22 attendants.

3.7.3. Visits to NIOZ by educational institutes, government institutions *etc.*

20 January	Utrechtse Geologen Vereniging
29 January	students Internationaal Agrarisch Centrum - Wageningen
15 February	Prof. H.C. van Hall Instituut - Groningen
25 February	course Milieubiologie - NIOZ
8 March	course Oceanography - NIOZ
10 March	HAVO/Atheneum - Alkmaar
12 March	Visserijvereniging - Den Oever
26 April	Prof. H.C. van Hall Instituut - Groningen
24 May	Hogere Laboratorium Opleiding - Beverwijk
27 May	Proefstation voor de Bloemisterij - Aalsmeer
15 June	Scholengemeenschap - Hoorn
16 June	Hogeschool Midden Nederland - Utrecht
29 June	Open School - Den Burg
30 June	Ouderen Studie Kring - Den Helder
27 August	Laboratoriumschool - Voorhout
23 September	Rijkswaterstaat - Flevoland
11 October	Pedagogische Akademie - Sittard
16 December	Prof. H.C. van Hall Instituut - Groningen

4.1. TECHNICAL SUPPORT SERVICES

General

On 1 January the rearrangement of the Technical Services was effectuated. The five Technical Services are now: Electronics, Instrumentation, Sea Technology, Ships and Logistics, Buildings and Installations.

The first three Services develop, build, innovate, maintain and repair instruments for NIOZ and for the national oceanographic instrumentation pool, seagoing lab containers and auxiliary equipment and give onboard support during national and NIOZ scientific cruises.

The Ships and Logistics Service renders technical and nautical support, provides harbour maintenance and logistic support to scientists and national and NIOZ research vessels. The Buildings and Installation Service provides maintenance of buildings, premises and installations, and prepares and executes building and refurbishment of offices, laboratories and installations.

Four vacancies were filled, on RV 'Pelagia', RV 'Navicula', in the Sea Technology and the Buildings and Installations Service, respectively. A temporary vacancy was filled in the Instrumentation Service.

After the completion of the Netherlands Indian Ocean Programme with the national RV 'Tyro', the Netherlands Marine Research Foundation SOZ announced that the ship would be disposed of. At the same time The Netherlands Science Foundation NWO announced a merger of SOZ's national facilities with NIOZ. Now national facilities for sea research will be organized as part of NIOZ. The Technical Services will take part in this new organizational structure which is to be set up in 1994.

The Technical Services also participated in logistic and onboard support, shore activities, developments and projects. The foreign research vessels 'Urania', 'Charles Darwin' and 'Jean Charcot' were visited to become acquainted with their research facilities.

A booklet explaining how the Technical Services are organized and whom to address for certain services has been distributed in the institute. A guide for chief scientists explaining the various procedures to be followed before, during and after a cruise is in preparation.

Logistic support

Logistic support was rendered to scientists of NIOZ and Dutch universities and other scientific institutions for cruises with SOZ, NIOZ, RWS (the Ministry of Transport and Public Works), and on foreign ships. Transports were arranged to and/or from Curaçao, Djibouti, France, Germany, Indonesia, Italy and Turkey.

Onboard support

Technical onboard support was rendered by the various services during:

—the second part of the NIOP programme with RV 'Tyro' from January to May
—cruises during 1993 with RV 'Pelagia' for NIOZ
—a cruise with RV 'Pelagia' to Greenland for Denmark's Geological Survey (DGU) and Greenland's Geological Survey (GGU)
—a cruise with RV 'Poseidon' from Brest to Porto
—two cruises with RV 'Urania', one in the Adriatic Sea for NIOZ and one in the Mediterranean Sea for the University of Utrecht
—a cruise with RV 'Gelendzhik' in the Black Sea.

Ship and harbour affairs

RV 'Tyro' has been moored in NIOZ's harbour since May. RV 'Pelagia' cruised for 37 weeks including 15 weekends and was delayed for three weeks in April due to repair activities caused by the spontaneous burn-out of the portside propulsion alternator. A cruise of 8 weeks was carried out for the Danish Institutes DGU and GGU to the Faroer and Greenland with a stop-over in Reykjavik. A new conductor cable of approx. 4500 m for the CTD winch and a new cable of approx. 3000 m for the piston-core winch were installed.

RV 'Navicula' cruised for 28 weeks, her longest being a 4-week-trip along the Wadden Sea coast to Denmark for an EC bird-counting programme. Due to corrosion of the hull plates under the accommodation floor, some hull plates were renewed; all other plates under the floor were de-rusted and conserved. A new sink was placed in the galley and a more accurate GPS positioning system was installed on the bridge. Her certificate of seaworthiness was renewed. The restriction to sail max. 15 nautical miles or 6 hours from her 'home port' was extended to max. 15 nautical miles or 12 hours from her 'port of operation'.

RV 'Griend' was dry-docked and her underwater hull painted. Her life raft was renewed.

A raft to moor small ships in our harbour threatened to sink due to leaking of the polythene floating units. The raft was dry-docked and the floating units were replaced by steel ones. The location of the raft in the harbour was dredged, and so was the harbour entrance. With easterly winds our small fleet is still insufficiently protected against the waves coming into the harbour. Improvements, however, are very expensive and funds are not yet available. Two heavy bollards were placed on the quay to improve mooring of the large ships.

Since 1960, fishing with traps has been done by the fisherman of the institute. From April to November the traps are investigated and emptied daily. The catch is identified and measured. This year much material has been delivered to the institute for dissection in otolith studies.

Developments

—The three existing tripod ocean bottom landers were upgraded after the NIOP cruise. Several hardware changes were carried out, *e.g.* the motor drive control and new oxygen- and pH probes of the measuring pot for the TROL. Tests were carried out in a high-pressure tank at IFM, Kiel. Improved software was installed in all three systems. *In situ* tests were carried out in the Adriatic Sea and in the Bay of Biscay.

—A new tool for *in situ* observation of suspended matter was developed, based on a superfast firing strobe synchronized to a video camcorder. This technique is very promising. It allows a major simplification of the present technology, which uses traditional (chemical) still photography. High pressure underwater housings were produced for the various components and the camcorder was modified completely to fit one of these housings.

—So far only the breaking strength of cables could be recorded. The test facility for these measurements was upgraded. By also measuring the elongation of a cable and plotting this figure against the applied tension, characteristic information on its behaviour (*e.g.* ageing) is revealed without destroying the cable.

—A series of multiple oxygen and pH probe signal conditioner systems has been built. Each system controls 6 probes and has 'onboard' intelligence to pre-process the data. It communicates with a host computer using RS 232. For this application accompanying multi-tasking acquisition software has been written.

—Modifications of the sediment recorder were carried out for the Department of Benthic Systems. The exchange mechanism for the catching cups is working satisfactorily.

—Four large mesocosms have been built for the Department of Pelagic Systems.

—Six titration cells have been built. One cell was built with automatic controls for valves and plunger.

—A flasher with a parallel light beam has been built for the Transmisso-Advanced-Spectral-Radiation meter.

—Upgrading of the piston-core system provided 18-m cores, the longest cores produced during the NIOP cruise.
—A piston modification of the piston corer guarantees a constant suction pressure, thus preventing the sample being disturbed.
—A system was developed for acoustic releasing of a mooring-string anchored in a trough in the sea floor, filled with high-density brine which scatters the acoustic release signals. The system consists of two releases, a pre-programmed one and an acoustic one, plus a drum with a pre-arranged length of wire rope. The pre-programmed release causes the acoustic release to rise above the high density brine, due to the wire rope which is veering from the drum, after which the release can be addressed properly. The system has been used several times without any problems in Bannock Basin in the Mediterranean Sea.
—A frame has been designed and built for the high-frequency electro-hydraulic vibro corer which was purchased earlier this year. This will allow us to take 6-m cores of hard-packed sand or stiff clay in a few minutes. The frame is approximately 8 m high and is provided with 4 hydraulic-controlled supporting legs for stabilization.
—Test facilities with a tidal control system were installed at neighbouring IBN for use by the Department of Coastal Systems.
—Various laboratory test facilities were adapted or upgraded.
—A suction pump to collect cfk's from cooling and freezing units was purchased in order to meet government environmental regulations.
—The feasibility study to install a high-efficiency thermal power unit was concluded. A 165 kW gas fired diesel alternator-set appeared to be the optimal solution for the institute and it was decided to hire such a set, which was installed in December. Apart from the electricity supplied by the alternator, the thermal heat produced by the diesel engine and its exhaust will be used for central heating of the buildings, thus reducing the energy bill.
—After municipal and provincial approval a 1300 m^2 storage shed has been built under our supervision next to the NIOZ harbour. Approximately one kilometre of pallet shelves has been constructed to store equipment.
—After municipal approval a 600 m^2 pre-fabricated laboratory and office unit was built and equipped under our supervision for the new Marine Biogeochemical Department. Most of the furniture, such as laboratory tables and fume-extractor cabinets, was purchased second hand.
—Following the rearrangement of the Technical Services, a number of workshops have been rearranged, extended or made more practical for their purpose.
—A laboratory was converted into offices for the International Core Project Office of LOICZ, which was established at NIOZ as of 1 November.
—Part of the exhibition hall was converted into office space to cover the need of room for new personnel.
—Due to the rapid increase of personnel at the institute, a lack of office and laboratory space is felt. Therefore, an analysis of existing and needed space has been concluded by Berenschot Osborne Consultants.

4.2. FINANCE AND ACCOUNT SERVICE

The Finance and Account Service, FED, was formed in 1993 by an integration of the Administrative Service, the Project Management and the management of the Supply Service, aiming at an optimal use of the expertise of these services in the Institute. As of 15 October C.W. Luursema M.Sc. was appointed head of the FED.

In spite of an increasing pressure of work, the Administrative Service has attempted to ensure effective management. The great amount of work caused by the increased number of projects and cruises, so far accomplished only with great effort, will be streamlined and integrated into a new administrative organization.

The various scientific departments have received considerable support from the project manager in launching new projects and keeping track of existing projects. Special attention was devoted to BEWON, which was confronted with a reduction of its guaranteed funding. This and the increased pressure of work

exceeds the capacity of the present FED. The reorganization planned for 1994 has to lead to a better management of all projects.

Although the Supply Service experiences increasing pressure of work due to the continued growth of the Institute, its employees have been able to meet demands in 1993.

Further steps have been taken towards registering all the institute's equipment and drawing up a plan for its management. The moral support from NWO is acknowledged, but the absence of a good set-up in the past now adds to the difficulty of making an inventory system.

4.3. SCIENTIFIC SUPPORT SERVICES

Centre for Information Processing and Automation (CIA)

To establish priorities better and to streamline the activities of the Technical and User Committees and the CIA, monthly sessions were initiated in 1993 between the CIA and the Director of General Affairs. A list is drawn up of actions to be taken.

G. Manshanden had a 6-month paternity leave. During that period, K. van der Meulen, a student at the HOI Leeuwarden, worked two days a week at the CIA.

The ABC data logging system aboard RV 'Pelagia' demands attention. Improvements and adjustments were carried out based on the observations made by chief scientists and cruise participants. The level A data are available to the scientists by means of so-called day files in Excel. These files contain data on all measured parameters, averaged per minute. It is recommended that CTD data should be registered in the ABC system.

The inventory, started in the middle of 1993, of the number of PCs and Macs showed that there were 235 such computers at NIOZ. The increasing number of connections to the network causes a lack of disk space, and the well-functioning of the network requires constant supervision. Regular adjustments, such as the up-grading of the system software on the work stations as well as the PCs, have to be carried out. Time is invested in obtaining a thorough knowledge of new software.

In co-operation with the User Committee, the periodical 'Octopus' appears a few times a year. It contains relevant articles on software, hardware and other interesting computer information.

User Committee and Technical Committee

The User Committee deals with questions and problems received from the various departments about hard- and software. The Committee also advises the board of directors concerning the automation management within the institute.

The Committee members are: J. van der Meer (chairman), R. Dapper/G.M. Manshanden (CIA), L.R.M. Maas (Physical Oceanography), K. Booij (Chemical Oceanography), J.H.F. Jansen (Geology), J.J. Beukema (Coastal Systems), H.J. Witte (Pelagic Systems), A. Kok/G. Duineveld (Benthic Systems), H. Malschaert (BEWON), M. Baas (Marine Biogeochemistry), J. Nieuwenhuis (Electronics Division/on behalf of the Technical Services) and P. Ruardij (chairman Technical Committee). Administrative members of the User Committee are N. Barten-Krijgsman (Editorial staff), R. Nichols (Reprographic Service), I. Wernand-Godee (Financial Service) and a representative of the Library (vacancy). C.S. Blaauboer-de Jong is the secretary of the Committee as well as an administrative member (Secretariat). The User Committee meets every two months; in 1993 five meetings took place.

The Technical Committee discusses the technical aspects of automation problems and advises thereupon the board of directors.

The Committee members are: P. Ruardij (chairman), R. Dapper, F. Eijgenraam, G.M. Manshanden, E. Embsen, B. Koster, R.X. de Koster, J. van der Meer and W. Pool. C.S. Blaauboer-de Jong takes care of the minutes of Committee meetings; in 1993 five meetings of the Technical Committee took place.

The editorial staff of the periodical 'Octopus' consists of G.M. Manshanden, H. Malschaert and C.S. Blaauboer-de Jong. The periodical gives the users 'hot' information on automation and has been issued once in 1993. As a supplement, a single issue of 'Octo*plus*' was issued.

The library
In 1993 the library collection has been increased by 148 books and the following periodicals:

KNMI Klimaatknipselkrant 12 (1992)-
Climate Research (1993)-
Donghai Marine Science Vol 10/3 (1992)-
Filter (Actuele Publicaties Milieu) Vol 1/1 (1992)-
Reprints RIVO 1 (1993)-
Coletanea de Publicacoes Niteroi (1991)-
Behavioral Ecology Vol 4/1 (1993)-
FWG Report 1 (1992)-
Geomar Report Kiel 4 (1991)-
Global Environmental Change Report Vol 5/11 (1993)-
Biochemistry, Geology and Paleogeography of the Baltic Sea Vol 1 (1983)-

Editorial office—see 2.1.2.

Reprographic Service
The flatbed scanner which was installed last year as a link between existing archive drawings and the computer system has already proved its worth; it forms an important link with diverse computer programmes and as such is being frequently used.

The use of the copiers is still on the increase, especially for the production of internal and external reports in large quantities, which requires extra attention and maintenance.

The printing shop, in contrast with past years, has been more intensively used, especially for specialized projects which could not be produced on the copiers.

As part of its normal work, the Reprographic Service carried out assignments for the Netherlands Journal of Sea Research and preparatory work for the Second Flatfish Symposium.

Audio-visual Service
In 1993 a total of 41 posters were produced, 21 more than the previous year. Again many of these posters were for presentation during the 'Verwey-dagen', held at NIOZ in February.

A considerable amount of work was carried out for BEWON. A complete exhibition was produced for the MAST Days, held in Brussels from 15 to 17 March, with a video presentation of the ERSEM film and 3 posters presented at the EUROMAR (D. Eisma). An exhibition was also produced in the Kurhaus, Scheveningen, to mark the fifth anniversary of BEWON.

Progress was made with the video editing of the research on Knots (P. de Goeij, T. Piersma and J. van Gils). Assistance was rendered to J. Boon, who organized an Open House day at NIOZ, and to H. van der Veer and co-workers, who organized the Second International Flatfish Symposium at NIOZ in September. A double poster for presentation in the United States was made for P. Reijnders and S. Brasseur of IBN.

Educational Materials Service
For the Educational Materials Service at Den Helder 1993 was a year of great changes. For several years the exploitation had not been paying, despite increased publicity both within the Netherlands and abroad. Therefore the NIOZ board and directors decided to close down the service, and on 30 September the 'Petotjoloods' closed its doors. The temporary contract of E. Eliveld expired on 8 July and has not been renewed. J.M. Nieuwenhuizen was appointed Head of General Services at NIOZ.

The aquaria were donated to the foundation 'Stelling Den Helder' and will be exhibited in the Kijkduin fortress. A number of living fishes were given to the Sea Life Centre, Scheveningen. In September the animals that had not been sold were given to schools or any organization that cared to collect them. The remaining fixed animals were donated to the Free University Amsterdam. Part of the furnishing of the building has been moved to NIOZ.

5.1. ALGEMEEN

In de voorgaande hoofdstukken zijn samenvattingen opgenomen van de wetenschappelijke activiteiten en ontwikkelingen. Deze ontwikkelingen hebben invloed op de infrastructuur van het instituut, maar ook externe factoren spelen daarbij een belangrijke rol. In het vorige jaarverslag werd reeds gewezen op de herstrukturering van het zee-onderzoek binnen NWO. In de nieuwe structuur voor het zee-onderzoek onder NWO zullen de uitvoerende taken met betrekking tot de nationale zeegaande faciliteiten en uit te voeren expedities behoren tot het takenpakket van de stichting NIOZ.

Verder werd ook reeds gewezen op de decentralisatie ten aanzien van de regelgeving van arbeidsvoorwaarden en het overleg tussen de centrales van overheidspersoneel en de werkgevers die ressorteren onder de NWO-koepelorganisatie.

Het in de eerste week van november met een site-visit afgesloten peer review, waarvan eind december het rapport aan het gebiedsbestuur BOA werd uitgebracht is voor het komende jaar aanleiding om de organisatiestructuur van het wetenschappelijk onderzoek en de daarmee samenhangende financieringsstructuur te herzien.

In dit hoofdstuk is de samenstelling van het Bestuur en de Wetenschapcommissie opgenomen en wordt kort ingegaan op de organisatie van de uitvoerende taken voor de nationale faciliteiten voor zeegaand onderzoek. Verder is opgenomen de personeelslijst per 31 december 1993 en is het organogram wederom aangepast. Er wordt kort ingegaan op de arbeidsvoorwaarden, het formatie-onderzoek, de arbeidsomstandigheden en het gevoerde overleg.

5.2. BESTUUR EN WETENSCHAPCOMMISSIE

Bestuur Stichting NIOZ

Per 1 januari 1993 is Prof.dr. J.E. van Hinte teruggetreden als voorzitter Wetenschapcommissie en lid van het bestuur. In zijn plaats werd benoemd Prof.dr. R.A. Prins.

Per 31 december 1993 was het bestuur als volgt samengesteld:

Prof.dr.ir. J.A. Battjes	voorzitter	Afd. Civiele Techniek, Technische Universiteit Delft
Prof.dr. H.J.Th. Goos		Vakgroep Experimentele Dierkunde, Universiteit Utrecht
Prof.dr. J.G. Kuenen		Vakgroep Microbiologie en Enzymologie, Technische Universiteit Delft
Ktz.b.d. Th.G. Loeber	secretaris/penningm.	Hilversum
Prof.dr. R.A. Prins		Vakgroep Microbiologie, Universiteit Groningen

Het bestuur kwam in het verslagjaar 1993 vijf maal met de directie in vergadering bijeen: op 11 maart, 3 juni en 27 september op Texel, op 28 oktober en 10 december in het vergadercentrum van het Centraal Station Amsterdam. De vergaderingen werden namens de algemeen directeur NWO bijgewoond door Dr. H. van Dommelen en/of Dr. J. Dijkhof. Genotuleerd werd door mevrouw C.S. Blaauboer.

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 1993 als volgt samengesteld:

Prof.dr. R.A. Prins	voorzitter	Vakgroep Microbiologie, Universiteit Groningen
Prof.dr. B.L. Bayne		Plymouth Marine Laboratory, Plymouth, UK
Prof.dr. R.H. Drent		Zoölogisch Laboratorium, Universiteit Groningen
Prof.dr. J.C. Duinker		Institut für Meereskunde, Universität Kiel, Duitsland
Prof.dr. W.P.M. de Ruijter		Instituut voor Marien en Atmosferisch Onderzoek (IMAU), Universiteit Utrecht
Prof.dr. V. Smetacek		Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, Duitsland
Prof.dr. G. Wefer		Geowissenschaften, Universität Bremen,Duitsland
Prof.dr. W.J. Wolff		Instituut voor Bos- en Natuuronderzoek,Leersum

De Wetenschapcommissie kwam in 1993 twee maal bijeen: op 6-7 mei 1993 en 2-3 december 1993. 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.

Organisatie van de nationale faciliteiten ten behoeve van zeegaand onderzoek

Het NIOZ wordt uitvoerder van deze taken, waaronder is begrepen het beheer van de nationale faciliteiten zeegaand onderzoek. Deze facilteiten bestaan uit schepen en apparatuur. De stichting NIOZ wordt eigenaar van deze faciliteiten. In de nieuwe structuur zal het onderscheid tussen beheren van oorspronkelijk NIOZ middelen en oorspronkelijk nationale middelen voor de uitvoering van het Vaarplan komen te vervallen. Er zal een coördinator Nationale zeegaande Faciliteiten (CNF) worden aangesteld. Hiermee wordt bereikt, dat ten behoeve van externe contacten/relaties (universitaire groepen, onderzoekinstituten) een duidelijk onderscheiden aanspreekpunt aanwezig is voor de inzet en het beheer van de nationale zeegaande faciliteiten. Voor deze taken zal een afzonderlijke begroting worden gemaakt en er zal afzonderlijke financiële verantwoording plaatsvinden. De implementatie zal zijn beslag krijgen in 1994.

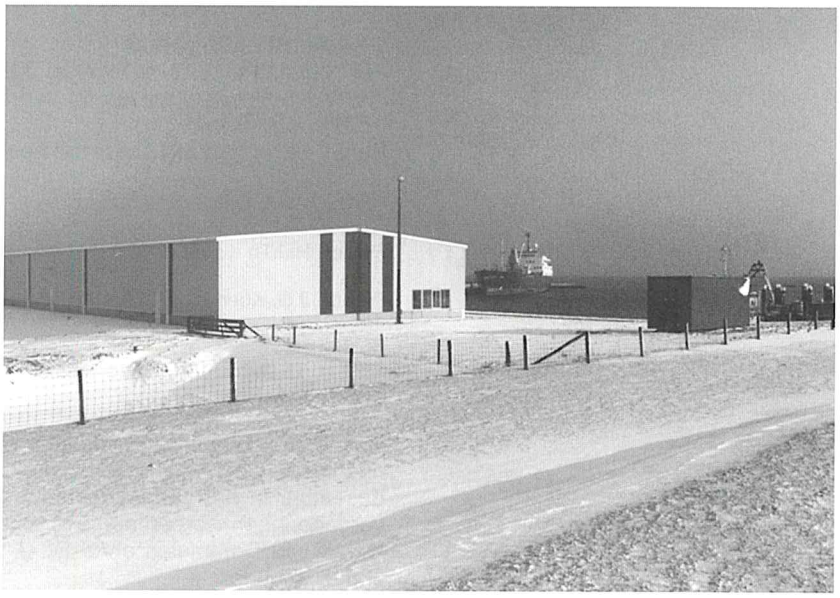
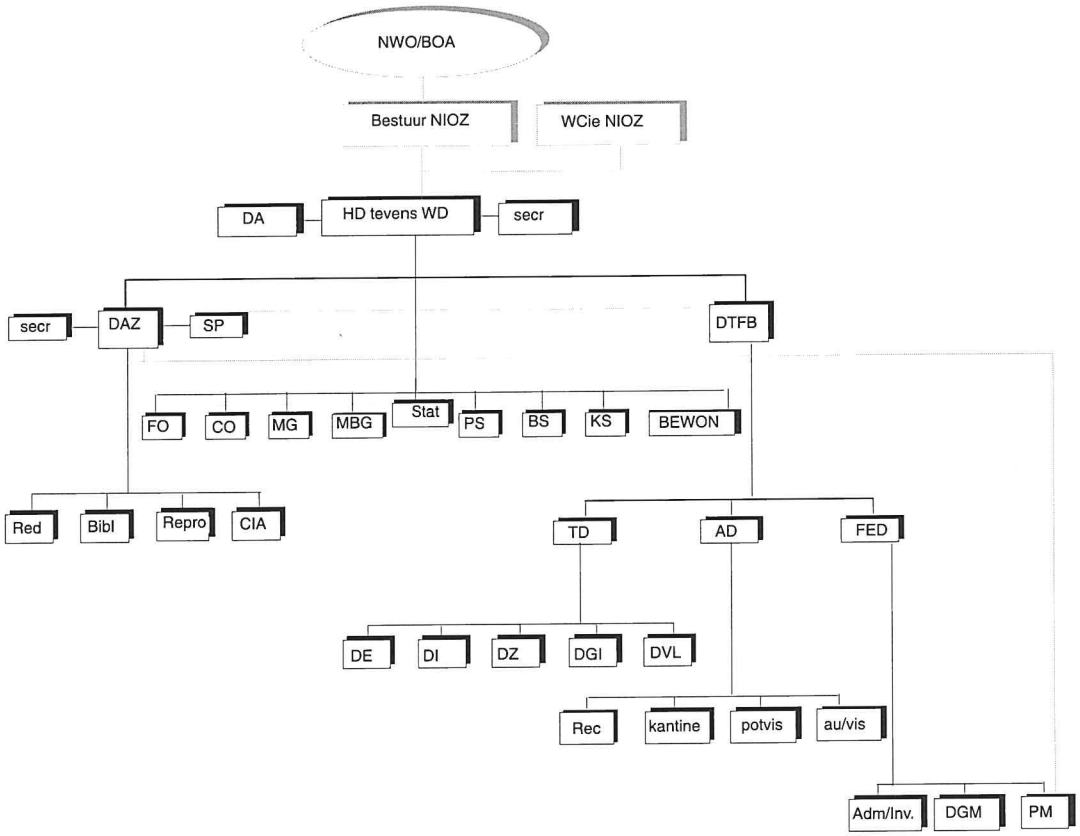


Photo: B. Aggenbach

Nieuwe loods bij de NIOZ haven

5.3. ORGANOGRAM NIOZ



Verklaring van afkortingen in organogram NIOZ

AD	Algemene Dienst
Adm/Inv	Administratie en Inventarisbeheer
Au/vis	Audiovisuele Afdeling
Bewon	Afdeling Beleidsgericht Wetenschappelijk Onderzoek NIOZ
Bibl	Bibliotheek
BOA	Gebiedsbestuur Biologische-, Oceanografische- en Aardwetenschappen
BS	Afdeling Benthische Systemen
CIA	Centrum voor Informatieverwerking en Automatisering
CO	Afdeling Chemische Oceanografie en Zeeverontreiniging
DA	Directie-assistent
DAZ	Directeur Algemene Zaken
DE	Dienst Electronica
DGI	Dienst Gebouwen en Installaties
DGM	Dienst Goederenontvangst en Magazijn
DI	Dienst Instrumentmaken
DTFB	Directeur Technisch en Financieel Beheer
DVL	Dienst Vaartuigen en Logistiek
DZ	Dienst Zeetechniek
FED	Financieel Economische Dienst
FO	Afdeling Fysische Oceanografie
HD	Hoofddirecteur
KS	Afdeling Kustsystemen
MBG	Afdeling Mariene Biogeochemie
MG	Afdeling Mariene Geologie en Geochemie
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek
PM	Projectmanager
Potv	Potvis logeergebouw

PS	Afdeling Pelagische Systemen
Rec	Receptie/telefoniste
Red	Redactie
Repro	Reprografische afdeling
Secr	Secretaresse
SP	Staffunctionaris Personeelszaken
Stat	Statisticus
TD	Technische Diensten
WCie	Wetenschapcommissie NIOZ
WD	Wetenschappelijk directeur

5.4. PERSONEELSLIJST 31-12-93

NAAM	UREN	FUNCTIE	PERIODE
DIRECTIE			
Mook W.G. *Prof. dr.*	34.6	hoofddirecteur, tevens wetenschappelijk directeur	
Rietveld M.J. *Drs.*		directeur algemene zaken	
Abs E. van *Ing.*		directeur technisch en financieel beheer	
Hart-Stam J.M.G.		dir. secretaresse	
Blaauboer-de Jong C.S.		dir. secretaresse	
Rommets J.W.		wet. dir. ass.	
Witte J.IJ.		wet. dir. ass.	
Meer J. v.d. *Drs.*		statisticus	
Vooys P.C.		stafm. pers. zaken	
Heetvelt L.H.M.	7.6	formatiedeskundige	
Wolf P. de *Dr.*		onderzoeker	
Pernetta, J.C. *Dr.*		projectmanager (LOICZ-EG)	m.i.v. 01-11
AFDELING BENTHISCHE SYSTEMEN			
Wilde P.A.W.J. de *Prof. dr.*		afdelingshoofd	
Vosjan J.H. *Dr.*		senior onderzoeker	
Bak R.P.M. *Prof. dr.*		senior onderzoeker	
Duineveld G.C. *Drs.*		onderzoeker	
Pauptit E.	24.0	assistent	
Kok A.		assistent	
Berghuis E.M.		assistent	
Nieuwland G.		assistent	
Noort G.J. van		assistent	
Gast G.J. *Drs.*		OIO NIOZ	m.i.v. 04-10
Hondeveld B.J.M. *Drs.*	34.2	OIO NIOZ (50% BEWON)	
Witbaard R. *Drs.*	32.0	OIO NIOZ	
Tahey T.M. *Drs.*		OIO EG	
Holtmann S.E. *Drs.*	34.0	onderzoeker (project-)	
Balen A.L.H.H. van		assistent (project-)	tot 01-02
Belgers J.J.M.		assistent (project-)	
Klein R.		assistent (project)	m.i.v. 05-05
Weele J.A. van der		assistent (project)	m.i.v. 01-10
AFDELING PELAGISCHE SYSTEMEN			
Fransz H.G. *Dr. ir.*		afdelingshoofd	
Baars M.A. *Dr.*		senior onderzoeker	
Klein Breteler W.C.M *Dr.*		senior onderzoeker	
Kuipers B.R. *Dr.*		onderzoeker	
Veldhuis M.J.W. *Dr.*		onderzoeker	
Hansen F.C. *Dr.*		post doc. NIOZ	
Wal P. van der *Dr.*		post doc. NWO	
Kraay G.W.		assistent	
Oosterhuis S.S.		assistent	
Gonzalez S.R.		assistent	
Witte H.J.		assistent	
Schogt N.		assistent	
Bleijswijk J.D.L. van *Drs.*		OIO NIOZ	
Stolte W. *Drs.*		OIO NIOZ (50% BEWON)	
Heemst J.D.H. van *Ir.*		OIO NWO/VVA	
Buitenhuis E.T. *Ir.*		OIO NWO/VVA	
Kempers E.S.		assistent (project-)	

AFDELING KUSTSYSTEMEN

Beukema J.J. *Dr.*		afdelingshoofd/hoofdredacteur	
Swennen C. *Dr.*		senior onderzoeker	
Fonds M. *Dr.*		senior onderzoeker	
Spaargaren D.H. *Dr.*		senior onderzoeker	
Cadée G.C. *Dr.*		senior onderzoeker	
Veer H.W. van der *Dr. ir.*		onderzoeker	
Piersma T.		onderzoeker	m.i.v. 01-12
Duiven P.		assistent	
Bruin W. de		assistent	
Puyl P. v.d.		assistent	
Hegeman J.		assistent	
Zuidewind J.		assistent	
Flach E. *Drs.*		OIO NIOZ	t/m 31-12
Bolle L. *Drs.*	34.2	OIO NIOZ (50% BEWON)	
Goeij P.J. de *Drs.*		OIO NIOZ	
Honkoop P.J.C. *Drs.*		OIO NOP	
Walker P.A. *Drs.*		OIO NAM	
Leopold M.F. *Drs.*	24.0	onderzoeker (project-)	t/m 31-12
Dekker R.*Drs.*	30.0	onderzoeker (project-)	
Postma T.A.C.		onderzoeker (project)	van 25-10 t/m 31-12
Weber A. *Drs.*		onderzoeker (project)	van 01-04 tot 01-10
Poot M.J.M *Drs.*	26.0	onderzoeker (project-)	tot 01-03
Kwast D.		assistent (project-)	
Verkuil Y.F. *Drs.*		assistent (project-)	m.i.v. 01-06

AFDELING CHEMISCHE OCEANOGRAFIE & ZEEVERONTREINIGING

Helder W. *Dr.*		afdelingshoofd	
Everaarts J.M. *Dr.*		senior onderzoeker	
Baar H.J.W. de *Prof. dr. ir.*	30.4	senior onderzoeker	
Booy K. *Dr.*		onderzoeker	
Brummer G.J.A. *Dr.*		post doc.	
Timmermans K.R. *Dr.*		post doc. NWO	
Hillebrand M.T.J.		assistent	
Nolting R.F.		assistent	
Ooyen J.L. van		assistent	
Kloosterhuis H.T.		assistent	
Bakker K.M.J.		assistent	
Koutrik A. van		assistent	
Weerlee E.M. van		assistent	
Sleiderink H.M. *Ir.*		OIO NIOZ (50% BEWON)	
Lohse L. *Drs.*		OIO NIOZ	
Leeuwe M.A. van *Drs.*	34.2	OIO NIOZ	
Epping H.G. *Drs.*	32.0	OIO NWO/BION	tot 01-10
Bakker D.C.E. *Ir.*		OIO NOP	
Wilde H.P.J. de *Ir.*		OIO NOP	
Stoll M. *Drs.*		OIO NWO/CO2	tot 15-06
Löscher B.M. *Drs.*		OIO NWO/AWON	
Wiebinga C.J. *Drs.*	30.4	OIO NWO/VVA	
Majoor A.A.J. *Drs.*		OIO NWO/VVA	
Hey H. de *Drs.*	30.4	onderzoeker (project-) NWO/VVA	m.i.v. 16-05
Jong J.T.M. de		assistent	
Fischer C.V. *Drs.*	28.0	assistent (project-)	
Jong E. de		assistent (project)	m.i.v. 01-10
Koning E.		assistent (project) NWO/VVA	m.i.v. 01-11
Kerkhoven F.A.		assistent (A&O-fonds)	tot15-05
Das J.H. den		assistent (project)	van 01-06 tot 01-08

AFDELING FYSISCHE OCEANOGRAFIE

Veth C. *Drs.*		afdelingshoofd	
Aken H.M. van *Dr.*		senior onderzoeker	
Otto L. *Dr.*		senior onderzoeker	
Zimmerman J.T.F. *Prof. dr.*	26.6	senior onderzoeker	
Maas L.R.M. *Dr.*		onderzoeker	
Munck de J.C. *Dr.*		post doc.	
Bruin T.F. de *Drs.*		onderzoeker BCRS	

Shimwell, S.J. *Drs.*		onderzoeker BCRS	m.i.v. 01-10
Wernand M.R.		assistent	
Manuels M.W.		assistent	
Ober S. *Ing.*		assistent	
Koster R.X. de		assistent	
Hiehle M.A.		assistent	
Toorn R. v.d. *Ir.*	32.0	OIO NIOZ	
Lam F.P.A. *Drs.*		OIO NIOZ	
Boer C. de *Drs.*		OIO NWO/MFO	
Gerkema Th. *Drs.*		OIO NWO/MFO	
Beerens S.P. *Drs.*		OIO NWO/MFO	

AFDELING MARIENE GEOLOGIE EN GEOCHEMIE

Eisma D. *Prof. dr.*		afdelingshoofd	
Jansen J.H.F. *Dr.*		senior onderzoeker	
Weering T.C.E. van *Dr.*		senior onderzoeker	
Bennekom A.J. van *Drs.*		onderzoeker	
Gaast S.J. v.d.		wet. assistent	
Kalf J.		assistent	
Iperen J. van	8.0	assistent	
Okkels E.	32.0	assistent	
Vaars A.J.		appl. technicus	
Ufkes E. *Drs.*		OIO NIOZ	
Gipp H.J.W. *Drs.*		OIO NIOZ	m.i.v. 01-04
Beks J.P. *Drs.*		OIO NIOZ	
Werff W. van der *Drs.*		OIO NIOZ/UvA	tot 15-12
Beusekom J.E.E. van *Dr.*		onderzoeker (project) NWO	van 01-03 tot 01-06
Witte A.	20.0	assistent (project-)	
Graaff J.W.M. de *Drs.*		erk.gewetensbezwaarde	tot 30-06

AFDELING MARIENE BIOGEOCHEMIE

Leeuw J.W. de *Dr.*		afdelingshoofd	
Sinninghe Damsté J.S. *Dr. ir.*		senior onderzoeker	
Pool W.G.		wet. assistent	
Rijpstra W.I.C.	19.0	assistent	
Baas M.		assistent	
Dekker M.H.A.	36.0	assistent	
Schouten S. *Ir.*		OIO NIOZ	
Hartgers W.A. *Drs.*		OIO NIOZ	
Koopmans M.P. *Drs.*		OIO NIOZ	
Kaam, H. van *Drs.*		OIO NIOZ	

AFDELING BEWON

Lindeboom H.J. *Dr.*		afdelingshoofd	
Bol-den Heijer A.C.	28.2	secretaresse	
Baretta J.W. *Drs.*		senior onderzoeker	buitengew.verlof ontslag 01-05
Berg A.J. van den *Drs.*		onderzoeker	tot 01-09; 01-10 19.0 u.p.w
Bergman M.J.N. *Ir.*		onderzoeker	
Boon J.P. *Dr.*		onderzoeker	
Daan R. *Dr.*		onderzoeker	
Duyl F.C. van *Dr.*		onderzoeker	
Raaphorst W. van *Dr. ir.*		onderzoeker	
Ridderinkhof H.J. *Dr.*		onderzoeker	
Riegman R. *Dr.*		onderzoeker	
Ruardij P. *Drs.*		onderzoeker	
Veer H.W. van der *Dr. ir.*		onderzoeker	
Kop A.J. *Ing.*		assistent	
Malschaert H. *Ing.*		assistent	
Mulder M.		assistent	
Lewis W.E.	28.0	assistent	
Noordeloos A.A.M.		assistent	
Embsen E.G.M. *Ing.*		techn.wet.progr. (EG)	
Smit J.P.C. *Ing.*		techn.wet.progr. (EG)	van 01-02 t/m 31-12
Brussaard C.P.D. *Drs.*		OIO EG	
Osinga R. *Drs.*		OIO NOP	
Slomp C.P. *Ir.*		OIO NOP	

Mensink B.P. *Ir.*		OIO VROM/DGW	
Sleiderink H.M. *Ir.*		OIO NIOZ (50%)	
Bolle L.J. *Drs.*		OIO NIOZ (50%)	
Stolte W. *Drs.*		OIO NIOZ (50%)	
Hondeveld B.J.M. *Drs.*		OIO NIOZ (50%)	
Santbrink J.W. van *Drs.*		onderzoeker (project)	van 01-06 tot 01-12
Moodley L. *Dr.*		onderzoeker (project)	tot 16-01
Leaper G. *Drs.*		onderzoeker (project)	van 22-01 tot 22-05
Hovenkamp F. *Dr.*		onderzoeker (project-)	tot 15-04
Camphuijzen C.J.		wet.assistent (project-)	
Hoek J. van der		assistent (project-)	20-01 tot 20-4
Gast G.J. *Drs.*	19.0	assistent (project)	van 08-02 tot 17-07
Klein R.		erk. gewetensbezwaarde	tot 05-05
Jong J.J.M. de		erk. gewetensbezwaarde	m.i.v. 05-04

WETENSCHAPPELIJKE HULPAFDELINGEN

CENTRUM VOOR INFORMATIEVERWERKING EN AUTOMATISERING

Dapper R.		automatiseringsdeskundige	
Eijgenraam F.		automatiseringsdeskundige	
Manshanden G.M.	30.4	automatiseringsdeskundige	
Meulen C. van der	16.0	assistent	van 01-04 tot 01-10

REPROGRAFISCHE AFDELING

Aggenbach R.P.D.		wnd. hoofd reprografie	
Verschuur B.	35.15	tekenaar	
Nichols R.C.		tekenaar	
Graaf A.C. de	30.0	reprografisch assistent	

REDAKTIE

Beukema J.J. *Dr.*		hoofd-redacteur	
Bak-Gade B.	19.0	redaktie-assistente	
Mulder-Starreveld J.P.	28.5	redaktie-assistente	
Barten-Krijgsman N.	34.2	redaktie-assistente	
Lindeboom-Pollen P.R.	7.6	assistent-redacteur	tot 01-07
Hobbelink H.		grafisch ontwerper	

BIBLIOTHEEK

Wal v.d.-Doornekamp J.	29.9	hoofd	t/m 31-12
Bruining-du Porto M.	33.25	bibliotheekassistent	
Hashemi Saleh S.H.	8.0	bibliotheekassistent	t/m 31-12
Lanser E.	35	bibliotheekassistent	van 19-10 tot 29-11

ALGEMENE DIENST

Nieuwenhuizen J.M.		hoofd	
Eliveld E.		medewerker	tot 08-07

RECEPTIE

Zonnenberg G.	35.15	telefoniste/receptioniste	
Zoetelief H.	8.0	telefoniste/receptioniste	
Kikkert A.	14.75	telefoniste/receptioniste	

KANTINE

Spigt H.		hoofd	
Jourdan M.T.		medewerkster	

LOGEERGEBOUW 'IN DEN POTVIS'

Steenhuizen G.H.		beheerder	
Borculo T.C. van	19.0	medewerkster Potvis	

AUDIOVISUELE AFDELING

Hart W.	24.0	medewerker	

FINANCIEEL ECONOMISCHE DIENST

Luursema C.W. *Drs.*	hoofd	m.i.v. 15-10
Bosch J.J.C.	hoofd	van 01-09 tot 03-10
Arkel M.A. van *drs.*	projectmanager	

ADMINISTRATIE

Wernand-Godee I.	hoofd	
Bruin D.J.	medewerker salarisadministratie	
Keijser A.	medewerker financiële administratie	
Spel M.M.	medewerker financiële administratie	
Porto S.W. de	medewerker inventarisatieadministratie	

CENTRAAL MAGAZIJN

Ran A.	hoofd	
Gieles S.J.M.	medewerker	

TECHNISCHE DIENSTEN

Bakker C.L.	hoofd	
Bonne E.	medewerkere (detachering)	m.i.v. 01-11

DIENST ZEETECHNIEK

Porto H.H. de	hoofd	
Schilling J.	plv.hoofd	
Bos E.B.M.	1e medewerker	
Wijsman M.A.	medewerker	
Nieuwpoort E.J.	medewerker	tot 09-08
Willems C.	medewerker	
Polman W.	medewerker	
Bakker M.G.	medewerker	
Blom J.J.	medewerker	
Persoon P.L.T.	medewerker	tot 01-04
Bakker J.A.	medewerker	van 19-07 tot 02-08

DIENST VAARTUIGEN & LOGISTIEK

Buisman T.C.J.	hoofd	
Zwieten C. van	med.naut.zaken	
Visser A.J.	chauffeur	
Gerssen C.	gezagvoerder Pelagia	
Souwer A.J.	1e stuurman Pelagia	
Groot J.C.	2e stuurman Pelagia	
Pieterse J.M.	hoofdwerktuigkundige Pelagia	
Seepma J.	1e werktuigkundige Pelagia	
Kalf J.J.	2e werktuigkundige Pelagia	
Koomen W.	scheepskok Pelagia	
Grisnich P.W.	scheepsgezel Pelagia	
Saalmink P.W.	scheepsgezel Pelagia	
Stevens C.T.	scheepsgezel Pelagia	
Star C. van der	schipper Navicula	m.i.v. 08-01
Anthonijsz R.J.R.	machinist Navicula	
Tuntelder J.C.	scheepsgezel/kok Navicula	
Adriaans E.J.	schipper Griend	
Jongejan W.P.	komvisser	

DIENST INSTRUMENTMAKEN

Boekel H.J.	hoofd	
Heerwaarden J. van	medewerker	
Keijzer E.J.H.	medewerker	
Kuiken N.	medewerker	m.i.v. 01-09

DIENST ELEKTRONIKA

Groenewegen R.L. *Ing.*	hoofd	
Koster B. *Ing.*	plv. hoofd	
Franken H. *Ing.*	hoger electronicus	
Laan M.	hoger electronicus	
Nieuwenhuis J.	middelbaar electronicus	
Derksen J.D.J.	electronicus Pelagia	

DIENST GEBOUWEN & INSTALLATIES

Schilling F.J.		hoofd	
Alkema P.R.		med. werktuigbouw	
Groot S.P.		med. werktuigbouw	
Kuip T.		med. werktuigbouw.	
Lakeman R.		med. werktuigbouw	
Heerschap L.	34.2	med. houtbewerking	
Daalder R.M.		med. houtbewerking	
Witte R.J.C.		med. houtbewerking	
Broudsema A.		med. energietechniek	m.i.v. 01-07

5.5. STAGIAIRES

Naam:	Periode:	Afd.:	Opl.inst.:
A. Mets	01/01/93 - 31/01/93	Benthische Sys.	IJmond College
R.J.M. Franken	25/01/93 - 26/05/93	Benthische Sys.	H.S.IJsseland
J.A. van Weele	01/02/93 - 15/06/93	Benthische Sys.	IAH Larenstein
J.G.A. van den Berg	01/01/93 - 01/09/93	Bewon	H.S.A'dam
J.P. Kraayenoord	01/01/93 - 24/04/93	Bewon	Omschol.Milieukunde
J. Kralt	01/01/93 - 24/04/93	Bewon	Omschol.Milieukunde
J.A.C. Vriezen	01/01/93 - 01/03/93	Bewon	IAH Larenstein
J.L.M. Wopereis	01/01/93 - 01/03/93	Bewon	IAH larenstein
J.D. Lont	01/02/93 - 24/05/93	Bewon	Noorderhaaks
J. Koldewijn	01/03/93 - 01/07/93	Bewon	H.S.Enschede
J.W. Klaas	01/03/93 - 01/07/93	Bewon	H.S.Enschede
J.L. Nauta	08/03/93 - 23/07/93	Bewon	Hog.Inform.Onderwijs
C.J.G. van Damme	01/08/93 - 31/12/93	Bewon	H.S.W-Brabant
B.J. Tijhuis	15/08/93 - 31/12/93	Bewon	Hog.Inform.Onderwijs
M.C.J. Schop	23/08/93 - 31/12/93	Bewon	H.S.Noorderhaaks
A.E.M. Slot	06/09/93 - 31/12/93	Bewon	H.S.Midden Ned.
J.H. den Das	01/01/93 - 31/05/93	Chem.Oceanogr.	H.S. Alkmaar
P. Zillen	01/01/93 - 01/02/93	Chem.Oceanogr.	H.S. Alkmaar
A. Buijs	01/01/93 - 01/06/93	Chem.Oceanogr.	H.S. Alkmaar
C.C. van denBerg	01/01/93 - 31/03/93	Chem.Oceanogr.	IJmond College
J. Oosthoek	25/01/93 - 01/07/93	Chem.Oceanogr.	H.S.IJsseland
I. Loonstra	01/09/93 - 31/12/93	Chem.Oceanogr.	IJmond College
T.J.P. Happee	01/09/93 - 31/12/93	Chem.Oceanogr.	H.S. Alkmaar
D.M. Zuurbier	01/09/93 - 31/12/93	Chem.Oceanogr.	H.S. Alkmaar
D.F. Broeren	26/04/93 - 16/07/93	Geologie	H.S.W-Brabant
J.F. Borsje	01/01/93 - 09/07/93	Kustsystemen	Van Hall Inst.
N.G. den Hollander	01/01/93 - 01/07/93	Kustsystemen	H.S.W-Brabant
J.D. van Gorsel	26/04/93 - 16/07/93	Kustsystemen	H.S.W-Brabant
C. Blauwboer	01/06/93 - 01/12/93	Kustsystemen	H.S.Amsterdam
E.B. Adema	01/06/93 - 01/10/93	Kustsystemen	HC. v. Hall Inst.
C.C. Tielemans	01/01/93 - 05/03/93	Energietechn.	MTS-Alkwaard
M. van Gerven	11/01/93 - 18/06/93	Energietechn.	MTS-Noorder Hooft
A. den Hollander	08/03/93 - 25/06/93	Gebouw.& Inst.	MTS-Alkwaard
D. Ypma	30/08/93 - 31/12/93	Gebouw.& Inst.	MTS-Alkwaard
E.G. Verschoor	01/01/93 - 15/01/93	Electronica	MTS-Alkwaard
C. Sieders	01/01/93 - 08/01/93	Electronica	MTS-Noorder Hooft
R.C. de Ridder	01/01/93 - 15/01/93	Electronica	H.S.Utrecht
A. Maasland	11/01/93 - 18/06/93	Electronica	MTS-Noorder Hooft
P. Groen	18/01/93 - 03/09/93	Electronica	MTS-Alkwaard
N. van Bruinisse	30/08/93 - 31/12/93	Electronica	MTS-Alkwaard
A. van der Gracht	30/08/93 - 31/12/94	Electronica	MTS-Noorder Hooft
T. Roeters	01/01/93 - 26/02/93	Instrumentenm.	MTS-Noorder Hooft
M.E. Koopmans	01/03/93 - 18/06/93	Instrumentenm.	MTS-Noorder Hooft
G.B. van Driel	01/01/93 - 15/06/93	Mar. Biogeochem.	HLO-Delft
R. van Malderen	01/01/93 - 31/12/93	Mar. Biogeochem.	H.S.Rotterdam
J. Jellema	06/09/93 - 31/12/93	Mar. Biogeochem.	HLO Leiderdorp
K. van der Meulen	01/01/93 - 31/01/93	Rekencentrum	H.S.Leeuwarden
P. van Liere	30/08/93 - 26/11/93	Zeetechniek	MTS-Noorderhooft
W. Noordzij	01/12/93 - 31/12/93	Zeetechniek	MTS-Noorderhooft

5.6. ARBEIDSVOORWAARDEN

Het beleid van de overheid richt zich op een verdergaande decentralisatie ten aanzien van de regelgeving van arbeidsvoorwaarden.

Vanaf 1 april 1993 vindt het overleg inzake de (primaire) arbeidsvoorwaarden van het overheidspersoneel en van het personeel werkzaam binnen de gesubsidieerde instellingen plaats binnen 8 sectoren. Dit heeft onder meer tot gevolg dat het resultaat van de loononderhandelingen per sector kunnen verschillen.

Voor de sector Onderwijs- en Onderzoekpersoneel, waaronder het personeel in dienst van het NIOZ ressorteert, heeft de minister van Onderwijs en Wetenschappen op 28 oktober 1993 met de centrales van overheidspersoneel een overeenstemming bereikt over onder andere de volgende arbeidsvoorwaarden.

- invoering van de Seniorenregeling Onderwijs Personeel (SOP-regeling);
- verhoging van de salarissen van het onderwijs- en onderzoekpersoneel per 1 oktober 1993.

De overeenkomst heeft een looptijd tot 1 april 1995.

Seniorenregeling Onderwijs Personeel

De SOP-regeling houdt kortweg in dat medewerkers vanaf 57 jaar in aanmerking kunnen komen voor een kortere werkweek tegen een beperkte vermindering van het salaris.

Vanuit een volledig betrekking kan er uit de volgende varianten worden gekozen.:

Variant 1

- vanaf 57 jaar wordt de feitelijke werktijd bij een volledige betrekking teruggebracht naar 32 uur tegen 95% salaris;
- vanaf 61 jaar wordt de feitelijke werktijd bij een volledige betrekking teruggebracht naar 24 uur tegen 90% salaris;

Variant 2

- vanaf 57 jaar wordt de feitelijke werktijd bij een volledige betrekking teruggebracht naar 24 uur tegen 75% salaris;
- vanaf 61 jaar wordt de feitelijke werktijd bij een volledige betrekking teruggebracht naar 20 uur tegen 75% salaris.

Variant 3

- vanaf 59 jaar wordt de feitelijke werktijd bij een volledige betrekking teruggebracht naar 24 uur tegen 90% salaris.

Ook bij degenen met een deeltijdbetrekking is deze regeling toepasbaar. De omvang van de vermindering wordt voor deze categorie naar rata berekend.

De aan het salaris gerelateerde aanspraken zoals bijvoorbeeld pensioenopbouw, ontslag- VUT- en vakantieuitkering, blijven onverminderd van kracht. Bij gebruikmaking van de SOP-regeling vervallen de zogenaamde leeftijdsvakantiedagen en ADV-dagen (verplichte ADV-dagen uitgezonderd)

Het aantal reguliere vakantiedagen wordt niet verminderd.

Het doel van de SOP-regeling is het bereiken van een meer passende arbeidssituatie voor werknemers van 57 jaar en ouder, waardoor het voor hen aantrekkelijker is om aan het arbeidsproces te blijven deelnemen. Met de regeling die is gericht op taakvermindering/taakverlichting van senioren, wordt mede beoogd de uitval wegens ziekteverzuim en arbeidsongeschiktheid zoveel mogelijk te vermijden. Voor hen die voor 1 april 1995 gebruik gaan maken van deze regeling, blijft deze van kracht tot het bereiken van de leeftijd waarop uittreding voor het eerst mogelijk wordt.

Algemene salarisverhoging

Per 1 oktober 1993 zijn de salarissen van het onderwijs- en onderzoekpersoneel met 2,1% verhoogd. Tevens zullen de salarissen per 1 januari 1995 met 0,5 % worden verhoogd. De verhogingen hebben een algemeen karakter: zij

werken zowel door in de uitkeringen als in de pensioenen.

Indien de sociaal- economische situatie, waaronder begrepen de ontwikkeling in de marktsector, op grond van nog af te sluiten contracten daar aanleiding toe geeft, zullen partijen in de loop van 1994 de onderhandelingen over de loonontwikkeling van het onderwijs- en onderzoekpersoneel heropenen.

5.7. FORMATIE-ONDERZOEK

In het eerste kwartaal is de herstructurering van de Technische Dienst afgerond. Het doel van deze herstructurering is gericht op het inzichterlijker maken van de taakstelling van deze dienst ter verbetering van de prioriteitstelling, planning en controle.

Alle medewerkers van deze dienst zijn in kennis gesteld van het bij de functie behorende schaalniveau. Een aantal medewerkers heeft gebruik gemaakt van de bezwaarprocedure functiewaardering. In 3 gevallen leidde dit tot behandeling in de Adviescommissie Personeelsaangelegenheden NWO

Teneinde een aantal facilitaire en serviceverlenende taken van het instituut beter op elkaar af te stemmen, is per 1 september de Algemene Dienst nieuw in de organisatiestructuur van het NIOZ opgenomen. Onder deze dienst ressorteren de Huishoudelijke Dienst, de Kantine, de Receptie en het Logeergebouw.

Een aantal administratieve afdelingen, te weten: de Administratie, de Dienst Goederenontvangst en Magazijn, het Inventarisbeheer en het Projectmanagement is ondergebracht bij de nieuw ingestelde Financieel Economische Dienst, waarvoor tevens een nieuw hoofd is aangesteld.

Vervolgens is een formatie-onderzoek ingesteld bij de wetenschappelijke- en de overige ondersteunende afdelingen. Er wordt naar gestreefd dit onderzoek medio 1994 af te ronden.

5.8. ARBEIDSOMSTANDIGHEDEN

Arbeidsmarkt- en Opleidingsfonds (A&O-fonds)

Door de overheid zijn in 1993 middelen beschikbaar gesteld ter initiëring van maatregelen op het gebied van scholing en arbeidsomstandigheden.

Een deel van deze middelen is besteed aan scholing/training van OR-leden.

Een bedrag is gereserveerd voor nog te realiseren management-trainingen waarover inmiddels informatie is ingewonnen.

Tevens is vanuit deze subsidie een regeling voor telewerken gefinancierd ten behoeve van een situationeel arbeidsongeschikte medewerker.

Gewerkt wordt aan het vervaardigen van een instructiefilm over het veilig werken aan boord van schepen. Er is een systeem ontwikkeld ten behoeve van een adequate ziekteverzuimregistratie.

Bedrijfsgezondheidszorg

Met een aantal ARBO-diensten zijn besprekingen gevoerd in het kader van het optimaliseren van de Bedrijfsgezondheidszorg. Dit heeft geleid tot het sluiten van een overeenkomst met de Gewestelijke Gezondheidsdienst "Kop van Noord-Holland" te Den Helder. Het gesloten contract is afgestemd op het relatief lage ziekteverzuimpercentage bij het NIOZ.

Ziekteverzuim

Het totale ziekteverzuim ten opzichte van 1992 is nagenoeg gelijk gebleven, te weten 4,01% (1992: 4%). Ook het verzuim bij het wetenschappelijk en niet wetenschappelijk personeel is nauwelijks veranderd (w.p.: 2,03% tegen 1,9% in 1992; n.w.p.: 5,11% tegen 5,25% in 1992).

Het valt op dat het ziekteverzuim bij het wetenschappelijk personeel in de leeftijdsklasse 25-35 jaar iets hoger is dan bij de andere leeftijdsklassen in

deze categorie. Dit betreft voornamelijk oio's en postdocs. Bij het niet wetenschappelijk personeel is het ziekteverzuim het hoogst bij de categorie personeel die is ingedeeld in de salarisschalen 1 tot en met 5. Opgemerkt dient te worden dat de verzuimpercentages enigszins nadelig worden beïnvloed door enkele langdurig zieke personeelsleden.

5.9. OVERLEG

Collectieve arbeidsvoorwaardenregeling

Op 24 juni 1993 is op het NIOZ door de centrales van overheidspersoneel en door de werkgevers NWO, FOM, SMC en NIOZ de Collectieve Arbeidsvoorwaardenregeling (CAR) ondertekend. Deze is op 1 september 1993 in werking getreden en heeft een looptijd van 3 jaar.

Aan alle medewerkers is een exemplaar van deze regeling uitgereikt.

Ter nadere uitwerking en detaillering van de in de CAR opgenomen arbeidsvoorwaarden dienen er per afzonderlijke werkgever en in overleg met het lokale medezeggenschapsorgaan "Uitvoeringsregelingen" te worden opgesteld. Hiermee is in het laatste kwartaal een aanvang gemaakt.

Door een ingestelde werkgroep is reeds een aantal regelingen in concept opgesteld. Deze concept-regelingen zullen aan de Directie worden voorgelegd ter bespreking met de Ondernemingsraad. Tevens is er een begin gemaakt met de NIOZ-overwerkregeling, dit met betrekking tot zeegaande expedities, die apart deel uitmaakt van de CAR.

De belangrijkste wijzigingen op het gebied van de arbeidsvoorwaarden die in de CAR zijn opgenomen, worden hieronder genoemd.

- bij de tegemoetkoming in de reiskosten voor het woon-werkverkeer is de vergoeding voor het reizen per openbaar vervoer hoger dan wanneer er van de auto gebruik wordt gemaakt;
- de algehele verhuisplicht is afgeschaft; medewerkers met een dienstverband van meer dan 2 jaar die binnen een straal van 30 kilometer van de standplaats komen te wonen, komen in aanmerking voor een tegemoetkoming in de verhuiskosten; verhuist de werknemer binnen 2 jaar vóór beëindiging van het dienstverband, dan vervalt de vergoeding en geldt een terugbetalingsregeling;
- het aantal basisvakantiedagen is verhoogd van 23 naar 24; de "salarisdag" is afgeschaft en het aantal leeftijdsvakantiedagen is verminderd; vakantieaanspraken verjaren na verloop van twee jaar;
- bij buitengewoon verlof is een regeling m.b.t. verzorgings-/calamiteitenverlof opgenomen; ook is een verlofregeling voor wetenschappelijke en/of studiedoeleinden expliciet in de CAR opgenomen;
- in de bestaande ouderschapsverlofregeling is een terugbetalingsregeling geïntroduceerd indien de werknemer binnen 1 jaar na beëindiging van het ouderschapsverlof ontslag neemt of wordt ontslagen zonder recht op uitkering;
- de bestaande regeling kinderopvang is aangepast; het NIOZ heeft één kindplaats gekocht, waardoor een aantal dagdelen ter beschikking is gekomen.

Georganiseerd Overleg

Aan het GONWO (Georganiseerd Overleg NWO) nemen deel de centrales van overheidspersoneel ABVA/KABO, AC, CFO, CMHF en de werkgevers NWO, FOM, SMC en NIOZ. In het GONWO wordt overleg gevoerd over algemene (personele) aangelegenheden ten behoeve van het personeel dat in dienst is van voornoemde werkgevers.

Overleg OR - Directie

Het overleg tussen de OR en de directie heeft dit jaar geregeld en op constructieve wijze plaatsgevonden. Onderwerpen van overleg waren onder andere de afloop van de financieringsperiode BEWON, de Bedrijfsgezondheidszorg, de bezwarenprocedures rond de formatievaststelling van de Technische Dienst, het formatie-onderzoek en de instelling van de Financieel Economische Dienst en de Algemene Dienst en de herstructurering van het zeeonderzoek binnen NWO en de integratie van de uitvoerende taken ten behoeve van het door NWO gefinancierde zeegaande onderzoek.

5.10. VERSLAG VAN DE PERSONEELVERENIGING

Het traditionele pannekoekenfeest werd gehouden op vrijdag 26 maart. Tijdens dit feest werden in de colloqiumzaal de kinderen (en zeker ook de ouders) vermaakt door "Het afgestofte poppentheater" van Ila van der Pouw met de voorstelling " circus Doemaraki".

Dit jaar werd er een alternatieve sportdag georganiseerd op 9 september. Swier Oosterhuis en Piet Keizer hadden aangeboden om een puzzeltocht over het eiland te organiseren. Door hun ervaring als organisatoren van de WAMPEX en hun vindingrijkheid slaagden zij erin een zeer orginele tocht in elkaar te zetten. Op diverse typisch Texelse locaties waren posten uitgezet waar de deelnemers opdrachten moesten uitvoeren. Zo kon het gebeuren dat men, al lopend door de duinen op zoek naar diverse attributen, opeens een telefoon hoorde rinkelen: de nieuwe opdracht werd per veldtelefoon doorgegeven. Of dat men, fietsend over het Schillepaadje, een visser zag zitten die al heel wat gevangen had uit de Schilsloot, zoals een haring en een haai. De vangst van de visser moest benoemd worden, een opdracht waarbij vele biologen door de mand vielen. De lunch werd gebruikt in een schuur van de fam. Witte van Wezenspyk. Aan het eind van de tocht wachtte de prijsuitreiking en een barbecue op de speelweide. Winnaar werd Zeetechniek en eervol laatste, zoals gebruikelijk, de Administratie.

Op 3 december trad de cabaretier Mark van de Veerdonk op met het programma "De schaduw van een pygmee". Van de Veerdonk, winnaar van het Leids Cabaretfestival van 1991, oogstte veel bewondering doordat hij vele gebeurtenissen die zich af hebben gespeeld op het NIOZ vloeiend in zijn programma wist te verwerken.

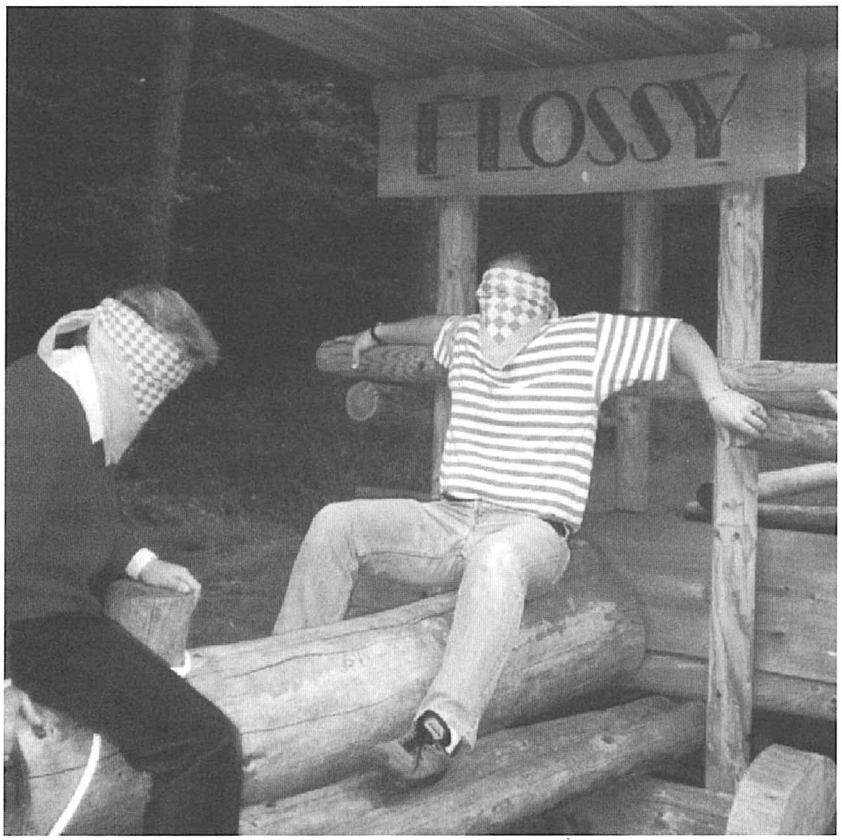


Photo: M.R. Wernand

De afdeling reprografie op een van de hindernissen van de sportdag.