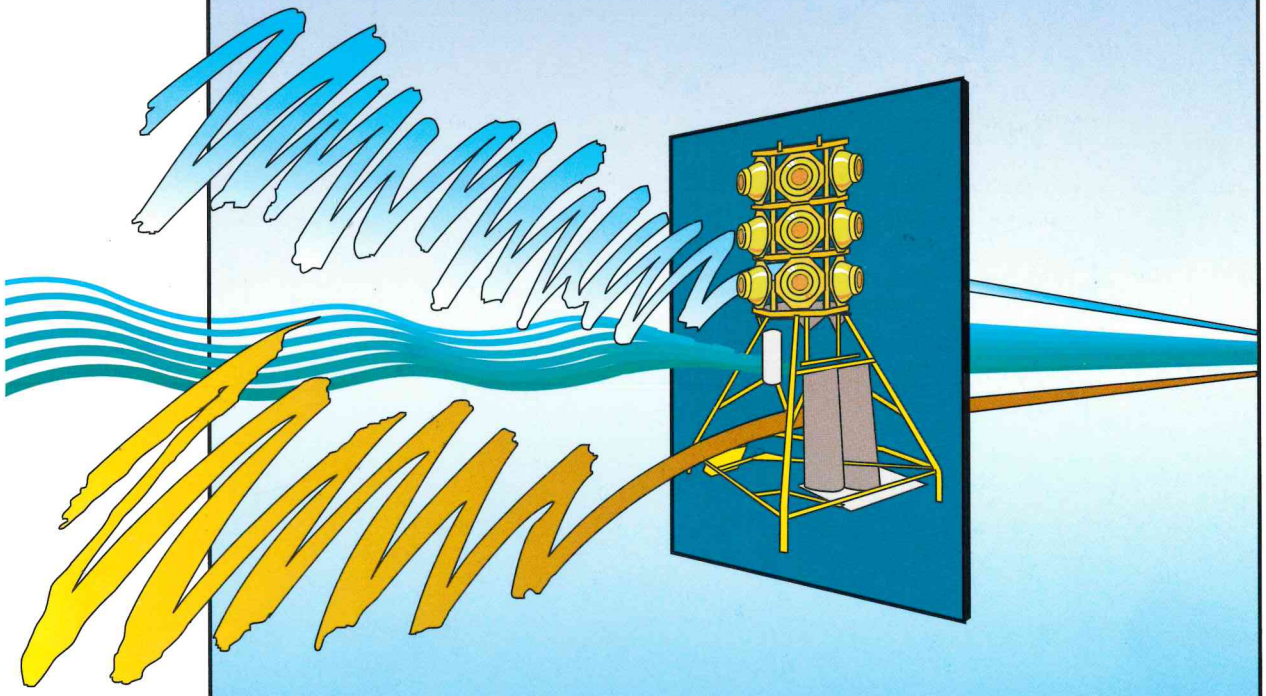
ANNUAL Report 1997



NETHERLANDS INSTITUTE FOR SEA RESEARCH (NIOZ)

NETHERLANDS INSTITUTE FOR SEA RESEARCH
ANNUAL REPORT 1997

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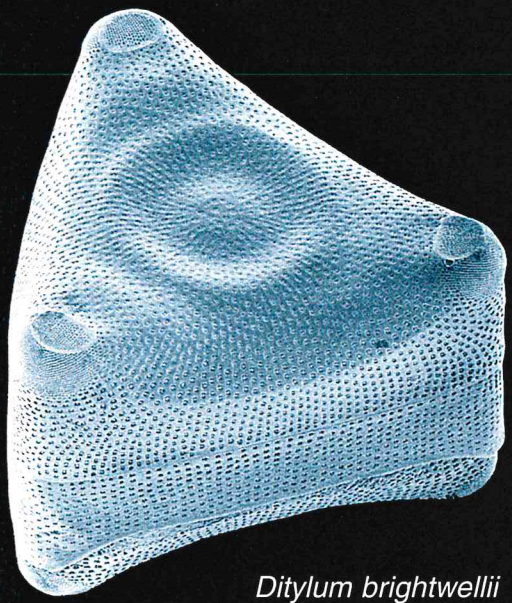

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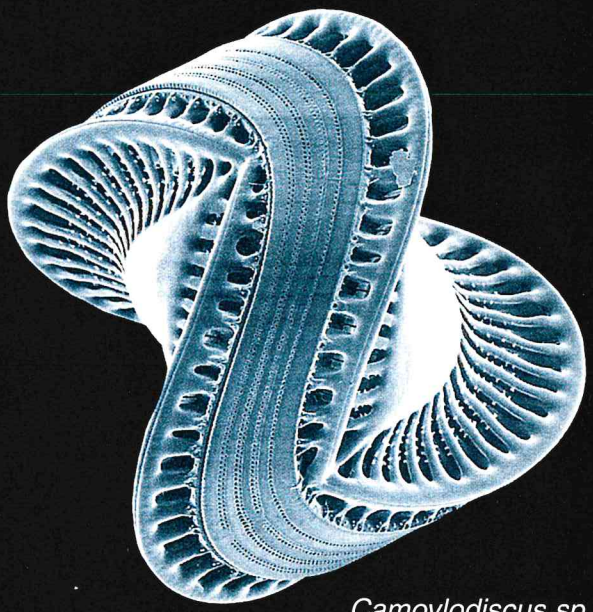

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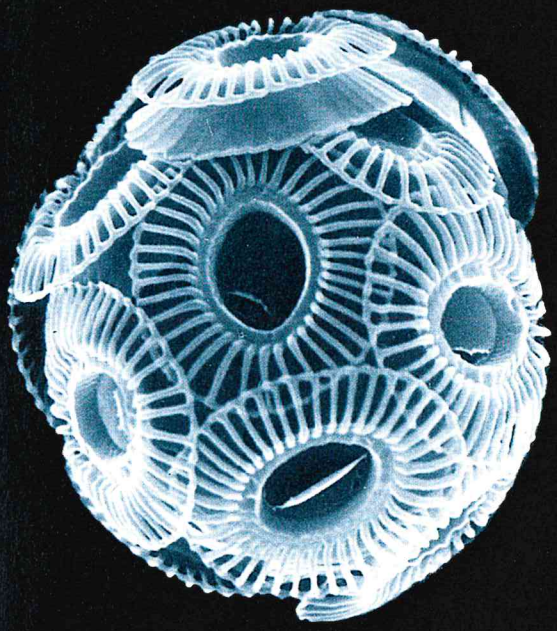

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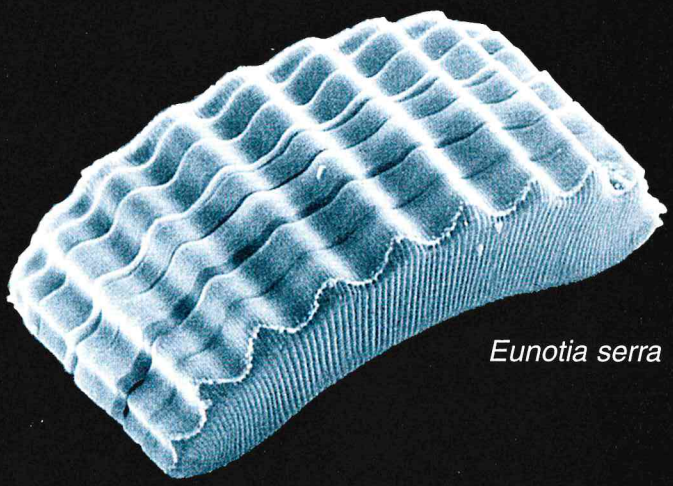

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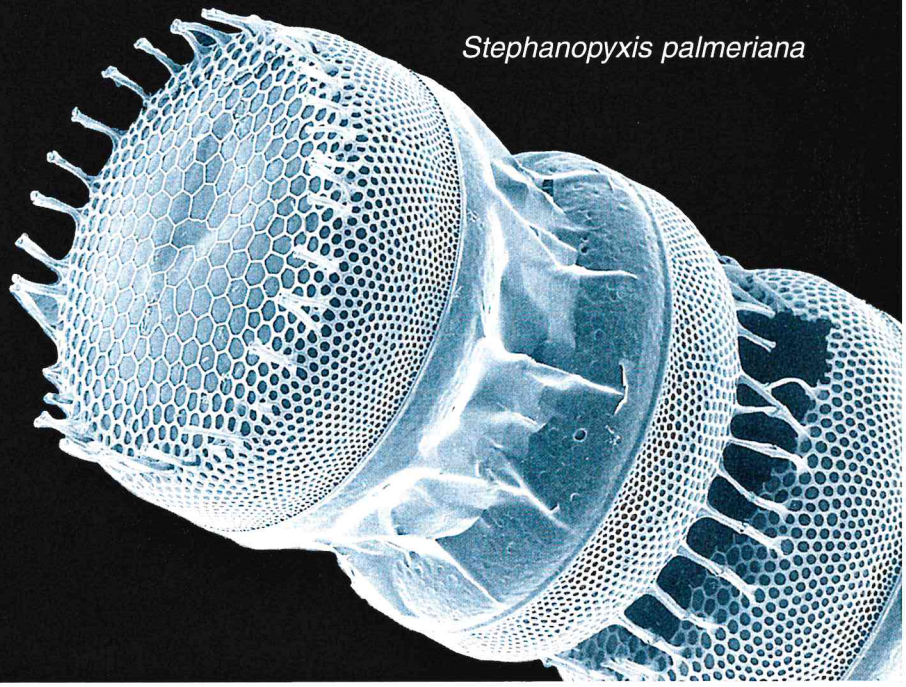


The photographs are (reproducced) by courtesy of the Japanese Society of Phycology

CONTENTS

The year 1997 can be considered as a relatively quiet year, when compared with the turbulent year 1996. The many scientific, managerial, financial and socio-economic changes triggered by the second phase of the reorganisation have been implemented fully, providing a new and hopefully better embedding of the marine sciences in the years to come.

In 1997 ten PhD students defended their theses succesfully and one of them, Ramses van der Toorn, received his degree cum laude.

On May 23 the experimental waderbird facility was officially opened by Koen Verhoeff, chair of the NIOZ board, after a mini symposium attended by many visitors also from outside NIOZ. Another date to mention is October 6. Aboard the RV Polarstern at Bremerhaven the science ministers of Germany, Land Bremen and the Netherlands officially signed a contract of co-operation between NIOZ and four research institutions at Bremen and Bremerhaven (AWI, MPI, ZMT and GeoB). The five partners will co-operate on a number of research topics, i.e. climate history, the ocean carbon cycle, coastal and continental margin processes and advanced technology and methodology, a.o. through the efforts of 21 PhD students and 5-year post-docs, supervised by the permanent staff of the participating institutes. Furthermore, within the context of this co-operation called NEBROC: Netherlands Bremen Oceanography, a Graduate School for Marine Sciences will be founded.

Two new department heads were appointed. Gerhard Herndl moved from Vienna to Texel to become head of the department of Biological Oceanography. Through his appointment the microbial ecology and the application of molecular biological techniques and methodologies will be enforced significantly. In August Jan Boon, a permanent staff member of NIOZ, became the head of the department of Marine Biogeochemistry and Toxicology. This department is entering a new phase, because the very succesful PIONIER project of Jaap Sinninghe Damsté emphasizing on the role of sulphur in the carbon cycle and on palaeo-environmental reconstructions, ended December 31.

Han Lindeboom, head of the department of Marine Ecology, was appointed chair of the international Scientific Steering Committee of LOICZ. Partly due to this time consuming appointment it was decided to create three working groups within our largest department, focussing on long-term variations, intertidal population ecology and shelf benthic ecology headed by Han Lindeboom, Jaap van der Meer and Rolf Bak, respectively.

No major changes occurred in the two other departments, Physical Oceanography and Marine Chemistry and Geology.

In May Rob Haas was appointed as controller and manager of the non-scientific departments. Through his appointment financial affairs and the management of the technical and supporting departments are improving considerably already. From a financial/economic point of view 1997 was a remarkable year. From the budget set for 1997 it was clear that very substantial additional funding was required to realize the budget. Thanks to the creativity and efforts of many scientists, technicians and members of the technical and supporting departments such additional funds were obtained. Apart from that a large income was realized through renting of our research vessel Pelagia. Thanks to major and excellent efforts of our crew and the shore officers the renting activities were very successful, economically and otherwise.

At the end of the year it was decided that the international project office of LOICZ (IPO-LOICZ) will be financed for the next five years and that it will stay at NIOZ on Texel. A new executive officer to run the office will be appointed in February 1998. It was also decided that a liaison officer tying up activities of the LOICZ office and the office of Coastal Zone Management located at RIKZ at the Hague will be appointed in 1998.

I should like to end this introduction by mentioning that the Netherlands Organisation for Scientific Research (NWO) has decided that our institute will remain located on Texel, at least for the next 20 years. This decision had to be made explicitly before NWO could make available substantial funds to NIOZ to renovate the large-scale experiments building ('aquarium') and our guesthouse ('In den Potvis'), and to extend the institute with a building of ca. 1000 m^2. These renovation and building activities will start in 1998 and will last till 2000. Hence, NIOZ is preparing itself for the new millenium.

Jan W. de Leeuw
Director

1. Scientific Activity

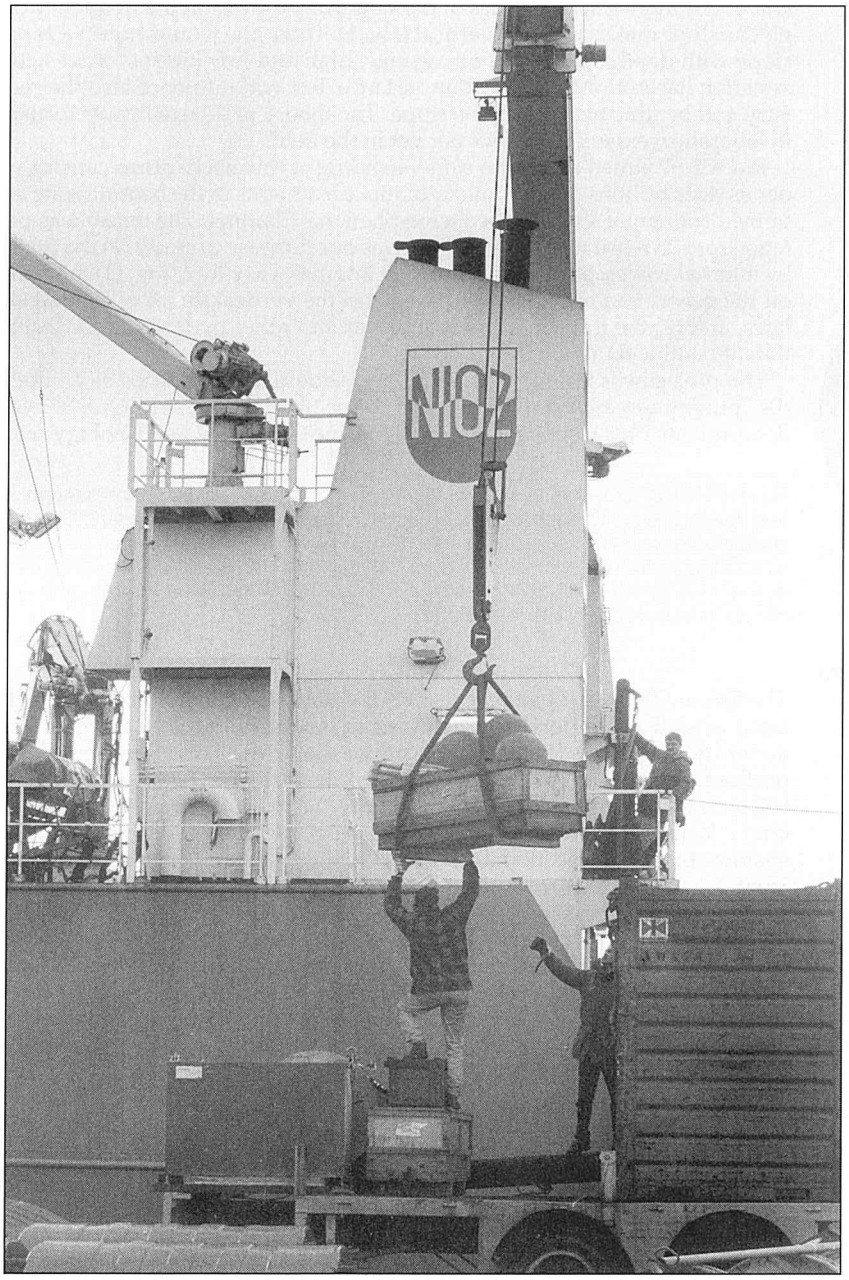


Photo: Sjoerd van Delden

MULTIDISCIPLINARY PROGRAMMES

PROCS '97: PROCESSES ON THE CONTINENTAL SLOPE. A MULTIDISCIPLINARY RESEARCH CRUISE IN THE FÆROE-SHETLAND CHANNEL

contributors: *W. Van Raaphorst, J.J.M. Van Haren, H.J. Ridderinkhof, R. Daan, G.-J.A. Brummer, C. Veth, M.W. Manuels, J.F.P. Malschaert, J.C. Van Ooyen, E.M. Van Weerlee, M. Mulder, R. De Koster, R.L. Groenewegen, M.C. Bakker, L. Boom* and the crew of the 'Pelagia'

The project

Mixing processes in the interior of the world's oceans are still not well understood. Modelling studies almost all point at vertical mixing rates which are about ten times higher than actually observed in the open ocean. This discrepancy has led to the idea that strongly enhanced mixing should occur near the boundaries of the ocean basins, i.e. the continental slopes and shelf edges, and that this mixing may be so intense that it influences the oceans as a whole. One of the candidate mechanisms causing enhanced mixing is the occurrence of internal waves which may either come in from the interior of the ocean and impinge and reflect on the slopes, or be generated on the slopes. Recently, a theory was developed at NIOZ which predicts the focusing of internal wave reflection at specific sites of the slope, depending on the frequency of the waves and the angle the slope makes with the vertical (Fig. 1). Thus, one would expect a zonation on the continental slope with depth areas with, on average, high and low internal wave activity, respectively. Such zonation has not only physical importance, but will influence also the sedimentology, geochemistry and benthic biology on the slope. The theory of internal wave focusing has been confirmed in laboratory experiments, but not yet in the field.

PROCS'97 aimed at a better understanding of the mechanisms causing enhanced, yet heterogeneous distributions of biotic and a-biotic constituents in the benthic zone and lower water column of the continental slope of the Færoe-Shetland Channel. The cruise was performed with R/V Pelagia from 28 April to 19 May 1997. It was our purpose to study (1) the mixing of the water column by internal waves, particularly through internal wave focusing, (2) the influence of internal waves on the generation of nepheloid layers and the vertical fluxes of lithogenic and biogenic particulates, and (3) the impact of internal waves and other hydrodynamic features on the depth zonation of benthic fauna on the slope.

The project was financed by NIOZ and should be considered as a pilot study for future multidisciplinary research activities in the Færoe-Shetland area. PROCS'97 was a joint activity of the departments Physical Oceanography, Marine Chemistry and Geology, and Marine Ecology.

Fig. 1. PROCS '97 aimed at studying the impact of internal waves on the generation of turbulence and nepheloid layers at specific depth zones across the slope of the Færoe - Shetland Channel. One of the mechanisms could be the geometric focusing of internal waves on the slope. The logo shows the study area and a schematized impression of the results of laboratory experiments dealing with internal wave focusing. The white solid lines indicate the wall and bottom of a basin, the white spots the ray path of the focused wave where enhanced turbulence is to be expected.

The Færoe-Shetland area

The Færoe-Shetland Channel connects the Rockall Trough and the Iceland Basin in the North Atlantic as well as the Hebrides Shelf west of Ireland with the Norwegian Basin. The channel is bordered by the Færoe Shelf in the northwest and the West Shetland Shelf in the southeast. The northern entrance is 1500-2000 m deep, while the southwestern connections have depths of about 850 m in the Færoe Bank Channel and only 450 m across the Wyville-Thomson Ridge (Fig. 2). The cruise focused on the West Shetland Slope between the West Shetland Shelf and the axis of the channel, but some additional studies were made on the opposing slope of the southeastern Færoe Shelf.

A complex hydrography exists in the Færoe-Shetland Channel in which five water masses may be recognized, all taking part in the global conveyor belt system. The surface waters consist of two branches of the North Atlantic Current, of which the largest flows along the West Shetland Shelf into the Norwegian Basin, and the other is confined to the western and central parts of the channel. Below the surface three water masses come in from the cold Norwegian Basin and drain to the Iceland Basin in the west, of which the Norwegian Sea Arctic Intermediate Water and the Færoe-Shetland Channel Bottom Water are the most important.

The bottom of the study area consists of coarse, partly draped sands on the shelf and near the shelf break, gravel and stones on top of a finer sediment layer on the upper slope, and a 5-10 cm thick layer of gravely mud overlying a layer of silty clay at depths larger than about 650 m. The benthic fauna is dominated by tube building worms, a large variety of echinoderms, sea spiders and brachiopods. Further, every piece of stone and gravel on top of the sediment is over grown by a wealth of sponges, bryozoans, and hydroid polyps.

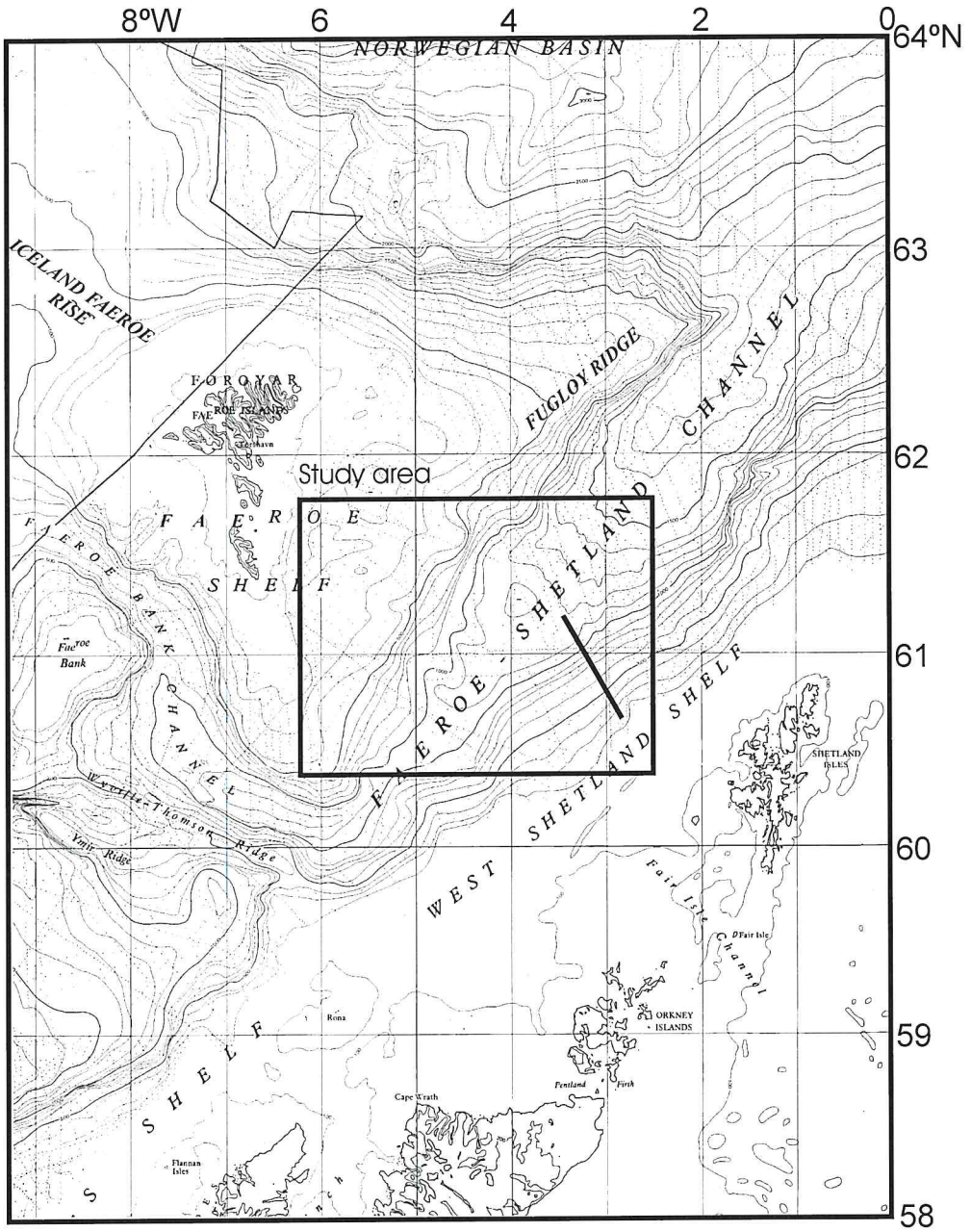


Fig. 2. Study area of PROCS '97 in the Færoe - Shetland Channel area. The solid line in the box shows our main section across the slope between the West Shetland Shelf and the Channel where all moorings were deployed. Additional sections were occupied at the opposing slope and parallel to the indicated section.

Equipments and techniques

The materials applied during the cruise were (1) an extensive CTD, equipped with transmissometer and fluorometer, and Rosette sampler, (2) 3.5 kHz and Chirp penetrating echosounders for examination of the sea floor, (3) a SIMRAD EK500 38 kHz echosounder for examination of the water column, (4) boxcorers and a multicorer for sampling the surficial sediments, (5) a deep-sea Agassiz trawl equipped with a video camera to survey the benthic fauna, and (6) four moorings holding current meters, a fast thermistor string, ADCPs and near bottom sediment traps. In total we occupied 6 hydrographic sections across the slopes of the channel. All moorings were deployed at different depths on the same section where also most of the bottom samples were collected.

First Results

As data processing and some part of the analysis of the samples is still in progress, no conclusive results are presented here. What follows below are some striking first results and impressions obtained during the cruise.

Water column characteristics

The CTD sections confirmed the known water mass distribution (see above). At the West Shetland Slope a front was visible at about 300 m depth, marking the western boundary of the main branch of the North Atlantic Current which flows along the shelf break (Fig. 3). A little deeper (400-600 m) on the same slope different water masses converge, thus giving rise to a layer of strong vertical gradients in, e.g., potential temperature and salinity which extends slightly upwards from the slope to the interior of the channel. At the point of convergence some upwelling of deeper water with elevated nutrient concentrations was observed. Probably the most striking feature in the water column was the presence of a broad layer with high acoustic reflection as detected by the 38 kHz SIMRAD echosounder, also at a depth between 400-600 m and extending across the entire channel, though crawling upwards when approaching the slope (Fig. 4). Closer inspection showed that this layer consisted of several sub-layers above each other, of which the lower one was the most intense and the only one which completely bridged the channel. The layer was displaced vertically in the order of 100-200 m during the day and shows waves and distinct irregularities, particularly on the upper side near the point where it meets the slope. Similar observations, although with less detail, were made recently by other institutes, which seems to indicate that the, what we called 'SIMRAD layer', is a persistent phenomenon in the Færoe-Shetland Channel. So far we have no clear explanation for the 'SIMRAD layer', but it is hypothesized that it is either caused by peculiarities in the vertical density profile, or by the acoustic reflection of euphausids, zooplankton or marine snow accumulating at distinct depths in the water column.

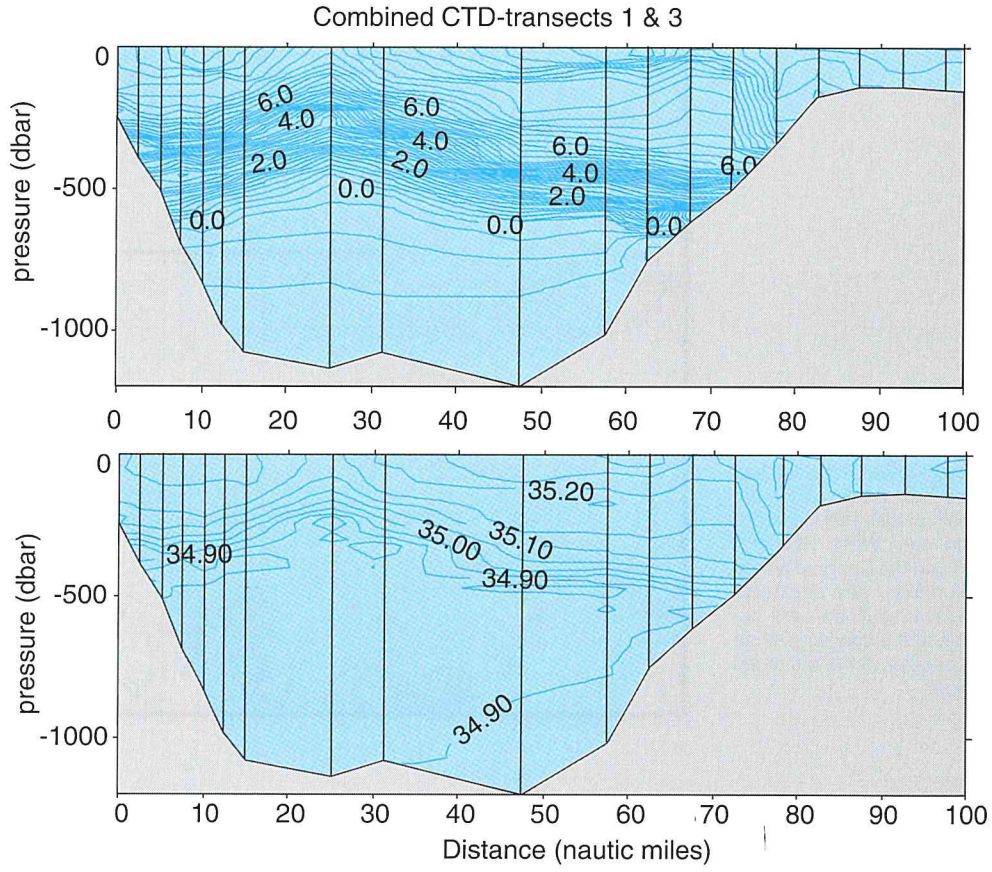


Fig. 3. Potential temperature (a; in °C) and salinity (b; in psu) in the Færoe - Shetland Channel. The West Shetland Shelf is to the right in this figure, the Faeroe Shelf to the left. The contour lines indicate the presence of a front at about 300 m depth below the West Shetland Shelf break, and further point at sharp gradients across the whole channel between 300 and 600 m depth.

Benthic fauna

The Agassiz deep-water trawl, equipped with a video camera, was lowered several times to the seabed, at depths between 450 and 1100 m. However, it was not possible to collect the epibenthic fauna from the seabed because the net did not stand the large amount of stones and was disrupted when it was hauled even for a few minutes over the seabed. The video recordings, however, gave a fine impression of how the seabed looked like. Smaller and larger stones appeared to occur everywhere, but were most numerous at depths between ~500 and 600 m. On these stones a variety of suspension feeders was observed including sea anemones, gorgonaceans, crinoids, sea cucumbers, beautiful ophiuroids and sea urchins. Between the stones lived soft sediment dwellers like starfish, whelks and often dense populations of tube-building worms. Generally, the fauna was richest in areas where stones were most numerous. Deeper down the slope, stones were covered by a thin layer of muddy sediment and megabenthos was less abundant.

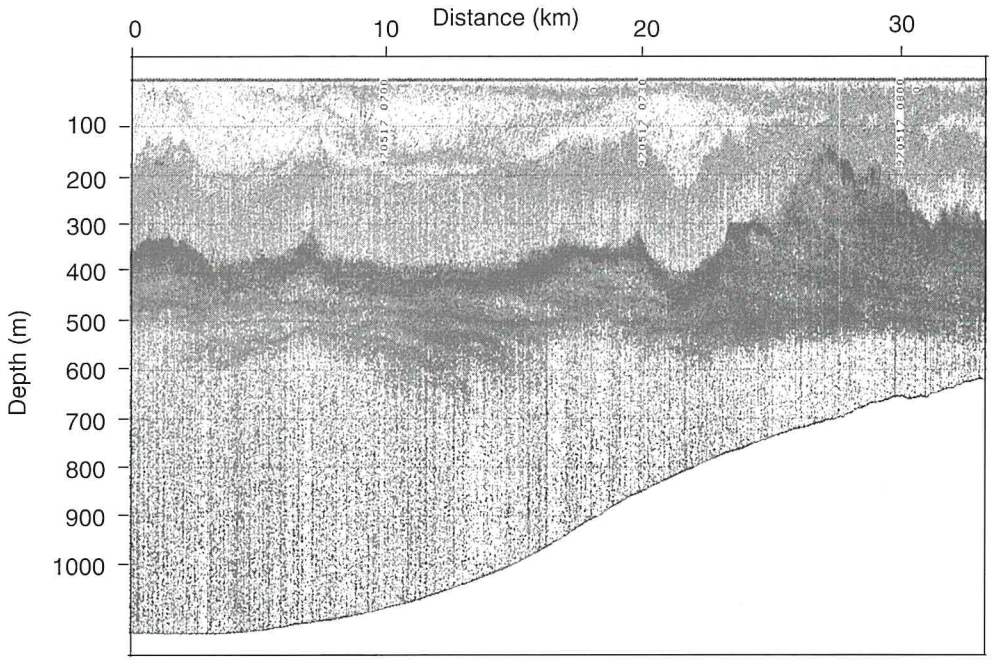


Fig. 4. Results obtained with the SIMRAD 38 kHz echo-sounder indicating a distinct band of enhanced acoustic reflection at 400-600 m depth in the Færoe - Shetland Channel.

Boxcore samples were collected at depths between 200 and 1250 m. The fauna was quite rich but the occurrence of living benthos was limited to a very thin top layer of the sediment. Tube building worms, brittle stars, amphipods and isopods, sea spiders and brachiopods were frequently observed. The lower part of the slope (below 750 m) was less rich. Although hardly seen on board during sieving of the sediment cores, a large diversity of small molluscs appeared to occur in the samples. Identification in the laboratory under the microscope yielded 75 different species, of which 36 were collected alive. The species richness was highest high up the slope (200-500 m) and lowest at the base (700-1250 m). A zonation in frequency of occurrence across the slope: arc shells and scallops were particularly abundant at shallow depths, whereas nut shells and buccinids where found especially deeper than 500 m. Identification of other taxonomic groups is still in progress.

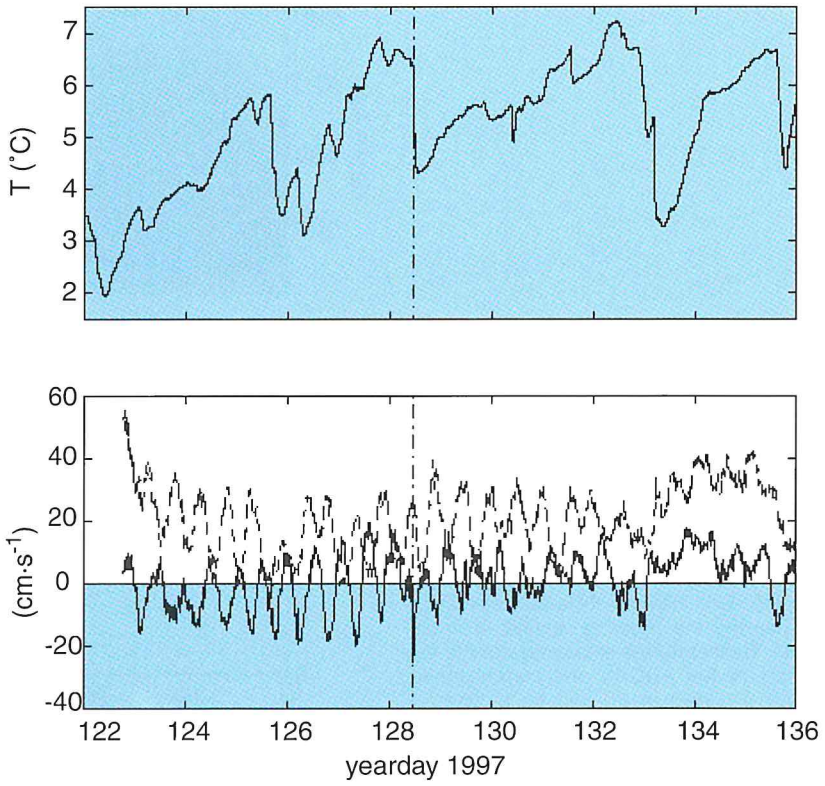


Fig. 5. Time series of temperature (a; in °C) measured at 1 m from the bottom and along- (dashed lines) and cross-slope (solid lines) currents (b) measured at 11 m from the bottom by ADCP at 500 m water depth.

Mooring data

Two moorings were deployed approximately at the position where the "SIMRAD" layer reached the bottom, at a waterdepth of ~500 m. One of these moorings consisted of two sediment traps and two current meters at 8 and 34 m above the bottom. The other one was located only a few 100 m away horizontally and consisted of a bottom lander holding two broadband ADCPs, the first (1.2 MHz) looking downward to sample the near bottom layer and the second (600 kHz) looking upward to sample between 4 and ~45 m from the bottom, and two thermistor-strings with a total length of 50 m and temperature sensors at every m. At a 600 m deep station, a 75 kHz upward looking ADCP, moored at 50 m above the bottom, sampled the water column in bins of 4 m over a range of 280 m, thus including the SIMRAD layer. At a station of 700 m depth on the slope, a sediment trap mooring similar to the one at 500 m depth was deployed.

From the CTD and echo sounder surveys it became clear that the local bottom slope was near-critical for internal tidal waves, to within the limits of accuracy. Despite the large "residual" currents up to 10-25 cm s^{-1} a few m from the bottom at the 500 m station, tidal currents dominated temporal fluctuations, and were highly variable in magnitude and phase across the slope. Temperature, however, was not dominated by variations at tidal frequencies, albeit the change of temperature with time may be related to the tides occasionally. Instead, near bottom temperature varied strongly at the larger time scale of several days (Fig. 5), which can be explained only by

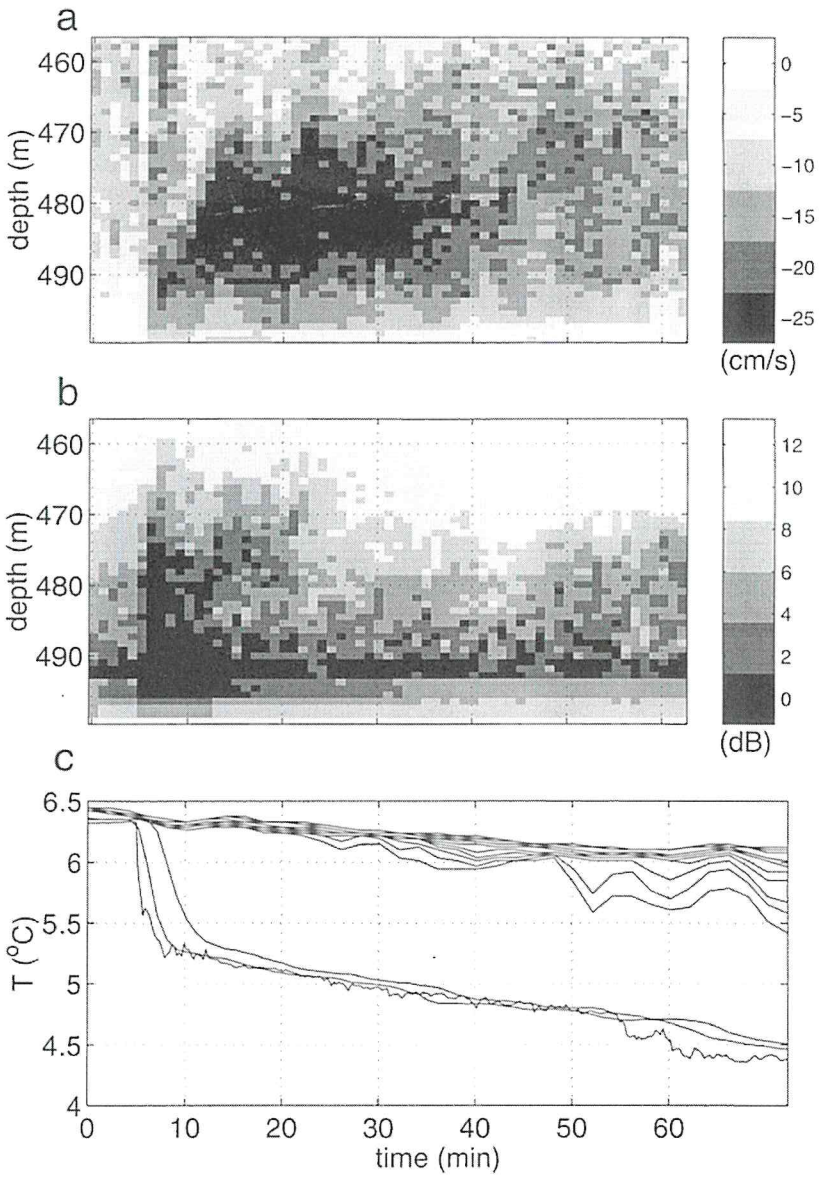


Fig. 6. Example of a short time burst of current (a), echo intensity (b) and temperature (c) passing the mooring at 500 m water depth. Temperature is measured close to the bottom by the ADCP's and current meter (lower 3 curves in c), and by a thermistorstring located between 35-55 m from the bottom (upper lines in c).

assuming that water is moved up and down the slope over 100-200 m vertical distances. This was confirmed by the CTD surveys, which showed that, near the bottom, dense water was moved up the slope between the 500 and 300 m isobaths, and it corroborates also with the 'up-crawl' of the SIMRAD layer at this depth on the slope. The up-slope movement was rapid, as in a breaking wave, with near bottom temperatures falling by 1-1.5 °C within a few minutes only, while cross-slope currents increased from about 0-30 cm s^{-1} and echo intensity, a measure of suspended matter content, rising accordingly (Fig. 6). The importance of these short-lasting "benthic storms" for sediment transport and, their possible association with variations in the internal wave, is under investigation. Hereto, a coupling will be made with the data collected with the upward looking 75 kHz ADCP deeper on the slope, and with the data collected with the two sediment trap moorings.

Nepheloid layers

It was our hypothesis that nepheloid layers would be generated at those sites where internal waves meet the slope of the channel. Suspended particle concentrations were measured in water samples collected with Niskin bottles after dittering 2l filtration and weighing the mass retained on the filters. The weighing procedure was optimized to measure low quantities with sufficient accuracy. Notably, all weighing procedures were done under constant relative humidity (30%) to avoid errors due to variability in the water content of the filters and residues. Across sections 1 (the same as shown in Fig. 3) and 2 (where the moorings were deployed) enhanced particle concentrations were observed at depths of 300-500 m and 600-700 m, corresponding to the upper and lower boundaries of the "SIMRAD layer".

The bands with high particle concentrations were not confirmed by the raw data of the transmissometer mounted on the CTD/Rosette. There are two reasons for this discrepancy: 1) optical instruments are sensitive mainly for very fine particles, thus flocs and other large aggregates may not have been detected by the transmissometer, and 2) the signal of the transmissometer was dominated by chlorophyll, thus obscuring variations in particulate matter. Therefore, we corrected the raw transmisson data for the contribution by chlorophyll, which resulted in a pattern more consistent with the particle concentrations described above (Fig. 7). The results show a band of enhanced light attenuation (or reduced transmission, pointing at enhanced particle concentrations) near the bottom, originating at the shelf break and extending across the slope to a depth between 300-600 m, from which it intrudes horizontally into the interior of the channel. In addition to this nepheloid layer associated with the shelf break, attenuation peaks were observed near the bottom between 500 and 700 m, and these may point at nepheloid layers generated on the slope. It is not clear yet whether one or several points of intensified resuspension are responsible for the observed near bottom turbidity.

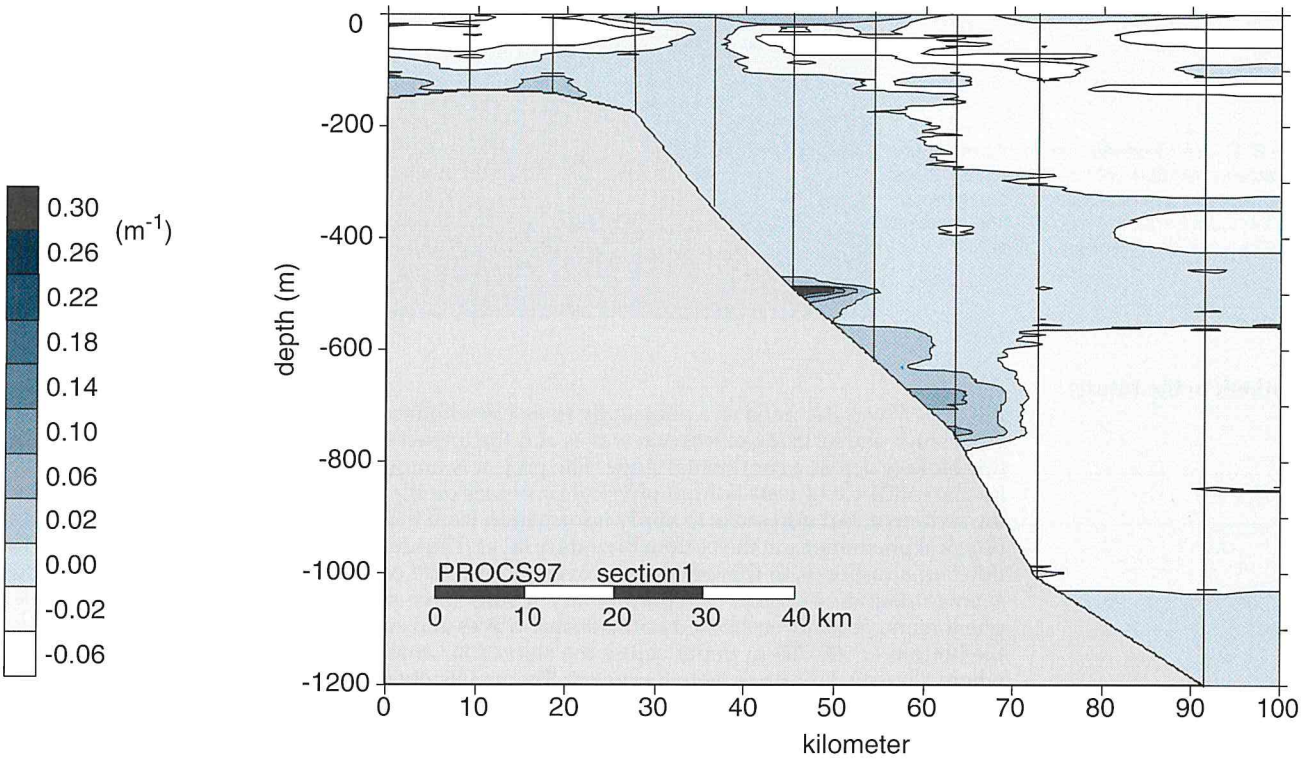


Fig. 7. Distribution of light attenuation on the western slope of the Færoe - Shetland Channel. The data were collected with a transmissometer mounted on the CTD/Rosette after correction for chlorophyll, and are relative to an arbitrary reference level. High values point at high particle concentrations, low and negative values at low concentrations.

Sediment traps

In the PROCS '97 project we looked at particle fluxes in the water column using time-series sediment traps with their aperture at 2 m and 28 m above the sea floor and two current meters about 2 m above each trap. Arrays PiP1 and PiP2 were deployed at bottom depths of 502 m and 708 m, respectively, with the traps programmed to collect in 12 synchronized intervals of 24 hours. In order to intercept near-bottom fluxes of settling particulate matter within the bottom nepheloid layer it was deemed necessary to integrate the lowermost sediment trap, the bottom anchors and both release gears in a single lander-type frame. The NIOZ design effectively reduced the distance between the sea floor and the trap's aperture from 12 m to 2m above the bottom, i.e., equal to the height of the sediment trap itself. Tilt measurements show that mooring line motion in the upper most trap was eliminated in the bottom most trap and will not have affected particle collection. Another experimental design performed equally well, i.e. the conversion of a conventional funnel-shaped trap into a cylindrical one with a high aspect ratio suited for sampling particulate fluxes in the high-energy regime of the Fæeroe - Shetland Channel.

Despite the near vicinity of the moorings, their total mass fluxes differed markedly in quality and quantity. PiP2 at 708 m bottom depth and below the "SIMRAD-layer" intercepted much higher fluxes of, especially, fluffy particles than did PiP1 at 502 m within the "SIMRAD-layer", which predominantly consisted of fecal strings probably secreted by (bentho)pelagic euphausiids. Mass fluxes collected by the near-bottom traps were higher by at least a factor 2 than those above for both arrays, yet were similar in composition, suggesting a significant contribution by "rebound" fluxes (resuspension) from the sediment-water interface. Despite these differences, the fluxes measured with traps on the same array showed similar patterns in time, at least during part of the 12 days deployments. Notably, maximum fluxes occurred during the first 4 days in both traps of PiP2 (Fig 8). Based on these first observations, we conclude that the traps of PiP1 and PiP2 had different particle sources, possibly related to the different bands of enhanced particle concentrations described in the previous section.

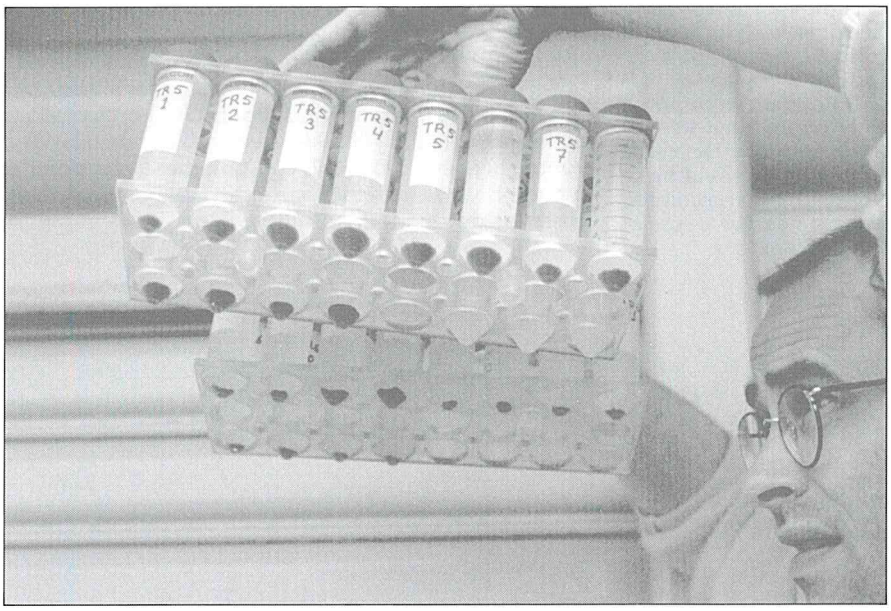


Fig. 8. G.-J.A. Brummer, while inspecting the particles collected with the sediment traps. Each sample cup has collected particles during 24 h, differences in the collected amounts thus indicate day-by-day variability.

Outlook to the future

PROCS '97 was intended as a pilot study to assess whether the Fæeroe - Shetland Channel is suited to study the focusing of internal waves and the impact thereof on the sedimentology and benthic biology across a continental slope. The project is unique in the sense that it not only searches for the influence of near-bottom physical processes on the geochemistry, geology and biology of the sediment, but also seeks to apply information from these disciplines to better understand the physical phenomena in the bottom boundary layer. The idea behind this approach is that, e.g. benthic fauna responds to the longer-term average physical conditions and as such may function as a time-integrative sensor. The preliminary results have sufficiently confirmed our basic ideas, phenomena possibly associated with internal waves and enhancd turbulence were observed near the bottom at 500-700 m depth across the slope. Our analysis thus focuses on this depth range, where also our moorings were deployed. The results obtained so far do, however, indicate that the slope should be studied with high spatial resolution to unravel the relevant processes with sufficient detail, and that measurement of near-bottom turbulence profiles is indispensable. Therefore, new expeditions are being prepared for the coming years.

THE NETHERLANDS INDIAN OCEAN PROGRAMME 1992-1993

Contributors: *Tj.C.E. van Weering, W. Helder, G-J.A. Brummer* and *M.A. Baars*

The Netherlands Indian Ocean Programme was carried out with the RV "Tyro" in the Arabian Sea, Gulf of Aden, Red Sea and off Kenya and the Seychelles during 1992-1993, with the objective to study the effects, on both spatial and temporal scales, of the monsoons on the marine system in the north-western Indian Ocean. The programme comprised five research projects.

Project A was co-ordinated by NIOO/CEMO and included considerable participation of NIOZ staff. This project was directed towards the effects of the seasonally reversing monsoonal system on the coastal ecosystems in Kenya, especially to gain a clear understanding of the physical, chemical and biological processes occurring in the coastal zone.

Project B was co-ordinated by NIOZ and aimed at describing the dynamics of the pelagic system including a quantification of the carbon flux and biogeographical studies, with the emphasis on seasonal shifts in plankton biomass and productivity. Part of this project was designed as a pilot study for the JGOFS Arabian Sea Process Study (1994-97) and covered most of the JGOFS core measurements.

Project C "Tracing a seasonal upwelling system" was co-ordinated by NIOZ together with the Free University of Amsterdam and had as goal to determine the spatial and temporal variability of biological, chemical and geological parameters that define an upwelling system, and to recognize these in the sedimentary record as proxies for upwelling in the waters off Somalia and Yemen.

Project D was co-ordinated by the University of Utrecht and concentrated on two main issues, the late Quaternary productivity and the dynamics of the Oxygen Minimum Zone in the northeastern Arabian Sea and the depositional architecture and sediment facies of the middle and lower Indus fan. Input from NIOZ side was through the support of marine technicians and analytical personnel.

The biology of oceanic reef systems of the Seychelles, directed towards biogeographical, taxonomical and ecological studies of the reefs formed the last project (E), and was co-ordinated by the Natural History Museum, Leiden with a small scientific input from NIOZ scientists.

Results were published in a Special Issue of Deep-Sea Research Part II. Here we restrict our selves to topics of the cruises within projects B and C. The relatively unknown monsoon-induced upwelling off the coast of eastern Yemen and in the NW Somali Basin were studied to establish the contrasts between July/August (at the height of the SW monsoon) and January/February (NE monsoon) by water mass analysis and observations at stations along tracks perpendicular to the coasts of Yemen, NW Somalia and between Cap Guardafui and Socotra. Additional data were collected in the Gulf of Aden and the Red Sea during project B.

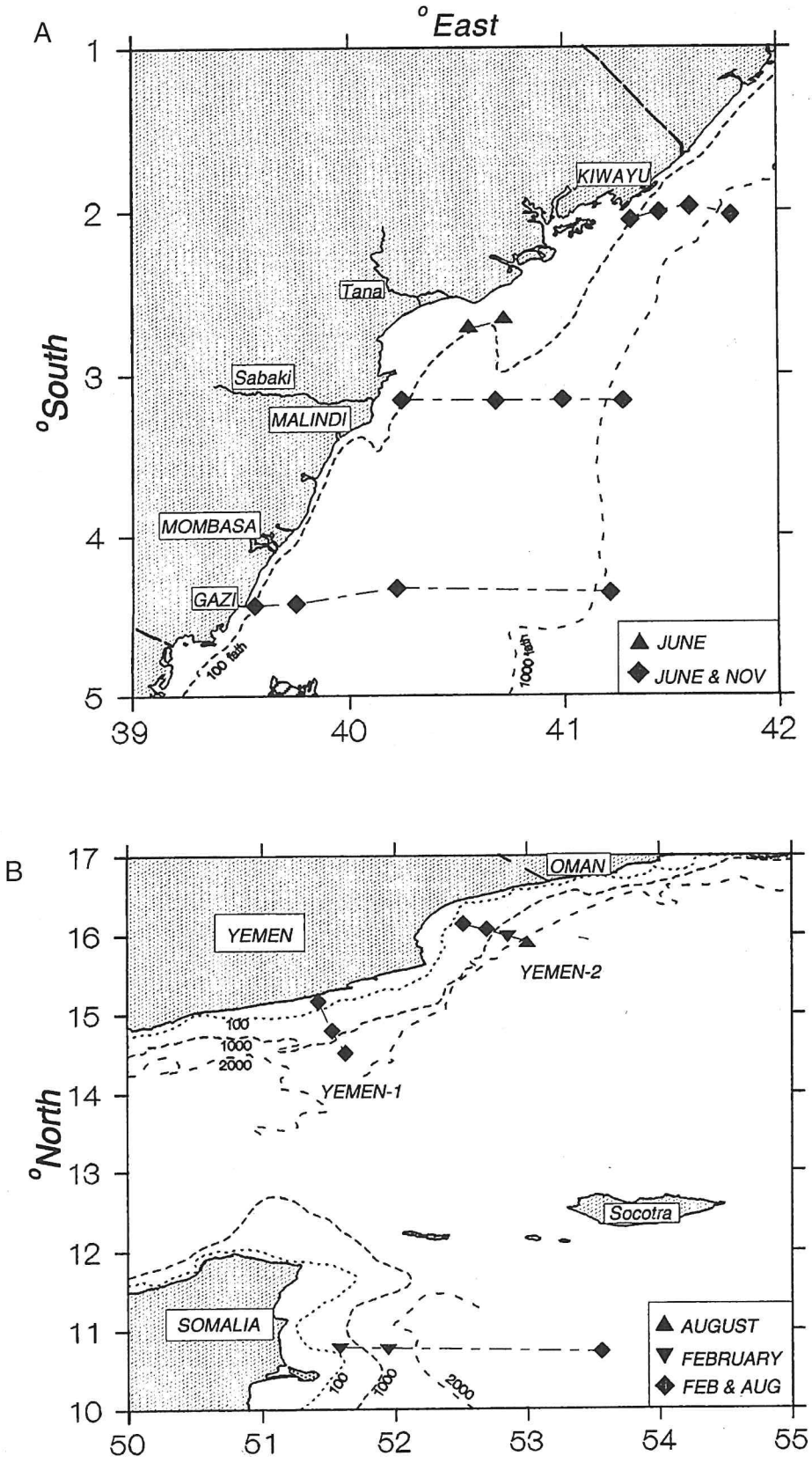
Surface waters

Upwelling in the Yemen/Oman and NW Somali upwelling areas was indicated by low temperatures and high nutrient concentrations in the surface water in narrow zones along the coasts. Along the Somali coast the temperatures were lower and the nutrient concentrations higher in July than in August. The table shows the extreme values for surface waters along the Somali and eastern Yemen coasts.

Area	Temperature (°C)	PO_4 (µM)	NO_3 (µM)	H_4SiO_4 (µM)
Somalia	17.3-19.6	1.37-1.63	17.6-20.3	11.7-16.1
Yemen	20.1-21.1	1.63-1.84	17.4-19.4	10.4-15.4

The high nutrient concentrations along the Somali coast (7 to 11°N) were very similar to those given earlier by Smith & Codispoti, but at 5°N neither low temperatures nor high nutrients were found in July 1992. Apparently enhanced nutrients in surface waters were, from mid July to mid September 1992, carried by the Great Whirl to at least 500 km offshore, reaching north of Socotra and into the Arabian Sea. In February 1993 the concentrations of nitrate in surface waters were below 0.2 µM, but in January the surface nitrate concentration was 0.8 - 1.1 µM in the NW Somali Basin.

From the end of July, primary productivity off the Somali coast was relatively low in the deep surface mixed layer considering the high nutrient availability, probably due to the fact that the photic zone was shallower than the mixed layer, and this mayalso have contributed to the offshore transport of nutrients. In August the oxycline off the Yemen coast was much shallower (<20 m) than off the Somali coast (80-90 m).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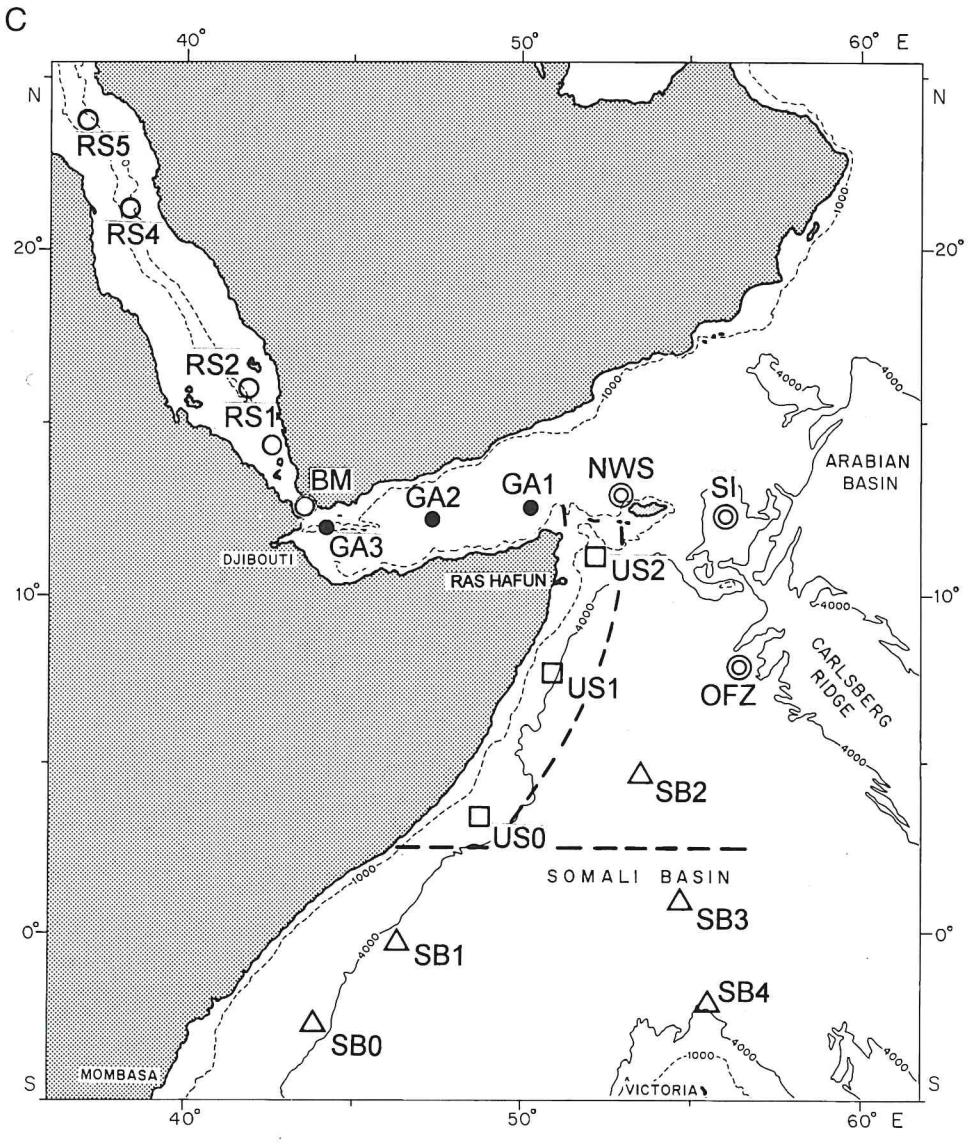


Fig. 1. Study area with track-lines and stations of projects A (left top), B (left bottom), and C (right).

Studies regarding the influence of seasonal variations in upwelling intensity on phytoplankton abundance, composition, primary production and growth rates, bacterial dynamics in the euphotic zone of the Red Sea, Gulf of Aden and in the Somali upwelling area showed that strong upwelling dominated off the Somali coast during the SW monsoon (July 1992). This resulted in diatoms dominating the patchy blooms of the phytoplankton north of Ras Hafun at the margin of the Somali current. Picophytoplankton was present, however contributing relatively little to the chlorophyll-*a* content (less than 30 %). Around the island of Socotra, in the Great Whirl and in the freshly upwelled water of the Somali current, chlorophyll-a concentrations were relatively low in spite of the high nutrient concentrations. The mean primary production for the northern Somali Basin was 1.25 $gCm^{-2}day^{-1}$ (with a range from 0.8-2.8 $gCm^{-2}day^{-1}$).

In the same period the highest bacterial production in the nutrient-enriched waters of the Somali Current was measured (849 $mgCm^{-2}day^{-1}$) with strikingly small spatial differences.

During the NE monsoon the phytoplankton was dominated by picophytoplankton forming up to 80% of the total chlorophyll-*a* content. The mean primary production of the Somali Basin during this period was 0.8 $gCm^{-2}day^{-1}$, with a range from 0.5-1.0 $gCm^{-2}day^{-1}$ or about two third of the SW monsoon primary productivity. The bacterial production (73-139 $mgCm^{-2}day^{-1}$) was lower than in the SW monsoon, despite the entrainment of nutrients in the wind-mixed layer.

A reversed seasonal shift was found in the Gulf of Aden and the southern Red Sea (Fig. 2), with oligotrophic conditions during spring / summer 1992, and high phytoplankton and bacterioplankton productivity during January 1993. Winter cooling gave rise to blooms of small eukaryotes >3 µm in the Gulf of Aden and of diatoms in the Red Sea.

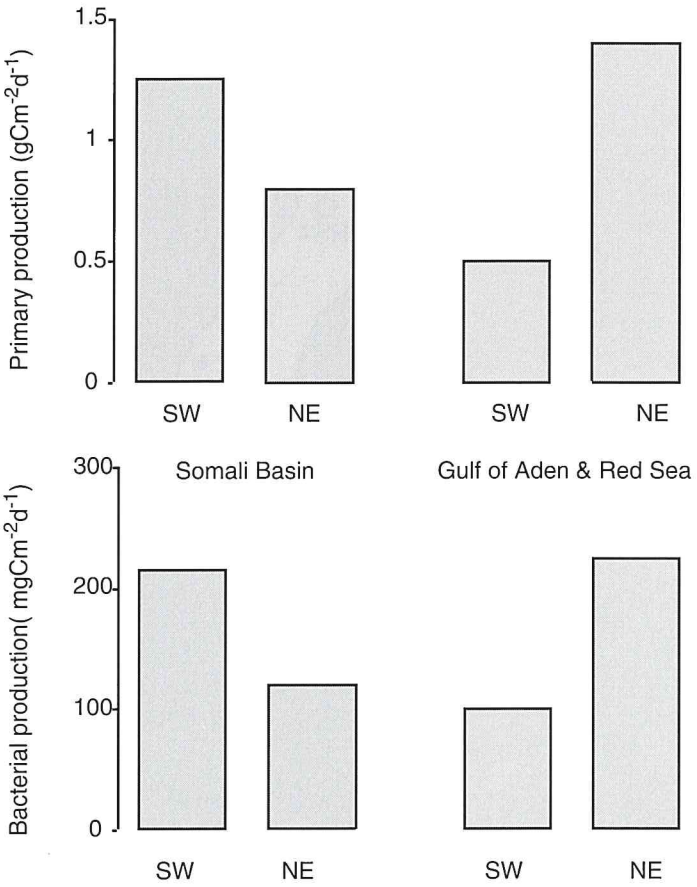


Fig. 2. Primary production ($gCm^{-2}day^{-1}$, upper bars) and bacterial production ($mgCm^{-2}day^{-1}$, lower bars) in the northern Somali Basin versus the Gulf of Aden and southern Red Sea during the SW and NE monsoon, respectively.

Deeper water layers

Salinities down to 1150 m were up to 0.5 PSU higher in February 1993 than in August 1992 at a station between Cap Guardafui and Socotra while oxygen was lower in February than in August in nearly the entire Oxygen Minimum Zone (OMZ). In August the subsurface oxygen concentrations mirrored the salinity profile but in February the relation between oxygen and salinity was less clear. A section measured in February about 100 km more to the south showed that the oxygen values were <20 µM from 200 to 800 m depth in the OMZ with extremes (< 10 µM at 270 m) in the eastern part of the section. Unfortunately, this section could not be measured in August due to very strong winds, but 100 km to the north, the oxygen content never fell below 20 µM in that month.

Surprisingly, the subsurface oxygen concentration during the relatively unproductive NE monsoon was lower than during the more productive SW monsoon, suggesting a substantial exchange of deep water through the gap between Socotra and Cap Guardafui. The role of exchange of waters from the south in maintaining dysoxic conditions in the Arabian Sea was stressed by Olson as the region west of Socotra apparently plays a vital role in this exchange. In the region around Socotra the oxygen concentrations of 6-20 µM (especially in the shallow OMZ between 200 and 300 m depth) were much lower than the value given earlier by Wyrtki.

The contrast between August and February in the area off eastern Yemen was most clear in the shallow subsurface oxygen distribution. In August the oxygen concentration was < 30 µM at about 20 m depth at stations in the middle of the section, and except for the outermost station, a substantial undersaturation was found at 3-4 m depth. In February the surface mixed layer, saturated with oxygen was about 40 m deep. The lowest subsurface oxygen minimum concentrations (2-4 µM) were found in February at about 230 m depth in thin layers, associated with salinity maxima between 35.90 and 36.00 PSU and σ_θ of 26.55, suggesting Persian Gulf Water. Differences in oxygen minima are thought to have originated from displacement of water masses, rather than from local oxygen consumption. The oxygen minima did not originate from the Persian Gulf, but were acquired by Persian Gulf Water while passing below areas with high productivity. No nitrite maxima were found associated with the oxygen minima.

Data on the occurrence of N_2O in the water column of the Somali Basin and its emission to the atmosphere, show that emissions reached maximum values of 260 - 500 µmol m^{-2} d^{-1}, three orders of magnitude above the global mean oceanic N_2O flux, and that the N_2O was produced by nitrification rather than denitrification.

Particle settling fluxes

Two arrays with sediment traps and current meters were moored on a transect across the Somali ocean margin to determine the nature and fluxes of settling particulate matter within a nearly 9 month interval spanning the SW to NE monsoon, until their recovery by mid February 1993 (Fig. 3). The traps should also allow for assessing sediment burial efficiencies and the differential contribution of particles settling out of the euphotic zone and those transported 'laterally' over the continental slope. One array was deployed at station 905 within the zone of active coastal upwelling during the SW monsoon on the Somali continental slope and was moored at a bottom depth of 1533 m with a sediment trap at 1265 m depth, i.e. 268 m above the sea floor. At the same site a tripod was deployed for measuring the near bed hydrodynamic regime, and a box- as well as a 15 m long piston-core were taken for detailed studies of monsoonal sediment accumulation at glacial-interglacial time scales.

Near-bed current velocities at station 905 (June 4-July 7, 1992) measured with the tripod lander BOBO 1 showed a semi-diurnal tidal effect with velocities up to 12 cm s^{-1}, the currents above 5 cms^{-1} being generally associated with a dominant flow to the north and northeast. Maximum current velocities consistently coincided with a drop in near-bottom water temperature of 0.4 °C. There was little difference in current velocities measured at 25 cm and at 50, 75, and 100 cm above the bottom. At 30 m above the bottom mean along-slope velocities were about 10 cm s^{-1}, although up to 20 cm s^{-1} in rare instances, during the SW monsoon and decreased to about 6 cm s^{-1} in the NE monsoon. Total mass fluxes settling to the sea floor were dominated by a pronounced maximum in October 1992 of up to 4340 mg $m^{-2}d^{-1}$, with the highest content of $CaCO_3$ (69.6%) compared to other periods. Although the mass fluxes of organic matter and biogenic opal were the highest as well (180 and 404 mg $m^{-2}d^{-1}$, respectively), their proportional contributions were the lowest measured (4.8% and 10.7%). Particle-specific analyses of the material showed a pronounced flux of assorted species of small benthic foraminifera, ostracods and bivalves as well as abundant fragments of sessile calcareous biota derived from sediments on the inner shelf to the uppermost slope. Its temporal occurrence coincided with the end of the SW monsoon as was also indicated by a marked change from upwelling-supported to non-upwelling-supported ratios of their stable nitrogen isotopes. Possibly, the changing circulation caused by the waning SW monsoon triggered the resuspension of sediment material from around the shelf break. At other times, the relative contribution of resuspended sediment to the mass flux on the Somali slope was lower by at least 3 orders of magnitude. Apparently, along-slope directed currents dominated the sediment transport at site 905, introducing episodic fluxes of resuspended sediments into the trap at 268 m above the Somali slope.

A different mode of lateral advection, i.e. by surface currents carrying bottom-derived material offshore in suspension, was suggested by the presence of benthic and epiphytic diatoms that occurred in trace amounts in all traps, particularly during the SW monsoon. Both mooring sites were close to or overrun by the Great Whirl and the Southern Gyre, that transport large quantities of coastal upwelled water offshore along their margins at velocities of up to 3 m s^{-1}. Excluding the sediment-derived contribution, total mass fluxes to the Somali slope amounted to 215 g $m^{-2}y^{-1}$, about 2 to 4 times higher than those in the deep and shallow Somali Basin south of Socotra. On an annual basis the estimated total mass flux to the deep Somali Basin St. 915 was about 80g m^{-2}, similar to the highest annual values reported from the same depth in the open Arabian Sea. In all traps fluxes were highest during the SW monsoon (about June to October), attaining the lowest values in November-December during the SW-NE intermonsoon, increasing again in January-February during the NE monsoon. Following the onset of coastal upwelling and the development of the Great Whirl-Socotra Gyre system in late May 1992, upwelling supported organic matter fluxes first arrived almost simultaneously in all traps in late June as shown by their nitrogen stable isotope composition. On the Somali slope they persisted almost without interruption into October, whereas in the Somali Basin they were interrupted during mid to late July and also ended earlier, by mid September, when gyral advection of coastal upwelling water ceased. In general the mass fluxes of major constituents, i.e. $CaCO_3$, biogenic opal and organic matter covaried strongly, although their proportional contributions to the total flux did change. The highest variation was in the proportional contribution of biogenic opal, which was during the SW monsoon on the Somali slope about 40 wt%. However, less than 10% of the biogenic silica arriving at the seabed of the Somali Margin is buried in the sediments (Fig. 4), which is lower than reported from the open Arabian Sea but consistent with estimates for other regions. It was concluded that most dissolution occurs at the sediment-water interface.

Benthic carbon cycling

When benthic respiration, biomass and phytodetritus of the continental margins of Yemen/Somali are compared with the margin off Kenya, the original hypothesis, that the upwelling region would be a site of intensified benthic activity and high biomass due to enhanced productivity, could not be verified. The benthic standing stock was of similar magnitude off Yemen/Oman and on the non-upwelling Kenyan margin. Strong benthic-pelagic coupling was observed at the northernmost Kenyan offshore transect.

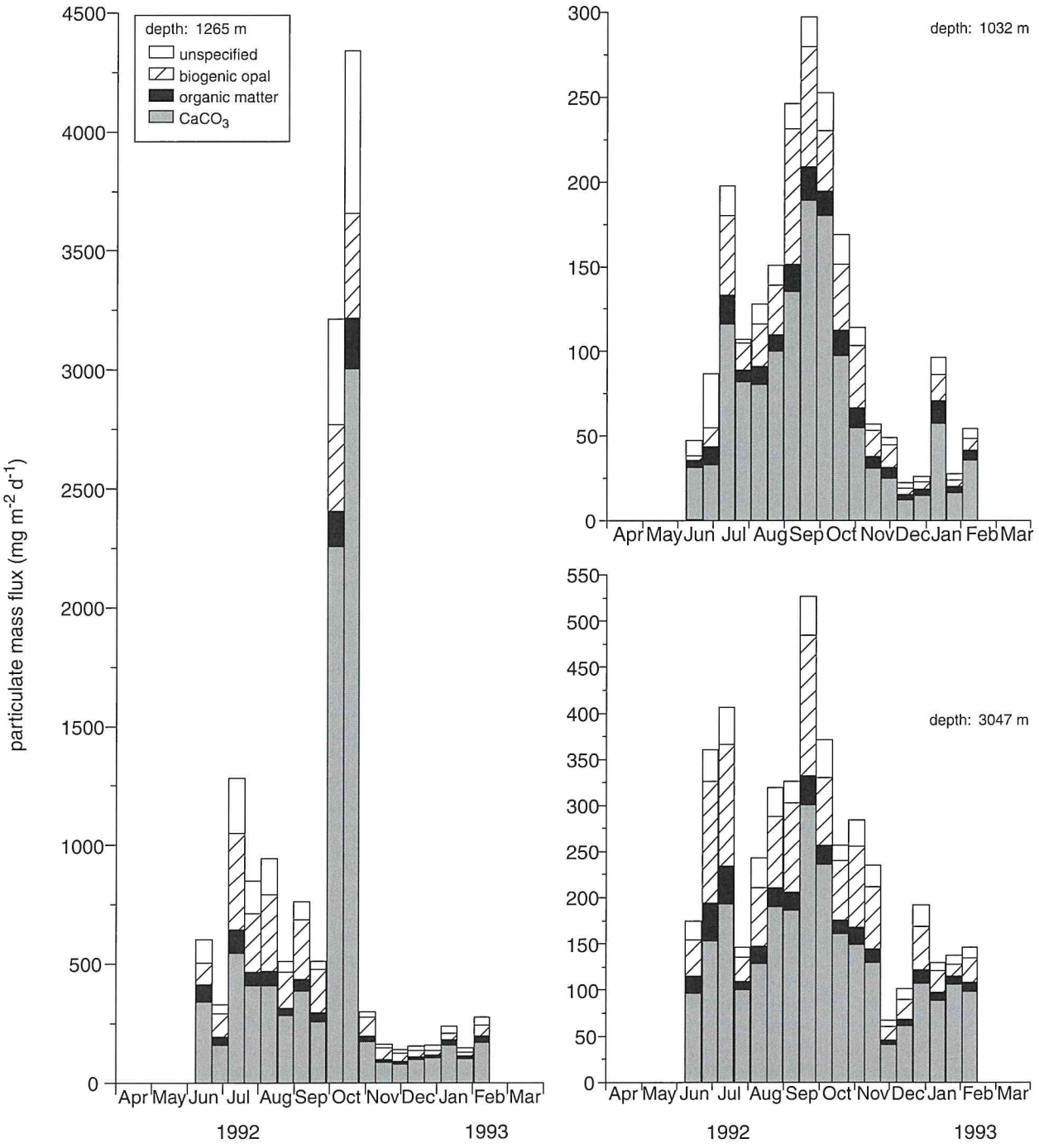


Fig. 3. Particulate mass fluxes and their composition intercepted by sediment traps moored on the Somali slope (left; station 905) and in the deep Somali Basin (right; station 915).

Contrasting views prevail as to the processes responsible for generating the relatively high organic carbon contents in sediments of the NW Indian Ocean upwelling zones given the high upwelling-induced seasonal productivity. For the Yemen-Oman region with Corg contents up to 4%, Pedersen advocated the "production hypothesis" which relates the high organic content in the sediment primarily to the high productivity in overlying surface waters. Parokpari, on the other hand, related it directly to the low oxygen concentrations of overlying bottom waters ("the preservation hypothesis"). In addition to these views the time of exposure to oxic conditions rather than the oxygen concentration of overlying bottom water itself was considered by Canfield as most important for preservation of organic carbon in deeper (anoxic) marine sediments. NIOP cruises C1 (August 1992) and C2 (February - March 1993) supported the earlier conclusions of Pedersen because highest C_{org} contents in surface sediments did not coincide with lowest bottom water oxygen concentrations. Pore water profiles of diagenetic indicators showed that the porewater concentrations of dissolved Mn and dissolved Fe, as well as the concentrations of reactive Mn- and Fe-oxides were extremely low. We conclude that the restricted oxygen penetration into the sediment and the low oxygen concentrations at the sediment - water interface cause inefficient re-oxidation of upward diffusing Mn^{2+} and Fe^{2+}, which thus may escape to the overlying water column. Another direct consequence of low oxygen concentrations in overlying bottom waters was an accumulation of caretenoid pigments in the sediments along the Yemen transects, an indication of the lack of chlorophyll-*a* degradation.

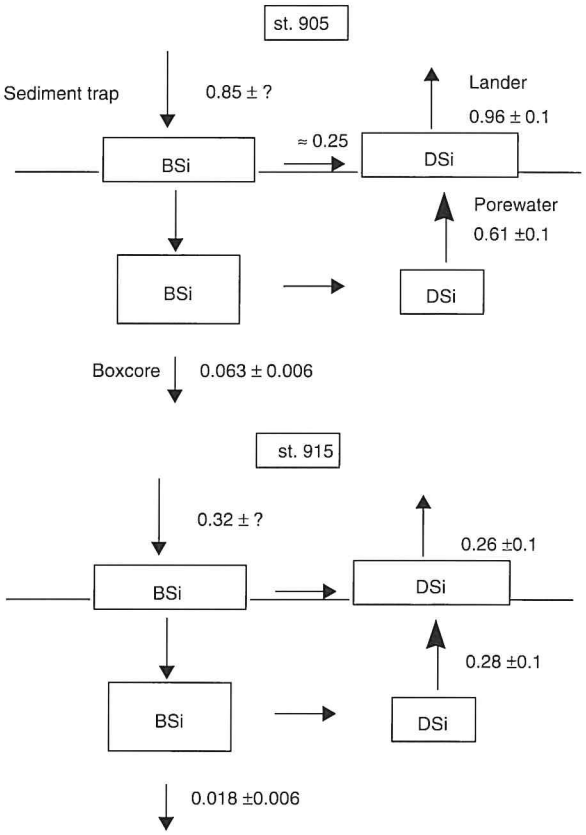


Fig. 4. Mass balance of biogenic silica at stations 905 and 915 in mol m^{-2} $year^{-1}$, based on measurements of settling fluxes, sediment accumulation, pore water profiles and sediment incubations.

DEPARTMENT OF PHYSICAL OCEANOGRAPHY

The department continued to work under the following main themes:
1. water circulation and hydrography of the North Atlantic
2. dynamics of (non)linear marine processes
3. physical aspects of marine ecosystems

As a part of theme 1) the TripleB (Bay of Biscay Boundary) programme was continued with a 4 weeks hydrographic survey with RV Pelagia in the Bay of Biscay in the summer of 1997.

Within theme 2) projects concerning the study of the thermohaline circulation and chaotic mixing in tidal areas were continued. A study on the intrinsic drift of oceanic monopolar vortices was completed with a Ph-D thesis (cum laude, see below). Theoretical predictions on geometric focusing of internal waves were confirmed in laboratory experiments (see below).

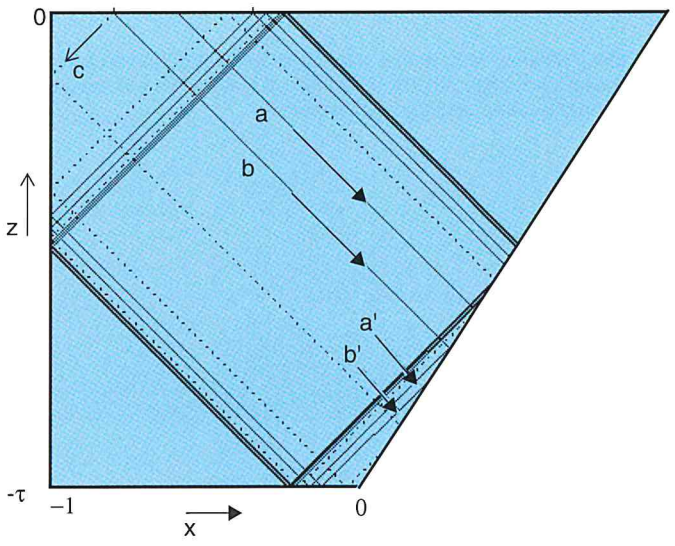
Multidisciplinary projects in which the department was involved under theme 3) were the pilot-program on processes near the continental slope (PROCS), the study of the behaviour of cohesive sediments in the Dollard, the Deep Chlorophyll Maximum (DCM) project and the application of marine optics. The JGOFS/Southern Ocean Project was completed (see below).

INTERNAL WAVE ATTRACTORS

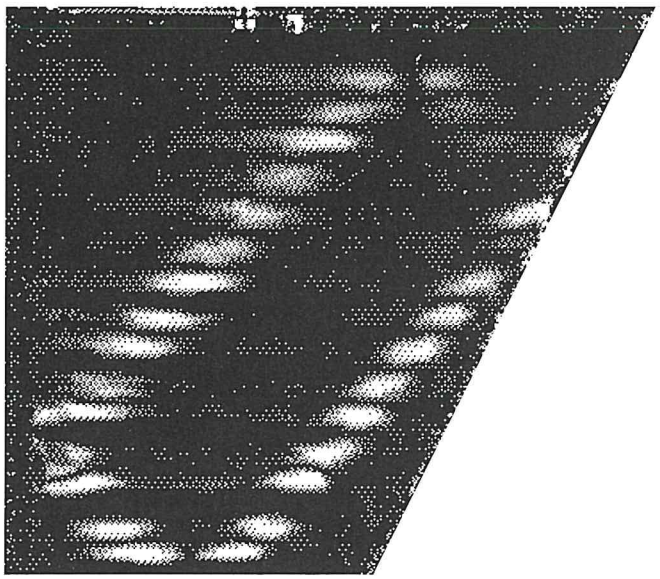
Contributors: *L.R.M. Maas, F.-P.A. Lam*

In general, the ocean is a stably-stratified fluid. Adding heat leads to expansion of water, thus reducing its density, while adding salts increases its density. Water 'formation' and 'transformation' usually take place at the surface, where both day-time insolation and nightly cooling occur, as well as evaporation and rainfall. Together with freezing and melting, and the inflow of extremely fresh or salt water from rivers or 'salt-pans', that equally occur at the surface, these processes lead, depending on the geographical location, to a wide range of watermasses, each of which, under the action of gravity, sinks off to its equilibrium depth, feeding the stable density stratification of the oceans. In the actual ocean, this 'background stratification' is characterized by a surface mixed layer, below which a strong seasonal and weaker permanent pycnocline are found, respectively. In order to concentrate on the effects of stratification per se, it will here be assumed that the stratification, i.e. the rate with which density increases with increasing depth, is constant.

Although a stably-stratified, motionless ocean, contained in a realistically shaped basin, is, strictly speaking, not dynamically stable (because heat and salt, diffusing through the sloping side walls, will set the water into motion), it may still be regarded as stable on short time-scales. Now, what is perhaps not intuitively clear, but what has been predicted at an earlier stage, is that such a medium, of given container shape and static stratification, has a geometric structure attached to it. In fact, for any frequency below the stability frequency (by which the stable stratification can be characterized), a different geometric structure is dormantly present.



Side-view of a tank with sloping bottom, filled with uniformly stratified fluid. The vertical has been stretched so that the angle along which internal wave energy propagates (lines a, b and c and their continuations) is always 45 degrees. Upon a single reflection lines converge (as the decreased distance between a' and b' shows). Regardless of the starting position, upon multiple reflections, an attractor is reached, the central square.



Laboratory experiment demonstrating internal-wave focusing in a tank with sloping bottom in a uniformly-stratified fluid. Internal waves are generated by oscillating the tank vertically. The fluid was dyed in a number of initially horizontal layers. Once internal waves start to develop, the oscillating isopycnals become visible as localized distortions of the layers of dye. By subtracting the initial dye at each pixel, the present picture is obtained. Black indicates regions where there is no difference in dye (and hence no wave motion) while bright regions indicate locations where wave motion is present. The latter is seen to occur in a box-shaped region around the single periodic orbit at which the attractor is theoretically predicted to occur.

The geometric structure results from the fact that perturbations of the stable stratification will be manifest as internal gravity waves, whose energy propagates obliquely, with the strong constraint that their angle with respect to the vertical is fixed. This angle is determined by the ratio of the forcing frequency to the stability frequency. It will approach zero, and the energy will propagate up and down, when the frequency reaches the stability frequency, while it will approach 90 degrees, the energy propagating back and forth, when the frequency drops to zero. The energy thus follows straight paths, that, upon reflection, continue as lines with a decreased mutual distance. Upon multiple reflections from a sloping side wall, these will in general converge onto a periodic, limiting orbit: an internal wave attractor.

Each structure is, however, dormant (invisible) until the moment that it is somehow and somewhere 'enlightened', by forcing the fluid at the frequency associated with this structure. We demostrated this phenomenon in a tank with one sloping side wall which was filled with a uniformly-stratified fluid and which was put on a table that oscillated vertically. The oscillation leaded to the growth of tiny perturbations of half the frequency with which the table oscillated. These perturbations grew everywhere in the fluid, and propagated away in each of the four directions available to them (maintaining the same angle with the vertical). By following energy paths from a point at the surface along lines and their continuations, these waves nevertheless always approached the same attractor.

An important property of these structures is that the perturbation pressure on each (set of connected) lines is a conserved quantity. Now, since pressure gradients determine flow speed, convergence of these lines, such as occurs upon reflection, implies that the same pressure difference extends over a smaller distance and thus intensifies its gradient and consequently its flow speed. Hence, the internal waves should become more prominent around the attractor. In the laboratory experiment this was essentially confirmed.

Theoretically, this focusing process continues indefinitely. In reality, when pressure gradients and flow become too strong, nonlinear and viscous effects set in and mixing will ensue along the attractor. This mixing-band, around the attractor, may provide an important pathway for the localized, turbulent transport not only of heat, or salt and momentum, but also of sediment particles and dissolved constituents. It is this property of internal wave attractors, which might be of greatest relevance to the ocean environment.

Complications in the real ocean are that its stratification is non-uniform, that there exist sheared mean currents, and that its bottom shape is neither two-dimensional nor smooth (as in the above theory and laboratory experiment). The first two factors affect the shape of the lines (or surfaces) along which the internal wave energy propagates, without, however, affecting the final results: the existence of attractors. The last two factors may diffuse internal waves at an early stage and may thus blur the final picture of the attractor.

4

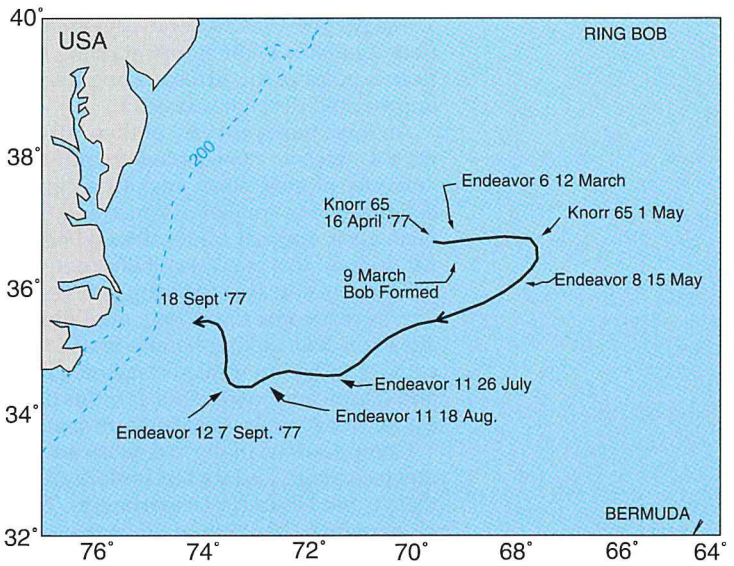
WHY TO THE WEST? ON THE PROPAGATION OF MONOPOLAR VORTICES ON A ROTATING EARTH

Contributors: *R. van der Toorn, J.T.F. Zimmerman*

Large scale vortices (or mesoscale eddies) are ubiquitous in the ocean. Their horizontal size ranges from 50 - 200 kilometers. These mesoscale eddies or "rings" are mainly shed off by western boundary currents like the Gulf Stream, the Kuroshio and the Agulhas Current. All these vortices invariably arise from some thermal or dynamic instability of the background currents by which they drift over the globe. Apart from this background drift however, there is ample evidence that monopolar vortices also have an intrinsic drift that would pertain in the absence of any background current and that this intrinsic drift has always a strong westerly component.

So, the central question as monopole propagation is concerned is why the intrinsic drift is basically to the west, albeit sometimes northwest and at other times southwest. The view we presented in this project is novel in the sense that it explained the drift entirely in terms of angular momentum dynamics on a rotating globe. In essence it appeared that the intrinsic drift is the fluids dynamical analogon of the precession of a spinning disk on a rotating globe, with an important difference: the disk precesses either eastward if it rotates in the same sense as the globe (cyclonically) or westward in the reverse situation (anti-cyclonically). Oceanic vortices, however, nearly always show retrograde precession, westward, whether they spin cyclonically or anti-cyclonically.

The reason for the precession of a spinning disk is a broken balance of its angular momentum dynamics. In the non-spinning state its angular momentum vector rotates with the Earth. This rotation requires a torque which is supplied by the horizontal component of the gravity force. As the disk goes spinning there is an additional component of angular momentum along its local vertical such that the balance for the total angular momentum is broken. The only way to restore the balance is either to precess westward for anti-cyclonic spin or eastward for cyclonic spin. For oceanic vortices the same way of reasoning applies but now, as we deal with a fluid continuum, only to the excess mass field of the vortex. Because of the Earth's rotation any rotating vortex either attracts or expels a certain amount of mass from or to the surrounding fluid. Anti-cyclones attract and have a positive mass anomaly, cyclones expel and have a negative anomaly. So, there are two sign changes between cyclone and anti-cyclone: spin and mass anomaly. In product this means that the sign of their precession is the same, i.e. it is always westward. Yet anti-cyclones travel faster - and are therefore also more stable - because their total spinning mass is larger than for cyclones and because their mass anomaly is larger. The latter occurs because the centrifugal and Coriolis accelerations in an anti-cyclone counteract requiring, for the same mass anomaly as in a cyclone, a larger spin. The theory presented this way gives a much more lucid physical explanation than former theories that used vorticity dynamics rather than angular momentum dynamics as their starting point.



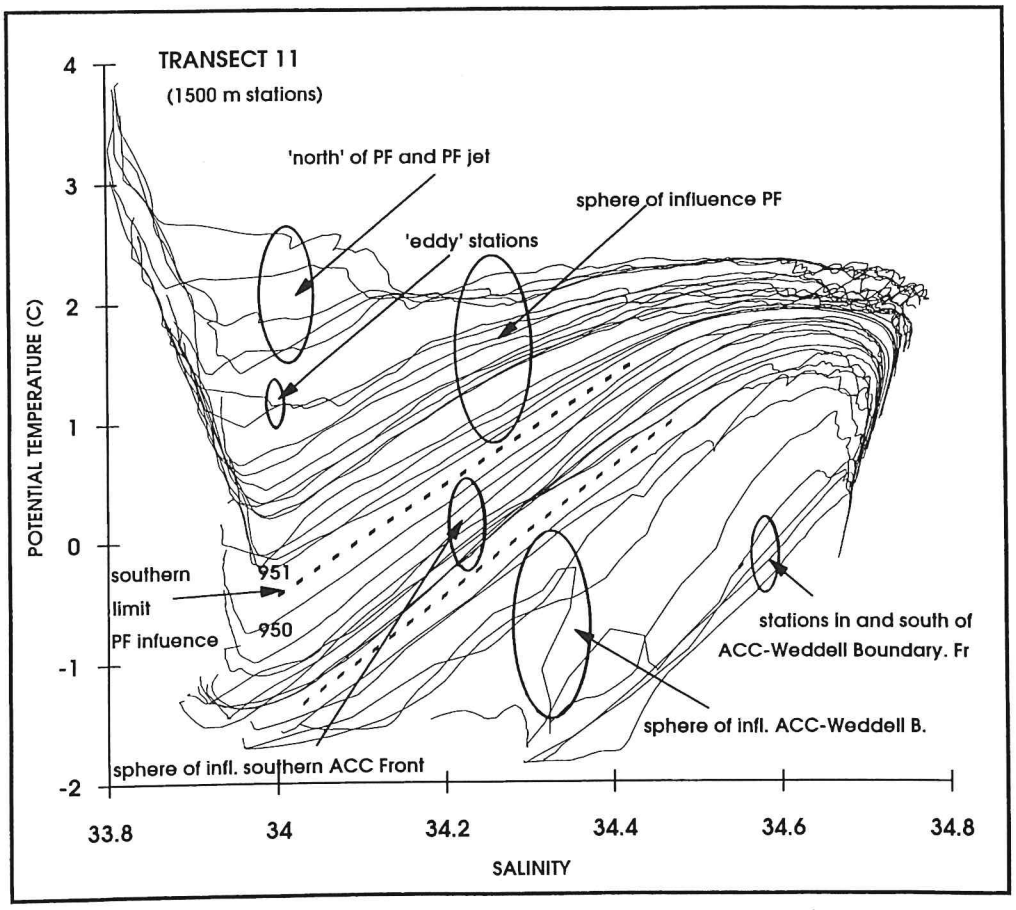
As an example of the westward drift of Gulfstream rings, this graph shows schematic summary of the movements of the cyclonic Gulf Stream ring Bob in the western North Atlantic, from free-drifting buoys, hydrographic (XBT) surveys and infrared imaging. This scheme covers a period of formation of the ring and strong interactions with the Gulf Stream (March, April and first week of May), a period of westward propagation (May to September) and the coalescence of Bob with the Gulf Stream in September. From: Richardson, P.L. (1980). Gulf Stream Trajectories. J. Phys. Oc. **10**: 90-104. Note that the characteristic westward drift speed of the ring as a whole, as inferred from this picture, is about 5 cm/s which is much less than the velocities of the swirling particles in the ring itself which may sometimes exceed 1 m/s.

THE PHYSICAL ANATOMY OF FRONTS IN THE ANTARCTIC CIRCUMPOLAR CURRENT AT 6° W

Contributors: *C. Veth, S. Ober, R.X. de Koster*

The Southern Ocean is characterized by the occurrence of a series of circumpolar features. In particular, the spatial structure of the Antarctic Circumpolar Current, ACC, is strongly determined by the position and flow regime of a number of frontal systems separating different ACC zones. These fronts are a striking permanent feature of Antarctic waters; although they are circumpolar, they show a strong temporal variability in latitude and structure.

During the austral spring cruise ANT X/6 of R.V. *Polarstern* 1992, organized within the framework of the European IGBP-JGOFS (Southern Ocean), data were collected along a meridional section at 6°W. The main goal of the expedition was to study those parameters that influence, directly or indirectly, the CO_2-flux between the atmosphere and the sea surface in this part of the world ocean. The project was a cooperation between a number of European institutes, in particular AWI (Bremerhaven), NIOZ and several university groups (Brest, Brussels and Kiel). The physical contribution to the project aimed at the understanding of the physical processes that govern this sea area. In particular the role of the frontal systems and meandering, the structure and evolution of the wind-mixed layer and the role of ice melting. The physical oceanographical investigations provided the background information for the biological and chemical studies in this multidisciplinary project.



Composite θ-S plot of all stations of a north-south transect (transect 11) between 47° and 60°S in austral spring 1992.

The different sphere of influence interleaving and mixing occurs, but no interleaving is found between different spheres of influence.

The section covered three distinct fronts, namely the Polar Front, the Southern Polar Front (also known as Southern ACC Front), and the ACC-Weddell Gyre Boundary Front. Physical measurements during repeated transects over a period of six weeks in October/November revealed strong variability in the Polar Frontal region, indicating meandering and eddy shedding. The Polar frontal jet showed a maximum velocity of about 0.18 m/s, but at different latitudes on the different transects. It was possible to make a quasi-synoptic reconstruction of the meandering flow field near the Polar Front, based upon the physical observations. Details in the flow field coincided strongly with the spatial distribution of a number of biological parameters such as phytoplankton biomass and species, and photosynthetic pigments.

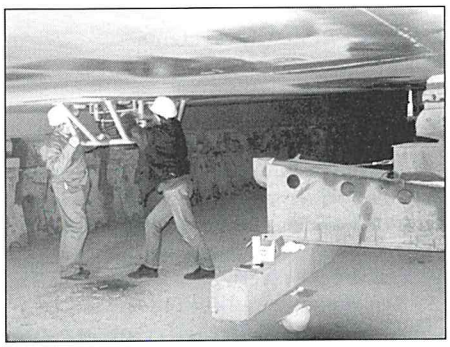
The meandering motion of the Polar Front is visible over the entire water column, a feature typical for fronts in the Southern Ocean. This correlation of motion over the whole column is probably the cause of the observation that the positions of the Southern Polar Front and the ACC-Weddell Gyre Boundary Front were found to be far more stable than that of the Polar Front. The proximity of the America-Antarctic ridge is thought to be responsible for the relative stability of the position of the two southern fronts.

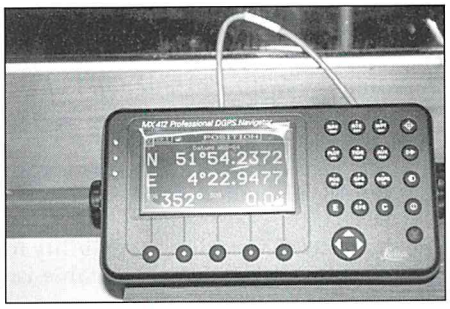
Evidence was found that the Antarctic Zone of the ACC can be subdivided into a number of spheres of influence related to the fronts. The subdivision could easily be made by the study of the θ-S diagrams of the transects. Interleaving and mixing of water is apparent between positions within such a region, occasionally over distances as far as 100 km, but hardly between neigbouring regions. The pattern of the different spheres of influence identified by physical parameters coincided strongly with the distribution of biological parameters, in particular the dominant zooplankters.

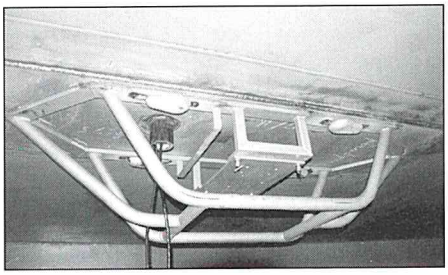
EXTERNAL PROJECTS OF THE DEPARTMENT OF PHYSICAL OCEANOGRAPHY

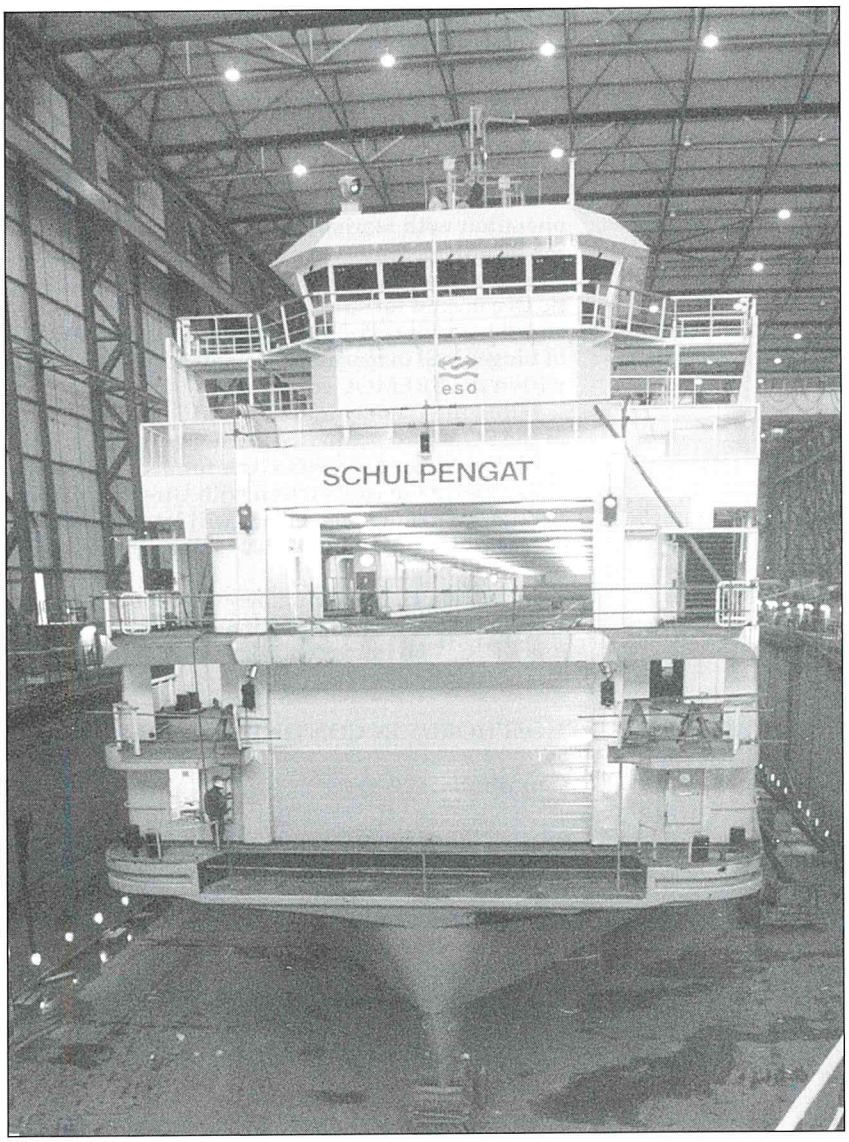
- The morpho-dynamic and bio-dynamic behaviour of mud in tidal areas (NWO-BOA) H.Ridderinkhof, M.Wilpshaar, J.T.F. Zimmerman
- Non-linear dynamics in physical oceanography (NWO-GOA) J.T.F. Zimmerman, G.Schramkowski, G. van der Schrier, L.R.M. Maas, H.Ridderinkhof
- Bay of Biscay Boundary (Triple B) (NWO-GOA) H.M. van Aken, C.Veth, J.J.M. van Haren, S. Ober, R. de Koster, R. Manuels
- Concertations on European Validation Experiments for coastal/shelf water remote sensing (CEVEx) (EEG) M.Wernand
- Coastal Surveillance Through Observation of Ocean Colour (COASTLOOC) (EEG) M.Wernand
- Dynamics of Internal Waves in Moving and Rotating Fluids (INTAS) (EEG) L.R.M. Maas

CONTINUOUS MEASUREMENTS FROM THE MARSDIEP FERRY









In a cooperation between NIOZ and TESO (Texels Eigen Stoomboot Onderneming) continuous observations from the ferry 'Schulpengat' will be performed, starting early 1998. The ferry covers the transect den Helder-Texel every 30 minutes daily between 06.00 and 22.00. Measurements include current velocity (using a ship mounted ADCP, Acoustic Doppler Current Profiler), salinity, temperature and fluorescence (using a flow-through system).

During a dock period of the ferry in december 1997 the ADCP was mounted near the haul of the ferry and the through-flow system was installed. The pictures show the ferry in the dock and the installation of the ADCP.

DEPARTMENT OF MARINE CHEMISTRY AND GEOLOGY

Within the department of Marine Chemistry and Geology (MCG) scientific efforts are organized within four research themes:
1. Biogeochemistry of carbon, phosphorus, silica, and sulphur in marine systems
2. Carbon and trace metals in the oceanic watercolumn
3. Palaeocenography
4. Sedimentation and sediment transport processes.

Within each of these research themes several projects, for the major part financed by national (NWO) and international (EU) agencies are carried out. Especially for themes 2 and 3 the cooperation with marine institutes in the Bremen region (AWI and University Bremen) within the BREMOC context has large influence for the near future. Five postdoc and PhD student positions became available for work on palaeoceanography in the Northern and Southern Atlantic Ocean, and for studies on the inorganic carbon system in the watercolumn of the southern- and the northern Atlantic Ocean and in the North Sea. Also the project on cycling/preservation of biogenic Si in marine sediments , originally started as a NIOZ PhD project, can be continued within the BREMOC context.

Wihin the framework of EU-MAST within theme 2 a project on CArbondioxide RegUlation in the SOuthern ocean (CARUSO) with NIOZ as the coordinating institute started in 1997.

Within theme 1 a NWO-GOA funded PhD project on Sedimentary Manganese and Iron cycLEs (SMILE) in cooperation with Utrecht University and NIOO-CEMO started in1997.

Within Theme 1 and 4 work will be continued in the EU funded ENAM-II (European North Atlantic Margins) and OMEX-II (Iberian Margin) and in the NWO funded Teluk Banten (Indonesia) Project.

In 1997 Dr. G. J. A. Brummer was appointed as staff member in MCG with responsibility for work on particle fluxes (sediment traps) and application of natural abundances of stable isotopes (^{13}C, ^{15}N) in biogeochemical processes.

EARLY DIAGENESIS OF PHOSPHORUS IN CONTINENTAL MARGIN SEDIMENTS

Contributor: *C.P. Slomp*

Most of the organic material in the oceans that reaches the sea floor is deposited on continental margins and their slopes, not in the deep-sea. This organic matter is the principal carrier of phosphorus to sediments. A part of the organic material is buried definitely. The other part decomposes, resulting in a release of dissolved phosphate to the pore water. The phosphate either returns to the overlying water and becomes available for uptake by phytoplankton, or is retained in the sediment in an organic or inorganic form. The research described here concentrated on the short-term processes controlling sediment phosphate release and retention in temperate, non-upwelling, continental margin environments. The project was financially supported with grants from NWO, EC-MAST and BEON.

The research commenced with a laboratory study on the effect of organic matter deposition and North Sea macrofauna on the sediment-water exchange and retention of phosphate in iron-poor, sandy sediments. The results of the 40-days experiment demonstrated that in this type of sediment, pore water concentrations and release fluxes to the overlying water are enhanced by the deposition of dead algal cells (*Phaeocystis* sp.). The macrofauna reworked the sediment but was not able to mix the organic matter deposited on the sediment surface into the underlying sediment layers. Thus, release processes at or close to the very top of the sediment determined the exchange fluxes and macrofauna had only a minor influence.

Adsorption of phosphate to iron oxides is the most important short-term process responsible for P-retention in sediments. Using a combination of differential X-ray diffraction and chemical extraction procedures, the character of the iron oxides that bind phosphate in four North Sea sediments was studied. The results provided evidence for the dominant role of poorly crystalline ferrihydrite and akageneite for the binding of phosphate in these sediments, and suggested that these iron oxides act as both temporary and long-term sinks for phosphate.

To obtain more insight in the (redox) cycling of iron and manganese, four sedimentary environments in the North Sea were studied in summer and winter. The quality and quantity of the organic matter deposited in each environment was found to determine whether sediments become sufficiently depleted of oxygen and nitrate to allow for iron and manganese reduction, and escape of dissolved Fe^{2+} and Mn^{2+} to the overlying water. A steady-state diagenetic model describing solid phase and pore water metal profiles was developed and applied to 14 sets of data. The model analysis showed that (1) reversible sorption in combination with sediment mixing can enhance

diffusive transport of dissolved iron and manganese; (2) precipitation of Fe^{2+} and Mn^{2+} in the form of, e.g., carbonates and sulphides, can explain the observed decrease of the concentration of dissolved metals at depth at many stations; (3) in most North Sea sediments, Fe and Mn oxides do not play an important role as redox intermediates in organic C-oxidation (accounting for < 4%), only in the Skagerrak metal reduction may contribute substantially to organic C oxidation (~20%).

The role of sorptive reactions in the sediment-water exchange of phosphate was investigated for 15 locations in the North Sea in winter and summer. At most stations adsorption of phosphate limited the exchange flux to the overlying water. At one station in the Skagerrak, however, desorption of phosphate from iron oxides, partly deposited here and partly formed *in situ*, was responsible for the maintenance of the release flux to the overlying water. Modelling the phosphate profiles confirmed that due to sorption processes both enhanced retention and enhanced release may occur.

The ultimate retention of phosphorus in marine sediments occurs through burial of P-containing authigenic minerals, which, in contrast to Fe-bound phosphate and organic compounds, may not be solubilized in deeper sediment layers. A combination of pore water and solid phase analysis was used to determine whether authigenic carbonate fluorapatite is currently forming at two locations on a North Atlantic continental platform (Goban Spur). Results of selective extractions suggested that an authigenic P-phase forms at the expense of Fe-bound P at both stations. Analysing the data with a steady-state early-diagenetic model indicated that the formation of carbonate fluorapatite can account for the observed increase of mineral-P with depth. Furthermore, the results showed that an intense cycling of phosphate between the pools bound to Fe and dissolved in the pore water at the redox boundary (Fe^{2+} - Fe^{3+}) can create conditions beneficial for CFA formation. This internal P-cycle is driven by downward bioturbational transport of mainly *in situ* formed Fe-bound P into the reduced sediment zone. Losses from the internal P-cycle due to Carbonate Fluor apatite (CFA) formation and phosphate fluxes to the overlying water are compensated for by adsorption of phosphate released from organic matter to iron oxides. Fe-bound P thus acts as an intermediate between organic P and CFA. Burial of CFA can account for 25-70% of the total burial flux of reactive P and thus may act as an important sink for P in this type of low sedimentation, continental margin environments.

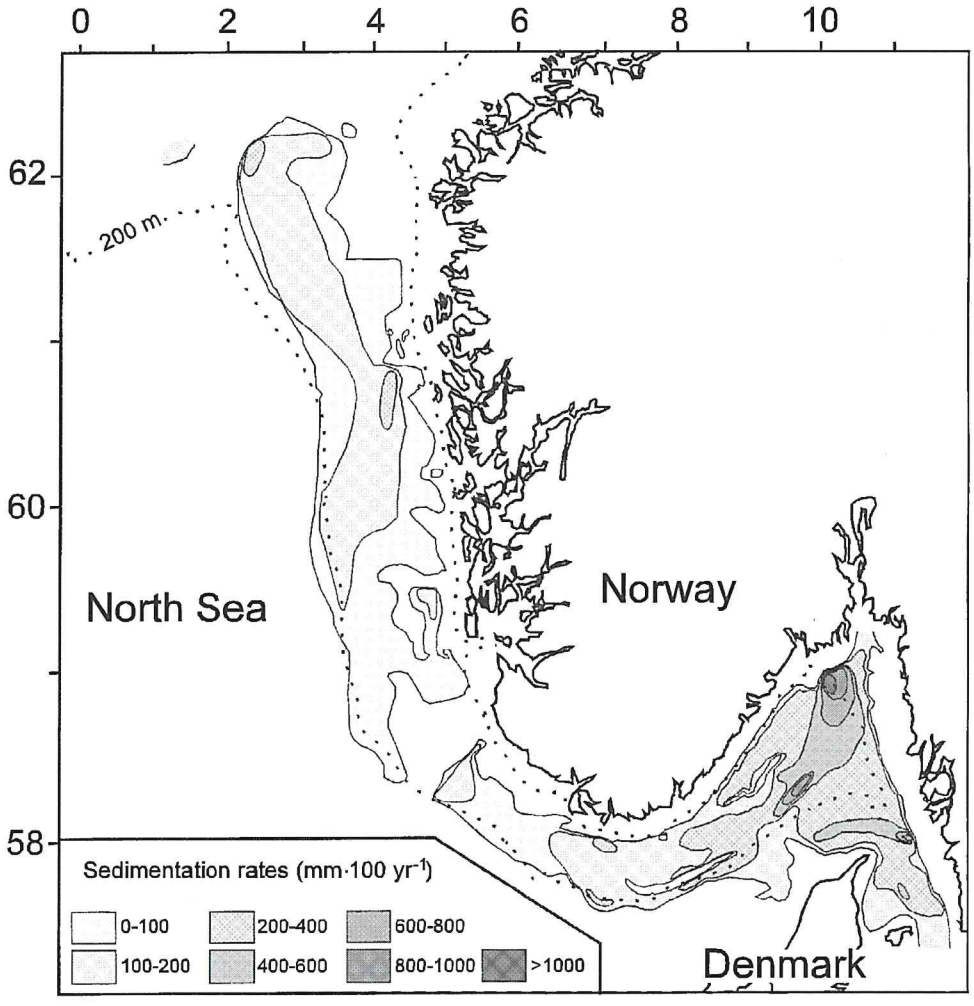
TRANSPORT, PRESERVATION AND ACCUMULATION OF ORGANIC CARBON IN THE NORTH SEA

Contributor: *H. de Haas*

Carbon in the form of carbon dioxide (CO_2) is one of the major contributors to the naturally occurring greenhouse effect. As a result of the increase in the combustion of fossil fuels by man, the amount of CO_2 in the atmosphere and therefore the greenhouse effect increases. In order to be able to forecast a reliable scenario of the possible future consequences of an increased greenhouse effect (climate change, melting ice caps, rising sea level, etc.) it is essential to understand the natural cycle of carbon in the geosphere and biosphere. In the marine environment CO_2 is incorporated into organic matter by algae during the process of photosynthesis. Organic matter containing organic carbon (C_{org}) is largely mineralized in the water column and at the sea floor. A small part however is buried in marine deposits, attached to fine grained sediments. In this manner a part of the carbon is withdrawn from the carbon cycle for a long period of time.

Shelf seas, like the North Sea, are important areas of primary production and therefore important possible sinks for C_{org}. The North Sea is a shallow shelf sea located in northwestern Europe. It is enclosed by the main land of Europe and the British Isles. Average water depth ranges from 40 meters in the south to 200 m meters at the shelf edge in the north. In the northeast two deep basins, the Skagerrak and Norwegian Channel, are located, having a maximum water depth of 750 and 400 meters, respectively. Transport of sediment, and thus organic matter transport in the North Sea, is largely dominated by the tides and wind induced waves and currents.

Measurements of sedimentation rates on box core sediments from the Norwegian Channel, using ^{210}Pb and ^{137}Cs isotopes, and 3.5 kHz and Chirp penetrating echo sounding data show that recent sedimentation rates in this area range from 3 to 28 cm/100 yr. Highest sedimentation rates occur in the northern Norwegian Channel. The present day deposition of sediments mainly occurs in the deepest part of the basin and in small local basins along the flanks of the Norwegian Channel. On a yearly basis $28x10^6$ tons of sediments are deposited in this area.



Geographical distribution of recent sedimentation rates in the northeastern North Sea.

The recent accumulation of fine grained sediments in the Skagerrak and northern Kattegat was determined in the same way as mentioned above for the Norwegian Channel. A total amount of $46x10^6$ tons/yr accumulates in this area. If the sediment accumulation rate in the Skagerrak and Norwegian Channel is combined with the C_{org} concentrations of the sediments, 1.8 and 0.6% on average, respectively, then the C_{org} accumulation in the two areas is calculated as 0.83 and $0.17x10^6$/yr. Of this amount only 10% is accounted for by local primary production. The remainder is produced elsewhere in the North Sea or imported from the Atlantic Ocean, Norwegian Sea, Baltic Sea and terrigenous sources. Storm-wave and -current induced bottom nepheloid layers are thought to be responsible for the transport of the fine grained sediments and the attached organic matter from the North Sea plateau into the Kattegat, Skagerrak and Norwegian Channel.

Determination of the burial of C_{org} in the North Sea outside the Skagerrak and Norwegian Channel reveals that the recent preservation of organic matter on the shelf is limited to ~$0.1x10^6$ tons/yr or about one tenth of the total carbon preservation in the North Sea. On large parts of the shelf sediments and organic matter are deposited only temporarily. Deposition mainly occurs during fair weather conditions, while storm events erode most of the deposits and transport the material further across the shelf. The majority of the fine grained sediments containing organic matter are transported over the shelf edge and deposited in the Norwegian Sea, Skagerrak and Norwegian Channel. The role of coarse grained sediments in the preservation of C_{org} in the North Sea is severely limited.

Piston cores, covering several thousands of years of sedimentary history, taken in the Skagerrak and Norwegian Channel, were studied in order to investigate the preservation of C_{org} on longer time scales. The grain size distribution of the sediments only partly explains the variation in C_{org} contents of the sediments in the Skagerrak and Norwegian Channel. Although grain size (clay content) explains the variation in C_{org} content of the sediments with time within each of the basins, it does not explain the difference between the two. The C_{org} density (the amount of C_{org} per square meter grain surface area) of the Skagerrak sediments is three times as high as in the Norwegian Channel deposits. Curie point pyrolysis-gas chromatography-mass spectrometry showed that there is a clear difference in the type of organic matter that is preserved in the Skagerrak and Norwegian Channel. The sediments in the Skagerrak contain a higher percentage of terrigenous organic matter than those in the Norwegian Channel. Since terrigenous organic matter is more difficult to mineralize than marine organic matter, the total amount of C_{org} in the Skagerrak sediments is higher. The preservation of C_{org} in the Skagerrak and Norwegian Channel is mainly a function of the sediment accumulation rate, grain size and type of organic matter.

Comparing the North Sea to other well studied shelf seas, it became clear that the preservation of C_{org} in the North Sea very well matches present day preservation processes on other shelves. All shelves show a C_{org} mineralization efficiency of 95% or more. On most of the shelves none or only a small fraction (<10%) of the preserved C_{org} is buried in the shelf sediments. The remainder is transported over the shelf edge and stored in canyons, on the continental slopes and abyssal plains. Only under exceptional conditions the preservation of C_{org} in the shelf sediments is higher. In all cases the preservation of C_{org} is a function of sediment accumulation rate, grain size and type of organic matter. On longer time scales (glacials-interglacials) fine grained shelf sediments containing organic matter are eroded and transported over the shelf edge, thus limiting the role of shelves as sinks for C_{org} even more.

EXTERNAL PROJECTS OF THE DEPARTMENT OF MARINE CHEMISTRY AND GEOLOGY

- Air-sea carbon-dioxide fluxes (NWO-NOP II)
  H.J.W. de *Baar, M.H.C. Stoll*
- Teluk Banten: Coastal marine sediments and sedimentation (NWO)
  T.C.E. van Weering, G. van de Berg, W. Boer
- Trace elements-Phytoplankton interactions (NWO-NAAP)
  H.J.W. de Baar, J.T.M.. De Jong, R.F, Nolting
- Cycling of silicate (NWO)
  A.J. van Bennekom, E. Koning, G.-J.A. Brummer, J. Van Iperen
- Biological availability of trace elements
  H.J.W. de Baar
- Neogene history of the Benguela Current
  J.H.F. Jansen
- Sedimentary manganese and iron cycles (SMILE; NWO-GOA)
  W. Van Raaphorst, C. van der Zee, W. Helder, J.F.P. Malschaert
- European North Atlantic Margins (ENAM; EC-MAST)
  T.C.E. van Weering, H.J. de Stigter, H. De Haas, W. Boer
- Remote sensing of water quality (RESTWAQ; BCRS)
  W. Van Raaphorst
- Air-sea gas exchange of MAGE (ASGAMAGE; EC-MAST)
  H.J.W. de Baar, M.H.C.Stoll
- Marine ecosystem regulation: Trace metals and carbon dioxide regulation (MERLIM; EC-MAST)
  H.J.W. de Baar, K.R. Timmermans, R.F. Nolting, J.T.M. de Jong
- Mass transfer and ecosystem response (MATER; EC-MAST)
  W. Helder, E. Koning, H.T. Kloosterhuis
- Autonomous lander instrument packages for oceanographic research (ALIPOR, EC-MAST)
  W. Helder, T.C.E. van Weering, L. Lohse, H. Franken, B. Koster)
- Biogases in European estuaries (BIOGEST; EC-MAST)
  W. Helder, H.P.J. de Wilde
- Ocean margin exchanges (OMEX; EC-MAST)
  W. Helder, T.C.E. van Weering,, W. Van Raaphorst, W. Boer, J.C. van Ooyen, K. M.J. Bakker, H.T. Kloosterhuis, L .Lohse, H.J. de Stigter, H. De Haas
- Combined action to study the oceans thermal skin (CASOTS, EC-MAST)
  H.J.W. de Baar

DEPARTMENT OF MARINE BIOGEOCHEMISTRY AND TOXICOLOGY

An overview of the research topics within the department of Marine Biogeochemistry and Toxicology (MBT).

The central theme of research of this department is the fate of organic compounds in the marine environment.

The major research topics are:

* **Occurrence, structural elucidation and role in the global carbon cycle of resistant bio-macromolecules (particulate and dissolved organic carbon, and kerogen).**
* **Examination of molecular indicators from palaeoenvironments to decipher (i) palaeo sea surface temperatures in upwelling systems, (ii) environmental conditions at crisis events, called boundaries, to discriminate between natural (e.g. astronomically induced) changes, and man-induced variations in the present day climate, (iii) the presence of photic zone anoxia in depositional environments in relation to the mechanisms of oil genesis, and (iv) diagenetic pathways of organic sulphur compounds and carotenoids. Within this theme, an NWO PIONIER project was granted previously, which will expire in 1998.**
* **This year, a very fruitful co-operation was established with the Department of Biological Oceanography, especially with Dr. W. Klein Breteler, to study the effects of zooplankton herbivory on the carbon isotopic compositions of algal lipids (see project of Dr. K. Grice below).**
* **Exchange processes of organic contaminants between different environmental compartments of the marine environment (water, atmosphere, particulate matter, food web), and enzyme mediated reactions occurring in biota. The aim is to understand the physical and biogeochemical processes that determine the distribution of these contaminants over different compartments of the marine environment and their toxic effects, in relation to their molecular properties.**
* **Impact of organotin compounds on the reproductive performance of marine gastropods (snails). The development of imposex (i.e. the formation of male sexual characteristics in female animals) appears to be a widely occurring phenomenon, which affects different snail species in a different manner at the population level. The influence of beam-trawl fishery on stocks of the common whelk (*Buccinum undatum*) in the North Sea and the Wadden Sea was investigated in a close co-operation with the department of Marine Ecology (Drs. M.J. Bergman, Dr. G.C. Cadée and Dr. M. Fonds).**

THE DEPOSITIONAL ENVIRONMENT OF JURASSIC ORGANIC-RICH SEDIMENTARY ROCKS IN NW EUROPE. A BIOMARKER APPROACH.

Contributor: *H.M.E. van Kaam-Peters*

Sedimentary organic matter consists of thousands of compounds, remains of once living organisms (algae, bacteria, zooplankton, vascular plants etc.). Certain compounds are diagnostic of specific (groups of) source organisms. Hence, these compounds are "biomarkers", providing information about forms of life at the time of deposition. Additional information on the origin of biomarkers (e.g. habitat of the source organism, way of carbon uptake of the source organism) can be inferred from the stable carbon isotopic composition of the biomarkers.

The project focused on a better understanding of depositional conditions of Jurassic organic-rich sedimentary rocks, using advanced analytical techniques (gas chromatography-mass spectrometry, compound-specific stable carbon isotope analysis) to unravel composition and origin of organic matter. Particular attention was paid to organic sulfur compounds, which had proven valuable biomarkers in earlier studies of Cretaceous and younger samples. Three different sedimentary sequences, located in France, England and Germany, were studied.

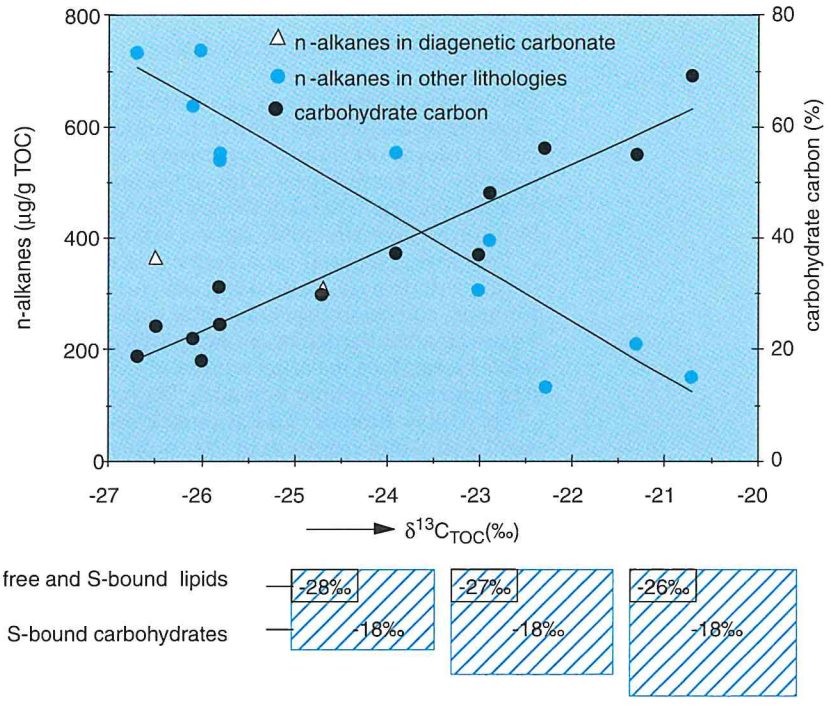
The Upper Jurassic "Calcaires en Plaquettes" Formation was deposited in a lagoonal environment and today crops out in the southern Jura mountains of France. The sedimentary sequence consists of massive limestones and laminated limestones, which were examined at the millimetre scale. Four carefully isolated laminae (light/parallel, dark/parallel, light/undulated, dark/undulated) and a massive limestone sample were analysed. The gross molecular composition of organic matter appeared similar in all samples. Extractable biomarkers are dominated by sulfur-bound *n*-alkane and hopanoid carbon skeletons. Derivatives of isorenieratene are relatively abundant. Upon pyrolysis (= heating in absence of oxygen) of the kerogen (= insoluble organic matter), predominantly organic sulfur compounds are produced. The organic matter in the light-coloured, undulated lamina is distinguished from that in the other samples by differences in the concentrations and distributions of a number of biomarkers. These differences are ascribed to the periodic occurrence of benthic microbial mats. The vast majority of the organic matter in all

samples, however, is derived from sulfur-bound planktonic lipids produced at times that bottom waters were euxinic and microbial mats were absent.

Samples from the Kimmeridge Clay Formation in Dorset (England), covering all different lithologies, contain abundant isorenieratene derivatives derived from photosynthetic green sulfur bacteria. This provides the first evidence for euxinic conditions in the photic zone in the palaeoenvironment. The positive correlation between total organic carbon (TOC) content and the stable carbon isotopic composition of TOC ($\delta^{13}C_{TOC}$) reported previously for shales was found to hold also for limestones if a correction is made for the dilution by carbonate. Since the $\delta^{13}C$ values of algal biomarkers exhibit only small changes among the samples, variations in $\delta^{13}C_{TOC}$ cannot have resulted from changes in the ^{13}C content or concentration of dissolved CO_2. The relative abundance of carbon isotopically heavy C_5-C_7 thiophenes produced upon pyrolysis of the kerogen is positively correlated wih $\delta^{13}C_{TOC}$. These thiophenes are probably partly derived from sulfurised carbohydrates, which are enriched in ^{13}C by several ‰ compared to lipids. The increasing proportion of thiophenes released upon kerogen pyrolysis with increasing $\delta^{13}C_{TOC}$ is coupled with an increasing proportion of orange, organic sulfur-rich, amorphous organic matter as observed by microscopy. Thus, our data suggest that an increasing sulfurisation of organic matter was accompanied by an increasing sulfurisation of carbohydrates, which due to their relatively high ^{13}C contents caused an increase in $\delta^{13}C_{TOC}$.

The third sample set was taken from the Lower Toarcian of SW Germany. Black shales of Early Toarcian age are found in many parts of the world, and their global occurrence has been explained by others by an oceanic anoxic event. This hypothesis was based on the positive carbon isotope excursion of Early Toarcian limestones in several of the Tethyan sections. Through the burial of large amounts of organic matter, which is rich in ^{12}C, the global carbon reservoir would have become relatively enriched in ^{13}C, explaining the increase in $\delta^{13}C$ of the limestones. However, in the same interval in the SW German section, both organic and inorganic carbon exhibit a negative isotope excursion. Our biomarker and compound-specific stable carbon isotope data indicate that this negative carbon isotope excursion was caused by changes in the ^{13}C content or concentration of dissolved CO_2 in the photic zone. This implies that the Early Toarcian oceanic anoxic event was not a true global event. As suggested previously by Küspert (1982), the negative excursion of $\delta^{13}C_{TOC}$ probably resulted from the mixing of isotopically light CO_2, derived from the bacterial decomposition of organic matter in anoxic bottom waters, with the atmospheric-derived CO_2 in the surface waters.

In summary, this work has led to a detailed reconstruction of the depositional environment of different organic-rich sedimentary rocks from the Jurassic of NW Europe. In addition, sulfur-bound biomarkers were shown to be stable over time spans of at least 150 million years, provided that they are not exposed to elevated temperatures during burial. Finally, evidence was presented that relatively labile carbohydrate carbon can be preserved through sulfurisation



Graph showing opposite trends in the amounts of lipid carbon (*n*-alkanes) and carbohydrate carbon (calculated from carbon isotope data) in samples from the Kimmeridge Clay Formation. *n*-Alkanes in the diagenetic carbonates have probably partly been consumed by bacteria involved in the post-depositional formation of dolomite, which explains the relatively low *n*-alkane concentrations in these samples. White and shaded rectangles represent proportions of lipid respectively carbohydrate carbon along the $\delta^{13}C_{TOC}$ gradient (not to scale).

IN VITRO BIOTRANSFORMATION OF ORGANOHALOGEN COMPOUNDS. POSSIBLE CONSEQUENSES FOR THEIR BIOACCUMULATION AND GENOTOXICITY.

Contributors: *J.P. Boon, W.E. Lewis, H.M. Sleiderink, C.M.E. van Hezik, M.T.J. Hillebrand*

This project lasted from 1994 to 1997 and was funded by BEON (Applied Ecological Research North Sea and Wadden Sea). It was carried out in co-operation with the Netherlands Institute for Fisheries Research (RIVO-DLO; residue analyses in wildlife), and the Government Institute of Coastal and Marine Management (RIKZ; mutatox ® assays for genotoxicity). Samples from recently died animals were obtained from the Marine Educational Centre 'Ecomare' at Texel, the Harderwijk Marine Mammal Centre (Ir. R. Kastelein), and the State University of Michigan (Prof. Dr. J. Giesy).

A number of highly lipid-soluble halogenated organic contaminants are well known for their persistence in the environment and their bioaccumulation through marine food chains. Classical examples of such classes of compounds are the polychlorinated biphenyls (PCBs), which have been studied at NIOZ for many years. There are, however, a number of other halogenated organic contaminants about which there is little knowledge with respect to their bioaccumulation and occurrence in the North Sea and the Wadden Sea. If such compounds would indeed be present in these waters, the highest concentrations are expected in lungbreathing top-predators, because these animals lack the ability of fish and macrobenthos to excrete these compounds via the gills. On the other hand, lung breathing animals have a stronger ability to alter the chemical structure of the pollutants by enzyme-mediated reactions. This process is called biotransformation. Biotransformation enzymes occur in many organs, but the liver is the most important. Enzymes of the cytochrome P450 dependent mono-oxygenase system play a central role in biotransformation processes of man-made organohalogen compounds by adding oxygen to the molecule, mostly by replacement of a hydrogen (H^+) atom by a hydroxy (OH^-) group.

Since experiments with marine mammals and birds are very difficult to conduct, the availability of a cheap alternative method to study the ability of marine top-predators to metabolise organic contaminants would be fruitful. In this project, an *in vitro* method was developed, which makes use of the membrane-bound cytochrome P450 enzyme complex isolated as microsomes from liver homogenates of animals which could be sampled within a few hours after death. The assay was validated with PCBs, because for this class of compounds the results of the *in vitro* test could be compared with the *in vivo* results obtained in earlier studies.

Since the results with PCBs were positive, other classes of compounds about which much less was known, could be studied. These were the insecticides toxaphene and chlordane; the polybrominated biphenyl (PBB) and diphenylether (PBDE) flame retardants and the polychlorinated terphenyls (PCTs), which have industrial application similar to the PCBs. *In vitro* studies were performed with microsomal preparations of sperm whale (*Physeter macrocephalus*), whitebeaked dolphin (*Lagenorhynchus albirostris*), harbour porpoise (*Phocoena phocoena*), harbour seal (*Phoca vitulina*), and Laysan albatross (*Diomedea immutabilis*), or eider duck (*Somateria mollissima*).

The initial results for **toxaphene** have already been described earlier. Last year, *in vitro* assays in which different iso-enzymes of cytochrome P450 were selectively inhibited have shown that a cytochrome P450 3A-like isoform (CYP3A) is involved in the biotransformation of two model chlorobornanes (CHBs) in the harbour seal. The *in vitro* assay was also used to study the enantiomeric preference of the biotransformation reaction of these two optically active chlorobornanes.

The technical mixture and one of the four individual chlorobornanes (CHB-32) showed a positive response in the mutatox® microbial assay for genotoxicity, which disappeared after biotransformation. A hypothetical reaction was put forward which explains why hydroxylation of CHBs by cytochrome P450 would make the formation of CHB-DNA adducts impossible.

Chlordanes tested were *cis*- and *trans*chlordene, *cis*- and *trans*-chlordane, *cis*- and *trans*-nonachlor, and heptachlor. Harbour seal microsomes metabolised all these compounds except *trans*-chlordene. Microsomes of sperm whale however metabolised only this compound. Microsomes of whitebeaked dolphin metabolised *trans* chlordene, *trans*-chlordane and heptachlor. Microsomes of eider duck metabolised these same compounds plus *cis*-chlordane. Heptachlor was metabolised exclusively to heptachlor epoxide B (and not to heptachlor epoxide A). Other metabolites formed were oxychlordane and another unknown metabolite.

When these results were compared to the results of the residue analyses which were analysed at the RIVO-DLO, the following conclusions were drawn:
Heptachlor epoxide B is also the only metabolite of heptachlor in the residues in wildlife.
The ratio parent compounds: metabolites decreases in the order sperm whale > whitebeaked dolphin > eider duck > harbour seal. This is also the order of increasing biotransformation activities in the *in vitro* assays.
An important difference between the *in vitro* assays and the residue patterns in wildlife is the relatively high concentration of the metabolite oxychlordane in the residues, whereas this metabolite was only synthesized in relatively small amounts in the *in vitro* assays.

The mixture of parent chlordane compounds showed a positive response in the mutatox® microbial assay for genotoxicity, which, like for toxaphene, disappeared after allowing for biotransformation.

For the **aromatic** compounds, no indication for biotransformation was obtained from the *in vitro* assay for both classes of brominated flame retardants, with the exception of the compound 4,4'-dibromobiphenyl which was rapidly metabolisable in all species of marine mammals tested, but not in the eider duck. A limited number of **polychlorinated terphenyls** (PCTs) were metabolisable by the harbour seal, but not by the other species tested.

Thus, in summary, minimal to sometimes quite extensive metabolism was observed for the classes of compounds tested, but within each class of compounds there were persistent representatives in the *in vitro* assay. Consequently, residues of such compounds should be expected in adipose tissues of marine mammals and birds when these had been exposed during their life-time in the Wadden Sea, the North Sea, or the eastern North Atlantic Ocean. Indeed, residues of all classes of the compounds investigated were measured in samples of marine mammals and birds; very often from the same animal of which the liver was used for the preparation of microsomes for use in the *in vitro* assay. Especially their presence in three sperm whales shows, that the occurrence of these classes of compounds is not limited to coastal waters and shelf seas, but have reached the open ocean. So, similar to the well-studied PCBs and DDT-like compounds, they can be characterized as global pollutants. Especially with respect to the brominated fire retardants, which are still currently allowed for use, e.g. in household electrical equipment, this would justify more attention from policy makers.

In the *in vitro* assay, the predator/prey relation in the real life situation is replaced by a suspension of liver microsomes of the predator in an erlenmeyer flask, which is fed by a solution of the test contaminants from a pipette.

DEVELOPMENT OF AN ALGORITHM FOR THE AUTOMATED PROCESSING OF GC/MS DATA.

Contributor: *W.G. Pool*

The separation of mixtures of natural or anthropogenic compounds by gas chromatography and on-line detection by mass spectrometry (GC/MS) is used in many diciplines. In spite of many attempts, a direct interpretation of measured GC/MS spectra is still difficult, generally, and often impossible because of background noise, skewing, and incomplete peak separation.

- Background noise: GC/MS data contain noise from several sources: *i*) Chemical noise resulting from column bleeding and the myriads of minor components present in all samples; *ii*) statistical noise resulting from the nature of the ionisation and fragmentation processes in the ion source and from the detection process of the ions; and *iii*) white noise added by the electronic circuits that amplify the signal after detection. It should also be noted that the limitations of analog digital convertors and the constraints used in peak detection algorithms can distort GC/MS data.
- Skewing: During the measurement of each scan, the concentration of components in the ion source changes. When scanning from high to low masses this causes a bias for the low mass intensities in the upslope and a bias for the high mass intensities in the downslope portion of the chromatographic peak.
- Incomplete separation of compounds: Extracts of samples of organic-rich layers of sediments always contain a very complex mixture of natural organic compounds. The same can be true for biota exposed to complex mixtures of anthropogenic substances. When complex mixtures of compounds are analysed the chromatographic column can often not separate all the components in the sample completely. Therefore, there will be mass spectra in the data set containing signals from more than one component.

Several methods have been described in the literature to cope with such problems. None of these, however, is widely adopted.

The object of this study was twofold: An examination of the existing methods, and the development of an algorithm for the automated processing of GC/MS data in the absence of *a priori* knowledge.

The existing methods of GC/MS data processing can be grouped into four approaches, *i)* inspection of chromatographic peak profiles; *ii)* library searching; *iii)* regression analysis and; *iv)* principal component analysis (PCA). Methods based on chromatographic peak profiles exploit the fact that a component emerging from the gas chromatographic column causes a maximum in each of the *m/z* channels present in its spectrum. It is obvious that limited chromatographic resolution and the absence of unique masses in the spectra are major difficulties here. Methods based on library searching are, of course, limited by the availability of library spectra, but are well suited for the identification of target compounds. Methods based on PCA and regression have difficulties in finding the correct number of components in the data and perform badly when components with very similar spectra are present.

All methods for the processing of GC/MS data suffer from skewed spectra. Gas chromatography is a continuous process, whereas mass spectrometry generally measures only one mass at the time. Because of that, different molecular masses are measured sequentially and their intensities are skewed: they reflect the change in concentration of the component in the source during the time it needs to scan the full range of masses selected. It can be expected that any algorithm will benefit from the availability of intensities taken at the same time position. Therefore, the first step to be taken in the processing of GC/MS data is the calculation of the intensities for each mass value of a complete scan as if they were all measured at the same time at the start of the scan.

To bypass the shortcomings of the methods described in literature a new method was developed which is based on backfolding. Backfolding itself is a two-step approach. First the intensities in each scan are subtracted, mass by mass, from those in the next scan. Positive and negative results are stored in separate sets of data. Then these sets of differentiated data are recombined. By this approach chromatographic resolution is enhanced and slowly changing signals are removed from the data. The backfolding algorithm can be repeated several times until the results converge and the chromatographic resolution is not further improved. At that stage each component spectrum is concentrated in only two scans. Special properties of the data matrices obtained with backfolding allow the detection of the components and the selection of unique mass peaks in the time window of each component in the backfolded data. With these unique peaks individual chromatograms can be constructed which are then used to calculate component spectra.

Quantification of the signals of spectra is achieved by pre-multiplying the data matrix with the chromatogram of each component. This product is multiplied with the generalised inverse of the spectrum of that component. This one-by-one approach circumvents the problem of singularity of the spectrum matrix that occurs when components with similar spectra are present.

The results obtained with the algorithm described above indicated that this approach of GC/MS data processing is promising. The shortcomings of other approaches were largely withdrawn because the problems one generally encounters in the processing of GC/MS data were addressed almost systematically.

IDENTIFICATION OF NEW SEDIMENTARY BIOMARKERS AND STABLE CARBON ISOTOPIC COMPOSITIONS OF ARCHAEAL AND ALGAL LIPIDS

Contributor: *S. Schouten*

New biomarkers

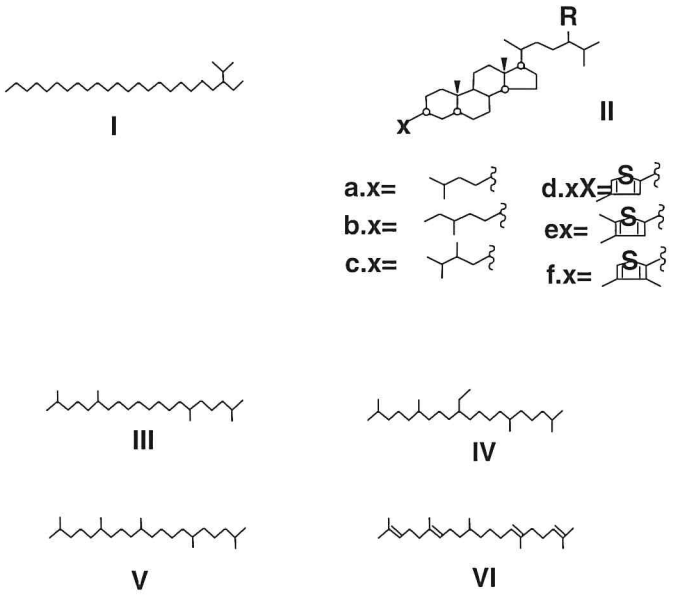
In the last few years a number of as yet undiscovered compounds have been detected in sediments or biota. Either through synthesis or isolation and subsequent NMR analyses, the structures of these compounds have been rigorously established. A few examples will be highlighted in the figure below.

C_{27} and C_{29} 3-isopropyl alkanes (eg. I) have been unambiguously identified in sediments from the Jurassic Kimmeridge Clay Formation through synthesis of a standard. The covarying concentrations and similar stable carbon isotopic compositions of C_{21} and C_{23} *n*-alkanes, C_{25} and C_{27} *iso* alkanes and C_{27} and C_{29} 3-isopropyl alkanes suggest a common, though unknown, biological source. Probably these compounds are all products of an, as yet unknown, biosynthetic scheme ultimately leading to the formation of isopropyl alkanes.

A novel series of thiophenes with C-3 alkylated steroid carbon skeletons (IId-f) has been identified in sediments of the Miocene Monterey Formation (California, USA) and in the Cretacous Tarfaya Basin (Morocco). Their carbon skeletons are unusual in the sense that the alkyl side-chains at C-3 are almost exclusively isopentyl, 3-methylpentyl and 2,3-dimethylbutyl moieties (IIa-c) whilst *n*-alkyl (pentyl or hexyl) moieties are almost absent. Although their occurrence as thiophenes, the number of carbon atoms in the C-3 alkyl side-chain and their carbon isotopic compositions point towards an origin from carbohydrates for the C-3 alkyl side-chain, the branched structures of the C-3 alkyl side-chains indicate a different biosynthetic pathway, possibly starting from the addition of isopentylpyrophosphate to sterols.

A novel C_{24} acyclic isoprenoid, 2,6,15,19-tetramethylicosane (TME; III), has been unambiguously identified, using a synthesised standard, in the saturated hydrocarbon fractions and in the kerogen pyrolysates of samples from a Cretacous black shale from SE France. In addition, a novel C_{26} acyclic isoprenoid, 10-ethyl-2,6,15,19-tetramethylicosane (IV), was tentatively identified. These compounds appear to be structurally strongly related to the relatively well-known C_{25} isoprenoid 2,6,10,15,19-pentamethylicosane (PME; V), and their co-occurrence in these sediments and similar ^{13}C-contents indicates a common origin. This suggests an alternative biosynthetic pathway for the biosynthesis of PME *via* the methylation of TME rather than the tail-to-tail coupling of farnesyl and geranyl. These irregular isoprenoids are likely to have originated as parts of ether lipids in some unknown archaea.

In a collaborative study with the Universities of Groningen and Regensburg, we have examined the lipids of a number of methanogenic archaea. 2,6,10,15,19-Pentamethylicosenes containing 3-5 double bonds were found in the methanogenic archaea *Methanosarcina mazei* (strain DSM 3338), isolated from sewage sludge, and in *Methanolobus bombayensis* (strain OCM 438), a non-extremophilic archaeon isolated from a marine sediment. These findings gave additional support for the use of compounds with the PME carbon skeleton as markers for methanogenic activity in marine environments. A tetra-unsaturated pentamethylicosane (VI) was isolated from *M. mazei* and its structure was established by NMR experiments, performed in collaboration with the University of Amsterdam.



Structures and biosynthetic compounds.
I 3-isopropyl alkanes
II C-3 alkylated steroids
III TME
IV 10-ethyl-2,6,20,15,19-tetramethylicosane
V PME
VI tetra-unsatureted PME

Compound specific isotope analyses of archaeal and algal lipids

In collaboration with the University of Utrecht and Skideway Oceanographic Institute (USA) a detailed investigation was performed on the presence of lipids of planktonic archaea. Acyclic and cyclic biphytanes derived from the membrane ether lipids of archaea were found in water column particulate and sedimentary organic matter from several oxic and anoxic marine environments. Compound specific isotope analyses of the carbon skeletons suggested that planktonic archaea utilize an isotopically heavy carbon source such as algal carbohydrates and proteins or dissolved bicarbonate. Due to their high preservation potential, these lipids provide a fossil record of planktonic archaea and suggest that they thrived in marine environments for more than 50 Ma.

In collaboration with Dr T. Eglinton, Woodshole Oceanographic Institute (USA), a number of surface sediments of the Black Sea were analysed for the stable carbon isotopic compositions of C_{30} diols. Through the HI-degradation technique, developed at NIOZ, these data could be fairly easily obtained. The compounds were found to be isotopically depleted compared to other biomarkers. These data fitted nicely with the observed ^{13}C-depletion of *n*-alkanes released upon pyrolyses of the kerogens of the sediments. This is in complete accordance with previous findings by the Department of MBT that Eustigmatophytes biosynthesize insoluble, non-hydrolyzable biopolymers which are resistant against biodegradation and end up in the sediments.

In collaboration with Dr. Wim Klein Breteler of the Department of Biological Oceanography, biosynthetic fractionation effects of lipids of algae were studied. Thirteen algae species covering a broad range of classes were cultured and their lipids were analysed for their stable carbon isotopic compositions. The fatty acids were found to have similar stable carbon isotopic compositions in all the algae studied with the exceptions of the C_{28} fatty acid in *Scenedesmus communis* and the polyunsaturated fatty acids in *Ampidinium* sp. and *Gymnodinium simplex* which are by 3.5‰ more depleted in ^{13}C and up to 8‰ more enriched in ^{13}C, compared to the C_{16} fatty acid, respectively. Phytol, derived from chlorophyll, is consistently enriched in ^{13}C by 2-5‰ compared with the C_{16} fatty acid in all algae, consistent with the use of the Rohmer pathway. The sterols are, however, consistently more enriched in ^{13}C by 0-8‰ compared to the C_{16} fatty acid, probably since they derive from a different pool of isopentylpyrophosphate, the precursor of poly-isoprenoids, in the cytosol. These findings are different from the classical predictions in the geochemical literature where (poly)isoprenoids are thought to be 1.5‰ enriched in ^{13}C compared to straight chain compounds. These large ranges in carbon isotopic compositions of lipids biosynthesised by the same eukaryotes significantly complicate the interpretation of $\delta^{13}C$-values of sedimentary biomarkers.

STABLE CARBON ISOTOPIC ANALYSIS OF SEDIMENTARY AND ALGAL LIPIDS

Contributor: *Kliti Grice*

"Hypersalinity" is generally defined as a water regime with a salinity concentration exceeding 40‰. The evaporation of seawater in arid or semi-arid regions can lead to the precipitation of salts with halites predominating. Variations in evaporation rates can lead to different lithological deposits with a salt concentration gradient which has shown to have an effect on the distributions of biota according to their halotolerant/halophilic properties.

Over the past decade, considerable interest has been devoted to the study of hypersaline environments. Since the advent of stable carbon isotope biogeochemistry further information has been provided about the sources of biological markers. However, the $\delta^{13}C$ data of biomarkers obtained from hypersaline ecosystems has, so far, provided a limited amount of information on palaeoenvironments of deposition. In this project, biomarkers in sediments from quite a unique hypersaline ecosystem (*e.g.* Dead Sea Basin, Israel) have been studied to help to provide a better understanding of the nature of these forever changing environments.

A series of halite/carnallite (Miocene/Pliocene in age) deposits from the Mount Sdom Formation (Dead Sea Basin, Israel) were analysed. The hydrocarbon fractions show a predominance of C_{21+} regular isoprenoids. Their $\delta^{13}C$ contents are enriched in ^{13}C, by up to 7‰, compared to the biomarkers of presumed phytoplanktonic origin (*i.e.* steranes and hopanes) within the same sediment, in agreement with a source other than algae and cyanobacteria, thus tentatively assigned as halophilic archaea. It is thought that these components could be derived from ether-bound membrane lipids of halophilic archaea. The lack of intact ether-bound lipids in the polar fractions indirectly infers that such components have already been released at early stages of diagenesis. Based on biomarker distributions, $\delta^{13}C$ contents and mineral compositions, these sediments appear to have been deposited in a salinity stratified water body with a bottom water brine. Continual evaporation and deposition of the higher salts (*i.e.* carnallites) are favourable conditions for the growth of halophilic archaeal communities. In the present day Dead Sea, a close heterotrophic relationship exists between the unicellular green algae of the genus *Dunaliella* and the halophilic archaea, which are often abundant in the same habitats. The halophiles readily feed off the biosynthetic products (in particular glycerol) of the *Dunaliella*. This heterotrophic relationship generally occurs after the development of *Dunaliella* blooms. Perhaps during Miocene/Pliocene times a similar primitive ecosystem existed. Furthermore, high growth rates during the development of *Dunaliella* blooms may explain why the lipids biosynthesised by the halophiles are considerably enriched in ^{13}C. High growth rates result in less discrimination against ^{13}C, leading to an enrichment in ^{13}C of biomass.

Two other sediments from the Mount Sdom Formation contain a novel series of organosulfur compounds (OSC) derived from functionalised lipids of the three races (A, B and L) of the freshwater algal species *Botryococcus braunii*. Desulfurisation of the polar fractions released high amounts of apolar components, attributed to the major part of the macromolecular matrix being comprised of multiple sulfur-linked biomarkers derived from a limited number of highly functionalised lipids of *Botryococcus*. Most of the OSC appear to be early thermal released products of sulfurisation, from labile high-molecular-weight OSC. Carbon isotopic signatures of the individual biomarkers derived from three races are widely dispersed. For example, $\delta^{13}C$ values of components derived from the L race are *c.* -21‰ and those from the B race are significantly enriched in ^{13}C having values in the -10‰ to -13‰ range. Overall, B and L race derived components are 13‰ to 20‰ and 5‰ to 7‰, respectively more enriched in ^{13}C than phytoplanktonic biomarkers of marine origin. Stable carbon isotopic data of the *B. braunii* components points to differing bloom periods for the three races. The specific structures of these biomarkers provide compelling evidence for the existence of freshwater algae in ancient hypersaline environments in a stratified water body. The presence of abundant OSC in both sediments indicates that sulfate reduction must have been an important microbial process in the palaeoenvironment. Furthermore, the presence of isorenieratane in one of the sediments indicates that there must have been periods when the anoxic zone extended into the photic zone. An enhanced salinity gradient (upper freshwater layer overlying saline deep waters) mainly from evaporation may have assisted the development of photic zone anoxia. Other biomarker parameters contradict this phenomenon, thus, it is likely that the euphotic zone fluctuated between freshwater and hypersaline conditions as a result of periodic marine and freshwater inputs in an arid climate.

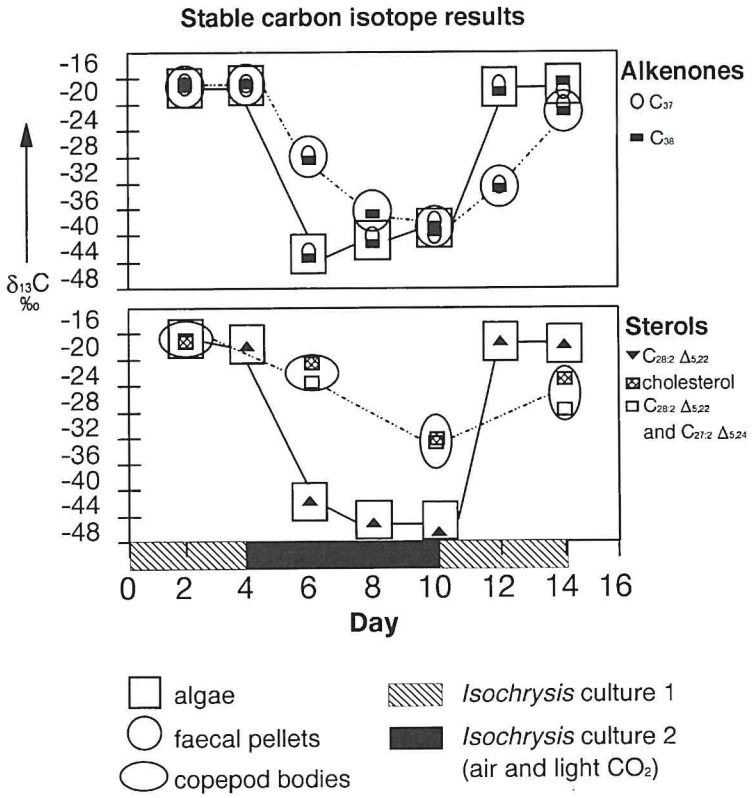
As studies on isotopic fractionations of biological constituents within food webs have been limited, we have carried out a series of continuous culture feeding experiments (involving a collaboration with W.C.M. Klein Breteler, Department of Biological Oceanography) using the copepod *Temora longicornis* as mesozooplankton to assess the effect of zooplankton herbivory on the stable carbon isotopic compositions of algal markers. Three independent grazing experiments were performed utilising the following algal food sources: cryptophyte (*Rhodomonas sp.)*, prymnesiophyte (*Isochrysis galbana*) and an alternating feeding experiment using two cultures of prymnesiophyte (*I. galbana*); one of the cultures was the same one as that used in the second experiment. The second culture used was fed with air and isotopically light CO_2. In the alternating feeding experi-

ment the food supply was switched from one culture to the other after a number of days and then switched back again. Faecal pellets released by the copepods, an aliquot of the algal food source and a number of copepod bodies were collected every two days typically over a time period of one to two weeks.

The major sterol biosynthesised by the two algal species studied is 24-methyl cholesta-5,22-dien-3β-ol ($C_{28:2}$ $\Delta^{5,22}$). Systematic compositional differences were noted between sterols of the algae, zooplankton and faecal pellets. 24-methyl cholesta-5,22-dien-3β-ol and cholest-5-en-3β-ol ($C_{27:1}$ Δ^{5}, cholesterol) were the two dominant sterols excreted from *Temora*; cholesterol and cholesta-5,24-dien-3β-ol ($C_{27:2}$ $\Delta^{5,24}$) were the two main sterols retained in *Temora*. In *Isochrysis*, the isotopic composition of the precursor sterol 24-methyl cholesta-5,22-dien-3β-ol was similar to the sterols (in particular cholesterol) of the zooplankton. The latter results indicate that any possible isotopic fractionations that may occur during demethylation of 24-methyl cholesta-5,22-dien-3β-ol at the C-24 position are indeed negligible. A similar observation was observed when the zooplankton was fed with the *Rhodomonas* sp. In addition to sterols, the *I. galbana* also biosynthesises a high relative abundance of long-chain alkenones (C_{37} and C_{38}). The alkenones passed through the guts of the zooplankton and their distributions and stable carbon isotopic compositions in the faecal pellets were identical to those in *Isochrysis*.

Results of the alternating feeding experiment show that lipids excreted and retained / produced in the zooplankton are coming directly from the algal food source. After the change in food supply the stable carbon isotopic composition of the lipids in the zooplankton and pellets gradually change in the direction of the $\delta^{13}C$ of the algal food source. Alkenones not utilised by the zooplankton reach "isotopic stability" at a faster rate (4-6 days) than the sterols used by the zooplankton.

With respect to zooplankton herbivory, the $\delta^{13}C$ values of sedimentary derivatives of cholesterol (*e.g.* 5α-cholestane) are indicative of primary producers in the euphotic zone and thus can be used as a reliable "average isotopic reference" point for algal lipids when reconstructing ancient environments of deposition. Ratio of alkenones and their isotopic compositions are unaffected by zooplankton herbivory, thus this process does not invalidate the use of alkenones as a proxy for sea surface temperature and pCO_2.

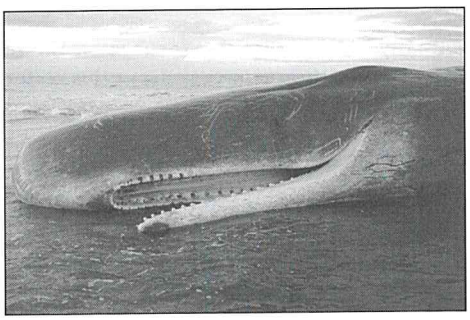
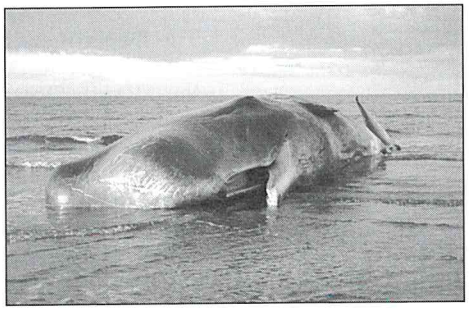


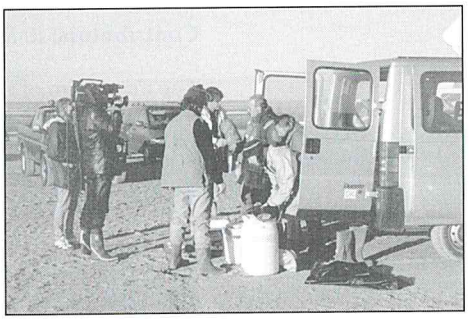
Stable carbon isotopes of algal lipids to show acclimation of feeding and metabolic requirements in marine copepods

EXTERNAL PROJECTS OF THE DEPARTMENT MARINE BIOGEOCHEMISTRY AND TOXICOLOGY

- 'Molecular palaeontology of marine sediments' (PIONIER project NWO-BOA), *J.S. Sinninghe Damsté, M. Baas, W.I.C. Rijpstra, M. Dekker, M. Kok, I. Höld, S. Schouten, K. Grice*
- 'Environmental changes at the time of the Permian/Triassic biotic crisis' (NWO-GOA), *M. Sephton, J.W. de Leeuw*
- 'Chemical composition of dissolved organic carbon' (NWO-NOP), *J.D.H. van Heemst, J.W. de Leeuw*
- 'High resolution continental - marine correlations: Reconstruction of Mediterranean late Neogene climatic and environmental history' (NWO-GOA), *H.J. Bosch, J.S. Sinninghe Damsté, J.W. de Leeuw*
- 'The role of euxinic conditions for formation of petroleum source rocks' (SHELL), *D. Clifford, J.S. Sinninghe Damsté*
- 'A molecular and carbon isotopic biogeochemical study of environmental conditions leading to deposition of 'black shales' during the Cenomanian/Turonian oceanic anoxic event' (NWO-GOA), *M.M.M. Kuypers, J.S. Sinninghe Damsté*
- 'Marine microalgae as major contributors to marine sedimentary organic matter and crude oils' (NWO-GOA), *P. Blokker, S. Schouten, J.S. Sinninghe Damsté, J.W. de Leeuw*
- 'Improved palaeoclimate reconstruction by an integrated compound-specific stable carbon isotopic, flash pyrolysis mass spectromet; main contractor University of Amsterdam), *A. Boom, S. Schouten, J.S. Sinninghe Damsté, J.W. de Leeuw*
- 'Recognition of palaeobiochemicals by a combined organic sulphur and isotope geochemical approach: its application in molecular palaeontology' (NWO-GOA), *H.M.E. van Kaam-Peters, J.S. Sinninghe Damsté, J.W. de Leeuw*
- 'Origin and characterization of suspended and sedimental organic matter by means of carbon isotopes' (NWO-GOA), *L. Megens, J.W. de Leeuw*
- 'Quantitative assessment of palaeo-upwelling and palaeo-river input: a high resolution study of sediments from the Angola Basin (SE Atlantic) using Uk^{37} and compound-specific isotopic data' (NWO-GOA), *G.J.M. Versteegh, J.W. de Leeuw, F.J.H. Jansen*
- 'Molecular and geochemical analysis of hot spring cyanobacterial and *Chloroflexus* mats as stromatolite analogs' (NASA), *M. van der Meer, J.W. de Leeuw*
- *'In vitro* biotransformation of organohalogen contaminants in marine mammals and birds. Possible consequences for bioaccumulation and genotoxicity' (BEON), *J.P. Boon, W.E. Lewis, C. van Hezik, D.E.C. Smith*
- 'Effects of tributyltin exposure on the sexual development of the common whelk (*Buccinum undatum*)' (RIKZ)., *B.P. Mensink, J.P. Boon, C.C. ten Hallers-Tjabbes, C.V. Fisher*
- 'Contaminants in the marine environment: Their fate in the abiotic and biotic compartments with emphasis on biological responses (biomarkers)' (EU-DG-XIIB), *J.M. Everaarts, K. Booij, E.M. van Weerlee, C.V. Fischer*

SPERMWHALES AND SCIENTISTS ON THE BEACH OF ROMØ, DENMARK



In most cases, sampling efforts for marine research are carefully planned months ahead, but in some cases it is an opportunistic event

In the case of the project "In vitro biotransformation in marine mammals in relation to bioaccumulation and genotoxicity", it had to be the latter way, since the liver enzymes (cytochrome P450) that are the subject o the study can only be obtained from animals that can be sampled within a few hours after they died.

The photographs show Jan Boon, Cees Camphuysen, Wilma Lewis and Martine Greve while busy with obtaining liver samples from sperm whales on the beach of Romø (DK) on 5 December 1997.

DEPARTMENT OF BIOLOGICAL OCEANOGRAPHY

The Department of Biological Oceanography focuses on the role of planktonic organisms in the carbon and energy flux and nutrient recycling in the water column of the North Sea and the Atlantic Ocean.

Main emphasis was put on 6 research topics:
1. Phytoplankton studies;
2. Experimental studies on zooplankton;
3. Deep chlorophyll maximum layer of the tropical Atlantic Ocean;
4. Bacterial production and consumption of exopolymers;
5. Bacterioplankton response to physically and chemically changing environments;
6. Ecosystem modelling;

Within theme 1, competition experiments for inorganic nutrients with selected phytoplankton species were performed as well as selective grazing by microzooplankton.

Within theme 2, the role of food quality on the limitation of zooplankton growth was studied. This project focused on the rate of growth and development of copepods in relation to their food.

Theme 3 dealed with the Deep Chlorophyll Maximum (DCM) in the tropical Atlantic. A multidisciplinary cruise in 1996, focused on the effect of physical processes on the ecosystem stability in the DCM. Analysis of samples and data have been performed.

In theme 4 the role of biostabilization by diatom-mucus on the particle transport in the Ems-Dollard Estuary was studied. Moreover, the production and release of polysaccharides by bacterioplankton was investigated.

Within theme 5, the role of turbulence on the activity and species composition of bacterioplankton was studied as well as the role of ultraviolet radiation on bacterioplankton and dissolved organic matter uptake.

Theme 6 focused on the development and application of the European Regional Seas Ecosystem Model (ERSEM) which has been developed in 2 successive EU-MAST projects. The ERSEM model was coupled to a 1D hydrodynamical model and has been applied to the Baltic and the Adriatic Sea.

PHYTOPLANKTON COMPETITION (BEON-GARDEN project).

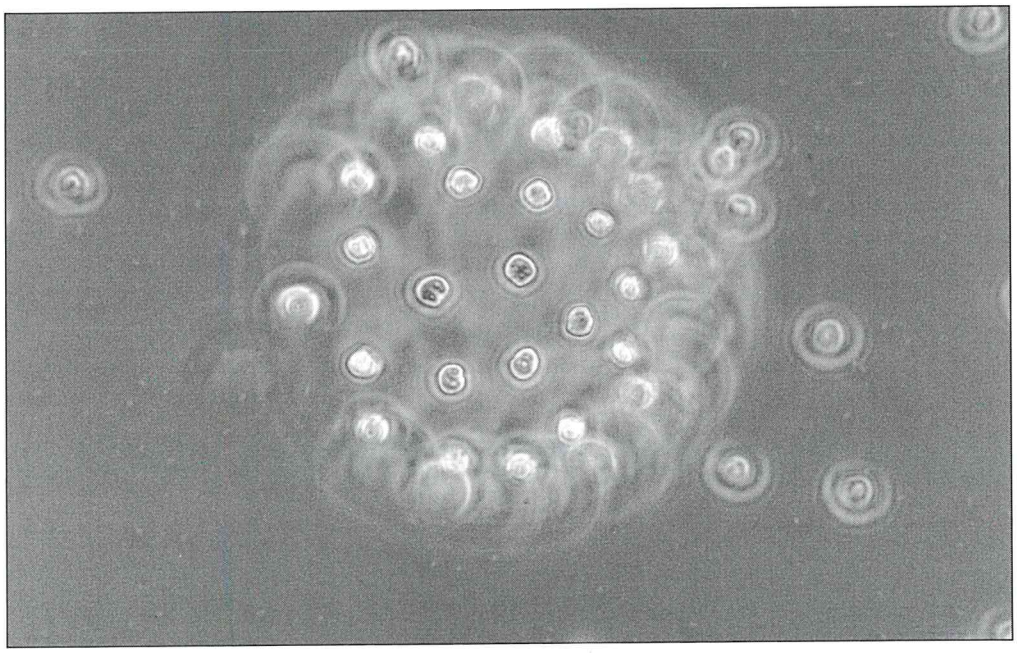
Contributors: *R. Riegman, A.A.M. Noordeloos, L. De Senerpont Domis, M. De Boer.*

The major aim of the BEON-GARDEN research project (1994-1997) was to establish the ecological niche of various phytoplankton species on the basis of their ability to compete for nutrients and/or light. This project was financed by BEON (The Netherlands).

Basically, eutrophication (i.e. the enrichment with nutrients) leads to enhanced algal biomasses. As possible consequences, coloration of the water (e.g. red tides), changes in foodweb structure and productivity, and the occurrence of oxygen depletion or foam on beaches can be observed. Since river nutrient discharges usually do not match the nutrient ratios in the recipient watermasses, shifts in nutrient ratios will occur in the coastal area. These shifts can lead to a change in algal species composition. Some algae can be toxic, may show high sedimentation characteristics, or may be poorly edible for zooplankton. Therefore, apart from biomass related effects, the algal species composition itself plays a crucial role in the biological and biochemical response of the ecosystem to eutrophication.

The impact of different nutrient load ratios on algal species composition was studied in discontinuously and continuously diluted cultures, using different assemblages from the Prymnesiophyceae *Chrysochromulina polylepis* and *Emiliania huxleyi* type , the dinoflagellates *Fibrocapsa japonica, Gymnodinium simplex, Gyrodinium aureolum, Heterocapsa triquetra, Heterosigma akashiwo, Prorocentrum micans, Alexandrium tamarense* and *Ceratium tripos*, the diatoms *Cymatosira belgica, Ditylum brightwellii, Lauderia borealis, Odontella aurita,* and *Streptotheca thamesis,* the rhodophycean *Rhodomonas* sp., and the cyanobacterium *Synechococcus.* Additionally, a natural inoculum from the Marsdiep area, including microzooplankton was used in some experiments.

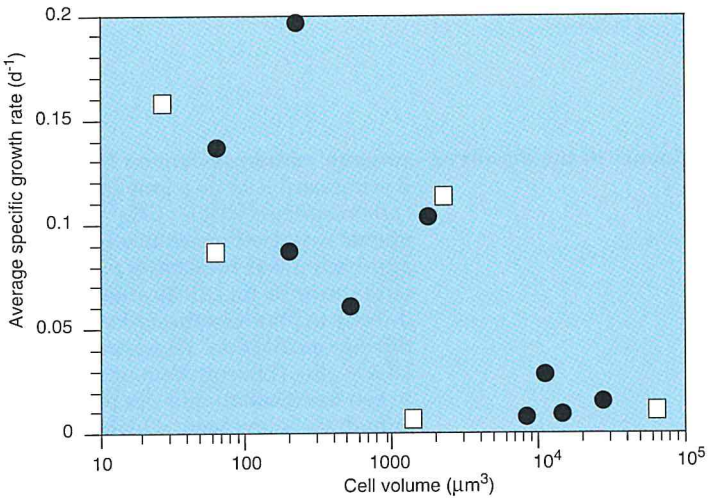
All species were tested separately for their capability to grow in the laboratory cultures. *Gyrodinium aureolum* was found very sensitive to mechanical disturbance and grew poorly. Some species, such as *Chrysochromulina polylepis* and *Emiliania huxleyi* were good competitors for N, P, and light. Others showed a more pronounced niche, being either on P- or N-limited growth. Nitrogen speciation also had an impact on algal species composition at N-limiting growth conditions. *Ditylum brightwellii* competed very well for nitrate, whereas *Cymatosira belgica* was a good competitor for ammonium.



A colony of *Phaeocystis* cells. Photo: Dr. W. Stolte.

In general, it can be stated that the dinoflagellates were poor competitors compared to the Prymnesiophyceae. The environmental fitness of Prymnesiophyceae appeared closely related to the reproductive capacity of the vegetative stage, whereas the natural distribution of dinoflagellates seems more closely dependent on the generative reproduction-related specific life cycle characteristics of the individual species. The marine diatoms comprehend a mixture of both types of species. Some marine diatom species clearly had the capability to outcompete non-diatoms at different types of nutrient- and light limitations when silicate was in excess. Other diatoms (for example *Odontella aurita)* seemed to be poor competitors. Apart from taxonomical differences, there was also the importance of cell size for the competitive ability of species. Obviously, smaller species grew faster than larger ones under severe nutrient limiting conditions.

Attempts to relate the ecological niche of the algae, as determined by their growth response in cultures grown under different nutrient and/or light limiting conditions, to their distribution in the natural environment were complicated by the fact that the natural distribution of a species is also determined by factors other than competition for nutrients or light. However, with respect to the management of eutrophied coastal areas, it could be stated that there is no clear connection between nutrient discharge ratios and the occurrence of harmful species. In other words, the probability of a (toxic) algal bloom in a N-controlled area is just as high as in a P-controlled area, although the species involved may differ. If reductions in nutrient discharges are not in balance with each other, changes in species composition are likely to be expected. In such a case, the nutrient reduction programme will lead to lower algal biomasses, but the replacement of unharmful species by toxic ones may occur during the transient period of restoration. Reduction of nutrient discharges will reduce the frequency of toxic algal blooms on the long term since most toxic algal species are poor competitors for inorganic nutrients.



Specific growth rates of different species of dinoflagellates and prymnesiophytes (circles), and diatoms (squares), grown under different nutrient-limiting growth conditions in relation to their cell size.

INTERACTIONS BETWEEN *EMILIANIA HUXLEYI* AND THE DISSOLVED INORGANIC CARBON SYSTEM

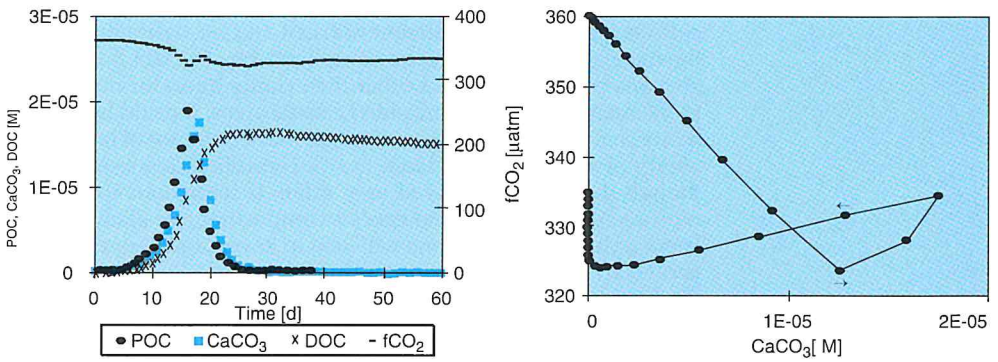
Contributor: *E.T. Buitenhuis*

The marine coccolithophorid *Emiliania huxleyi* is an interesting alga for studying the biogeochemical cycle of carbon since it influences this cycle in two ways. Like all algae it uses solar energy to convert dissolved inorganic carbon into organic carbon during photosynthesis. Additionally, it precipitates $CaCO_3$ into beautifully shaped coccoliths. From a chemical perspective these two processes of photosynthesis and calcification have opposite effects on the CO_2 concentration in sea water. Photosynthesis decreases the CO_2 concentration ($CO_2 + H_2O \rightarrow CH_2O)_{org} + O_2$), while calcification increases the CO_2 concentration ($2\ HCO_3^- + Ca^{2+} \rightarrow CaCO_3 + CO_2 + H_2O$). Due to the buffering of the HCO_3^- concentration ($CO_2 + CO_3^{2-} \rightarrow 2\ HCO_3^-$), the effect of photosynthesis is larger than the effect of calcification, so that when both processes take place at the same rate the CO_2 concentration decreases. To study the interactions between *E. huxleyi* and dissolved inorganic carbon, a combination of a field study during a natural bloom within a model description of that bloom and physiological laboratory experiments has been undertaken.

This project was funded by "Verstoring van Aardsystemen", Project 9 (NWO).

Influence of *Emiliania huxleyi* on the dissolved inorganic carbon system

E. huxleyi produces blooms over large areas of the ocean every year, especially in the temperate North Atlantic Ocean. One of these blooms was studied in the northern North Sea in June / July 1993. A model was constructed to analyze the importance of the various processes for the carbon fluxes, that were observed during that bloom. Production of POC, $CaCO_3$ and DOC led to a decrease in the CO_2 concentration. At the end of the productive stage, when POC production stops due to nutrient limitation $CaCO_3$ production continues for another two days. This leads to a transient increase in fCO_2. DOC production decreases more gradually. During the declining phase of the bloom POC, $CaCO_3$, and DOC are mineralized. Since more POC than $CaCO_3$ has been lost due to sedimentation, more $CaCO_3$ than POC is mineralized at this stage. This leads to a decrease of fCO_2. During the final stage air-sea exchange of CO_2 and mineralisation of DOC increase the fCO_2. During all stages of the bloom fCO_2 is undersaturated with respect to the atmosphere. This leads to continuous air-to-sea transport of CO_2. Thus, we identified blooms of *E. huxleyi* as atmospheric carbon sinks.



Output of a model run. A) Time course of a bloom showing the decrease in fCO_2 due to production and mineralisation of POC,, $CaCO_3$, and DOC, and sedimentation of POC and $CaCO_3$. B) The fugacity of CO_2 as a function of $CaCO_3$ standing stock. Arrows indicate the direction of time.

Influence of the dissolved inorganic carbon system on *Emiliania huxleyi*

It is impossible to do a univariate experiment with the chemical species in the dissolved inorganic carbon system (HCO_3^-, CO_3^{2-}, CO_2 and H^+). To solve this problem several complementary experiments were performed in which one species was kept constant while the others varied. With this approach it was possible to elucidate the mechanism of carbon uptake by *E. huxleyi*. HCO_3^- is the only substrate for calcification, while photosynthesis uses both CO_2 and HCO_3^-. CO_2 can be used directly in photosynthesis. For use of HCO_3^- in photosynthesis H^+ is needed. This H^+ is produced during calcification. Thus, calcification may stimulate photosynthesis by allowing the cells to use HCO_3^-, the concentration of which is about 100-fold higher than that of CO_2. The coupling between calcification and photosynthesis is very efficient. This suggests that the enzyme carbonic anhydrase is involved, which equilibrates HCO_3^- and CO_2. Other researchers have expressed carbon-limitation of photosynthesis in *E. huxleyi* as CO_2 limitation. However, our results refine this into CO_2 sufficiency and HCO_3^- limitation.

PHYTOPLANKTON CELL LYSIS AND ITS ECOLOGICAL IMPLICATIONS

Contributor: *C.P.M. Brussaard*

The dynamics of phytoplankton populations are determined by gain and loss factors. Losses due to natural mortality (autolysis) have attained far less attention than sedimentation and grazing. The general aim of this project was to investigate factors which cause algal cells to lyse, and to estimate the impact of algal cell lysis on carbon fluxes in natural systems. This project was funded by the EEC-STEP programme.

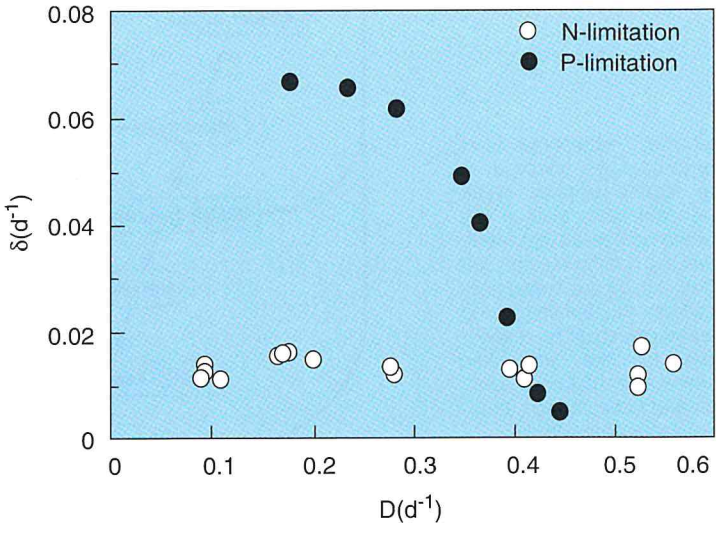
Two field studies carried out in the Marsdiep area (1992 and 1993) indicated nitrogen limitation induced cell lysis of *Phaeocystis* at rates up to 0.35 d^{-1}. Lysis rates in the diatom spring bloom never exceeded 0.1 d^{-1}. In the unstratified Marsdiep area, algal blooms were found to be terminated by nutrient depletion induced cell lysis, rather than sedimentation. During termination, bacterial production became enhanced and inorganic nitrogen (ammonium) and phosphorus increased due to microzooplankton grazing. The general stimulation of the microbial foodweb depended on the magnitude of the waning *Phaeocystis* bloom.

During a cruise to the more oligotrophic transition zone between the Atlantic Ocean and the North Sea (near the Shetland Islands), it was observed that here bacterial production was also correlated positively with algal cell lysis rates. A nitrogen depleted bloom of *Emiliania huxleyi* showed a high infection percentage by viruses. Up to 50% of the cells contained virus like particles (VLPs). Remarkably, two different types of VLPs were present. They were different in size (50-60 nm and 185-200 nm in diameter) and sometimes both present in one and the same algal cell.

Since in all these studies nutrient depletion seemed an important trigger for cell-lysis, subsequent laboratory studies were undertaken on the impact of nutrient stress on algal viability. Mathematical equations were developed for the description of cell-lysis rates in batch- and continuous cultures.

Axenic continuous cultures, being free of VLPs, of the diatom *Ditylum brightwellii* expressed an intrinsic invariable autolysis rate of 0.014 d^{-1} at N-limiting growth conditions. Under P-limitation, cell lysis rates varied from 0.010 to 0.065 d^{-1}, being inversely correlated with the specific growth rate of the cultures. Depletion experiments, performed with preconditioned *D. brightwellii*, revealed that N-starvation was survived for a longer period when the cell were grown at lower growth rates prior to starvation. For P, the opposite was found. Addition of bacteria prolonged the survival of *D. brightwellii* under N-depletion. On the contrary, bacteria stimulated algal cell lysis under P-depletion , which was not the result of direct impact of bacteria on algal cells, but due to competition for phosphate.

The results on nutrient-stress induced cell lysis of *D. brightwellii* showed that this algal species is better equipped in handling N- than P-deficiency. The kinetics of algal cell lysis was shown to be rather species specific. The diatom *Lauderia borealis* expressed lower lysis rates than *D. brightwellii* under N-depletion , and was found more sensitive to P-depletion. Evidently, algal cell lysis can not be neglected as an important organic carbon and nutrient source for the bacterial loop in natural pelagic communities. Therefore phytoplankton cell lysis should be accounted for in mathematical models on pelagic ecosystems. Cell lysis is obviously not constant, but species specifically related to the physiological state of the phytoplankton community.



Specific autolysis rates (δ, d^{-1}) of N-limited and P-limited *D. brightwellii* vs. specific dilution rate (D, d^{-1}). Under N-limitation no statistically significant relationship with D was found .

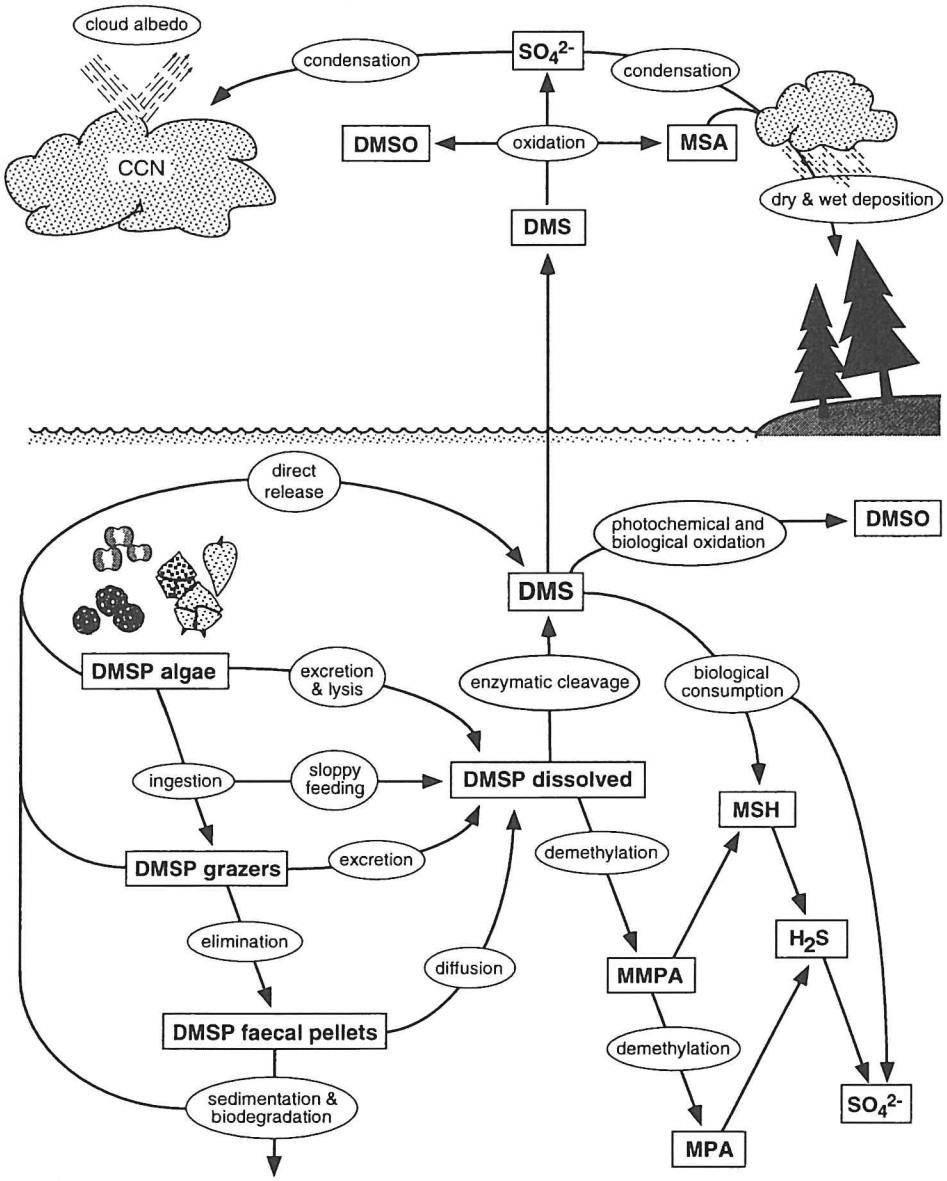
8

ROLE AND SIGNIFICANCE OF BIOLOGICAL PROCESSES IN DMS RELEASE FROM THE OCEAN TO THE ATMOSPHERE: A CLOSE EXAMINATION OF THE BLACK BOX

Contributors: *F.C. van Duyl, P. Ruardij*

In the framework of this EC-project research focused on biological processes determining DMS (dimethylsulphide) concentrations in seawater. Interest in DMS production and cycling has increased rapidly since the suggestion of Lovelock that this volatile sulphur component plays an important role in the global sulphur cycle and that it may control climate by influencing cloud albedo: DMS is a precursor of SO_4^{2-} condensation nuclei (sulphate aerosols) in the atmosphere. Interest was further fuelled when it was found that DMS can influence the acidity of rain. However, in order to predict emission of DMS to the atmosphere, the dynamics of the processes which determine DMS concentrations in surface seawaters should be understood.

The precursor of DMS is DMSP (dimethylsulphoniopropionate) which accumulates in many, but not all, algal species. Those macroalgae and microalgae which accumulate DMSP are often capable of enzymatic DMSP conversion to DMS and acrylate, by means of DMSP lyase enzymes. However, such enzymes differ considerably in their requirements (pH, salts, cofactors) for optimal *in vitro* DMSP cleavage in different species or even strains.



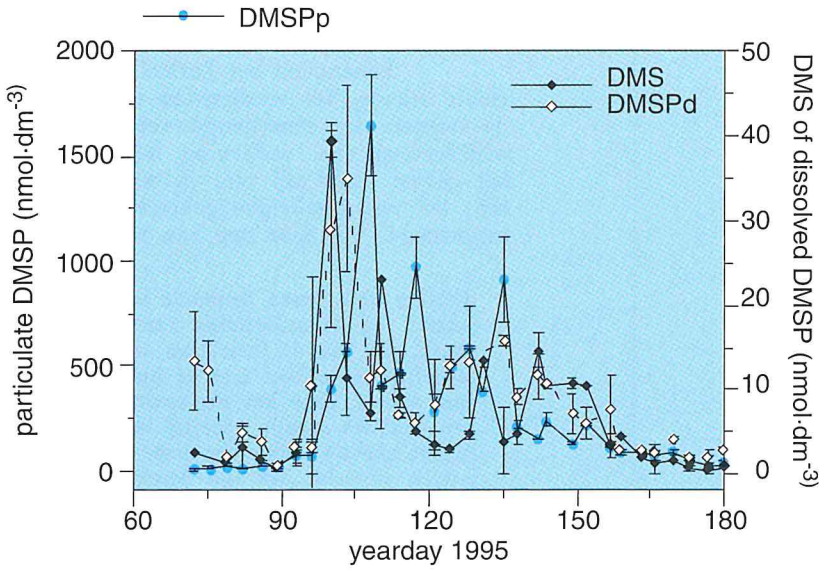
Schematic representation of the processes involved in the marine sulphur cycle. The right hand side of the marine processes are mediated by bacteria, the left hand side by phyto-and zooplankton. Phytoplankton and bacteria can both be responsible for the enzymatic cleavage of DMSP production and consumption (courtesy Jacqueline Stefels).

DMSO =dimethylsulphoxide
MSA =methane sulphonic acid
MMPA =methylmercaptopropionate
MPA =mercaptopropionate
MSH =methanethiol

In the spring of 1995 a closer study was made in the Marsdiep during the development of the bloom of *Phaeocystis globosa*, which is a prolific DMSP producer. Particulate DMSP correlates significantly with *Phaeocystis* cell abundance and colonies in seawater. Grazing pressure on *Phaeocystis* colonies is usually low early in the bloom. Evidence was obtained from experiments with other algae that acrylate, produced during DMSP cleavage, inhibits grazing by zooplankton. This might also explain the low grazing pressure on *Phaeocystis* in the wax of the bloom, which would imply that the mechanism by which DMSP is released from algal cells in *Phaeocystis* colonies is not grazing. DMSP is released during the exponential growth phase of *Phaeocystis* and its ectoenzyme DMSP-lyase generates the DMS production, which rapidly increased to 300 $nmol.dm^{-3}.d^{-1}$ in the wax of the bloom and declines towards the end of the exponential growth phase. Bacterial DMSP-cleavage plays a subordinate role in the *Phaeocystis* spring bloom, possibly due to the low temperatures. Bacterial DMS consumption roughly equals DMS production keeping the DMS concentrations relatively low in the ambient water. Only in the initial part of the exponential growth phase short-lasting accumulations of DMS concentrations occurred reaching values of up to 40 nM. Despite the rapid enzymatic cleavage of DMSP during the exponential growth of *Phaeocystis*, the major sink of the bulk of DMSP produced by *Phaeocystis* appears to be demethylation. Moreover, there was a shift from algal DMSP cleavage to demethylation in the course of the bloom, which implies that DMS concentrations are not necessarily highest at the peak or towards the end of blooms, as often reported in the literature.

In pelagic mesocosms in Den Helder harbour the fate of particulate DMSP was studied. Sedimentation of particles that contain DMSP can be a sink for DMSP, but, indirectly it can also be a source for DMS, if DMSP is converted to DMS at the sea floor. In shallow waters the latter may be the case when large amounts of DMSP-containing algae are deposited onto the sea floor. A rapid release of the intracellular DMSP followed by a rapid conversion of DMSP to DMS may occur. In pelagic enclosures, the wax and wane of a bloom of *Phaeocystis globosa* was followed in relation to the formation of DMS. Sedimentation was quantitatively important in these shallow enclosures, but was related to the standing stock in the water column. Elevated DMS concentrations were found during the first week of the experiment and during the late exponential growth of *Phaeocystis*. It is concluded that although rapid DMS production after mass sedimentation of algal cells may take place, this mechanism does not always lead to DMS accumulation. The observed pattern could not be explained without the involvement of other factors, like bacterial consumption and DMSP production by the algae.

The acquired knowledge has implications for DMS emission scenarios. A model was developed for DMS production in the southern North Sea. This model is coupled to the phytoplankton model FYFY that calculates the biomass of different phytoplankton groups with their specific contents of DMSP. The combined model provides a synoptic view of the DMS distribution and the sea to air exchange rates. Results are in close agreement with field data, showing a spring peak and high concentrations in the coastal area. Model analysis indicates that phytoplankton DMSP lyase may not be neglected in describing the spring peak DMS concentrations, because this would lead to an underestimation of the annual sea to air flux of up to 25%. Furthermore anthropogenic eutrophication of the southern North Sea more than doubled the mean annual DMS flux to the atmosphere from the beginning of this century to the 1980s.



Particulate DMSP, dissolved DMSP and DMS concentrations during the *Phaeocystis* spring bloom in 1995 in the Marsdiep.

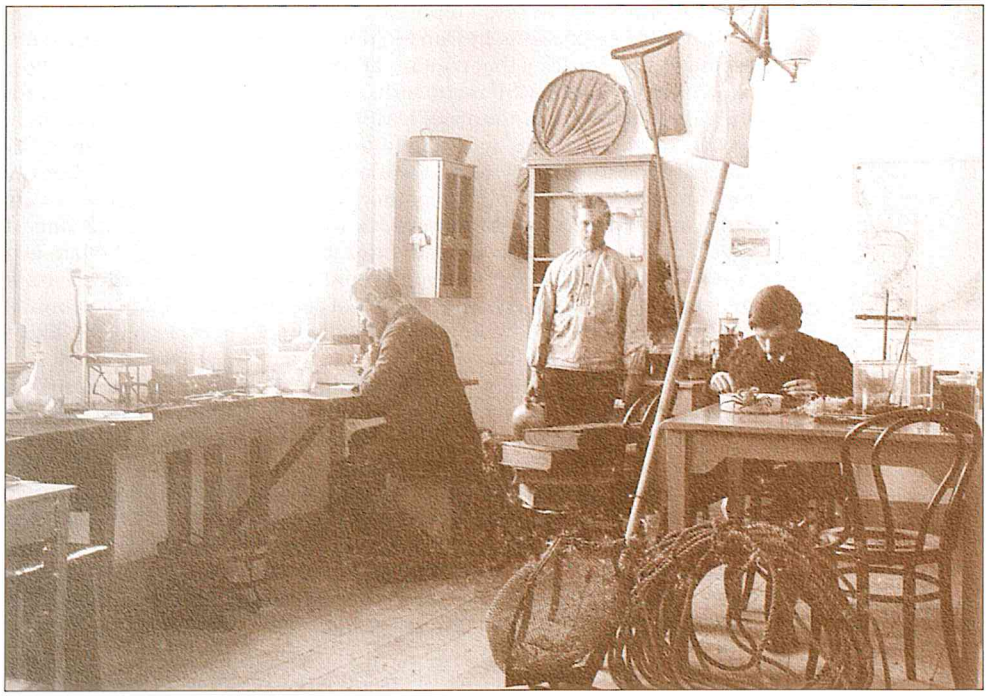
(*Overdruk uit: Tijdschrift der Ned. Dierk. Ver.* (2). *VI.* 1).

HET ZOÖLOGISCH STATION

DER

NEDERLANDSCHE DIERKUNDIGE VEREENIGING

in 1897

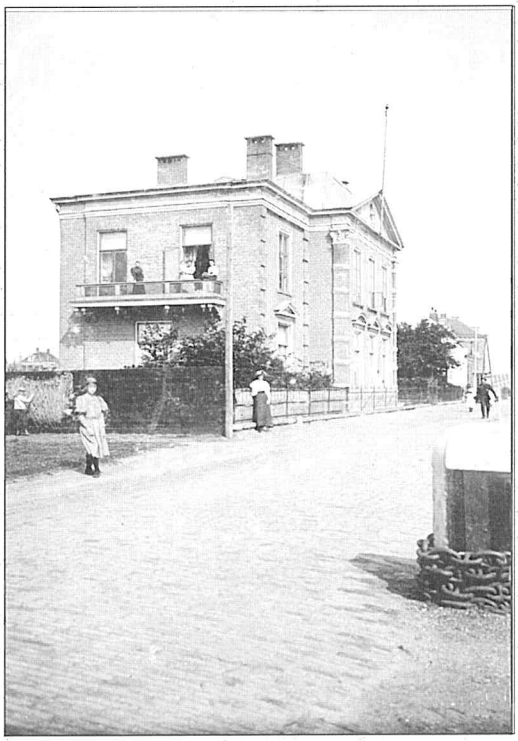


Behoudens het herstellen van door storm aan het dak aangerichte schade, het vernieuwen van door het donderen der kanonnen, of de steenen der straatjeugd vernielde vensterruiten, het uitvoeren van schilderwerk enz. onderging het gebouw verder geene veranderingen: het geheel komt mij voor in een alleszins voldoende toestand te verkeeren; het oorspronkelijke gebouw heeft door den vleugel, die er aan werd toegevoegd, blijkbaar nog aan hechtheid gewonnen.

Behalve over eenen bediende beschikt het Station thans ook over een jongen. Bij de uitbreiding van het gebouw en de toename van het gebruik, dat van de inrichting wordt gemaakt, was het allengs niet meer mogelijk het geheel met de hulp van eenen bediende in gang te houden, vooral, daar het zoo vaak noodzakelijk was, dat hij voor boodschappen enz. het station tijdelijk verliet. Terwijl nu de bediende bijna steeds in het gebouw aanwezig kan zijn, worden de boodschappen door den jongen verricht. Tot zijn departement hoort vervolgens ook het vangen en verzamelen van dieren, het gaan naar de vischmarkt, het afloopen van de visschersvaartuigen, in een woord, al die verrichtingen, waarvoor hij het gebouw moet verlaten.

op de begrooting voor het nu loopende jaar 1898 is door den Minister van Waterstaat voor het eerst een post uitgetrokken voor de benoeming van eenen blijvenden assistent, een post, die door het votum van het parlement tot wet geworden is. Het is ook voor ons Station een verblijdende gebeurtenis geweest, dat votum, dat mij als adviseur eenen assistent heeft toegevoegd. Immers niet alleen dat uitbreiding van het personeel, dat vast in het Station werkzaam is, het nut, dat door het Station in wetenschappelijken zin gesticht wordt, aanzienlijk doet toenemen; bovendien behoeft geen nader betoog, dat, al is de assistent een ambtenaar van den adviseur, het ook hem wel degelijk vrijstaat in den tijd, die hem van zijn ambtelijke bezigheden rest, den bezoekers van het Station behulpzaam te zijn, of den directeur van die instelling van dienst te wezen.

Trouwens op nog verschillende andere wijzen was het Station bij het instellen van waarnemingen en het doen van onderzoekingen behulpzaam. Het gewichtigste op dit gebied te vermelden is ongetwijfeld de medewerking verleend aan Prof. P. T. Cleve te Upsala, die zich in het belang van Hydrographie en Visscherij met de studie van het plankton der Europeesche Zeeën bezig houdt. Cleve tracht aan te toonen, dat er verband bestaat tusschen het zich in bepaalde tijden op bepaalde punten van de Noordzee vertoonen van sommige vissehen — haringen, ansjovis enz. — en den aard van het plankton, dat men daar dan aantreft. Ik zond hem in Augustus '97 een eerste collectie flesschjes met plankton, wekelijks verzameld op de Reede van Texel en op de vangsten van April—Juli betrekking hebbende. Hij meende uit die eerste zending, waarvan alle flesehjes o. a. ook Diatomeen bevatten, reeds iets te leeren omtrent het verband tusschen het plankton en den tijd van aankomst en vertrek van sommige visschen.



EXTERNAL PROJECTS OF THE DEPARTMENT OF BIOLOGICAL OCEANOGRAPHY

- Giftige Algen en Reductie van Nutrient belastingen' (BEON), *R. Riegman, A. Noordeloos*
- 'Model system approach to biological climate forcing: the example of Emiliania huxleyi' (NWO-NOP II), *W. Stolte, J. Snoek*
- 'De invloed van EUtrofiering op de PROductiviteit van mariene ecosystemen', (BEON), *R. Riegman, A. Noordeloos*
- 'The role of ultraviolet B radiation in the functioning of heterotrophic bacteria in coral reefs and adjacent tropical ocean waters off Curaçao, Netherlands Antillen' (WOTRO), *F.C. van Duijl, P. Visser*
- 'Baltic Sea System Study' (BASYS, EU-MAS-III project), *P. Ruardij, E. Embsen*
- Mass transfer and ecosystem response' (MATER, EU-MAST-III project), *P. Ruardij, E. Embsen, G.J. Herndl, I. Obernosterer*

DEPARTMENT OF MARINE ECOLOGY

The department of Marine Ecology consists of three theme groups:
1. Intertidal Population Ecology
2. Shelf Benthic Biology and
3. Long-term Changes.

Marine ecosystems, and especially benthic communities, harbour an astonishing biodiversity, and numerous complex biological, physical and (geo)chemical processes underlie its maintenance and functioning. Climate change, eutrophication, pollution, fisheries and several other human activities are a major threat to these systems.

With the political urge for possible protection of biodiversity, the concern about the effects of global change, and the increasing awareness that the natural variation can be huge, there is a growing need for basic knowledge on the structure and functioning of marine ecosystems. The department of Marine Ecology focuses on the short- and long-term development of marine ecosystems in shallow and deeper seas at the species, inter-species and community level. In a multidisciplinary approach, in close cooperation with other NIOZ departments and within numerous national and international research projects, the natural and man-induced variability of the benthic marine ecosystem is investigated.

TREE OF THE SEA

The application of shell growth-line analyses for the assessment of long-term environmental changes

Contributor: *R. Witbaard*

Like many bivalves *Arctica islandica* SHELLS grow by annual deposition of growth increments. From shell cross-sections these growth lines can be made visible, and counts revealed that North Sea *Arctica* could attain ages of over 100 years or even more, thereby corroborating results obtained along the eastern coast of the United States.

Since *A. islandica* is a benthic suspension feeder which does not move significantly during the course of its life, it was readily recognised that this bivalve had a great potential in environmental studies, i.e. the retrospective assessment of marine environmental change. During the deposition of its shell, environmental information is stored. Both the increment composition and its appearance are a reflection of the conditions under which they were laid down. However, until recently no-one had explored this option in detail. Therefore we stuied the growth of this species in the North Sea.

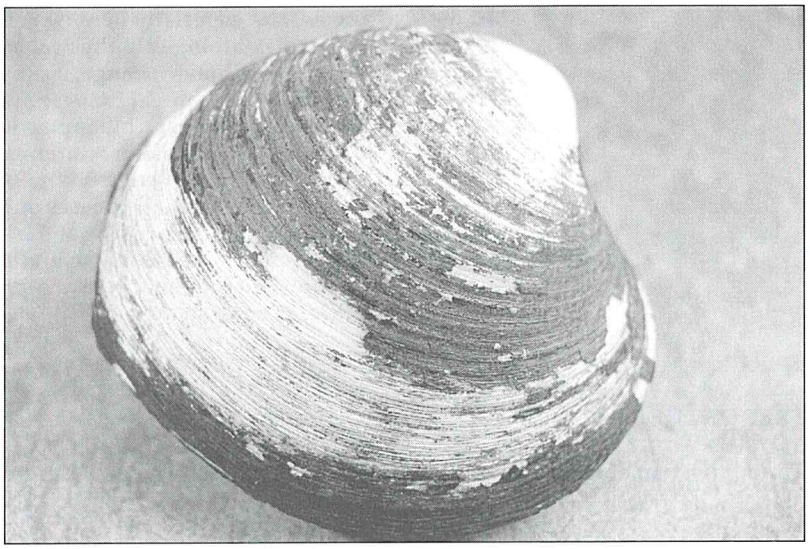
The annual increment deposition was confirmed by studying the isotopic signal, (both ^{14}C and ^{18}O and ^{13}C) in the shells. Additional evidence for the annual periodicity was derived from the comparison of growth line patterns of specimens caught in different years.

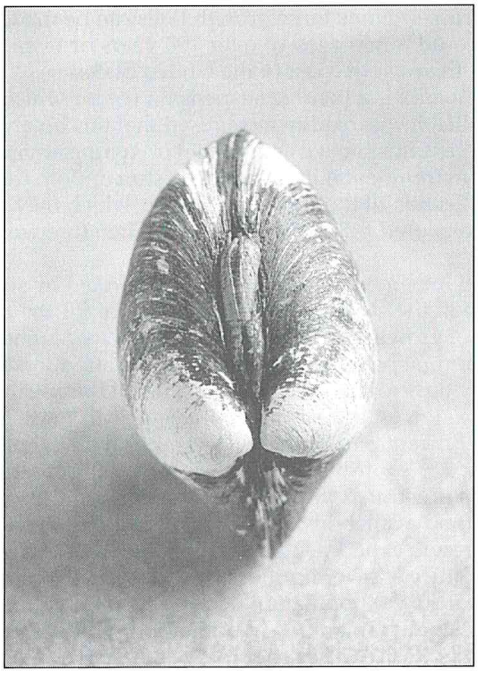
Once the annual periodicity was confirmed attention of this study focused on the applications. Subsequently the growth rates of several north European populations revealed a three fold difference between slowest and fastest average growth rates. Primary production and temperature explained a significant part of these differences but sediment grain size and water depth were also important factors contributing to the observed differences in growth rate.

The results illustrated the great heterogeneity in the basic environmental characteristics such like benthic food availability in the North Sea. The results fitted within the results obtained from laboratory growth experiments which showed that *Arctica* can grow at temperatures as low as 1°C while in literature a lower limit of approximately 6°C has been reported. For the Fladen Ground (Northern North Sea) population no clear relation with temperature or Continuous Plankton Recorder data like phytoplankton abundance or phyto-colour could be found. Comparison of these in-situ growth rates with hydrographic data, however, revealed a link with the influx of Atlantic water which is now supposed to regulate the food supply to the local *A. islandica* population. The shells of animals collected from this area were subsequently used to construct a long-term record of growth variations which goes back to the beginning of this century. Remarkably there is a regular alteration of growth accelerations and decelerations suggesting that there is a periodic variation in the influx of Atlantic water in the northern North Sea.

One of the other main topics in this research project was the retrospective assessment of the long-term effects of bottom fisheries in the south-eastern North Sea. There was a good correlation between the increasing scar frequencies and the development of the total engine capacity of the Dutch beam trawl fleet. Therefore the scar record is believed to reflect the fishing effort on a very local scale which was not documented before.

Many more questions may be answered by using the growth lines of *Arctica*. Analytical techniques are rapidly improving, thereby offering possibilities to sample calcium carbonate from the growth increments with a sub-annual resolution. The extraction of the information stored in the growth lines might help to analyse, and understand man's impact on climate and ocean processes. It might give the possibility to study (natural) changes in off shore and often difficult accessible environments. Since *Arctica* is so widely distributed over the North Sea and the North Atlantic there is still an enormous environmental archive waiting to be explored.



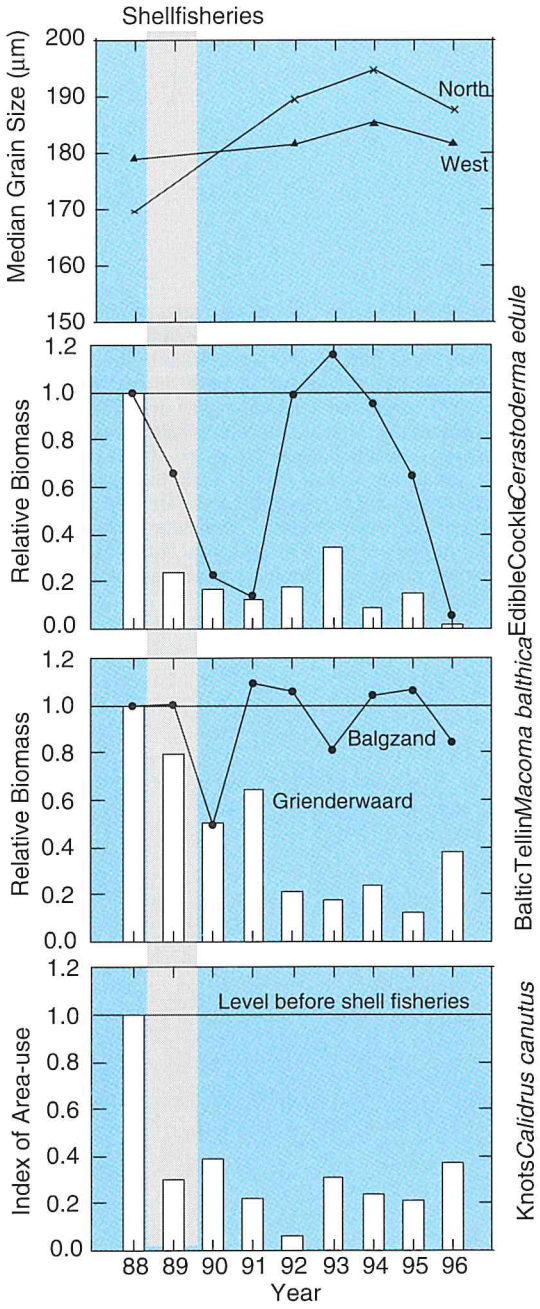


Arctica islandica.
Photo's: R. Witbaard.

FISHERY-INDUCED EXTERMINATION CASCADES ON INTERTIDAL FLATS?

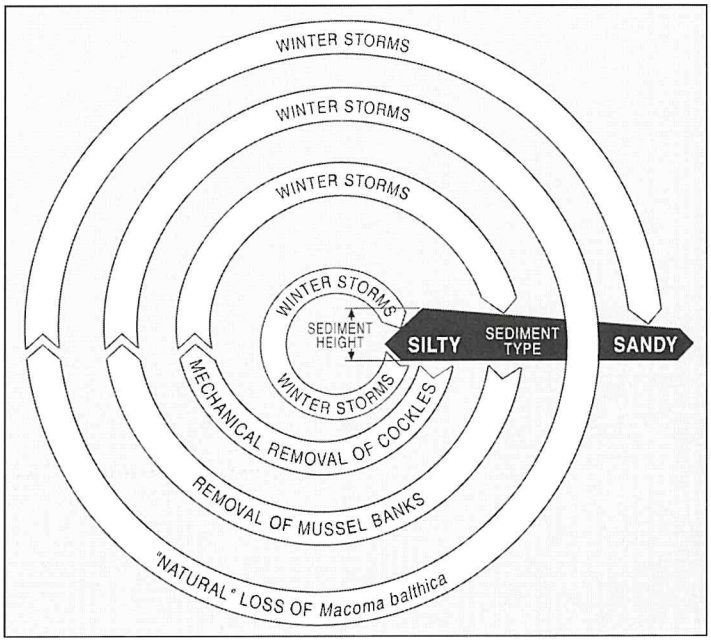
Contributors: *T. Piersma, A. Koolhaas*

During intense bouts of fishery in 1988-1990, involving large-scale sediment reworking during suction-dredging for cockles *Cerastoderma edule* and the complete removal of banks of mussels *Mytilus edulis*, the stocks of these two bivalve species were depleted on the intertidal flats around the island of Griend in the western Dutch Wadden Sea. The possible effects of these fisheries on sediment characteristics, recruitment of those and other mollusc species (baltic tellin *Macoma balthica* and soft-shelled clam *Mya arenaria*) and the use of remaining shellfish resources by red knots *Calidris canutus*, specialised mollusc-eaters, were studied over nine August-October seasons (1988-1996). In spite of their different feeding techniques, intertidal suspension and deposit feeding bivalves have been shown to compete for algal food resources and space. Yet, after the complete harvest of *Mytilus* and *Cerastoderma*, potentially competing *Macoma* also slowly disappeared, whereas by 1996 *Cerastoderma* had not returned in densities comparable to the pre-fishing era. The numbers of knots foraging on the intertidal flats around Griend showed dramatic declines from 1988 to 1992, in concert with decreases in the stocks of *Macoma*, a preferred food. From 1993 to 1996



Changes in median grain size of the fishery-affected intertidal flats west and north of Griend (top panel), the relative total biomass of two bivalve species, edible cockles and baltic tellins (mid two panels), and the relative numbers of foraging knots, on the intertidal flats around Griend (bottom panel). The benthic biomass data for Griend are compared with those for the Balgzand area (dots and lines, courtesy W. de Bruin, J.J. Beukema and R. Dekker), after scaling all figures to the value of 1988, just before the major shellfish-fisheries incidents. With respect to the bivalves, contrary to Griend, Balgzand shows a (temporary) recovery after the fishery pressure in 1988-1990.

numbers increased somewhat due to two summers with good spatfall of an alternative, but up to then rare prey, the soft-shelled clam *Mya arenaria*. The permanent decreases of bivalves and foraging knots were most pronounced in the sectors of intertidal flat that were most affected by the fisheries in 1988-1990. Between 1988 and 1992 the sediments in these affected areas lost part of their silt fraction and, thus, showed a remarkable increase in their median grain-sizes. These trends continued until 1994 and showed only slight reversals since. The absence of a recovery of mollusc stocks stands in sharp contrast to the well-documented situation in a nearby part of the Wadden Sea, Balgzand, which is much less exposed in terms of winds and tides. In this area *Cerastoderma* and *Macoma* have rebounced after the overfishing of 1988-1990. We suggest that, depending on the geographic position of intertidal flats in terms of exposure to winds and tides, modern dredging techniques and the removal of mussel banks can have very long lasting effects on whole tidal basins. The sediment-reworking by cockle-dredging in combination with the removal of intertidal mussel banks may have changed the sedimentary system into a site less favourable for deposition of organic particles, and one in which densities and availability of buried bivalves, and hence the availability of prey for some of the high arctic migrant wader species, have been permanently decreased. This causal chain is summarised as the 'negative-biodepositary-spiral' model.



Graphical model of the '*negative-biodepository-spiral*' by which mollusc-rich and reasonably silty sediments in the lee of a mussel bank, through the successive losses of cockles due to mechanical harvesting and the mussel bank itself, transform into permanently sandy, highly dynamic and lower lying intertidal flats where even baltic tellins are unable to maintain their population. Note that in the absence of human activities, the winter storms do not effect the balance of the sediments: the changes have to be kicked off by the (mechanical) removal of the stocks of large filter-feeding and faecal pellets producing bivalves (mussels and/or cockles) but can then turn into a self-perpetuating process with the additional loss of small filter-feeders.

IDEAL FREE THEORY AND DENSITY-DEPENDENT MORTALITY OF SHOREBIRDS

Contributor: *J. van der Meer*

One of the central problems in ecology is how animals will distribute themselves over patches of different food quality. Fretwell & Lucas (1970) used as a basic premise that animal distribution might best be understood by recognising that each animal will behave as to maximise its fitness. They further simplified the problem by assuming that each individual animal is "ideal", i.e. is able to choose the patch that maximises its fitness, and is "free", i.e. there are no costs associated with moving between habitats. Additionally, animals were assumed to be all alike. Students of foraging animals have eagerly picked up the ideas of Fretwell & Lucas, meanwhile interpreting fitness as the rate of food intake. Yet, in order to predict the spatial distribution of "ideal" and "free" predators, one needs to know how the food intake rate of an individual predator is related to characteristics of the population of the prey, as well as to the predators themselves. Surprisingly, a systematic theoretical investigation of models for the basic case, where both prey and predators are best characterised by their "standing stock" density, is lacking. In these models intake rate is supposed to decrease with increasing predator density as a result of interference among predators, instead of immediate consumption of the prey.

Together with Dr. B. Ens (IBN-DLO), I compared the various ways of incorporating interference in Holling's functional response model applied so far. Therefore we showed that the different models of interference result in qualitatively different predictions for "ideal" and "free" predators on (a) the form of the aggregative response (i.e. the relationship between prey and predator density), (b) the trajectory of the aggregative response as prey is depleted, and (c) the change in the aggregative response following an influx of predators. This sheds doubt on the general relevance of any one of these models, particularly if the mathematical formulation of interference is merely based on convention, instead of being derived from the underlying mechanism of interactions between predators. Our results underline the need for detailed knowledge about the components of the predation process in order to arrive at reliable predictions for a specific case.

The concept that all predators are alike has been criticised, because it has often been observed that intake rate is neither constant across individuals nor across patches. For example, it has been observed that individual oystercatchers *Haematopus ostralegus* differed in their susceptibility to interference. When intake rate was plotted against predator density, dominant birds showed hardly any decrease, whereas subdominants did show a decreasing intake rate with increasing density of conspecifics. Models have, therefore, been proposed in which individuals differ in their susceptibility to interference. The best-known model (Sutherland & Parker, 1985) proposes that animals should experience more interference when surrounded with relatively strong competitors than when surrounded with weaklings. Simulations with the model (animals are allowed to move until no individual can increase its intake rate by moving to another patch) predicted that strong competitors occupy the good sites where they achieve high intake rates, and that they leave the poor patches to the weaklings, which experience low intake rates. This type of distribution was called the "truncated phenotype distribution".

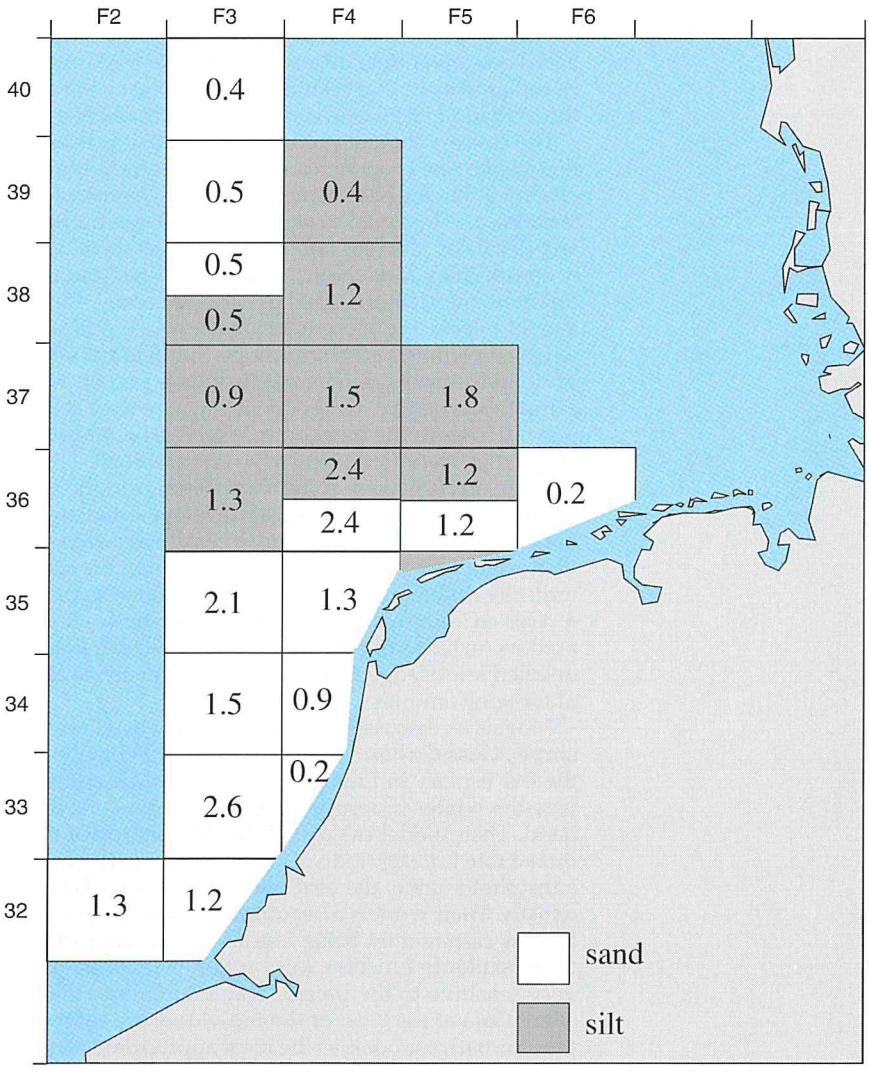
There are, however, some shortcomings in the models of Sutherland & Parker, and an alternative simple class of models was developed that are basically built on the same biological assumptions: animals experience more interference when surrounded with relatively strong competitors than when surrounded with weaklings. Yet, the spatial distributions that these models predict are radically different from the "truncated phenotype distribution". One of the models, for example, reveals an ideal free distribution that is wholly identical to the ideal free distribution of equal competitors (in terms of the number of animals per patch). These results demonstrate again that rather detailed knowledge is needed in order to arrive at reliable predictions of the spatial distribution of foraging animals.

Models as discussed above have been used for predicting population changes in time. For example, Goss-Custard and co-workers (1995), who were interested in wintering oystercatchers in the Exe estuary in England, have used such models for predicting the number of birds that survive the winter in response to the numbers arriving in early winter and to the food that was at hand. Their model calculated the distribution of the birds over the various food patches and the intake rate for each individual bird on a daily basis. If the intake rate of an individual got below a threshold value, the bird died. In this way they were able to show how mortality depends on density. Their work is a beautiful example of how knowledge about characteristics of individuals (in this case mainly behavioural and bio-energetic properties) can be used to derive the density-dependence function. But caution is warranted. The spatial distribution of the birds appeared very sensitive to the precise way interference and differences in competitive abilities are modelled. Data at the level of the individual are rather noisy and do not easily point towards one of the alternative models as the most appropriate way for describing the behaviour of the individual. Hence it remains to be seen whether the predicted density-dependence is robust for alternative (but not less likely) approaches to modelling individual behaviour.

EFFECTS OF TRAWL FISHERIES ON THE BENTHIC ECOSYSTEM

Contributors: *M.J.N. Bergman, M. Fonds, S. Groenewold, H.J. Lindeboom, C.J.M. Philippart, P. van der Puyl, J.W. van Santbrink.*

In the early 1900s the North Sea was already intensively fished by sailing vessels and steam trawlers using both passive gears and trawl nets. Technological advances intensified the fishing activity during this century. Nowadays, beam trawling is the most important fishery in Belgium and the Netherlands, and the most common demersal fishery in Germany. In the offshore part of the Dutch sector in the North Sea, where 12 m beam trawl fishery is the dominant type of trawling, every m^2 was trawled, on average, 1.2 times in 1994. The coastal zone and the Plaice-box were trawled with a similar frequency by the 4 m beam trawl fleet. In UK and Ireland, otter trawling is the most important fishing method. As a follow-up to the EU project IMPACT-I (1992-1994), the IMPACT-project (1994-1997; AIR2-CT94-1664) has been carried out to study the effects of different types of fisheries on the North Sea and the Irish Sea benthic ecosystem. Subprojects focused on the physical and biological impacts of bottom trawling, and on short-term as well as long-term effects. The project was undertaken by the following institutes: RSZV (Belgium); AWI, BFA-ISH, IfM-Kiel (Germany); CEFAS, MLA-SOAEFD, UWB (UK); FRC, MRI (Ireland) and NIOO-CEMO, NIOZ, RIVO-DLO, RWS-DNZ (The Netherlands). NIOZ and RIVO-DLO coordinated the project. The final report will be issued in 1998. The main conclusions are presented here.

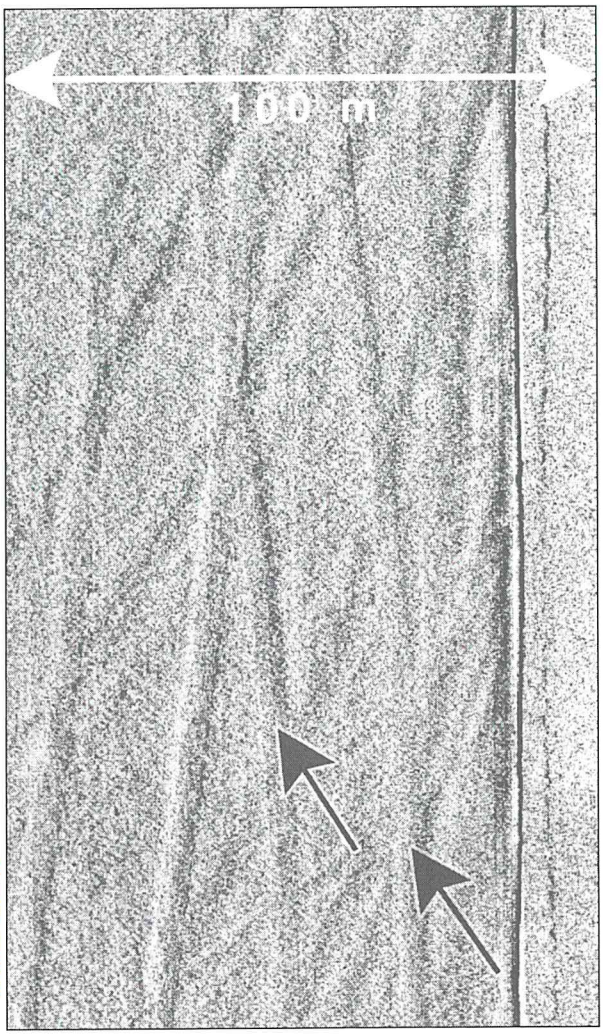


Mean yearly trawling frequency per ICES rectangle of the Dutch, Belgium, German and British fleet using 12 m beam trawls in the Dutch sector of the North Sea in 1994. In the offshore areas, every m^2 was trawled 1.2 times on average.

In commercial trawling, marketable fish is caught together with undersized target and non-target species. The latter two categories are to be returned to the sea ("discards"). In the North Sea studies on flatfish trawling, the amount (by weight) of discarded flatfish (mostly dab and plaice) was at least as high as the marketable catch, while the amount of discarded invertebrates (*e.g.* starfish, heart urchins, crabs) was several times the amount of marketable fish. The catch composition of 4 m and 12 m beam trawls, both rigged with tickler chains, was not significantly different. Both these trawls caught more marketable fish and non-target invertebrates (by weight) than 4 m beam trawls rigged with a chain matrix. In all types of beam trawls, the catch of marketable fish and discards was seven to more than ten times higher than in otter trawls.

In the North Sea, the mortality of animals caught in beam trawls and discarded into the sea during sorting of the catch was species-dependent and varied for invertebrates from < 10% of the individuals caught (*e.g.* starfish, brittlestars) to almost 90% of some bivalves (*e.g. Arctica islandica*), with most bivalve and crustacean species showing values between 50 and 70%. Discarded fish showed mortalities ranging of 50 to 100% in flatfish, of 80 to 100% in roundfish, with 100% mortalities for gadoids. Discard mortalities appeared to be rather independent from the type of trawls tested, *i.e.* the 12 m and the 4 m beam trawls with tickler chains, 4 m beam trawl with chain matrices and the otter trawl. Despite the high mortality of discarded small-sized fish and most invertebrate species, this mortality is still very low (a few %) when expressed as percentage of the initial density of these species at the seabed. This is due to the low catch efficiency of commercial trawls for these species (far less than 10%), which either do not enter the net or pass through the meshes.

In the North Sea, direct mortality of non-target invertebrate species appeared to occur mainly in the trawl path, possibly as a result of direct physical damage inflicted by the passage of the trawl or indirectly by disturbance and subsequent predation. The total direct mortality of invertebrates (mortality in the discards plus mortality in the trawl path, both as % of initial density) due to trawling once over the seabed, varied for various species of gastropods, starfish, crustaceans, and annelid worms between 10 and 50%. For a number of bivalve species, total direct mortalities of 30-80% were found. Fragile species or species living in the uppermost layers of the seabed showed high total mortalities, while robust or deeply burrowing species suffered low or



Side scan sonar recording showing the marks (see arrows) of commercial 4 m beam trawl fishery (13/6/1994) in a mobile, medium grained sandy seabed in the ICES rectangle 32F2 near Thornton Bank (water depth 25 m). Marks of trawls appeared to be visible during 37 hours in mobile sandy sediments and up to 18 months in low-energy, muddy areas. The passage of a trawl flattens the contours on the seabed. The penetration depth of a beam trawl into the bottom is estimated at 1-8 cm.

even no mortalities. In general, small sized species and specimens showed relatively low total mortalities. Mortalities due to trawling with 4 m or 12 m beam trawls was not significantly different. A lesser penetration depth into the seabed appeared to cause a lower direct mortality in many burrowing invertebrate species: in silty areas otter trawling caused less mortality than beam trawling, and beam trawling caused less mortality in sandy than in silty sediments.

The annual fishing mortality due to trawl fisheries could be estimated for some invertebrate populations in the Dutch sector of the North Sea in 1994. The calculations were based on (i) the spatial distribution of the trawling effort, (ii) the distribution of larger sized bottom fauna, and (iii) an estimate of total direct mortality of these species due to trawling once. The fishing mortality varied between 7 and 48% in the invertebrate populations considered, with half the number of species showing values of more than 25%. For most populations, the 12 m beam trawl fisheries caused much higher fishing mortalities than the 4 m beam trawl and otter trawl fisheries. Only in species restricted to the coastal zone, where 4 m beam trawl fishery is intensive, fishing mortality due to 4 m beam trawling was relatively higher and exceeded that due to the 12 m beam trawl fishery.

Benthic scavengers and predators feed both on fisheries discards and on animals damaged in trawl tracks. In some cases predatory species feed on scavenging species attracted by the trawling. Based on field studies of the annual production of damaged fauna and discards by beam trawl fishery, and on laboratory estimates of maximum daily food consumption of the most abundant scavenging benthic predators in the southern North Sea (dab, whiting, dragonet, starfish, hermit crabs, swimming crabs and shrimps), it is estimated that the annual amount of carrion produced by fishing activities accounts for less than 10% of the maximum annual food consumption by these species.

Experimental disturbance of a previously unfished site in the Irish Sea caused long-term effects on both epi- and infauna. Comparison of fished and protected sites in the Irish Sea showed differences in species composition. Opportunistic (small size, rapidly reproducing) species increased in abundance while sensitive (large size, fragile) species declined in numbers due to trawling disturbance. High *Nephrops* trawling effort led to a species-poor and biomass-poor fauna. Measures of diversity and evenness were consistently higher in unfished areas when compared to adjacent disturbed areas. In sheltered muddy sites at the east coast of the Irish Sea, recovery following disturbance took over 18 months.

Almost 100 years of trawling impact have certainly restructured the benthic system in the North Sea. In the German analyses, a decline in the frequency of occurrence of bivalves is observed for the period 1902-1986, whereas populations of scavengers and predators (crustaceans, gastropods and seastars) have increased. The benthic communities in the German Bight have shown a significant increase in biomass and a change in community structure with a dominance of opportunistic short-lived species (r-selected) and a decrease of long-living sessile organisms (K-selected) such as several bivalve species. Dutch analyses showed a rapid decline in numbers of some rare fish species (rays, sharks) and rare invertebrates delivered annually by trawlers to the Dutch Zoological Station in Den Helder, which appeared to be related to increasing fishing effort and the changes in gear of demersal trawlers. Otter trawlers delivered relatively more fish than invertebrates as compared to beam trawlers, while beam trawlers appeared to be much more efficient in catching all species (fish and invertebrates) considered. Considering the other results of the project (e.g. estimates of the total direct mortality and the fishing mortality of benthic invertebrates, and the comparison between fished and unfished areas), it was concluded that trawl fisheries has contributed to the observed long-term trends in benthic communities.

It is recommended that fisheries management should not only be based on management of fish stocks with commercial value, but also on ecosystem management. Measures to reduce the fishing mortality have to focus on reduction of trawling effort, on spatial restriction of trawling effort (e.g. zonation) and on reduction of direct mortality rate of under-sized or non-target species (e.g. alternative gear design). A well-balanced management has to be founded on knowledge of species characteristics (e.g. recruitment, size distribution, recovery time, succession patterns) and detailed information on the micro-distribution of fishing effort in time and space (e.g. registration of fishing activities).

EXTERNAL PROJECTS OF THE DEPARTMENT OF MARINE ECOLOGY

- Differentation in Caribbian reef-building coral populations (NWO) *R.P.M. Bak*
- Population dynamics of groupers (Serannidae) at Banten Bay, Serang - West Java - Indonesia - Teluk Banten II (NWO) *H.J. Lindeboom, Siti Nuraini*
- Coral community dynamics of an Indonesian coral reef under stress: focus Teluk Banten - Teluk Banten II (NWO) *R.P.M. Bak, E.H. Meesters*
- Population dynamics of some selected bird species in Teluk Banten, their food requirements and the changing environment - Teluk Banten II (NWO) *H.J. Lindeboom, Yus Rusila Noor*
- Dynamics through natural and anthropogenic causes of marine organisms: effects of large scale ecological changes on fish and fisheries (EU) *H.J. Lindeboom, C.J.M. Philippart, C. Winter, J.W. de Leeuw, J.J. Beukema, J. van der Meer, A.F. Zuur*
- Damage of coral reefs by recreational activities: Strategies and the development of novel markers for environmental stress (EU) *R.P.M. Bak, G. Nieuwland*
- Mediterranen targeted project II - Mass transfer and ecosystem respons (EU) *G. Duineveld*
- Modelling the impact of fisheries on seabirds (EU) *H.J. Lindeboom, C.J. Camphuysen*
- Autonomous lander instrument packages for oceanographic research (EU) *G.C.A. Duineveld, P.A.W.J. de Wilde, E. Berghuis, R. Witbaard*
- High resolution temporal and spatial study of the benthic biology and geochemistry of a north-eastern Atlantic abyssal locality (EU) *H.J. Lindeboom*
- Ocean margin exchange II - Phase II (EU) *G.C.A. Duineveld, E. Berghuis, A. Kok, J. van der Weele, M. Lavaleye, P.A.W.J. de Wilde*
- Onderzoek effecten bodemdaling op macro benthos (NAM) *J.J. Beukema*
- Monitoring exploiratie boring (NAM) *H.J. Lindeboom*
- Biologisch monitoring programma, onderdeel Noordzee en Voordelta (RWS) *R. Daan, M. Mulder, P.A.W.J. de Wilde*
- Biologisch monitorprogramma onderdeel macro zoöbenthos, Waddenzee, Balgzand en Eems-Dollard (RWS) *R. Dekker*
- Ecoprofiel Eidereend - 8860 (RWS) *T. Piersma*
- Bemonstering en analyse van grote soorten bodemorganismen nabij loslokaties in de Noordzee 1997 (RIKZ) *M.J.N. Bergman, R. Daan*
- De kardering van habitats/ecotopen in de Nederlandse zoute wateren (RWS) *H.J. Lindeboom*
- Verspreiding van (epi)bentische macrofauna op het Nederlandse Continentale Plat, in relatie met de verspreiding van de boomkorvissserij vanaf 1993 (RWS) *M.J.N. Bergman*
- Effects of fisheries on the benthic fauna of the North Sea and Irish Sea - II (EU) *H.J. Lindeboom, M.J.N. Bergman, M. Fonds, C.J.M. Philippart, J. van Santbrink, P. van de Puyl, S. Groenewold*
- A study of predator-prey relationships of waderbirds and benthic macrofauna (NWO-PIONIER) *T. Piersma*
- Shell carbonate preservation.(NWO-NAAP) *G.C. Cadée*
- Shellfisheries, shorebirds and benthos around Griend in 1988-1996 (Natuurmonumenten & Vogelbescherming-Nederland) *A. Koolhaas, C.J. Camphuysen & T. Piersma*

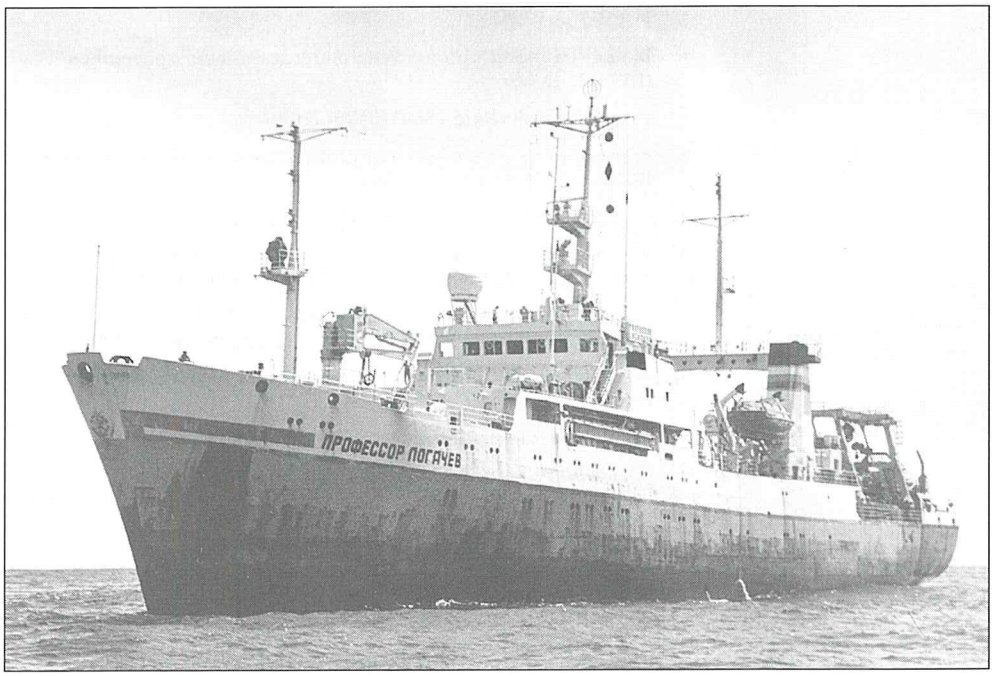
THE NETHERLANDS MARINE RESEARCH FACILITIES (MRF)

Contributor: *C.N. van Bergen Henegouw*

MRF advises GOA on the technical and financial aspects of the execution of the National Programme for sea research, and it provides suitable ship capacity and sea-going equipment. When sea-going projects have been approved and granted by GOA, MRF takes care of the planning, preparation and execution of these cruises. MRF also advises GB-BOA on long-term investments. The advice is prepared by the programme co-ordinator in consultation with the financial and technical division of NIOZ, scientists and the user advisory committees (on CTD systems, Autoanalyzer systems and Moored Instrumentation systems).

The National Programme in 1997 consisted of the following projects:

1. Triple B, hydrographic observations in WOCE Hydrographic Programme repeat area AR 12; project manager Dr. H.M. Van Aken (NIOZ). In a 21-days cruise in the Bay of Biscay with RV 'Pelagia' the programme of 1996 was repeated.
2. Late Quaternary Paleoceanography, a project focusing on the late Quaternary overflow history of the important East Greenland pathway. High resolution multi-channel sleeve gun seismic data recently collected by the Geological Survey of Denmark and Greenland (GEUS) allow precise identification of suitable box- and piston-coring sites. Results from the expected high-resolution cores, allowing direct correlation with regional atmospheric changes documented in the Greenland ice, will provide new information on causes and mechanisms of climate change (Greenland); project manager Dr. S.R. Troelstra (VU-IvA). An international team of 15 scientists and technicians, assisted by nine participants of Moskow State University (Russia), joined the Russian RV 'Professor Logachev' in Aberdeen (UK). In the harbour Dutch scientific equipment was fitted onto the ship to assure high quality piston cores in the target area. The core-sites were found by seismic survey done both on board the RV 'Professor Logachev' as well as on the Danish RV 'Dana'.



RV 'Professor Logachev'

3. Training through Research Cruise (TTR-97); project manager Dr. J.M. Woodside (VU-IvA), is part of an ongoing programme since 1991. The objective of this year's expedition was determining the evolution of small rifted basins (e.g. Rhodes and Finike basins) in a collisional tectonic setting, their structure and controlling tectonics, and their stratigraphic developments. The sources, rates, processes, and types of sedimentation were examined and compared with analogous basins in the geological record on land. This project was executed on board the Russian RV 'Akademik Boris Petrov' from 31 May - 7 June. Fifteen participants joined the ship in Antalya (Turkey). Due to technical and logistical problems only part of the objectives were met.

- Advice to GOA for ships of opportunity and programme 1998 and 1999:

For the execution of the 1998 programme of Triple B (projectmanager Dr. H.M. van Aken) and Escape (project manager Dr. W.W.C. Gieskes (RUG)), MRF advised the use of RV 'Pelagia'. MRF advised project manager Dr. J.J. Middelburg (NIOO-CEMO) to execute 'Sedimentary manganese and iron cycles: their role in organic carbon oxidation and recycling of nutrients and trace elements' in the Mediterranean Sea on board either an Italian or a Russian research vessel. Dependent on GOA funding 'Medinaut' (project manager Dr. J.M. Woodside) will be executed on board the French RV 'l'Atalante' and deep sea submersible 'Nautile' to investigate the processes and products of mud volcanos and fluid vents in two different settings in the eastern Mediterranean Sea, during thirty dives to the seafloor.

For the 1999 programme, MRF advised GOA on requests for five sea-going applications (three NIOZ, one University of Utrecht, and one NIOO-CEMO).

M.J. Rietveld and C.N. Van Bergen Henegouw (executive secretary) took part in the 11th meeting of the International Ship Operators, at the Institut de Ciencies del Mar, Barcelona, Spain.

On 17 September 1997 an agreement was signed between seven Dutch organisations (RIKZ, RWS-DNZ, WL, NITG-TNO, KM-Hydrography, KNMI, and NIOZ) to form a national oceanographic data commission (NODC) to enhance the availability of high quality oceanographic data for a wide group of users now and in the future, and to decrease the thresholds for making oceanographic data available between the participants.

The total effort of MRF in terms of cruise, ship days and personnel involved for 1997 is given in the table.

Project	ship	ship days	scientists	students	MRF	others
1	Pelagia	21	5	5	5	-
2	Logachev	22	9	4	2	9
	Dana	6	2	-	-	-
3	Boris Petrov	7	11	6	-	-

LAND-OCEAN INTERACTIONS IN THE COASTAL ZONE (LOICZ) INTERNATIONAL PROJECT OFFICE (IPO)

Contributors: *P.R. Boudreau, H.J. Lindeboom*

The world's coastal zone forms a long narrow boundary between land and ocean that is highly valued by man. The Land-Ocean Interactions in the Coastal Zone (LOICZ) is the International Project that is studying this relatively small but highly dynamic and sensitive area, where land, sea and atmosphere are in close contact. LOICZ is primarily interested in changes in fluxes of matter across these boundaries, their impact on man's activities as well as the impact of man on these fluxes.

The fact that the coastal zone is defined relative to the shoreline where water and land meet makes it particularly sensitive to changes in the global system that affect sea level change. Changes in sea level will have a direct impact on the state of coastal biological communities and their geological substrate. To some extent, the ecosystems have an ability to interact in a way that will allow organisms and their processes to be maintained, but this is not unlimited. Global change will affect ecosystems dramatically in ways that may limit their present operation and functioning.

Fluxes of materials in the coastal zone are focused on the movement of water, sediments and nutrients. The movement of each of these materials into and through the coastal zone depends upon the biology, chemistry and physics of the area. Global change that alters any of these components will result in changes to the existing functions of the coastal zone. Such functions presently include production of biological matter, generation and removal of bio-available nitrogen, and even providing substrate and protection for life in terms of the formation of deltas, barrier islands, etc.

A major component of this study is the interrelation of man and these fluxes. The coastal zone is presently under pressure from an increase of population density. This results from both population growth and the movement of people to the coastal areas. There are indications that by the year 2010, of the 20 predicted megacities, all but one will be in the coastal zone. The result of this growth is usually an increase in the input of sediments and nutrients, due to domestic and agricultural activities and a reduction in the delivery of fresh water, as a result of water extraction. Present use of the coastal waters for sewage treatment, recreation, transportation, etc. may not be globally sustainable under these increased pressures.

The interaction of land, water, atmosphere and man provides an exceptional challenge to the LOICZ project. The success of LOICZ will depend on a unified approach. The LOICZ Project is attempting to draw on a large number of researchers, e.g. biologists, chemists, geologists, socio-economists, etc., to contribute their expertise to this study. Successful global models will only result from successful co-operation.

Scientific Activities of the LOICZ International Project Office during 1997

One of the unique characteristics of the world's coastal zone, here defined between 200 m depth and 200 m elevation, is that it forms a long narrow strip which is highly variable along its length and with very strong gradients across it from land to the continental margins. This high degree of spatial variability and the limited amount of research demands modelling methodologies in maximise the usefulness of available information in generating global estimates of material fluxes. The LOICZ Project has developed two very useful tools that aid in this task:

- biogeochemical budget modelling methodology; and,
- global typology data grid and database.

Work in 1997 further developed these tools and we have started to bring them together to explore a typological approach to estimating global values for net metabolism and nitrogen fluxes. The results show trends that, if verified with additional research and data, might be useful in carrying out an extrapolation from well-studied to not-so-well studied sites and thus arrive at useful global estimates.

The central and essential objectives of the Biogeochemical Modelling Core Project of LOICZ are:

- to gain a better understanding of the global cycles of the key nutrient elements carbon, nitrogen, and phosphorus;
- to understand how the coastal zone effects these fluxes through biogeochemical processes; and,
- to understand relationships of these fluxes to human intervention.

Work on compiling additional budgets world-wide continues. Led by Professors S. Smith (School of Ocean and Earth Sciences and Technology, University of Hawaii, Honolulu, U.S.A.), F. Wulff (Stockholm University, Stockholm, Sweden) and the LOICZ International Project Office (IPO), a total of 50 budgets have been produced now for coastal areas in ranging in latitude from 64° N to 35° S. Most of these have been posted on the World Wide Web Page.

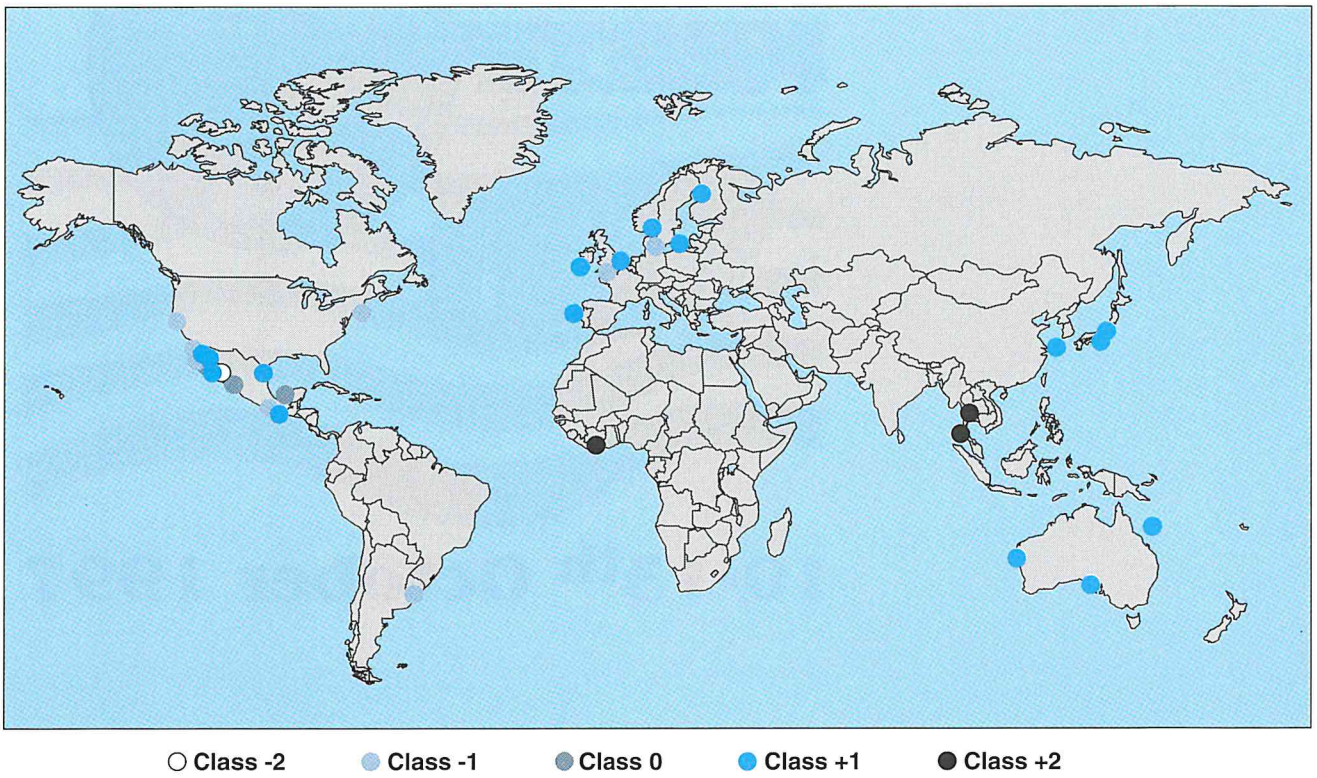
Class values for biogeochemical variables.
Note that the classes are non-linear and that the net ecological carbon production classes are roughly an order of magnitude larger than the nitrogen fixation minus denitrification (nfix-denit) classes.

Class Value	(nfix-denit) (mmoles m^{-2} $year^{-1}$)	NEP (p-r) (mmoles m^{-2} $year^{-1}$)
-2	<-2,500	<-20,000
-1	-2,500 to -250	-20,000 to -2,000
0	-250 to 250	-2,000 to 2,000
1	250 to 2,500	2,000 to 20,000
2	>2,500	>20,000

The second "tool" being developed is a coastal typology database. This work has been conducted mainly through the IPO using GIS software. Through this work an Access database now exists that compiles over 40 environmental and socio-economic parameters into a 1°X 1° grid for all of the worlds coastline. This database is being distributed free of charge to LOICZ researchers for their analyses.

Although it is anticipated that detailed analysis of global patterns will not be rigorous until 150 to 200 budgets have been compiled, work has begun on linking the numerous local budgets with more general information on global scales to begin to look for methods of scaling up.

For each of the 34 sites nitrogen fixation minus denitrification (*nfix-denit*) and net ecological carbon production (NEP) values have been calculated. Recognising that all of the data do not have the same precision or accuracy and to address the large standard deviation relative to the mean, the variables are classed for use in the analysis. The classes mentioned in the table were used for variables.



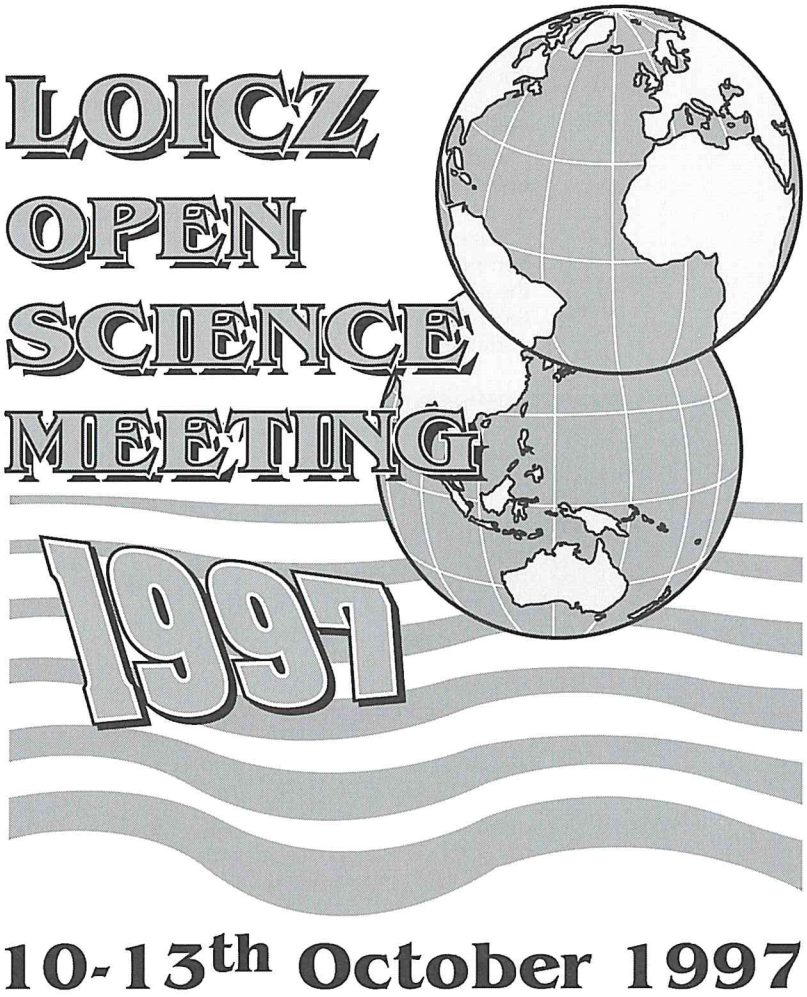
(Nitrogen fixation - denitrification) classes for sites with biogeochemical modelling results. Note that there appears to be a relationship between latitude and (nitrogen fixation - denitrification) with the highest class being found only at low latitudes in Mexico, Gulf of Guinea and Thailand. Although this may be a general trend, also note that there are low class -2 values found at low latitudes in Mexico. The middle class is found primarily at mid to high latitudes. The high range in values seen for low latitudes may indicate that high rates are possible but not necessarily realised. The low values could result from a large number of other factors which may be limiting these processes, such as increased local water depths, different ecosystems, different climatic conditions, etc. Similar patterns are also seen with the net ecological production values.

Unfortunately, the number of data points does not allow rigorous statistical analysis. Nevertheless, patterns, such as seen here with latitude, show promise for future modelling work within the LOICZ Project.

Organisational Activities of the LOICZ International Project Office

The main function of the LOICZ Core Project Office is to co-ordinate and promote the implementation and synthesis of global coastal zone research. As a result much of the activities in 1997 related to assisting others in accomplishing these missions.

In addition to a number of smaller focused workshops in the United Kingdom, the Netherlands, Mexico, Malaysia and The Philippines, the major organisational task of the IPO was the highly successfull Third LOICZ Open Science Meeting, Oct. 10-13th, 1997 in Noordwijkerhout, The Netherlands. Over 200 participants from 50 countries all around the globe met to review and discuss LOICZ global research activities.



Staffing of the Office at NIOZ

The turnover of staff at the LOICZ IPO during 1997 was the same as in the previous year. For eight months Dr. Roy C. Sidle acted as Executive Officer. Dr. Judith van Bleijswijk was employed part time as project assistant after Dr. Sidle's departure to help with the organisation of the Third LOICZ Open Science Meeting and preparing a number of reports. Dr. Han J. Lindeboom, chair of the LOICZ Scientific Steering Committee since 1 July 1997, acted as part-time Executive Officer. Paul Boudreau, the project scientist, left the office at the end of the year.

2. Publications and Presentations

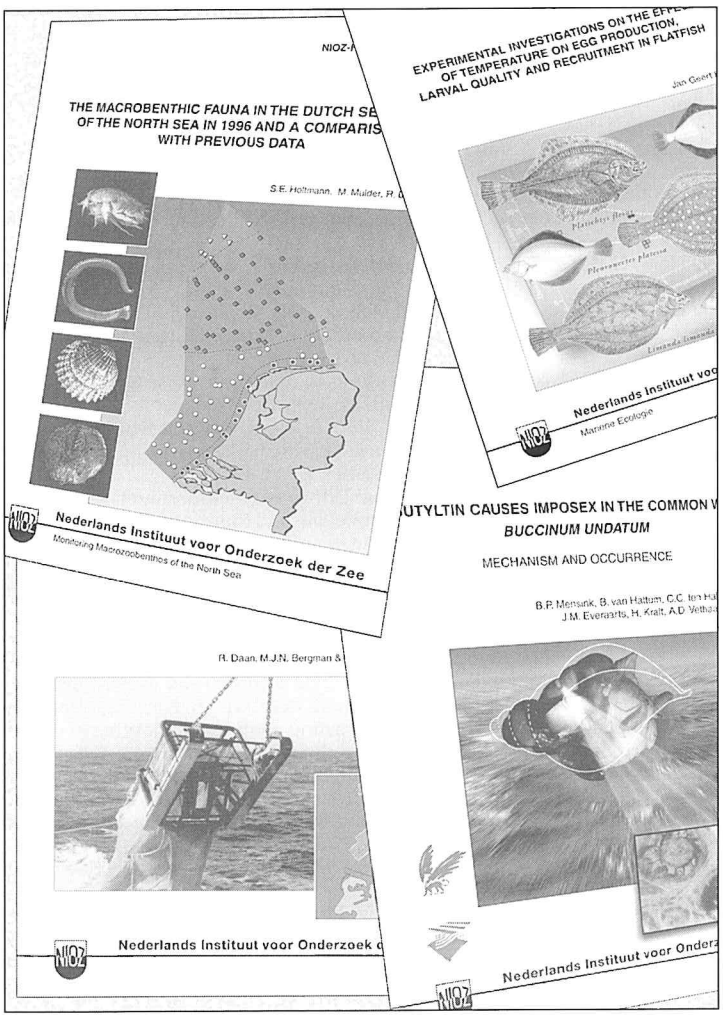


Photo:Henk Hobbelink

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Bosch, H.J., J.S. Sinninghe Damsté & J.W. De Leeuw. Molecular palaeontology of late Neogene Lacustrine rhythmites of the Florina-Kazani Basin (NW Greece). 18th International Meeting on Organic Geochemistry, 22-26 September, Maastricht, the Netherlands.

Clifford, D. J., J.I. Clayton & J.S. Sinninghe Damsté. 3,4,5-2,3,6 Substituted diaryl carotenoid derivatives (Chlorobiaceae) and their utility as indicators of photic zone anoxia in sedimentary environments. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Conan, S.M.H. & G.J.A. Brummer. Planktic foraminifera and monsoonal upwelling: two sediment trap records from the Somali Basin. EUG 9, Strasbourg, 23 March.

De Baar, H.J.W., L. Gerringa, J.T.M. De Jong, M.A.Van Leeuwe,R.F. Nolting, K.R. Timmermans & V. Schoemann. Iron and phytoplankton in thePacific section of the Southern Ocean. Gordon Research Conference in Chemical Oceanography,Meriden, New Hamsphire, USA, 11-12 August.

De Baar, H.J.W., L. Gerringa, J.T.M. De Jong, M.A.Van Leeuwe, R.F. Nolting, K.R. Timmermans & V. Schoemann, Iron and phytoplankton in the Pacific section of the Southern Ocean. Gordon Research Conference. New Hampshire, USA, 11-15 August.

De Jong, J.T.M., R.F. Nolting, L.J.A. Gerringa, K.R. Timmermans & H.J.W. De Baar. Ship-board measurements and speciation analysis of iron at subnanomolar levels in the Antarctic Ocean. International Workshop:

Marine analytical chemistry for monitoring and oceanographic research, Brest France, 17-19 November.

Del Rio, J.C., P.G. Hatcher, J.D.H. Van Heemst & J.W. De Leeuw. Characterization of dissolved organic matter by thermochemolysis with tetramethylammonium hydroxide. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

De Wilde, H.P.J. & M. De Bie. Nitrous oxide in the Scheldt estuary. ERF 97 (Estuarine Research Federation), Providence, Rhode Island, USA, 12-16 October.

Dietz, M.W., A. Dekinga & T. Piersma. Ultrasonic measurement of organ size in small birds to study physiological correlates: basal metabolic rate and thermogenic capacity. Thermal Biology Congress, Copenhagen, Denmark, 10-15 August.

Frost, R.L. & S.J. Van Der Gaast. Hydrogen bonding in kaolinite: a Raman and XRD study. The 11th International Clay Conference, Ottawa, Canada, 15-21 June.

Gast, G.J. Island Ocean Interactions in a reef zone: bacteria and nutrients in time and space. LOICZ-OSM, Noordwijkerhout 10-13 October.

Gast, G.J. Effects of anthropogenic eutrophication on microbes and nutrients in coral reef waters. LOICZ-OSM, Noordwijkerhout 10-13 October.

Gelin, F., M. Kok, J.S. Sinninghe Damsté & J.W. De Leeuw. Laboratory sulfurisation of the microalgae *Nannochloropsis salina*: Evidence for the formation of sulfurised long-chain lipids in kerogens. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Grice, K. , S. Schouten, K.E. Peters & J.S. Sinninghe Damsté. Molecular isotopic characterisation of Eocene-Paleocene anoxic, evaporitic, lacustrine sediments from the Jianghan Basin, China. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Grice, K., V. Grossi, S. Schouten, W. Klein Breteler, J.W. De Leeuw & J.S. Sinninghe Damsté. The effects of zooplankton herbivory on the molecular structure, distribution and stable carbon isotopic composition of algal markers. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Hartgers, W.A., J.F. Lopez, J.S. Sinninghe Damsté, C. Reiss, J.R. Maxwell & J.O. Grimalt. Sulphur binding in recent environments. II. Budgets of iron and sulphur and implications for the occurrence of organo-sulphur compounds in sediments. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Höld, I.M., N.J. Brussee, S. Schouten & J.S. Sinninghe Damsté. Occurrence of bound monoterpenoids in Palaeozoic and Proterozoic marine kerogens. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Höld, I.M., N.J. Brussee, S. Schouten & J.S. Sinninghe Damsté. Sequential selective chemical degradation of a Type II-S kerogen, (Monterey Formation, USA). 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Jansen, J.H.F., S.J. Van Der Gaast, B. Koster, A.J. Vaars - CORTEX, an XRF-scanner for non-destructive chemical analyses of split sediment cores. Core logging symposium Corsaires, Ifremer, Brest. 24-26 July.

Karstensen, J. , A. Hupe & J.Van Bennekom. Redfield ratios of remineralization in the deeper Arabian Sea. European Geophysical Society, Vienna, 21-25 April.

Kok, M.D., S. Schouten & J.S. Sinninghe Damsté. Formation of sulfur-rich kerogen by incorporation of inorganic sulfur species into algal sugars. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Koopmans, M.P., F.C. Carson, J.S. Sinninghe Damsté & M.D. Lewan. Generation and Thermal Stability of Biomarkers from Type II-S Kerogens in Claystone and Limestone during Hydrous and Anhydrous Pyrolysis. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Köster, J., M. Rospondek, S. Schouten, M. Kotarba, A. Zubrzycki, J.W. De Leeuw & J.S. Sinninghe Damsté. Biomarker geochemistry of a foredeep basin: the Oligocene Menilite Formation in SE Poland. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Kuypers, M.M.M., S. Schouten & J.S. Sinninghe Damsté. A molecular carbon isotopic study of the Cenomanian-Turonian boundary event at the NW African shelf. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Leenders, A., H.J. Bosch, J.S. Sinninghe Damsté & J.W. De Leeuw. An euxinic Pliocene Eastern Mediterranean during formation of sapropels. Neogene Mediterranean Paleoceanography, Erice, Sicily, 28-30 September

Leenders, A., H.J. Bosch, J.S. Sinninghe Damsté & J.W. De Leeuw. An euxinic Pliocene Eastern Mediterranean during formation of sapropels. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Lohse, L., W. Van Raaphorst & W. Helder. North Sea nutrient cycling: Benthic nitrification-denitrification coupling. LOICZ open science meeting, Noordwijkerhout, 10-13 October.

Lototskaya, A., G. Ganssen, P. Ziveri & G. Versteegh. High resolution geochemical and floral record of the last interglacial in the northeast Atlantic. EUG 9, Strasbourg, France, 23-27 March.

Maas, L.R.M., D. Benielli, J. Sommeria & F.-P.A. Lam. Observation of an internal wave attractor. European Geophysical Society, Vienna, 21-25 April.

Malschaert, J.F.P. & W. Van Raaphorst, North Sea nutrient cycling: Benthic pools of ammonium. LOICZ open science meeting, Noordwijkerhout, 10-13 October.

Megens, L., J. Van Der Plicht & J.W. De Leeuw. Chemical and isotopic characterization of particulate organic matter from the Ems-Dollard Estuary. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Mensink, B.P., C.C. Ten-Hallers-Tjabbes, H. Kralt, B. Van Hattum, A.D. Vethaak & J.P. Boon. Imposex in the common whelk *(Buccinum undatum)* by tributyltin (TBT) and consequenses for the supposed mechanism. Symposium 'Endocrine active compounds in food and environment - setting the research agenda-', Ede, 11 April.

M'harzi, A., M. Tackx, J.H. Vosjan & N. Daro. Changing phytoplankton community structure along a North Sea transect. LOICZ open-science meeting on Global Change Science in Coastal Zone. Noordwijkerhout, 10-13 October.

Obernosterer, I. & G.J. Herndl. Diurnal variations in hydrogen peroxide formation in the equatorial Atlantic. ASLO meeting, Santa Fe, USA, 10-14 February.

Pool W.G., J.W. De Leeuw & B. Van De Graaf. Automated processing of GC/MS data. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Reitner, B. & G.J. Herndl. Role of UV radiation on photochemical oxygen consumption of humic-rich dissolved organic matter and its utilization by natural bacterioplankton in a shallow lake. ASLO meeting, Santa Fe, USA, 10-14 February.

Schoemann, V., H.J.W. De Baar, J.T.M. De Jong & C. Lancelot. Effects of phytoplankton blooms on the cycling of manganese and iron in coastalwaters. Gordon Research Conference, Meriden, USA, 10-15 August.

Schoemann, V., H.J.W. De Baar, J.T.M. De Jong & C. Lancelot. Effects of phytoplankton blooms on the cycling of manganese and iron in coastal waters. LOICZ Open Science Meeting, Noordwijkerhout, The Netherlands, 10-13 October.

Schouten, S., M.J.L. Hoefs, J.W. De Leeuw, L.L. King, S.G. Wakeham & J.S. Sinninghe Damsté. Pelagic Archaea as revealed by their specific lipids in the marine water column and sedimentary record. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Sephton, M.A., R.J. Veefkind, C.V. Looy, H. Visscher, H. Brinkhuis & J.W. De Leeuw. Biogeochemistry of the Permian-Triassic extinction. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Sinninghe Damsté, J.S. C_{27} - C_{30} neohop-13(18)-enes and their aromatic derivatives in sediments: Indicators for water column stratification? 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Slomp, C.P. & W. Van Raaphorst. North Sea nutrient cycling: Sediment-water exchange of phosphorus. LOICZ open science meeting, Noordwijkerhout, 10-13 October.

Stoll, M.H.C., E. De Jong & H.J.W. De Baar. Variability of air-sea gasexchange of carbon in Dutch coastal waters, LOICZ Open Science Meeting, 10-13 October.

Stolte, W., A.A.M. Noordeloos & R. Riegman. Cell composition and growth of *Emiliania huxleyi* strain L under light limitation. 7th international Global Emiliania Modeling Initiative (GEM) meeting, Chateau de Blagnac, Cabara, France, 13-17 September.

Ufkes, E., J.H.F. Jansen & R.R. Schneider - SE Atlantic surface circulation during and after the Mid-Pleistocene transition: a study of planktonic foraminifera. NSG (Netherlands Research School Sedimentary Geology) Symposium, Amsterdam. 16 December.

Van Der Gaast, S.J., R.A. Kühnel, J.Vasterink & R.L.Frost. A new model for the structure of water in the interlayer of Ca-Wyoming montmorillonite. The 11th International Clay Conference, Ottawa, Canada, 15-21 june.

Van Heemst, J.D.H., B.A. Stankiewicz, P.F. Van Bergen, R.P. Evershed & J.W. De Leeuw. Multiple sources of alkylphenols produced upon pyrolysis of DOM, POM and recent and ancient sediments. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Van Hezik, C.M.E., P.G. Wester, W.E. Lewis & J.P. Boon. Inhibition of Toxaphene metabolism in hepatic microsomes of harbour seal. 9th International Symposium on Pollutant Responses in Marine Organisms (PRIMO-9), Bergen, Norway, 27-30 April.

Van Kaam-Peters, H.M.E., S. Schouten, J. Köster, V. Brücher & J.S. Sinninghe Damsté. Palaeoclimatical control on the bulk, molecular, carbon and sulfur isotopic composition of organic matter of the Kimmeridge Clay facies. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Van Raaphorst, W., S.J. Van Der Gaast, C.P. Slomp & J.F.P. Malschaert. North Sea nutrient cycling: Binding of inorganic nutrients onto marine minerals. LOICZ open science meeting, Noordwijkerhout, 10-13 October.

Veefkind R.J., M.A Sephton, C.V. Looy, H. Visscher, H. Brinkhuis & J.W. De Leeuw. Lateral variations in organic matter near the Permian-Triassic boundary, Northern Italy. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Versteegh G.J.M., H.J. Bosch, J.H.F. Jansen, P.J. Müller, R.R. Schneider & J.W. De Leeuw. Long-chain diols, keto-ols and hydroxy fatty acids as palaeoenvironmental tools to trace oceanic-front variations in the SE-Atlantic. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Vink, A., S. Schouten & J.S. Sinninghe Damsté. Unusual isoprenoidal carbon skeletons in the lower Albian Niveau Paquier black shale (Vocontian basin; SE France). 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Wiebinga, C.J., E. Buitenhuis, M. Okbamichael & H.J.W. De Baar. Dissolved organic carbon dynamics: implications for carbon cycling in a bloom of *Emiliania huxleyi* and during estuarine mixing. LOICZ Open Science Meeting, Noordwijkerhout, October 10-13.

Zonneveld, K.A.F. & G.J.A. Brummer. Dinoflagellate cyst flux in the Arabian Sea, NW Indian Ocean. EUG 9, Strasbourg, March 23.

ORAL PRESENTATIONS

Akhmetjanov, A.M., Tj.C.E. van Weering, N.H. Kenyon & M.K. Ivanov. Carbonate mounds and reefs at the Rockall Trough and Porcupine margins. 2nd ENAM II Workshop, Kinsale, Ierland, 30 October-2 November.

Baars, M.A. Pelagic ecosystems, with special reference to the North Sea and the Arabian Sea, University of Groningen, Haren, 13 June.

Bak, R.P.M. Coral reefs and pollution. Lecture University of Groningen, Haren, 26 May.

Bak, R.P.M. Coral reefs biogeografie. University of Groningen, Haren, 20 January.

Bak, R.P.M. Coral reefs. Lecture series University of Groningen, Haren, June.

Bak, R.P.M. Tropical Marine Biology Lecture series. University of Amsterdam, January.

Bergman, M.J.N. Impact of beam trawl fishery on the benthic ecosystem of the North Sea. Lecture for students Noordelijke Hogeschool Leeuwarden, NIOZ, 13 May.

Bergman, M.J.N. IMPACT-II, Planning and Conclusions. BEON, Den Haag, 21 October.

Bergman, M.J.N. New developments in sampling macrobenthos. Protection and Utilisation of Oceans, NIOZ, 2 September.

Beukema, J.J. Long-term data of macrozoobenthic abundance on Balgzand: relationships with disturbances. Workshop 'Disturbances in coastal marine ecosystems' Wilhelmshaven, Germany, 3-6 February.
Beukema, J.J. Structure and functioning of the ecosystem of the Wadden Sea. NIOZ, 20 November.
Beukema, J.J., P.J.C. Honkoop & R. Dekker. Recruitment in *Macoma balthica* after mild and cold winters. 32nd European Marine Biology Symposium, Lysekil, Sweden, 17-21 August.
Blokker, P. *et al.* Chemical structure of algaenans from fresh water algae. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.
Blokker, P. *et al.* Chemical structure of aliphatic biopolymers in the cell walls of *Tetraedron minimum, Scenedesmus communis* and *Pediastrum boryanum*. 6th International Phycological Congress, Leiden, 9-16 August.
Blokker, P. *et al.* Structure and stable isotope composition of algaenan from fresh water algae. ACS meeting, San Francisco, 13-17 April.
Boers, P., W. Van Raaphorst & D. Van Der Molen, Phosphorus in sediments - Beyond eutrophication, Internat. Symp. Eutrophication Processes in the Aquatic Environment, University of Wageningen, Wageningen, 28-29 August.
Booij, K. Dynamics of organic contaminants. Research School Environmental Chemistry and Toxicology, University of Wageningen, Wageningen, 20 March.
Booij, K. Fate of organic contaminants in the marine environment. University of Groningen, Groningen, 21 May.
Boon, J.P. Bioaccumulation and biotransformation of lipophilic organohalogens in marine mammals and birds. College voor de Cursus Marien Milieu, University of Groningen, Groningen, 21 Mei.
Boon, J.P. *et al.* Biotransformation of lipophilic organohalogen compounds. Possible consequenses for bioaccumulation and genotoxicity. BEON symposium 'Micropollutants', Den Haag, 19 June.
Boon, J.P. *et al.* In vitro biotransformation of organohalogen compounds in hepatic microsomes of marine mammals and birds in relation to bioaccumulation and genotoxicity. 9th International Symposium on Pollutant Responses in Marine Organisms (PRIMO-9), Norway, 2 May.
Boon, J.P. Kinetics of lipophilic halogenated organic contaminants in marine mammals and birds. Research School Environmental Chemistry and Toxicology, Wageningen, 20 March.
Boon, J.P. Toxic compounds in the North Sea. Scientific Bureau D66, Texel, 18 April.
Boon, J.P. What's in a peak? Symposium for the retirement of Prof. J.C. Duinker, Institute of Marine Science, Kiel, Germany, 13 March.
Boon, J.P. *et al.* In vitro biotransformation of organohalogen compounds in hepatic microsomes of marine mammals and birds in relation to bioaccumulation and genotoxicity. 9th International Symposium on Pollutant Responses in Marine Organisms (PRIMO-9), Bergen, Norway, 27-30 April.
Bosch, H.J., J.S. Sinninghe Damsté & J.W. De Leeuw. Photic zone anoxia during Eastern Mediterranean sapropel formation. EUG 9, Strasbourg, France, 23-27 March.
Brummer, G.J.A. Primary productivity, export fluxes and sedimentary diagenesis of bio-elements in the Somalia upwelling system. Univ. Utrecht, April 14.
Brummer, G.J.A., E. Koning,, R. Kloosterhuis & W. Helder. Seasonality and diagenesis of particle fluxes across the sediment-water interface in the Somalia upwelling system. EUG 9, Strasbourg, March 23.
Brummer, G.J.A., P. Ziveri & J. Giraudeau. Intercalibration of coccolithophore count data from sediment trap samples and a Holocene sediment. GEM 7, Bordeaux, September 14.
Cadée, G.C. Benthic plants, standing stock and primary production. NIOZ, 20 November.
Cadée, G.C. Information from damaged shells. Symposium Kust, Jeugdbond voor Natuur- en Milieustudie, Alkmaar, 29 December.
Cadée, G.C. The Wadden Sea, a playground for aktuopaleontologists. University of Granada, Granada, Spain, 12-16 May 1997.
Camphuysen C.J.. Seabirds of the Scottish Islands, an introduction. Plancius/Ocean Wide Presentation, Maarn, 18 January 1996
Camphuysen C.J. Seabirds and Fisheries. Zeevogels en visserij. Vogelwerkgroep Noordwijk, Noordwijk, 31 January 1996
Camphuysen C.J. Oiled seabirds in The Netherlands, 1969-97. Olieslachtoffers in Nederland van 1969 tot 1997. Studiedag 'Zeevogels en vervuiling van de zee'. Oostende, 26 April 1997
Camphuysen C.J. Seabirds and marine mammals in the North Atlantic arctic and subarctic waters. Vogels en zeezoogdieren in het Noordatlantische poolgebied. Vogelwerkgroep Tringa, Schagen, 27 October 1997
Camphuysen C.J.. Seabirds of the Scottish Islands, the Faeroe Islands and Jan Mayen, an introduction. Plancius/Ocean Wide Presentation, Amsterdam, 1 November 1997
Daan, R. Distribution of the benthic fauna around Loswal Noord. Workshop monitoring Loswal Noord/Noordwest, RIKZ, Den Haag, 7 Jan. 1997.
De Baar, H.J.W. De Rol van IJzer in Ecosystemen Rondom Antarctica. Artic Weekend, Soest, 16 November.
De Baar, H.J.W. Discrimination of Women in Science. Department of Marine Chemistry and Geology, NIOZ, Texel, 21 October.
De Baar, H.J.W. Discrimination of Women in Science. Rotary Service Club, Bergen, 7 October.
De Baar, H.J.W. Growth Limitation by Carbon Dioxide of *Phaecystis* sp. during Spring 1994 in the Marsdiep. Workshop ESCAPE, Amsterdam, 3 November.
De Baar, H.J.W. Low availability of Fe and the absence of diatom blooms in remote Pacific waters of the Southern Ocean. Invited keynote lecture, Challenger Society Meeting on 'Iron in the Marine Environment', London, 5 December.
De Baar, H.J.W. Plankton blooms: a biological pump for carbon dioxide uptake in the Antarctic Ocean. Invited lecture, Sixth International Phycological Congress, Leiden, 15 August.
De Baar, H.J.W. Pollutant Metals and Greenhouse Gases. Lecture courses Marine Environment, University of Groningen, 29 May.
De Baar, H.J.W. Regulation by Light and Iron of Diatom Blooms and Carbon Dioxide Budget of the Southern Ocean. Invited lecture, 33rd Executive Committee Meeting of the Scientific Committee on Oceanic Research (SCOR), Rio de Janeiro, 11 September.
De Baar, H.J.W. Lecture series Introductory Oceanography. Department of Marine Biology, University of Groningen, 10-20 February.

De Baar, H.J.W. Marine Ecosystems regulation by Trace Metals and Carbon Dioxide Limitation; where do we stand now? MERLIM workshop at Marine Biological Association, Plymouth, 25 February.
De Baar, H.J.W. Regulation of algal blooms and carbon dioxide uptake in the Antarctic Ocean. Colloquium, Marine Biological Association, Plymouth, 26 February.
De Baar, H.J.W. The global carbon cycle. NIOZ visit of Working Group on Agriculture, Conservation and Fisheries of Scientific Office of D66 Political Party. Texel, 18 April.
De Baar, H.J.W. The Oceanic Carbon Cycle. Review Panel of the Netherlands-Bremen Oceanography program, Bremen, 2 September.
Dekker, R. The macrozoobenthos at Balgzand, western Wadden Sea: a 30-year sampling programme. DYNAMO Workshop "Multivariate methods for the analysis of long-term ecological data", NIOZ, 21-23 January.
De Stigter, H. & Tj.C.E. van Weering. Carbon fluxes at Goban Spur. OMEX II Phase I workshop, NIOZ, Texel, 10-12 February 1997.
De Wilde, H.P.J. Distribution, production, and consumption of greenhouse gases in the Scheldt estuary. NIOZ colloquium series, 27 March.
De Wilde, H.P.J. Methane and nitrous oxide in European estuaries. ELOISE conference, Arcachon, France, 20-23 May.
De Wilde, H.P.J. Methane and nitrous oxide in the Rhine and the Scheldt. BIOGEST first scientific meeting, Luik, Belgium, 24-25 March.
De Wilde, H.P.J. The greenhouse effect in relation to aquatic emissions of trace gases. Lecture for students of the Hogeschool Utrecht, NIOZ, 12 May.
De Wilde, P.A.W.J. Lectures series Marine Ecosystems. University of Groningen, Haren, 9-10 June.
Edelaar, P. Subtidal Baltic Tellins: victims of passive migration or source population for bird bait? University of Groningen, Haren, 5 March.
Edelaar, P. The battle between the sexes: foraging in Bar-tailed Godwits *Limosa lapponica*. Edward Grey Institute for Field Ornithology Conference, University of Oxford, Oxford, U.K., 6 January.
Everaarts, J.M. Assessment of the Environmental Health of the Chagos Archipelago (Indian Ocean). Symposium 'Ecology of the Chagos Archipelago (British Indian Ocean Territory), London, 7 October.
Everaarts, J.M. PHAHs and PAHs in benthic polychaete worms *Nephtys* spp. and their habitat; A temporal trend in CB concentrations. 6th Symposium on Chemistry and Fate of Modern Pesticides, Amsterdam, 4-6 June.
Everaarts, J.M. Quality control and good laboratory practice in the analyses of PCBs and organochlorine pesticides, and in the determination of biological responses. - 4th RCM of the IAEA CRP on the distribution, fate and effect of pesticide residues on biota in tropical marine environment; use of radio tracers. Nairobi, 16-20 June.
Everaarts, J.M. The environmental Health of the North Sea. Texas A&M University, College Station, USA, 16 October.
Everaarts, J.M. Toxicological aspect of the marine environment. College Cursus Mariene Milieu, University of Groningen, Groningen, 23 May.
Fonds, M. The effect of beamtrawl fishery on bottomfauna in the southern North Sea. NIOZ, 23 June.
Fonds, M. The effect of winter temperature on reproduction of flatfish. University of Hamburg, Hamburg, Germany, 16 June.
Fransz, H.G. Vertical distribution of mesozooplankton biomass and activity in the subtropical Atlantic Ocean, NOC, Amsterdam, 26 November.
Gast, G.J. Microbes in coral reef waters. Verweydagen. NIOZ, 27-29 Januari
Gast, G.J. Microbes in coral reef waters. Colloquium. NIOZ, 11 September.
Gast, G.J. Microbes in coral reef waters. Nevecol jaarmeeting Wageningen, 11 December.
Grice, K., S. Schouten, W. Klein Breteler & J.S. Sinninghe Damsté. The effect of heterotrophic activity on the stable carbon isotopic composition of algal markers. ACS conference- Biogeochemistry of algae, San Francisco, USA, 13-17 April.
Helder, W. Mineralisation and burial of organic matter in sediments of the shelf, slope and abyssal plain of the Goban Spur (N E Atlantic). EC-MAST II Workshop, Vigo, Spain, 15 May.
Helder, W. LOICZ Open Science meeting. Global Change in the Coastal Zone. Noordwijkerhout Session North Sea Coastal Science: Biogeochemical fluxes. Introduction. 10 - 13 October.
Helder, W. NIOZ Department MCG. On the role of oxygen sensors in marine science, 4 November.
Helder, W. On the use of oxygen micro-electrodes in aquatic sciences. Onderzoeksschool voor Sedimentaire Geologie. 13 Oct. Utrecht Herndl, G.J. Aquatic microbial ecology: linking community structure and biogeochemistry, Symposium on òPerspectives in Aquatic Ecologyó, Max Planck Society, Marburg, Germany, 3 July.
Herndl, G.J. Bacterioplankton exopolysaccharide production: is it important for the oceanic DOC pool? University of Groningen, Haren, 4 November.
Herndl, G.J. Bacterioplankton-derived polysaccharides: are they important components in the oceanic DOC? Laboratoire d'Oceanographie Biologique et Ecologie du Plancton Marin, Universite Pierre & Marie Curie, Villefranche sur Mer, France. 16 December.
Herndl, G.J. Polysaccharides in the pelagic environment: formation and fate. Max Planck Institute for Marine Microbiology, Bremen, Germany, 16 October.
Herndl, G.J., I. Obernosterer, B. Reitner, C. Pausz & J.M. Arrieta. Role of UV-A versus UV-B in photolyzing marine and freshwater DOM and its impact on bacterioplankton activity, ASLO meeting, Santa Fe, USA, 12 February.
Jansen, J.H.F. IMAGES in and around the South Atlantic Ocean. IMAGES meeting KNAW, Amsterdam, 25 April.
Jansen, J.H.F. The climate and its astronomical pacemaker. Symposium Natuur en Geneeskundig Congres, Texel. 26 April.
Jansen, J.H.F., S.J. Van der Gaast, B. Koster, A.J. Vaars - CORTEX, an XRF-scanner for non-destructive chemical analyses of split sediment cores. Core logging symposium Corsaires, Ifremer, Brest. 24 July.
Jansen, J.H.F. Palaeoceanography of the Congo Basin. ODP Meeting, Joides Resolution, 22 August.
Koning, E. Settling, dissolution and burial of biogenic silica off Somalia (NW Indian Ocean). NIOZ, 19 June.
Köster, J. & J.S. Sinninghe Damsté. Black Shales deposited in euxinic, deep marine basins. 18 th Regional European Meeting of Sedimentology, Heidelberg, 2-4 September.

Köster, J. *et al.* Sulphurisation of homohopanoids: Effects on carbon number distribution, speciation and 22S/22R epimer ratios. 18 th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.
Kuipers, B.R. Horizons of fossil seagrass as tracers of paleo climate and -sealevel fluctuations, NIOZ, 25 September.
Kuipers, B.R. Microzooplankton grazing in the Deep Chlorophyll Maximum. NOC, Amsterdam, 26 November.
Kuipers, B.R. The microscopic food web, NIOZ, 30 May.
Lavaleye, M.S.S, G.C.A. Duineveld, P.A.W.J. De Wilde & E. Berghuis. The Whittard Canyon, a possible transport route for organic matter to the deep-sea. Third EU conference, Exchange processes at the continent/ocean margins in the North Atlantic, Vigo, Spain, 15 May.
Lavaleye, M.S.S. Research at the continental slope in the NE Atlantic (OMEX-project). NIOZ, 2 September.
Lavaleye, M.S.S. Taxonomy and ecology of marine 'worms'. Roebim'97 expedition, Broome, Australia, 19 June.
Lavaleye, M.S.S. The Roebim'97 expedition: Benthic fauna of a large intertidal mudflat in NW Australia. Scientific meeting of the Dutch malacological society, Middelburg, 15 November.
Lavaleye, M.S.S., G.C.A. Duineveld, E.M. Berghuis & P.A.W.J. de Wilde. Relations between the distribution of benthic fauna and food input on the slope and in canyons of the Celtic margin. 8th Deep sea biology symposium, Monterey, California, U.S.A., 24 September.
Lenhart, H., P. Ruardij & G. Radach. Biochemical budgets derived from the ecosystem model ERSEM, LOICZ open-science meeting, Noordwijkerhout, 12 October.
Lindeboom, H.J. Benthic life in the North Sea: Natural variation and the effects of Dutch beam trawling. Nederlands Natuur- en Geneeskundig Congres, Texel, 26 April.
Lindeboom, H.J. Interannual and decadal variability of the North Sea Ecosystem. International symposium on the temporal variability of plankton and their physico-chemical environment, Kiel, Germany, 19-21 March.
Lindeboom, H.J. LOICZ, the way forward. 3th Open Science Meeting LOICZ, Noordwijkerhout, 10 October.
Lindeboom, H.J. Natural variability of benthic ecosystems: Effects of fisheries, human impacts and natural variability. NATO Advanced Research Workshop on Benthic Biology, Gdansk, Poland, 3 September.
Lindeboom, H.J. Natural variability of marine ecosystems and the effects of fisheries. Congress on Marine Management, Stavanger, Norway, 26 August.
Lindeboom, H.J. Natural variability of marine ecosystems and the effects of fisheries. Visit of environmental department Culemborg, NIOZ, 9 September.
Lindeboom, H.J. Natural variability of marine ecosystems: Observations and possible causes. University of Groningen, Haren, 14 May.
Lindeboom, H.J. Natural variation of the marine ecosystem and the possibility to dump pig manure in the deep ocean. Texel Agricultural Society, Texel, 17 January.
Lindeboom, H.J. Variability of marine ecosystems. Lecture for students from University of Wageningen, NIOZ, 13 November.
Lindeboom, H.J. Variability of marine ecosystems. Workshop on Climate variability: models and paleodata, KNMI, De Bilt, 23 October.
Luttikhuizen, P.C. Introduction to current research on *Macoma balthica* at the Netherlands Institute for Sea Research. Seminar at Centre National de Recherche Scientifique (CNRS), Chizé, France, 26 February.
Luttikhuizen, P.C. Population genetics of *Macoma balthica*. Quantifying genetic variation and the links with life-history traits such as growth and burying depth. University of Groningen, Haren, 19 February.
Luttikhuizen, P.C. The evolutionary arms race between a burying bivalve and its avian predator; aspects of behavioural and population genetics. IFREMER, La Tremblade, France, 16 October.
Maas, L.R.M & A. Doelman. Chaotic tides in almost-enclosed basins. Prioriteitsprogramma niet-lineare systemen; IMAU, University of Utrecht, 6 May.
Maas, L.R.M. Internal wave attractors deny the existence of eigenmodes. Institute Non-Lineaire de Nice, France 9 September.
Maas, L.R.M. On a two-dimensional map describing convection as a simplification of the Lorenz equations, EGS, Wenen, 24 April.
Maas, L.R.M. On the nonlinear Helmholtz response of almost-enclosed tidal basins with sloping bottom, EGS, Wenen, 24 April.
Maas, L.R.M. Topographic filtering and reflectionless transmission of long waves , EGS, Wenen, 24 April.
Maas, L.R.M., Surprising behaviour of waves in stratified fluids. 'Ehrenfest-seminar' Leiden, 24 September.
Maas, L.M.R. Theory and observations of wave attractors in a uniformly stratified fluid. Geofysica, University of Utrecht, 20 November.
Maar, L.R.M. Geometric focusing of internal waves: theory and laboratory observations, University of Tokyo, 8 December.
Maas, L.R.M. Secondary tides: the nonlinear Helmholtz response of almost enclosed basins. Tokyo University of Fisheries, 9 December.
Mensink, B.P., H. Kralt, C.C. Ten Hallers-Tjabbes & J.P. Boon. Imposex in juvenile common whelks by tributyltin (TBT) and consequences for the supposed mechanism. 9th International Symposium on pollutant responses in marine organisms (Primo 9), Bergen, Norway, 27 April.
Mensink, B.P. Imposex in juvenile common whelks by tributyltin (TBT) and consequences for the supposed mechanism, Wageningen Agricultural University, Wageningen, 23 May.
Mensink, B.P. Imposex in the common whelk, OSPAR Working group on concentrations, Trends and Effects of Substances in the Marine Environment (SIME), Aberdeen, UK, 24-26 September.
Mensink, B.P. Imposex in the common whelk. BEON symposium 'Micropollutants', Den Haag, 19 June.
Mensink, B.P. The development of imposex in the common whelk in relation to organotin contamination. Nederlandse Oceanografen Club (NOC), Den Haag, 14 May.
Nolting, R.F & W. Helder. The contrasting behaviour of Pb, Cu, Zn, Ni, Cd, Mn and Fe in the Scheldt estuary, in relation to Cr and Al: implications for Kd values. 5th International Symposium on model estuaries, Rimouski, Quebec, Canada, 25-29 May.
Philippart, C.J.M. & G.C. Cadée. Long-term changes in phytoplankton biomass and species composition in the Marsdiep, the westernmost tidal inlet of the Wadden Sea. ICES Symposium on Temporal Variability in Marine Phytoplankton, Kiel, Germany, 19 March.

Philippart, C.J.M. Coastal and continental margin processes. External review Netherlands Bremen Oceanography (NEBROC), Bremen, 1-2 September.

Philippart, C.J.M. & I. Eggink. From fish to starfish; shifts in the benthic community in the south-eastern North Sea. ICES Symposium on Recruitment Dynamics in Exploitated Populations, Baltimore, USA, 22 September.

Piersma, T, P. De Goeij, P. Honkoop & M. Lavaleye. Results of the first year of benthic monitoring at Roebuck Bay, NW Australia. Broome Bird Observatory, Broome, Australia, 14 June.

Piersma, T. Adaptive body composition changes in shorebirds and the possible role of corticosterone. University of Washington, Seattle, USA, 24 January.

Piersma, T. Aspects of the distributional ecology of knots in the western Wadden Sea in relation to large-scale disturbances of the Wadden Sea sediments and benthic communities. Directie Noord of the Ministry of Agriculture, Nature Management and Fisheries, Leeuwarden, 20 February.

Piersma, T. Body moult and mass as indicators of migratory status in knots and other shorebirds. Mundo Marino/Fundacion Vida Silvestre, San Clemente del Tuyi, Argentina, 27 March.

Piersma, T. Ecology of (shore-)bird migration. Koninklijk Natuurkundig Genootschap, Groningen, 21 October 1997.

Piersma, T. Evolution of phenotypic flexibility during migration: physiological optimization contingent on ecological risks and rewards? Conference on Optimal Migration 1997, University of Lund, Lund, Sweden, 6 November.

Piersma, T. Evolutionary arms-race on the Wadden Sea mudflats. NWO/PIONIER Symposium, The Hague, 27 May.

Piersma, T. Fattening in Fryslân; on migration in Ruffs, Golden Plovers, Knots and Bar-tailed Godwits. 50 Year Jubilee Symposium BFVW, Leeuwarden, 15 November.

Piersma, T. Guts don't fly: the evolution of the evolution of organ size in migration waders. NIOZ, Texel, 22 May.

Piersma, T. Introducing the PIONIER-studies on the evolutionary-arms race between avian probing predators and buried bivalve prey. Seminar, Department of Population Genetics, University of Groningen, Haren, 19 February.

Piersma, T. Introducing the research programme and the new Experimental Shorebird Facility. NIOZ, Texel, 23 May.

Piersma, T. Knots as *Macoma*niacs: an evolutionary arms race on intertidal flats? NIOO-CL, Nieuwersluis, 6 January.

Piersma, T. Life history aspects critical to the conservation of migratory shorebirds. Symposium on Behaviour and Conservation, London, U.K., 4 December.

Piersma, T. Living close to the edge: habits of migratory shorebirds. University of Washington, Seattle, U.S.A., 21 January.

Piersma, T. Micro-evolution of shorebird migration patterns. Sixth Congress of the European Society for Evolutionary Biology, Arnhem, 28 August.

Piersma, T. Storage strategies of long-distance migrating shorebirds. University of Uppsala, Uppsala, Sweden, 10 November.

Piersma, T. Shorebirds, sediments and shellfisheries in the western Waddensea. De Koperen Tuin, Leeuwarden, 20 November.

Piersma, T. Experiences on mudflats in tropical Australia. Omrop Fryslân, Leeuwarden, 17 July.

Piersma, T. Mud baltic tellins and knot: recent studies on the ecological effects of shellfishery on the western Wadden Sea. Vogelbescherming-Nederland, De Koog, Texel, 12 September.

Piersma, T., R. Van Aelst & H. Berkhoudt. The remote detection of buried bivalves by knots: behavioural and morphological observations of the possible sensory mechanism. Annual Conference International Wader Study Group (IWSG), Vester Vedsted, Denmark, 10 August.

Pool, W.G. Processing of GC/MS data by backfolding. KNCV Chemometrie Symposium, Amsterdam, 3 December.

Pool, W.G., J.W. De Leeuw & B. Van De Graaf. Backfolding: A new algorithm for the processing of GC/MS data. 14th International Mass Spectrometry Conference, Tampere, Finland, 25-29 August.

Ruardij, P., H. van Haren & H. Ridderinkhof. INP mooring: Modelling the impact of stratification on pytoplankton production and distribution, Vrije Universiteit Amsterdam, Amsterdam, 22 April.

Schoemann, V. Biogeochemistry of Fe and Mn in the Balsfjord: Preliminary results. Workshop on the Balsfjord Programme of 1996, Université Libre de Bruxelles, Brussels, 6-8 January.

Schoemann, V., V. Rousseau & C. Lancelot. Life cycle strategy of *Phaeocystis* and its colonies. Verwey Symposium, NIOZ, Texel, 27-29 January.

Schouten, S. *et al.* Biosynthetic effects on the stable carbon isotopic compositions of linear *vs* isoprenoid lipids in algae. 213th American Chemical Society Meeting, San Francisco, USA, 13-17 April and Penn. State University, State College, USA, 9 July

Schouten, S. On the origin of organic sulphur compounds in sediments and oils. Penn. State University, State College, USA, 8 July.

Sinninghe Damsté, J.S. *et al.* Bias of the sedimentary biomarker record through oxic degradation at different rates. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Sinninghe Damsté, J.S. The role of organic compounds in marine sediments cores. Workshop "Climate variablity; models and paleodata", de Bilt, 23 October.

Sinninghe Damsté, J.S., H.M.E. Van Kaam-Peters, S. Schouten & J. Köster. Palaeoenvironmental controls on the molecular and carbon isotopic composition of organic matter of the Kimmeridge Clay facies. EUG 9, Strasbourg, France, 23-27 March.

Smith, S.V., P.R. Boudreau & P. Ruardij. Biochemical (N, P) budgets of the Southern North Sea, LOICZ open-science meeting, Noordwijkerhour, 12 October.

Stoll, M.H.C. Seasonality in carbon reservoirs, Greenland Sea, NIOZ, 10 April.

Stolte, W. Size-dependent competition for nutrients by marine diatoms, Nederlands-Vlaamse Kring van Diatomisten, Lelystad, 3 October.

Stolte, W. Size-dependent restrictions on competition for nutrients by marine phytoplankton. Sixth International Phycological Congress, Leiden, 9-16 August.

Stoker, M., Tj.C.E. van Weering, A. Stevenson & E. Gillespie. Aspects of mid to late Cenozoic deepwater sedimentation in the Rockall Trough based on ENAM and Rockall seismic Datasets. 2nd ENAM II Workshop, Kinsale, Ireland, 30/10-2/11.

Stuut, J.-B. & J.H.F. Jansen - Continental dust in the SE Atlantic - Postcruise meeting NAUSICÀA-IMAGES II. Arcachon, 27 October.

Ten Hallers-Tjabbbes, C.C. Chemosensory mediated orientation in marine snails and in humans in relation to environmental conditions. RIN97. Orientation and Navigation - birds, humans and other animals. Royal Institute of Navigation, Oxford, UK, 21-23 April.

Ten Hallers-Tjabbes, C.C. Common interest of OSPARCOM and IMO on TBT and its effects. OSPAR Working Group on concentrations, trends and effects of substances in the marine environment (SIME). Aberdeen, UK, 24-26 September.

Ten Hallers-Tjabbes, C.C. Field studies on impact of TBT on *Buccinum undatum* L. and trends in the North Sea. OSPAR Working Group on concentrations, trends and effects of substances in the marine environment (SIME). Aberdeen, UK, 24-26 September.

Ten Hallers-Tjabbes, C.C. Impact of TBT-antifouling paints on the temperate and tropical marine environment, policy developments and future perspectives. Institute of Marine Affairs, Trinidad and Tobago, 6-7 October.

Ten Hallers-Tjabbes, C.C. Organotin compounds in the sea: what, where and how: behaviour, toxicity, effects and political perspectives. University of Groningen, Groningen, 20 February.

Ten Hallers-Tjabbes, C.C. Organotin compounds in the sea; consequences for the environment and for policy development. University of Groningen, Groningen, 23 May.

Ten Hallers-Tjabbes, C.C. The impact of the whelk on the global opinion on shipping. University of Groningen, Groningen, 13 March.

Ten Hallers-Tjabbes, C.C. Why is the whelk declining? Netherlands Malacological Society, Middelburg, 15 November.

Timmermans, K., M.J.W. Swagerman, R.F. Nolting, M.A. van Leeuwe, L.J.A. Gerringa, J.T.M. de Jong & H.J.W. de Baar. American Chemical Society 12 - 17 april 1997 San Francisco. Presentation: Availability of iron in HNLC waters of the Southern Pacific Ocean

Van Aken, H.M. Biscay Margin Oceanography. OMEX workshop, NIOZ, Texel, 10 February.

Van Aken, H.M. Ocean Observations and climate variability. Klimaatcommissie KNAW, Amsterdam, 11 December.

Van Aken, H.M. The oceanic conveyor belt in the North Atlantic Ocean. "Het Nederlands Natuur- en Geneeskundig Congres", NIOZ,Texel, 26 April.

Van Bennekom, A.J. Gradients of silicic acid in near-bottom waters. Some case studies Ifremer, Physical Oceanography, Brest, 2 April.

Van Bergen Henegouw, C.N. Ocean Data Management in the Netherlands, Ocean Data Symposium, Dublin, Ireland, October 1997.

Van der Meer, J. Models of interference and their consequences for the spatial distribution of ideal and free predators. 5th meeting of the Dutch Society for Theoretical Biology and the SLW Working Group for Theoretical Biology, Texel, 21 February.

Van der Meer, J. Gradient analysis of benthic communities, Workshop Environmental Monitoring, NIOO-CEMO, Yerseke, 24 June.

Van der Meer, J. The Gaussian Response Model and Multivariate Methods. Dynamo Workshop on Multivariate Methods, NIOZ, 21 January.

Van der Meer, J. The Oosterschelde study: on the stability of a multivariate analysis of a benthic community. Dynamo Workshop on Multivariate Methods, NIOZ, 22 January.

Van der Meer, J. The spatial distribution of ideal and free predators, MIFOS Workshop, NIOZ, 3 October.

Van der Meer, J. Where the sea meets the land: interspecific competition on tidal flats. NIOZ, Texel, 16 January.

Van Heemst, J.D.H. *et al.* The origin of aromatic compounds in pyrolysates of dissolved and particulate organic matter in marine environments. Gordon Research Conference 1997: Frontiers in Pyrolysis '97: Detection, Identification, Characterization, New Hampshire, USA, 22-27 September.

Van Kaam-Peters, H.M.E. *et al.* Biomarker and compound-specific stable carbon isotope analysis of the Early Toarcian shales in SW Germany. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.

Van Noort, G.J. & J.H. Vosjan. Bacterial activities in the deep chlorophyll maximum layer of the Atlantic Ocean. NOC, Amsterdam, 26 November.

Van Raaphorst, W. Analysis of recent SPM observational data in the Dutch coastal zone. NCK-workshop, Delft Hydraulics, Delft, 13 November.

Van Raaphorst, W. Eutrophication of the Dutch Coastal Zone, D66 Scientific Bureau, NIOZ, 18 April.

Van Raaphorst, W., L. Lohse & C.P. Slomp. Benthic proceses in the North Sea: nutrient cycling and oxygen consumption at the sediment-water interface. LOICZ open science meeting, Noordwijkerhout, 10-13 October.

Van Weering Tj.C.E. De Noord Atlantische Oceaan in IMAGES perspectief. KNAW Amsterdam, 15 April.

Van Weering Tj.C.E. Introduction van het IMAGES programme. KNAW Amsterdam, 15 April.

Van Weering Tj.C.E. Introduction to Workshop on OMEX II Bridging Phase Results. OMEX II Phase I workshop, NIOZ, Texel, 10-12 February.

Van Weering,Tj.C.E. & H. de Stigter. Benthic boundary layer currents and sedimentation along the European continental Margin; the Goban Spur and Rockall Trough. 3rd EU Conference on Exchange Processes at the Continent/Ocean Margins in the North Atlantic, Vigo, Spain, 14-16 May.

Van Weering,Tj.C.E. & H. de Stigter. Recent sedimentation at Goban Spur. OMEX II Phase I workshop, NIOZ, Texel, 10-12 February.

Van Weering,Tj.C.E., M.S. Stoker, A. Akhmetjanov ,T. Svaerdborg. The role of along- slope currents in shaping the Rockall Trough Margins. 2nd ENAM II Workshop, Kinsale, Ierland, 30 October-2 November.

Van Weering,Tj.C.E., Particle fluxes, near bed sediment dynamics and recent sedimentation at Goban Spur, NE Atlantic Ocean. 9th Meeting European Union of Geosciences, Strassbourg, France, Abstracts, p 601.

Van Weering,Tj.C.E. Sedimentary Processes and Pathways at the NE Faeroe Continental Margin. 3rd EU Conference on Exchange Processes at theContinent/Ocean Margins in the North Atlantic, Vigo, Spain, 14-16 May.

Veldhuis, M. DNA in microorganisms. Bigelow Laboratories for Ocean Sciences, W. Boothbay Harbor, ME, USA, 16 October.

Veldhuis, M. Flow cytometry in Biological Oceanography. Coulter EPICS user day, Arnhem, 21 October.

Veldhuis, M. Introduction to the ecology of the deep chlorophyll maximum layer of the tropical and subtropical Atlantic, NOC. Amsterdam, 26 November.
Veldhuis, M. The oceanic desert. Nederlands Natuur- en Geneeskundig congres, NIOZ, 26 April.
Versteegh, G.J.M. Coccoliths and long chain alkenones. Is there an advantage in combining their datasets. 8th GEM Workshop, Blagnac, 13-17 September.
Versteegh, G.J.M. *et al.* The $U^{k'}_{37}$ of *Isochrysis galbana* as a function of culture temperature, light intensity and nutrient concentrations Implications for palaeotemperature estimates. EUG 9, Strasbourg, France, 23-27 March.
Veth, C. The hydrography during the Deep-Chlorophyll Maximum Project. Nederlandse Oceanografen Club, Amsterdam, 26 November.
Volkman, J.K. *et al.* Novel non-hydrolysable highly aliphatic biopolymers in marine and freshwater microalgae. Australian Society of Phycology and Aquatic Botany Conference, Hobart, Australia, 22-24 January.
Volkman, J.K. *et al.* Recent developments in marine algal biomarkers. 18th International Meeting on Organic Geochemistry, Maastricht, 22-26 September.
Vosjan, J.H. Marine bacteriology. Lecture series for the postgraduate course on fundamental and applied marine ecology of the free University, Brussels, Belgium, 6-10 January.
Wernand, M.R. Vliegtuig remote sensing met behulp van CORSAIR. De toepassing van waterkwaliteits algorithmen boven kustwater. Nederlandse Vereniging van Aquatische Ecologie, Den Haag, 7 februari.
Wiebinga, C.J. & H.J.W. de Baar. Determination of the distribution of dissolved organic carbon in the Indian sector of the Southern Ocean. Symposium on Antarctica and global change: Interactions and impacts, Hobart, Tasmania, July 13-18.
Wiebinga, C.J. Heterotrophic bacteria in the oceans: general methodologies and their implications. Colloquim at the departments of Marine Biology and Microbiology, University of Groningen, September 15.
Wiebinga, C.J., M. v.d. Maarel, M. Veldhuis, G. Kraay & G. van Noort. Heterotrophic bacteria in the North Atlantic Ocean (DCM 1996). Nederlandse Oceanografen Club, Amsterdam, 26 November.

EXTERNAL PROFESSIONAL FUNCTIONS

M.A. Baars
- member JGOFS Indian Ocean Planning Group (SCOR)
- member Working Group JGOFS Nederland
- co-editor Journal of Sea Research
- member SLW-discussiegroep PIG (Plankton Interaction Group)
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- co-editor Journal of Sea Research
- member SCOR Working Group 104

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- member Working Group on Ecosystem Effects of Fishing Activities ICES
- member ICES Study Group on the Work programme to Evaluate the Environmental Impacts of Fisheries

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- member ICES Marine Chemistry Working Group
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- member Editorial board of Ecotoxicology
- member "commissie voor de milieu-effect rapportage"
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- member NWO/GOA research program committee 'Tracing a seasonal upwelling'
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- chairman European Seabirds At Sea Database (ESAS) Co-ordinating group
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- coordinator MERLIM research programme EU-MAST
- coordinator CARUSO research programme EU Climate and Environment
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- member BRIDGE Steering Committee (NERC)
- member of research School Sedimentary Geology

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- member Editorial Board of Wallaceana
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- member Editorial Board of Ecotoxicology

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- member ASMO-working group for International Model Comparison

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- member Dutch LOICZ commission
- member Dutch JGOFS commission
- chairman 'Gebruikers Adviesgroep Auto-Analyser (GOA)'
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- guest editor Special Volume Deep-Sea Research
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- member SteeringCommittee EC-MAST Programme ALIPOR

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- member Editorial Board of Aquatic Microbial Ecology
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- coordinator MICOR research programme EU Climate and Environment

J.H.F. Jansen
- member Scientific Committee IGBP-PAGES-IMAGES 2 (The International Marine Past Global Change Study
- member Dutch Ocean Drilling Project (ODP) working group
- member GEONETH, Geoscience Network of the Netherlands for International Cooperation
- member Scientific Committee: Dynamique à long terme des écosystèmes forestiers intertropicaux, Symposium International

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- member 'Nederlandse werkgroep deeltjes-karakterisering'
- member users group Quantimet (Image Analysis)

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- member flow-cytometer working group

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- chairman 'Begeleidingsgroep Effekten Visserij' (BEON)
- coordinator EG-project IMPACT-II
- member Board Sir Allistair Hardy Foundation of Ocean Sciences
- member Scientific Steering Committee LOICZ
- board member 'Onderzoekschool Functionele Ecologie'
- member SCOR Working group 105, the IMPACT of World Fisheries
- coordinator EG-project 'Dynamo'
- member Steering Committee and working group Indonesian-Dutch Cooperative Research on Integrated Coastal Zone Management, Teluk Banten
- member Steering Committee WOTRO project 'Rivers and coastal zones'
- member UNESCO working group 'Year of the Ocean 1998'
- member Scientific Committee for the IGBP
- coordinator NAM project 'Dutch Coatal Zone and Wadden Sea'

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R.F. Nolting
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S. Ober
- member 'overleg-groep 'waarnemen en interpreteren' Raad van overleg fysisch-oceanografisch onderzoek Noordzee'

C.J.M. Philippart
- editor Journal of Sea Research
- member external review committee 'Milieueffect rapportage'

T. Piersma
- vice-chairperson International Wader Study Group (WSG)
- editor Ardea
- member editorial board Current Ornithology, Plenum Press, New York
- member Science Advisory Board the Western Hemisphere Shorebird Reserve Network (WHSRN)
- member BirdLife International/IWRB Grebe Specialist Group

H. Ridderinkhof
- member 'Overleggroep Waterstanden en Getijden van de Raad van Overleg voor het Fysisch Oceanografisch onderzoek van de Noordzee'

- member 'Overleggroep Stoftransporten van de Raad van Overleg voor het Fysisch Oceanografisch onderzoek'
- advisory member School voor Atmosferisch en Marien Onderzoek
- member Committee `Milieueffectrapportage'
- member 'Beoordelingscommissie aanvragen GOA'

R. Riegman
- co-editor Journal of Sea Research

M.J. Rietveld
- member 'Directeuren Overleg Beleidsgericht Ecologisch Onderzoek Noordzee/Waddenzee' (BEON)

R.C. Sidle
- associate editor Journal of Environmental Quality
- associate editor Journal of Forest Research
- vice-chair, International Affairs Committee, American Water Resources Association
- member, Erosion and Sedimentation Committee, American Geophysical Union
- Adjunct Professor, Departments of Civil and Environmental Engineering and Forest Resources, Utah State University, USA

J.S. Sinninghe Damsté
- associate scientist University of Utrecht, faculty of Earth Sciences
- associate editor Organic Geochemistry
- guest editor special issue Organic Geochemistry
- member scientific committee of the 18th International Meeting on Organic Geochemisty, 22-26 September, Maastricht

D.H. Spaargaren
- secretary 'Commissie voor buitenlandse marien-biologische instituten' KNAW, Amsterdam
- member Board of advisory editors 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/Yvette
- secretary, treasurer organising committee 4th International Crustacea Congress, Amsterdam, July 1998
- chairman science committee subtheme Physiology & Biochemistry ICC4

C.C. Ten Hallers-Tjabbers
- Advisor to IUCN for the London Convention 1972
- External advisor Faculty of Zoology & Anthropology, University of Porto, Portugal

M.H.. Stoll
- member Joint Global Ocean Flux Study Data Management Task Team (JGOFS-DMTT)

H.M. Van Aken
- chairman Nederlandse Oceanografen Club
- member ICES Hydrography Comittee
- member ICES Working Group on Ocean Hydrography
- member EUROGOOS Science Advisory Working Group

M.A. Van Arkel
- member Working group 'Monitoring rond Mijnbouwinstallaties'

C.N. Van Bergen Henegouw
- executive secretary International Research Ship Operators Meeting (ISOM)
- member for Ministry O, C & W of the 'Interdepartementaal Overleg Zeegaande Vaartuigen' (IOZV)
- secretary National Oceanography Data Committee

A.J. Van Bennekom
- deputy member Dutch Antarctica committee
- member editorial board Circumpolar Journal
- member Council for Geosciences of the KNAW
- member ICES working group on oceanographic hydrography

S.J. Van Der Gaast
- member editorial board of Applied Clay Science
- president Dutch Clay Group

J.Van Gils
- survey coordinator international Wader Study Group (IWSG)

J. Van Der Meer
- member Working Group on the statistical aspects of environmental monitoring (ICES)
- editor Ardea 'Tijdschrift der Nederlandse Ornithologische Unie'
- member Science Advisory Board SOVON (Foundation for Ornitological Field Research in the Netherlands)

H.W. Van Der Veer
- member Organizing Committee Fourth Intern. Symposium on Flatfish Ecology, Moorehead City, USA
- adjunct associate-professor of Zoology, North Carolina State Univ., Raleigh, USA
- adjunct associate-professor of Marine Science, Univ. of South Carolina, Columbia, USA

F.C. Van Duyl
- board member Treub-Mij
- advisor Studiekring Suriname en de Nederlandse Antillen

W. Van Raaphorst
- member 'Begeleidingsgroep Eutrofiëring BEON'
- member Evaluation Panel of the 'Institut für Meereskunde ' (ifM) Kiel, Kiel 23-24 October

A. Van Schanke
- Member organizing committee of the 'Third symposium for PhD students in toxicology', Oosterbeek, 14-15 November

T.C.E. Van Weering
- member Scientific Steering Committee EU-MAST Program OMEX
- member Scientific Steering Committee EU-MAST Program ENAM
- member Editorial Board Geologie en Mijnbouw
- member Editorial Board Marine Geology
- member Scientific Committee IMAGES
- member Proposal Review Committee for EU TOBI and GLORIA HCM and TMR programmes
- special guest editor Progress in Oceanography Volume OMEX Benthic Processes
- special guest editor Deep Sea Research Volume Netherlands Indian Ocean Program

M.J.W. Veldhuis
- member working group JGOFS-NL
- member advisory board Sarsia (USA)
- member Climate Committee KNAW
- member flow cytometer working group NL

G.J.M. Versteegh
- Member GEM Working Group

C. Veth
- member Southern Ocean Planning Group for JGOFS
- member Committee Antarctic Research
- membre du Comité Scientifique de JGOFS France
- member Working group Joint Ocean Global Flux Study NWO/GOA

J.H. Vosjan
- Lecturer Marine Bacteriology, Postgraduate training course on Ecological Marine Management, Free University Brussels, Belgium

M.R. Wernand
- member REmote sensing of WAter quality in the NETherlands group REWANET
- member Sensor Intercomparison and Merger for Biological and interdisciplinary Oceanic Studies [NASA] team. SIMBOIS

J.T.F. Zimmerman
- Professor Fysische Oceanografie, Rijksuniversiteit Utrecht
- member editorial board Continental Shelf Research
- member editorial board Journal of Sea Research
- IAPSO representative national UGGI comite (ARA-KNAW)
- member Committee 'Milieueffectrapportage'
- member 'themacommissie kustonderzoek' (BOA-NWO)
- member New York Academy of Sciences

DISSERTATIONS

Brussaard, C. Phytoplankton cell lysis and its ecological implications. University of Groningen: 107 pp.
De Haas, H. Transport, preservation and accumulation of organic carbon in the North Sea. University of Utrecht 149pp.
Koopmans, M.P. Diagenetic and catagenetic transformations of sequestered biomarkers. University of Utrecht: 304 pp.
Pool, W.G. Backfolding: A new algorithm for the processing of GC/MS data. University of Delft: 116 pp.
Slomp, C.P. Early diagenesis of phosphorus in continental margin sediments. Agricultural University of Wageningen: 172 pp.
Van Der Meer, J. A handful of feathers. University of Groningen: 262 pp.
Van Der Toorn, R. Geometry, angular momentum and the intrinsic drift of oceanic monopolar vortices. University of Utrecht: 243 pp
Van Kaam-Peters H.M.E. The depositional environment of Jurassic organic matter-rich sedimentary rocks in NW Europe. A biomarker approach. University of Utrecht: 248 pp.
Van Leeuwe, M.A. A barren ocean. Iron and light interactios iwth phytoplankton growth in the Southern Ocean. Rijksuniversiteit Groningen: 189 pp.
Witbaard, R. Tree of the Sea. The use of internal growth lines in the shell of *Arctica islandica* (Bivalvia, Mollusca) for the retrospective assessment of marine environmental change. University of Groningen: 150 pp.

Gast, G.J. NIOP-Somalia workshop, 8 January.

Philippart, C.J.M. & J. Van Der Meer. DYNAMO workshop 'Multivariate Analysis', 21-23 January.

The 9th **Verwey Symposium** was held from 27-29 January, as part of the national PhD programme in Marine Life Sciences organized by the RUG and the NIOZ. The symposium is integrated in the educational programme of the Graduate School of Functional Ecology.

Van Weering, Tj.C.E. OMEX Bridging Phase workshop, 10-12 February.

The course **Introduction to Oceanography** is part of the Marine Biology curriculum at the RUG and was attended by 65 students, 30 majoring marine biology and 35 majoring environmental biology. The introductory lectures were given by Prof. Dr. Ir. H.J.W. De Baar at the RUG from 10-21 February. The 35 environmental biologists took part I a one-day excursion with demonstrations at NIOZ on 18 February. The 30 marine biologists followed a series of several practical research projects at NIOZ from 24-4 April, including filed work at the tidal flats and aboard the vessels Navicula and Pelagia in the Wadden Sea and the North Sea, respectively. This practical part was coordinated by J.W. Rommets Each student completed a written report on one of the research projects. The enthusiastic commitment of a great number of NIOZ scientific and supporting staff ensured an overall stimulating course. The students evaluated the course as very interesting and useful. Final examinations were taken by 60 students of whom 52 passed.

Riegman, R. Mini-symposium ' Towards modelling the growth of *Emiliania huxleyi*', 25-26 March.

Van Bennekom, A.J. Annual meeting of the ICES Working Group on Oceanic Hydrography, 21-23 April.

Van Bennekom, A.J. & Tj.C.E.Van Weering. International Symposium on the occasion of the retirement of Prof. Dr. Doeke Eisma, 29 April.

The course **Marine Ecosystems** (24 students), which is a fixed part of the Marine Biology programme of the RUG, was held from 9 June to 4 July. During the first week Prof. Dr. P.A.W.J. De Wilde and several other NIOZ scientists gave a series of lectures in the Biological Centre at Haren. The second and third week were, as in other years, dedicated to practical work at NIOZ. A Programme of benthos and fish sampling, guided by the department MEE, was carried out with the R/V Pelagia in the North Sea (Frisian Front, Oyster Grounds) and with the R/V Navicula in the Wadden Sea. In the department BIO a phytoplankton springbloom was studied in pelagic mesocosms. These experiments included a.o. flowcytometrical measurements of grazing on bacteria. The extensive "Results Report" (two parts) was finished at 27 June. Individual reports were prepared by the students during the last week of the course, preceding their final examinations at the RUG.

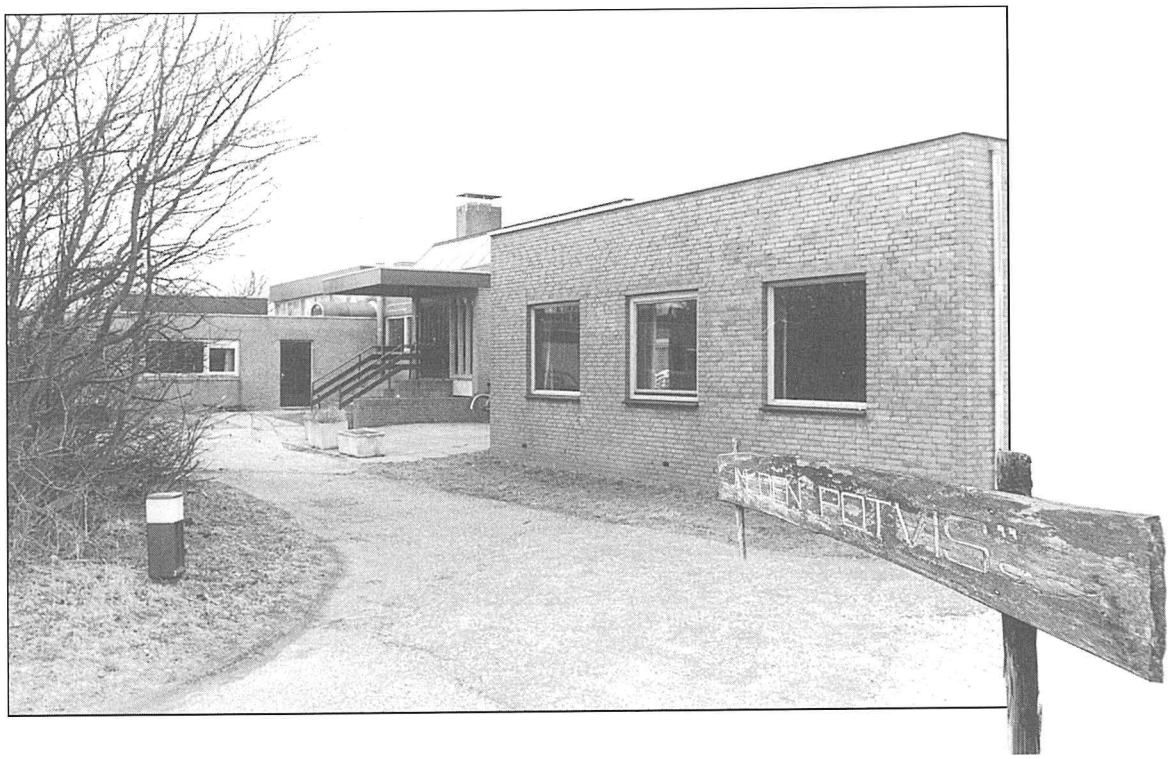
Camphuysen, C.J. MIFOS (Modelling the Impact of Fisheries on Seabirds) project officers meeting and workshop, 2-5 October.

Philippart, C.J.M. & H.J. Lindeboom. DYNAMO workshop 'Fish and Climate', 31 October.

The course **Oceanography** for Ph.D students was held from 17-21 November and coordinated by J.W. Rommets, .M.Van Aken, W. Van Raaphorst and H.J. Lindeboom. The topics of this year were: physics of waves and tides, the geology of sediments, the chemistry of bottom processes, and the biology of the benthic system and macrofauna. The course existed of a great number of lectures given by NIOZ scientific staff and was attended by 23 students, of whom 4 were from outside NIOZ.

JGOFS/LOICZ CMTT Meeting No. 2. 5 and 9 October 1997. JGOFS-LOICZ/CMTT-2.
JGOFS/LOICZ Workshop on non-conservative fluxes in the continental margins. 6-9 October 1997. JGOFS-LOICZ CMTT/WKSHP/97-21.
LOICZ Workshop on Typology. 24-26 February 1997. LOICZ/WKSHP/97.17.

3. Guest scientists, visitors and students



GUEST SCIENTISTS

- Baker, Prof. Dr. A.J., Centre for Biodiversity and Conservation Biology, Royal Ontario Museum, Toronto, Canada.
- Belzunce Segarra, M., Instituto de Investigacions Marinas, Vigo, Spain.
- Bouman, H., Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada, 15 April - 17 May.
- Boyd, Dr. H., National Wildlife Research Centre, Canadian Wildlife Service, Environment Canada, Ottawa, Canada, 29 September-3 October.
- Dorrestein, Prof. Dr. G.M., Department of Veterinary Pathology, University of Utrecht, Utrecht, The Netherlands, 23-25 October.
- Gordon, Dr. C., Volta Basin Research Project, University of Ghana, Accra, Ghana, 10-21 September.
- Hafentörn, Büsum, Germany, 25 - 29 November.
- Jacobson, A., Department of Fisheries and Marine Biology, University of Bergen, Norway, 24 February - 26 March.
- Jensen, J. , National Environmental Research Institute, Dept. of marine ecology and microbiology,
- Koski, M., Finnish Institute of Marine Research, Helsinki, Finland. 1 October - 15 December.
- Köster, Dr. J.
- Landys, M. , Department of Zoology, University of Washington, Seattle, Washington, U.S.A., 26 April-6 June.
- Lassen, S. University of Aarhus, 6 October-28 November, 1997 Joint work on N. Atlantic Paleoceanography and ENAM II PistonCores
- Letcher, Robert, Dr. J., RITOX
- Nebel, S. , University of Göttingen, Göttingen, Germany, 20 July-31 December.
- Ntiamoa-Baidu, Prof. Dr. Y., Department of Zoology, University of Ghana, Accra, Ghana, 7-22 September.
- Noor, Drs. Y. Rusila, Wetlands International, Bogor, Indonesia, 15 August-15 November.
- Reckermann, M., Forschungs- und Technologiezentrum Westküste (FTZ)
- Rogers, D., Department of Zoology, University of Melbourne, Victoria, Australia, 20 August-20 September.
- Slezak, D., Department of Marine Biology, University of Vienna, Austria, 1 June - 15 December.
- Stoker, M.S. British geological Survey, Edinburgh, 17-21 Marc and 23-28 November (Joint ENAM Studies)
- Thomsen, L. Geomar, 3-11 February ALIPOR developments
- Unanue, Dr. M., Departamento de Inmunología, Microbiología y Parasitología, Facultad de Ciencias, Universidad del País Vasco, Bilbao, Spain. 2-30 June.
- Van Aelst, R., Department of Animal Sciences, University of Illinois, Urbana, Illinois, U.S.A., 5 January-31 May.
- Winter, C., Department of Marine Biology, University of Vienna, Austria, 1 October - 20 December.
- Zdanowski, Dr. M., Department of Antarctic Biology. Polish Academy of Sciences, Warsaw, Poland. 1-15 August.

VISITORS

- Berkhoudt, Dr. H., Leiden University, Leiden, The Netherlands
- Blom, Dr. J., University of Münster, Germany
- Bijma, Dr J., Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, Germany.
- Davidson, Dr. N.C., Joint Nature Conservation Committee/Wetlands International, Peterborough, UK/Wageningen, The Netherlands
- Dierschke, Dr. V., Vogelwarte Hiddensee, Kloster/Hiddensee, Germany
- Flynn, Dr. K., University of Wales, Swansea, UK
- Fuhrman, Prof. Dr. J.A., UniveRsity of Southern California, Los Angeles, USA
- Garthe, Dr S., Institut für Meereskunde, University of Kiel Germany
- Hamer, Dr K., Durham University, Durham, UK
- Hansen, Dr B., Fisheries Institute Faroe Islands
- Hayes, Prof. J.M., Woods Hole Oceanographic Institution, Woods Hole, USA
- Hogan, Prof. Dr. J.A., Department of Psychology, University of Toronto, Toronto, Canada
- Hötker, Dr. H., FTZ, University of Kiel, Büsum, Germany
- Irriberi, Prof. Dr. J., Departamento de Inmunología, Microbiología y Parasitología, Facultad de Ciencias, Universidad del Pí's Vasco, Bilbao, Spain
- Jazdzewsk, Prof. Dr. K., University of Lodz, Poland
- Junosza-Szaniawski, Prof. Dr. H., University Poznan, Poland
- Kostrzewski, Prof. Dr. A., University of Poznan, Poland
- Kramer, G., University of Rostock, Germany
- Lewan, Dr. M.D., U.S. Geological Survey, Denver, USA
- Ligowski, Prof. Dr. R., University of Lodz, Poland
- Merrett, Dr. M., University of Wales, Swansea, UK
- Myrcha, Prof. Dr. A., University Warsaw, Poland
- Ollason, Dr J., Aberdeen University, Aberdeen, UK
- Opalinski, Dr. K., Institute Ecology, Acadademy of Science, Warsaw, Poland
- Pepping, M., University of Kiel, Kiel, Germany
- Reid, Dr S., Seabirds and Cetaceans Team, Joint Nature Conservation Committee, Aberdeen Scotland UK
- Röhl, Dr U., Fachbereich Geowissenschaften, Universität Bremen, Germany.
- Smith, Prof. Dr. S.L., Rosenstiel School of Marine and Atmospheric Sciences, Miami, USA

- Schneider, Dr R.R., Fachbereich Geowissenschaften, Universität Bremen, Germany.
- Suszczewski, Prof. Dr. R., Academy of Science, Warsaw, Poland
- Turrell, Dr. W., Marine Laboratory Aberdeen, UK
- Volkman, Dr. J.K., CSIRO, Hobart, Australia
- Von Rad, Dr U., Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, Germany.
- Webb, A., Seabirds and Cetaceans Team, Joint Nature Conservation Committee, Aberdeen Scotland UK
- Wefer, Prof. Dr. G., Fachbereich Geowissenschaften, Universität Bremen, Germany.
- Weglenski, Prof. Dr. P., University of Warsaw, Poland
- White, R., Joint Nature Conservation Committee, Dunnet House, Aberdeen Scotland UK
- Zdzitowiecki, Prof. Dr. K., Academy of Science, Warsaw, Poland

UNDERGRADUATE UNIVERSITY STUDENTS

- Aardoom, Y., Faculty Pharmacology, RUG
- Atkins, R., UvA
- Bos, O., RUG
- Bouma, S., RUG
- Brocken, F., RUG
- Cameron, M., University of South Carolina, U.S.A.
- De Boer, K., RUG
- De Leeuw, R., UT
- Greve, drs. M.J., Marine Biology, RUG
- Hezik, drs. C.M.E. van, Biology, RUL
- Kuyl, S., UvA
- Lohr, A., RUG
- Norde, D.J., UvA
- Ollers, M., RUU
- Poos, J.J.P., RUG
- Sabatino, S., University of South Carolina, U.S.A.
- Scheper, B., UvA
- Schuit, M., UvA
- Snelder, E., UvA
- J.-B. Stuut, Department of Geology, Institute of Earth Sciences, RUU
- Svaerdborg,T. University of Aarhus, Department of Geophysic
- Ten Tij, M., UvA
- Te Raa, L.A., RUU
- Van de Akker, S., UvA
- Van Belle, J., RUG
- Van Heyst, S., RUU
- Van der Meer, D., Dalhousie University Halifax
- Van der Put, A., LUW
- Van Rheede, T., UvA
- Van Rossum, J., UvA
- Veefkind R., RUU

4. Support Services

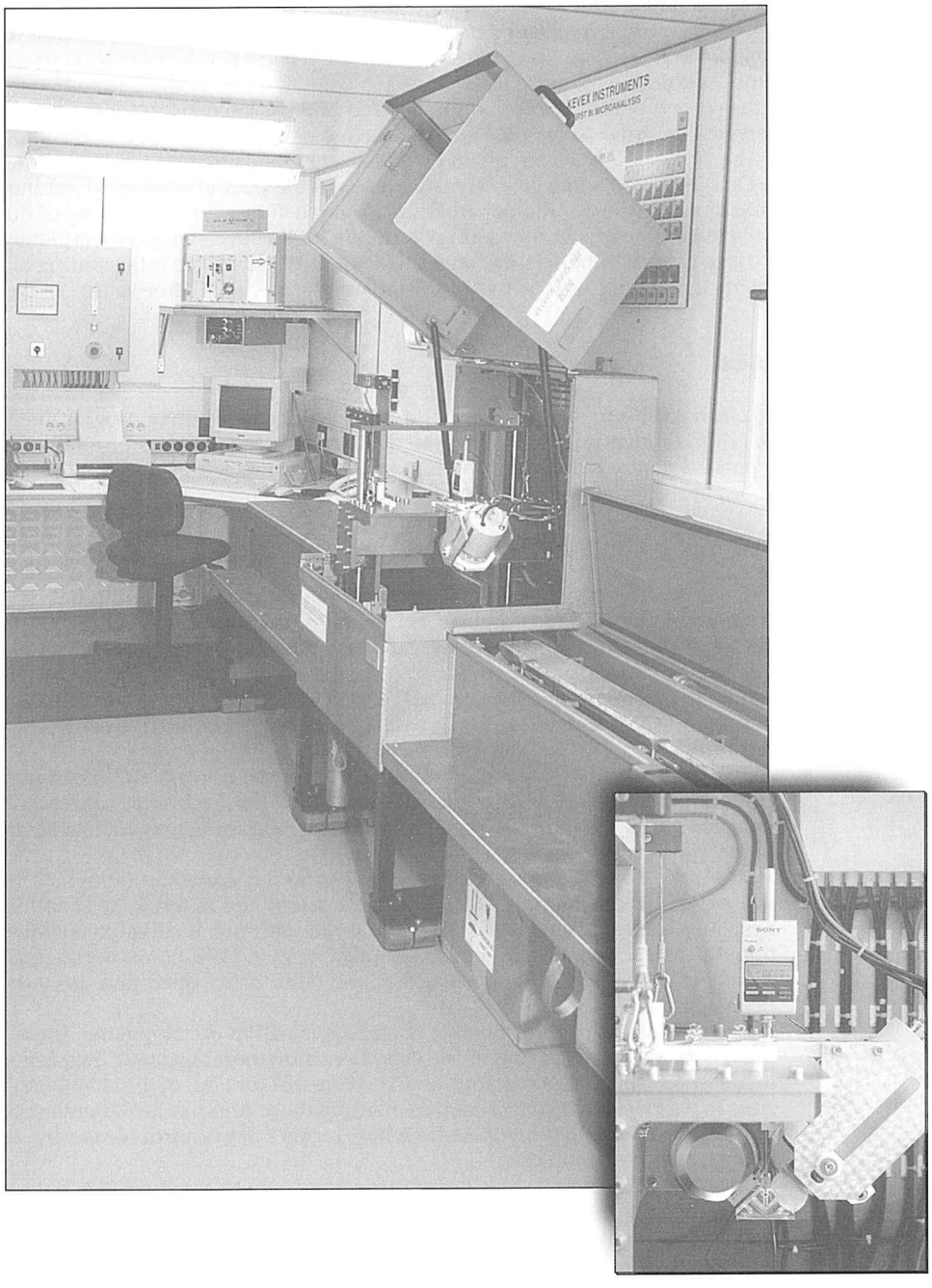


Photo: Henk Hobbelink

FINANCE & CONTROL

One of the major issues during the reorganisation in 1995 was the restructuring of the financial department and the introduction of the control function. In the years 1996 and 1997 a start has been made in the development of a economical management system. The object in view is to get a more business-like budgeting system to reinforce the management of the scientific goals. Such an operation covers a period of about 5 or 6 years, in which the organisation has a to learn to deal which this new way of management.

In the field of personal affairs this meant the appointment of a new head of the Finance and Accounting Department mrs. A.C.M. Bijsterveld-Kessels in February 1996, which was followed in June 1997 by the appointment of the controller mr. R.G. Haas.

From the beginning of 1996 much effort has been put in the implementation of the new financial software EXACT and in the adjustment of the administrative organisation and the matching procedures

Just two years later, overspending of the individual budgets, except with explicit permission of the director, is exceptional. The financial administration keeps the department head's permanently informed on the state of affairs of the 'internal' budgets by means of the internal network. Separately every project manager gets a quarterly report of the project costs and income. At the end of 1997 the first step has been made to integrate the order-administration to get a better sight on the stock within the organisation.

In the second part of 1997 an internal workshop has been given for the management (a total of 25 persons), in order to broaden the knowledge of using a more business-like management system. The workshop has been given by an external management-advisor of the Iris Adviesgroep from De Bilt. A relation has been made between the overall strategy planning of NIOZ and the making of year plans for the departments in connection with the forming of budgets.

In the meantime preparations has been made for the next step in the implementation of the system to step over to Windows-oriented software. Part of this step is the adding of the financial commitments in the reports, to get a better sight on the so-called "free space" in the budgets.

TECHNICAL SUPPORT SERVICES

Much effort has been put in two important long-range investment programmes, the development of the NIOZ-landers and the development of an infrastructure for the biological research. Also in 1997 phase 1 of the building of the Experimental Shorebird Facilities, the so-called "Wadvogel-unit" has been completed and put into use.

NIOZ Lander development

In 1996 we already reported the start of the development of different types of landers, which enables simultaneous measurements of sediment-water fluxes, biogeochemical process rates, physico-chemical characteristics in-situ near the sediment-water interface, or in the surface sediment. In 1997 this development continued:

- TROL; the Temperature, Resistivity, Oxygen Lander, which makes detailed profiles of oxygen in bottom water and across the diffusive boundary layer into the sediment with high vertical resolution.
- A 2nd generation TROL has been made with new frame-work and the modifications in the positioning of the ballast weights. In this new TROL there are three calibrated benthic chambers installed and a rugged solid state sensor for pH measurements. The whole lander was tested with good results during the OMEX cruise.
- ALBEX; the Autonomous Lander for Biological Experimentation; which is developed for *in situ* experimental manipulation. The predessesor the BOLAS; the Benthic Oxygen LAnder System is a benthic chamber lander equipped with two incubation chambers. During operation the instrument was lost in the Atlantic Ocean in 1996, but in the beginning of 1997 immediately a new one was constructed and still is in operation in various international programmes.
- A new ALBEX with three benthic chambers is still in development. These chambers are improved to make the mixing in the chambers more homogeneous. Besides, developments are made to get well defined quantities of mixture into and out of the chambers. This makes it possible to perform *in-situ* experimental manipulation. Another development is the measurement of gasses like oxygen with optrodes which forms a new way of measuring without disturbing or absorbing the samples.
- At the moment the first steps have been set to come to a biological event sensor. For instance when the sensor measures a certain level of chlorophyll concentration near the bottom this may trigger an in-situ experiment.
- BOBO; the Bottom Boundary lander, which is a long-term (6-12 months) deployment lander for the study of the variability in benthic boundary layer dynamics. At the moment one lander

is in operation off the coast of Portugal. In 1997 the 2nd generation lander will be built with a new data logging system and a new built up of the instruments. A new development within Europe is the appliance of an ADCP with a high resolution of about 5 cm to measure the variations in water velocity and direction in the benthic boundary layer over a height of 2 m. This lander has been tested with extremely good results during the ALIPOR\ENAM cruises.

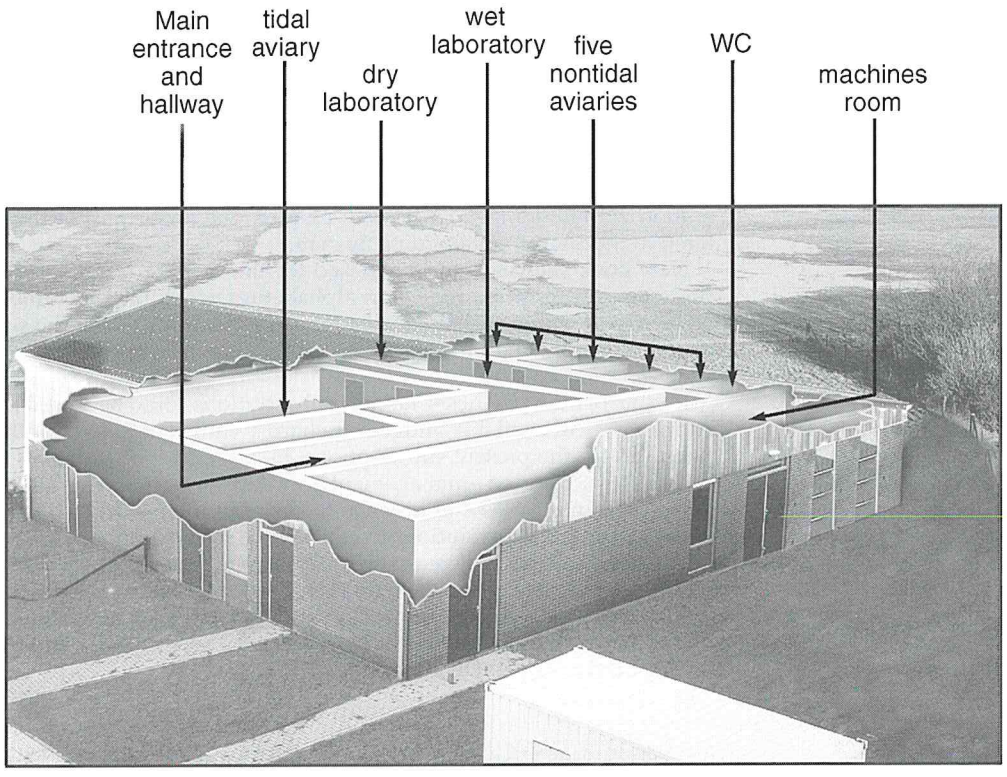
The molecular biology facilities

The molecular biology facilities at NIOZ have been established in 1997. Basic molecular biology instrumentation is now available at NIOZ and the sequenzer has been set up in collaboration with RUG. Some advanced instruments with a wide range of applications (such as the capillary zone electrophoresis) have also been set up. The molecular biology laoratory is fully operational and is currently used for a number of Ph.D. thesis works mainly addressing microbial ecological questions. With the appointment of an additional scientist focusing on molecular ecology by June '98, the molecular biology facilities will broaden their spectrum of research.

Important issues for future research at NIOZ are questions related to biodiversity in different marine systems and the genetic variability within populations and its relation to key ecological parameters, such as stability and disturbance. Moreover, it is foreseen that the molecular tools available now will be used to address ecotoxicological problems and to quantify DNA damage in organisms exposed to different toxic compounds or to solar radiation.

Experimental Shorebird Facility "The Wadvogel-unit" in full operation

After a preparation and building time of about 4 years, the research in the Experimental Shorebird Facility started in 1997. This Shorebird Facility makes it possible to carry out truly unique experiments to study the behaviour of shorebirds under all kinds of simulated environmental conditions.



Shorebirds are small and warmblooded - with a mean temperature of about 41may appear as if they always have a fever!. Especially for small animals with such high body temperatures, it makes a big difference whether it is warm, sunny and windless on the intertidal flats, or whether it is foggy, cold and stormy.Thus, when the weather is cold and the need for energy will be high, shorebirds such as sandpipers, oystercatchers and curlews, are predicted to make quite different choices with regard to food type and feeding site, than when it is warm and cost levels are low. Many shorebirds migrate over very long distances. In some cases it takes them just a few days to

travel from a tropical environment into a cold temparate environment; from an ambient temperature of more than 30mbient temperature of less than 10changing within their bodies: not only do they loose fat, they even burn up some muscles and organs because they no longer need them during the long flight. In the Experimental Shorebird Facility of NIOZ it will possible to simulate the variety of environmental conditions encountered by shorebirds throught their lifetimes. This will make it possible, for the first time in the history of science, to experimentally study the interactions between environmental conditions, internal factors such as hormonal state and the size of the organs, and patch and prey choice decisions in marine vertebrates. We hope to be able to find out how shorebirds make the best of difficult jobs. In turn this will tell us how they influence benthic prey animals on intertidalflats under well defined and controlled circumstances.

The accompanying figure x gives a three-dimensional outline of the Experimental Shorebird Facility. It consists of a tidal aviary, which can be split up into two separate, and separately controllable, parts. There is a wet work floor to process and prepare the shellfish-food for the birds, and a small 'dry laboratory' where all kinds of detailed energetic measurements can be done on the birds. Furthermore there are five climatically controlled nontidal aviaries in which small groups of shorebirds can be exposed to different environmental conditions before being studied in the tidal aviary. For example, birds can be put in a warm cage - the simulated tropical intertidal flat of Guinea-Bissau - and from there to a cold tidal-cage - the intertidal flat of the Netherlands in May - to see what this dramatic change in environment means to shorebirds.

Every aviary has its own independent water-, air- and light-system. These systems can be centrally adjusted to any required level by a computer. In all aviaries measurements are made of the air- and water-temperature, the water level (in the tidal aviary) and the condition of the lights (off or on), and all data are automatically stored The control room, and all the pumps- and filter systems, are located on the side of the building. To prevent disturbance to the shorebirds, the machines have been separated as much as possible from the aviaries.

Because of the abundant use of sea water, the building has got a high environmental class (number 4) and the most durable materials were used. Indeed, building-phases 2 (to install the systems to simulate air temperatures from 5 to 40d 3 (to install the systems to simulate water temperatures from 5 to 35till to be implemented. In the meantime, however, it is becoming clear that knots, the favourite research-species within NIOZ, feel very comfortable in the Experimental Shorebird Facilities. The first exciting discoveries have already been made in this new facility.

SCIENTIFIC SERVICES

The Library

In 1997 considerable progress was made with the computerisation of the NIOZ Library, in co-operation with Groningen University Library. The major part of the periodicals has now been entered in the Shared Cataloguing System.

New book shelves were purchased for the reading room, in order to create enough space to place new issues of periodical in alphabetical order. Back volumes of the periodicals in storage were also placed in alphabetical order. Periodicals for which the subscription has been cancelled in the past, remained in the former order (e.g. in accordance with the SN-numbering) on the shelves.

In spite of many requests, no new subscriptions could be added to the library collection in 1997. At the moment available budgets are hardly sufficient to cope with the ever increasing subscription rates for the present subscriptions. In November a student of the IDM Academy ("Informatiedienstverlening en -management") in Amsterdam started with an evaluation of the use of periodicals in the NIOZ library. On the basis of the results of his study decisions might be made about cancelling subscriptions to enable new subscriptions.

The book collection increased with 188 books. There were 1194 loans from our library collection and 1334 requests for copies of articles from other library collections.

In order to get a better representation of the departments in the Library Committee, G.J. Brummer from the Department of Marine Chemistry and Geology, replaced T. Piersma, one of the three representatives of the Department of Marine Ecology.

The Editorial Office

Starting from January 1997, the Journal of Sea Research is published by Elsevier Science in collaboration with the Netherlands Institute for Sea Research. To this end, NIOZ established an editorial office. Four NIOZ staff members run this office. In 1997, they handled over 100 submitted manuscripts.

In 1997, four double issues (two volumes) appeared. Vol. 37 (1/2) and vol. 38 (1/2) were regular issues, edited by the permanent editors. Vol. 37 (3/4) contained part I of the Proceedings of the Third International Symposium on Flatfish Ecology and was edited by R. Berghahn, A.D. Rijnsdorp and H.W. van der Veer. Vol. 38 (3/4) was devoted to the European Regional Seas Model (ERSEM) and was edited by J.G. Baretta-Bekker and J.W. Baretta.

5. Sociaal Jaarverslag

Photo: Henk Hobbelink

ALGEMEEN

In 1997 werd de implementatie van de reorganisatie van het NIOZ vrijwel volledig voltooid, waardoor goede vooruitzichten zijn geschapen voor de toekomst. Nietemin vergde de aanhoudend krappe financiële situatie dat een zeer stringent financieel beleid werd gevoerd. Dat betekende ook, dat vacatures niet zonder meer konden worden vervuld, maar alleen nadat kon worden aangetoond dat dit beslist noodzakelijk was om de bedrijfsvoering en het wetenschappelijk onderzoek niet in gevaar te brengen. Verjonging en vernieuwing van de wetenschappelijke staf bleven daarbij het uitgangspunt.

Mede dankzij het feit, dat de Pelagia succesvol kon worden verhuurd, is het NIOZ er in geslaagd al zijn financiële verplichtingen na te komen. Extra inkomsten uit verhuur zullen worden ingezet voor versnelde aflossing van de nog resterende schulden uit het verleden.

Er zijn meer aanwijzingen om vanuit een zorgelijke periode, waarin alle zeilen moeten worden bijgezet, de toekomst met vertrouwen tegemoet te treden. Dit zijn onder meer de formeel bekrachtigde samenwerking tussen het NIOZ en vier onderzoekorganisaties in Bremen en Bremerhaven (AWI, MPI, ZMT en GeoB), waarvoor extra financiële middelen vanuit het ministerie voor OC&W beschikbaar zijn gesteld en de positieve reactie vanuit NWO op de voorstellen om plannen uit te werken voor renovatie van de bestaande gebouwen en nieuwbouw op Texel. Desalnietemin zal het strikte bezuinigingsregime de komende jaren blijven voortduren.

BESTUUR EN WETENSCHAPCOMMISSIE

Bestuur Stichting NIOZ

In 1997 heeft prof.dr. J.G. Kuenen zijn functie als bestuurslid neergelegd. Hij werd opgevolgd door Prof.dr. J.E. Meulenkamp.

Ook voor prof.dr. R.H. Drent en Ktz..b.d. Th.G. Loeber was 1997 het laatste jaar van hun bestuurslidmaatschap. Prof. Drent is opgevolgd door Prof.dr. W. van Delden.

Per 31 december 1997 was het bestuur als volgt samengesteld:

Prof.dr. K. Verhoeff, voorzitter	Wageningen
Prof.dr. W. van Delden	Vakgroep Genetica, faculteit Biologie, Rijksuniversiteit Groningen
Prof.ir. H.P. van Heel	Hoechst Holland NV, Vlissingen
Prof.dr. J.E. Meulenkamp	Vakgroep Geologie/Universiteit Utrecht
Ktz.b.d. Th.G. Loeber	Hilversum

Het bestuur kwam in het verslagjaar 1997 viermaal met de directie in vergadering bijeen op 11 maart, 5 september en 22 december te Amsterdam en op 23 mei op Texel. Bij deze gelegenheid werd de Experimentele Wadvogelunit door de voorzitter officieel geopend. Tevens werd op feestelijke wijze afscheid genomen van Prof. Kuenen.

De vergaderingen werden namens de algemeen directeur NWO bijgewoond door Dr. J. Dijkhof. Genotuleerd werd door mevrouw C.S. Blaauboer-de Jong.

Wetenschapcommissie NIOZ

De Wetenschapcommissie adviseert het Bestuur en de Directie over het algemene wetenschappelijk beleid van de Stichting en het Instituut, zij evalueert periodiek het wetenschappelijk programma en zorgt voor de wetenschappelijke beoordelingsprocedure van de eigen NIOZ OIO-voorstellen.

Het overlijden van Prof.dr. R.A. Prins op 26 februari 1997 betekende niet alleen een groot verlies voor de Wetenschapcommissie. Als zeer betrokken wetenschapper en vriend had hij een warme plaats in het hart van velen op het NIOZ. In zijn nagedachtenis wordt een R.A. Prins Fellowship ingesteld door NIOZ en RUG gezamenlijk.

De Wetenschapcommissie kwam in 1997 bijeen op 24 november te Texel. Hierbij namen de voorzitter Prof.dr. R.H. Drent en Prof.dr. W. Wolff afscheid.

Prof.dr. V. Smetacek had al eerder laten weten zijn lidmaatschap te zullen beëindigen. Als opvolger van Prof. Drent heeft het bestuur Prof.dr. W. van Delden benoemd, die daarmee tevens lid is van het bestuur. De commissie zoekt nog naar enkele nieuwe leden.

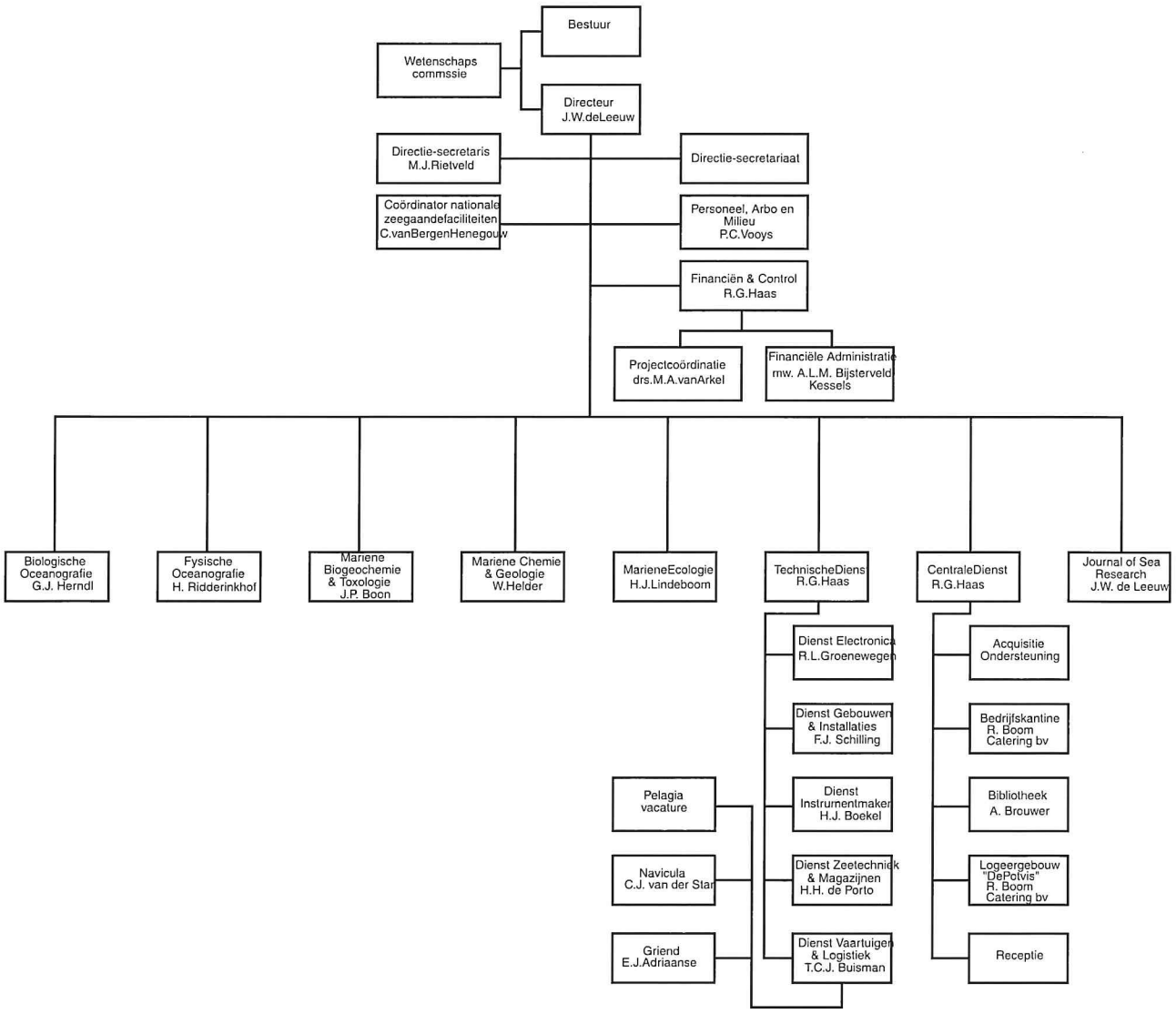
De Wetenschapcommissie was per 31 december 1996 als volgt samengesteld:

Prof.dr. W. van Delden	voorzitterVakgroep Genetica, faculteit Biologie, Rijksuniversiteit Groningen
Prof.dr. J.C. Duinker	Institut für Meereskunde, Universität Kiel, Duitsland
Prof.dr.ir. G.J.F. van Heijst	Afd. Technische Natuurkunde, Technische Universiteit Eindhoven
Prof.dr. W.M. Warwick	Plymouth Marine Laboratory, Engeland
Prof.dr. G. Wefer	Geowissenschaften, Universität Bremen, Duitsland

Na de vergadering werden de afdelingen Mariene Ecologie en Biologische Oceanografie door de commissie bezocht.

Genotuleerd werd door mevrouw C.S. Blaauboer-de Jong.

ORGANOGRAM



PERSONEELSLIJST 31-12-97

DIRECTIE

Leeuw J.W. de *Prof. dr.*	34.2 uur	directeur	
Rietveld M.J. *Drs.*		directie-secretaris	
Directiesecretariaat			
Hart-Stam J.M.G.		dir. secretaresse	
Blaauboer-de Jong C.S.	30.4 uur	dir. secretaresse	
Bol-den Heijer A.C.	29.25 uur	dir. secretaresse	
Barten-Krijgsman N.	15.2 uur	dir. secretaresse	

STAFEENHEDEN

Personeels-, Arbo en Milieuzaken			
Vooys P.C.		hoofd	
Mulder-Starreveld J.P.	28.5 uur	medewerker	
Rommets J.W.		coördinator Arbo en Milieuzaken	
Verschuur B.	35.15 uur	medewerker Arbo en Milieuzaken	tot 01-11
Financiën en control			
Haas R.G. *Drs.Ir.*		hoofd Bedrijfsvoering/Controller	m.i.v. 01-06
Bijsterveld-Kessels A.L.M.		hoofd fin. administratie	
Arkel M.A. van *Drs.*		projectcontroller	
Wernand-Godee I.	32.3 uur	medew. project-administratie	
Keijser A.		medew. financiële administratie	
Spel M.M.	19.0 uur	medew. financiële administratie	
Tuinen H.A. van	30.4 uur	medew. financiële administratie	
Graaf A.C. de	30.0 uur	medewerker	
Nationale zeegaande faciliteiten (MRF)			
Bergen Henegouw C.N. van *Drs. Ing.*	32.0 uur	coördinator	

CORE PROJECT OFFICE (LOICZ/IGBP)

Sidle R. *Dr.*		executive officer	tot 01-10
Boudreau P.R. *Drs.*		project scientist	tot 31-12
Zyp M. van der *Drs.*		junior data-analist	m.i.v. 17-02
Bleijswijk J.D.L. van *Dr.*	15.0 uur	onderzoeker	m.i.v. 10-09
Pattiruhu C. *Drs.*		office-administrator	
Jourdan M.T.	16.0 uur	administratief medewerkster	
Bleijswijk, J. van *Dr.*	part-time	from 9-97 to 12-97	

WETENSCHAPPELIJKE AFDELINGEN

AFDELING FYSISCHE OCEANOGRAFIE

Ridderinkhof H. *Dr.*		hoofd	
Veth C. *Drs.*		senior onderzoeker	
Zimmerman J.T.F. *Prof. dr.*	26.6 uur	senior onderzoeker	
Aken H.M. van *Dr.*		senior onderzoeker	
Maas L.R.M. *Dr.*		senior onderzoeker	
Haren J.J.M. van *Dr.*		onderzoeker	
Schramkowski G.P. *Dr.*		project-onderzoeker NWO/GOA	
Bruin T.F. de *Drs.*		datamanager MRF	
Lam F.P.A. *Drs.*	32.0 uur	OIO NIOZ	tot 01-06
Wilpshaar J.M.R. *Ir.*		OIO NWO/BOA	
Schrier G. van der *Drs.*		OIO NWO/GOA	
Eijgenraam F.		automatiseringsdeskundige	
Nieuwenhuis J.		middelbaar electronicus	
Wernand M.R.		senior onderzoekmedewerker	
Ober S. *Ing.*		senior onderzoekmedewerker	
Hillebrand M.T.J.		senior onderzoekmedewerker	
Manuels M.W.		onderzoekmedewerker	
Hiehle M.A.		senior laboratoriummedewerker	
Koster R.X. de		systeemanalist	

AFDELING MARIENE CHEMIE EN GEOLOGIE

Helder W. *Dr.*		hoofd	
Raaphorst W. van *Dr. ir.*		senior onderzoeker	
Baar H.J.W. de *Prof. dr. ir.*	30.4 uur	senior onderzoeker	
Eisma D. *Prof. dr.*		senior onderzoeker	tot 01-09
Weering T.C.E. van *Dr.*		senior onderzoeker	
Jansen J.H.F. *Dr.*		senior onderzoeker	
Bennekom A.J. van *Drs.*		senior onderzoeker	
Brummer G.J.A. *Dr.*		onderzoeker	
Timmermans K.R. *Dr.*		project-onderzoeker	
Stigter H.C. de *Drs.*	24.0 uur	project-onderzoeker OMEX	
Stoll M.H.C. *Dr.*		project-onderzoeker NWO/VvA	
Lohse L. *Dr.*	32.0 uur	project-onderzoeker	
Wilde H.P.J. de *Ir.*		project onderzoeker	
Gipp H.J.W. *Drs.*		OIO NIOZ	tot 01-04
Haas H. de *Dr.*		projectonderzoeker	m.i.v. 01-06
Wiebinga C.J. *Drs.*	30.4 uur	OIO NWO/VvA	tot 31-12
Gaast S.J. van der		senior onderzoekmedewerker	
Vaars A.J.		applicatietechnicus	
Nolting R.F.		senior onderzoekmedewerker	
Kloosterhuis H.T.		senior onderzoekmedewerker	
Ooijen J.C. van		senior onderzoekmedewerker	
Bakker K.M.J.		onderzoekmedewerker	
Malschaert H. *Ing.*		onderzoekmedewerker	
Boer W. *Ing.*		onderzoekmedewerker	
Iperen J. van	8.0 uur	senior laboratoriummedewerker	
Kalf J.		senior laboratoriummedewerker	
Koutrik A. van		laboratoriummedewerker	
Witte A.	19.0 uur	laboratoriummedewerker	
Koning F.A. *Drs.*	30.4 uur	toegev. project-onderzoeker	m.i.v. 01-03
Jong J.T.M. de		project-assistent NWO/GOA	
Jong E. de		laboratoriumassistent (project)	tot 13-07
Das J.H. den		laboratoriumassistent (project-)	m.i.v. 01-08 tot 31-12

AFDELING MARIENE BIOGEOCHEMIE EN TOXICOLOGIE

Boon J.P. *Dr.*		hoofd	m.i.v. 01-09
Everaarts J.M. *Dr.*		senior onderzoeker	
Sinninghe Damsté J.S. *Dr. ir.*	34.2 uur	senior onderzoeker	
Booy K. *Dr.*		onderzoeker	
Versteegh G.J.M. *Dr.*		post-doc NWO/GOA	
Koopmans M.P. *Dr.*		post-doc	tot 01-03
Kok M.D. *Drs.*		OIO NIOZ/pionier	
Mensink B.P. *Ir.*	32.0 uur	OIO NIOZ	tot 01-05
Schanke A. van *Ir.*		OIO NIOZ	
Hold I.M. *Drs.*		OIO NWO/pionier	
Heemst J.D.H. van *Ir.*		OIO NWO/VvA	
Kaam H. van *Drs.*		OIO/NWO/GOA	tot 01-02
Blokker P. *Drs.*		OIO-NWO	
Pool W.G. *Dr.*		senior onderzoekmedewerker	
Baas M.		onderzoekmedewerker	
Rijpstra W.I.C.	19.0 uur	onderzoekmedewerker	
Dekker M.H.A. *Ing.*	32.0 uur	onderzoekmedewerker	
Lewis W.E.	28.0 uur	senior laboratoriummedewerker	
Weerlee E.M. van		laboratoriummedewerker	
Fischer C.V. *Drs.*	28.0 uur	laboratoriummedewerker	

AFDELING BIOLOGISCHE OCEANOGRAFIE

Herndl G.J. *Dr.*		hoofd	m.i.v. 01-03
Ruardij P. *Drs.*		onderzoeker	
Fransz H.G. *Dr. ir.*		senior onderzoeker	
Baars M.A. *Dr.*		senior onderzoeker	
Klein Breteler W.C.M. *Dr.*		senior onderzoeker	
Vosjan J.H. *Dr.*		senior onderzoeker	
Veldhuis M.J.W. *Dr.*		senior onderzoeker	
Duyl F.C. van *Dr.*		senior onderzoeker	
Riegman R. *Dr.*		senior onderzoeker	
Kuipers B.R. *Dr.*		onderzoeker	
Boelen P. *Drs.*		OIO NIOZ	
Buitenhuis E.T. *Ir.*		OIO NWO/VvA	tot 01-12
Leenders A. *Drs.*		OIO NIOZ/UvU	tot 01-12

Embsen E.G.M. *Ing.*		automatiseringsdeskundige	
Kraay G.W.		senior onderzoekmedewerker	
Kop A.J. *Ing.*		onderzoekmedewerker	
Oosterhuis S.S.		onderzoekmedewerker	
Noordeloos A.A.M. *Ing.*		senior laboratoriummedewerker	
Noort G.J. van		senior laboratoriummedewerker	
Gonzalez S.R.		senior laboratoriummedewerker	
Witte H.J.		senior laboratoriummedewerker	
Schogt N.		laboratoriummedewerker	
Schoemann V.F.		projectonderzoeker	
Snoek J. *Ing.*	30.4 uur	projectmedewerker	
Visser P.M. *Dr.*		project-onderzoeker NWO	
Stolte W. *Drs.*	32.0 uur	projectonderzoeker NWO	
Kip S.F.G.	7.6 uur	laboratoriummedewerker	tot 15-01

AFDELING MARIENE ECOLOGIE

Lindeboom H.J. *Dr.*		hoofd	
Meer J. van der *Dr.*		senior onderzoeker	
Wilde P.A.W.J. de *Prof. dr.*		senior onderzoeker	
Beukema J.J. *Dr.*		senior onderzoeker/hoofdredacteur NJSR	
Bak R.P.M. *Prof. dr.*		senior onderzoeker	
Spaargaren D.H. *Dr.*		senior onderzoeker	
Fonds M. *Dr.*		senior onderzoeker	
Cadée G.C. *Dr.*		senior onderzoeker	
Veer H.W. van der *Dr. ir.*		senior onderzoeker	
Piersma T. *Dr.*		senior onderzoeker	
Wolf P. de *Dr.*		gastonderzoeker	
Bergman M.J.N. *Ir.*		onderzoeker	
Duineveld G.C. *Drs.*		onderzoeker	
Daan R. *Dr.*		onderzoeker	
Dekker R. *Drs.*		onderzoeker	
Philippart C.J.M. *Dr.*		project-onderzoeker	
Holtmann S.E. *Drs.*	28.0 uur	project-onderzoeker	tot 01-11
Lavaleye M.S.S. *Drs.*		project-onderzoeker	m.i.v. 23-06
Witbaard R. *Dr.*	30.4 uur	project-onderzoeker	
Santbrink J.W. van *Drs.*		toegevoegd projectonderzoeker	
Camphuysen C.J.	19.0 uur	wet. assistent (project-)	tot 01-02
Gast G.J. *Drs.*		OIO NIOZ	tot 04-10
Boon A.R. *Ir.*		OIO NWO/VvA	tot 16-04
Drent J.		OIO NWO	
Epstein N.	24.0 uur	OIO NIOZ	
Dapper R.		automatiseringsdeskundige	
Berghuis E.M.		senior onderzoekmedewerker	
Nieuwland G.		senior onderzoekmedewerker	
Spaans B.	16.0 uur	senior onderzoekmedewerker	
Hegeman J.		onderzoekmedewerker	
Duiven P.		onderzoekmedewerker	
Kok A.		onderzoekmedewerker	
Mulder M.		onderzoekmedewerker	
Witte J.IJ.		onderzoekmedewerker	
Puyl P. van der		laboratoriummedewerker	
Bruin W. de		laboratoriummedewerker	
Zuidewind J.		laboratoriummedewerker	
Weele J.A. van der		project-assistent	m.i.v. 17-02
Winter C.		project-assistent	
Dekinga A. *Drs. Ing.*		project-medewerker NWO	
Koolhaas A.N. *Drs. Ing.*		project-medewerker	tot 01-08
Groenewold S.A.	30.4 uur	project-onderzoeker	tot 01-02

ONDERSTEUNENDE DIENSTEN

Dienst gebouwen en installaties			
Schilling F.J.		hoofd	
Alkema P.R.	35.15 uur	assistent hoofd DGI	
Groot S.P.	22.8 uur	med. werktuigbouw	
Kuip T.		med. werktuigbouw	
Lakeman R.	20.0 uur	med. werktuigbouw	
Daalder R.M.		med. houtbewerking	
Witte R.J.C.		med. houtbewerking	
Brondsema A.		med. energietechniek	
Kantine			
Spigt H.		hoofd	tot 20-01

R. Boom Catering B.V.			
Logeergebouw 'In Den Potvis'			
Borkulo T.C. van	19.0 uur	medewerkster	tot 01-02
R. Boom Catering B.V.			
Receptie			
Kikkert A.	20.0 uur	telefoniste/receptioniste	
Jourdan M.T.	20.0 uur	telefoniste/receptioniste	
Starink J.M.	8.0 uur	telefoniste/receptioniste	
AON			
Aggenbach R.P.D.		eerste medewerker	
Hart W.	24.0 uur	medewerker	
Bibliotheek			
Brouwer A.		hoofd	
Bruining-De Porto M.	31.5 uur	medewerker	
Zonnenberg G.	35.15 uur	administratief medewerker	tot 27-01
Redactie			
Beukema J.J. *Dr.*		hoofdredacteur	
Bak-Gade B.	20.0 uur	assistent redacteur	
Hobbelink H.		grafisch ontwerper	tot 01-09

TECHNISCHE DIENSTEN

Bakker C.L.		hoofd	
Manshanden G.M.	32 uur	automatiseringsdeskundige	
Bonne E.		medewerker (detachering)	
Instrumentmaken			
Boekel H.J.		hoofd	
Keijzer E.J.H.		medewerker	
Heerwaarden J. van		medewerker	
Electronica			
Groenewegen R.L. *Ing.*		hoofd	
Koster B. *Ing.*		plv. hoofd	
Franken H. *Ing.*		hoger electronicus	
Laan M.		hoger electronicus	
Derksen J.D.J.		electronicus Pelagia	
Zeetechniek			
Porto H.H. de		hoofd	
Schilling J.		plv. hoofd	
Polman W.		medewerker	
Bakker M.C.		medewerker	
Blom J.J.		medewerker	
Wuis L.M.		medewerker	m.i.v. 14-04
Boom L.		medewerker	
Porto S.W. de		medewerker Inventarisbeheer	
Nieuwenhuizen J.M.		medewerker Inventarisbeheer	
Ran A.		hoofd Magazijn	
Gieles S.J.M.		medewerker Magazijn	
Vaartuigen en logistiek			
Buisman T.C.J.		hoofd	
Zwieten C. van		medewerker	
Eelman A.		chauffeur (detachering)	
Souwer A.J.		gezagvoerder Pelagia	tot 01-09
Groot J.C.		1e stuurman Pelagia	
Duyn M.D. van		2e stuurman Pelagia	
Pieterse J.M.		hoofdwerktuigkundige Pelagia	
Seepma J.		1e werktuigkundige Pelagia	
Kalf J.J.		2e werktuigkundige Pelagia	
Grisnich P.W.		scheepstechnicus Pelagia	
Saalmink P.W.		scheepstechnicus Pelagia	
Stevens C.T.		scheepstechnicus Pelagia	
Steenhuizen G.H.		scheepskok Pelagia	tot 31-12
Adriaans E.J.		schipper Griend	
Star C. van der		schipper Navicula	
Tuntelder J.C.		scheepstechnicus/kok Navicula	
Vis van der P.C.A		machinist/motordrijver Navicula	m.i.v. 01-03
Jongejan W.P.		komvisser	

ARBEIDSVOORWAARDEN.

Collectieve Arbeidvoorwaardenregeling

In 1997 zijn de besprekingen tussen de Werkgeversvereniging (WVOI*) en de vakbonden over de nieuwe CAR, die per 1 september 1997 in werking had moeten treden, vastgelopen.

In onderling overleg werd besloten te streven naar de totstandkoming van een nieuwe CAO voor de onderzoeksinstellingen met als ingangsdatum 1 januari 1999. Dit mede om reden dat per deze datum naar alle waarschijnlijkheid ook de primaire arbeidsvoorwaarden onderdeel zullen zijn van de CAO. Tussentijds zou getracht worden over twee items wel overeenstemming te bereiken, te weten over een nieuwe seniorenregeling die in de plaats moet komen van de per 1 december 1997 vervallen SOP-regeling en over de invoering van de Arbeidsduurverkorting voor de sector Onderwijs en Onderzoek die per 1 augustus 1998 haar beslag krijgt. Naar het zich laat aanzien zullen deze twee onderwerpen in het tweede kwartaal van 1998 worden geformaliseerd.

* De WVOI bestaat uit de Koninklijke Bibliotheek (KB), het Rijksinstituut voor Oorlogsdocumentatie (RIOD), de Koninklijke Nederlandse Academie voor Wetenschappen (KNAW) en de Nederlandse organisatie voor Wetenschappelijk Onderzoek (NWO) waarin vertegenwoordigd o.a. het NIOZ.

Flexibel Pensioen en Uittreden (FPU)

Per 1 april 1997 is de regeling Flexibel Pensioen en Uittreden in werking getreden. Deze regeling, die in de plaats is gekomen van de VUT-regeling, biedt aan medewerkers de mogelijkheid om vanaf de leeftijd van 55 jaar, onder zekere voorwaarden, geheel of gedeeltelijk vervroegd te stoppen met werken. De hoogte van de FPU-uitkering is afhankelijk van het aantal ABP-dienstjaren en van het moment waarop men van de regeling gebruik wil maken. Voor bepaalde leeftijdscategorieën zijn garantieregelingen getroffen ten aanzien van het uitkeringspercentage. Gedurende de tijd dat men gedeeltelijk of geheel gebruik maakt van de FPU-regeling bouwt men voor dat deel geen pensioentijd op. Wel bestaat de mogelijkheid om op individuele basis met het ABP een regeling te treffen voor een verhoogde pensioenuitkering bij het bereiken van de pensioengerechtigde leeftijd.

Primaire arbeidsvoorwaarden

Overeenkomstig het bereikte akkoord in1996 tussen de centrales van overheidspersoneel en de Minister van Onderwijs, Cultuur en Wetenschappen zijn in 1997 de salarissen met 1% verhoogd. Aanvankelijk zou deze salarisverhoging per 1 augustus 1997 worden ingevoerd. In het voorjaar werd echter besloten 0.25% van deze verhoging reeds per 1 april toe te passen en vervolgens per 1 augustus de resterende 0.75%.

In de maand december volgde een eindejaarsuitkering van 0,5% van de in 1997 genoten bezoldiging.

De eindejaarsuitkering en de salarisverhoging werken door in de pensioenen en uitkeringen.

ARBODIENST

Eind 1997 heeft het NIOZ het contract met de Arbo-dienst "Kop van Noord-Holland" tussentijds opgezegd. Met de N.V. TESO Bootdienst werd overeengekomen om gezamenlijk offertebesprekingen te voeren met 3 gecertificeerde Arbodiensten. Ter bepaling van een gemotiveerde keuze, werden enkele selectiecriteria geformuleerd, waaronder de kwaliteit van de administratieve organisatie van de Arbodienst, de kwaliteit en de organisatie van de ziekteverzuimbegeleiding, de visie ten aanzien van Bedrijfsgezondheidszorg, de spreekuurlocatie. Na overleg met de Ondernemingsraad werd besloten een contract te sluiten met de Arbo-dienst Avios.
Het basispakket omvat de volgende onderdelen:

- de verzuimbegeleiding van zieke werknemers
- het arbeidsgezondheidskundig spreekuur
- het vrijwillig periodiek arbeidsgezondheidskundig onderzoek (PAGO)
- de inventarisatie en evaluatie van risico's die het werk meebrengt
- uitvoeren van keuringen.

Avios Arbo-dienst beschikt over een spreekuurlocatie op Texel.

KLACHTADVIESCOMMISSIE

Volgens de Uitvoeringsregeling Individueel Klachtrecht dient het NIOZ te beschikken over een Klachtadviescommissie. Deze commissie heeft als taak advies uit te brengen aan de Voorzitter van

het Bestuur respectievelijk aan het Bestuur inzake een klacht die door een werknemer bij deze commissie is ingediend. Deze commissie, die in 1996 is benoemd, bestaat uit een voorzitter en twee leden. Zij hebben ieder een plaatsvervanger. De werkgever en de Ondernemingsraad wijzen ieder één lid en hun plaatsvervanger aan. De voorzitter en de plaatsvervangend voorzitter worden in gezamenlijk overleg tussen de werkgever en de Ondernemingsraad aangewezen. Voor de administratieve ondersteuning wordt de commissie bijgestaan door een secretaris. De secretaris heeft geen stemrecht.

In 1997 heeft de commissie geen klachten in behandeling behoeven te nemen.

Arbo- en milieujaarverslag NIOZ 1997
Arbo- en milieujaarplan NIOZ 1998

Inleiding

In dit verslag wordt gerapporteerd over de belangrijkste activiteiten op het terrein van arbo en milieu die in 1997 hebben plaatsgevonden. Omwille van de leesbaarheid is de rapportage zo beknopt mogelijk gehouden.

In het volgende hoofdstuk is aangegeven welke zaken in 1998 extra aandacht verdienen: het kan worden beschouwd als een arbo- en milieujaarplan.

Jaarverslag 1997

1. Beleid

Het NIOZ is begonnen met het opzetten van een integraal management systeem. In verband met internationale afspraken in eerste instantie voor de dienst vaartuigen. Het systeem zal later stapsgewijs worden uitgebreid.

2. Personeel

Arbo- en milieuzaken werden besproken in de overlegvergaderingen van directie met de OR en van directie met de kleine staf.

3. Ongevallen

Dit jaar waren er geen bedrijfsongevallen of bijna-ongevallen.

4. Veiligheids- en milieuzaken

Er is een overzicht gemaakt van alle gasreduceerventielen die binnen het NIOZ gebruikt worden. Hoofd DZM zal een contract afsluiten om deze apparatuur periodiek te onderhouden.

Er is een controle op electrische aarding uitgevoerd op een gedeelte van de wandcontactdozen van alle gebouwen van het NIOZ conform NEN 3140. In 1998 moet de controle worden afgerond.

Met ingang van 1 januari zijn ten behoeve van de door Rijkswaterstaat verleende lozingsvergunning elk kwartaal analyses gedaan van het afvalwater van het aquariumgebouw en de laboratoria.

Via de gehuurde container is in 1997 door de firma Ecotechniek 1345 kg klein gevaarlijk afval afgevoerd; dit was in 1993 805 kg, in 1994 2155 kg, in 1995 1395 kg en in 1996 2295 kg. De belangrijkste componenten waren oplosmiddelen, giftige chemicaliën, verfafval, ontwikkelaar, batterijen en TL buizen.

Apart werd door de firma Ecotechniek 484 kg oliefilters, smeervetten en oliebevattende poetsdoeken afgevoerd.

Overzicht papierverbruik in vellen A4.

Jaar	*Totaal*	*Kopieermachines*	*Overige*
1990	746.567	736.567	10.000
1991	1.034.654	886.654	148.000
1992	1.279.539	993.539	286.000
1993	1.391.614	967.614	424.000
1994	1.686.015	1.124.015	562.000
1995	1.696.993	996.993	700.000
1996	1.172.000	774.175	397.825
1997	1.261.000	814.741	446.259

Overzicht energieverbruik en energiekosten

Jaar	*kWh*	*m_3 gas*	*m3 water*	*Energiekosten*
1991	1.406.820	300.707	15.500	404.437
1992	1.729.800	278.716		454.748
1993	1.991.180	307.489		481.909
1994	2.082.247	479.480	16.716	443.122
1995	1.285.740	422.477	15.923	417.168
1996	1.147.907	562.329	13.599	462.221
1997	1.212.420	491.194	12.380	452.186

Door de windmolen is nog extra 127.104 kWh voor NIOZ gebruik geleverd.

5. Bedrijfsgezondheidszorg
Door de afdeling Bedrijfs Gezondheids Zorg van de Gewestelijke Gezondheids Dienst Kop van Noord Holland zou een Periodiek Arbeids Gezondheidskundig Onderzoek verricht worden:
bij een groep technici in februari- maart
bij de onderzoekers in mei-juni en
bij het personeel van de ondersteunende groepen in september-oktober.
Alleen het onderzoek van de groep technici is gedaan.

De bemanningen van de schepen zijn medisch gekeurd door de GG&GD te Den Helder volgens eisen van Scheepvaartinspectie.

Ziekteverzuim
In 1997 is het ziekteverzuim ten opzichte van 1996 met bijna 1.3% gedaald (6.03% tegen 7.3%). De daling van het ziekteverzuim manifesteert zich vooral bij het niet-wetenschappelijk personeel, zowel bij de vrouwelijke als mannelijke medewerkers. Bij het wetenschappelijke personeel is er bij de mannelijke medewerkers echter sprake van een stijging van het ziekteverzuim.

jaar	*WP*	*M*	*V*	*NWP*	*M*	*V*
1996	2.1	1.8	4.3	9.5	8.1	14.1
1997	4.33	4.34	4.29	6.83	6.13	9.77

6. Bedrijfshulpverlening
Omdat een van de leden van de Bedrijfsbrandweer niet meer in dienst van het NIOZ is, ging een NIOZ werknemer de cursus brandwacht volgen bij de Regionale Brandweer.
Om de EHBO ploeg weer op sterkte te brengen ging één persoon de basiscursus EHBO volgen te Den Helder.
Ten behoeve van de EHBO voorziening zijn negen personen op herhaling-cursus geweest voor het eenheidsdiploma EHBO van het Oranje Kruis. De cursus werd gegeven door de Regionale Arbo-dienst uit Den Helder.

De leden van de bedrijfsbrandweer oefenden maandelijks 2 uur.
De jaarlijkse controle van de brandmeldinstallatie en alle brandmelders is verricht evenals de controle van de kleine blusmiddelen en de zes adembeschermingsapparaten van de brandweerploeg.

7. Investeringen
Door de afdelingen en diensten is in totaal f 77.000 geïnvesteerd voor de verbetering van de werkplek.

8. Vergunningen
In verband met de vergunning voor het lozen van afvalwater op de Waddenzee heeft het laboratorium van Tauw Milieu te Deventer ieder kwartaal het geloosde afvalwater geanalyseerd op de onderstaande parameters volgens de vermelde methode:

Omschrijving	Methode	Maximum	1e	2e	3e	4e
grens	kw	kw	kw	kw		
Ontsluiting	NEN 6465					
Cadmium	NEN 6458	10 µg/l	0,2	<0,2	0,6	<0,2
Kwik	NEN 6449	0,1 µg/l	<0,1	<0,1	<0,1	<0,1
Arseen	NEN 6457	1,0 µg/l	1,0	<10	<2	<10
Zink	NEN 6426	1000 µg/l	80	14	16	33
Chroom	NEN 6426	1000 µg/l	<20	2,5	<2	<2
Nikkel	NEN 6426	1000 µg/l	<20	4,5	2,5	2,0
Koper	NEN 6426	1000 µg/l	75	<4	13	<4
Lood	NEN 6426	1000 µg/l	<100	<10	<10	<10
Molybdeen	NEN 6426	1000 µg/l	<60	12	14	19
Zilver	NEN 6426	1000 µg/l	<40	<4	<4	<4
PAK EPA (16)	o-NEN 5771	4 µg/l	0,02	n.a.	n.a.	n.a.
EOX	NEN 6676	100 µg/l	<100	<1	1	<1
Som van MAK	o-NEN 6407	100 µg/l	24,6	<1,8	<1,7	<1,8
Totaal cyanide	o-NEN 6655	1 µg/l	<5	<3	<3	<2
pH	NEN 6411	0,1 eenheden	7,5	8,0	7,7	7,4
Chloride	NEN 6476	mg/l	12100	10200	13900	13300
OCB-PCB	NEN 5718	0,01 mg/l	n.a.	n.a.	n.a.	n.a.
Geloosde hoeveelheid	m^3	13.920	12.280	11.040	13.520	

Het NIOZ heeft opgave gedaan van de geloosde hoeveelheid zeewater en laboratoriumafvalwater in m^3/kwartaal. Voor een beter inzicht in de aard van het water is een chloride bepaling gedaan als aanvulling op de vereiste metingen.
Deze gegevens zijn uiterlijk één maand na het beeindigen van ieder kwartaal toegezonden aan Rijkswaterstaat Directie Noord Holland met afschrift aan het RIZA.

Jaarplan 1998

1. Beleid
Er zal gewerkt worden aan het opzetten van een integraal management systeem.
2. Personeel
3. Ongevallen
4. Veiligheids- en milieuzaken
Omdat op een aantal plaatsen organismen in formaline foutief zijn opgeslagen (zie de RI&E), zal een vorstvrije en geventileerde bergruimte met vloeistofdichte vloer worden gebouwd ten behoeve van de langdurige opslag van deze collecties.
Er is een controle op aarding uitgevoerd op een gedeelte van de wandcontactdozen van alle gebouwen van het NIOZ conform NEN 3140. In 1998 moet de controle worden afgerond.
Er is een overzicht gemaakt van alle gasreduceerventielen die binnen het NIOZ gebruikt worden. Hoofd DZM zal een contract afsluiten om deze apparatuur periodiek te onderhouden.
5. Bedrijfshulpverlening
Om de EHBO ploeg weer op sterkte te brengen gaan twee personen in maart de basiscursus EHBO volgen te Den Helder.
6. Investeringen
Door de afdelingen en diensten is in totaal f 102.900 begroot voor de verbetering van de werkplek.
7. Vergunningen

PERSONEELSVERENIGING

De eerste activiteit van de personeelsvereniging was het jaarlijkse kinderfeest op 4 april. Met wederom de zelfgebakken pannekoeken en limonade voor de kinderen en begeleiders. Het optreden werd dit jaar verzorgd door de huisgoochelaar Jan van Woesik. De goochelaar vertoonde weer allerlei trucs en vermaakte de zaal met de wereld van de magie.

Op 24 april kwam Nick Lesli alias Mbongi naar het NIOZ voor een cabaretoptreden. Voor de mensen die aan de overkant wonen en normaal gesproken het cabaret niet kunnen bijwonen, was er door de PV daarom voor een andere opzet gekozen. Er werd een diner verzorgd in de kantine door Ruud Boom Catering om 17.00 uur en daardoor kon het optreden van Mbongi al om 18.30 uur beginnen zodat iedereen weer om 21.00 uur met de laatste boot naar Den Helder kon vertrekken. Mbongi vertelde in het Engels en Zuid-Afrikaans allerlei oude verhalen en sagen. Tijdens de cabaretavond was de opkomst van het NIOZ personeel zeer laag en mede hierdoor is er door het bestuur van de personeelsvereniging besloten om een enquete te houden met betrekking tot de activiteiten van de personeelsvereniging. De enquete is door 68% van de PV leden weer ingeleverd, opmerkelijk was hierbij dat de behoefte aan een PV reis vrij hoog is (86%). Conclusie: in 1998 gaan we weer op reis! Tevens heeft er een bestuurswisseling plaatsgevonden Theo Hillebrand en Siem Groot hebben het bestuur verlaten. Gelukkig is er één nieuw lid bijgekomen namelijk Santiago Gonzalez. Het PV bestuur zit helaas nog steeds te springen om nieuwe bestuursleden.

Op 9 oktober werd er ondanks regen en wind (kracht 9) de sportdag gehouden. Swier Oosterhuis en Piet Keizer hadden een puzzeltocht uitgezet die zowel op de fiets als met de auto kon worden afgelegd. Tussen de middag en 's avonds werd er gegeten in jeugdherberg Panorama. Ondanks het slechte weer toch een zeer geslaagde dag.

ACRONYMS USED IN THIS ANNUAL REPORT

AABW	Antarctic Bottom Water
ACC	Antarctic Circumpolar Current
ADCP	Acoustic Doppler Current Profiler
ALBEX	Autonomous Lander for Biological Experimentation
ARGOS	a satellite location and data collection system
AWI	Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
BELS	Benthic Links and Sinks in North Sea Nutrient Cycling
BEON	Beleidsgericht Ecologisch Onderzoek Noordzee/Waddenzee Applied Ecological Research North Sea and Wadden Sea
BFA-ISH	Bundesforschungsanstalt für Fischerei-Institüt für Seefischerei, Hamburg
BOA	Gebiedsbestuur voor de Biologische, Oceanografische en Aardwetenschappen Foundation for Biological, Oceanographic and Earth Sciences
BOBO	Bottom benthic boundary lander
BOLAS	Bottom Lander System
CARUSO	Carbondioxice Regulation in the Southern Ocean
CEFAS	Ministry of Agriculture, Fisheries and Food Laboratory, Conwy, Wales (UK)
CNRS	Centre National de la Recherche Scientifique
CTD	Conductivity-Temperature-Depth
DCM	Deep Chlorophyll Maximum
DCS	Dutch Continental Shelf
DMS	Dimethylsulphide
DMSO	Dimethylsulphoxide
DMSP	Dimethyl sulphoniopropionate
DNZ-RWS	Dienst Noordzee-Rijkswaterstaat Directorate North Sea, Ministry of Transport and Public Works
DUTCH-WARP	Deep and Upper Transport, Circulation and Hydrography, WOCE Atlantic Research Programme
EC	European Community
ENAM	European North Atlantic Margins
ERSEM	European Regional Seas Ecosystem Model
FRC	Fisheries Research Centre Dublin, Ireland
FYFY	Fysics-fytoplankton model
GeoB	Universität Bremen, Geowissenschaften
GLOBEC	Global Ocean Ecosystem Dynamics
GOA	Geologie, Oceanografie, Aardwetenschappen Geosciences Foundation
ICES	International Council for the Exploration of the Sea
IDM	Informatie dienstverlening en -management
IfM	Institut für Meeresforschung, Hamburg, Germany
IFREMER	Institut Français de Recherche pour l'Exploration de la Mer
IMAU	Instituut voor Marien en Atmosferisch Onderzoek, Universiteit Utrecht Institute for Marine and Atmospheric Research
IPO-LOICZ	International Project Office LOICZ
ISOW	Iceland-Scotland Overflow Water
JGOFS	Joint Global Ocean Flux Study
KM	Koniklijke Marine Royal Navy
KNMI	Koninklijk Nederlands Meteorologisch Instituut
LDW	Lower Deep Water
LOICZ	Land Ocean Interaction in the Coastal Zone
LSW	Labrador Sea Water
LUW	Landbouw Universiteit Wageningen Agricultural University Wageningen
MAFF	Ministry of Agriculture, Fishery and Food (UK)
MAST	Marine Science and Technology programme
MLA-SOAEFD	Fisheries ResearchServices, Marine Laboratory Aberdeen (n executive of the Scottish Office formerly known as Marine Laboratory), Aberdeen, Scotland (UK)
MMPA	Methylmercaptopropionate
MPA	Mercaptopropionate
MPI	Max Planck Instituut
MRF	Marine Research Facilities
MRI	Martin Ryan Marine Science Institute University College Galway, Galway, Ireland
MSA	Methane sulphonic acid
MSH	Methanethiol
NAC	North Atlantic Current
NAM	Nederlandse Aardolie Maatschappij Dutch Oil Company
NAO	North Atlantic Oscillation
NAOI	North Atlantic Oscillation Index
NEADW	North East Atlantic Deep Water
NEBROC	Netherlands Bremen Oceanography

NIOO-CEMO	Nederlands Instituut voor Oecologisch Onderzoek-Centrum voor Estuariene en Mariene Oecologie Netherlands Institute of Ecology-Centre for Estuarine and Coastal Ecology
NITG-TNO	Nederlands Instituut Toegepaste Geowetenschappen, TNO
NMR	Nuclear Magnetic Resonance
NODC	National Oceanographic Data commission
NOWESP	Northwest European Shelf Programme
NSDW	Norwegian Sea Deep Water
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek Netherlands Organization for Scientific Research
OBM	Oil Based (drilling) Muds
RGD	Rijks Geologische Dienst
RIKZ	Rijksinstituut voor Kust en Zee National Institute for Coastal and Marine Management
RIVO-DLO	(Rijks Instituut Visserij Onderzoek-directie landbouwkundig Onderzoek)
RSZV	Rijskstation voor Zeevisserij Oostende, Belgium
RUG	Rijksuniversiteit Groningen University of Groningen
RUU	Rijksuniversiteit Utrecht eng;University of Utrecht
RWS	Rijkswaterstaat Department of the Ministry of Transport and Public Works
SPMW	Sub-polar Mode Water
SPMW	Subpolar Mode Water
STED	Short-Term Dynamics in benthic microbial activities and nutrient fluxes related to sedimentation and current velocities in the Oystergrounds, North Sea
TNO	Toegepast Natuurwetenschappelijk Onderzoek Applied Research Netherlands
TRIPLEB	Bay of Biscay Boundary
TROL	Temperature Resistivity Oxygen Lander
TUD	Technical University Delft
ULB	Université Libre Bruxelles
UvA	Universiteit van Amsterdam University of Amsterdam
UWB	University of Wales Bangor, Wales (UK)
VU	Vrije Universiteit Amsterdam Free University Amsterdam
VU-IvA	Vrije Universiteit-Instituut voor Aaardwetenschappen
VvA	Verstoring van Aardsystemen (NWO)
WHP	WOCE Hydrographic Programme
WL	Waterloopkundig Laboratorium
WOCE	World Ocean Circulation Experiment
WOTRO	Wetenschappelijk Onderzoek Tropen
ZMT	Zentrum Marine Tropen Ökologie Bremen