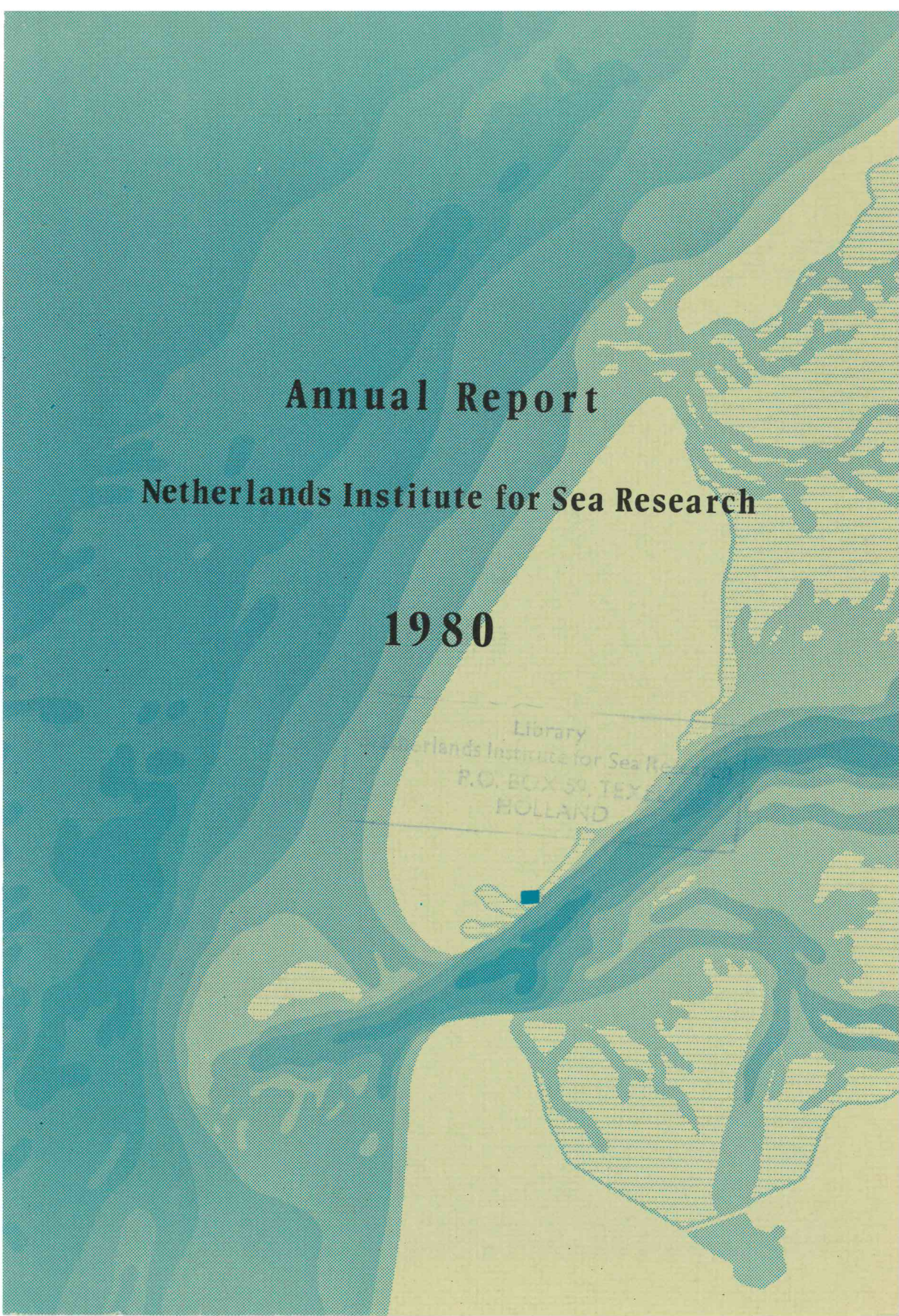




Annual Report

Netherlands Institute for Sea Research

1980

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Executive editor

J.W. DE BLOK (Texel)

Editors

I.N. McCAYE (Norwich, U.K.)

H. POSTMA (Texel)

P.H. NIENHUIS (Yerseke)

R.E. WEBER (Odense, Denmark)

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Correspondence should be addressed to the executive editor, J.W. de Blok, Netherlands Institute for Sea Research, P.O. Box 59, 1790 AB Den Burg, Texel, The Netherlands.

ANNUAL REPORT
NETHERLANDS INSTITUTE FOR SEA RESEARCH
1980

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The old building of the Netherlands Institute for Sea Research (formerly Zoological station) situated in Den Helder. In 1969 the NIOZ moved to new buildings on the island of Texel. The old building still exists and is in use by a cooperative fishery organization.

1. INTRODUCTION

1.1. GENERAL

1980 was a quiet year for the NIOZ as an organization. The number of staff remained the same. This means that our objective of gradual increase in staff towards an optimal level has come no nearer for a number of years now. In the past we have repeatedly pointed to the dangers of such a policy for an Institute like ours, where several branches of science seek to work together.

However, it must immediately be said that the consultations with the Ministry of Education and Sciences took place in an atmosphere of goodwill and understanding, as previously. The Government recognizes the central role of the Institute in Dutch oceanographic research. Among other things, the building of a new research ship for the Wadden Sea, the NAVICULA, was approved, and the ship was launched in December.

The results of research were recorded in some sixty publications. The fruits of many other activities by members of the Institute are not as easily pointed to in an annual report. Within the Netherlands more time than ever was given to consultations about the application of oceanographic research for the public benefit, especially in protecting the natural environment. The Institute is involved with almost all aspects of this problem. Besides the problematic dredging of sand (mentioned in the annual report 1979) we were concerned with the pollution of the North Sea and its estuaries, the dumping of radio-active wastes in the deep-sea, and the climatological consequences of the increase of CO₂ in the atmosphere. The work of BOEDE (Biological Research Eems-Dollard Estuary) belongs in this category also.

Outside the country the number of contacts increased steadily.

1.2. RESEARCH

The different projects are discussed extensively in the following pages. Here we wish to make some general remarks about every department of research.

1.2.1. The Department of Physical Oceanography investigated the Southern Bight with six buoys, whose position could be determined by Decca. For the first time the laser-doppler velocity meter developed by the department was used success-

fully in the sea. In the area of marine optics some attention was given to the development of the relation between so-called sea truth data and observations made by remote sensing.

1.2.2. The Department of Marine Geology and Geochemistry continued its investigation of sediment-transport in the North Sea, in part by winter cruises that covered the entire area. As part of the Ocean Programme, the study of the seismics of the "Zaire fan" was continued; for the first time cores with a length of 18 m were collected. Furthermore, work was done on the nephelometrics of the deepest waterlayers. A contribution was made to research on the chemistry of the Angola Basin: attention was mainly focused on the water supply across the deepest bars. The investigation of the silicic acid cycle was continued. Great interest was shown for a technical improvement on classic röntgen diffraction measurement of clay minerals.

1.2.3. The Department of Chemical Oceanography continued research on the exchange of chemical elements between the interstitial water in the sediment and the overlying water; deep sea samples (southern Atlantic) were also studied. It was found that on tidal flats it is not so much diffusion as horizontal movement through the body of sand that is important. The investigation of the day/night rhythm of oxygen in the Southern Bight was continued. During a quiet spring season a strong increase of oxygen (the result of plankton bloom) was found, on which the daily rhythm was superposed. In the Eems-Dollard area we continued the study of the nitrogen cycle.

1.2.4. The Department of Marine Pollution Research succeeded in perfecting a method for determining individual polychlorobiphenyl-components. Because of their different chemical properties these components follow different courses in the natural environment, and are deposited in different places. This had made it possible to study the components and their effects in more detail than with total PCB determination. During a winter cruise of the entire North Sea, metals and trace metals in solution and suspension were measured. This will increase insight in the fate of these elements outside the estuaries. Separately, the relationship between the concentration of plankton and metals was investigated. The possible accumulation of pollutants in the Wadden Sea was a matter of continual concern for the Department. Biological research was directed towards sublethal effects of chemicals on marine organisms, both from PCB-components and from metals.

1.2.5. The Pelagic Systems Department continued studying primary production both in the North Sea and in the open ocean. An interesting conclusion was reached, *viz.* that the classic ^{14}C method, which yields too low figures for real production in the ocean, is quite reliable for the North Sea. More investigation of the transition from one situation to the other is desirable. The investigation of population dynamics of secondary producers in the Wadden Sea and North Sea clearly showed a summer decrease of herbivores, possibly for lack of food (phytoplankton). Model calculations on the total pelagic system show the possibility of quick changes in concentrations of phyto-, zoo-, and bacterio-plankton, but do not explain why the growth of phytoplankton is limited in summer. Among other things, the role of herbivores in the system needs more study. Experimental work on zooplankton supported the work done in the field.

1.2.6. The Benthic Systems Department again put much time into the study of nutrients in the Wadden Sea. Insight was gained in the formation of dissolved organic carbon by algae. It seems likely that this carbon is formed when these organisms die, and not through excretion by living algae. Additional data were gathered on the contribution of the IJsselmeer and the organic production of the Wadden area. The long-term investigation of secondary production of tidal flats was continued, where we profited from the strong fauna decline that resulted from the severe winter of 1979, and the following recovery.

1.2.7. The Autoecology Department continued study of North Sea benthic fauna. The area studied was extended northwards to 55°N . Work was done on mortality and growth of young plaice in the Wadden Sea. The critical period determining both mortality and growth differences turned out to be the "settling stage" in April-May. During this period competition for food by young plaice and the predation on these plaice by other animals (shrimps) is highest. Both this and other research stimulated thought on the total cycle of organisms and food supply in the Wadden area; spring seems to be the crucial season, the period when all processes are most strongly interrelated.

1.2.8. The Experimental Systems Department investigated the properties of organic material in the tidal flats. It was concluded that degradable material in fact is present only in the top few cm, while the underlying layers consist of "fossil" plant remains such as finely dispersed peat. This means that

the organic material here is for the main part very old, a fact which had already been concluded by others from direct dating. Much attention was devoted to conversions of the "active fraction" by measuring oxygen consumption and heat production (microcalorimetrics). These measurements were extended to the North Sea.

Measurements of bacterial respiration in the water column of the Wadden Sea (oxygen consumption and ETS activity) showed that this is highest in June and lowest in winter. In autumn the bacteria begin to lack food, which was confirmed by the fact that addition of peptone stimulates respiration.

For the experimental work on fish and crustaceans we refer to the project report in question.

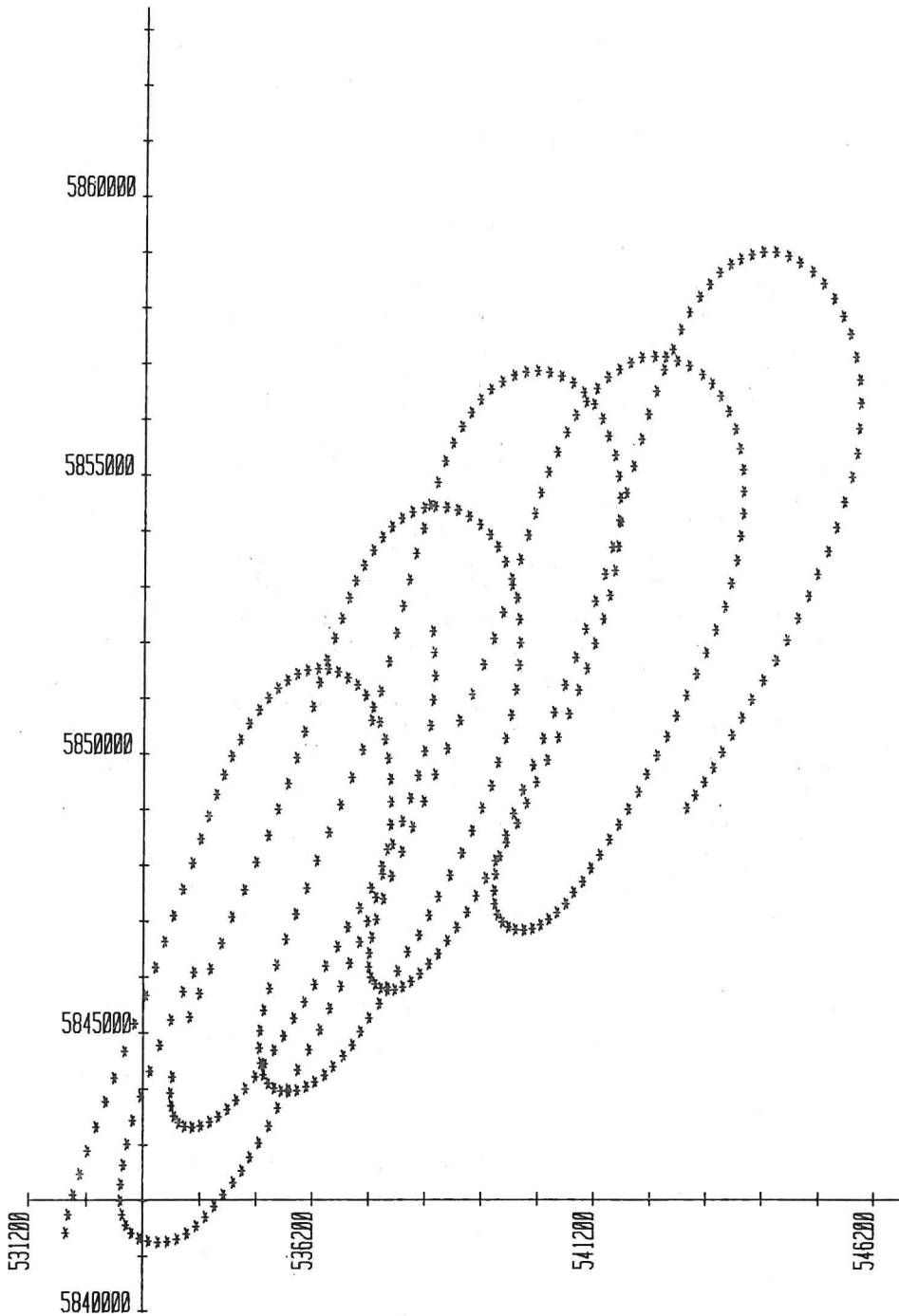
2. PROJECT RESEARCH

2.01. CIRCULATION AND HEAT BALANCE OF THE SEA

2.01.1. Circulation and mixing in the North Sea and Wadden Sea

Research on the mesoscale dynamics of tidal currents in the southern part of the North Sea with Decca tracer buoys ("Lagrangian method") gave us 9 series of measurements in several positions. The different series varied from 1 to 10 tidal periods; six drifters were used at a time. Simultaneously, KNMI or Rijkswaterstaat (Hoorn) conducted fixed measurements of current velocities. On top of that, we were able to make use of two series of measurements made by Rijkswaterstaat (Hellevoetsluis). These last have been provisionally analysed for: (1) absolute displacement of the several drifters and their centre of gravity; (2) relative displacement of the drifters in relation to their centre of gravity, caused by first order shearing components; (3) relative displacement caused by turbulent diffusion. It was found that (1) is clearly determined by both tide and wind-related residual circulation; (2) contains components like vorticity, varying with the tide, and also depends on position; (3) contains noise-like elements in the velocity field, appearing to produce a fairly constant diffusion coefficient. Although this interpretation is premature, it appears to be worth-while to use this type of analysis on the entire series of 1980 data.

Besides the Decca tracer system, the laser-doppler velocity meter was used in sea for the first time. Testing measurements were taken in tidal waters of varying turbulence. Additional laboratory experiments took place. The investigation focused on noise problems caused by too many scattering particles (Wadden Sea), ship movements, and signal transmission (from cables, winches, etc.). Ship movement turns out to be quite troublesome when measuring Reynolds stress, but does not materially hinder energy dissipation measurements. The laboratory experiments supported these conclusions. Work is now in progress on a fixed arrangement for the meter in order to measure shearing stresses in a reliable way, at least near the bottom. To meet the problems of very turbid waters, such as in the Wadden Sea, a special correlation technique was developed to determine energy density spectra (and thus energy dissipation parameters) in spite of high levels of noise. A first analysis of measurements made in sea shows that going



Trajectory of drifter near the Brown Bank in April 1980. The positions of a Decca tracer buoy are indicated with an asterisk each 10 minutes (2.01.1).

from the coast towards the centre of the North Sea, turbulent energy dissipation becomes some orders of magnitude smaller.

2.01.2. Heat balance of the Wadden Sea

Because the new measuring instruments were not delivered on time the fieldwork planned for the summer of 1980 could not take place.

2.02. SEDIMENTS AND SEDIMENT TRANSPORT

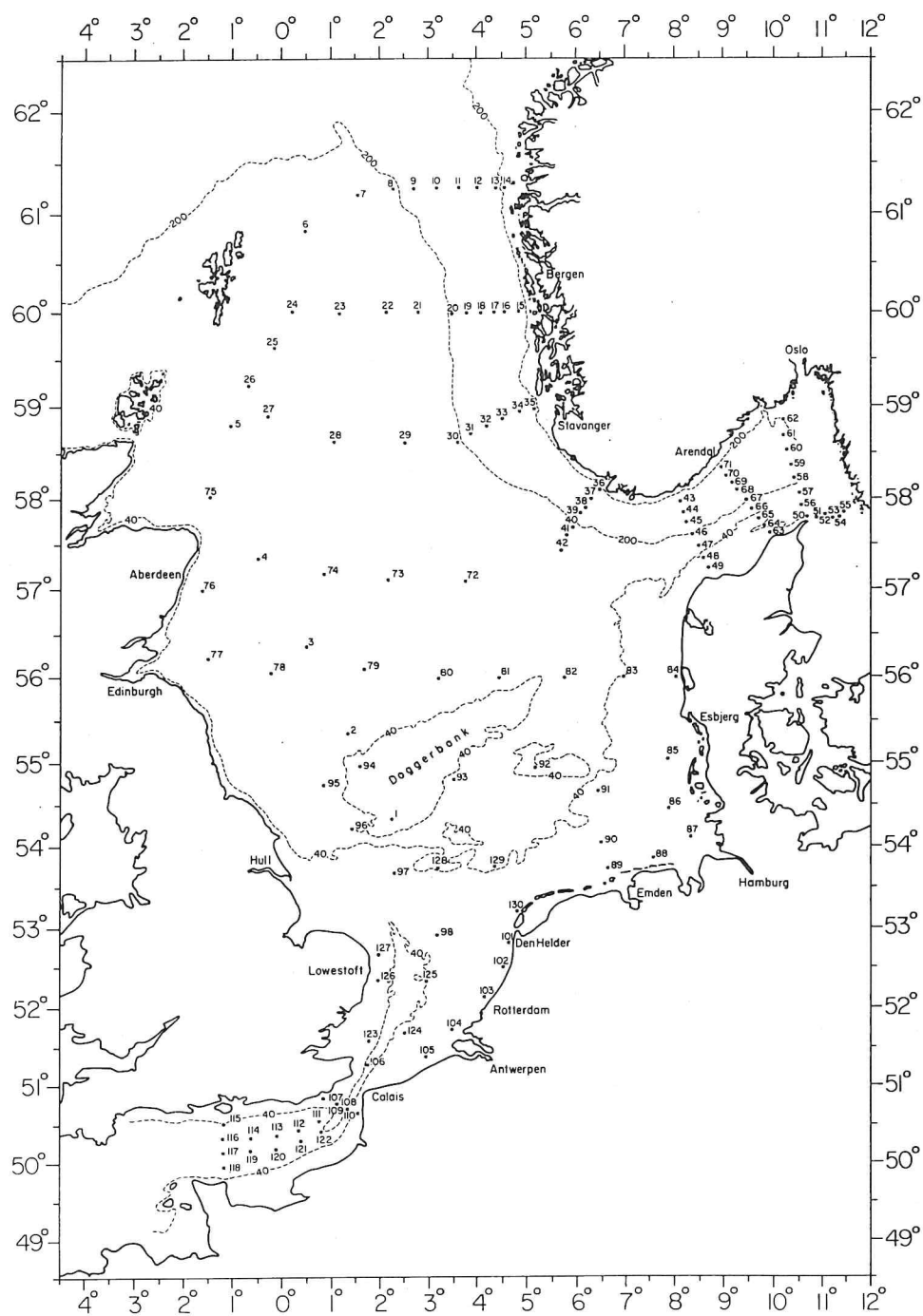
2.02.1. Sediment transport in the North Sea

The ocean programme called for water and suspension samples to be made by TYRO and AURELIA, together with the group Pollution of the Sea. This occurred in January and February in the northern part of the North Sea, from Shetland to halfway the Channel. It was done in winter to prevent interference by living plankton. Particle sizes of suspended material were determined on board with the Coulter Counter. Also, from 1 to 15 litres was filtered through a 0.4 μm Nuclepore filter to determine the total amount of suspended material and the concentrations of main elements. These can give some indication of the origin of the material, as was shown by analysis of bottom samples. This year a start was made with the analysis of the samples and other data; it will be completed in 1981.

To supplement earlier data about particle and aggregate formation in the Rhine estuary, suspension and bottom samples were taken (in May) in and over the "fluid mud" that can usually be found in the mouth of the Caland canal and the Waterweg. These samples were acquired with the assistance of a ship and apparatus of Rijkswaterstaat (Hoek van Holland). The results were combined with earlier outcomes, and published (see 4.2.1.22). The TEM study was done together with M. Veenhuis of the Biological Centre, Groningen.

2.02.2. Sedimentology northern North Sea

The usefulness of cysts of dinoflagellates as indicators of palaeo-ecological circumstances during the Quaternary in the northern North Sea was investigated. The results have been recorded in a report of the laboratory for Palaeobotany and Palynology of Utrecht University.



Sample stations in the North Sea (see 2.02.1).

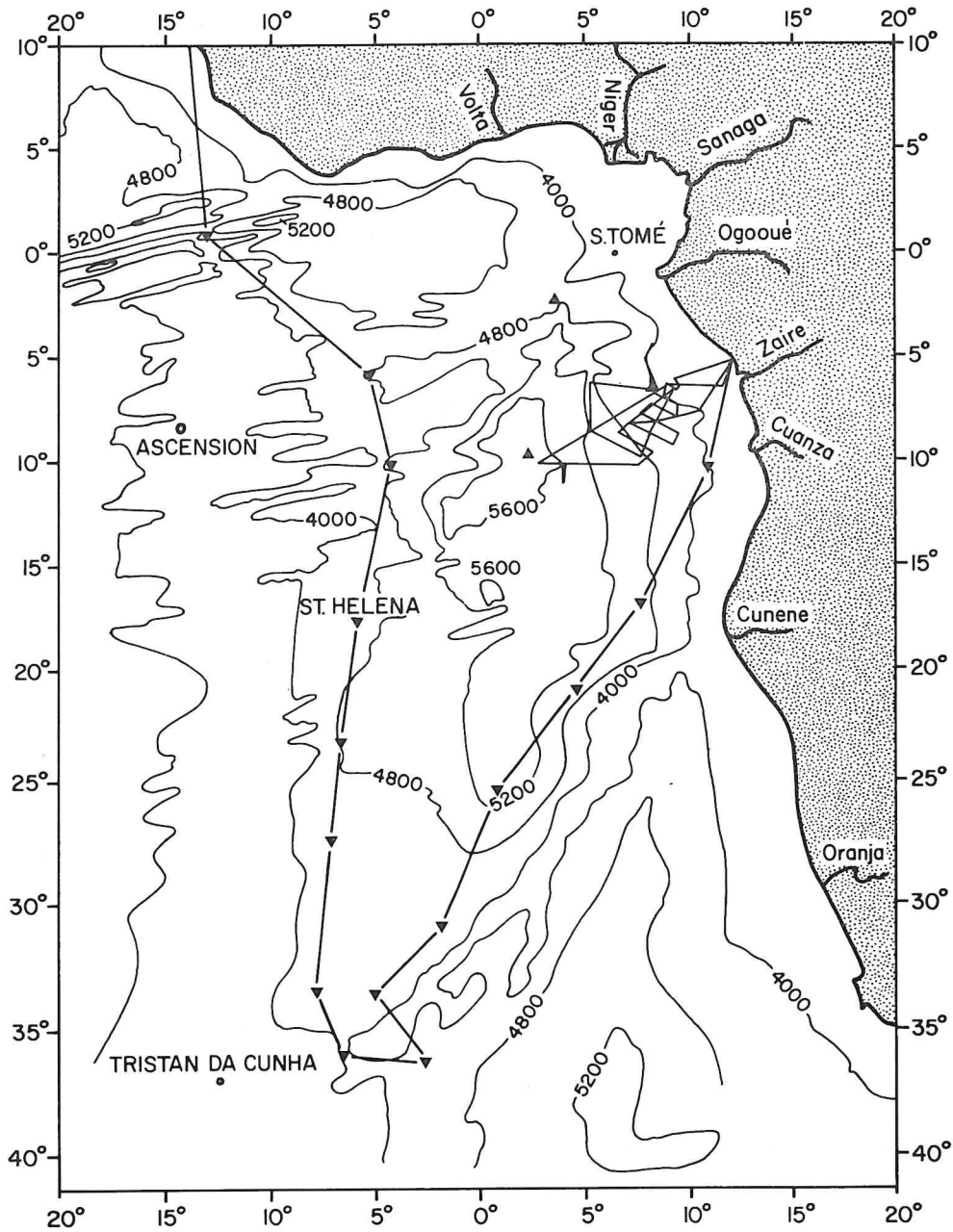
2.02.3. Sedimentology Norwegian Channel and Skagerrak

The results of the analyses of surface sediment of the Skagerrak have been published in an article (4.2.1.58); this will be part of a doctoral thesis about late Quaternary sedimentation history in Norwegian Channel and Skagerrak. Some work has been done on cores from the Skagerrak in order to make a biostratigraphic classification; this was done in cooperation with the State Geological Service and Mrs G.B. Qvale of Oslo University. A number of samples was analysed for clay minerals; it was found that the proportions of these minerals vary considerably in both time and place. The vermiculite that is also present strongly changes both mechanically and diagenetically. Samples from the Skagerrak have also been analysed for gravel composition. From the composition places of origin have been tentatively established.

2.02.4. Sedimentology Angola Basin (southeast Atlantic Ocean)

The cores taken in the Zaire deep-sea delta in 1978 have been analysed for calcium content, particle size, foraminifers, clay minerals, main elements and U/Th isotope ratio. These analyses were performed on selected samples. March 1980 saw a gathering on Texel of Dutch and foreign scientists who work on these cores, to prepare a combined publication in the Neth. J. Sea Res. The cores originating from above the lysocline (the level below which carbonate solutions are increasingly noticeable) could clearly be related by their carbonate content and the sedimentation structures visible by X-ray. The carbonate contents show the characteristic Atlantic vertical profile. The cores from deeper layers could be fitted into the scale by means of microfossils (foraminifers, coccoliths, radiolarians, diatoms) and a few ^{14}C datings. The difference between low carbonate content in deposits from cold periods, and high contents from warm periods, is mainly caused by differences in the productivity of calcareous organisms, and only in small part by differences in the amount of calcium solution and dilution through the supply of mainland material by the Zaire river. It seems that the river transported more during cold periods, judging by the amount of freshwater diatoms. Clay was deposited mainly in warmer periods. Different origins of clays are not only established from mineralogical variations, but also from magnetic characteristics (2.02.5).

Airgun and echosounder profiles give an impression of the



Sample stations in the Atlantic Ocean (see 2.02.4).

age of the Zaire deep-sea delta. Although this area still receives more sediment than neighbouring parts of the continental slope, yet most of the deep-sea delta was deposited right after the southern Atlantic was opened up in the late Cretaceous period.

The results obtained in 1978 on the continental shelf of Congo and Gabon were worked out together with P. Giresse and G. Moguedet (Perpignan), and summarized in two articles (4.2.1.36).

In May a test cruise of a few days was made from Villefranche-sur-Mer in deep Mediterranean water; the results were satisfactory. This test cruise was conducted with a research ship from the Station Géodynamique sous-marine (Villefranche), the "Cathérine Laurence".

This autumn a cruise was made to the Angola Basin with the TYRO. The airgun-system, developed by NIOZ in consultation with KSEPL (Rijswijk), functioned well. Thanks to the good resolution of this system a great part of the channel network of the Zaire Deep Sea Fan and its changes in time could be detected.

This trip yielded a number of cores with a length of 17 to 18 m. Most could be taken with good acoustic control as to their places of origin. Together with samples taken earlier these cores provide a fairly complete picture of the sediments and sedimentation processes of the Zaire Deep Sea Fan and the Angola Basin.

The method used, where cores were opened on board within 24 hours to take samples of the interstitial water, worked well. This was done in cooperation with C.H. van der Weijden and C.J. de Lange, Utrecht University. The same method was followed with the analyses of the small cores obtained with the gravity corer mounted under the Rosette sampler. M.M. van der Loeff worked on this. At the water stations in the Angola Basin and around the Walvis Ridge between $\pm 38^{\circ}\text{S}$ and 1°N samples were taken to determine nutrient values, aluminium, ^{14}C and suspended material. A great many suspension samples were prepared on board for SEM and TEM analyses (type of particles, composition). The nephelometer, linked to the CTD, turned out to be very useful and gave direct profile readings on deck.

2.02.5. Palaeomagnetic dating

Palaeomagnetic measurements have been performed on a few cores from the Angola Basin (declination, inclination, intensity).

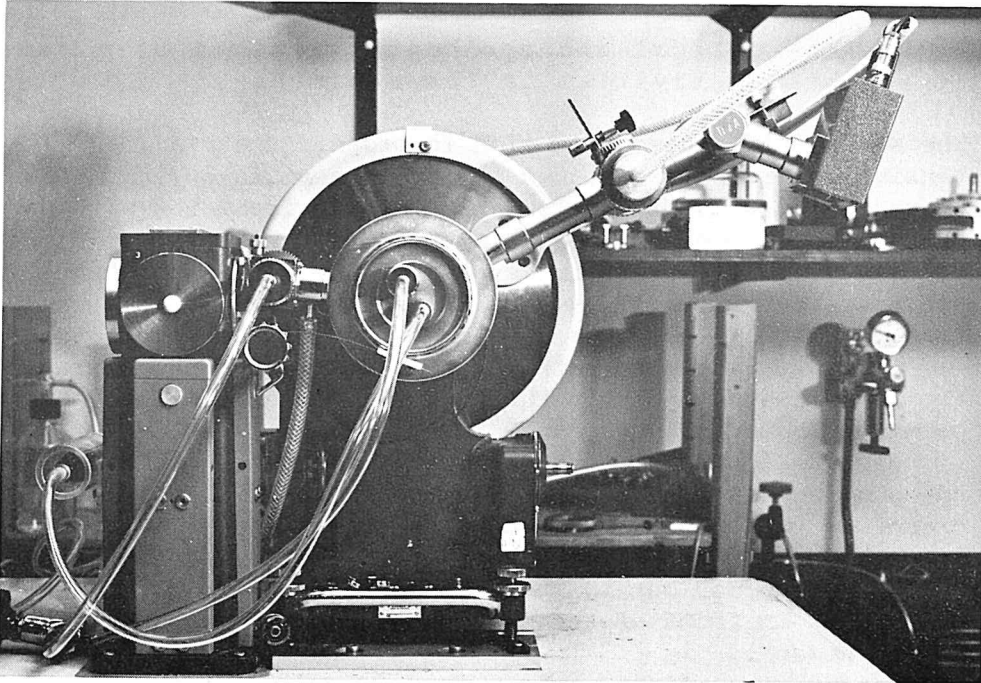
On the basis of magnetization, land material (associated with turbidites with or without macrostructure) can be distinguished from material of oceanic origin. Three different magnetic parameters give practically identical results. It may be concluded that in cores from the middle of the Angola Basin the material up to 2 m above the last turbidite originated on land, while the material in higher layers is oceanic. The measure of magnetization also indicates that the sedimentation velocity of clays in the lower part of the core (associated with turbidites) was about 40 times that of the higher oceanic material. Cores nearer the coast have lower magnetization and consist mainly of land material, even if the cores contain no turbidites. The differences in magnetization between land and oceanic material are probably caused by a difference in composition in the smallest particles (a few μm). We found no evidence for inversion of the earth's magnetic field in the cores.

2.02.6. Röntgen diffraction and clay mineral analysis

In the summer S.J. van der Gaast and A. Vaars developed a röntgen diffractometer system (which they demonstrated at a clay congress in München) that can determine quantities of clay minerals in a mixture in an improved manner. Linked up with a NIOZ computer the system proved its ability to subtract röntgen spectra from each other. Thus small differences can be distinguished and measured. It is now also possible to characterise material amorphous to X-rays. A secondary advantage is the much higher intensity during normal use, which increases the detection limits and improves the resolution. In the new situation a specimen must be analysed in different gases under identical relative humidity. Apparatus for this has been constructed. The Philips concern has shown great interest: it is the first real development since the röntgen diffractometer was developed in 1940-1945, opening new perspectives in diffraction analysis. Among other things, the new technique will be applied to problems in the transformation of clay minerals in the sea.

2.02.7. Sedimentation around the Scotland-Greenland Ridge

In preparation of a more extensive study of the sedimentation in the northern Atlantic Ocean and the Norwegian Sea under the influence of the Scotland-Greenland Ridge, five ocean-floor cores from Lamont Geological Observatory (New York)



Röntgen diffractometer with vacuum-helium system as developed at the NIOZ (2.02.6).

were analysed for clay minerals, calcium content, and total concentration of coccoliths. This last was done by means of the SEM of Utrecht University. These first results clearly show a correspondence between the current pattern as it is supposed to have been during the Weichsel-period, and the transport of montmorillonite-rich material from the Far Oer. This material has not been transported northwards during the Weichsel. These data also show that the Eem interglacial period must have lasted a little longer than was supposed on the basis of foraminifer research by KELLOGG (1975). This longer duration explains the presence of coccoliths, which are better indicators of whether the surface water was frozen or not than foraminifers. This study will be continued on more Lamont cores, in order to gain more insight in the spread of sediment in this part of the ocean floor during Eem, Weichsel and Holocene.

2.03. MINERALIZATION IN THE SEDIMENT, SULPHUR CYCLE

2.03.1. Energetical and ecological aspects of microbial activities in the sediment

The Wadden Sea sediment is rich in organic material, and intensive mineralization takes place. In aerobic environments by oxidation with oxygen, in anaerobic environments with sulphate. Both processes are accompanied with electron transport along an electron transport system of which the activities can be measured. During a year ETS activities were measured in the sediment; no clear annual cycle could be established.

Sulphate reduction rate was measured by the use of radioactive sulphate, and this turned out to be on the level of the primary production.

Because *Arenicola* aerates the bottom through bioturbation and pumping water through the sediment, the biomass of the organisms present in and around its tube was determined by means of an ATP method. The sediment funnel above *Arenicola*'s mouth turned out to be rich in ATP ("gardening"), while also right in front of the mouth a clear peak in ATP was found ("filtration").

During mineralization heat is produced. A start was made on measuring heat production in the sediment with a microcalorimeter.

2.03.2. Sulphide oxidation: ecological and metabolic aspects

The work on the sulphur cycle was stopped; two manuscripts on ecology and bioenergetics of *Thiomicrospira denitrificans* were produced.

2.04. MINERALIZATION IN THE WATER COLUMN

2.04.1. Ecological aspects of heterotrophic bacteria

In three places in the western Wadden Sea (Marsdiep, Balgzand channel, Wierbalg) oxygen consumption in the water phase and ETS activity of suspended material were measured. The respiration was highest around June and lowest in winter. By addition of peptone the respiration rate can be increased. The effect is most explicit in September Wadden Sea samples.

Evidently at that time there is a hungry biomass that quickly uses up the added peptone. The coefficient for hetero-

trophic activity is 10 at that moment, while the annual average is about 4. This coefficient is lowest in June, about 1, which is to say that addition of organic material at that time has no effect on the velocity of oxygen consumption: there is then no lack of organic material. The ratio between ETS activity and oxygen consumption varies over the year from 1 to 4, the average being 2.1. Biomass was determined by ATP measurements during periods of 24 hours (two tidal cycles), in Vlietstroom and Marsdiep.

A manuscript on oxygen consumption and ETS activity was offered for publication.

During the next NECTAR expedition measurements will be taken to determine bacterial activity as connected with mineralization in the open ocean, bacterial biomass and "bacterial numbers". All this will be related to biotic, chemical and physical factors, possibly depending on the day-night rhythm. For this, ATP measurements, ETS measurements and L.P.S. measurements with the immunological "Limulus-amoebocyte-lysate" reaction will be conducted. Epifluorescence microscopy and calorimetrics will also be used.

2.04.2. Redox-reactions of inorganic nitrogen compounds

The experiments with chemostats to investigate NH_4^+ and NO_2^- oxidating and chemo-autotrophic bacteria were stopped at the end of 1979. The results are being worked out, while a large number of samples from the cultures was analyzed for nutrients, protein content and C content. In cooperation with Groningen University electronmicroscope photographs of the organisms were made and analyzed.

2.05. EXCHANGE OF NUTRIENTS BETWEEN BOTTOM AND OVERLYING WATER

2.05.1. Exchange of nitrogen and phosphorus between bottom and overlying water in the Southern Bight

The investigations up to this point are discussed in two publications (see 4.2.1. 45 and 46).

2.06. DISTRIBUTION OF NUTRIENTS IN THE SEA

2.06.1. Chemical components in the Wadden Sea

Together with 2.18.2 studies were carried out on the seasonal and tidal dependence of fluorescent matter and chlorinity of the interstitial water in the sediment and the overlying water.

2.06.2. Nitrogen compounds in the Wadden Sea

In cooperation with BOEDE the exchange of nutrients between sediment and water in the Ems-Dollard area was investigated. Attention was paid to nitrogen-redox reactions in the sediment (nitrification and denitrification). Besides determinations of NH_4^+ , NO_2^- and NO_3^- , MPN methods were used to describe the vertical distribution of nitrifying and denitrifying bacteria in the top layer of the sediment (down to 40 cm).

An automatic method to determine uranium in sea water and pore water was studied. This determination is sensitive enough for the intended work, but will be studied more closely for specificity.

2.06.3. Oxygen day-night rhythm and nutrients in the Southern Bight

During March and April every 4 hours oxygen measurements were taken at three depths in the same mass of water, marked by a Decca tracer-buoy (see 2.01.1). This was done in the North Sea area with highest salinity, 80 km west of Den Helder. In both months a day-night rhythm could be clearly established. In March primary production was low and probably in steady state; in April during quiet, sunny weather a fine 72 hour graph was obtained during a *Phaeocystis* bloom, where the oxygen level increased from 115 to 125%. In this month for this spot net and gross primary production of 2.0 and 3.1 g C·m⁻²·d⁻¹ was calculated. During the period of daylight production the velocity was almost constant, and moreover this increased by 0.3 μmol O₂·dm⁻³·h⁻¹·d⁻¹. Preliminary results were reported in an ICES lecture (see 4.2.1. 55 with illustration). There was little attention to spare for nutrient rhythms during this series of measurements. However, nitrate content appear to decrease to a very low level.

A fair amount of work was done on improving the phototitrator and on verifying gauges. An exposition of the method of oxygen analysis was given at a symposium in Czechoslovakia (see 5.2).

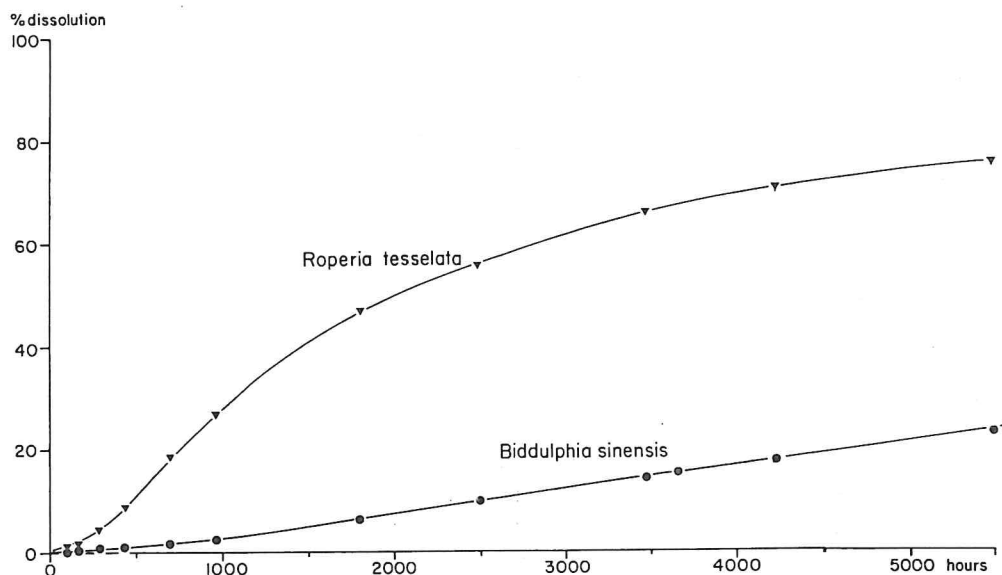
2.06.4. Marine silica cycle

The samples taken during the expedition in October and November to the Angola Basin completed the study of the vertical structure of the water column in this basin. Together with the expedition of 1976, 1978 (2.02.4) and 1979 (2.02.5) a total of 36 deep water stations, with depth varying from 4000 to 5400 m have been carried out. The layers deeper than about 1000 m are flushed via sills in the Mid-Atlantic Ridge where water masses with a high percentage of Antarctic Bottom Water, characterized by a lower temperature and salinity, a much higher concentration of silicic acid, a somewhat higher concentration of nitrate and phosphate and a lower concentration of dissolved aluminium, enter the basin. In the Guinea Basin the vertical stratification remains present; in the Angola Basin the structure gradually disappears by vertical mixing. The sill in the Whale Ridge at 36° S near Tristan da Cunha appears to be important only for the bottom water in the extreme south of the Angola Basin. In the silicic acid budget of the Angola and Guinea Basins the higher proportions of Antarctic Bottom Water flowing at some distance from the bottom over the Whale Ridge also have to be taken into account.

The ages of the deep waters near the Romanche and Chain fracture were determined from the C-14 content of the dissolved bicarbonate in cooperation with the Department of Isotope Physics of Groningen University. Generally they agree well with data in the literature, it is interesting that the bottom waters have a smaller age than the waters at 1 km from the bottom.

In laboratory experiments it was found that diatom frustules from the North Sea (*Biddulphia sinensis* with 0.33% aluminium) dissolved much more slowly than frustules collected near Cap Blanc (*Roperia tesselata* with 0.13% Al). See illustration. The two species have a comparable ultrastructure, probably the Al causes the differences in dissolution kinetics. These results were presented at the 6th Diatom Conference in Budapest, a paper will be in the Proceedings.

In areas like the North Sea, where the concentration of silicic acid is low, diatom growth depends during a large part of the year on dissolution of old frustules and the coupling between Al and Si may have important consequences for the phytoplankton species composition.



Difference in dissolving velocity between diatoms from the North Sea and from the upwelling area near Cap Blanc (*Biddulphia* and *Roperia* respectively).

2.06.5. Nutrients and primary production in the Gulf of Guinea under the influence of the rivers Zaire and Niger

Samples and data from the October-November 1979 expedition were worked out (see also 2.06.4, 2.07, 2.08.3 and 2.09.3). Some provisional results are:

1) The shape of the total irradiance profiles and the depth of the chlorophyll layer proved to be well correlated, as during the NECTAR cruises.

2) Temporal variations in the irradiance profiles may possibly give an impression of the vertical migration of suspended material.

3) In contradiction to what was found during the NECTAR investigations, the chlorophyll content and the ^{14}C incorporation did not decrease with the size of the incubation bottles.

4) The chlorophyll a isomere identified during NECTAR 1977 and 1978 shows no photosynthetic activity.

5) The density of sea birds is probably related to an increased food supply caused by equatorial upwelling. The

data obtained will be published in 1981.

During the cruise analyses were made of the sediment and the interstitial water of the top meter of the sediment (trip-cores); there was no reason to repeat this study under more favourable circumstances (nitrogen atmosphere, 40°C) during a cruise on the central Atlantic (2.02.4).

2.06.6. Nutrients and oxygen distribution, stratification, primary production and biomass in the North Equatorial Current (NECTAR)

Data on oxygen distribution in this area are being studied.

2.07. MARINE OPTICS

The results obtained on the ocean-cruise in the Gulf of Guinea (1979) were further worked out. As with the results of the NECTAR investigations (1978), a relationship was discovered between the depth of the chlorophyll maximum and the diminution coefficient for sunlight irradiance; also a linear relation was found between the absorption coefficient and the concentration of chlorophyll. Because of technical improvements it was now possible to observe spatial variations in the field of light under water; the interpretation must be sought in the dispersing characteristics of the water column.

More and more attention is being given to application of marine optics in remote sensing, for instance through the work of Landsat, Seasat and Nimbus 7. The colour of the surface of the sea, caused by differences in distribution and concentration of suspended material, is central here. Together with Rijkswaterstaat and RIN an experiment in the western Wadden Sea was prepared to correlate measurements from an aeroplane with optic measurements above the sea surface and with the composition of sea water samples. Bad weather in August made it impossible to execute these plans; next year a new attempt will be made. To gain more experience in interpreting and processing remote sensing data, a three-week course in Dundee on this subject was attended.

2.08. PHYTOPLANKTON AND PRIMARY PRODUCTION

2.08.1. Production and import of organic matter in the Wadden Sea

This year measurements of production by microphytobenthos were carried out at the reference point on the NIOZ tidal flat, and

at three points on the Balgzand. At the latter three points we cooperated with a study of oxygen consumption of benthic communities *in situ* (8.12.3). This cooperation produced (for 1979) a possible relation between a high density of *Hydrobia ulvae* and a relatively low primary production in summer, possibly a form of overgrazing? We will attempt to study this relationship more fully, perhaps profiting from comparable investigations by PACE *et al.* on *Nassarius obsoletus* in the USA where methods are concerned.

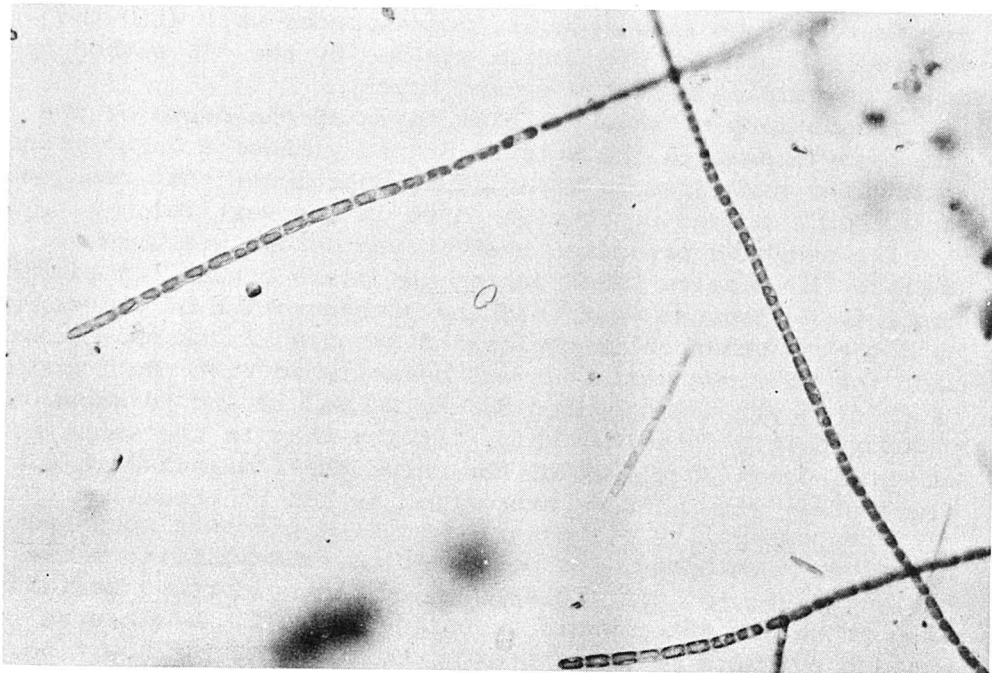
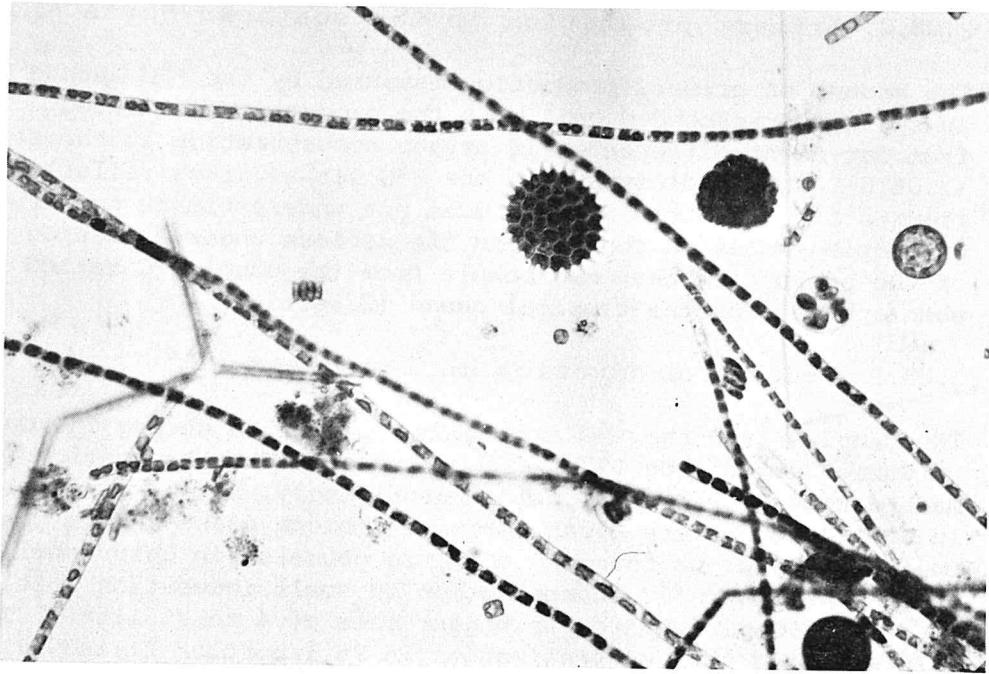
For three years, it appeared from routine sampling of the Marsdiep during high tide, that there is a peak in dissolved organic carbon (DOC) a few weeks after the phytoplankton spring peak. This is probably caused by algae mortality, and not by excretion from living algae.

The IJsselmeer appears to be an important source of DOC in the Wadden Sea: expressed per m^2 the supply is about equal in amount to the primary production *in loco* (about $120 \text{ g C} \cdot \text{m}^{-2} \cdot \text{a}^{-1}$). However, the nutrient value of this material is presumably low as it behaves conservatively during mixing with sea water in the Wadden Sea, which indicates that it is not being consumed.

It turns out that the IJsselmeer also contributes significantly to the particulate organic carbon (POC) in the Wadden Sea (about $40 \text{ g C} \cdot \text{m}^{-2} \cdot \text{a}^{-1}$): it consists for the greater part of phytoplankton which probably is suitable for consumption. On the basis of these new data the supply of POC from the North Sea must be somewhat lower than was estimated earlier (200 instead of $240 \text{ g C} \cdot \text{m}^{-2} \cdot \text{a}^{-1}$).

During the high tide measurements in the Marsdiep, samples were also collected for the Pollution Department which is investigating whether there is a relationship between the organic carbon content or amount of phytoplankton and metals or pesticides.

From the Lake IJssel a large amount of organic material is sliced into the Wadden Sea (2.08.1). Phytoplankton is an important component of the suspended organic material in the water of Lake IJssel. This phytoplankton is often found in Wadden Sea samples. This summer *Tribonema minus* (Heterokontophyta, Xanthophyceae) played an important role: in the Marsdiep amounts of more than 500 threads per ml were encountered. The top figure shows (Lake IJssel phytoplankton) *Tribonema* threads and *Pediastrum*, *Scenedesmus*, *Oocystis* and *Diatoma*; the lower figure shows *Tribonema minus* from a Marsdiep sample.



2.08.2. Primary production in the southern North Sea

The amount of primary production measured by the ^{14}C method in spring corresponded well with the production estimated from day-night differences in oxygen concentration in the sea (2.06.6). This indicates that the ^{14}C method gives reliable figures for the North Sea and does not underestimate primary production—this in contrast to the serious underestimation of the production that can result from the usual ^{14}C method when applied for the tropical ocean (2.08.3).

2.08.3. Primary production in the ocean

The samples from the ^{14}C experiments performed during the Gulf of Guinea expedition 1979 were worked out. The observations made during NECTAR 1978 could, surprisingly, not be confirmed in the richer waters along the west African coast and in the Gulf of Guinea: we found no dramatic decrease in chlorophyll, nor a much lower ^{14}C incorporation in small incubation bottles of 40 to 300 ml compared to bigger ones of 4 to 25 litres. It also appeared that mineralization in 25 l bottles filled with surface water, measured by oxygen titrations with the photometric technique (see 2.06.6), corresponded well with the figures for primary production yielded by the ^{14}C method applied to samples from the mixing layer.

Incubations of water samples taken at the depth of the chlorophyll peak in the Gulf of Guinea yielded a large production under simulated *in situ* light conditions; this resulted in a double topped production curve in the vertical.

The new high pressure fluid chromatograph was used to analyze the samples taken during the ocean cruise for pigment content. We measured not only the concentration of chlorophyll a, but also other chlorophylls and carotenoids that are important for photosynthesis. It was established that the isomere of chlorophyll a discovered during NECTAR 77 and 78 shows no photosynthetic activity, which implies that in the eastern Atlantic Ocean 30 to 70% of the chlorophyll measured in the classic way with acetone extraction is non-functional.

The possibility of measuring so many pigments opens perspectives in taxonomy, for certain pigment combinations are characteristic of certain species of phytoplankton. Besides, only these chromatographic techniques make it possible to measure products of pigment-decomposition. We can now find a reliable correlation between these derivatives and some decomposition processes in the ocean.

As a preparation for the third NECTAR expedition, to be carried out in 1982, experiments with tropical phytoplankton were conducted on Curaçao, to determine the day-night variation of the algae standing crop, and of the photosynthetically active pigments and their derivatives. The Curaçao expedition was financed partly by WOTRO and by the Napels-Roscoff commission.

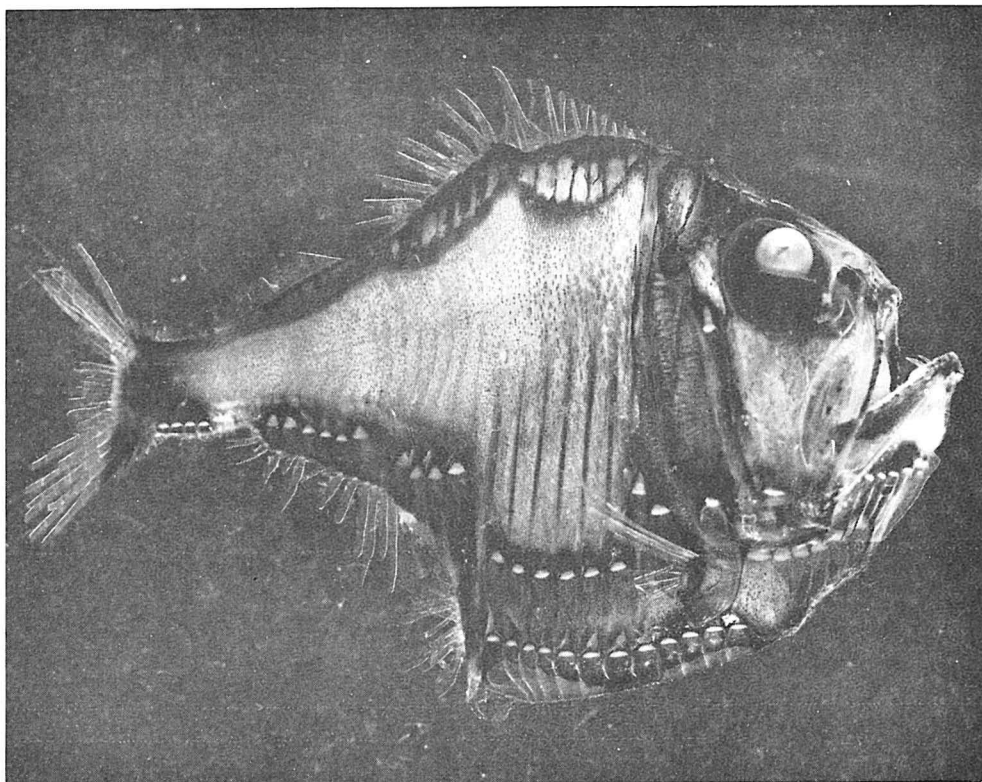
2.09. ZOOPLANKTON AND SECONDARY PRODUCTION

2.09.1. Population dynamics and production of zooplankton in the Wadden Sea and the North Sea

Estimations of density and growth of herbivorous and carnivorous zooplankton in the Dutch coastal waters of the North Sea in June and July 1979 showed the well-known high concentration of copepods inshore. We observed a clear summer-decrease of herbivores. This decrease had to be ascribed to low growth and reproduction, possibly because of lack of food. In spite of the presence of carnivores (mainly postlarvae of sprat and sardine and the scyphomeduse *Cyanea lamarckii*) the influence of predation seemed of secondary importance. The density of fish larvae and hydromeduses, the most important copepod predators in summer, was low compared to 1973 and 1977 observations probably because of the high density of *Cyanea*.

Together with the Fisheries Laboratory (Lowestoft) in February and March in the Southern Bight the plankton development in a concentration of plaice-larvae was followed. To follow the watermass floating buoys (see 2.01.1 and 2.08.2) were used. Nauplii and copepodites of *Pseudocalanus elongatus* and the tunicate *Oikopleura dioica* were most numerous and formed 80% of the biomass. The herbivore biomass increased slowly in the area under study, in spite of very slow growth and the presence of fish larvae. The latter grew daily by 1 to 6%. *Oikopleura dioica* is considered the main prey for pelagic plaice-larvae. The biomass of this small tunicate seemed too small to explain the growth of these fish larvae.

Much attention was paid to the determination of length/dry-weight relations for biomass estimation of copepod species. These were completed for *Temora longicornis*, *Acartia clausi* and *Centropages hamatus*. The tests were performed on animals from the copepod cultures (2.10.1), which originated from the Dutch coastal waters. Tests on *Pseudocalanus elongatus* are still in progress. Also, measurements on nauplii are being done, and C-contents being determined.



Argyropelecus aculeatus caught at 20°N and 23°20'W between 0 and 300 m during NECTAR-78.

The growth rates of copepods observed in experiments with and without food (2.10.1) agree with estimates of growth in the field for the same temperatures. Thus the experimental data are used to test the methods for calculating production from field observations. A calculating model was also developed to simulate the changes of copepod populations, composed of 12 stages of development.

The zooplankton samples from the Wadden Sea, gathered in 1976, 1977 and 1978 were analysed. We devised BASIC programmes to take in the counts, to store data on flexible disc, and to calculate development and production; as a result, all zooplankton data can be processed in the NIOZ computer centre.

2.09.2. Analysis of the pelagic system of the Southern Bight

Results of calculations with the model SEASIM indicate the possibility of large short term changes in phyto-, zoo- and bacterio-plankton, besides DOC and POC. The causes of phytoplankton growth limitations turn out to be insufficiently known for the coastal area of the Southern Bight. The model does not show phosphate limitation, at least not for the rich coastal zone, because this nutrient accumulates in the organic material that is formed, and is sufficiently quickly released to keep primary production going. It is caught away in locally bound biomass and organic material before it disappears via net transport and diffusion. Thus in the model the algae that are not limited by silicate escape regulation. Herbivores have in the model insufficient influence to prevent this, possibly the importance of carnivores is overestimated in this model.

2.09.3. Zooplankton research in the stratified ocean (NECTAR)

The counts on samples gathered with the planktonrecorder during NECTAR-78 were continued and this descriptive work will be completed during 1981 (for other parts of the NECTAR work see 2.04.1, 2.06.6, 2.07, and 2.08.3). A start was made on the testing of methods for determining assimilation and respiration of zooplankton in natural circumstances (as far as possible). The aim is to determine during NECTAR-82 a possible 24-hours periodicity in the activity of the most numerous copepods, correlated with the day-night variations in oxygen (2.06.6), organic material and other parameters. Possible indicators for such a rhythm are the concentrations of digestive enzymes amylase and trypsin. Measurements on deeply frozen material from the Gulf of Guinea (1979) look promising in this respect, and at the moment this technique is being tested for several North Sea species obtained by sampling a watermass and its planktonpopulation that was marked by a floating buoy (see 2.01.1). Following this, a start was made on measuring chlorophyll and chlorophyll-decomposition products in stomachs, to determine the rates of intake and digestion by herbivore copepods. A third approach to this type of investigation will consist of experiments with labelled food, both *in situ* and on deck. Finally, the results of oxygen titrations for respiration measurements of zooplankton during the Gulf of Guinea expedition, turned out to be accurate enough to use this

method in estimating the share of zooplankton in the total amount of respiration during NECTAR-82. As a preparation for this third expedition to the North Equatorial Current we will apply these techniques during the ocean programme Central North Sea-1981.

In 1978 a series of measurements of filtration efficiency of plankton nets was started, both on board the AURELIA and in laboratory experiments (at the Institute of Technology, Delft); it was completed this year. It was shown that the plankton-torpedo's used by NIOZ have ideal efficiency of 100 to 120%, no matter at what velocity or with what mesh-width used. In the past there have been conflicting reports on open and closed torpedo's, but it appears now that the efficiency of both types of high speed samplers is sufficiently high, provided the construction meets certain standards; the choice should be determined by circumstances.

2.10. ZOOPLANKTON, INTERACTIONS AND BEHAVIOUR

2.10.1. Experimental investigation on zooplankton

This project aims to investigate population dynamics and bioenergetics of important copepods from the North Sea in the laboratory, to be able to interpret the complex data yielded by sea research (2.09.1).

With this in mind, the four most important North Sea copepods *Acartia clausi*, *Temora longicornis*, *Centropages hamatus* and *Pseudocalanus elongatus* were bred from generation to generation, which yielded information on growth rate, reproduction and mortality for different levels and types of food.

The food-intake of *Temora* was also studied this year. Up till now a very old type of Coulter Counter was used. The purchase of an advanced particle counter makes study of grazing rate, and food selection of copepods really possible. The culture facilities will be extended, so that growth and survival of copepods at different combinations of temperature and food can be investigated.

2.11. BENTHOS, DISTRIBUTION AND SECONDARY PRODUCTION

2.11.1. Secondary production and population dynamics of benthos in the Wadden Sea and adjacent parts of the North Sea

More than ten years of research of tidal flats in the Wadden Sea has yielded estimations of average density, growth rate

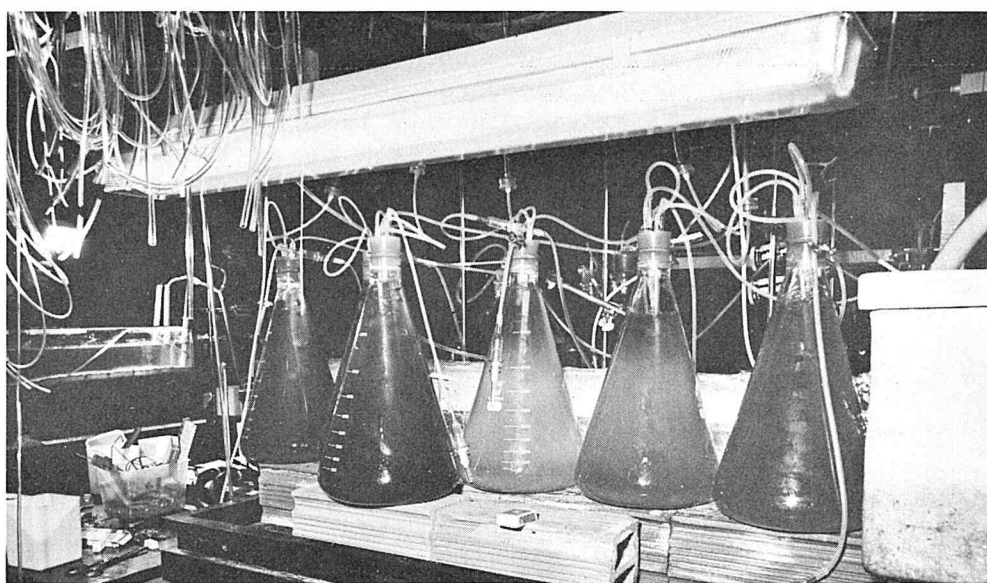
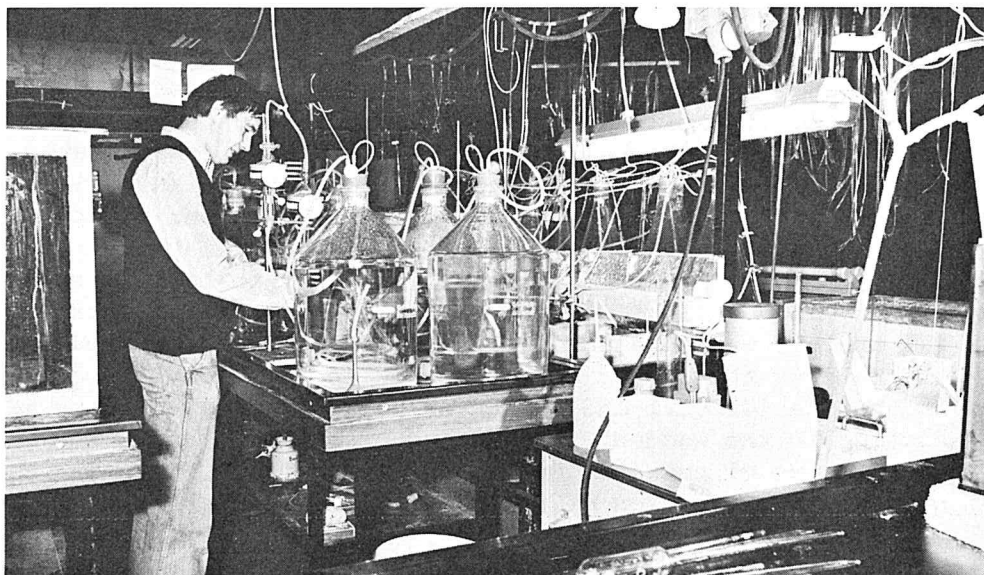
and productivity for the most important types of secondary producers, and of the variations in space and time of these quantities.

Great differences from place to place and year to year were found. Differences in production could be ascribed mainly to the highly variable success in reproduction of several important species, and partly also to different growth rates. Papers have been published on variations in biomass values (according to season, year, and place) and number of species (according to year and place); also, on the relation of these values to mild and severe winters, the composition of the sediment, and the level in the intertidal zone. This year a general article was published about these data, and a summary on the role of the larger invertebrates in the ecosystem of the Wadden Sea (4.2.1.1 and 2). An article on the shell lime production in the Wadden Sea is being prepared. A start was made on a series of publications about distribution, dynamics, growth and production of separate species of larger benthic animals.

The observation-series was continued in 1980. After the severe 1978-1979 winter the tidal flat fauna showed a lowered diversity because some species became extinct, while the biomass was reduced by about 25% through decimation of the stock of cockles. The biomass recovered very soon both by high growth rates and an extraordinarily large recruitment of several species later in 1979. Especially the cockle increased spectacularly, so that the entire biomass on the tidal flats in the summer of 1980 was larger than ever registered before (since 1968). The species richness was almost back to normal at the end of 1979. Only two winter victims were lacking, of which one returned in 1980.

2.11.2. Meiofauna

In 1980 the sampling of meiofauna was continued at one station on the Balgzand tidal flat area. This yielded the same picture as found in 1979 and 1975. The winter situation could not be studied in 1979 because of the weather, but it appeared to be the same in 1980 as in 1975. These investigations were related to studies of benthic communities *in situ* (2.12.3), that are being carried out in the same place. A publication is in preparation.



The experimental arrangements with continuous algae-cultures (*Isochrysis*), that are used to culture food for the bivalves *Macoma balthica* (2.11.3). Seawater and nutrients are filtered and led into large bottles. Under favourable circumstances, the contents of the culture bottles are replaced gradually, in two days, by the contents of the large bottles.

2.11.3. Rates of food intake and growth of *Macoma balthica* in the Wadden Sea

A better insight in the relationship between primary and secondary production can be obtained by qualitative and quantitative knowledge of food intake of secondary producers. The animal chosen for this study is the bivalve *Macoma balthica* (L.), a common element of the Wadden Sea fauna.

Field research in earlier years showed that *Macoma* feed mainly during the periods when the animals are under water. Food is mostly filtered from the water, judging by the similarity between stomach contents and suspended material. The rate of food-intake turned out to be positively correlated to the food concentration in the water, and not to the concentration at the bottom. Yet *Macoma* spent a lot of time taking in food from the bottom!

This year special attention was given to experiments in the laboratory to study the influence of food concentration and temperature on growth rates. Growth was measured for temperatures of 6, 10, 15 and 20° C, and for food-concentrations ranging from 0.2 to 12 mg C per litre. At concentrations lower than 1 mg C per litre the weight of the soft parts of *Macoma* decreased. Growth was most rapid at 10 and 15° C, and at food-concentrations of 2 to 7 mg C per litre.

Because of the ZWO subsidy (assigned via the BION work-group Aquatic Ecology) is coming to an end, the investigation will be concluded at the beginning of 1981.

2.12. EXPERIMENTAL WORK IN RELATION TO THE SECONDARY PRODUCTION OF THE BENTHOS

2.12.1. Bio-geochemical investigations in experimental tidal flat ecosystems and on the Balgzand

Of the surface samples and cores gathered on the Balgzand from March 1979 to January 1980, the organic material in the sediment was characterized. This work supported the studies of metabolism and fauna composition on the Balgzand (2.12.3), and besides, in this way the natural tidal flat could be compared with the experimental tidal flat ecosystems studied earlier.

In the samples, the organic carbon content, the amount of hydrolysable sugars, and the fingerprinting of organic compounds by means of spectrometric methods was determined. Moreover, the pigment composition in surface samples (0 to 5 mm)

was measured by means of differentiation by high pressure liquid chromatography.

The organic carbon contents were between 1 and 2% of dry weight. At a depth of 20 to 30 cm higher amounts were sometimes found, as a result of the sorting activities of the lugworm (*Arenicola marina*). The relationship of the concentrations of hydrolysable sugars and depth showed a marked resemblance to the relationship between the carbon and depth. The pyrolysis mass spectrometric data also indicated numerous fragments of sugar polymers, showing similar gradients. Moreover, the results of pyrolysis showed characteristic peaks of lignin fragments. The organic sediment material below 4 cm in the mud-flat turns out to consist mainly of fossil plant remains, consisting of finely dispersed peat. In the pyrolysis mass spectra other gradients are observable; the interpretation of these data is difficult because the processes influencing the organic material in the sediment are still insufficiently known.

The determination of the pigment composition in the surface samples showed the presence of fucoxanthin, neofucoxanthin, diatoxanthin and diadinoxanthin, compounds characteristic for diatoms. In spring and early summer often other allover chlorophylls are found than in summer and autumn. These differences are probably caused by grazing activities of *Hydroidia* and *Corophium*.

2.12.2. Energy consumption by tidal flat fauna

The purchase of a microcalorimeter made it possible to start investigations of heat production as an indication of the metabolism of small zoobenthos components.

2.12.3. Measuring oxygen consumption of benthic communities *in situ*

Because of promising results, it was decided to continue the Balgzand project (started in 1979) for half a year; in this project a great number of biotic and abiotic factors were measured. Two additional sampling stations near Amsteldiep and Malzwin were indicated, in order to facilitate conclusions about the entire Balgzand area. The results will be available in 1981.

The automation of *in situ* oxygen consumption measurements was almost finished.

In May and September metabolism measurements of benthic

communities were carried out in the central area of the North Sea. The local fauna was surveyed.

2.12.4. Experimental tidal flat systems

These investigations under controlled circumstances in two large concrete tanks with a mud-flat bottom and an artificial tidal regime, aim to the understanding of a living community and the accompanying processes over long periods. Only incidental attention could be paid to this important project.

For one of the tanks, of which the ecosystem still shows marked stability after five years, a preliminary energy budget was drawn up.

2.13. PRODUCTION AND DISTRIBUTION OF PREDATORS: MACROBENTHOS

2.13.1. Role of carnivores (tertiary producers) in the benthic system of the southern North Sea

The study on the role of benthic carnivores in the southern North Sea is being worked out. For the accessibility of the data the edition of a series of internal NIOZ reports, started in 1979, under the title "AURELIA-cruise reports on the benthic fauna of the southern North Sea" is continued.

In the laboratory a study was initiated on the consumption of swimming crabs and hermitcrabs by determining their rates of digestion at various temperatures.

New research was also started by a geographic extension of the area studied. This extension was mainly directed towards the Puzzle Hole area between 54° and 55° N and 4° and 5° E, where oceanographers will study the occurrence of a summer thermocline in 1981.

This year again attention was paid by means of underwater photography to the pending problem of the efficiency of the trawl-net that has been used for years. For this purpose two underwater camera's were borrowed from the Ocean Programme of the State Museum for Natural History in Leiden. This cooperation also entailed taxonomic help, especially on Crustacea, from Mr J.P.H.M. Adema. In the field of Polychaeta we hope to receive the help of Mr G.C.A. Duineveld, who has started this work in August, with a subsidy from the Veth Foundation to Support Wadden Research.



Migrations of various fish species between the North Sea and the Wadden-sea are studied ever since 1959 by means of passive fishing-gear like fish-traps and fykes placed in the Marsdiep tidal inlet near the Institute. The nets are emptied daily.

2.14. PRODUCTION AND DISTRIBUTION OF PREDATORS: FISH AND CRUSTACEANS

2.14.1. Annual and seasonal fluctuations of western Wadden Sea fish species

The series of observations on daily catches in fykenets near 't Horntje, started in 1959, was continued in 1980.

Special catches by fishermen delivering to the Den Helder fishmarket were booked in the NIOZ files. From this material data on some species were made available on request to Dr H. Nijssen, Institute for Taxonomic Zoology in Amsterdam.

2.14.2. Tertiary producers in the pelagic system

From 1981 onwards, in cooperation with the working-group Pelagic Systems, research on predators of the pelagic ecosystem will be concentrated on measuring the consumption of the main predators. This work will have to be carried out chiefly by experiments to measure rates of digestion, respiration and possibly heat production (the latter together with the working-group Experimental Systems, see also 2.10.1).

2.14.3. Density-dependent mortality and growth of young plaice in the Wadden Sea

As part of a study of food-intake of some bottom fauna predators in Balgzand (*e.g.* plaice, shrimp, gobies), from 1973-1979 extensive material was gathered on the presence of young plaice in the area. An analysis of the data on the youngest age class of plaice (O-group) established that the length of the animals in autumn is inversely correlated with the initial densities. This relation, found earlier in German material (RAUCK & ZIJLSTRA, 1978), suggests density-related growth. However, the differences in length from year to year appeared already by early June, at the end of the settling period, while the subsequent summer growth seemed to be entirely determined by temperature and not by lack of food. The question of possible density-related growth is then limited to the larval and settling stages. British investigations on growth during the larval stages do not indicate density dependence, so that possibly the critical stage for growth limitation in relation to density is to be found at the settling stage (April-May). A preliminary analysis of mortality in young plaice also indicates that any relation with density is mainly to be found at the settling stage. Mainly at this stage, field studies in the past showed predation and damage, chiefly by shrimp (BERGMAN *et al.*, 1976).

A ZWO subsidy via BION (population biology workgroup) in the past year enables us to make a detailed study of the causes of the decrease in numbers of young plaice both at the settling stage and after. For this purpose every week from February to the end of May, frequent pelagic fishing in the channels around the Balgzand was carried out, to obtain an estimate of the number of plaice larvae entering the area.

Besides this, the usual biweekly sampling programme was carried out from February to July on the tidal flats of Balgzand, which makes the determination of the course of number

and mortality of young plaice on the Balgzand flats possible. By a combination of data on the immigration of larvae and the sampling data on Balgzand, an estimation is attempted of the success of larval settlement on the flats.

To determine the causes of mortality among young plaice, an intensive programme was carried out from the beginning of the larval settlement in February until July. In a selected area on the Balgzand every week the channels and creeks were fished every two hours for 24 hours. The results of this programme yield a picture of the settlement, the numerical changes and the tidal movements in the course of time of young plaice, and of all other species present (*e.g.* shrimp, crab, goby).

An investigation of stomach contents will have to show which species prey on young plaice and are therefore responsible for the annual decrease in numbers.

The following year will be spent on experimental research, where we will attempt to measure predation-pressure by various predators and different prey-densities, in order to compose functional - response curves. From such data it can be concluded whether or not a predator has the capacity to act as regulator in simplified experimental circumstances. A large part of the year will have to be taken up with working out the field data of 1980.

2.14.4. Migration and food-intake of predators on tidal flats

This project, which has been directed towards the study of predation by several fish and crustacean populations on the Balgzand for the past 8 years, formed the basis for various activities during 1980. The Balgzand high water sampling was continued unaltered (as a part of 2.14.3); and together with colleagues of the Experimental Systems Department a start was made on the study of a group of carnivores that had hitherto been left out of consideration. This is a group of small organisms forming a complex of food relationships that is difficult to unravel, and operating partly as carnivores. Examples are the youngest stage of *Crangon crangon*, settling on the flats in large numbers all summer; *Corophium volutator* and the young *Nereis*; while in principle also such carnivores as bacteria-eating ciliates, turbellaria, oligochaetes and ciliate-eating harpacticoids on the tidal flats belong in this project. As the work of several foreign institutes proves, much more organic material is processed in this type of food-chain than

by the group of the macro-carnivores, because the turn-over rates are quite high. Any investigation in this direction requires a different approach from what was being used until this moment. A start was made this year, in cooperation with the Experimental Systems Department and a group of three students from Utrecht University.

2.15. EXPERIMENTAL WORK ON PREDATORS: FISHES AND CRUSTACEANS

2.15.2. The influence of abiotic factors on activity, metabolism and growth of marine animals

The results of an experiment with the Pacific mangrove shrimp *Palaemon debilis* were worked out; these experiments were carried out in November 1979 at the Steinitz Marine Biological Laboratory, Eilat, Israel. Groups of shrimp from the mangroves of the Sinai were kept at 26° C with different food regimes. The food intake of the animals was measured and correlated with their weight, while the growth in 14 days was correlated with the amount of food consumed. The food was shrimp-meat of the related Atlantic species *Palaemon elegans*, which was present (introduced) in the salt water pools near the Institute. This species was also used in the experiments for comparison. As was to be expected, the daily food intake of both shrimp species turned out to be correlated with their metabolism, that is to say the metabolic weight $w^{0.8}$. The maximum daily food intake at 26° C was $0.15 w^{0.8}$ (in mg dry-weight). If the daily weight increase (dW) and the daily food intake (dV) at the different regimes are expressed as a percentage of the shrimps' metabolic weight ($\% w^{0.8}$, all in mg dry-weight), the following linear correlation results:

$$dW (\% w^{0.8}) = 0.4 dV (\% w^{0.8}) - 5.5$$

It follows that the daily minimum ("maintenance") ration without growth (dW = 0) equals $5.5/0.4 = 13.8 (\% w^{0.8})$, while the net conversion of shrimp-meat into shrimp is 0.4, i.e. 40%. When biomass ("standing stock"), length distribution and growth (production) of the shrimp in the mangroves are known, the amount of food consumed can be calculated from a caloric value of the shrimp-meat of 4.9 cal/mg dry weight as: (standing stock × maintenance × 4.9) + (production × net conversion × 4.9). A lecture on the results of the small study was held on 3 October at the European Marine Biology Symposium (15th EMBS), Kiel (5.2).

In the laboratory, measurements were carried out on the food intake and growth of the brown shrimp, *Crangon crangon*. This investigation was conducted in the same way as that on the mangrove shrimp; but the measurements were taken at a series of constant temperatures (2, 6, 10, 14, 18, 22 and 26°C) which more or less reflect the seasonal variation of the temperature in the Wadden Sea. Thus we hope to add temperature as an important variable to the descriptive model of food intake and growth (food intake = maintenance + net conversion × growth). A report on this investigation may be expected in 1981.

2.16. EXPERIMENTAL WORK ON ADAPTATIONS TO ABIOTIC MARINE ENVIRONMENTAL FACTORS

2.16.1. Biochemical composition of shore crabs in relation to abiotic environmental circumstances

This investigation aims at throwing light on the factors determining the adaptation of animals to changing circumstances in the environment. This year attention was paid to the Nitrogen budget of shore crabs in relation to temperature and salinity.

When the shore crabs' blood is analysed it appears that the total amount of organic N depends little on temperature, but very much on the salinity of the environment: the strong increase (100%) in organic N at higher levels of salinity is not reflected in the concentration of free α -amino acids in the blood. As was already known, these last show a marked decrease at high levels of salinity. These opposite tendencies can be explained as reversible synthesis and degradation of proteins. Ammonia and nitrate concentrations in the blood appear to be independent of environmental factors: NH_4^+ is stabilised at a low level, NO_3^- , strangely enough, at a high level, far higher than the nitrate concentration in the environment. Ureum and uric acids are usually not present as excretion products, unless the ammonia concentration in the environment is high - e.g. at low salinity, when the NH_4^+ excretion increases greatly. The influence of salinity (and temperature) on ammonia excretion can be related to the role ammonia plays in preserving the alkaline reserves at hypo-osmotic circumstances.

Research on biological anti-freeze relation. The investigation of low temperature acclimation on the crystallizing

point in shrimps and crabs was concluded and the results need to be worked out.

The study of the effect of natural electro-magnetic radiation on metabolic activity (heartbeat) was not continued, for lack of positive results.

2.16.2. Vision of Odontocetes

The investigation of concentrations and numbers of ganglion cells in the retina, a fairly simple and viable method to get an impression of the visual capacity of several species, was continued on material from *Orcinus orca*, *Balaenoptera physalus* and *Inia geoffrensis*. The latter is very different from the species studied earlier, because of the immobility of the eye and the very different use the animal probably makes of it. In earlier Annual Reports the hope was expressed of carrying out measurements on the living eyes of *Inia*. This plan has been relinquished; only an anatomical description of the eye of this special type of dolphin will be provided. This description will presumably be ready before the end of 1980.

Two students from Utrecht University (A. van Esch and J. de Wolf) studied the function of cone-like elements in the retina of *Tursiops truncatus*. This training investigation, carried out in the Dolphinarium at Harderwijk in 1978 and 1979, led to a short publication (4.2.1.26).

In cooperation with others a description was written on some deviations found in our collection of eyes of marine mammals; publication will follow in 1981.

2.16.3. Influence of sulphide on the physiology of the lugworm

This investigation was rounded off during 1980. The data gathered were worked out. A second publication was written (4.2.1.38); a third is in preparation.

2.17. PRODUCTION AND DISTRIBUTION OF PREDATORS: SEABIRDS

2.17.1. Population research on seabirds

In previous years great numbers of eider ducks were ringed in the Wadden area, chiefly near Vlieland, and smaller numbers near the other islands.

Checks on the dispersion from birthplace or from chosen breeding colony, established earlier indications that female

eider ducks are very loyal to their chosen breeding ground, and that female chicks breeding for the first time mostly choose their birthplace. During the 1980 investigations 533 females (breeding birds) could be caught near Terschelling. Nine of these already wore rings. These females had all been ringed on Terschelling before, one as a chick, one as a moulting bird, the others as breeding birds. On Vlieland 232 breeding females were caught, of which 159 (68%) had been ringed before, 16 as chicks and the others as breeding birds. This remarkable loyalty to breeding ground and birthplace does not appear in the males. The 4 eiders caught with a cannon net near Schiermonnikoog were three males and one female. The males had been born in Denmark (1) and on Vlieland (2), while the one female was from Schiermonnikoog.

Although many chicks had been ringed in the 4 previous years, the number caught later as breeding bird was rather small as compared to catches of birds that had earlier been ringed as breeding birds. Possibly a number of the younger birds do not breed at first, or are not very successful. The catching method favours females that have bred successfully. The advantage of this method is its efficiency, and its very low level of disturbance to the birds.

2.17.2. Parasitical relations

No work on this subject was done in 1980.

2.17.3. Laboratory research on seabirds

No work on this subject was done in 1980.

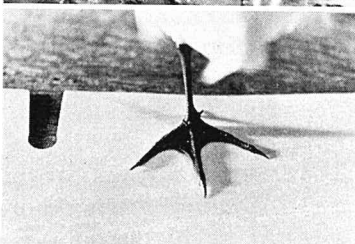
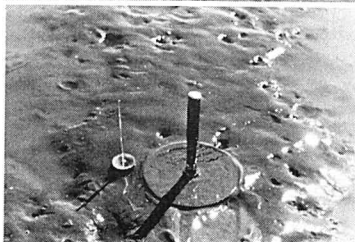
2.17.4. Relations between bottom fauna and predating tidal flat birds

Last year it was proved that in late summer, when the number of birds on the flats is greatest, there exists a clear correlation between the biomass of the bottom fauna, as present on the Balgzand in different places (2.11.1), and the biomass of predating birds there. This year we found evidence that this correlation is probably much less clear during the breeding season, when the number of foraging birds is much lower. Factors such as human disturbance of the foraging grounds and the distance to undisturbed high water resting places then appear to play a relatively more important role.

Research in the tidal area of Surinam showed similarities but also marked differences from the situation in the Wadden



Semipalmated Sandpipers (*Calidris semipalmatus*) at a high water resting place, not in the Wadden Sea, but along the tropical coast of Suriname. On the very soft "sling mud" flats there, comparative studies were carried out on the relationship between bottom fauna and their bird-predators. The resistance of the mud and the foot pressure of the birds were measured, because foot characteristics may limit the birds in their choice of foraging ground (see 2.17.4).



Sea. In the Wadden Sea the benthic biomass is mainly determined by molluscs and polychaetes, while in Surinam crustaceans and fish proved to be by far the most important components. The birds foraging on the flats were partly local breeding birds (herons and ibis), but a far greater number were waders nesting a great deal further north, just as in the Wadden Sea. The local waders evidently did not use the tidal zone as an important foraging ground. In Surinam clear indications were found that not every tidal flat species can find its food on every tidal flat, simply because the nature of part of the flats makes walking on them impossible for certain species. A preliminary study of differences in foot pressure among the species looks promising, and is a reason to study this point also among Wadden Sea birds.

2.18. POLLUTANTS: DISTRIBUTION, CHEMISTRY

A start was made with the publication of results obtained during a trip covering the entire Wadden Sea in 1976, by describing the situation in the Varde Å (Denmark) (4.2.1.13). On invitation, a summary was written of the most important results of the group in the past years (ICES).

2.18.1. Organochlorines

The methods developed by the group in the last years for obtaining very low blanks in the determination of organochlorines in solution and suspension, contributed significantly to the success of the workshop "On the intercalibration of sampling procedures of the IOC/WMO/UNEP pilot project on monitoring background levels of selected pollutants in open-ocean waters" (Bermuda, January 1980); two members of the group participated actively in this workshop. A second important factor was the application of temperature programmed (capillary) gas-chromatography, which made it possible to identify and quantify both early eluting compounds and individual polychlorinated biphenyl components. The results of these workshops came from research by the NIOZ-group Marine Pollution and the Chemistry Group of the Institute for Sea Research at Bergen (Norway).

The investigation of organochlorines in such diverse samples as open ocean water, suspended matter, coastal water, lower and higher organisms (plankton, crustaceans, fish, mammals) has convinced us that the use of packed columns for the analysis of these compounds—and especially PCB's—gives in-

sufficient insight in the different origins, transport mechanisms, sinks and biological effects. The arguments for this proposition, and the possibilities of great improvement in analysis methods by the use of capillary columns, have been published recently in cooperation with our colleagues in Norway (4.2.1.14). It is to be expected that this new approach will have considerable consequences for many laboratories and their policies. The existing GLC-apparatus (TRACOR MT 220) has been replaced by a HP 5880 A.

A great deal of time had been spent in order to make the gas-chromatography/mass-spectrometric apparatus (Finnigan) work properly. We cooperated in several intercalibration programmes: PCB's in fish oil (ICES), and dissolved organochlorines in open-ocean water (IOC/WMO/UNEP).

Much work has been done on the analysis of organisms that form the food of seals (as part of the LaSOM project). Support was given to the Delta Institute for Hydrobiological Research (Yerseke) and the seal project of the RIN (Mink research).

2.18.2. Metals

In the beginning of the year we took part in a cruise with the RV TYRO, during which samples were taken in the northern North Sea, the Norwegian Channel, the Southern Bight and the Channel, to determine metals and tracemetals in solution and suspension, suspended organic carbon and oxygen in solution. Dissolved concentrations of some metals were measured on board with electrochemical techniques.

The analysis was completed of a sample series from the Marsdiep, to determine contents of metals in solution and suspension, and suspended organic carbon. This study was carried out parallel to plankton studies (2.08.1). Thus we hope to find out what role plankton plays in the variations of dissolved metal concentrations.

We cooperated in an IOC/WMO/UNEP intercalibration programme in which samples of Sargasso Sea water, obtained in different ways, were tested by a great number of laboratories. The higher values found in coastal waters, and the lower values we found in the central part of the Southern Bight receive extra significance in the light of the results of the open ocean samples.

A new Atomic Absorption Spectrometer (Perkin Elmer 5000) with a micro-processor-controlled graphite oven could be purchased from a liberal contribution by the Ministry of Public Health and Environment, as part of the project "Accumulation

of contaminants in the Wadden Sea". The first results are promising.

For this project a number of trips were made. Measurements were taken in the tidal channels and in the more inward parts of the western Wadden Sea. The series of measurements during complete tidal cycles are meant to contribute to the formulation of balances in the Wadden Sea. The role of organic matter in binding dissolved trace metals was investigated by studying organic matter extracted from sediment: fulvic acids proved to be more important for short term binding of copper than humic acid (a publication on this subject is forthcoming).

2.19. POLLUTANTS: BIOLOGICAL EFFECTS

2.19.1. Sublethal effects of chemicals on marine organisms

The investigation of the effects of sublethal concentrations of heavy metals on the respiration of a number of tidal flat animals was continued. After earlier tests with copper and zinc, the effects of cadmium on the oxygen-binding capacity of the haemoglobin of *Arenicola marina* were determined. Provisional results indicate the Cd causes a small decrease in oxygen-affinity, compared to copper and zinc. The affinity increases slightly at a concentration increasing from 10^{-8} to $0.5 \cdot 10^{-3}$ M CdCl_2 . At concentrations higher than 10^{-3} M denaturation and oxidation of the blood pigment occurs.

The kidneys of eider ducks (*Somateria mollissima*) were analysed, as part of the experimental study of the effects of separate PCB-components on some haematological parameters, organ weight, and the measure of infection with *Polymorphus botulis*, a parasite specific for eider ducks. The results have been worked out, while it must be mentioned that the gas-chromatographic analysis of PCB-components will be repeated according to the improved method as described under 2.18.1.

A 70 day experiment has been carried out with the arrangement of continuous flow and dosage systems. During the experiment the behaviour was followed of a pollutant (here CuSO_4), added in certain doses to aquariums containing sediment. It appears that from the moment the pollutant was administered, the concentration of Cu^{2+} in the water shows a more or less linear increase to a certain level, lower than the theoretic concentration. A certain fraction of the added ionogenic copper disappears from the water, mainly to the sediment. It may be

bound by organic material. There are indications that this fraction is about the same for systems dosed with 5, 15 and 30 $\mu\text{g}\cdot\text{l}^{-1}$ CuSO_4 . The intake of copper by young plaice and its effects on growth were also watched. The results are being worked out. It seems that the copper (and also zinc) chiefly end up in the digestive tract. Growth is retarded by copper.

The continuous flow-dosage system was fitted with apparatus for daily checks on the concentrations of heavy metals (Cu, Zn, Cd, Pb), by anodic stripping voltammetry.

2.20. BIOLOGICAL RESEARCH EEMS-DOLLARD ESTUARY (BOEDE)

BOEDE has stopped publishing annual reports, which have been replaced by quarterly publications. These are not included in this annual report.

However, lists of Internal Reports, publications and personnel are included here.

2.30. RESEARCH OF THE STATE INSTITUTE FOR NATURE MANAGEMENT (RIN) - TEXEL STATION

The Texel Station of this Institute is situated next to the NIOZ buildings, in the polder 't Horntje. The Station houses the RIN staff doing research on behalf of nature management in the Dutch coastal waters. The following paragraphs also serve to express the cooperation between NIOZ and RIN-Station.

2.30.1. Wadden Sea "White Book"

As a part of the COBW project again two reports were printed, while for the remaining six reports most of the contributions have been sent in. All compilation projects have been completed, and only editorial work remains to be done.

2.30.2. Transport of dissolved material and particles between a salt marsh and the Dollard

To gain insight in the balance of material of salt marshes and the role of salt marshes in the balance of material of the coastal waters, we carried out measurements and sampling in the drainage and supply channel of a salt marsh in the Dollard during one year. Very valuable measurements were made during a gale that raised the water level by about 1.50 m. The results are being processed.

2.30.3. Accuracy of bird counts in the Wadden Sea area

Some additional data were gathered to check how mistakes in bird counts may have consequences for the final results of counts in large areas.

2.30.4. Wadden Sea charting

The charting of the main Wadden Sea habitats cannot yet be concluded.

2.30.5. Study of the causes of decrease in seal numbers in the Wadden Sea

Field research on the decrease of the Dutch seal population led to a thesis (4.2.3.9). On the basis of the results described there, further studies will be carried out along two lines. One is an ethological field study that attempts to find out if and how survival of young seals is influenced by human disturbance. The other line includes experimental research of the influence of PCB's and possibly other toxic components of the food of seals on their reproduction. In this experiment, several groups of mink—fish-eating mammals with a reproductive cycle resembling that of the seal—are fed fish from the Wadden Sea, fish from the North Sea and food with different concentrations of PCB's. It is expected that the consumption of Wadden Sea fish and PCB's will lead to a decreasing reproduction as compared to the animals that get the cleaner North Sea fish. Simultaneously, an experiment was started with two groups of seals, where one is fed with Wadden Sea fish and the other with fish from cleaner locations. Again we expect the Wadden Sea fish to cause decreasing reproduction. One way of checking the course of the reproductive cycle is by determining the level of sexual hormones in the blood of the animals. The 30 animals needed for this experiment were chiefly obtained on two expeditions to the Wash Bay on the east coast of England.

To prepare for this experimental study, an investigation was made of the amount of toxic material to which Wadden Sea fish are subjected, together with NIOZ (Department of Marine Pollution) and RIVO. This investigation was supported by LaSOM. The results are still being worked out.

2.30.6. Effects of cockle fishing

To quantify the effects of cockle fishing in the Dutch coastal waters on bottom fauna and thus on the food supply of birds and fish, fished and non-fished areas in the Wadden Sea and Oosterschelde were repeatedly checked. Also, the direct effects of different methods of fishing on the bottom fauna were investigated. Finally, an accurate estimate of the percentage of bottom fauna in the Wadden Sea that disappears as a consequence of cockle fishing was attempted. The fieldwork was concluded in 1980.

2.30.7. Literature study on the effects of oil pollution

To be optimally prepared for any possible oil catastrophe in the Wadden Sea or Delta area, a large literature study was started to discover more about the effects of oil pollution in estuarine areas. We aimed at acquiring a solid base for advice on the application of certain pollution combating methods, from the point of view of nature management. However, there appear to be no simple answers to this problem, which would indicate the necessity of further research. A proposal for investigation of this problem by means of artificial tidal flat ecosystems ("flat-tanks") has been formulated in cooperation with NIOZ (Department of Experimental Systems), TNO, Rijkswaterstaat and Shell Research, and has been submitted for subsidy to several bodies.

2.30.8. Report on delivery of LNG to the Eems Harbour

Together with BOEDE a report was written on the expected ecological effects of delivering LNG at the Eems Harbour (4.2.2.3). Information from NIOZ was included.

2.30.9. Study of the effects of disturbance on wading birds

In consultation with NIOZ (Department of Benthic Systems) and the Zoological Laboratory of Groningen University plans were made for investigating the long-term effects of disturbance on wading birds. Besides the direct effects (flying away, discontinuing feeding) frequent disturbance might lead to lower reproduction or less successful survival. An attempt will be made to unravel this for at least one type of bird.

Also, the direct effects of military jet manoeuvres near Ter-schelling were studied.

2.30.10. Recolonization after sand-suppletion on beaches

A modest research programme was started to follow the effects of sand-suppletion at beaches on the Wadden island Texel.

2.30.11. Inventory and description of European saline vegetations

A request from the European Council made at the end of 1980, to compile a review of saline vegetations in Europe, was accepted.

3. INCIDENTAL RESEARCH

3.1. RESEARCH BY GUESTS

Mr S. Balian (UNESCO) received training in the analysis of metals and organochlorines.

Dr G. Hallegraeff (CSIRO, Cronulla, Australia) compared the chromatographic methods for the differentiation of algal pigments that he and his colleagues used, with high pressure fluid chromatography techniques (25-30 August).

L. de Groot worked for a year on organochlorine compounds and heavy metals in the food chain of the seals from the Dutch/German/Danish Wadden area, as part of the LaSOM seal project (RIN).

S. Lamade (Kernforschung Geesthacht, W-Germany) tried our methods for measuring algal pigments (thin layer, paper, and high pressure fluid chromatography) on her own samples (21-31 January).

Dr C.G.N. de Vooy was enabled by the Roscoff Commission of the Dutch Royal Academy of Sciences to do research at the Station Biologique (Arcachon), for 2½ months (15 October-7 January). This study involved a comparison of the anaerobic metabolism of *Mytilus edulis* and *Mytilus galloprovincialis*, which are both present in the tidal zone there. The investigation will be aimed at the question whether the differences, found in 1978 studies in Naples, must be accounted for by differences between the species, or by environmental factors (*Mytilus galloprovincialis* is sublittoral in the Mediterranean).

Yu Guo-Hui (UNESCO) is being trained in modern techniques for pollution research, at the Department of Marine Pollution.

3.2. PARTICIPATION IN NATIONAL AND INTERNATIONAL PROGRAMMES

3.2.1. On invitation of the Umeå Universitet, B.R. Kuipers worked at the Zoological Ecology Department of the University in northern Sweden from 1 May to 1 September. The aim of this visit was to explain, through lectures and continual discussions, what the Netherlands, and especially NIOZ, does in the area of marine and biological research; this might help answer the question: how can we start a modern, coordinated ecosystem research programme in the enormous brackish water system of the Botnic Gulf, in which scientists from several branches of science would be interested.

Furthermore, together with the group led by Prof. K.

Müller, comparative investigations were carried out in a small estuary and in several bays, where sediment composition, organic material contents, macrobenthos composition and biomass, chlorophyll contents, *in situ* oxygen consumption in the bottom, and ETS activity were measured, to discover more about the influence of a small river on the coastal area. The results of these investigations are being processed.

3.2.2. The ICES-group for the evaluation of methods for the estimation of primary production visited NIOZ from 23-27 June. The participants in the group came from 11 different countries. A report on the subjects discussed was presented during the autumn consultations of ICES in Copenhagen.

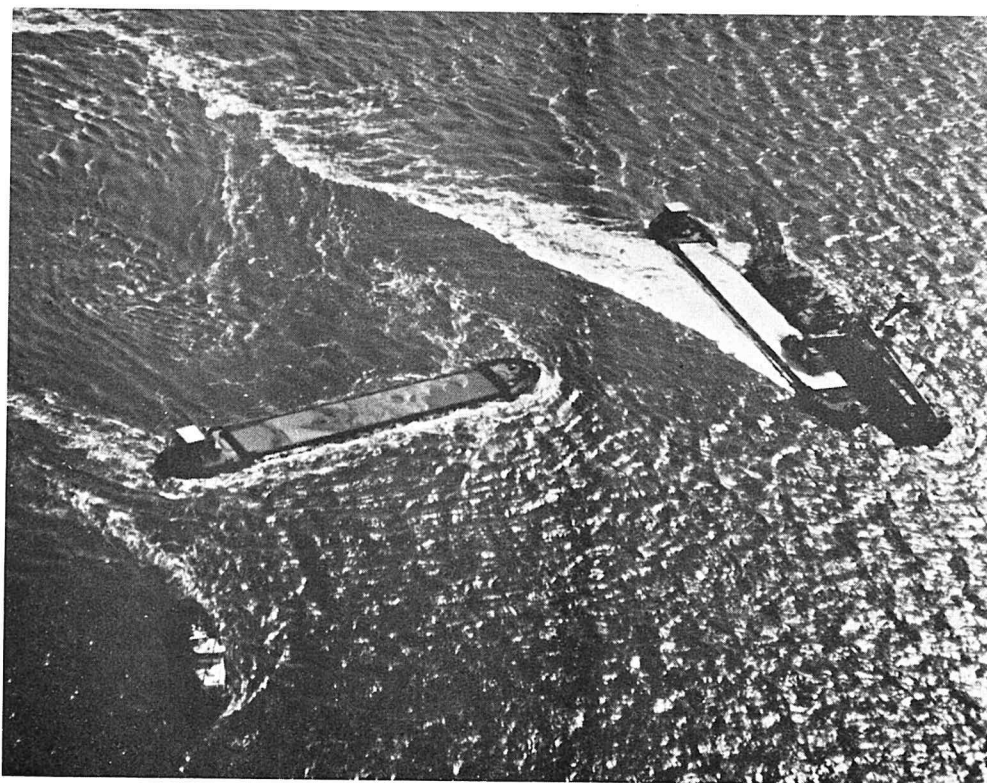
3.2.3. Paid by the Common Market, the NIOZ was represented in The Hague at consultations on the OCZ-experiment for Remote Sensing, especially to explain the presentation of the results of a large intercalibration for measuring chlorophyll that had been organized by the Joint Research Center of the Common Market at Ispra (Italy).

3.2.4. At the expense of "Sonderforschungsbereich 95" NIOZ participated in discussions on the measuring of primary production and algal pigments in the sea, as a part of the running investigations of this "Sonderforschungsbereich".

3.2.5. In July, in Plön (W-Germany) for the second time an international consultation was held on measuring algal pigments.

3.2.6. In October, partly at the expense of NATO, NIOZ participated in a "Summerschool" on the subject "Photosynthesis of marine algae". The two-week meeting was held on the island of Lipari near Sicily. The meeting had been arranged to exchange the newest data on the ecological physiology of the photosynthetic process with colleagues from all over the world.

3.2.7. In spring NIOZ cooperated with Fisheries Laboratory (Lowestoft) and the Royal Dutch Meteorological Institute (De Bilt) in a study on the development and distribution of plaice eggs and larvae in the Southern Bight. This was originally an ICES programme. With floating buoys the Lagrange current pattern was studied (2.01.2); oxygen production and consumption were followed (2.06.3), as was primary production (2.08.2) and zooplankton development (2.09.1).



Sand dredgers in the Wadden Sea. Under auspices of NIOZ, the effects of this activity on life in this marine area were studied during previous years.

3.2.8. In January on Bermuda a group participated in the workshop "On the intercalibration of sampling procedures of the IOC/WMO/UNEP pilot project on monitoring background levels of selected pollutants in open-ocean waters". The group contributed to the final recommendations for a PCB determining method in ocean water, and to the success of the intercalibration of methods and techniques for the determination of metals in solution (see also 2.18.1).

3.2.9. As part of the preparations for SCOR/IABO Group 65 (Coastal - Offshore Ecosystems) the extent of the group's work was indicated, and correspondence was carried on with aspiring members. A meeting of the group has been organized for September 1981, in Arcachon (France).

3.2.10. In preparation of the ICES/SCOR/FAO Symposium on the

"Productivity of continental seas in the northern Atlantic", to be held in March 1982 in Kiel (W-Germany), there were consultations in Kopenhagen with the organizing committee, and invited speakers were approached.

3.2.11. Preparations were made for the European Marine Biological Symposium, to be held on Texel from 14-18 September 1981, on the subject of "Dynamic Aspects of Marine Ecosystems".

3.3. RESEARCH FOR OTHERS

3.3.1. Since the OPEX-project (Oil Pollution Experiment) has been made possible by Common Market financing, a start will be made on this project in 1981 as a cooperative effort of NIOZ, RIZA, MT-TNO, and Shell Research.

3.3.2. Together with the fish-culture Department of the Agricultural University (Wageningen), investigations were started on the consumption of artificial food by juvenile sole (*Solea solea*). Industrial interests are concerned in this study.

3.3.3. The Department of Marine Pollution started research on the accumulation of contaminants in the Wadden Sea in 1979. The Ministry of Public Health and the Environment has arranged the financing of a scientist and necessary technical equipment. The supervisory committee met twice in 1980 (president is Ir H. van 't Sant).

3.4. ADVICES ISSUED

- Advice to the National Science Foundation, USA, on American research on the vision and brains of Odontocetes.
- Advice to Delta Marine Consultants B.V. about an OTEC project on Curaçao.
- Advice to the Joint Monitoring Group on the desirability and possibility of an investigation of PCB in seawater (2.18.1).

4. PUBLICATION

4.1. NIOZ PUBLICATIONS

4.1.1. Netherlands Journal of Sea Research

The Neth. J. Sea Res. is published by NIOZ and takes articles from Dutch and foreign institutes working in sea research. Since 1973 one volume a year has appeared, consisting of 4 numbers. During recent years there has been a delay of about six months in publication.

The numbers of volume 14 are dated September (122 pages), October (106 p.) and December (combined numbers 3 and 4, 144 p.). Volume 14 contains 24 articles, of which 8 come from NIOZ, 1 from NIOZ together with foreign colleagues, 3 from the Delta Institute, 1 from the RIVO, 4 from BOEDE, 2 from Chemical Animal Physiology Utrecht, and 5 from foreign institutes.

If classified according to subject matter, the articles can be described as follows: 4 articles on taxonomy and distribution (animals and bacteria), 5 on production biology and predation, 2 on migration, 2 on animal physiology, 4 on the effects of toxic matters, 5 on behaviour of chemicals and particulate material, and 1 article on methods.

In 1980 26 manuscripts were presented (in 1979, corrected number: 33), to which must be added 10 remaining from 1979 (20). Of these 36 manuscripts 24 were included in the Journal in 1980 (36 in 1979), none (1) was promised publication, 1 (10) were kept for further consideration, and 11 (6) were refused or taken back by the author.

One article, combined with others previously published, also appeared as a dissertation (4.2.3.9).

4.1.2. Netherlands Institute for Sea Research Publication Series

This series appears as a supplement to the Journal, has the same editors, and will appear as needed, therefore irregularly. The numbers are produced in offset by the NIOZ Reprographic Department. In 1980 no. 5 appeared, this Annual Report 1980.

4.1.3. Internal Reports NIOZ

These report on results achieved in studies carried out at the Institute; they are for internal use and are not considered publications. See 4.3. for reports written in 1980.

4.2. PUBLICATIONS 1980

4.2.1. Publications NIOZ 1980

These appeared in 1980 unless specified otherwise (1979 or 1981). Each publication is entered only once (under number) in an Annual Report. At the end some unnumbered publications from 1979 are added, to correct or complete bibliographic data.

1. BEUKEMA, J.J. Quantitative data on the benthic communities of the Wadden Sea proper. In: N. DANKERS, H. KÜHL & W.J. WOLFF. Invertebrates of the Wadden Sea. Balkema, Rotterdam.
2. ———. The role of the larger invertebrates in the Wadden Sea ecosystem. In: N. DANKERS, H. KÜHL & W.J. WOLFF. Invertebrates of the Wadden Sea. Balkema, Rotterdam.
3. BOON, J.J., W.R. DE BOER, F.J. KRUYSEN & J.T.M. WOUTERS (1981). Pyrolysis mass spectrometry of whole cells, cell walls and isolated cell wall polymers of *Bacillus subtilis* var. *niger* W.M.—J. gen. Microbiol. 22: 119-127.
4. BOON, J.J., W.I.C. RIJPSTRA, J.W. DE LEEUW & A.L. BURLINGAME. The occurrence of triglycerides in Namibian Shelf diatomaceous ooze.—Geochim. cosmochim. Acta 44: 131-134.
5. CADÉE, G.C. Subjects: "Diatomeeën", "Andere eencellige planten in zee", "Mosdiertjes". Spectrum Natuur Encyclopedie IX.
6. CREUTZBERG, F. & F. VAN LEEUWEN. The life cycle of *Crago allmanni* Kinnahan in the southern North Sea. ICES, CM 1980/L 71.
7. DRAL, A.D.G. A magnetic sense organ in dolphins?—Aq. Mammals 8 (1): 1.
8. DUINKER, J.C. On the analysis of polychlorinated biphenyls (PCB) in seawater. 5th Meeting of the joint monitoring group of the Oslo and Paris Commissions, Edinburgh.
9. ———. Partition of Fe, Mn, Al, K, Mg, Cu and Zn between particulate organic matter and minerals, and its dependence on total concentrations of suspended matter. Proc. Int. meeting on holocene marine sedimentation in the North Sea basin. Int. Ass. Sedimentologists Special Publ. 5.

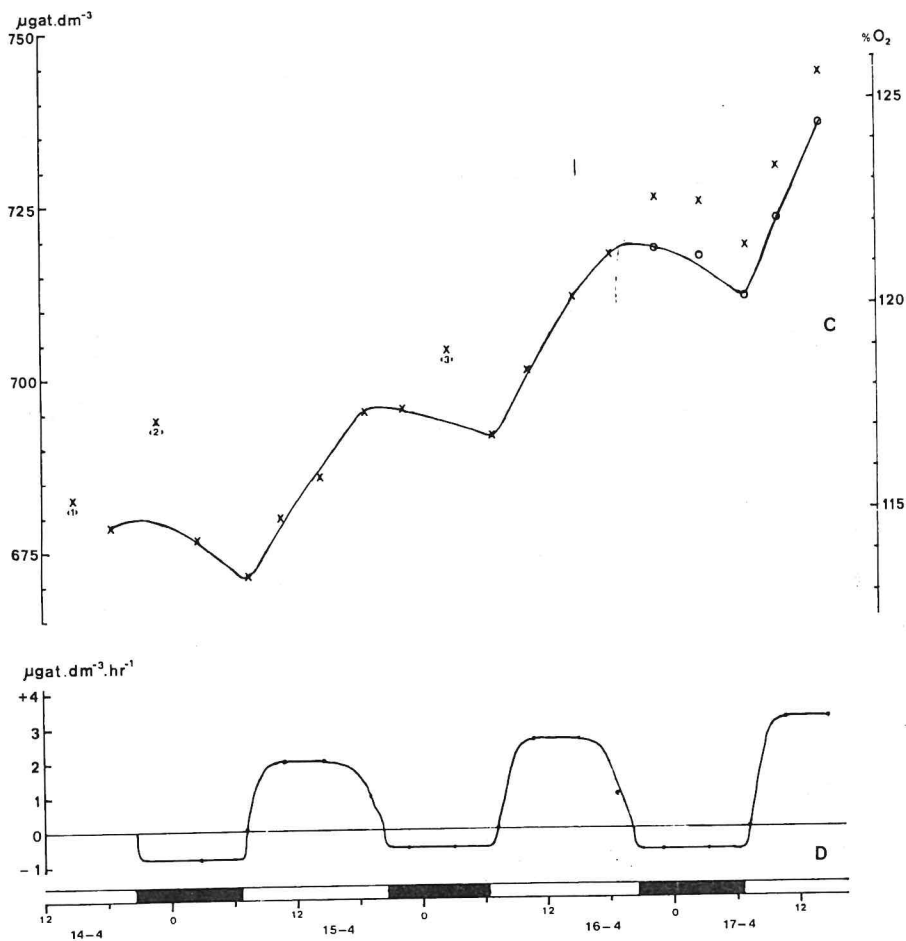
10. ———. Subject: "Zeeverontreiniging". Spectrum Natuur Encyclopedie.
11. ———. Processes affecting the behaviour of contaminants (metals and organochlorines) during estuarine mixing and in coastal areas, with particular reference to the southern North Sea. ICES invited paper for mini-symposium Statutory Meeting, 1980/E 34: 1-48.
12. ———. Suspended matter in estuaries: Adsorption and desorption processes. In: E. OLAUSSON & I. CATO. Chemistry and biogeochemistry of estuaries. J. Wiley & Sons Ltd.: 121-151.
13. DUINKER, J.C., M.T.J. HILLEBRAND, R.F. NOLTING, S. WELLERSHAUS & N. KINGO JACOBSEN. The river Varde Å: processes affecting the behaviour of metals and organochlorines during estuarine mixing.—Neth. J. Sea Res. 14 (3/4): 237-267.
14. DUINKER, J.C., M.T.J. HILLEBRAND, K.H. PALMORK & S. WILHELMSEN. A discussion on the value of the estimation of polychlorinated biphenyls (PCB's) in environmental samples from packed column gas-liquid chromatographic data. ICES 1980/E 35: 1-9 (mimeo).
15. ———. An evaluation of existing methods for quantitation of polychlorinated biphenyls (PCB's) in environmental samples and suggestions for an improved method based on measurement of individual components.—Bull. env. contam. Toxicol. (U.S.) 25: 956-964.
16. DUINKER, J.C., R.F. NOLTING & H.A. VAN DER SLOOT (1979). The determination of suspended metals in coastal waters by different sampling and processing techniques (filtration, centrifugation).—Neth. J. Sea Res. 13 (2): 282-297.
17. DUINKER, J.C., R. WOLLAST & G. BILLEN (1979). Behaviour of manganese in the Rhine and Scheldt estuaries. II. Geochemical cycling.—Estuar. coast. mar. Sci. 9: 727-738.
18. EISMA, D. Supply and deposition of suspended matter in the North Sea. Int. Ass. Sedimentologists Special Publ. 5.
19. ———. The mass-balance of suspended matter and associated pollutants in the North Sea. ICES.
20. ———. The North Sea: a summary. Proc. Seminar The North Sea and its environment; uses and conflicts. Amsterdam.
21. ———. Natural forces. In: K.S. DIJKEMA, H.-E. REINECK & W.J. WOLFF. Geomorphology of the Wadden Sea area.

- Balkema, Rotterdam: 20-31.
22. EISMA, D., J. KALF & M. VEENHUIS. The formation of small particles and aggregates in the Rhine estuary.—Neth. J. Sea Res. 14 (2): 172-191.
 23. EISMA, D., W.G. MOOK & C. LABAN. An early-Holocene tidal flat in the Southern Bight. Int. Ass. Sedimentologists Special Publ. 5.
 24. EISMA, D. & W.J. WOLFF. The development of the westernmost part of the Wadden Sea in historical time. In: K.S. DIJKEMA, H.-E. REINECK & W.J. WOLFF. Geomorphology of the Wadden Sea area. Balkema, Rotterdam: 95-102.
 25. EVERAARTS, J.M. Subject: "Biologische effecten van de zeeverontreiniging". Spectrum Natuur Encyclopedie.
 26. ESCH, A. & J. DE WOLF. Evidence for cone function in the dolphin retina.—Aq. Mammals 7 (2): 35-36.
 27. FARKE, H., P.A.W.J. DE WILDE & E.M. BERGHUIS (1979). Distribution of juvenile and adult *Arenicola marina* on a tidal mud flat and the importance of nearshore areas for recruitment.—Neth. J. Sea Res. 13 (3/4): 354-361.
 28. FRANSZ, H.G. Computation of secondary production of *Calanus finmarchicus* using a multiple regression method. Proceedings of the final ICES/JONSIS Workshop on JONSDAP '76. ICES C.M. 1980/C 3: 99-109.
 29. ———. Zooplankton development in a patch of juvenile plaice during 26 February - 18 March 1980 in the Southern Bight of the North Sea. ICES C.M. 1980/L 72: 1-10.
 30. ———. Carbon dynamics in the food web of the south-eastern North Sea; a simulation study. In: State-of-the-art in ecological modelling II. Proc. of the ISEM Conference on Ecological Modelling, Liège, Belgium, April 18-24.
 31. ———. Zooplankton species of the Wadden Sea. In: N. DANKERS, H. KÜHL & W.J. WOLFF. Invertebrates of the Wadden Sea. Balkema, Rotterdam.
 32. ———. The copepod *Temora longicornis* (O.F. Müller). In: N. DANKERS, H. KÜHL & W.J. WOLFF. Invertebrates of the Wadden Sea. Balkema, Rotterdam.
 33. ———. Quantitative data on plankton communities of the Wadden Sea proper. In: N. DANKERS, H. KÜHL & W.J. WOLFF. Invertebrates of the Wadden Sea. Balkema, Rotterdam.

34. FRANSZ, H.G. & W.G. VAN ARKEL. Zooplankton activity during and after the phytoplankton spring bloom at the central station in the FLEX box, northern North Sea, with special reference to the calanoid copepod *Calanus finmarchicus* (Gunn.).—"Meteor" Forsch. Ergebn. A22: 113-121.
35. GIESKES, W.W.C. & G.W. KRAAY. Primary productivity and phytoplankton pigment measurements in the northern North Sea during FLEX-76.—"Meteor" Forsch. Ergebn. A22: 105-112.
36. GIRESSE, P., J.H.F. JANSEN, G. KOUYOUMONTZAKIS & G. MOGUEDET. Les fonds de la plateforme congolaise, le delta sous-marin du fleuve Congo. Bilan de huit ans de recherches sédimentologiques, géochimiques et géophysiques. O.R.S.T.O.M., Paris.
37. GROENENDAAL, M. (1979). On sulphide and the distribution of *Arenicola marina* in a tidal mud flat in the Dutch Wadden Sea.—Neth. J. Sea Res. 13 (3/4): 562-570.
38. ———. The tolerance of the lugworm (*Arenicola marina*) to sulphide.—Neth. J. Sea Res. 14 (2): 200-207.
39. JANSEN, J.H.F. Holocene deposits in the northern North Sea: evidence for dynamic control of their mineral and chemical composition?—a comment.—Geologie Mijnb. 59 (2): 179-180.
40. JANSEN, J.H.F. & A.M. HENSEY. Interglacial and Holocene sedimentation in the northern North Sea: an example of Eemian deposits in the Tartan Field. Int. Ass. Sedimentologists Special Publ. 5.
41. KLEIN BRETELER, W.C.M. Continuous breeding of marine pelagic copepods in the presence of heterotrophic dinoflagellates.—Mar. Ecol. Progr. Ser. 2: 229-233.
42. OTTO, L. & D. EISMA. Questions regarding the assessment of the fluxes of suspended matter in the sea. ICES C.M. 1980/C 37: 1-3.
43. POSTMA, H. Is de zee blauwer in de morgen?—Versl. gewone Vergad. Afd. Natuurk. K. ned. Akad. Wet. 89 (5): 53-60.
44. ———. Sediment transport and sedimentation. In: E. OLAUSON & I. CATO. Chemistry and biogeochemistry of estuaries. J. Wiley & Sons Ltd.: 153-186.
45. RUTGERS VAN DER LOEFF, M.M. Time variations in interstitial nutrient concentrations at an exposed subtidal station in the Dutch Wadden Sea.—Neth. J. Sea Res. 14 (2): 123-143.

46. ———. Nutrients in the interstitial waters of the Southern Bight of the North Sea.—Neth. J. Sea Res. 14 (2): 144-171.
47. SPAARGAREN, D.H. Hydrodynamic properties of benthic marine Crustacea: I. Specific gravity and drag coefficients.—Mar. Ecol. Progr. Ser. 2: 351-359.
48. ———. Hydrodynamic properties of benthic marine Crustacea: II. Energy requirements for maintaining vertical position.—Mar. Ecol. Progr. Ser. 2: 153-156.
49. ———. The significance of seawater viscosity for the tidal transport of common shrimps, *Crangon crangon* (L.).—Ophelia 19 (2): 145-153.
50. SPITZER, D. Efficiency of primary production in the upper layer of the euphotic zone of the tropical North Atlantic. Comparison of different methods.—Neth. J. Sea Res. 14 (2): 220-228.
51. SWENNEN, C. Effecten van olieverontreiniging op zeevogels. In: C. DEN HARTOG. Olieverontreiniging op zee. Lab. voor Aquatische Oecologie, Nijmegen: 54-64.
52. ———. Articles: Bergeend, Eidereend, Middelste Zaagbek, Grote Zaagbek, Toppereend en Scholekster. In: R.M. TEIXEIRA. Atlas van de Nederlandse broedvogels. Deventer: 82-85, 132-133, 399.
53. ———. Eidereenden in Nederland. De Lepelaar 66: 14-16.
54. SWENNEN, C., P. DUIVEN & L.A.F. REYRINK. Notes on the sex ratio in the common eider *Somateria mollissima* (L.).—Ardea 67: 54-61.
55. TIJJSSEN, S.B. & A. EIJGENRAAM. Diurnal oxygen rhythm in the Southern Bight of the North Sea: net and gross primary production in April 1980 in a *Phaeocystis* bloom. ICES C.M. 1980/C 17.
56. VETH, C. A laser-doppler velocimeter for small turbulence studies in the sea. In: J.C.J. NIHOUL. Marine turbulence. Elsevier, Amsterdam: 303-317.
57. VOOYS, C.G.N. DE. Anaerobic metabolism in sublittoral living *Mytilus galloprovincialis* in the Mediterranean. II. Partial adaptation of pyruvate kinase and phosphoenolpyruvate carboxykinase.—Comp. Biochem. Physiol. 65B: 513-518.
58. WEERING, T.C.E. VAN. Recent sediments and sediment transport in the northern North Sea. Part 1. Surface sediments of the Skagerrak. Int. Ass. Sedimentologists Special Publ. 5.
59. ZIMMERMAN, J.T.F. Vorticity transfer by tidal currents over an irregular topography.—J. mar. Res. 38 (4): 601-630.

60. WOLFF, W.J. & J.J. ZIJLSTRA. Management of the Wadden Sea.
—Helgoländer wiss. Meeresunters. 33: 596-613.



Day/night rhythm of oxygen contents in the Southern Bight of the North Sea; 72-hour measuring series, from 14-17 April during a *Phaeocystis* bloom which clearly shows the effect of primary production. The top curve indicates the concentrations measured, the lower curve shows the velocity of change (cf. 2.06.3 and 4.2.1.55).

Here follow publications from the 1979 Annual Report, for correction or completion of bibliographical data.

- BAUMFALK, Y.A. On the pumping activity of *Arenicola marina*.
—Neth. J. Sea Res. 13 (3/4): 422-427.
- . Heterogeneous grain size distribution in tidal flat sediment caused by bioturbation activity of *Arenicola marina* (Polychaeta).—Neth. J. Sea Res. 13 (3/4): 428-440.
- BOON, J.J. & J. HAVERKAMP. Pyrolysis mass spectrometry of a benthic marine ecosystem—the influence of *Arenicola marina* on the organic matter cycle.—Neth. J. Sea Res. 13 (3/4): 457-478.
- CADÉE, G.C. & J. HEGEMAN. Phytoplankton primary production, chlorophyll and composition in an inlet of the western Wadden Sea (Marsdiep).—Neth. J. Sea Res. 13 (2): 224-241.
- FARKE, H. & E.M. BERGHUIS. Spawning, larval development and migration behaviour of *Arenicola marina* in the laboratory.—Neth. J. Sea Res. 13 (3/4): 512-528.
- . Spawning, larval development and migration of *Arenicola marina* under field conditions in the western Wadden Sea.—Neth. J. Sea Res. 13 (3/4): 529-535.
- KRAMER, C.J.M. Degradation by sunlight of dissolved fluorescing substances in the upper layers of the eastern Atlantic Ocean.—Neth. J. Sea Res. 13 (2): 325-329.
- SPAARGAREN, D.H. & R.E. WEBER. Osmotic responses in the coelomic fluid of *Arenicola marina* subjected to salinity change.—Neth. J. Sea Res. 13 (3/4): 547-561.
- VLAS, J. DE. Secondary production by tail regeneration in a tidal flat population of lugworms (*Arenicola marina*), cropped by flatfish.—Neth. J. Sea Res. 13 (3/4): 362-393.
- WEBER, R.E. & D.H. SPAARGAREN. Osmotic relations of the coelomic fluid and body wall tissues in *Arenicola marina* subjected to salinity change.—Neth. J. Sea Res. 13 (3/4): 536-546.
- WILDE, P.A.W.J. DE & E.M. BERGHUIS. Laboratory experiments on growth of juvenile lugworms, *Arenicola marina*.—Neth. J. Sea Res. 13 (3/4): 487-502.
- . Spawning and gamete production in *Arenicola marina* in the Netherlands, Wadden Sea.—Neth. J. Sea Res. 13 (3/4): 503-511.
- WITTE, F. & P.A.W.J. DE WILDE. On the ecological relation between *Nereis diversicolor* and juvenile *Arenicola marina*.—Neth. J. Sea Res. 13 (3/4): 394-405.

4.2.2. Publications BOEDE

1. ADMIRAAL, W. & H. PELENTIER. Influence of seasonal variation in temperature and light on the growth rate of cultures and natural populations of intertidal diatoms.—Mar. Ecol. Progr. Ser. 2: 35-43.
2. ———. Distribution of diatom species on an estuarine mud-flat and experimental analysis of the selective effect of stress.—J. exp. mar. Biol. Ecol. 46: 157-175.
3. ES, F.B. VAN. Bacteriën in een Wadden-oecosysteem. In: H. VELDKAMP. Oecologie van micro-organismen. Pudoc, Wageningen: 86-106.
4. ES, F.B. VAN, M.A. VAN ARKEL, L.A. BOUWMAN & H.G.J. SCHRÖDER. Influence of organic pollution on bacterial, macrobenthic and meiobenthic populations in intertidal flats of the Dollard.—Neth. J. Sea Res. 14 (3/4): 288-304.
5. JONGE, V.N. DE. Fluctuations in the organic carbon and chlorophyll-a ratios of estuarine benthic diatom populations.—Mar. Ecol. Progr. Ser. 2: 345-353.
6. JONGE, V.N. DE & L.A. VILLERIUS. Interference of sulphide in inorganic phosphate determination in natural waters.—Mar. Chem. 9: 191-197.
7. LAANE, R.W.P.M. Some observations on the lipid concentration in the Ems Dollart estuary and the western Wadden Sea.—Estuar. coast. mar. Sci. 10: 589-596.
8. ———. Conservative behaviour of dissolved organic carbon in the Ems-Dollart estuary and the western Wadden Sea.—Neth. J. Sea Res. 14 (2): 192-199.
9. MULDER, M. & M.A. VAN ARKEL. An improved system for quantitative sampling of benthos in shallow water using the flushing technique.—Neth. J. Sea Res. 14 (1): 119-122.
10. SCHRÖDER, H.G.J. & F.B. VAN ES. Distribution of bacteria in intertidal sediments of the Ems-Dollard estuary.—Neth. J. Sea Res. 14 (3/4): 268-287.

4.2.3. Publications RIN (COBW)

1. BOERE, G.C. & C.J. SMIT. Subjects: Grey plover, Knot, Sanderling, Curlew sandpiper, Dunlin, Bar-tailed godwit, Curlew, Spotted redshank, Redshank, Green-shank, Turnstone. In: C.J. SMIT & W.J. WOLFF. Birds of the Wadden Sea. Balkema, Rotterdam.
2. COLIJN, F. & K.S. DIJKEMA. Species composition of benthic diatoms and distribution of chlorophyll a on an inter-

- tidal flat in the Dutch Wadden Sea.—Mar. Ecol. Progr. Ser. 4: 9-21.
3. DANKERS, N.M.J.A. & K.S. DIJKEMA. De ecologische effecten van aanvoer van LNG in de Eemshaven, I. BOEDE-RIN rapport 1980-11: 1-61.
 4. DIJKEMA, K.S. Towards a vegetation and landscape map of the Danish, German and Dutch Wadden Sea islands and mainland coastal areas.—Acta Bot. neerl. 29: 523-531.
 5. ———. Large-scale geomorphologic pattern of the Wadden Sea area. In: K.S. DIJKEMA, H.-E. REINECK & W.J. WOLFF. Geomorphology of the Wadden Sea area. Balkema, Rotterdam: 72-80.
 6. DIJKEMA, K.S., H.-E. REINECK & W.J. WOLFF. Conclusions, recommendations. In: K.S. DIJKEMA, H.-E. REINECK & W.J. WOLFF. Geomorphology of the Wadden Sea area. Balkema, Rotterdam: 5-7.
 7. EISMA, D. & W.J. WOLFF. The development of the westernmost part of the Wadden Sea in historical time. In: K.S. DIJKEMA, H.-E. REINECK & W.J. WOLFF. Geomorphology of the Wadden Sea area. Balkema, Rotterdam: 95-102.
 8. GOETHE, F., C.J. SMIT & W.J. WOLFF. Threats to the birds of the Wadden Sea. In: C.J. SMIT & W.J. WOLFF. Birds of the Wadden Sea. Balkema, Rotterdam.
 9. REIJNDERS, P.J.H. On the causes of the decrease in the harbour seal (*Phoca vitulina*) population in the Dutch Wadden Sea. Wageningen: 1-116 (thesis).
 10. ———. Organochlorine and heavy metal residues in harbour seals from the Wadden Sea and their possible effects on reproduction.—Neth. J. Sea Res. 14 (1): 30-65.
 11. SCHARENBURG, K. VAN & C.J. SMIT. Hoofdstukken: Spotvogel, Braamsluiper, Grasmus, Tuinfluit, Zwartkop, Fluiter, Tjiftjaf en Fitis. In: R.M. TEIXEIRA. Atlas van de Nederlandse broedvogels. Natuurmonumenten, 's Graveland: 298-313.
 12. SMIT, C.J. Hoofdstukken: Introduction, The importance of the Wadden Sea for birds, Production of invertebrates and consumption by birds in the Dutch Wadden Sea area. In: C.J. SMIT & W.J. WOLFF. Birds of the Wadden Sea. Balkema, Rotterdam.
 13. SMIT, C.J. & C. SWENNEN. Red-breasted merganser. In: C.J. SMIT & W.J. WOLFF. Birds of the Wadden Sea. Balkema, Rotterdam.

14. WOLFF, W.J. Biotic aspects of the chemistry of estuaries.
In: E. OLAUSSON & I. CATO. Chemistry and biogeochemistry of estuaries. J. Wiley & Sons Ltd., Chichester: 263-295.
15. WOLFF, W.J., M.J. VAN EEDEN & E. LAMMENS (1979). Primary production and import of particulate organic matter on a salt marsh in the Netherlands.—Neth. J. Sea Res. 13 (2): 242-255.
16. WOLFF, W.J., A.J.J. SANDEE & H. STEGENGA. The Archianne-lida of the estuarine area of the rivers Rhine, Meuse and Scheldt, with some remarks on their ecology.
—Neth. J. Sea Res. 14 (1): 94-101.
17. WOLFF, W.J. & J.J. ZIJLSTRA. Management of the Wadden Sea.
—Helgoländer wiss. Meeresunters. 33: 596-613.

4.3. INTERNAL REPORTS

4.3.1. Internal Reports NIOZ 1980

- BAAN, S.M. VAN DER. Hydromedusae in the surface water around the "Texel" lightvessel. No. 1980-1.
- SPAARGAREN, D.H. Hydrodynamic properties of some pelagic crustacea from the North-Equatorial Gulfstream. No. 1980-2.
- JANSSEN, G.M. De voedselopname van de garnaal *Crangon crangon* (L.). No. 1980-3.
- AFMAN, B. De voedselopname van de strandkrab, *Carcinus maenas* (L.). No. 1980-4.
- OOSTRUM, R.W. VAN. Voedselopname van de mariene pelagische copepod *Temora longicornis* (Müller). No. 1980-5.
- CRUL, M. Bepaling van de omvang van de Vlielandse broedpopulatie van de eidereend. No. 1980-6.
- BAAN, S.M. VAN DER. Overzicht macro-plankton onderzoek bij het lichtschip "Texel", 1961-1966. No. 1980-7.
- . The seasonal occurrence of Scyphomedusae in surface waters near the "Texel" lightvessel. No. 1980-8.
- BERGMAN, M.N., P.J. SPLIETHOFF & H.W. VAN DER VEER. De ecologie van de O-groep schol (*Pleuronectes platessa* L.) op het Balgzand. I. Aantalsverloop, verspreiding en getijdemigraties. No. 1980-9.
- HOFSTEDE, J. VAN DER & C. STELDER. Stofkringloop en energiehuishouding in wadbak zuid. No. 1980-10.
- KUITERS, L. De invloed van predatie op de zomerafname van het herbivoor zoöplankton in de Zuidelijke Bocht van de Noordzee. No. 1980-11.

MULDER, R. & M.W. MANUELS. A description of drifter trajectories in the neighbourhood of current meters in the southern North Sea near the coast of Texel. No. 1980-12.

4.3.2. Internal Reports BOEDE

ZEEMAN, G. De relatie tussen het voorkomen van Mysidacea en de waterkwaliteit in het Eems Dollard estuarium. 1980-1: 1-50.

RUARDY, P. Aanzet voor een mathematisch model van het oecosysteem van het Eems Dollard estuarium. 1980-2: 1-69.

ADMIRAAL, W. Experiments on the ecology of benthic diatoms in the Eems-Dollard estuary. 1980-3: 1-125.

BARETTA, J.W., J.G. BARETTA-BEKKER, V.N. DE JONGE, L.A. VILLERUS & P. DE WOLF. Slibspecielozingen in het Eems estuarium nabij Delfzijl, zoals gemeten volgens verschillende meetmethoden. 1980-4: 1-34.

BARETTA, J.W. Het zoöplankton van het Eems-Dollard estuarium, soorten, aantallen, biomassa en seizoensfluctuaties. 1980-5: 1-40.

MALSCHAERT, H. Experimenteel onderzoek naar de invloed van gesuspendeerd slib op de groei van kokkels (*Cerastoderma edule*). 1980-6: 1-34.

ROMEYN, K. Een inventarisatie van de nematodenfauna van de Dollard en de rol van diatomeeën als voedsel voor enkele Nematodensoorten. 1980-7: 1-40.

LUDDEN, D.J.H. De primaire produktie van het fytoplankton in het Eems Dollard estuarium. 1980-8: 1-46.

BEVERDAM, H. & H.G.J. SCHRÖDER. Modellering van de zwavelcyclus. 1980-9: 1-21.

KOOLE, L. De relatie tussen fluorescentie en opgelost organisch koolstof. 1980-10: 1-22.

5. LECTURES

5.1. SEMINARS AND LECTURES AT THE INSTITUTE (titles translated)

25 January

- C. Smit (RIN): Accuracy of bird counts.
 C. Swennen (NIOZ): The study of eider ducks in the Wadden Sea.
 R. Koenekoop (Utrecht Univ.): The size of the Vlieland breeding population of the eider duck as computed from countings.
 M.R.M. Crul (Nijmegen Univ.): The size of the Vlieland breeding population of the eider duck as computed from re-catching of ringed birds.
 H.H.M. Bergman (Nijmegen Univ.): When do the eider ducks start to breed?
 F. van Heijzen & C. 't Hooft (Utrecht Univ.): Local differences in predation pressure of birds on the Balgzand.

8 February

- G. Jansen (G.U. Amsterdam): Field experiments on food intake of *Crangon crangon*.
 B. Afman (Wageningen, Agricultural Univ.): Field experiments on food intake of *Carcinus maenas*.
 H. Hummel (NIOZ): Food-intake of *Macoma balthica* in the field and in the laboratory.

15 February

- J. Boon (V.U. Amsterdam): Accounts of organochlorines and metals in various Wadden Sea organisms.
 J.C. Duinker (NIOZ): Organochlorines in the Rhine and the sea.
 J.M. Everaarts (NIOZ): Influence of Zn and Cu on the binding of O₂ of *Arenicola* haemoglobin.

7 March

- A. Timmer-ten Hoor (NIOZ): Mineralization and ATP measurements during NECTAR-1978.
 S.S. Oosterhuis (NIOZ): Zooplankton profiles in the vertical during NECTAR-1978.
 M.A. Baars (NIOZ): The pelagic system during NECTAR and in other areas of the tropical Atlantic Ocean.
 J.J. Zijlstra (NIOZ): Macroplankton during NECTAR-1978.

21 March

- M. Groenendaal (NIOZ): Can *Arenicola* render sulphides harmless?
 P. van Zwieten (Wageningen, Agricultural Univ.): The influence of the lugworm on nutrient cycling and the O₂ budget in a micro-ecosystem.
 D.H. Spaargaren (NIOZ): Exchange processes between the blood of the shore crab and the surrounding water.

3 April

W.W.C. Gieskes (NIOZ): Primary production of organic material and its consumption by heterotrophic processes in the North Sea.

E. Verburg & L. Kuiters (V.U. Amsterdam): Predation of fish larvae and comb-jellies on herbivorous zooplankton in the North Sea.

H.G. Fransz (NIOZ): Dynamics of herbivorous zooplankton in the North Sea.

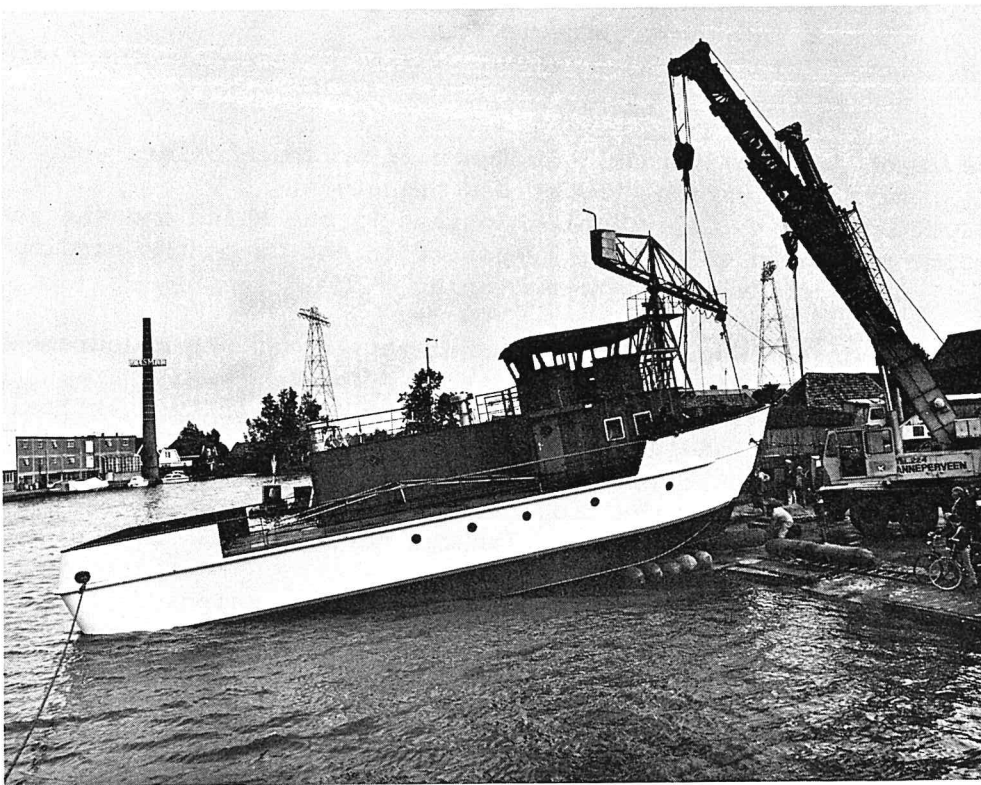
17 April: Physics of tidal areas

G. Abraham (Waterloopkundig Lab. Delft): On internally generated turbulence in partly mixed estuaries.

C. Veth (NIOZ): Turbulence measurements in tidal currents: laser-doppler and other methods.

J. Dronkers (State Waterworks Agency, D.D., Den Haag): Interpretation of salinity data in the Oosterschelde.

J.M. Suylen (State Waterworks Agency, WW/FA, Den Haag) & H.W. Riepma (KNMI, De Bilt): First results of diffusion experiments in the southern North Sea.



G.C. van Dam (State Waterworks Agency, WW/FA, Den Haag): A model with discrete particles for simulation of transport processes in two dimensions.

L. Otto (KNMI, De Bilt): Report on the study of water circulation of the North Sea.

18 April: Physics of tidal areas

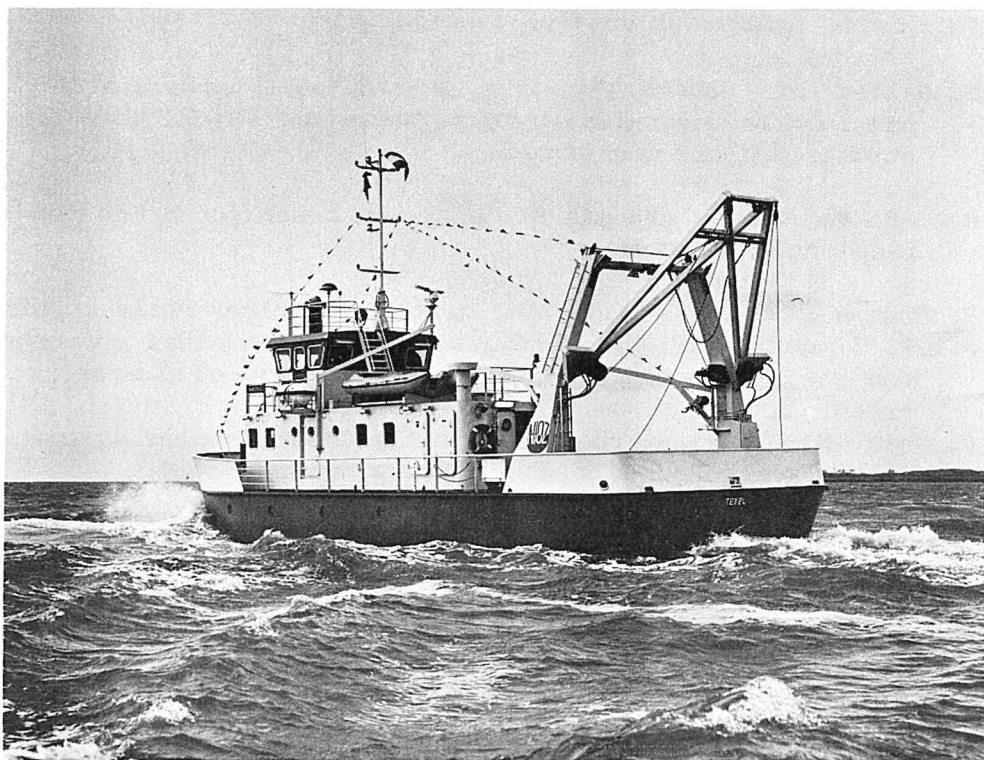
P. Brolsma (State Waterworks Agency, WW/KZ, Hoorn): Water movements in the Wadden Sea and the adjacent North Sea.

R. Mulder (NIOZ): Lagrange current measurements with floaters in the southern North Sea.

J.T.F. Zimmerman (NIOZ): The vorticity balance in quasi-two-dimensional tidal currents.

H. Tennekes (KNMI, De Bilt): What can a hydraulic model mean to North Sea research?

NAVICULA still in the shipyard and for the first time in the NIOZ-harbour on December 18. This new research ship of the Institute will take the place of EPHYRA and EIDER for use in the Wadden Sea. Pictures of these two ship are shown elsewhere in this report, after many years of faithful service.



G.L. Komen & H.W. Riepma (KNMI, De Bilt): Vestigial vorticity in the southern North Sea.

J.J. Boon (NIOZ): Pyrolysis mass spectrometrics of Balgzand sediments.

2 May

W.C.M. Klein Breteler (NIOZ): The cultivation of pelagic copepods.

R.W. van Oostrum (Univ. Leiden): Food-intake of pelagic copepods in cultures.

J.W. Baretta (BOEDE): Distribution of zooplankton in the Eems-Dollard estuary related to salinity and season.

9 May

M.M. Rutgers van der Loeff (RIN): Regeneration of nutrients in the bottom of the Southern Bight.

A.J. van Bennekom (NIOZ): Transport of nutrients from land to sea by rivers.

30 May

J.H. Vosjan (NIOZ): Mineralization in the western Wadden Sea.

J.J. Boon (NIOZ): Seasonal influence on the pyrolysable material from a Balgzand sediment.

P.A.W.J. de Wilde (NIOZ): Activity and dynamics of the benthos in a tidal flat on the Balgzand during the year.

G.C. Cadée (NIOZ): Primary production on the Balgzand.

28 August

G. Hallegraeff (CSIRO, Cronulla, Australia): Phytoplankton pigments in Australian waters. Measurements with thin-layer chromatographic techniques.

24 October

M.A. Baars (NIOZ): Aspects of ecosystem research in the tropical Atlantic Ocean.

31 October

H. Postma & D. Spitzer (NIOZ): Is the ocean bluer in the morning?

J.T.F. Zimmerman (NIOZ): Vestigial vortices in tidal currents and their importance for the geomorphology of coastal areas.

C. Veth (NIOZ): First results with the laser-doppler system in the North Sea.

14 November

H.G. Fransz (NIOZ): Zooplankton in a plaice larvae patch in the Southern Bight (February-March 1980).

A. Eijgenraam (Utrecht Univ.): Oxygen measurements in the Southern Bight (February-March 1980).

28 November

R.W.P.M. Laane (BOEDE): The qualitative relationship between dissolved organic matter and fluorescence in estuaries.

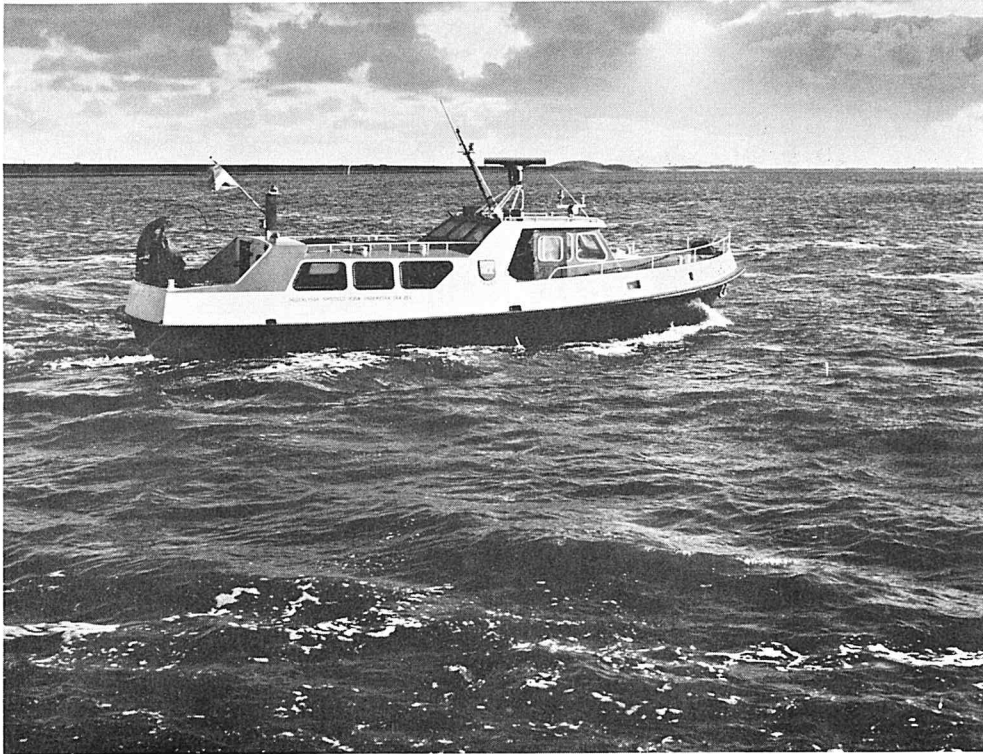
- H. Postma & J.W. Rommets (NIOZ): Fluorescence of interstitial water at different stations in the Wadden Sea.
- C.J.M. Kramer (NIOZ): The binding of Cu-ions to humus extracted from tidal flat sediment.
8 December
- K. Vooren (Funwaçao, Univ. do Rio Grande, Brazil): Sharks and rays in the South Brazilian seas.
19 December
- M. Fonds (NIOZ): Influence of water temperature on respiration and food-intake of plaice and flounder.
- J. van Loon (Wageningen, Agricultural Univ.): Sublethal effects of Cu and Zn pollution on physiological processes in young plaice (accumulation, growth).

6. VISITORS FROM ABROAD

- Dr Kj.R. Bjørklund, Geologisk Institutt, University of Bergen,
Norway.
- Dr Callandar, Hamilton, New Zealand.
- A. Chabot, University Ste-Anne, Nova Scotia, Canada.
- J. Derick, Institute of Geological Sciences, Edinburgh, Scotland.
- Edwards, Institute of Oceanographic Sciences, Wormley, England.
- Dr A.-O. Folkestad, Eiksund, Norway.
- Mr S. Genç, Middle East Technical University, Department of
Environmental Engineering, Ankara, Turkey.
- Prof. Dr M. Gilmartin, Center for Marine Studies, University
of Maine, U.S.A.
- Dr P. Giresse, Centre des Recherches de Sédimentologie marine,
University of Perpignan, France.
- Dr G. Hallegraeff, CSIRO, Cronulla, Australia.
- Dr V. Hansen, Fisheries Institute, Charlottenlund, Denmark.
- Dr V. Ittekkot, Scope/Unep Intern. Carbon Unit Hamburg,
W-Germany.
- Dr E. Kühner, Wilhelm Pieck University, Rostock, East-Germany.
- S. Lamade, Kernforschungsanlage, Geesthacht, W-Germany.
- S. Lausted, Chairman Nordsøcentret, Hirtshals, Denmark.
- Dr A. Maldonado, Department de Estratigrafia Y Geologia His-
torica, University of Barcelona, Spain.
- M. Maloungula, Department Geology, University Marine Ngouabi,
Brazzaville, Congo.
- Dr N. Mikkelsen, Danmarks Geologiske Undersøgelse, Copenhagen,
Danmark.
- Dr V.M. Nijampurkar, Physical Research Laboratory, Akmedabad,
India.
- Prof. E. Olausson, Marinegeologiska Laboratory, University of
Göteborg, Sweden.
- Dr G. Qvale, Institute of Geology, University of Oslo, Norway.
- Dr S. Rainer, CSIRO, Division of Fisheries and Oceanography,
Cronulla, Australia.
- P. Roberts, Institute of Geological Sciences, Edinburgh, Scot-
land.
- Mr T. Tamei, Regional Directorate of Fisheries, Izmir, Turkey.
- Dr R.F. Uglow, Department of Zoology, University of Hull,
England.
- Prof. Dr K. van Vooren, Funwaçao University do Rio Grande,
Rio Grande, Brazil.
- Dr M. Whitaker, Shell Explor. Laboratory, Rijswijk, The Nether-
lands.



This year again a charter-trip was made to the southern Atlantic Ocean (Angola-basin), on the freighter TYRO (top left); in the harbour of Den Helder the necessary containers and deep-sea winches were put on board (lower right). The sampling stations in both areas are shown on page 8 and 10.



EIDER (top figure) and EPHYRA (lower figure).

7. TEACHING

7.1. STUDENTS' RESEARCH SUBJECTS

As a part of their final degree studies, the following students participated in research:

M.A.P.A. Aerts	R.U. Utrecht	(2.17.4)
G.J. Arbouw	R.U. Leiden	(2.17.1)
A. Baks	L.H. Wageningen	(2.18.2)
R.M.M. Berns	R.U. Utrecht	(2.18.2)
J.P. Boon	V.U. Amsterdam	(2.18.1)
S.Th. Bouwer	R.U. Leiden	(2.10.1)
E. de Cock	S.O.L. Amsterdam	(2.08.2-2.09.1)
G.H. van Dam	R.U. Utrecht	(2.18.2)
A. Eijgenraam	R.U. Utrecht	(2.06.3)
A. Joosse	R.U. Utrecht	(2.12.3)
J. den Hartigh	S.O.L. Utrecht	(2.19.1)
G. Helling	Biol., T.H. Braunschweig	(2.09.3)
E. ter Horst	R.U. Utrecht	(2.01.1)
W. Karssemeyer	S.O.L. Amsterdam	(2.08.2)
M. Kortekaas	R.U. Utrecht	(2.15.2)
L. Kuiters	Biol., V.U. Amsterdam	(2.09.1)
J.J.A. van Loon	Biol., L.H. Wageningen	(2.18.2)
R.W. van Oostrum	R.U. Leiden	(2.10.1)
M. van de Polder	R.U. Utrecht	(2.12.3)
J.G.J. Spieksma	R.U. Utrecht	(2.17.4)
B. Tournois	S.O.L. Utrecht	(2.19.1)
N. Velten	Biol., T.H. Braunschweig	(2.09.3)
E. Verburg	Biol. V.U. Amsterdam	(2.09.1)
F. de Vries	R.U. Utrecht	(2.12.3)
M. Wildschut	R.U. Utrecht	(2.08.2)
A. Wolfard	R.U. Utrecht	(2.02.2)

7.2. NIOZ COURSES

7.2.1. Course on Marine Biology. This was held from 9-20 June; 47 students, from the various universities in the Netherlands took part. They were introduced to several subjects both in the field and in the laboratory, such as hydrography, primary production, zooplankton, tidal flat sampling, fisheries, marine pollution, physiology and microbiology.

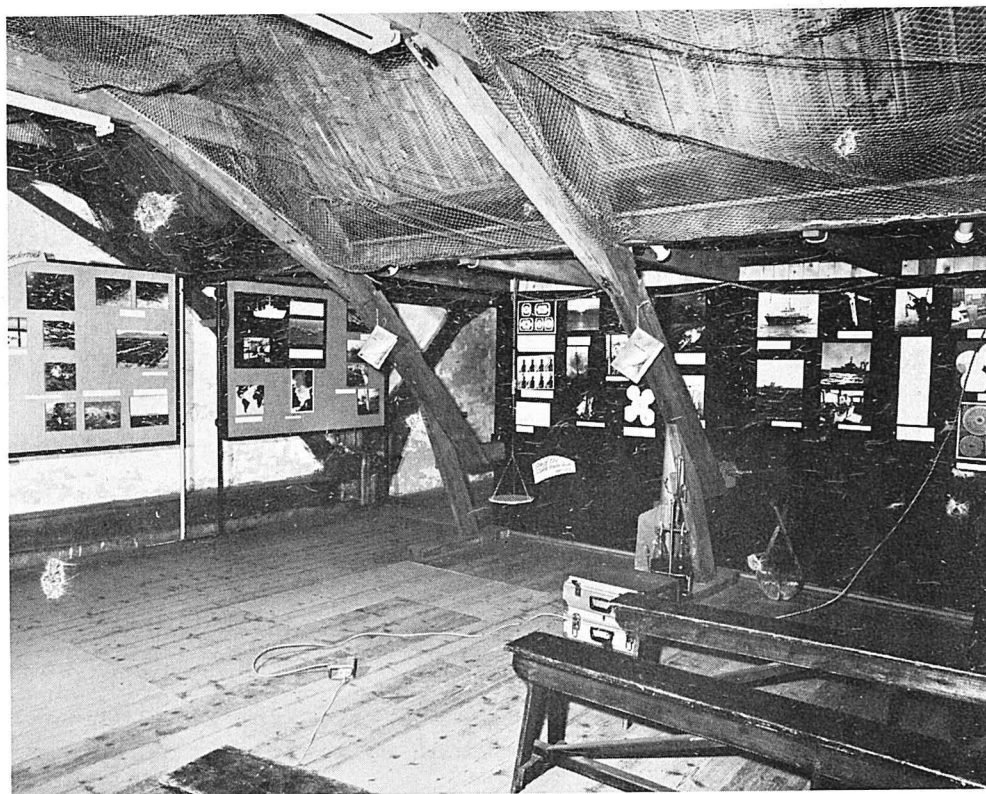
7.2.2. Oceanography Course. This was held from 25-29 August, with 25 participants. The practical work was carried out in

the same form as last year. The students could choose from the following subjects: chemical and physical research (Wadden Sea), heavy metals in water and bottom (laboratory), sedimentological processes and techniques (laboratory). The last two subjects required some hours of sampling on a tidal flat and on the Wadden Sea. The participants showed great enthusiasm.

7.2.3. In September a four-day course was organized for ecology analyst students from the Van den Broek Institute (Amsterdam). The NIOZ staffmembers were involved in this course, which consisted of lectures, films, excursions and laboratory work.

7.3. COURSES ACCOMODATED AT THE NIOZ

15-17 February: Zoological Institute Technical University
Braunschweig.
19-23 May: Aquatic Ecology, G.U. Amsterdam.
23 June-5 July: Marine Biology, University Odense, Denmark.
1-4 September: Zoological Institute, Köln University.
8-12 September: Van den Broek Institute (AVSH), Amsterdam.

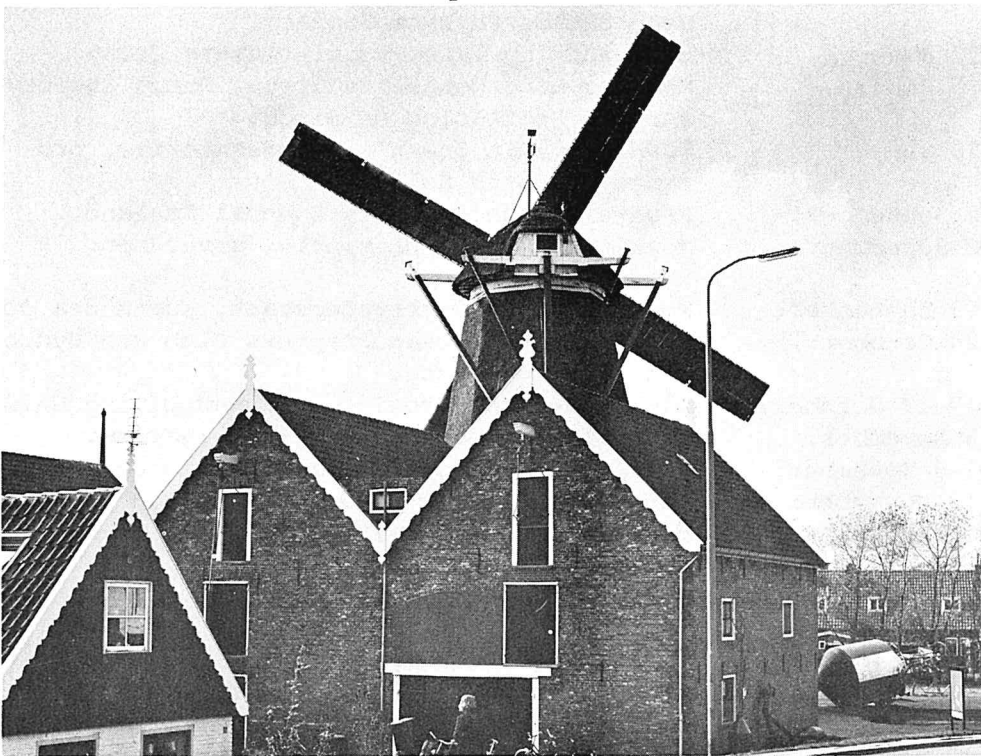


- 17-19 September: Laboratory of Zoological Ecology and Taxonomy, Utrecht University.
5-8 October: Biology Department Teacher Training College Zuidwest Nederland.
12-14 October: Vegetation Studies Group, Agricultural University Wageningen.
19-21 November: Environmental Studies Group, Leiden Univ.

7.4. MEETINGS AND EXCURSIONS RECEIVED AT THE INSTITUTE

- 8 January: Excursions building committee, V.U. Amsterdam.
18-20 January: Diving weekend Groningen Biologists.
29 January: Working visit Mayor and Aldermen Texel Council.
10 February: Excursion Youth Nature Students, Texel branch.
21 February: Excursion Biology Teachers from Alkmaar.

In an old warehouse of the windmill "De Traanroeier" at the Oudeschild harbour, the Texel Maritime Museum was organized. The occasion was the "200 years Oudeschild Harbour" celebrations. The NIOZ took part with an exposition.



- 28-29 February: Meeting BION-group Biosystematics.
 29 February: Meeting Royal Dutch Mining Engineering Society.
 12-14 March: Meeting RIN, Botany Department, Leersum.
 26 March: Excursion International Institute for Aereal Survey and Earth Sciences, Delft.
 11-13 April: Diving weekend Gronigen biologists.
 24-25 April: Meeting BION-group Gen. Microbiology.
 1 May: Excursion Mayors and Aldermen of the Wadden Islands.
 1-2 May: Preparatory excursion teachers Köln Univ.
 13-14 May: RIN meeting.
 20 May: Excursion Teachers Training College Hamburg.
 20 May: Excursion students Aquatic Ecology.
 29 May: Excursion TNO, Department of Environment and Health Technology.
 30 May: Excursion staff Texel Municipality.
 5 June: Excursion Volkshogeschool Bergen, PTT staff course.
 5-6 June: Excursion and meeting RIN.
 6 June: Optic Day Meeting, Section Optics of the Netherlands Physics Society.
 12 June: Work meeting laser-doppler Users Group.
 16 June: Meeting Bird Mortality Group, Dutch Society for the Protection of Birds.
 18 June: Working visit Queen's Representative, province of North Holland.
 2 September: Excursion Municipality Council Ameland.
 6 September: Working visit of provincial government Labour Party.
 19 September: Working visit Rijkswaterstaat, North Sea dept.
 24 October: Meeting Dutch Oceanographers Club and Hydrobiological Society.
 17-19 October: Diving weekend Groningen Student Diving Union.
 5 November: Excursion Veterinary Service, Haarlem.
 7-8 November: Meeting BION-group Population Biology.
 12 November: Excursion biology students Leiden.
 17 November: Excursion Municipality Committees of Texel and Harmelen.
 27-28 November: Meeting BION-group Ethology.

7.5. EDUCATION

7.5.1. Help was given to the Maritime Museum, an exposition celebrating the bicentennial of Oudeschild Harbour.

7.5.2. Preparations were made for repeating the school radio series "The Unknown Sea", for the second semester of 1980/1981.

8. GENERAL PART

8.1. AUXILIARY DEPARTMENTS

8.1.1. Library

To the Journal department of the library were added the following publications: Aquatic Sciences and Fisheries Abstracts, Biological Sciences & Living Resources, Boundary layer Meteorology, Current Contents: Agriculture Biology Environmental Sciences, Geological Society of American Bulletin, Izvestiya, Atmospheric and Oceanic Physics Academy of Sciences USSR, Journal of Fluid Mechanics, Marine Biology Letters, Marine Ecology Progress Series, Marine Micropaleontology, New Scientist, Oceanic Abstracts and by exchange (Netherlands Journal of Sea Research): Boletín de la Sociedad de Historia Natural de Baleares (from 1972), Mitteilungen aus dem Zoologischen Museum der Universität Kiel, Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg (from 1970), Nanhai Studia Marina Sinica, Revista Nordestina de Biologia, Steenstrupia, Zoological Museum Univ. Copenhagen (from 1970) and Wader Study Group Bulletin.

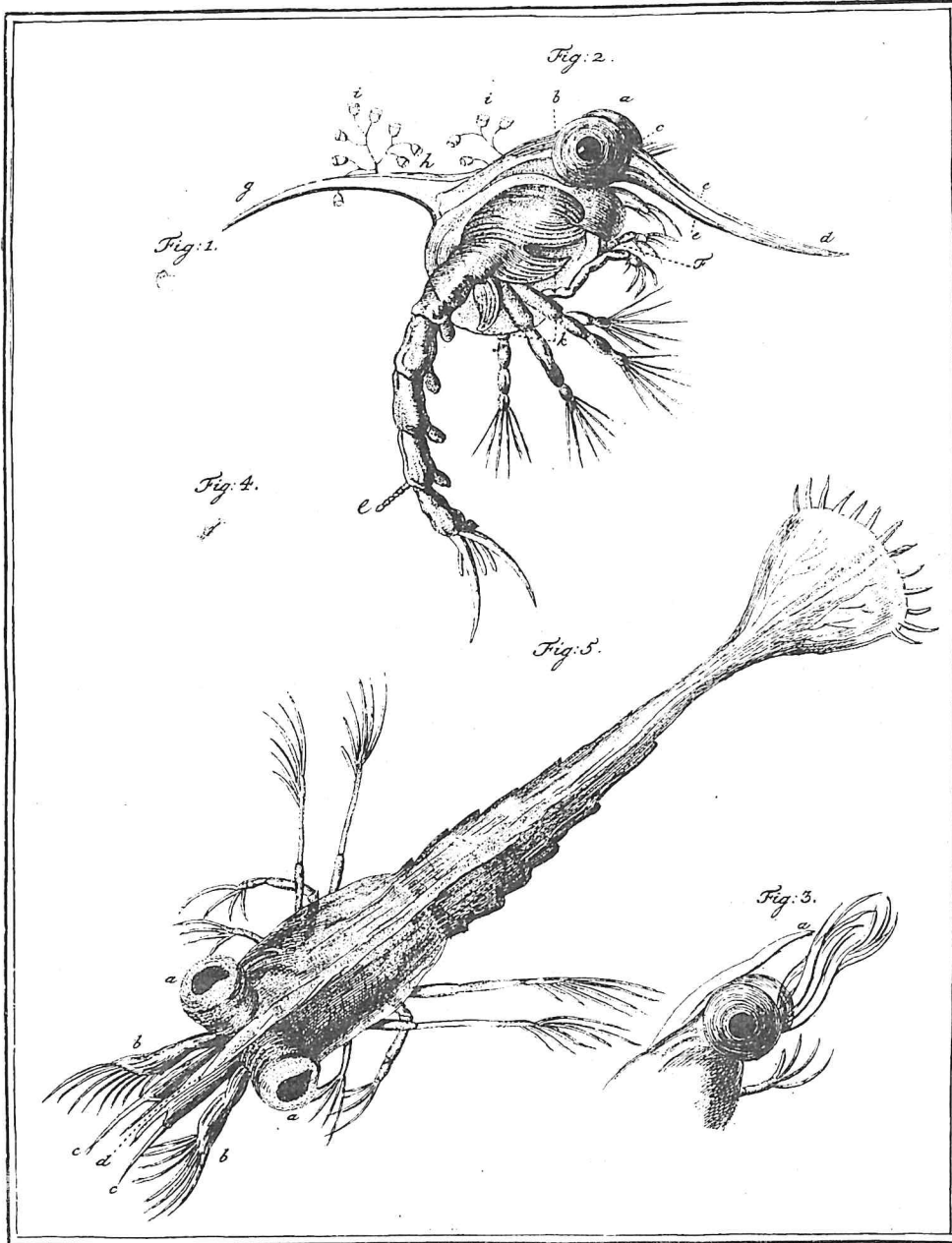
The following subscriptions were ended (because of the shrinking budget) from 1980: Archives Hydrobiologie, Chemical Geology, Cumulative Index + BioResearch Index from Biological Abstracts, Fresenius Zeitschrift f. Analytische Chemie, Journal of Biological Chemistry, Journal of Cellular Physiology, Journal of Chemical Education and South African Journal of Science.

8.1.2. Computer centre

F. Eijgenraam was appointed manager of the computer centre, and the General Manager was made responsible for this department.

The two Tektronic 4051 machines were equipped with "flexible disc" units. The computing and memory capacity has thus been increased to such an extent that the use of outside computers can be very much reduced.

By automatizing observing apparatus, and because of increasing need to use stored data efficiently, it seems that the present equipment, which only two people at a time can use at a relatively slow rate, will soon be too small. The terminal committee aims at the purchase of a mini-computer for distributed data processing, with which 16 users can calculate simultaneously via terminals in the departments. Information is



P. M. Brasser. ad Vivum delin.

R. Muys fecit.

Two pages and accompanying illustration from Martinus Slabber's *Natuurkundige Verlustingen* (1778), from the NIOZ Library. This naturalist from Zeeland described many marine animals.

AAN DEN
HOOG EERWAARDEN

EN
HOOGGELEERDEN
HEREN

JAKOBUS WILLEMSSEN,

S. S. TH. DOCTOR,

HOOGLEERAAR IN DE HEILIGE GODGELEERDHEID
IN DE DOORLUGTIGE SCHOOLE, EN BEDIENNAAR
DES GODDELIKEN WOORDS TE MIDDELBURG,
MEDELID VAN HET ZEEUWSCH GE-
NOOTSCHAP DER WETENSCHAP-
PEN TE PLISSINGEN:

W O R D,

UIT BYZONDERE HOOGACHTING,
D I T

V R E D E S T U K J E

M Y N E R

NATUURKUNDIGE VERLUSTIGINGEN

T O E G E W Y D,

D O O R

ZYN EERWAARDENS

Nederig Dienaar en Vriend,

Middelhburg d' 2. d. 3. 3. 3. 3.

WAARNEMING

VAN EEN

ZEE-WATERVLOO,

GENAAMD

T A U R U S OF S T I E R.

Bladz. 35

Ik twyfel niet, of de Liefhebbers der *Natuurlyke Historie* zullen reeds verlangende zyn naar myne belofte, in myne Voorreden gedaan, betreffende het uitgeven of bekend maken van *Zee-Dierlyes*; waar van ik dan met dit Stukje een aanvang maak.

Dan vooraf, eer ik tot de beschryving van het Dier zelve overga, moet ik, zo veel in my is, zyn *Geflacht* mededeelen: teboon ik gaarne wil betuigen, hoe meer vreemde Dieren ik waarneem, hoe onvolmakter ik de Geslachten en kenmerken van dezelve vinde; en evenwel is men genoodzaakt, wil men het Dieren-Ryk niet tot een *Chaos* brengen, (dat ik my zo uitdruk,) om de bekende Geslachten te volgen, of om nieuwe aan te leggen; welk laatste vry wat moeite in heeft. Dan, om zulks te ontgaan, heb ik dit onbekende Zee-Dier onder de *Manoculi* of *Water-Vloojen* geplaatst; al schoon hy, trikt geclassif. volgens het woord *Monoculus*, *Een-oog*, onder die gene, waar van de groote *LINNAEUS* deeze Geslachtsnaam

being sought from firms and institutes with experience, to make the best choice technically and financially from an enormous field. Attention is also paid to the possibility of automatised text-processing.

8.1.3. Reprographic Department

Besides the usual drawings and photographic work for publications, lectures, internal registrations and the NIOZ offset printing machine, this department has taken in hand the completing of the (now ready) North Sea model.

Several expositions were designed and realized, and shown in the Den Burg Library (12 May-24 July), during the Fisheries Days in Den Helder (28 July-2 August), and in the Maritime Museum in Oudeschild (31 July-25 October). Together with BOEDE and RIN, preparations were made for a permanent exposition in the Nature Recreation Centre (Texel). For activities such as these a tape/slide series was composed.

A number of film fragments were contributed to an informative TV programme (15 October). In 1980 three copies of the NIOZ-film "Deposit Feeding" were sold.

8.1.4. Biological study materials

The department supplied living and prepared material to universities, schools and other institutes.

117.545 sea animals were bought, and 110.341 sold. 58.000 l seawater was bought, and 112.490 l was transported from Texel to the Study materials department in Den Helder, of which 30.000 l was for NIOZ use. 140.490 l seawater was sold.

8.1.5. Workshops

Maintenance: The ocean programme brought a great deal of work. Also, a number of large projects were carried out. For the Benthic Systems Department, a "floating" observation tower for use on tidal flats was built. In the Aquarium an experimental construction was mounted. The central cooling system there was taken into service this year. The seawater inlet has been modified and automatized in such a way that the supply of 25.000 l sea water per hour is guaranteed. For the ocean programme a container was turned into a cooling tank with a range of -5° to $+18^{\circ}$ C. The A-frame of the (Shell) deepsea winch was equipped with a hydraulic mechanism. Changes to the airgun system of the geologists gave satisfaction in practical use.

The woodworking department and the reproduction department built a booth for the Oudeschild Harbour exposition. A new van was purchased for transport.

Instruments: Besides maintenance, several modifications to existing apparatus were made. The largest of these was the vacuum adaptation of the goniometer in the röntgendiffraction meter of the Geology Department.

New apparatus was constructed, partly together with the electronics department. For the Department of Physical Oceanography a watertight container for the laser-doppler velocity meter was made, also a pressure-proof cover and optically accurate mechanical machinery for irradiance meters, and 6 Decca tracer buoys with accompanying pressure tight accuboxes and depressors. For the Department of Chemical Oceanography a mechanically steerable burette for the automatic oxygen-titrator was constructed.

Electronics: Besides the regular work such as adaptation of bought material, repairs, assisting in laboratories, and advice for the purchase and use of apparatus, several larger projects were taken on. For the Department of Physical Oceanography a number of Decca Hyfix receivers were adapted for building into buoys by the instrument makers. With those went feeding-units and transmitting apparatus developed by the department. A communication-receiver was made suitable for the frequencies used, and linked to the Hyfix receiver and the HP-9825 desktop computer that stores, and later processes, all data.

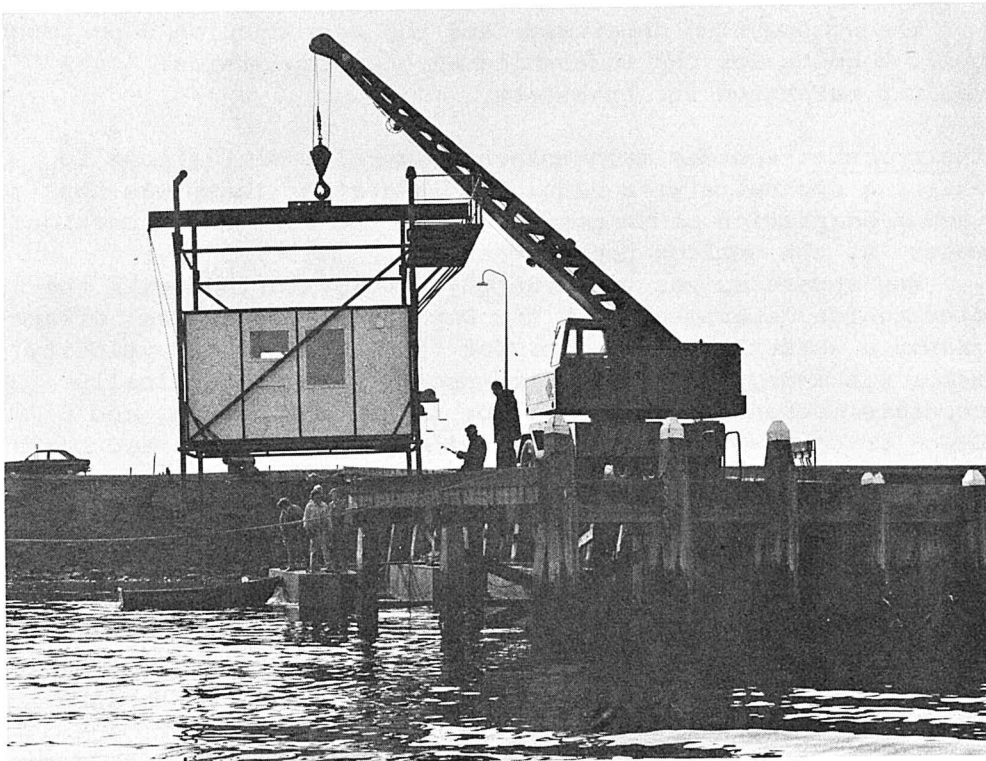
For the Geology Department were built a booster-amplifier of 10 kW for the penetrating echo sounder, a delayed firing unit for the airguns (after a Shell design), a seismic receiver for the "eel" and an eight-channel seismic monitor.

For the Experimental Systems Department two five-channel oxygen/temperature meters were constructed. The oxygen titrator of the Department of Chemical Oceanography was extended with an interface to the Apple microcomputer, to make this arrangement automatic.

A large part of our time was spent on preparing for the ocean trip, during which two staff members were present. Assistance was given during several North Sea trips.

8.1.6. Harbour and ships

In February, the construction of a new Wadden Sea research vessel to replace both EIDER and EPHYRA was ordered. The new



A new observation tower was constructed for use on the tidal flats. These towers have proved their usefulness as moveable laboratories and lodgings for many years, especially for investigations on the Balgzand.

ship's length is 21 m, width 7 m, and draught 85 cm. It possesses two DAF engines of 130 HP, and was built by J.A. Visscher, Zwartsluis. The vessel was launched on 12 September, and taken into service on 8 December by Mrs E. Postma-Heeres naming it NAVICULA.

The other vessels received the usual maintenance. In spring one of the jetties was strengthened with fluid asphalt, and the roads were re-tarred.

For research purposes, the number of sailing days was: Aurelia: 166; Eider: 96; Ephyra: 105; Griend: 97.

8.1.7. Guest House

Accommodation for students and participants in meetings was provided for 2184 nights; for students, guest-researchers and post-graduates 6807 nights; other visitors 275 nights. Altogether lodging was provided for 9266 nights.

8.2. REVENUES AND EXPENDITURES

exploitation funds	f 9.267.000	
sale of study material	58.000	
rents and accomodation charges	45.500	
subscriptions Neth. J. Sea Res.	12.000	
assistance fees received	95.000	
banking interest	1.000	
personnel costs		f 7.337.000
general costs		1.038.500
laboratory costs		320.000
auxiliary departments		442.000
Neth. J. Sea Res.		90.000
assistance fees paid		82.000
guest house costs		91.000
aquisitions library		78.000
	f 9.478.500	f 9.478.500

Long-term investments:

funds for scientific and general equipment	f 900.000
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9. MANAGEMENT AND STAFF

9.1. MANAGEMENT

The NIOZ is an institute of the Netherlands Zoological Society. The main source of money is the Ministry of Education and Sciences. The directors of the Institute are appointed by the Minister and are responsible for management of the Institute to the Society.

The Board of the Society has delegated the regular supervision to one of its members, the Commissioner. Budgetary matters are handled by the Finance Committee, consisting of the Commissioner as chairman, the Treasurer of the Society, the chairman of the Science Committee, and if he so desires, an appointee of the Minister. Without the Government official the Committee also acts as a Board of Supervisors.

Concerning the scientific activities of the NIOZ the above mentioned Science Committee is asked for advice. The members of this Committee are appointed by the Minister. These consist of representatives of the universities and of related scientific institutes.

The Science Committee met at the NIOZ on 12 December.

Board of Supervisors:

Prof. Dr J.Th. Wiebes	(Commissioner)
Dr J.L. Dubbeldam	(Treasurer)
Prof. Dr A.D.F. Addink	(Chairman Science Committee)

Science Committee:

Prof. Dr C. den Hartogh (Laboratory for Aquatic Ecology) for Nijmegen University.
 Prof. Dr W.G. Mook (Physics Laboratory) for Groningen University.
 Dr R.C. Peters (Laboratory for Comparative Physiology) for Utrecht University.
 Prof. Dr A.D.F. Addink (chairman) (Zoological Laboratory) for Leiden University.
 Dr P.J. Roos (Zoological Laboratory) for G.U. Amsterdam.
 Prof. Dr A.J. Wiggers (Earth Sciences Institute) for V.U. Amsterdam.
 Dr A.G. Vlasblom (Delta Institute for Hydrobiological Research, Yerseke).
 Drs K.H. Postuma (State Institute for Fisheries Research, IJmuiden).
 Dr L. Otto (Research department KNMI, De Bilt).

Prof. Dr J.Th. Wiebes (Systematic Zoology and Evolution Biology, Leiden University) for the Netherlands Zoological Society.
 Dr J. van der Land (State Museum for Natural History, Leiden).
 Dr H.J. Veenstra (Geological Institute) for Groningen University.
 Dr E.H.Th. Verdurmen (ZWO Laboratory for Isotope Geology, Amsterdam).

9.2. STAFF

-) not employed anymore, +) new appointed, °) not in NIOZ employment

9.2.1. NIOZ staff

The numbers behind the names indicate on which research project(s) the staff members worked. For guest researchers, see 3.1; for student research see 7.1.

Director:	Secretaries
H. Postma	J. Hart-Stam
J.J. Zijlstra	L. Everhardus

RESEARCH DEPARTMENTS

Scientists

Assistants

Chemical Oceanography

H. Postma 2.06.1; 2.06.6; 2.08.3	J.W. Rommets 2.06.1; 2.06.6; 2.08.3
S.B. Tijssen 2.06.1; 2.06.3; 2.06.6	F.J. Wetsteyn 2.06.1; 2.06.3; 2.06.6
W. Helder 2.04.2; 2.06.2; 2.06.5	R.T.P. de Vries 2.04.2; 2.06.2; 2.06.5
C.G.N. de Vooy [°] 2.08.3	

Physical Oceanography

J.T.F. Zimmerman 2.01.1; 2.01.2	
C. Veth 2.01.1	
D. Spitzer 2.07	M.R. Wernand 2.07
R. Mulder [°] 2.01.1	M.W. Manuels 2.01.1

Marine Pollution

J.C. Duinker 2.18.1; 2.18.2	M.T.J. Hillebrand 2.18.1
C.J.M. Kramer [°] 2.18.2	R.F. Nolting 2.18.2
J.M. Everaarts 2.19.1	

Marine Geology and Geochemistry

D. Eisma 2.02.1;2.02.4 S.J. v.d. Gaast 2.02.1-4;
2.02.6;2.06.4
J.H.F. Jansen 2.02.2;2.02.4 J. Kalf 2.02.1-4
T.C.E. van Weering 2.02.2;2.02.3; J. Schilling 2.02.1-4
2.02.4
A.J. van Bennekom 2.02.4;2.06.4 G.W. Berger 2.02.4;2.06.4;
2.06.5
M. van Vreumingen^o) 2.02.5 R. Gieles-Witte 2.02.1-4
J. van Iperen^o) 2.02.1-4

Experimental Systems

P.A.W.J. de Wilde 2.08.1;2.11.1; E.M. Berghuis 2.08.1;2.11.1;
2.11.2;2.12.3;2.12.4 2.11.2;2.12.3;2.12.4
J.H. Vosjan 2.03.1;2.12.3 A. Kok 2.03.1;2.08.1;2.11.1;
A. Timmer-ten Hoor⁻) 2.04.1 2.11.2;2.12.1-4
B. van der Werf⁺) 2.04.1 F. Eijgenraam 2.03.1;2.12.3
J.J. Boon^o) 2.12.1 E. Pauptit 2.03.1;2.12.3

Auto-ecology

F. Creutzberg 2.13.1 G. van Noort 2.13.1;2.14.3
A.D.G. Dral 2.16.2
M. Fonds 2.13.1;2.15.2 P. v.d. Puyl 2.13.1;2.15.2
B.R. Kuipers 2.14.2-4 R. Dapper 2.13.1;2.14.3;
2.14.4
H.W. van der Veer 2.14.3
D.H. Spaargaren 2.16.3

Benthic Systems

J.J. Beukema 2.11.1 W. de Bruin 2.11.1
G.C. Cadée 2.06.5;2.08.1 J. Hegeman 2.08.1
C. Swennen 2.17.1-4 P. Duiven 2.17.1-4
H. Hummel^o) 2.11.3 G. Nieuwland 2.10.1;2.11.3
T. Gerritsen^o) 2.17.4 J. Zuidewind 2.11.1;2.17.1-4

Pelagic Systems

H.G. Fransz 2.09.1;2.09.2
W.W.C. Gieskes 2.08.2;2.08.3 G.W. Kraay 2.08.2;2.08.3
W.C.M. Klein Breteler 2.10.1 S. Gonzales⁺) 2.09.1;2.10.1
M.A. Baars 2.06.5;2.08.3;2.09.3 S.S. Oosterhuis 2.06.5;
2.08.3; 2.09.3
N. Berger-Schogt^o) 2.09.3
A. Kikkert^o) 2.09.1

J.J. Zijlstra 2.09.3;2.11.2; J.IJ. Witte 2.09.3;2.11.2;
 2.12.4;2.14.1;2.14.3 2.12.4;2.14.1;2.14.3

AUXILIARY DEPARTMENTS

Head (skipper): Assistants:
 E. van Abs (manager) G. Swaan-Zonnenberg (telephone)

Administration

G. Goslinga D.J. Bruin E.C. Lanser
 I. Wernand-Godée

Publication and Library

J.W. de Blok D.E. Jourdan-Thomas G.E. de Schipper
 J. v.d. Wal- M. Bruining-du Porto
 Doornekamp

Reprography

H. Hobbelink B. Verschuur R.P.D. Aggenbach

Maintenance

T. Verveer L. Heerschap R.J.R. Anthonijsz
 F.J. Parlevliet F.J. Schilling
 T. Buisman R.M. Daalder
 A. Ran S. Gieles
 J. Visser H.H. de Porto⁺
 J. de Vries

Experiment Aquarium

H.J. Boekel J.M. Nieuwenhuizen

Instrument Maintenance and Development

M. Manshanden J. van Heerwaarden A.J. Vaars

Electronics

J.J.A. van Weereld G.M. Manshanden R.L. Groenewegen

Biological Study Materials (Den Helder)

M. Buhre

Domestic Service

T. Agema-Lebbe G.C. Weijdt-Eelman

Guest House "De Potvis"

S.W. de Porto

	<u>Harbour and Ships</u>	
H.A. Beumkes	W.P. Jongejan	C. Snijders
	R. de Vries	
C. van Zwieten	C. Gerssen	A. Boon
	A. Schol	G.L. de Vries
	G.H. Steenhuizen	A.J. Souwer
	J.C. Groot	
J.H. Oversluizen	S. Dogger	
C. Wisse	J.C. Tuntelder	

9.2.2. BOEDE Staff

Scientists:

Assistants:

	<u>Microbiology</u> (Groningen)	
H.G.J. Schröder	A.J. Kop	
F.B. van Es	W.H. Witman-Knol	
	G. Kamstra	
	M. de Jonge-Swieter	

	<u>Algology</u> (Groningen)	
W. Admiraal	H. Peletier	
V.N. de Jonge	L. Villerius	
F. Colijn	L.A.H. Venekamp	
L.A. Bouwman	K. Romeyn	

	<u>Zoology</u> (NIOZ)	
P. de Wolf	A. Bol-den Heijer	
M.A. van Arkel	M. Mulder	
J.W. Baretta	H. Malschaert ⁺)	
R.W.P.M. Laane		
A. Stam		
P. Ruardij		

9.2.3. RIN Staff

W.J. Wolff	M.A. Binsbergen	
M. Bergman ⁻)	J.L. de Groot (detached at NIOZ)	
N.M.J.A. Dankers	P. Horst ⁺)	
K.S. Dijkema	J. Schoonheden	
P.J.H. Reijnders	A. Sleutel	
C. Rappoldt ⁺)	M.C. Vleugel	
M.M. Rutgers van der Loeff ⁻)	C. Wielinga	
J. de Vlas ⁰)	J. Zegers	

9.3. STAFF MATTERS

9.3.1. Training courses followed

M.R. Wernand	advanced (sec.) electronics
M.R. Wernand	digital techniques
G.M. Manshanden	advanced (tert.) electronics
J. Groot	nautical course

9.3.2. Institute Council

The Institute Council met the Directors five times in 1980. The NIOZ is obliged by law to have a Council. The Institute Council and directors have drawn up draft regulations, and after consultation with staff and unions, this has been presented to the Social Economic Council for definitive approval. Next year elections will be held.

Other points of discussion: budgetary matters, staff policy and planning, job application procedure, shorter work times and part-time positions, safety aspects, ocean programmes, compensation for protective measures, and a magazine to be made by the staff club, Council, and directors (one number has appeared). A few times there were consultations on individual cases.

9.3.3. Staff Club

The staff club organized the traditional New Year Reception, a film afternoon with noodle dinner in November, and on New Year's Eve "oliebollen".

On 12 April "Comedia de la NIOZ" performed Jan Wolkers' one-act play "Closed owing to bereavement". After the play the party continued into the small hours; a very successful night.

On 21 May a club-trip was organized. We visited the radio telescope and the Rubbish Processing Plant in Wijster. The day was concluded with a dinner in Grouw. A pleasant and instructive day.

The sportsday this year was on 21 August. The enthusiasm of the participants and the fine weather made this a very nice and relaxing day, concluded with a barbecue party. The Challenge Cup went from Autoecology to Workshop-1. Financial support was given to several sports events, such as the biologists tournament and a volleyball tournament.

The staff club has had a busy and very successful year.



In 1980 the NIOZ held a sportsday, with several activities, ending in the prize distribution.