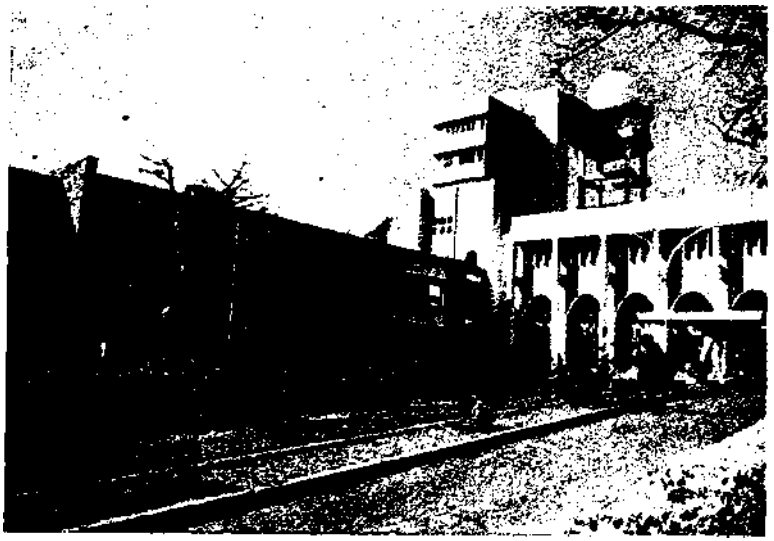
Annual Report

1979

NATIONAL INSTITUTE OF OCEANOGRAPHY

DONA-PAULA, GOA

INDIA



Main Building of the National Institute of Oceanography at Dona Paula, Goa

Facts about N. I. O.

Established	1966
Number of Divisions	7
Number of Regional Centres	3
Total Staff's Strength	437

Divisions at the Headquarters	Established	Present Staff
1. Physical Oceanography	1966	22
2. Biological Oceanography	1966	28
3. Planning & Data	1966	24
4. Chemical Oceanography	1970	31
5. Geological Oceanography	1973	34
6. Oceanographic Instrumentation	1973	40
7. Ocean Engineering	1976	9
Administration, Accounts, Purchase, Stores and Works	1966	141
Library and other supporting staff	1966-79	17

Regional Centres

1. Cochin	1966	47
2. Bombay	1975	26
3. Waltair	1976	18

ANNUAL REPORT

1979

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NATIONAL INSTITUTE OF OCEANOGRAPHY
(Council of Scientific & Industrial Research)
DONA PAULA-403004
GOA, INDIA

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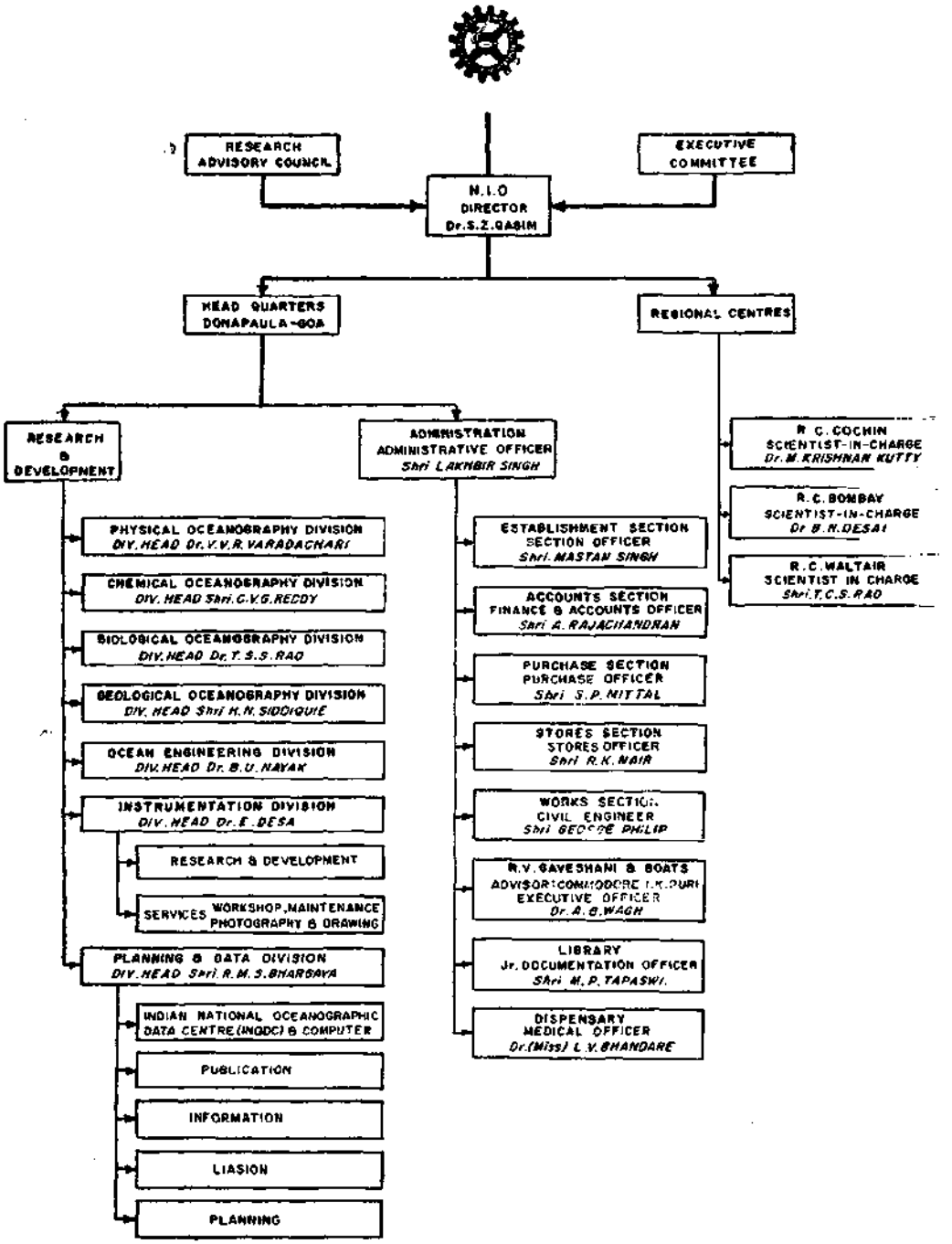
NATIONAL INSTITUTE OF OCEANOGRAPHY
ORGANISATION CHART



1

Director's Report

The year 1979 has been important and eventful for the Institute. Research activities of NIO were accelerated under the 23 different R and D projects. During the year, the Institute achieved notable progress in almost, all the research programmes. Several projects sponsored by the public and private sector organizations and international agencies were completed and some new projects were initiated.

A large number of scientists participated in the oceanographic cruises of R. V. Gaveshani and also in sponsored research work. Besides the generous financial support given by CSIR for the R & D work and infrastructure facilities and services, the total revenue received by the Institute for sponsored work from its clients was Rs. 75 lakhs (7.5 million) as compared to Rs. 43 lakhs (4.3 million) of the previous year.

A. Areas of Research

The 23 ongoing R & D institutional projects have been selected from the 7 major priority areas identified by the Institute. These are:

(1) Food from the Sea *(2)* Minerals from the Sea (3) Drugs from the Sea (4) Energy from the Sea (5) Coastal zone management (6) Pollution control (7) Development of marine instrumentation

B. R and D activities

(a) Headquarters — Goa

(i) R. V. Gaveshani undertook 19 cruises in 1979 covering 31,000 line kilometres in the Arabian Sea and Bay of Bengal. In these cruises, 765 station were worked and a large volume of information was collected on different oceanographic features of the seas around India.

(ii) The Institute actively participated in the Monsoon Experiment of 1979 (MONEX-79) from May to August as part of the First Garp Global Experiment (FGGE) under the Global Atmospheric Research Programme (GARP). Under this programme, R. V. Gaveshani undertook six cruises — 4 in the Arabian Sea and 2 in the Bay of Bengal collecting meteorological and oceanographic data from 534 stations on the progress of monsoon in the Indian Ocean.

(iii) Oceanographic cruises of the Andaman Sea were undertaken for the first time in which the following features are worth mentioning:

(a) monotonic decrease in temperature with depth on the western side of the Andaman islands and almost constant temperature below 1500 m.

(b) off Andaman, nitrate was almost absent and oxygen concentration was extremely low

(c) column primary productivity was fairly high (273 $mgC/m^2/day$)

(d) changes in the benthic population appear to be related to changes in hydrography, biotic features and bottom characteristics

(iv) In the northern Arabian Sea, water masses and circulation studies revealed some interesting features. The circulation was comprised of numerous eddies. The bottom topography, featured by depressions and rises, appears to influence the circulation to generate the eddies.

(v) Sound velocity studies in the Persian (Arab) Gulf waters indicate a seasonal variation in the flow path and consequent changes in the sound velocity structure.

(vi) Under the project 'Drugs from the sea', 15 more organisms from the sea were identified having promising antifertility activity.

(vii) Konkan coast was found to have heavy mineral deposits up to a depth of about 11 m in the sea bed.

(viii) Underwater (diving) survey carried out in the Malvan Bay (central west coast) along the Maharashtra coast revealed the presence of pearl oysters and corals.

(ix) Marine instruments like the wave and tide gauges, air thermometer (3 channel) and CTD system were designed and developed.

(x) Paleoclimate studies indicate that 10,000 years ago, the climate over India was warmer and drier than what it is at present. The precipitation in the past was heavy but short-lived, and the change from dry conditions to the present humid conditions appears to be somewhat sudden.

(xi) A manual on the protection and control of coastal erosion in India was finalised and sent to the press for publication.

(xii) Investigation on the culture of brine shrimp was initiated under a grant received from the International Foundation of Science (IFS), Stockholm, Sweden.

(b) **Regional Centres**

The Regional Centres made considerable progress in R & D and sponsored work. Some of the main features of their work were as follows :

(1) **At Cochin**

Further work was carried out on :

(i) Lakshadweep Islands and on several aspects of the estuarine system of Kerala.

(ii) Shrimp-cum-paddy culture in Cochin backwaters: marketable size of shrimps was obtained in three months in high-density-culture and two crops could be taken in one season before the paddy crop.

(iii) Giant oyster on raft: their growth on rafts was much faster than in natural beds.

(iv) Sorting of samples received from CSIRO, Australia.

(2) At Bombay

Marine environmental monitoring along the Bombay coast was continued. The Centre worked on several sponsored projects related to the selection of suitable discharge points for waste disposal in the sea. This laboratory has already established itself as a centre of excellence in environmental monitoring and pollution control.

(3) **At Waltair**

The Centre carried out oceanographic studies off Waltair and in adjacent areas. Echosounding and side scan sonar surveys and current measurements in the outer harbour area of Visakhapatnam were carried out at the request of the Visakhapatnam Port Trust. This work was in addition to the institutional work undertaken on the geophysical surveys of the Andhra coast.

C. Sponsored Research

The Institute worked on 19 sponsored projects which included a variety of scientific areas such as monsoon studies, pipeline surveys, pollution control, coastal development, resources survey etc. Of the 19 projects, 9 were continued from the previous year and 10 additional projects were undertaken during the year. The cost of these 10 additional projects was Rs. 75 lakhs. Besides these, a large number of consultancy services were provided to public and private undertakings.

D. Infrastructure

(i) Many instruments such as the CHN analyser, atomic absorption spectrophotometer, underwater camera, gas-liquid cromatograph, spectronic-20 etc. were added during the year. 'Transocean Atlantic' radio telephone system was also installed at the Institute for communication with R. V. Gaveshani.

(ii) Under the Indo-Norwegian Technical Assistance Programme, electronic ship-board instruments worth Rs. 30 lakhs have been received. These include Simrad EK deep sea echosounder (6000 m), miniranger, ORE sub-bottom profiler and EG and G seismic unit with boomer and 8 KJ sparker system.

(iii) Expandable bathythermograph (XBT) system was installed on R. V. Gaveshani.

(iv) The Computer TDC-316 was upgraded with the addition of one magnetic tape, 28 K core memory, business emulator, two magnetic tape units, memory allocation, floating point processor and system clock. These have increased the capacity of the computer to process almost every type of data.

(v) More than 350 books and 450 technical reports have been added to the Library. These were in addition to about 300 periodicals and a very large reprint collection.

(vi) Construction of Phase II of the laboratory building was started.

E. Collaboration with other Organisations

Work on four All India Coordinated Projects was continued in collaboration with the Regional Research Laboratory (RRL), Bhubaneshwar, National Geo-

physical Research Institute (NGRI), Birla Sahani Institute for Paleobotany (BSIP), Indian Petroleum Exploration (IPE), Central Drug Research Institute (CDRl), National Physical Laboratory (NPL) and Central Scientific Instruments Organization (CSIO). Several investigations were also undertaken in collaboration with the universities and fisheries departments.

A national seminar on the "Protection of Marine Environment and Related Ecosystem" was organized at the Institute. This was jointly sponsored by the Department of Science and Technology, Ministry of Shipping and Transport and NIO.

F. Publications and Information Services

More than 100 research papers were published during the year by the staff and 20 technical reports were brought out by the different divisions. A new service was started in the form of a quarterly NIO Newsletter. Brochure on 'Technical Information and Publication Services' and on 'Sponsored Projects undertaken during 1978' were released. Many news items on the work of the Institute were released and radio talks related to the activities of NIO were given.

The Institute was visited by a large number of scientists, university professors, engineers and very important persons from public and social life of India and abroad. The total number of visitors to the Institute by the end of the year was 2,500. Several professors, scientists and engineers delivered talks and held group discussions with the staff.

G. Honours and Awards

During the year several members of the staff of NIO worked on national and international committees working groups and received recognition on their work. Shri H. N. Siddiquie, Head GOD was awarded the Shanti Swarup Bhatnagar Prize in Earth Sciences for the year 1978.

S. Z. QASIM
DIRECTOR

2

Research Activities

2.0 Oceanographic cruises of Research Vessel 'Gaveshani'

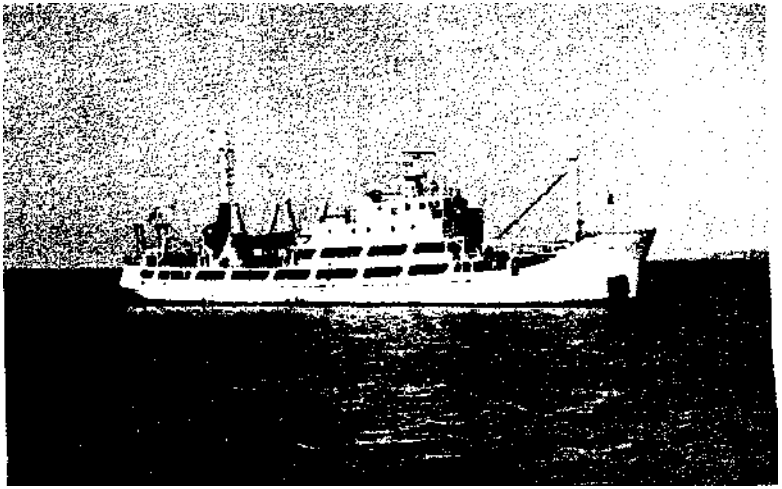
During the year 1979, R.V. Gaveshani completed 19 cruises and worked at 765 stations along 31,000 line km. Of these 15 cruises were undertaken in the Arabian Sea and 4 in the Bay of Bengal.

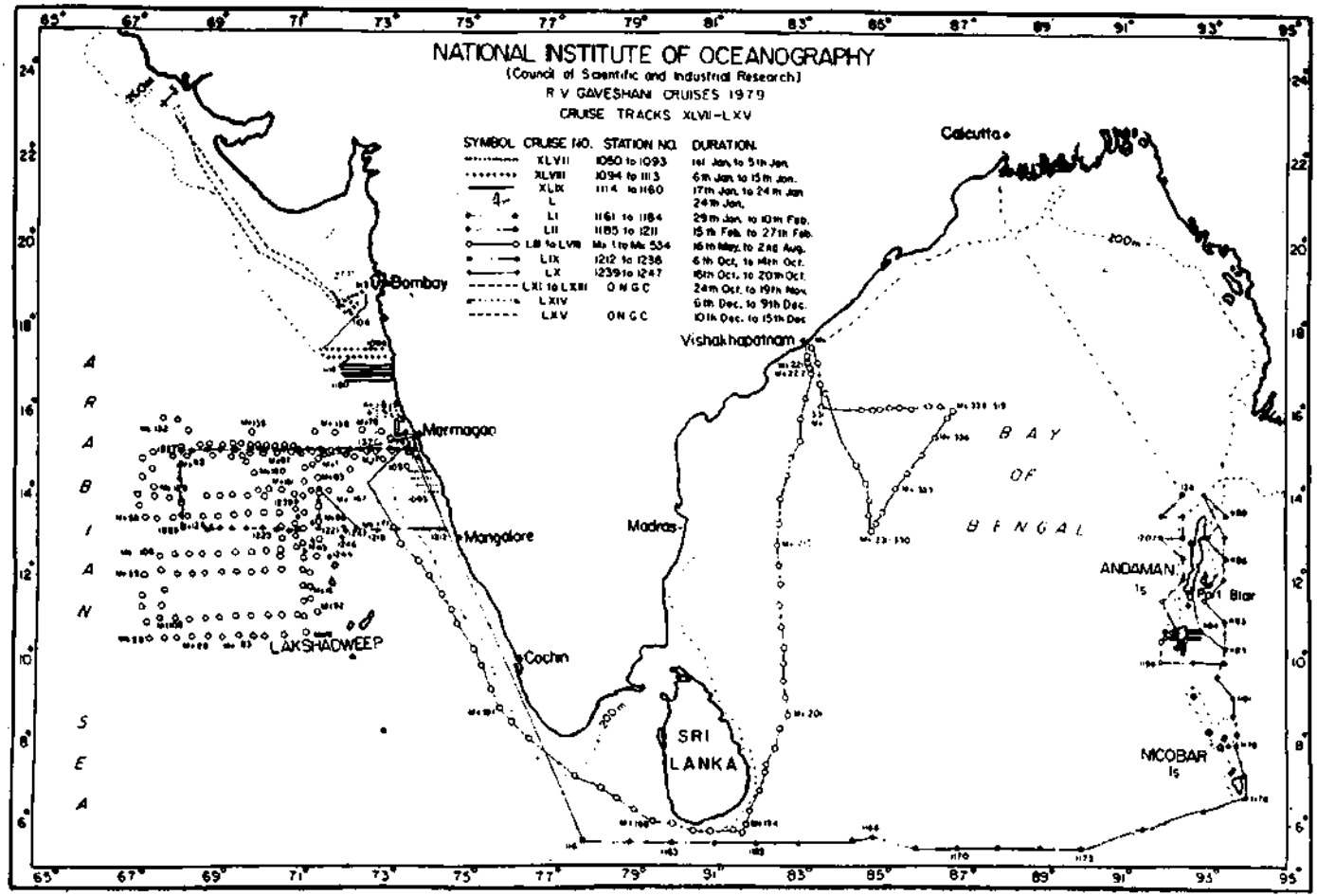
Cruises in the Arabian Sea

Of the 15 cruises in the Arabian Sea, one cruise was undertaken for the sampling of sediments from 44 stations between Mormugao and Karwar. Two cruises were devoted to geological and geophysical surveys of the continental shelf and slope of the west coast of India. One was undertaken in collaboration with the Geological Survey of India (GSl) for the preparation of surficial geological map of the continental shelf of India. One cruise was organised at the request of Andhra University to demonstrate the operation of various marine geological and geophysical equipments on board to the participants of the course "Marine Geophysical Technology". One cruise was for the sea trial of the geological and geophysical equipments received under the NORAD assistance programme. One cruise was of multidisciplinary nature. Four cruises were organised under MONHX-79 sponsored by the Government of India as part of the First Garp Global Experiment (FGGE). The remaining 4 cruises were undertaken for the Oil and Natural Gas Commission (ONGC) for the survey of submarine oil pipeline route from south Bassein to Gujarat.

Cruises in the Bay of Bengal

Of the 4 cruises in the Bay of Bengal one was for the study of pollution along the oil tanker route across the Bay of Bengal upto the head of Malacca Strait. One cruise was devoted to the study of oceanographic conditions in the Andaman Sea and the remaining two cruises were for the MONFX-79 programme.




NATIONAL INSTITUTE OF OCEANOGRAPHY
(Council of Scientific and Industrial Research)
R V GAVESHANI CRUISES 1979
CRUISE TRACKS XLVII–LXV
SYMBOL CRUISE NO. STATION NO. DURATION
XLVII 1060 to 1093 1st Jan. to 5th Jan.
XLVIII 1094 to 1113 6th Jan. to 15th Jan.
XLIX 1114 to 1160 17th Jan. to 24th Jan
L 24th Jan.
LI 1161 to 1184 29th Jan. to 10th Feb.
LII 1185 to 1211 15th Feb. to 27th Feb.
LIII to LVII Ms 1 to Ms 534 16th May. to 2nd Aug.
LIX 1212 to 1238 6th Oct. to 14th Oct.
LX 1239 to 1247 15th Oct. to 20th Oct.
LXI to LXIII ONGC 24th Oct. to 19th Nov.
LXIV 5th Dec. to 9th Dec.
LXV ONGC 10th Dec. to 15th Dec
Calcutta
Vishakhapatnam
Bombay
Marmagao
Mangalore
Madras
Cochin
LAKSHADWEEP
SRI LANKA
ANDAMAN Is
Port Blair
NICOBAR Is
BAY OF BENGAL
ARABIAN SEA
200m

Summary of the work done in each cruise is as follows:

Cruise 47 (Chief Scientist: R. R. Nair)

During the 5-day cruise from January 1-5. the area between Goa and Bhatkal — a geologically transit region, where the Deccan Traps and the Dharwarian rocks occur, was covered.

During the cruise forty four grab samples, spaced at 5 km. were collected along 4 transects 20 km apart. The length of each transect ranged from 36 to 51 km and the number of samples collected varied from 9 to 12 in each transect. About 200 line km of echosounding data was obtained. Sample positioning was done by radar and shore light fires. CTD system fabricated by the Instrumentation Division of NIO was tested for water tightness at 400 m depth.

Cruise 48 (Chief Scientist: H. N. Siddiquie)

This cruise of 11 days duration was organised from 6-16 January to fill in the gap between the INS Darshak surveys north of Ratnagiri (off Warori Bluff) and the R. V. Gaveshani surveys carried out in the southern region.

Echosounding, side scan sonar, shallow seismic and magnetic surveys over 370 line km were carried out on the shelf off Warori Bluff and 135 line km on the Direction Bank. Moreover, 12 bottom samples were collected off Warori Bluff and 9 on the Direction Bank. In addition, 175 line km of magnetic surveys were carried out from the shelf edge upto Bombay.

Cruise 49 (Chief Scientist: H. N. Siddiquie)

The 8-day cruise was organised from 17 to 24th January as a continuation of the collaborative programme between NIO and Geological Survey of India (GSI) for the surficial geological mapping of the continental shelf between Vengurla and Vijaydurg. The continental shelf in the northern parts, between Rajapur Bay and Warori Bluff was also covered during this cruise. The locations were obtained with Decca Hifix, Radar and Dead Reckoning. The survey included about 703 line km of echosounding. 638 line km of side scan sonar. 565 line km of shallow seismic and 690 line km of magnetics. In all, 46 grab and 6 dredge samples were collected. A newly acquired underwater camera was also operated during the cruise.

Cruise 50 (Chief Scientist: H. N. Siddiquie)

This one day cruise on 24th January, a training cruise, was conducted to demonstrate the operation of various marine geological and geophysical equipment to the participants of the short-term specialist course on "Marine Geophysical Technology" organized by the Andhra University with the assistance of the University Grants Commission. Besides the NIO scientists, the participants included 8 from different universities. 2 from Indian Institute of Technology, 1 from National Geophysical Research Institute (NGRI) and 4 from Geological Survey of India (GSI).

Over 50 line km echosounding side scan sonar, shallow seismic and magnetic surveys were carried out on the continental shelf off Mormugao. In addition to these, the operation of seabed samplers was also demonstrated to the trainees.

Cruise 51 (Chief Scientist: S. Z. Qasim)

This cruise was multidisciplinary in nature and the objective of the cruise

R. V. *Gaveshani* Port Blair - Scientific staff and officers during the 51st cruise to the Andaman Sea.

Visit of R. V. Gaveshani to Port Blair - Dr. *R.* Sen Gupta explaining the work done during the cruise to the Chief Commissioner of Andaman. Shri S. M. Krishnatri who was on board *Gaveshani*

were (i) a survey of the oil tanker route across the Bay of Bengal up to the head of Malacca Strait and (ii) a study of oceanographic conditions in the Andaman Sea.

During the 13 day cruise from 29th January to 10th February, the ship covered about 3900 line km and worked at 24 stations of which 11 were in the Andaman Sea. In all, 164 water samples were collected and 1344 analyses were carried out on board. 368 samples were treated and or preserved on board for the analyses in the shore laboratory. The parameters measured were salinity, dissolved oxygen, pH, phosphate-phosphorus, nitrate-nitrogen, nitrite-nitrogen, ammonia-nitrogen, silicate-silicon, fluoride, dissolved and paniculate matter, heavy metals, petroleum hydrocarbons, primary productivity, zooplankton biomass, benthic fauna etc.

The ship-borne wave recorder was operated at all the stations and the thermosalinograph on board was run between the stations. The CTD probe and the oxygen-temperature sonde were operated at a few stations. Long-line fishing was carried out at one station south of the Great Nicobar Island. Routine meteorological observations were made throughout on board. While at Port Blair a reconnaissance survey of beach erosion at Corbyn's Cove was conducted.

Cruise 52 (Chief Scientist: R. Sen Gupta)

The 13 day cruise from 15 February to 27 February was in continuation of the earlier cruise. During this cruise the waters around the Andaman islands upto 30 miles from the coast were surveyed. In all 39 stations were worked. Hydrographical, hydrochemical and marine biological studies including productivity, zooplankton biomass, extra-cellular products and benthos were conducted. Current measurements were made for 12 hours at one anchor station off Little Andaman. A parachute drogue was also released to study the flow of water. A new CTD probe and a current meter designed and fabricated at NIO, were tested at several deep stations.

During the cruise, the ship covered a distance of about 2400 line km and 1782 analyses were carried out on board, 658 samples were treated and/or preserved on board for examination of different biological constituents, heavy metals and petroleum hydrocarbons. Several samples of sediment were collected for radiological studies to be conducted by the scientists of the Bhabha Atomic Research Centre (BARC), Bombay.

Cruise 53 (Chief Scientist: J. S. Sastry)

This 3-day cruise from May 16 to 18 was multi-disciplinary and multi-agency in nature. It was specifically organised to test all the instruments on board R. V. Gaveshani which were to be used during MONEX-79. This was, therefore, a trial cruise or a preparatory cruise and has been termed as MONEX I. This formed a part of the First Garp Global Experiment (FGGE). Besides the 8 scientists from NIO. 6 scientists from Space Application Centre (SAC), 4 from India Meteorological Department (IMD) and one from Electronics Corporation of India Ltd (ECIL) participated in this cruise.

Cruise 54 (Chief Scientist: V. V. V. Varadachari)

This 14-day cruise MONEX II—from 21st May to 3rd June was again a multi-disciplinary and a multi-agency in nature. Along with the NIO scientists, 3 scien-

tists from Naval Physical and Oceanographic Laboratory (NPOL), 4 from IMD and 2 from SAC participated in the cruise. Its objective was to study the oceanographic and meteorological features of the Central Arabian Sea, between latitudes 11° N and 15° N and longitudes 68°E and 72°E prior to breaking of monsoon.

During this cruise about 3400 line km were covered and 73 stations were occupied. About 101 surface meteorological observations at three hourly intervals were made. Thirty-three upper sounding observations were also recorded. About 2958 samples were analysed on board for chemical analysis. Position fixing throughout the cruise was done by SATNAV System.

Cruise 55 (Chief Scientist: J. S. Sastry)

This MONEX III cruise, like the earlier two cruises, was a multi-disciplinary and multi-agency in nature. Three scientists from SAC, 3 from IMD and 1 from NPOL participated in this cruise along with NIO scientists. The objectives of this cruise were to investigate the variations in time and space of the oceanographic and meteorological conditions of the Arabian Sea. The cruise was planned to coincide with the normal onset of the southwest monsoon.

This 12-day cruise was from 8-19 June. The track covered and the observational pattern were similar as those during the 54th cruise. In all 63 stations were worked during the cruise. At these stations BT, hydrocast, CSTD, wave and surface meteorological data were collected. At standard depths water samples for 23 stations were collected for chemical analysis. Upper observations were also conducted by using Omega Sonde System.

Cruise 56 (Chief Scientist: J. S. Sastry)

This MONEX IV 6-day cruise from 29 June to 4 July was again multi-disciplinary in nature. The objective of this cruise was to study the oceanographic and meteorological parameters during the south-west monsoon season and hence this cruise was the concluding one of the Monex programme in the Arabian Sea.

Due to difficulty in the operation of all equipment from the ship, because of turbulent weather, only MBT or XBT stations at three hourly intervals could be undertaken. At these BT stations, wave recording was also carried out. A total number of 34 BT records were obtained Surface meteorological observations at 3-hourly intervals were taken regularly. Due to the strong winds and high seas, the filling of the balloons and releasing them had been extremely difficult and only three ascents could be taken successfully for upper wind measurements.

Cruise 57 (Chief Scientist: L. V. Gangadhara Rao)

This MONEX V cruise was undertaken in the Bay of Bengal. The objective of this cruise was to collect data on oceanographic and meteorological parameters during southwest monsoon. Like the other four cruises, this was also a multi-disciplinary and multi-agency cruise.

This 11-day cruise was from July 9-16. In all, 52 stations were worked during this cruise. At all the stations, XBT system and wave recorder were operated and temperature profiles and wave data were obtained. Sea surface salinity was also recorded. Besides these, at all the stations meteorological observations comprising

of wind speed and direction, temperature, pressure, humidity etc were also made. Position fixing was done with SATNAV system.

Cruise 58 (Chief Scientist: L. V. Gangadhara Rao)

This was the concluding MONEX cruise which lasted 17 days from July 17 to August 2. Two stationary locations were occupied during this cruise which formed a very important phase of the observational programme in the Bay of Bengal under Monex-79.

In all, 313 stations were worked during this cruise. Water samples were collected from various depths at the two stationary locations by Nansen cast operations on different days and were analysed on board for salinity, dissolved oxygen, phosphate, nitrate, nitrite, silicate and pH. In total, 1251 analyses were carried out. Surface meteorological observations were carried out at hourly intervals. Upper air observations were conducted at the stationary locations on these 17 days.

Cruise 59 (Chief Scientist: T. S. S. Rao)

This cruise of 9 days duration from 6th to 14th October was multi-disciplinary in nature and was undertaken to study the oceanographic features of the area between latitudes 13° and 15° N and longitude 68° E on the west coast. The importance of this cruise lies in the fact that the same area had been studied earlier during the Monex cruises. Hence this cruise gave continuing information of this area during the post-monsoon season. In this cruise, 2360 line km and 48 stations were covered, of which 21 stations were taken for XBT observations only. All hydrographic parameters were studied at 27 stations. The parameters determined were temperature, salinity, dissolved oxygen, pH, phosphate-phosphorus, nitrate-nitrogen, nitrite-nitrogen, ammonia-nitrogen, dissolved and paniculate trace elements, mercury from both water and sediment, petroleum hydrocarbons, primary productivity using radio-carbon technique, chlorophyll a, zooplankton biomass, etc., Meteorological observations included dry and wet bulb temperatures, sea surface temperature, sea state, atmospheric pressure, wind speed and direction, clouds, etc. Ship-borne wave recorder was used at all the stations.

Cruise 60 (Chief Scientist: H. N. Siddiquie)

The 5-day cruise from 16th to 20th October was organised for the geological and geophysical surveys of the continental shelf and slope between Mormugao and Karwar. During this cruise more than 715 line km of echosounding and magnetic survey, 240 line km of side scan sonar and 198 line km of shallow seismic profiling were carried out. Five grab snapper samples were collected. The heat flow measurements were carried out at the request of National Geophysical Research Institute (NGRI). A marine heat flow probe designed and fabricated by the 'Physics of the Earth Institute', Moscow was used for this purpose.

Cruise 61 (Chief Scientist: M. Veerayya)

This 11 days cruise was undertaken from 24th October to 3rd November at the request of the ONGC for the sea bed survey at locations (D & I) on Kori Great Bank, and B38-6 on Direction Bank. More than 240 line km of echosounding, 220 line km side scan sonar. 145 line km shallow seismics were carried out on the Kori Great Bank and 65 line km of echosounding and side scan sonar on

the Direction Bank followed by sea bed sampling. In addition, 1350 line km of echosounding and magnetic surveys were also carried out between Direction Bank and Kori Great Bank. The surveys were undertaken on the Decca Navigator Chain.

Cruise 62 (Chief Scientist: M. Veerayya)

This cruise of 4 days from November 7 to 10 was organised for (i) fixing the location of R12-2, the proposed site for jacking up D. V. Gettysberg, with the Miniranger system, and (ii) seabed surveys between locations R12-1 and B38-7 with the Miniranger system in conjunction with the Decca Navigator Chain. During the cruise, more than 90 line km of shallow seismics were carried out, besides fixing the location of R12-2.

Cruise 63 (Chief Scientist: M. Veerayya)

This 9-day cruise was from 11th to 19th November. About 40 line km of echosounding and side scan sonar and 18 line km of shallow seismic profiling were carried out at South Bassein.

About 25 line km of echosounding, side scan sonar and shallow seismic profiling were carried out near the Tapti Dome Structure. These were followed by tide and current observations for 30 hours at anchored station.

Cruise 64 (Chief Scientist: H. N. Siddiquie)

This short cruise of 4 days from 6th to 9th December was organized off Goa for the sea trails of the geological and geophysical equipment received under the NORAD assistance programme and installed on R.V. Gaveshani. The equipment received included Motorola Mini Ranger System, Simrad Deep Sea Echosounder, ORE Seismic Profiler and EG and G Sparker / Boomer. The Mini Ranger Position Fixing System gave very accurate positions to a distance of about 75 km while the remote depth indicator Simrad IS was connected to Simrad DQ and operated. The ORE Seismic profiler was operated with the hull mounted transducer and both the EG & G sparker and boomer were operated and a penetration of about 10 m was obtained by the ORE Profiler and 50 to 150 m by the EG & G Sparker and Boomer. The performance of the equipment was excellent and the cruise was useful for redesigning of the circuits, rearrangement of the equipment and planning of the next refit of the vessel.

Cruise 65 (Chief Scientist: H. N. Siddiquie)

During the 6 days cruise from 10-15 December, a survey of submarine pipeline route from South Bassein to Gujarat was undertaken. The surveys were carried out on the Mini Ranger Position Fixing System with base stations at Umbargaon, Tarapur, Arnala and Erangal. However, the south-western part of the lines (more than 70 km from the shore) were outside the range of the Mini Ranger and consequently they were surveyed by the Decca Navigator. Over 448 line km of sub-bottom profiling were carried out during the cruise.

Cruise 66 (Chief Scientist: T. S. S. Rao)

This cruise was started on 27 December from Mormugao and ended in Penang (Malaysia) on 8th January 1980.

2.1

Physical Oceanography

2.1.1. Studies on ocean-atmosphere interaction

1. Monex-77 and 79
2. Studies on heat budget of Andaman Sea
3. Potential energy
4. General hydrography and circulation
5. Storm surges
6. Microstructure

2.1.2 Studies on physical processes in the seas around India

1. Studies on northern Arabian Sea
2. Studies on wave climate of Bay of Bengal
3. Studies on the surface boundary layer
4. Feasibility studies on thermal energy

2.1.3 Studies on land-sea interaction and nearshore circulation along the Indian coastline with application to coastal zone management

1. Nearshore circulation along the central west coast of India
2. Testing of new equipments and methods
3. Development of computer programmes
4. Studies on Mandovi-Zuari estuarine system
5. Oceanographic studies along the Gujarat coast
6. Oceanographic survey of the sea off Travancore
7. Beach changes along Kerala coast

2.1.4 Utilization of wave energy for shore protection and water pumping

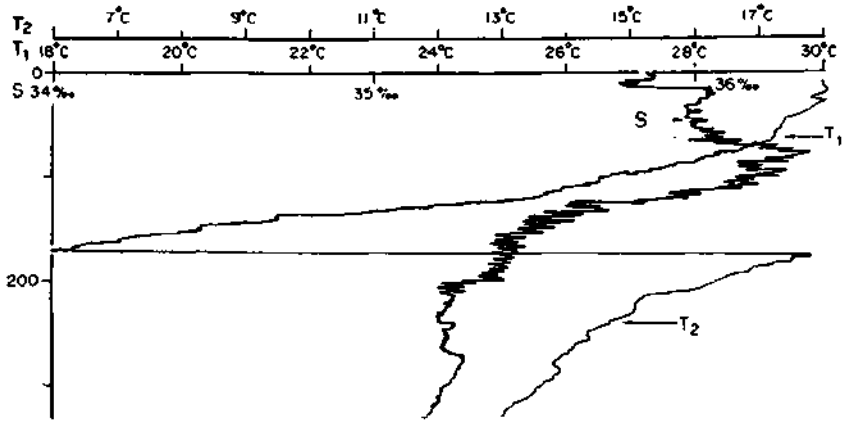
The research activities of Physical Oceanography are comprised of four projects. The progress made under each project is as follows:

2.1.1 Studies on ocean-atmosphere interaction

1. Monex-77 and 79

(a) Monex-77: Oceanographic and surface meteorological data collected on board Russian ships in the Arabian Sea and Bay of Bengal during 1977 have been analysed to illustrate the development of mixed layer. Strength of vertical current shear was found to decrease from the first phase (beginning of monsoon) to the second phase (after the onset of monsoon) in the upper layers of 200 m along with an increase in the current field. The wind stress curl was negative and steady during the phase II as compared to positive and fluctuating values during the Phase I.

(b) Monex-79: Under Monex-79, six cruises of R. V. Gaveshani were undertaken in the Arabian Sea and Bay of Bengal from May to August 1979.



Continuous records of salinity, temperature and depth obtained from a CSTD system during Monex-79

The Arabian Sea programme consisted of collection of data at several stations in the Monex square between 11° and 15° N and 68° and 72° E. Repeated observations were made during May, June and July to study the lime variations in the oceanographic and meteorological parameters with the advance of southwest monsoon. MBT and XBT casts were made at every 20 mile intervals alone the track. An analysis of this data showed that the sea surface temperature was high during May and June (about 30°C) and by July it lowered by about 2.0°C. The thickness of the surface layer also increased with the advance of southwest monsoon.

The CSTD records which were collected at 3-hourly intervals have been digitised at every 5 m intervals and corrections for salinity and temperatures were made. A few wave records have been digitised at an interval of 1 sec with a view to study the spectral characteristics of ocean waves during the period. The hydrocast data have also been processed. Some salient features of the observations are:

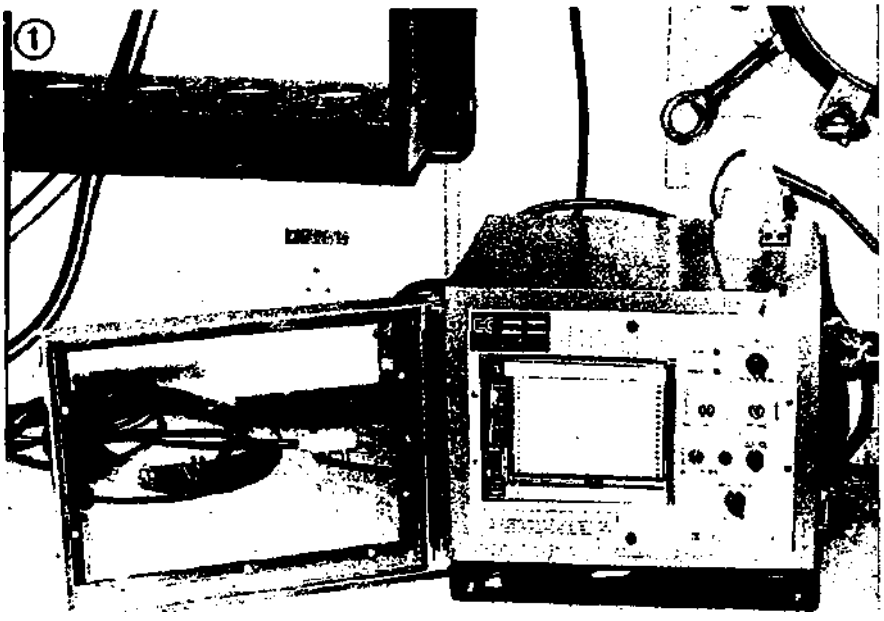
(i) Appearance of step-link structure in temperature and salinity at a few locations

(ii) Appearance of salinity maxima and minima corresponding to various water masses in the Arabian Sea

(iii) Occurrence of high (9-10 m) waves during July

(iv) Lowering of SSTs by about 4° C off southwest coast of India with the advance of southwest monsoon.

In the Bay of Bengal, R. V. Gaveshani had occupied two stationary locations where observations were carried out. In addition, three more sections were occupied where XBT data were collected at every 30 miles apart and the data have been digitised at 5 m intervals. Further analysis is being carried out.



Expandable bathythermograph (XBT) system installed on R. V. Gaveshani for obtaining continuous record of temperature upto 460 m depth in the sea.
(1 -Recorder, 2-Launcher)

2. Studies on heat budget of the Andaman Sea

These studies have been initiated during the year under report, to study the hurricane heat potential of this region which is known for its cyclogenesis. Radiation data of Port Blair (published by IMD) and surface meteorological and oceanographic data (mainly BT data of about 1200 stations) are being utilized to compute the various components of heat budget viz., incoming and the net out-going radiations, heat storage in the sea and their seasonal variations.

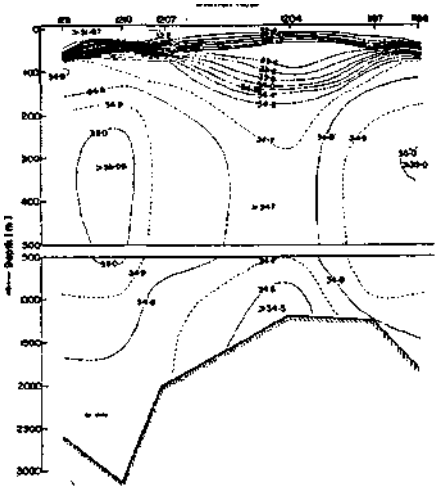
3. Potential energy

A study of the energy transformations within the sea has been initiated during the year to understand the microstructlure observed in the CSTD profiles collected during Monex-79 and earlier. The data on pressure, volume and temperature are being analysed to study the potential energy of water parcels and its transformation as the water parcel is displaced to a new location.

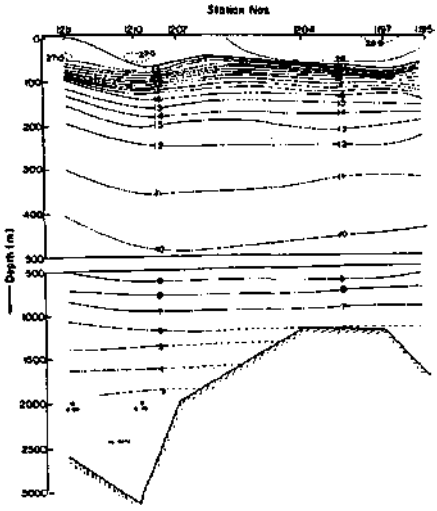
4. General hydrography and circulation

(i) Lakshadwecp Sea: The mixed layer was found to extend upto 90-100 m depth with a two layered structure — an upper isothermal layer and a lower layer with weak thermal gradient. The Arabian Sea high salinity water was observed as a sub-surface high salinity core in the Lakshadweep Sea. The Persian Gulf water and the Red Sea water were also observed. Surface salinity showed wide variations and these were related to the influx of water from the Bay of Bengal. Considerable meridional salinity gradients existed at the surface.

(ii) **Andaman Sea and the Bay of Bengal**: Based on the data collected



Distribution of salinity along the section west Andaman & Nicobar Islands.



Thermal structure along a section west of Andaman & Nicobar Islands.

during the 51st and 52nd cruises of R.V. Gaveshani vertical profiles of temperature and salinity, longitudinal sections along the western and eastern sides of the Andaman and Nicobar group of Islands have been prepared. It is observed that, in contrast to the monotonic decrease of temperature with depth on the western side of the Andaman islands, the temperature below 1500 m depth remains unchanged (about 5°C) in the Andaman Sea. Salinity below 1500 m in the Andaman Sea also remains remarkably uniform.

5. Storm surges

Computations have shown that the amplitude of storm surge was approximately 15% of the tidal range and fluctuated with periodicities of the order of 12 hours. Computer programmes have been developed for computing storm surges at selected stations along the east coast of India and predictions, based on quasi-steady state approximation, seems to be encouraging.

6. Microstructure

Digitisation of CSTD records collected from R. V. Gaveshani during 11th cruise have been completed and spectral characteristics are being studied. A computer programme for the spectral analysis has been developed.

2.1.2 Studies on physical processes in the seas around India

1. Studies on northern Arabian Sea

a) Thermohaline structure, watermasses and circulation: Studies based on the temperature and salinity data collected during I.N.S. Darshak cruises revealed the existence of a deep mixed layer during winter. A shallow seasonal thermohaline was found during March-April. Along with the formation of seasonal thermohaline, the surface layers exhibited complex salinity structure. High salinity water was noticed at about 60 m depth in the eastern sector of the northern Arabian Sea and Persian Gulf water was generally identified around 300 m depth.

Studies on circulation from geostrophic computations and distribution of temperature, salinity, depth and oxygen on isanosteric surfaces revealed some interesting features. The circulation was found to comprise of numerous eddies of large dimensions. The bottom topography of the study region, featured by depressions and rises, appears to influence the circulation to generate these eddies. Distribution of properties on isanosteric surfaces revealed several pockets of high and low values.

b) Sound velocity structure: Small scale features of sound velocity structure in the upper 500 m of the sea during pre-monsoon period were studied using the STD data obtained during I. N. S. Darshak cruises. Relatively warm and saline waters of the Persian Gulf, intruding into the Arabian Sea at intermediate depths (200 m — 400 m), influence the sound velocity structure and lead to the formation of upper sound channel in the northern Arabian Sea. The Persian Gulf waters have been found to spread out as tongues at one or two levels (up to a limited extent), besides the prominent one characterised by temperature inversion and salinity maxima causing significant perturbations in the sound velocity. As the distance from the source region increases, the Persian Gulf water loses its identity

and does not affect the sound velocity structure. In the upper 50 metres, the sound velocity structure changes significantly from spring to summer during which period a seasonal thermocline gets formed due to intense surface heating. The studies indicate a seasonal variation in the flow paths of the Persian Gulf water probably leads to changes in the sound velocity structure.

2. Studies on wave climate of the Bay of Bengal

Wave characteristics in the western and northwestern Bay of Bengal during the southwest monsoon have been studied using the wave data collected with a shipborne wave recorder during August and September, 1978. The wave data have been analysed for significant, root mean square and maximum wave heights, zero-crossing period, average period and spectral width parameters. The significant wave height varies over a wide range (between 30 and 220 cm) while the zero-crossing period varies from 6 to 15.5 sec with a maximum occurrence between 6.5 and 8 sec. The percentage occurrence of spectral width parameter showed that the zero-crossing period exceeds the average period in most cases.

Investigations on wave persistence in the central Bay of Bengal have been carried out with the wave data collected during July 1979 under Monex-79 programme. The different wave parameters have been evaluated and the persistance diagrams for different wave height levels for both rough and calm conditions have been prepared and studied. The significant wave height is more than 1 m with 60% of the values between 1 and 2 m. 75% of the values of zero-crossing period lie between 7.5 and 9.5 sec. The values of spectral width parameter are confined to 0.7-0.9.

3. Studies on the surface boundary layer

The energy transfer from oceanic surface to the overlying atmosphere and vice versa in the form of water vapour, heat and momentum, mainly affects the surface boundary layer (SBL). Information on the conditions of SBL is essentially required for a detailed understanding of atmospheric boundary layer (ABL). As a prelude to these studies, the different forms of stability parameters and their interrelationships, largely in terms of stability functions, have been worked out. The surface boundary layer conditions over the northern Indian Ocean during the summer monsoon are being studied making use of the surface meteorological data collected during Monsoon-77 expedition.

4. Feasibility studies on thermal energy

Preliminary studies have been carried out on the choice of working fluid and its thermodynamics in ocean thermal energy conversion plants. Causes for high cost of OTEC plants and suitability of a number of alternate working fluids for a low-powered OTEC plants are being investigated.

2.13 Studies on land-sea interaction and nearshore circulation along the Indian coastline with application to coastal zone management

The studies under this project have been carried out partly from the headquarters and partly from the Regional Centres at Cochin and Bombay.

1. Nearshore circulation along the central west coast of India

Strong tidal influence on currents was noticed very near the shore in the sea off Mangalore which decreased with increasing distance from the shore. At about 2 km from the shore, the currents showed the least shoreward component.

The pattern of currents at two locations in Gurpur River and one location in the New Mangalore Harbour were recorded at 15 min interval for a duration of 24 hours. The maximum observed current in the river was 46 cm/sec during the ebb tide and 33 cm/sec during the flood tide. The currents inside the New Mangalore Harbour were relatively weak with their maxima lying between 17 to 21 cm/sec only.

2. Testing of new equipments and methods

A number of Aanderaa current meters and a few tape readers and tape punches received under NORAD assistance project were tested. A test mooring of one of the current-meters was carried out to evaluate the performance of the current meter and the mooring system used.

3. Development of computer programmes

Computer programmes for (1) decoding and processing the data from Aanderaa current meters, (2) finding harmonic constants for seven principal constituents of the tide and (3) predicting the tide and tidal currents from the harmonic constants and mean sea level have been developed and extensively used for the analysis of different data.

4. Studies on Mandovi-Zuari estuarine system

A comprehensive survey of the hydrodynamic characteristics of the Mandovi and Zuari rivers including the Cumbarjua Canal have been carried out. The study includes investigations on current, tidal influence, stability, stratification, mixing processes, flushing/residence time etc. The Mandovi and Zuari river basins have an estimated runoff of 16 km^3 year and 9 km^3 year.

Studies on salt intrusion indicate that salinity in the river Mandovi, 67 km upstream during May is 0.9%o and during June/July similar salinity occur 10-15 km upstream. In the river Zuari 0.9%o salinity occurs at a distance of 65 km upstream during May and 20 km of upstream in July. These estuaries are more or less homogeneous from surface to bottom for a major part of the year except during the southwest monsoon. Salt wedges have been found in both the estuaries during the monsoon months.

Tidal currents predominate in both the estuaries as well as in the Cumbarjua Canal. The strongest current encountered during the survey was 122 cm/sec near the Mandovi bridge in July.

5. Oceanographic studies along the Gujarat coast

Work done under this programme has been reported separately under the Regional Centre, Bombay.

6. Oceanographic survey of the sea oil Travancore

Detailed information in respect of the work done under this programme has been reported under the Regional Centre, Cochin.

7. Beach changes along the Kerala coast

The progress made under this investigation has been reported under the Regional Centre, Cochin.

2.1.4 Utilization of wave energy for shore protection and water pumping

Some field models of the wave energy oscillator have been developed and these are being tested.

2.2

Chemical Oceanography

2.2.1 Chemical studies in the coastal and offshore waters of the Arabian Sea and Bay of Bengal

1. Investigations in the Arabian Sea, Bay of Bengal and Andaman Sea
2. Inorganic (dissolved) phosphorus and nitrogenous compounds in the sediments off Bombay and Gulf of Kutch
3. Urea degradation in sea water
4. Distribution of dissolved silicate in the Arabian Sea and Bay of Bengal
5. Studies on boron in Zuari estuary
6. Arsenic cycle in the coastal waters around India
7. Studies on some major constituents of sea water in northern Indian Ocean
8. Chemical speciation of some important metals in the sea and estuarine waters
9. Regeneration of nutrients from sediments and plankton
10. Organic constituents in the sea
11. Studies on desalination of sea water

2.2.2 Drugs from the sea

1. Screening of extracts from marine organisms for biological activity
2. Studies on carrageenan from **Hypnea musciformis**
3. Chemical investigations of marine organisms
4. Bromine and iodine contents of marine organisms from Andamans

2.2.3 Protection of marine environment and monitoring of pollutants with special reference to rural areas along the Indian Coast

1. Marine environmental monitoring in the Arabian Sea and Bay of Bengal
2. Pollution monitoring along the Kerala coast
3. Marine environmental monitoring along the Bombay coast

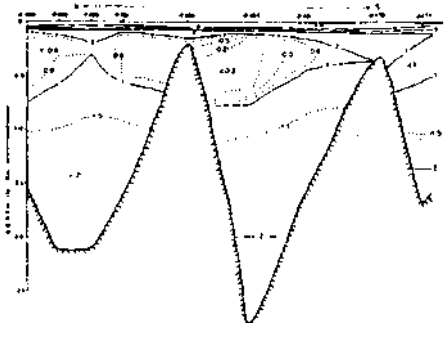
In all the three projects, namely, i) chemical studies in the coastal and offshore waters of the Arabian Sea and Bay of Bengal, ii) drugs from the sea and iii)

protection of marine environment and monitoring of pollutants with special reference to rural areas along the Indian coast were investigated and the findings of each arc summarised in the following pages.

2.2.1 Chemical studies in coastal and offshore waters of the Arabian Sea and Bay of Bengal

1. Investigations in the Arabian Sea, Bay of Bengal and Andaman Sea

Hydrochemical characteristics of waters of the Arabian Sea, Bay of Bengal and Andaman Sea were studied. Under the programme Monex-79, chemical parameters were investigated during the SW monsoon in the Arabian Sea. Low oxygen and the presence of nitrite at intermediate levels suggested wide spread occurrence of denitrification. Nitrite concentration was found to be a record highest (5 µg-at/1).



Isopleths of oxygen along a north-south transect west of Andaman & Nicobar Islands.

On the basis of chemical studies along the east coast of India, the occurrence of upwelling was confirmed off Visakhapatnam and Madras during the SW monsoon. This probably resulted in high primary production. In the Andaman Sea, nitrate was almost absent at offshore stations in surface waters, whereas it was present at nearshore stations. Along the 10° channel, the oxygen concentrations were found to be extremely low (0.05 — 0.06 ml/l). Water masses in the central basin of the Andaman Sea appeared to be nearly stagnant due to limitation in water transport to deep layers. This resulted in low oxygen and high nutrients of oxidative origin.

2. Inorganic (dissolved) phosphorus and nitrogenous compounds in the sediments off Bombay and Gulf of Kutch

Distribution of interstitial phosphate, nitrate, nitrite, and ammonia and adsorbed phosphate in the sediments near Bombay and Gulf of Kutch was studied. The fractionation of phosphorus and nitrogenous compounds in the sediments seems to be related to the texture of the sediments and their proximity to the coast. High concentration of adsorbed phosphate was found near Bombay, at the mouth of Gulf of Cambay and in the Central Gulf of Kutch. Among the nitrogenous compounds, ammonia was dominant in the interstitial waters. The variance in the levels of these compounds in the sediments and in the overlying waters suggests controlled exchange of the compounds between the mud water and surface.

3. Urea degradation in sea water

Experiments were continued on the degradation of urea in sea water under various conditions and the kinetics of degradation was worked out. The decomposition experiments conducted with the effluent sample and relatively unpolluted sample showed that the rate and the magnitude of ammonia oxidation were low in polluted waters, resulting in the accumulation of ammonia. The urea decomposing bacteria

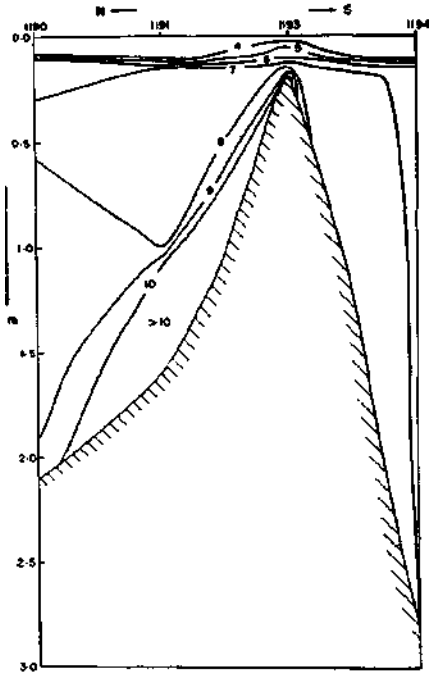
varied between 7 to 40% from the total heterotrophic bacteria in the Velsao Bay and 15 to 20% near Mormugao (Goa). The rates of urea degradation due to biological and chemical oxidation were compared. The effect of different urea concentrations and pH on the nitrogen transformation processes was also studied.

4. Distribution of dissolved silicate in the Arabian Sea and Bay of Bengal

A study was made on the distribution of dissolved silicate in the Arabian Sea and Bay of Bengal. Silicate values in the surface layers showed wide variations. In the Bay of Bengal low silicate concentrations were observed in the nearshore regions, suggesting that the enrichment of inshore waters with respect to silicate by the riverine runoff is significantly low. In the Arabian Sea, higher silicate concentrations were observed in the nearshore regions, especially north of 15°N latitude. Intermediate layers between 200 to 800 m, however, showed almost similar silicate concentrations, perhaps due to the occurrence of Red Sea and Persian Gulf waters.

5. Studies on boron in Zuari estuary

A study was carried out on the distribution of boron in Zuari estuary in all seasons to examine the behaviour of this element during estuarine mixing. Boron values were high (average 4.7 mg/l) during the premonsoon period at the mouth of the estuary where salinity was about 35.7‰. The values decreased upstream (0.2 mg/l) at the fresh water zone. During the monsoon, the values ranged between 0.1 and 1.6 mg/l, while the values increased again (4.92 mg/l) in the post-monsoon period with the increase in salinity. Addition or removal of boron to the estuary by sea water was studied using boron-salinity relationship.



Calcium anomaly in the eastern region of Andaman Sea (in mg/g).

6. Arsenic cycle in the coastal waters around Goa

Water, plankton and sediment samples were collected from the Goa coast and analysed for their arsenic content. Total arsenic concentration in the water varied from 0.75 to 4.8 µg/l (av. 3.01 µg/l). Of the total amount of arsenic in water, 61% was found to be inorganic and 39% in organic form. Plankton and sediments showed marked accumulation of this element. Nearshore sediments showed high values, indicating the influence of land drainage and industrial effluents.

7. Studies on some major constituents of sea water in the northern Indian Ocean

Studies on some major constituents, namely, calcium, magnesium and fluoride were carried out in the Arabian Sea and Andaman Sea. In the Andaman Sea, the

distribution of these elements revealed several interesting features. The most noteworthy was the lower concentration of calcium and fluoride at the surface and higher concentration in the bottom waters. This may probably be due to the dissolution of these elements from the bottom sediments which is largely composed of coralline and| or volcanic materials or the results of large runoff. In the Arabian Sea, on the other hand, the calcium concentration remained almost constant from a depth of 500 m to a depth of 2000 m. However, the Ca/Cl ratio showed significant variations in relation to depth, with a maximum in intermediate layers. Both magnesium and Mg/Cl ratio showed significant variations in depth.

8. Chemical speciation of some important metals in the sea and estuarine waters

Laboratory experiments were carried out to determine the complexing capacity of riverine and estuarine waters of Mandovi and Zuari. The experiments on copper binding ligands in Mandovi water were done using a specific ion electrode. It is observed that the copper binding ligands arc equivalent to 1.1μ moles of copper per litre. Iron binding ligands were estimated by passing the spiked sea water through a sephadex gel column and photo-oxidising the fractions. Sea water was found to contain iron binding ligands equivalent to 4.8μ moles of Fe/l. Further experiments using sephadex gel are in progress.

9. Regeneration of nutrients from sediments and plankton

Short term laboratory experiments on the estuarine sediments were carried out to study the process of regeneration of phosphorus. The sediment samples collected were silly clay, silty sand and clayey sand. The upper 10 cm of the sediment column were used for the experiment. Total phosphorus on the top 4 cm of the sediment varied considerably with the sample type and depth. The interstitial P concentrations were 30, 20 and 24 μg/g respectively in silty clay, silty sand and clayey sand. The adsorbed P was higher than the interstitial and this increased with depth in silty clay whereas interstitial P showed a reverse trend. Changes in the concentration of phosphate in the water just above the mud water interface were taken as an index of the release of phosphate from the sediments. Antibiotics were added to one of the sets from each group of samples to study the role of microbes in the regeneration of phosphate from the sediments. On the 13th day. there was a sudden decrease in the redox potential and dissolved oxygen in the silty clay sample. The phosphate concentration of water, just above the interface, showed an increase from 0.45 to 0.6μg-at/l. No change was noticed in the sample treated with antibiotics. The interstitial P increased to 32 μg/g from the initial value of 30 μg/g; whereas there was a decrease in the adsorbed P. The changes in the concentrations of adsorbed P and interstitial P were noticed only on the top 4 cm of the sediments. In the case of silty sand and clayey sand, the release of phosphate to the overlying water started on 19th and 26th day respectively. An examination of the data revealed that (a) only a thin 4 cm upper layer of the sediment may be involved in the exchange of phosphate with water (b) phosphate is exchanged between the mud and water both in the presence and absence of oxygen (c) though the rale of exchange may be lower in aerobic condition, some phosphate is released at all times (d) the variations in the texture of the sediments appear to play a very significant role in the regeneration of phosphate and (e) bacteria play an important role in the regeneration activity.

10. Organic constituents in the sea

(i) Distribution of particulate carbohydrates in the Bay of Bengal: Particulate matter collected during 37th to 40th cruises of R. V. Gaveshani in the Bay of Bengal were analysed for particulate carbohydrates. The sampling area was divided into three regions. In the northern region, the concentration of particulate carbohydrates for the inshore water varied from 10 to 174 µg/l and in the offshore region it varied from 3.9 to 148 µg/l. Carbohydrates values for the inshore and offshore waters ranged from 23 to 174 µg/l and 27 to 200 µg/l, respectively in the central region. In the southern region carbohydrates values ranged from 5 to 249 µg/l for inshore and 7.8 to 122 µg/l for offshore region. The carbohydrate|chlorophyll a ratio for the depth sampled varied from 7.7 to 3350. It was interesting to note that the distribution of particulate carbohydrates is quite reverse to that of chlorophyll a. While chlorophyll a increased from north to south, particulate carbohydrate decreased.

(ii) Distribution and composition of organic matter in the sediments from Bay of Bengal: Sediment samples collected from the Bay of Bengal during 37th to 40th cruises of R. V. Gaveshani were analysed for organic carbon, nitrogen, carbohydrates and sediment texture. The samples were found to be relatively rich in organic matter. The organic carbon content in the sediment ranged from 1.44 to 3.10% while the carbohydrates varied from 5.30 to 21.28 mg/g. Total nitrogen concentration varied from 0.028 to 0.4%. High C/N ratio was observed at certain stations. Total nitrogen was directly proportional to organic carbon.

11. Studies on desalination of sea water

Based on the earlier findings, a study was undertaken to increase the performance efficiency (P.E.) of the multi-surface solar still using an admixture of lamp black particulates and saw dust of similar granular size in the ratio of 1:1. The increase in P.E. was compared with the control, i.e. sea water evaporated in a blackened tray in an ordinary still. The results showed that P.E. increased to about 35%.

An experimental study conducted for 11 days in July 79 showed that a reasonable number of solar stills (22 stills for a family of 5 persons) would not only meet the daily needs of the family but will ensure surplus water for about 27 days.

2.2.2 Drugs from the sea

1. Screening of extracts from marine organisms for biological activity

Aqueous methanolic extracts prepared from fifteen more marine organisms have been subjected to pharmacological screening during this period. Out of the new species examined, three more corals **Porites sp., Acropora corymbosa** and **Lobophylia** corymbosa and three seaweeds, **Padina tetrastomatica, Acantophora specifera** and **Gelidiella acerosa** showed promising antifertility activity. The extracts from these are now being fractionated for the confirmation of the activity and the isolation of active constituents.

Methanolic extract of **Acanthus illicifolius,** mangrove plant was tested for analgesic activity by tail clip method with pethidine hydrochloride as standard drug

and by HCl induced writhing in mice using sodium salicylate as standard drug for comparison. ED_{50} of the extract administered intraperitoneally was 2.5 ± 1 and 13.0 ± 1.5 mg/kg in the two methods respectively. The extract exhibited statistically significant ($P < 0.01$) anti-inflammatory activity in carrageenan induced oedema in rats. LD_{50} was found to be >1g/kg.

2. Studies on carrageenan from Hypnea musiformis

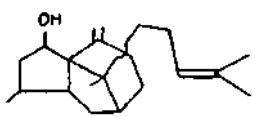
Investigations on the exploitation of seaweed resources of Indian coast for economically important chemicals led us to the extraction of this polysaccharide. Its pharmacological properties were compared with those of carrageenan obtained from the seaweed **Chondrus crispus,** the main source of this phycocolloid. The results indicate that this phycocolloid can be obtained in good yields (ranging from 51.6% in December to 29.2% in May) from this source and it could serve as effective substitute for imported carrageenan (yields 33% — 40.9%). Purity of one such sample of carrageenan was tested by determining sugars, sulphate, moisture and ash content of the polysaccharide and was found to be almost 100% pure.

Pharmacological studies on K-carrageenan extracted from **Hypnea musciformis** have shown that it antagonises histamine induced spasm in concentrations of 10 μg/ml and above but does not show blockade of acetylcholine induced contractions. Reverse was the case with commercial carrageenan. Similarly, K-carrageenan did not show significant effect on blood pressure and respiration in doses of 75 μg/kg while commercial carrageenan showed slight rise in blood pressure without significant effect on respiration.

The inflammatory activity of carrageenan from **Hypnea musciformis** was compared with two imported brands of carrageenan using phenylbutazone as the standard anti-inflammatory agent. The results indicate that like the other two carrageenans **Hypnea musciformis** carrageenan produces a peak effect at 3 hrs and is more potent than the other two when used in a dose of 1 mg. In the light of this study one may conclude that **Hypnea musciformis** carrageenan could serve as an effective substitute for imported carrageenans at least as far as screening anti-inflammatory agents is concerned. In view of the fact that **Hypnea musciformis** carrageenan was not fractionated further, it is deemed that L-fraction is responsible for the inflammatory action.

3. Chemical investigations of marine organisms

During the investigations on the isolation of active principle from **Staechospermum marginatum,** a new diterpene alcohol, stoechospermol, with unique tricyclic skeleton was isolated. This compound was assigned the following structure based on the spectral and chemical evidences :



The alcohol is isomeric with pachydictyol, a bicyclic diterpene, showing mild antibiotic activity isolated from a number of brown seaweeds belonging to the same family. The structural elucidation of other diterpenes which are probably related to stoechospermol is in progress.

Chondria armata: Chemical studies on the extracts showing hypotensive activity resulted in the isolation of several compounds including hydrocarbons, long chain fatty esters, cholesterol and an unknown keto-steroid. Investigations are in progress on the structural assignment of this keto-steroid.

Chrotella australiensis: The fact that sponges contain bioactive organo halogeno compounds led us to the study of this sponge which is abundant along the Goa coast. It resulted in the isolation of C_{29} steroid in high concentration (0.6% of dry weight). Its spectral studies suggested it to be a 24 ethylcholesterol having extra carbons in the side chain. This type of steroids are known to possess antilipemic activity (reduction of blood cholesterol) for which the isolated steroid will be tested. Further, this sponge can be used as a source of raw material (steroid) for the manufacture of hormones and corticoids.

Porites sp. : Three crysalline compounds in pure state were isolated from the coral **Porites** sp. Structural elucidation of these compounds has been undertaken.

Acanthus illicifolius: A detailed chemical analysis of the mangrove plant **Acanthus illicifolius,** the extract of which showed promising analgesic activity, has been undertaken. The extract was fractionated successively with different solvents of increasing polarity. The pet-ether fraction showed the presence of hydrocarbons, fatty esters, and a C_{29} 3beta-hydroxy steroid. Spectroscopic data have been collected for the characterization of this steroid. A crystalline solid has also been isolated from butanol fraction. It seems to be a phenol. Its structural elucidation is in progress.

4. Bromine and iodine contents of marine organisms from Andamans

A study was undertaken to determine the bromine and iodine contents of marine organisms in order to identify the species possessing halogeno-compounds which are known to have biological activities.

The results showed that, in most of the sponges, the concentration of bromine is higher than that of iodine. Bromine concentration ranged from 0.025 to 1.29% whereas iodine ranged from 0.0013 to 0.85%.

Iodine and bromine concentrations in seaweeds from the Andamans were found to be very low.

2.2.3 Protection of marine environment and monitoring of pollutants with special reference to rural areas along the Indian coast

Studies under this project have been carried out partly from headquarters and partly from Regional Centres at Cochin and Bombay.

1. Marine environmental monitoring in the Arabian Sea and Bay of Bengal

(a) Monitoring of petroleum hydrocarbons in the marine environment

Observations were conducted during the cruises in the Bay of Bengal and also during some of the Monex cruises for floating petroleum residues, oil slicks and other floating pollutants and dissolved dispersed hydrocarbons in sea water. These observations were carried out using a sampler, designed at NIO for the collection of contamination-free water samples; and by applying an analytical method, also deve-

loped at NIO. Briefly, the method comprises of chromatographic lean up to remove biogenic hydrocarbons followed by ultra-violet spectrophotometry.

In the Bay of Bengal, the dissolved petroleum hydrocarbons were observed to be higher during February, 1979 along the oil tanker route as compared to the earlier observations made in the same area in June 1978. In the Andaman Sea the dissolved petroleum hydrocarbon was practically nil. In the Arabian Sea, heavy concentrations of particulate petroleum residues (tar balls) were observed during the MONEX cruises. This was as expected, because of the reversal of the surface currents during the monsoon period. Studies on petroleum hydrocarbons, marine biota and sediments have been initiated.

Testing and evaluation of 18 imported chemical dispersants for their efficiency in oil removal and their suitability in Indian conditions were conducted. It was found that, excepting 4, the other chemical dispersants were not quite suitable.

Investigations have also been carried out to isolate suitable strains of bacteria which could be effective in degrading tar deposits on beaches and oil spills in the sea. The results obtained so far are very encouraging and the experiments on mass culture and freeze-drying of these bacteria before applying them to field trials are in progress.

(b) Toxic and non-toxic heavy metals and metalloids in sea water and marine organisms

The concentration of heavy metals like copper, zinc, iron, cobalt, manganese, nickel and mercury in water were found within the acceptable range and their concentrations in plankton and fishes were also not at dangerous levels. It is proposed to extend the study to cover as many species of fishes as possible.

(c) Organo-chlorine and organo-phosphorus pesticides in the marine environment

Fishes were collected during the cruise of R. V. Gaveshani and their tissues were collected, dried, macerated and preserved. The analysis of the samples using gas chromatograph has been taken up.

2. Pollution monitoring along the Kerala coast

The progress made under this investigation is reported separately under the Regional Centre, Cochin.

3. Marine environmental monitoring along the Bombay coast

The work done under this investigation is reported under the Regional Centre, Bombay.

2.3

Geological Oceanography

2.3.1 Geological and geophysical surveys to assess the petroleum and mineral prospects of the western continental margin of India.

1. Geomorphology
2. Surficial geology
3. Acoustic masking due to gases
4. Magnetics
5. Exploration for ilmenite placers off Konkan coast

2.3.2 Regional geology and manganese nodules deposits in the Arabian Sea and Central basins of the Indian Ocean.

2.3.3 Geochemistry of the sediments of the continental margins of India

2.3.4 Sediments of the western continental margin of India

2.3.5 Foraminifera as indicators of pollution in the marine environment

1. Foraminifera of the western shelf
2. Nannoplankton
3. Effluent discharge sites studies

2.3.1 Geological and geophysical surveys to assess the petroleum and mineral prospects of the western continental margin of India.

Geomorphological and surficial geological studies off Goa and between Jaigad and Vengurla were carried out. Magnetic surveys and exploration for ilmenite placers off Konkan coast were also undertaken.

1. Geomorphology

(a) Goa Coast: Multidated aerial photographs of the Goa coast indicate that the landforms are marine (beaches, offshore islets, abrasion platforms, cliffs and laterite mesas), aeolian (dunes and dune ridges), fluvial (old and recent tidal flats), denudational and volcanic. The cliffs indicate that the coast is retrograding along the rocky shore and headland but the old beach ridges and old and young dunes indicate prograding along the beaches. These studies have been extended to satellite imageries.

(b) Jaigad to Vengurla: Between Jaigad to Vengurla, about 115 km off Karwar, a shelf break occurs at about 130-140 m depth. A 15 m long ridge along the shelf break off Jaigad becomes prominent. The continental shelf up to a depth of about 60-65 m is marked by even topography beyond which it is marked by un-

even topography due to N-NW trending and coral and algal reefs and limestones. The continental slope off Karwar is marked by a flat ridge rising from a depth of 970 to 320 m and extending up to a distance of about 75 km.

The depth on the crest of the Direction Bank ranees from 40 to 56 m, the echograms and side scan sonar records of the bank are marked by periodic bed-forms.

2. Surficial geology

The nearshore area from Jaigad to Vijaydurg and Karwar is covered by 10 to 15 m thick clays which at some places show acoustic masking due to gases. The prominent reflectors near the shore are steeply dipping and these are overlain by another reflector which can be identified below the clays up to a depth of about 30 - 40 m extending to the middle and outer shelf. The underlying reflectors below the clays are marked by channelling and erosion which extend 20 to 30 m below the sea bed. The thickness of the clay decreases seaward and about 55 to 65 m the underlying oolitic sand gets exposed. On the outer shelf the penetration is limited due to compact sand or hard formation but prominent reflectors are seen at about 5 to 10 m, and in some cases, thin transparent clay over-lie the sand in depression.

A lensoid clay, increasing from 15 m in the north to 40 m thick in the south, overlies the relict oolitic sands on the Direction Bank. The clays towards the top of the banks are sandy and silty while towards the base these arc shelly.

3. Acoustic masking due to gases

Surveys on the western continental shelf indicate that seismic profiles over large areas are marked by acoustic masking due to gases. The cores of the area marked by acoustic masking, show minute bubbles and fissures in the clays. An analysis of the gas indicates that these bubbles contain dominantly methane with traces of higher hydrocarbons. The occurrence of these gas-rich sediments on the middle shelf and also in the vicinity of estuaries and rivers and its common depth of 5 to 10 m indicate that either the depth represents the boundary between the sulphate-reducing and underlying methane-producing zone or the gases were formed probably due to biogenic degradation of higher organic matter supplied pre-sumably by the increase in productivity or because of the influx of organic matter in the recent past.

4. Magnetics

(a) Bombay High: Magnetic anomalies on the wide shelf off Bombay trend NW-SE, E-W and in the north-eastern part NNE-SSW. The frequencies of the NN-SE anomalies are more than 100 km with an amplitude of about 400 gammas and most of these are symmetrical and localised. Low frequency, high amplitude anomalies are prominent in the west and these are separated by a broad regional anomaly east of Bombay High resembling a fault. The E-W trending anomalies have large areal coverage and some are 130-140 km wide with a magnitude of about 400 gammas. The NNE-SSW trending anomalies are of the order of 200 gammas and may repre-sent the extension of the Cambay trough towards offshore.

(b) Off Goa: The nearshore areas off Goa are marked by short period high frequency anomalies. The anomalies on the inner shelf trend NNW-SSE to N-S and resemble the Dharwarian trend on the shore. The Dharwarian basement in the area also contains other bodies at a depth of about 1000 m. Some of the magnetic anomalies have been inferred to be due to dykes (1.5 km wide — Cuddapah age) intruding the Dharwarian basement at a depth of about 300 m.

5. Exploration for ilmenite placers off Konkan coast

The exploration for ilmenite placers was continued during the year and over 500 samples were collected from an area of 135 km^2 in Tiwri, Malgund. Are, Pavas and Punagad bays. Seismic profiling was carried out in an area of 105 km^2 in Jaigad, Malvan, Nandivad, Ambwah and Varvada bays. Though the coast along the bays is rocky, the offshore areas show enrichment of heavy minerals down to a depth of 11 m in the Tiwri, Malgund and Are Bays. The offshore area from Ratnagiri to Pavas is largely covered by clay and heavy mineral placers.

The grain size parameters of the samples, collected during the earlier survey in Kalbadevi. Mirya and Ratnagiri bays, were computed and these were compared with the heavy mineral distribution. The heavy minerals are concentrated in fine size grains and in the palimsest environment.

2.3.2 Regional geology and manganese nodules deposits in the Arabian Sea and Central Basins of the Indian Ocean

The available literature on manganese nodule deposits in the Indian Ocean has been reviewed. Maps showing the concentration of various elements in nodules have been prepared. Based on these maps, the future plan of action has been drawn. A few equipment, on which action has already been taken, are about to arrive, and towards the end of 1980 or early 1981, it is greatly hoped that R.V. Gaveshani will go on the cruise for the manganese nodules.

2.3.3 Geochemistry of the sediments of the continental margins of India

Fractionation and estimation studies of trace elements of the western shelf and slope areas have been carried out during the year under report.

(a) Mangalore to Cochin: Fractionation studies of iron and titanium in the sediments of the Mangalore-Cochin shelf have broadly revealed the following features :

1. Iron is mainly partitioned between detrital phase and HCl soluble fraction (in clays and iron oxide phase). Between these two fractions, relatively high amounts of it are held in clays or in oxide phase than in detrital phase. It is not associated in these sediments to any significant extent in the form of adsorbed iron or in association with carbonate or reducible phase.

2. Titanium is also partitioned between detrital phase and clays and oxide phase as is the case with iron. However, in its partition between these two phases, it exhibits a difference in concentration which is more in the detrital phase than in the clays and or oxide phase. No significant amount of titanium is associated with the carbonate phase or with reducing phase.

(b) Vengurla to Mangalore: Fractionation of Al and estimation of $CaCO_3$ and P_2O_5 (in the bulk samples and acetic leaches) of the sediments have been completed while the estimation of P_2O_5 in the HCl leaches is in progress.

Some of the preliminary findings show that

(i) in general, the major element chemistry of the bottom sediments reflects the mineralogy in which Si concentrations decrease and AI, Fe, Mn, Ti concentrations increase with decreasing grain size.

(ii) all the elements studied (Al, Fc, Mn, Ti, Cu, Co, Ni and Zn) exhibit decreasing trend in their concentrations away from the shoreline. This trend seems to be the result of $CaCO_3$ acting as a dilutent.

(iii) partition patterns indicate that Al is mainly held in these sediments in the HCl soluble fraction and to a small extent in the HCl insoluble residues (detritals),

(iv) Ti is mainly associated with the detritals and only to a small extent in the clays (HCI soluble fraction).

(v) Fe is partitioned between HCl solubles and HCl insolubles and it is not held to any significant extent in the acetic acid phase and in the acid reducing phase.

(vi) in marked contrast to the partition pattern of iron, Mn is not associated with the HCI insolubles to any significant extent. Much of it is partitioned between HCl soluble phase and the acid reducing phase. Considerable amounts of Mn is held in the acetic acid leaches also,

(vii) phosphate content is higher in the line grained nearshore sediments and in the slope sediments and lower in the outershelf sediments. This is in marked contrast to the distribution pattern of $P_2'O_5$ observed in the northern half of the western continental shelf of India.

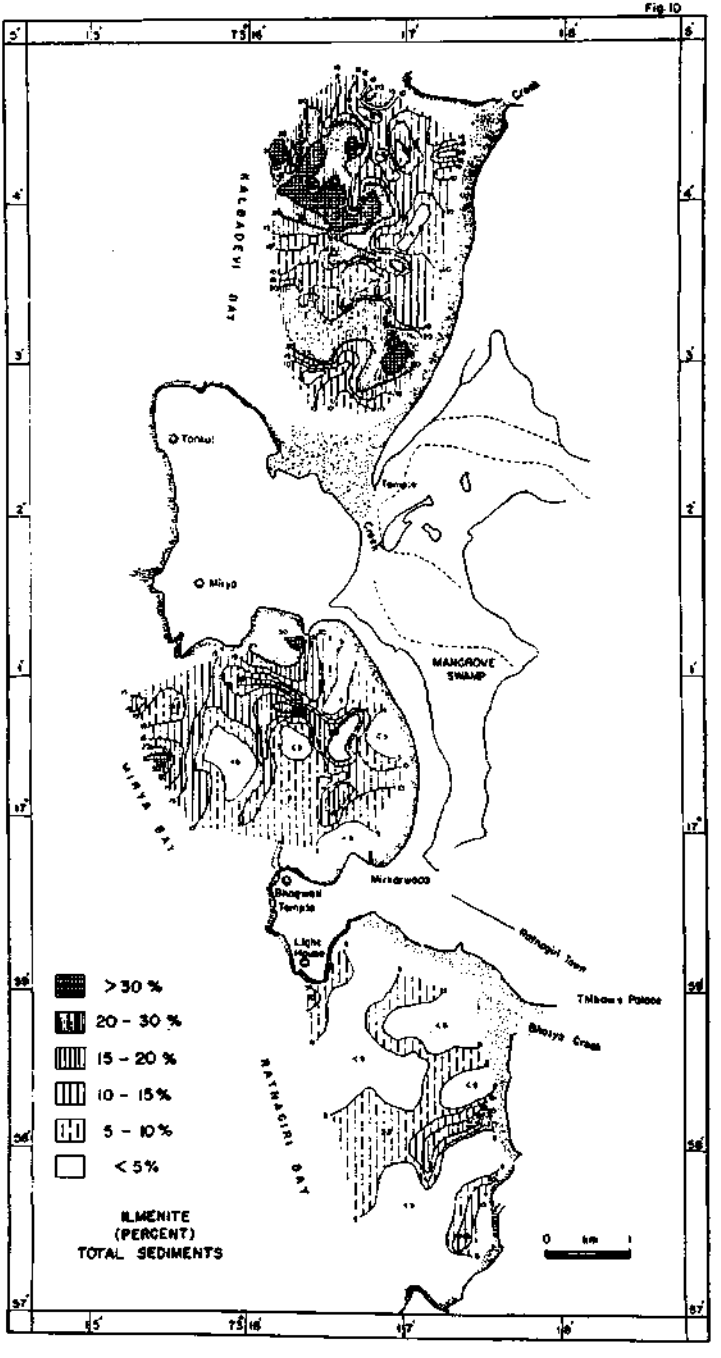
(c) Calimere Pt. to Ganges: Studies have been initiated on the sediment samples collected during the IIOE period and subsequently, during the cruises of R. V. Gaveshani. Acetic acid leaches have been prepared of the samples and estimation of P_4O_5 and Fe have been completed and the estimations of other elements in these leaches arc in progress.

2.3.4 Sediments of the western continental margin of India

Statistical computation of the grain size data and a comparison of moment and graphic methods reveal that in the continental shelf sediments, the mean size sorting shows an excellent comparison while the skewness shows a fair comparison and kurtosis shows no relationship.

The distribution of heavy minerals in the sediments of the continental shelf, between Vengurla to Mangalore, has been studied. Heavy minerals range from 1-5%. Four heavy mineral provinces, each characterised by the abundance of one or more heavy minerals have been demarcated.

X-ray diffraction studies of mineralogy of the continental shelf sediments, rocks and live and dead corals have been completed. Aragonite is the most common carbonate mineral followed by low and high magnesium calcite. A further finding was that no diagenetic change has taken place in their mineralogy after even 9,000 years of the formation.



Distribution of ilmenite in total sediments along Konkan Coast.

Paleoclimate studies indicate that 10,000 years ago the climate of India was warm and drier than that at present. The precipitation was heavy but short-lived, the change from dry conditions to the present moist condition occurred rather suddenly.

The data on surficial sediments of the shelf off Karnataka were compiled and a comprehensive report was prepared.

A sedimentological study of the continental shelf sediments around Cape Commorin is in progress.

2.3.5 Foraminifera as indicators of pollution in the marine environment

1. Foraminifera of the western shelf

(i) Vengurla to Mangalore: Samples from the Vengurla-Mangalore transect collected during the 17-18 cruises of R. V. Gaveshani are being processed. Studies include identification and estimation of organic carbon in the sediments.

(ii) **Gulf of Cambay**: 28 grabsnapper samples collected from the Gulf of Cambay were analysed. Several samples from the Eastern Bank of the sand bar and the adjoining depression, contain reworked foraminifera eroded from the Paleocene sediments of Surat-Broach and allegedly transported by the Narmada-Kim-Tapti rivers. The index and triangular plot index indicate mixing due to tidal influx.

(iii) **Excentricity and twinning in foraminifera**: A microanalysis of some assemblages off Vengurla revealed that **Virgulinella pertusa** (Reuss) occurs in this region. This species also exhibits certain morphological variants resulting in excentricity of growth and twinning which are considered to be ecophenotypic in character.

(iv) **Organic carbon and foraminiferal assemblage ratio**: An analysis indicated that **Ammonia** and **Ammobaculites** have positive (direct) correlation whereas mililid — **Florilus-Nonion-Nonionella** suite have a negative correlation. This relationship from several ecosystems has been computed and compared with the western shelf regions.

2. Nannoplankton

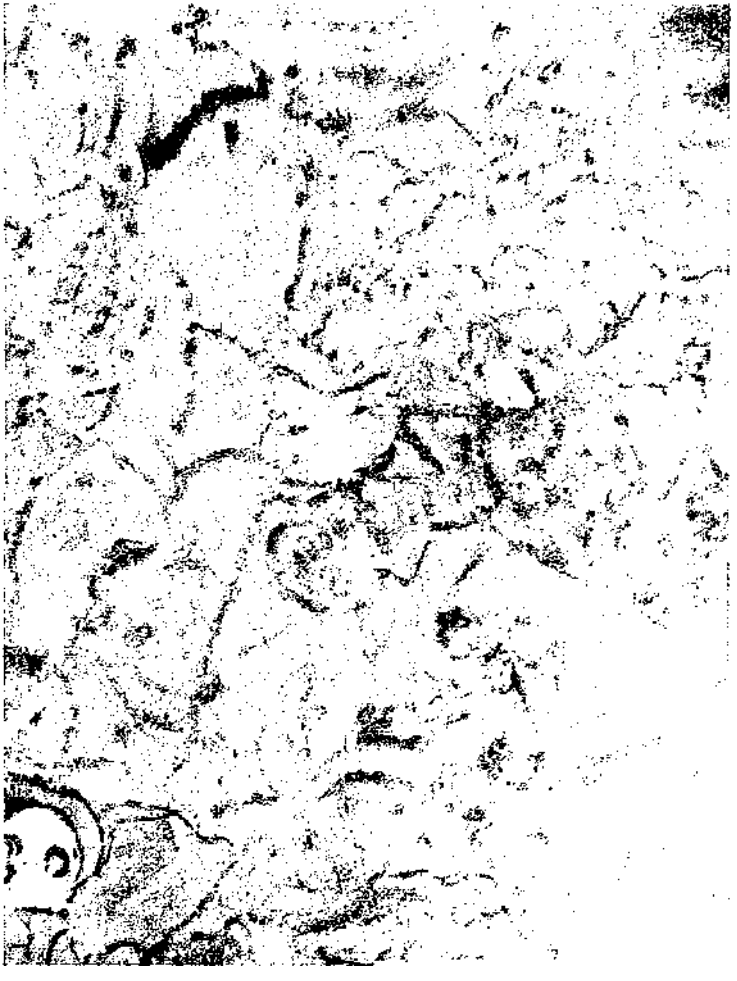
A study of calcareous nannoplankton from the sediments of Andaman region has been completed. Analysis of about 80 sediment samples of the western continental shelf in the NE Arabian Sea have also been completed. Samples collected on the shelf between Ratnagiri to Cochin are being prepared for SEM work.

3. Effluent discharge sites studies

(i) Karwar (Karnataka): 24 samples from 6 transects of the effluent discharge (alkaline) site of Ballarpur Industries Ltd., collected in January/ February, 1979 were studied. The causative effects on foraminifera are found to be low TSN and TFN reduction in size, thinning of the test wall (as in **Notion** sp. and **Ammonia** sp.) increase in agglutinated species nearshore. However, with the dilution and dispersal, there is an increase in the abundance of foraminifera at the distant end of the survey.

(ii) Trivandrum (Kerala): 25 samples were collected from the effluent discharge (acidic) area of the Travancore Titanium Products. The effects of this effluent on the calcareous foraminifera were morphological abnormalities, corrosion on wall. sutaral thickening and ornamentation, reduction and thinning of the test wall more particularly along the peripheries, dissolution and destruction of small, thin walled species, fragmentation and thinning of thick walled forms and induced growth in the few chambers in species like **Operculina** and **Cibicides.**

Virgulinella pertusa, a type of foruminifera found off *vengurla.*



Photograph of the sea bottom off Madras taken from R. V. *Gaveshani* using an underwater camera.

2.4

Biological Oceanography

2.4.1 Survey of biological resources in the seas around India

1. Primary production
2. Extracellular production
3. Secondary production
4. Detritus production
5. Benthic production
6. Biochemical investigation
7. Mangrove ecology
8. Bloom studies
9. Microbiological studies

2.4.2 Coastal aquaculture

1. Aquaculture in waters of Goa
2. Aquaculture in waters of Cochin
3. Laboratory and field studies on bio-energetics of some marine and estuarine animals

2.4.3 Biogeographical, ecological and experimental studies on phytoplankton and zooplankton from the Indian Ocean

2.4.1 Survey of biological resources in the seas around India

1. Primary production

Data on primary productivity were collected from 18 stations in the Andaman Sea and from 13 stations in the Arabian Sea. In the Andaman Sea, column primary productivity ranged from 120 to 615 mg C/m^2 /day (mean 273). column chl a from 0.43 to 11 mg/m^2 (mean 3.64), particulate organic carbon from 0 to 13.9 gm^2 (average 4.59) and detrital carbon ranged from 64 to 98% of POC (average 87). Dinoflagellates formed an important phytoplankton constituent unlike the coastal areas of the Bay of Bengal and Arabian Sea. The cruise in the Arabian Sea was undertaken during October to study the post-monsoonal conditions with regard to primary productivity and allied parameters. It is found that, the column primary productivity varied from 233 to 1527 $mgC/m^2/day$ (average 706) and chl a from 2.4 to 50.9 mg/m^2 (average 19.8).

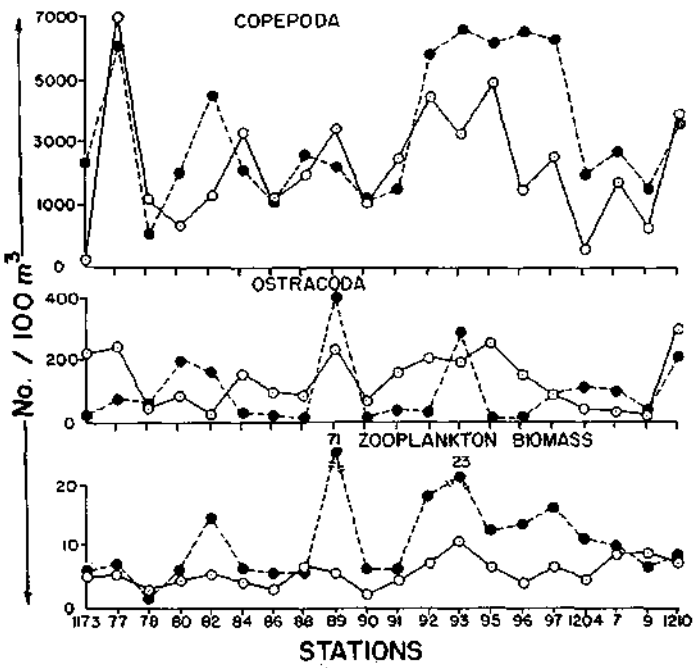
2. Extracellular production

Estimates of extracellular particular primary production in the Andaman Sea showed a pattern different from those of the Arabian Sea and Laccadive Sea. GIycollic acid data showed that its concentration ranged from 100 to 300 mg/m^3 and is numerically between that of oceanic and nearshore water bodies. Extracellular production, which ranged from 0 to 1.2 mg C/m^3/hr, showed a great deal of variation with respect to station position and depth.

3. Secondary production

Data on secondary production were collected from different regions of the Indian Ocean. Analysis of zooplankton samples from the western Bay of Bengal during the south-west monsoon revealed an increasing trend from north to south. Maximum zooplankton biomass value of 480.0 ml/100 m^3 was obtained and this was due to the swarms of pelagic tunicates. Higher plankton production in the surveyed area may be due to increased salinity and upwelling which noticed along the southern part of the western Bay of Bengal.

Zooplankton studies in relation to thermocline in the Andaman Sea showed the aggregation of several species of zooplankters along the discontinuity layer. The average secondary production for the area was estimated to be 289.8 mgC/m^2 for the 200 m column depth.



Distribution of copcpoda, ostracoda and zooplankton biomass above the thermocline layer (closed circle) and in 200 m water column (open circle) in the Andaman Sea.

Zooplankton distribution in the coastal waters of Konkan region showed plankton abundance particularly off the Ratnagiri coast. Decapod larvae including the larval forms of commercially important species of penaeid prawns dominated the zooplankton community. The decapod population was recorded as high as 49,722/100 m^3 at the 20 m isobath at the Ratnagiri transect.

Zooplankton investigation of the Shastri and Kalji estuaries along the Konkan regions during the late premonsoon season showed higher production in the Kalji estuary. The molluscans and decapod populations of Kalji estuary indicate high fishery potential in this area.

The progress made on plant pigments concentrations and zooplankton of Narmada estuary is reported under Regional Centre, Bombay.

Studies on the larval distribution of penaeid prawns in relation to depth in the estuarine and nearshore waters of Goa is being continued for seed collection.

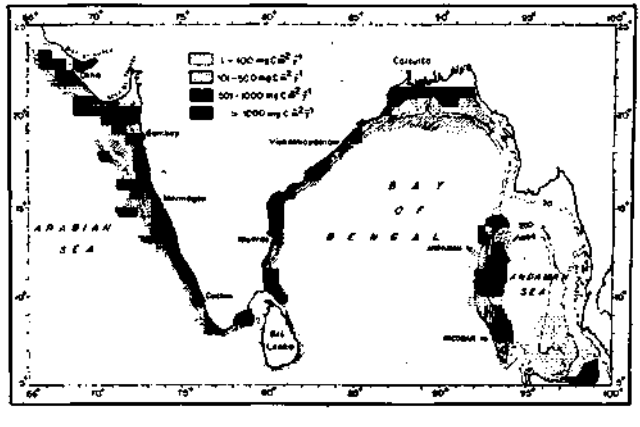
4. Detritus production

Studies made on the detrital production in the Andaman Sea showed that the concentration of detritus in the particulate matter ranged from 77.5 to 98%, as compared to phytoplankton and zooplankton which amounted to 2-22% of the particulate matter in the 200 m water column.

5. Benthic production

Studies on ecology, distribution, production and trophic relationship of benthos of the Arabian Sea, Andaman Sea and Goa estuaries were continued, and some of the findings reported are as follows:

(i) Arabian Sea: A detailed investigation on the benthic production in the inshore regions of less than 80 m depth between 24° and 60° N latitudes, revealed that the average biomass production was high (18 gm^{-2}) although it showed wide variations (0.5-225 gm^{-2}). In trophic relationship, the benthic production has a



Distribution of benthic production along the Indian coast.

direct relationship with demersal fisheries in general, and commercial prawn catches in particular.

Vertical and horizontal distribution of meiofauna was studied off Goa, from the data collected during the 46th cruise of R.V. Gaveshani. The total number of animals ranged from 25 to 293/cm^2. The highest density was observed in the top 2 cm layer. The fauna consisted of two main groups: nematodes and foraminiferans which together formed 60 to 80% of the total meiofauna. Fine sand supported a rich fauna. Interstitial water and organic content of the sediment were found to be the limiting factors in the distribution of meiobenthos.

(ii) Andaman.Sea: During the 51st and 52nd cruises of R.V. Gaveshani, benthic (macro- and meio-) samples, from the depth range of 30 to 2750 m were collected from Andaman and Nicobar islands.

Macrobenthic fauna comprised of 20 faunal taxa. Polychaetes alone contributed 83%. The distribution was substrate specific with maximum (410 m^{-2}) population in clayey deposits and minimum (266 m^{-2} in sandy coralline areas.

Standing biomass was relatively low (3.4/$gm^{2)}$ and showed unusually low values at the intermediate depths (300-600 m) as compared to higher depths (> 1000 m). Biomass of infauna was considerably lower than those of epifauna and onfauna.

Qualitative and quantitative impoverishment of the benthic macrofauna in the Andaman Sea seems to be a direct consequence of low temperatures and oxygen deficient bottom waters.

Meiobenthic fauna of the Andaman Sea ranged numerically between 6 to 43 per cm^2 (mean =.4). Faunal components were maximum in clayey deposits and minimum in the coralline sand. The population was generally dominated by nematodes. Faunal density showed unusually low values at the intermediate depths. At all the depths, the fauna was mostly present in the upper 2 cm of the sediment and only nematodes and foraminiferans were found below 4 cm depth. Changes in the population density appear to be related to the changes in the hydrography, biotic features and bottom characteristics.

(iii) Estuaries of Goa: Studies on the annual cycle of benthic distribution, production and trophic relations in the Mandovi, Cumbarjua canal and Zuari estuarine system of Goa, showed that the macrofauna is very rich (111 species) and varies considerably from place to place. Fauna is mostly contagiously distributed showing high degree of aggregation, less affinity, lowest degree of association and high diversity. Six faunal assemblages, based on dominant species and faunal associates, could be identified. Polychaetes and bivalves together contribute more than 70% of the macrofauna both in numbers and weight.

Biomass production, inspite of large temporal and spatial variations, was high (54.17 gm^{-2} y^{-1}) with proportionately high rate of organic production of 4.08 $gCm^{-2}y^{-1.}$ The estimated annual benthic production, based on the standing stock measurements was 49.95 gm^{-2} (5 tonnes/km^2).

(iv) Narmada river: Benthic studies carried out on the Narmada estuary are reported under Regional Centre, Bombay.

6. Biochemical investigation

Soluble eye lens proteins of 10 fishes, **Sardinella longiceps & S. fimbriata** (Clupeidae); **Hemirhamphus georgii** (Hemirhamphidae); **Lactarial lactarias (Lactariidae); Rastrelliger kanagurta** (Scombridae); **Parastromateus niger & Pampus argenteus** (Stromatidae); **Psettodes erumei** (Psettodidae); **Pseudorhombus arsius** (Bothidae) **and Brachirus orientalis** (Soleidae), collected from the fish-landing centres of Panaji (Goa), were studied by immunoelectrophoresis using the lens antiserum of **Sardinella longiceps.** Each species had a specific antigenic complex. The degree of antigenic correspondence, among the species, varied in accordance with their taxonomic relationship. There was a decrease in the number of shared components with an increase in the phylogenetic distance.

7. Mangrove ecology

(a) Mangroves: On the basis of the aerial photographic survey of the mangroves of Goa, it has been estimated that, of the total of 13,157 hectares, about 2,000 hectares of the estuarine area, are occupied by mangrove vegetation. **Kandellia rheedii** and **Sonneratia caseolaris,** which are supposed to be on the way to extinction have been recorded in large numbers in the upstream areas (riverine) of Mandovi and Zuari estuaries.

(b) Seagrasses: Biochemical studies on **Halophilia beccarii** revealed that the accumulation of heavy metals do not have toxic effect on this species.

(c) Seaweeds: Ecological and biochemical studies on **Caloglossa leprieurri** were undertaken during the year. It was observed that this alga, which grows in spray zone prefers diffused light, high temperature, high nutrients and average (medium) salinity. The average protein value obtained from this species was 169.95 mg/g dry wt.

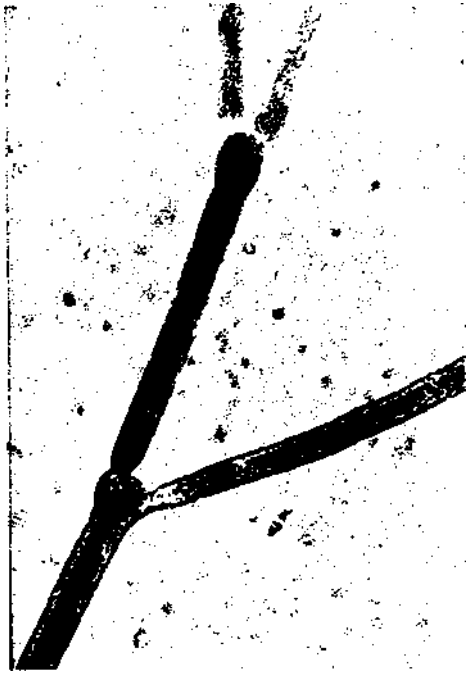
A detailed survey of the marine algal resources of the Maharashtra Coast was completed. It has been estimated that total seaweed yield from this coast is about 20,000 tonnes (wet wt) or 3000 tonnes (dry wt) per season. Redi, Malvan, Ratnagiri and Undi were found to be the areas of good seaweed growth. In all, 94 marine algal species belonging to 30 families and 51 genera have been recorded from this coast. Of these, **Monostrama** sp. and **Ernodesmis** sp. were the new records for the Indian waters, while 13 species were new records for the west coast of India.

On the basis of luxurient growth, presence of algal species and environmental conditions, Malvan region has been selected for a project on seaweed cultivation. Also keeping in view of the flora and fauna of this region, it has been suggested to develop the Malvan area into a marine park.

(d) A new species of alga—**Dichotomosiphen salina** was recorded from the brackish water areas of Goa region.

8. Bloom studies

Trichodesmium bloom studies in the coastal waters of Goa were continued. The role of these blooms in enriching the impoverished environment during the pre-monsoon season is manifested by the appearance of a series of organisms in succession



Filament of a marine alga *Dichotomosiphen salina* (new species from a Goa estuary).

Entire plant of a green alga *Ernodesmis verticillata* (Kuetzing), Boergesen from Malvan.

viz. the diatoms, cladocerans, dinoflagellates, copepods and finally the carnivores (siphonophores and chaetognaths).

9. Microbiological studies

Microbial flora associated with the decomposition of **Rhizophora mucronata** leaves were studied in the laboratory and in situ conditions. Maximum population was noted on the 28th day ($995 cm^2$) in the field and $2475/cm^2$ after 42 days of incubation in the laboratory. Dominant group of bacteria were **Pseudomonas, Vibros** and **Bacillus.**

Microbial survey was carried along the Konkan coast. Jaigad area was highly rich in heterotrophic population with enzyme dehydropenase activity of 1249.95 mg/g formaxon.

Mangroves were studied in detail for their microbiological activities. Total counts of bacteria and fungi were high during the various seasons. The dominant forms of bacteria were **Bacillus,** Corniforms and Pleamorphic. Fungi included **Mucor, Monilia** and **Sporotrichum.** Most of the bacterial and fungal isolates were cellulose degraders and pectin and starch hydrolyscrs. Nitrogen fixing bacteria were also ob-

served. Laboratory studies showed that bacteria and fungi were effective in converting mangrove foliage into protein rich material.

2.4.2 Coastal aquaculture

1. Aquaculture in waters of Goa

(i) Culture of shellfish in Goa : Studies on the culture of 7 species of edible bivalves, including two species of mussels **(Perna viridis** and **Modiolus metcalfei);** one species of oyster **(Crassostrea gryphoides);** 3 species of hard clams **(Merertrix casta, Paphia malabarica** and **Villorita cyprinoides var Cochinensis)** and one species of bean clam **(Donax incarnatus)** were continued. Mussels and oysters were grown on ropes, nylon bags/plastic trays/sandwich nets suspended from anchored rafts. All the 4 species of clams were found to adapt themselves well in ground clutch culture or in bottom rearing method.

Rope culture of transplanted seeds hung from floating rails was found to be the most appropriate method, both technically and economically for the green and brown mussels. The giant Indian oyster **(C. gryphoides),** when grown on rafts, showed considerable increase in its average monthly growth (dorso-ventral distance) which increased from 7 mm in its natural bed to 12 mm in the 'off bottom culture'.

Similarly, the ground clutch culture, with proper stocking densities in sandy regions rich in particular organic matter, accelerated the growth of black clam **(V. cyprinoides)** by 30% and 50% of **M. casta.** Preliminary results on the seeding of surf-beaten open sea beaches with young bean clams **(D. incarnatus)** indicate an increase in the average monthly growth progression, by more than 50%. Economic aspects of some of these techniques have been worked out. The rate of returns on the investments has been estimated to be fairly high. Moreover, the farming of edible bivalves is more promising than that of shrimps or finfishes, as the bivalves are most efficient to convert the organic matter into body weight. Work on the refinements of the most techno-economically viable method of edible bivalve culture is in progress.

(ii) Occurrence of pearl oysters

(a) Konkan coast: An underwater (diving survey carried out in Malvan Bay during November 1979, revealed the presence of a bed of pearl oyster **Pinctata chemnitzi** (Philippi) along with live corals at 4-6 metre depth. Small oysters ranging from 9 to 16.5 mm in length and 10 to 16 mm in breadth were dominant. From their size it appears that there must have been a heavy spatfall in September-October. This is probably the first record of a pearl oyster bed from the Konkan coast. Detailed studies on the ecology, breeding and growth of **P. chemnitzi** are in progress.

In the same vicinity a colony of red corals was found, which is of rare occurrence and of considerable economic importance.

(b) **Goa coast**: A large population of the windowpane oyster, **Placuna placenta** was found to exist in Nauxim Bay, Goa. A survey showed the density of about 350-400 animal/ m^2. Pearls of different sizes are found in the mantle of a large number of oysters. The pearls recovered were either ivory or white in colour. Many of them were spherical or nearly spherical. About 35% of the population was found to contain pearls. These pearls though smaller than the ones produced by

Red coral at Malvan (70 km away from Goa) discovered by NIO scientists.

Pearl oyster attached to the substratum at Malvan.

the true Indian pearl oyster **Pinctada fucata** may have some ornamental value in addition to their wide use in the preparation of indigenous medicine.

2. Aquaculture in waters of Cochin

The progress made under this investigation is reported separately under Regional Centre. Cochin.

3. Laboratory and field studies on the bioenergetics of some marine and estuarine animals

Laboratory and field studies on the decomposition of mangrove leaves **(Rhizophora mucronata)** were carried out for a period of four months to evaluate its nutritional value to estuarine animals. The results showed an increase in protein and caloric content of the decomposing leaves whereas their carbohydrate content and C:N ratio declined. The role of mangrove detritus as a source of nutritionally rich food has been evaluated by conducting feeding experiments on the shrimp, **Metapenaeus monoceres** (Fabricius). The shrimps fed on decomposed leaves gave a greater food conversion efficiency and growth as compared to non-decomposed leaves.

Two types of cheap compound prawn diets have been formulated and prepared from locally available food-stuff. Three species of penaeid prawns viz., **Metapenaeus monoceros, M. affinis** and **Penaeus indicus** were fed on these diets for biological evaluation. Data on growth rates and food conversion ratios on penaeid prawn species indicate that the formulated diets give high growth rates and can be used in the mass culture of prawns.

2.4.3 Biogeographical, ecological and experimental studies on phytoplankton and zooplankton from the Indian Ocean

The progress made under the project is reported under Regional Centre. Cochin.

2.5

Ocean Engineering

2.5.1 Coastal engineering studies applicable to rural development

2.5.2 Development of offshore engineering and technology for the utilisation of coastal resources

2.5.1 Coastal engineering studies applicable to rural development

This project is aimed at making a comprehensive study for understanding the complex environment of the coastal zone for developing optimum solutions to problems associated with coastal protection, harbour development, tidal inlets and coastal pollution.

The progress of the work done can be summarised as follows :

Improvements were made in the wave-sled, so as to improve its performance in low as well as at high wave action zones. Surface and sub-surface floats, which were designed earlier, have been tested successfully using the locally available material.

Computer programmes for analysing the refraction and diffraction of waves and to carry out spectrum analysis of the waves using Fast Fourier Techniques have been developed and applied successfully to the wave data collected from Goa and Bombay High regions. Some work on the design parameters for the foundation of coastal structures, subjected to static and dynamic loads, has been carried out. These studies showed that as the depth of foundation embedment increases, the amplitude of foundation vibration decreases.

Engineering analysis of few soil samples collected from Dona Paula (Goa), off Mangalore and Karwar have been completed.

A manual on the protection and control of coastal erosion, based on the environmental conditions prevailing in India, has been prepared. This manual contains information on coastal processes, collection and analysis of environmental data, availability of local construction material, design procedures and guidelines for the construction and maintenance of various types of coastal protective measures.

2.5.2 Development of offshore engineering and technology for the utilization of coastal resources

Surface and sub-surface fibre glass buoys which were developed earlier were successfully tested as a part of the mooring system of Aanderaa current meters. This mooring system will help to install wave rider buoys and the Aanderaa current

meters at different depths and to obtain the data on both waves and currents simultaneously.

The piston gravity corer was modified as per the requirement. Besides this the design of a core-cutter, core-catcher, piston and winch wire, casting weights, tailfin and triggering mechanism has been modified for their smooth functioning and better recovery of undisturbed soil samples. Pore pressure measuring device for the **in-situ** testing is being developed using the pressure cell. Standard procedures are being developed for the design of submarine pipelines and ocean outfalls. For the stress analysis of submarine pipeline, an analytical solution, based on approximate numerical method, has been developed. The stability analysis of both oil and gas submarine pipelines off Bombay High have been completed.

Fabrication of Blinker light along with its protective corer has been initiated. This system will be fixed on spar buoy.

Design of an ocean thermal energy conversion plant has been initiated.

2.6

Oceanographic Instrumentation

2.6.1 Development of optical and acoustic instrumentation and system engineering

2.6.2 Development of marine instrumentation system

2.6.3 Development of buoy telemetry data acquisition system

2.6.4 Development of marine data logging system

The progress of the four projects, which have been continued during the year under report, is summarised below :

2.6.1 Development of optical and acoustic instrumentation and system engineering

Shallow depth echosounder: This instrument has reached the final stage of its development. The electronics of transmitter and receiver have been designed, these are being tested to determine their maximum depth operation in the field.

Acoustic wave height analysers: During the echosounder development, it was found that the same system could be modified to work as an acoustic wave height analyser. Necessary circuits to convert the echo-sounder output on to chart recorder have been designed and the instrument will be tested in the field. A protective housing for the transducers, when operating in the wave height mode, has been fabricated.

2.6.2 Development of marine instrumentation system

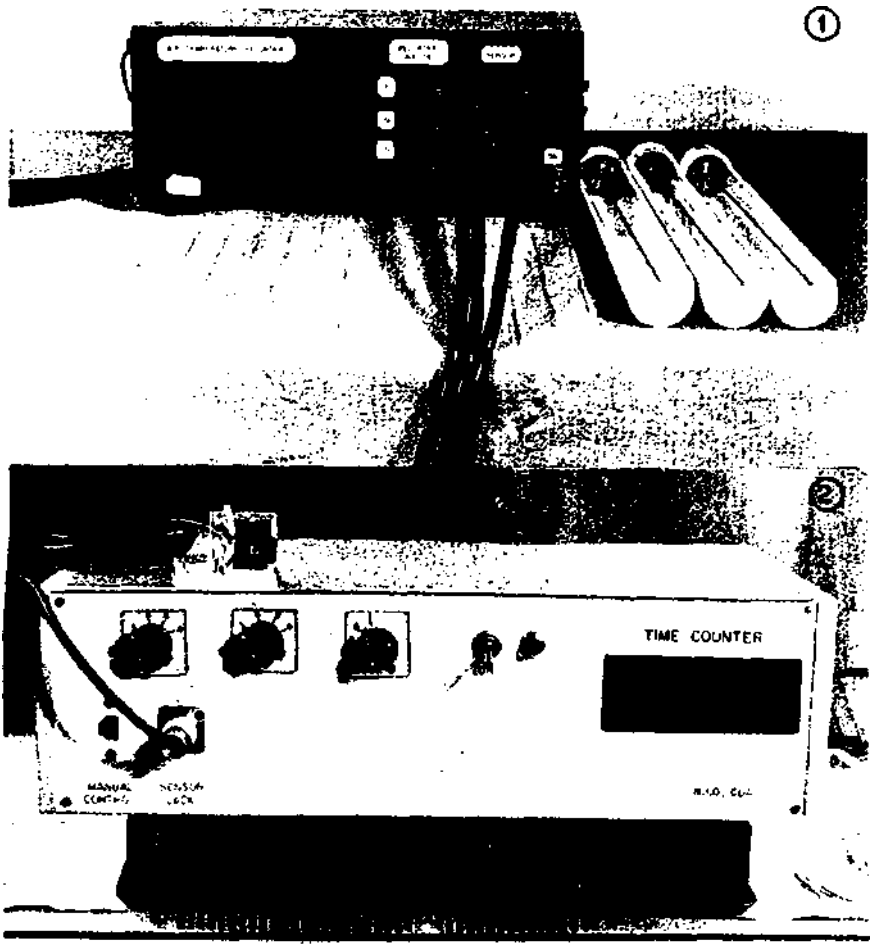
1. Wave and tide gauge: A wave and tide gauge has been developed using the pressure transducer developed by the Indian Space Research Organisation, Bangalore. The first model comprised of the sensor and associated electronics is housed in a brass cylinder and the complete unit is lowered into the sea for recording waves and tides.

The unit has been tested as a tide gauge for over 24 hours at Versova (Bombay) and was found to be very suitable for tidal measurements. The second model is comprised of only the sensor in the underwater housing which is excited by a constant current. This will bring down the cost of the unit with equally good results as the circuit components arc not subjected to hostile marine environment.

The CTD system with improved cicuitry has been developed and tested at sea on board R.V. Gaveshani. The results have been encouraging and the system is at present being calibrated. A salinity/temperature bath, which has been acquired during the year, enables the CTD system to be calibrated to a greater accuracy.

2. Three channel air temperature recorder: This was developed for the simul-

NEW INSTRUMENT DEVELOPED AT NIO



1. Three channel air-temperature recorder
2. Electronic Time counter

taneous measurements of air-temperature at different altitudes for MONEX programme. It measures temperature in the range of 20 to 40° C.

3. Electronic time counter: This is developed for trolley speed measurement used into the current meter calibration system. It measures the time duration between 5 photo pulses and stores the information which can be manually displayed.

2.6-3 Development of buoy telemetry data acquisition system

In this project, the following oceanographic and meteorological parameters have been identified for transmission : wind speed, wind direction, humidity, air temperature, surface temperature, water current and direction (self-recording) and wave height.

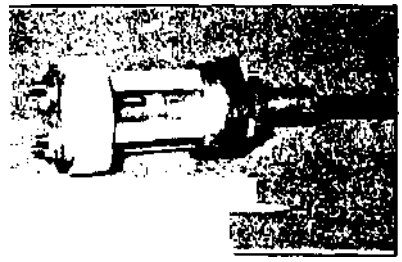
The 405 MHs transreceiver from the Space Application Centre, Ahmedabad has been chosen for transmission to shore once a day (except wave height data for a longer period). The buoy will be powered through solar panels (C.E.L. make). The control electronics has been designed and the implementation of the whole system is in progress. The design and fabrication of a mechanical buoy is underway. It is hoped that this unit will be installed by the end of 1980 in the Arabian Sea.

2.6.4 Development of marine data logging system

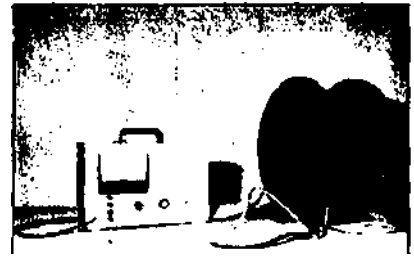
In view of the accuracy required of the time signal for different laboratories on board R.V. Gaveshani, it is proposed to interface the different parameters through a standard teleprinter — interface on a teletype. The design and development of the control board has been completed using Burr Brown Multiplexer MPC 8S, A/D Converter ADC80AG12 and Samplel/Hold Amplifier SHC80KP. The parallel digital data obtained at the ADC is converted into BCD using 74185 IC for onward printing on Datel DPP-7 Printer.

The unit is undergoing test trials and is expected to be installed on the ship in 1981.

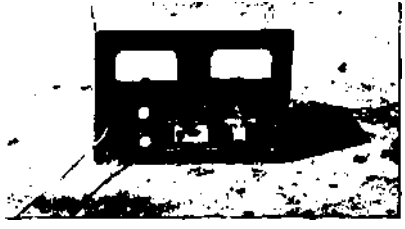
Transducer of
tide and wave recorder
& counter



Assembly of the sparker
for marine seismic survey



In situ temperature
and salinity meter



Tide and wave recorder
& counter

Electromagnetic
current meter
assembly

Operational depth meter

Marine INSTRUMENTS DEVELOPED EARLIER BY NIO SCIENTISTS

2.7

Planning, Publications, Information & Data

During the year, a greater emphasis was laid on the development of information system and quick dissemination of information received. The progress made under each section is as follows :

2..7.1 Planning

Planning Section continued its activities related to the Annual Plan of the Institute, on monitoring, evaluation and coordination of R & D projects. During the year costing of the All India Coordinated Projects and Rural Development Projects was also initiated.

Planning Section issued several reports. These include a document on Costing and Evaluation of all the R and D projects of 1978-79, which has been prepared for the first time. Other reports are: Annual Plan of the Institute, Three-years Performance of R.V. Gaveshani and Current Research Projects 1979-80.

A close link was maintained with the Planning and Technology Utilisation Divisions of CSIR, and other sister laboratories within CSIR and with the other organizations like IIP, BSIP (Lucknow) which are collaborating in the All India Coordinated Projects.

2.7.2 Publications

The Publications and information Section of this Division continued to bring out the regular publications viz. Annual Report, cruise reports, annual oceanographic cruise report of R.V. Gaveshani, INODC Newsletter and **Mahasagar** -- bulletin of the National Institute of Oceanography. Efforts were intensified to increase the circulation of the journal in India and abroad under the sales promotion programme.

The following publications were brought out by the end of the year:

— Pamphlet on NIO
— Brochure on sponsored projects 1978
— Annual Report 1978
— 19 cruise reports of R. V. Gaveshani

— Oceanographic cruise report of R. V. Gaveshani — 1978

— **Mahasagar** — Volume 12 (1979), Numbers 1-4

— Collected Reprints — 1974 (Vol. 6). 1975 (Vol. 7) and 1976 (Vol. 8)

— NIO Newsletter: this quarterly newsletter was started this year to keep all marine based organisations/ institutions informed with the activities of the Institute. This year two numbers of first volume of the Newsletter were released.

Printing facility: The small printing and binding facility established last year helped a great deal in carrying out the routine printing jobs of the Institute.

2.7.3 Information

Realising the need of an up-to-date and prompt information service in oceanography a 'Technical Information and Publication Services in Oceanography' (TIPS) was constituted to organise several activities related to the information system. A brochure on ' Technical- Information Services in Oceanography (TlSO)' was released.

Under this service the following activities were also carried out:

1. attention to technical enquiries received on diverse subjects fields;
2. revision of the Indian National Directory of Marine Research Projects (INDMRP) on a computerised format;
3. release of selected bibliographies: a bibliography on aquaculture is in progress;
4. news to the press.

The Section also attends to the Public Relation work and takes the visitors, Indian and foreign, round the laboratories, briefs them about the objectives of NIO and the R & D work in progress and the contributions made by the Institute.

In 1979 more than 100 ColIege/University parties consisting of about 2400 students visited the Institute. These were in addition to the research scholars, scientists and VIPs who visited the Institute.

Reprography services: Reprography services of the Planning & Data Division were extensively used by the different divisions and sections of the Institute. Seeing its demand, it is now being planned to expand this service by installing a plain paper copier.

News clippings: The collection of current news items related to different fields of oceanography and marine science in the world was continued. These were classified subjectwise for quick retrieval and dissemination.

I.O.C. Depository Centre: This Centre has continued to receive various publications from different organisations such as UNESCO, 1OC, FAO, UNEP, WHO, **WMO** on hydrology, meteorology, climatology, pollution, living resources of the ocean, geology and geophysics. These publications are made available to the users in India on request. A list of publications available in the IOC Depository Centre is being circulated to different marine organisations in India.

2.7.4 Indian National Oceanographic Data Centre

During the year under review, INODC further strengthened its computer capa-

bilities and the first phase of the Computer TDC-316 installed last year was upgraded with the peripherals like: one magnetic disc, 28K words core memory, business emulator, two magnetic tape units, a memory allocation and protection device (MAP), floating point processor and system clock etc.

The various activities of the data centre are as follows:

(a) **Acquisition:**

(i) R. V. Gaveshani data: A part of physical, chemical, meteorological and biological data collected by R.V. Gaveshani during 1976 have been transferred on punch cards. The evaluation and further processing of this data are in progress.

(ii) **Estuarine data**: Physical and chemical data of Mandovi and Zuari estuaries are available in the data bank during the year.

(b) **Processing**:

(i) The following computer programmes were developed for processing the oceanographic data and these are available in the data centre.

GRAINS	—	Computes grain size using graphic method
SALINITY	—	Computes salinity from temperature, depth and conductivity using Cox and | or Brown's formulae
SIGMA	—	Computes sigma-t values from temperature, salinity and depth
PRES	—	Computes total pressure at a particular depth
KELVIN	—	Generates Kelvin function for 0.01 with a regular interval of 0.01 (double precision accuracy)
OGL00l	—	Processing of soil mechanics data resulting from Hydrometer analysis
OGL002	—	Specific Gravity Test
RIJCOM	—	Computation of coefficient of regression and regression lines and S.E.
INSPOS	—	Interpolation of oceanographic parameters at standard depths using splinefits
SPCTRM	—	Spectrum density analysis
DAMPED	—	Programme for plotting of sine curve
SESIAN	—	Sediment size analysis
TIDE	—	Interpolation of tidal heights at given time between high water and low water (from Predicated Table)
EKMAN	—	Computes the resultant velocities in two directions at different depths with respect to the region (Ekman's equation)
CURRENT FREQUENCY	—	Computes the current frequency and percentage in a particular direction and speed.

Besides these, several programmes for processing the data for the preparation of directories, etc. have been developed and are widely used. Several programmes were also developed on DCM Micro-system 1101.

(ii) **Plotting of data from the Exclusive Economic Zone**: A project which was taken up last year to prepare statewise map of hydrographic and biological data

available from the Exclusive Economic Zone was continued. During the year, plotting of data for two states Orissa and West Bengal has been completed. The plotting of data for Maharashtra and Karnataka states was also initiated during the year.

(iii) **Processing of ONGC data:** Hydrographic data and data on currents collected off Gujarat under the ONGC sponsored project were processed. Several programs were also developed for the circulation of resultant velocities in two directions at different depths, with respect to region, current frequency and percentage in a particular direction etc. Computer-processed data were submitted to the sponsors in the form of data report.

(c) **Data Management**

(i) INODC Catalogue: Catalogues of the holdings in the INODC for physical, chemical and meteorological data have been prepared and will be released shortly. The catalogue of the data collected by R. V. Gaveshani is in progress.

(ii) **INODC Newsletter**: The Data Centre continued to publish the annual INODC Newsletters and the latest for the year 1978 has been released. It contains information on the data collected by R.V. Gaveshani during 1978 and the data collected under the Pelagic Fisheries Project in the standard ROSCOP forms.

(iii) **Data holdings** : Physical, chemical and meteorological data holdings were updated by adding data from nine cruises of **Eltanin** and seven cruises of INS **Kistna.** Punching of MBT data was also initiated during the year.

(iv) **Inventory forms**: The inventory forms of ROSCOP (Report of Observations/Samples, Collected by Oceanographic Programmes), ROMBI (Results of Marine Biological Investigation), IG/GCI (International Geological/Geophysical Cruise Inventory) were completed for the 19 cruises of R. V. Gaveshani undertaken during 1978.

(d) Training

Two training courses in Computer Programming were conducted during the year. More than 70 persons participated in these two courses which were :

(1) **Course on FORTRAN IV:** A course on Computer Programming in FORTRAN IV was conducted from 14 February to 7 March, 1979 with the help of Software Training Unit of ECIL, Hyderabad. Forty persons participated in this course. Theoretical as well as practical trainings were given to the participants.

(2) **Course on COBOL:** A three-week course on Computer Programming in COBOL was organised from 15 August to 5 September. Dr. D. Nagaraja and Mr. Raman Murthy from ECIL, Hyderabad delivered a series of lectures. Thirty one persons participated in this course. These included seven from outside organizations, 11 unemployed graduates and the rest were from NIO.

2.8

Regional Centres

2.8.1 Regional Centre, Cochin

Research activities of this Centre during the year were carried out under the following 5 projects in conjunction with the headquarters :

A. R and D Projects

A.1 Biogeographical, ecological and experimental studies on phytoplankton and zooplankton from the Indian Ocean

(i) Systematics and distribution : Studies on the systematics and distribution of hyperiid amphipods (from the IIOE samples) of the family Oxycephalidae were completed. All the 17 species under 10 genera of this family found in the Indian Ocean were described.

Metalycea species, **Rhabdosoma brevicaudatum** and the males of **R. minor** were recorded for the first time from the Indian Ocean.

Information on the morphology, systematics and distribution of different larval stages of 21 species belonging to 10 genera of the sub-family Penaeinae including 3 commercially important genera, **Metapenaeus, Penaeus** and **Parapenaopsis** from the IIOE samples have also been completed. They include the complete developmental stages of **Penaeopsis rectacuta** currently exploited in a small scale off Bombay and the post-larvae of two species of the primitive genus **Funchalia** recorded from the Indian Ocean for the first time.

Samples collected during 1974 under the UNDP off Cape Comorin and Tuticorin indicate that zooplankton biomass, dominated by carnivores like chaetognaths, ostracods and salps was high off Tuticorin. Copepods and decapod larvae dominated the samples off Cape Comorin. Swarming of the ostracod **Cypridina** dentata was noticed off Tuticorin in the November samples. A few species of copepods formed a significant portion of the total copepods from the shelf and slope regions.

Copepods in the samples collected during 1976 by R.V. Gaveshani from a transect (17° 55'- 2° 32'N lat.) on both sides of the Indian Peninsula were also examined. Samples represented from two different layers (i) Thermocline to the surface and (ii) 500 m to the thermocline or to the surface. The surface layers were do-

minated by 3 species and the deeper layers by another 4 species. The deeper layers had larger numbers of immature forms.

Samples collected during 1968 from Kavaratti and Kalpeni islands within the lagoon and around the atoll were analysed for mysidacea. Ten species belonging to five genera were obtained from the collections. The Kalpeni lagoon showed a higher density of mysids than the Kavaratti lagoon. Different maturity stages of the dominant species were found in most of the samples.

(ii) Other studies: Samples of gammarid (amphipods) collected from the Cochin backwaters during the year 1975-77 were examined to understand their ecology and abundance. In all, 11 species belonging to 9 genera were identified.

Gammarid amphipod is one of the most dominant groups of benthic organism in the Cochin backwater. Highest population density was found during December while peak juvenile recruitment, irrespective of the species was found in September. **Corophium triaenonyx** was the most dominant species in the samples.

Biochemical estimations of the zooplankton samples collected during 1978 from the Laccadive Sea show that carbohydrate content was less than 6% in all the organisms while their protein content was uniformly high. The average values of carbohydrate (as % dry weight) was 2.58 for calanoid, 5.1 for cyclopoid, 2.55 for euphausid and 4.65 for mysids. The corresponding protein contents were 59.35, 57.18, 60 and 59.03%. Lypids estimations were 23 to 25% in copepods, 32% in euphausid and 21.8% in mysid.

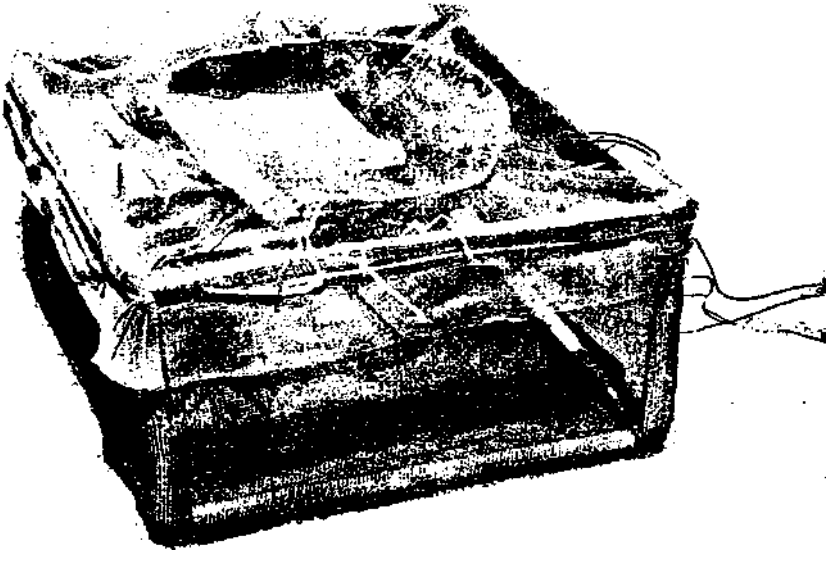
A.2 Coastal aquaculture

(i) Ecological studies of certain natural and impounded nursery grounds of prawn in the Cochin backwater: Effect of different densities on the growth of **Penaeus indicus** was studied in a highly productive nursery ground using cages. Cages with prawns of similar sizes in sets of 5, 10, 20 and 40 were kept in the pond at a depth of 1 m at low tide and their growth rate was measured for six months. The average growths in length in the first month in the different densities were 28.1, 22.0. 18.6 and 10.4 mm respectively which progressively decreased in subsequent months. Experiments conducted earlier have shown that they are voracious feeders. The inflection in the growth rate occurred only after a few months of unabated growth.

Four tidal ponds were selected for bio-ecological studies in relation to prawn production of which one is large with an area of nearly 30 acres. Phytoplankton counts were uniformly high in all the ponds but the absence of zooplankton was conspicuous throughout the course of the study. All the ponds maintained fairly high benthic biomass although the number of species was limited. The bottom fauna was largely composed of polychaetes, tanaidaceans, amphipods and molluscs, most of them being highly preferred by the prawn as food. Food chain as a whole is relatively simple and short with prawns as the major predators although crabs and fishes were also present in smaller numbers. The general condition in these ponds was highly conducive to the growth of prawn.

Experimental studies have shown that the feeding efficiency of prawn is unaffected in clean fine sand but this is not so when the substratum is muddy.

Penaeid and nonpenaeid prawns sampled from these ponds include **Penaeus**



Cage used for studying the effect of density on the growth of *P. indicus.*

indicus, P. monodon, Metapenaeus dobsoni, M. monoceros and **Macrobrachium idella. M. dobsoni** was the dominant species followed by **P. indicus.** Since three of the four ponds were open for fishing, adequate samples could not be collected for studying the growth and mortality rates. However, cage studies were conducted for getting a rough estimate of growth in all the ponds along with a separate study on the effect of density on growth in the fourth pond.

The nutrient concentrations in these ponds were high especially phosphates with values greater than 2μg at/1. Nutrients were therefore not a limiting factor for primary production. Chlorophyll a values were high throughout the year under observation with values exceeding 300 μg at/1 during certain months. Values of particulate organic carbon varied from 2 to 20 mg/Cl and was partly of terrestrial origin. Range of values of the dissolved and paniculate carbohydrate were respectively 0.5 — 11.0 mg/1 and 70 — 4000 μg/l. The calorific content of the mud in these ponds was 200 cal/g dry weight.

(ii) Experimental studies to evolve improved methods of shrimp culture in the Cochin backwater: Large areas of the Cochin backwater system used for shrimp culture arc highly productive. In order to assess the carrying capacity of some of

these areas, a high density short term mono-culture of **P. indicus** was carried out. Three identical square enclaves of 25 m^2 were made using plastic netting and bamboo poles. They were then stocked with juveniles of **P. indicus** at a density of 2,00,000/ha. The three enclosures were harvested at the end of 4, 8 and 12 weeks to yield 1.601, 2.186 and 3.646 kg of prawn equivalent to 640.4, 874.4 and 1458.4 kg/ha respectively. Annual shrimp yield from traditional fields in the experimental area was about 526.44 kg/ha which clearly indicates the under utilization of the fields for prawn culture.

Further, the study also indicated that (1) marketable size can be attained in three months even the density of culture is high (2) two crops can be taken in one season before the fields are utilized for paddy culture. Since natural supply of juveniles also seems to have dwindled, an increase in the yield of prawn from the Cochin backwater may be possible only by ensuring adequate supply of post-larvae and juveniles.

(iii) Studies on parasites and diseases of prawn: A parasitic trematode belonging to the genus Carneophallus was isolated from the shrimp **Metapenaeus monoceros** caught from the Cochin backwater. About 150-200 metacercariae were found in the prawn. It is reported that this species, if ingested can cause serious illness in man.

A.3 Protection of the marine environment and monitoring of pollutants with special reference to rural areas along the Indian Coasts

(i) Pollution monitoring along the Kerala coast: Studies were continued on the major 7 estuaries and 12 beaches of Kerala to develop baseline information on the environmental features, water quality and the rate of production. Variations in the hydrographic features, water quality and production in the estuaries were found to be related to the monsoons. Korapuzha and Beypore estuaries were found to have a fairly high standing stock of primary and secondary producers.

The annual range in COD and BOD_5, at Kallai, Beypore and Neendakara estuaries which are under intense human use were 1 — 35 mg/1 and 3.5 — 120 mg/1 and 2 - 30 mg/1 of BOD_5, and 35-350 mg/l, 35 — 2735 mg/l and 77 — 3764 mg/l of COD respectively. The other estuaries under lesser human pressure had maximum values in BOD_5, of 20 mg/l and 700 mg/l of COD. All the estuaries showed a sharp increase of organic load following the first pulse of the monsoons.

The beaches surveyed were found to have varying degrees of land influence adjoining the beaches. Such beaches are Neendakara, Alleppey, West Hill and Mopla Bay. Calicut and Mopla Bay beaches, where sewage is discharged showed BOD_5, values up to 60 mg/l and COD values 1912 mg/l. Localised depletion of dissolved oxygen was also noticed and values upto 0.05 ml/l were recorded at Calicut.

Preliminary investigations were also carried out on the pollution at Chaliyer river due to the discharge of effluents into it by the Gwalior Rayon Factory at Mavoor.

(ii) Bacteriological studies of pollution: As part of the pollution monitoring programme, the extent of faecal contamination of the beaches and estuaries of Kerala have also been carried out. The occurrence and significance of pathogens like

Salmonella, Vibrio parahaemolyticus, Shigellae and Staphylococcus aureus are being investigated. Two beaches, Ezhumalai and Kappad in North Kerala having potentialities for development into tourist resorts were studied for bacterial contamination. Their suitability for recreational activities were also determined.

A study of the heterotrophic bacterial population at many beaches in relation to organic carbon, inorganic phosphates and nitrates and abundance of meiofauna has been initiated from July 1979. The cellulose degrading bacterial population of the wood curing yard at Kallai was also investigated.

(iii) Plankton studies in the estuarine system of Kerala: Monthly samples of zooplankton from seven major estuaries of Kerala coast extending from Trivandrum to Cannanore were analysed. Neendakara, Korapuzha and Beypore estuaries were found to be more productive, their annual average biomass ranged from 0.13 to 0.15 ml/m^3. Typical estuarine conditions prevailed in these water bodies, salinity being the major factor controlling the variation in the distribution and abundance of zooplankton. Copepods in general contributed to the main bulk of the biomass. Maximum biomass observed was in December at Beypore when hydromedusae and ctenophores appeared in large numbers.

Highly diverse zooplankton population could be observed at Neendakara, Korapuzha and Beypore during the premonsoon period. Zooplankton biomass was generally low at Thottapally and Veli estuaries throughout the year where freshwater regime prevailed for most of the year.

A.4 Oceanography of the waters around Lakshadweep

Studies related to the exploitation and management of aquatic . resources around Lakshadweep islands were carried out during the year. The exploitable living resources, besides tuna, include marine turtles, rock lobster Purulus sp., squids and octopus. The breeding grounds of the turtles in the islands have been located and their breeding season was also determined.

Tuna fishing at Pitti island is more extensive than at Kavaratti island although the two islands are only 22 km apart. Productivity studies showed that the sea around Pitti island is more productive. Pitti island is the rooster ground for the oceanic birds (sooty terns and noddies) and their droppings are washed into the sea providing enrichment for the growth of plankton.

Studies on intertidal ecology carried out at Kavaratti island show that the bivalve, Mesodesma glabratum contributes a large portion of the benthic biomass.

Studies on the zonation of mollusca on Kavaratti atoll show that species diversity is greatest in the intertidal rocky shore as compared to sandy beach, lagoon floor and inner reef platform.

A.5 Studies on land-sea interaction and nearshore circulation along the Indian coastline and their application to coastal zone management

(i) Beach changes along the Kerala Coast: Studies were continued on the Chellanam Beach (about 8 km south of Cochin) which was seriously eroded when the sea walls collapsed at several places under the influence of deep depression of November 1978. The possible causes for the damage to the sea wall which slumped

under the fury of waves were investigated. Initial investigations revealed that the 'Mound' type sea wall constructed has caused reflection of the breakers thereby increasing the breaker energy from 50 to 60%. This is the main factor which has caused damage to the sea wall. It was found necessary to reduce the steepness of the sea wall facing the sea to minimize the reflections of the breaker and thereby reducing the damage to the sea walls in the area. These findings have been brought to the notice of the Working Group on Coastal Erosion. Government of Kerala.

(ii) Studies on the dynamics of the Cochin backwater estuarine system : Studies on the dynamics of the Cochin backwaters have been continued during the year under report. The extensive data on physical characteristics collected during 1975-76 has been further analysed. Hydrographic characteristics at the harbour inlet around Willingdon Island and the mixing of low saline water with the sea water in the harbour region were studied.

(iii) Oceanographic survey of the sea off Travancore : Data on beach profiles, littoral and coastal currents, waves, tides and bathymetry of the sea off Travancore were analysed. Nearshore circulation in diffrent seasons of the year indicate that beyond a distance of 1.45 km off the coast, the currents are more off shore or along the shore than onshore.

B. Sponsored project

Progress made under the project 'Sorting of zooplankton samples sponsored by CSIRO. Australia is reported under the section of sponsored projects.

2.8.2 Regional Centre, Bombay

During the year the Centre continued its researches on three R & D projects in collaboration with the headquarters. The Centre also worked on 3 sponsored projects. Details of the work done under each project are as follows :

A. R & D Projects

A.1 Protection of marine environment and monitoring of pollutants with special reference to rural areas along the Indian Coast

(i) Marine environmental monitoring along Bombay coast

Studies on contamination of mercury in Thana creek were continued during the year. Mercury in the water was estimated by cold vapour atomic absorption technique. The range obtained was 79-320 µg/l in the samples collected at nine locations along the length of the creek|harbour. The total concentration of mercury in the system has been estimated to be 195 kg which is about 77 kg in excess of the expected background (assuming 75µg/1 as the base line concentration). Domestic waste water released in the creek|harbour was found to contain an average of 650 µg/1 of mercury. Mercury concentration in grab samples obtained from 23 locations using a grab varied from 0.14 to 8.21 ppm (dry weight) with marked increase from the harbour to the creek. The pattern suggests substantial mercury input in the creek region. Although definite correlation between mercury and oxidizable organic matter was not evident, chemical extraction by hydrogen peroxide indicated that more than 70% of mercury was leachable and therefore, probably gets organically bound rather than gets charged to authigenic sulphides. Vertical distribution of mercury in the sediment cores sampled at every 2 cm indicated a decrease in the mercury content from about 10 to 25 cm in the Creek region and from 0 to 8 cm in the Harbour area. From these data it can be estimated that an excess of 14 tonnes of mercury is found in the sediment from the natural background.

(ii) Boron-chlorinity relationship in polluted and unpolluted marine environment

Coastal marine regions of Bombay, Navapur, Daman and Tithal were investigated to evaluate the boron-chlorinity relationship. Monsoonal fresh water flow had a pronounced effect on boron levels which decreased considerably with the fall in chlorinity. The high-boron-chlorinity ratio at chlorinities lower than 0.7%, reveals a non-conservative behaviour of boron at low chlorinities. The statistical analysis of the data showed that the industrial and domestic wastes discharged into the Thana Creek and Mahim Bay are responsible for the overall high ratios observed at these locations as compared to less polluted regions of Bombay.

Boron levels in the interstitial waters have been studied for the first time. The concentrations of boron was higher than in the overlying water column with high B/Cl ratio in the coastal region. Reverse trend, with lower boron levels in the interstitial water, than in the overlying water observed in the Thana Creek was the result of transport of sediment of riverine origin to the Creek.

(iii) Zooplankton abundance in polluted and unpolluted environments

A rich zooplankton population was observed throughout the period of study

with peaks in October/November and March/April. Mean zooplankton biomass varied between 3.8-8.7 mg/100 m^3. Maximum biomass and population density of zooplankton were recorded in the polluted environment. Group diversity of zooplankton, however, was relatively greater in unpolluted environment than in polluted waters. Copepods dominated at all locations and their percentage occurrence ranged between 86.8 to 97.0% of the total zooplankton counts. Among the 21 genera of copepods represented in the collection, **Oithona, Paracalanus** and **Acartia** were more abundant in polluted waters.

A.2 Survey of biological resources in the seas around India

Studies on plant pigments, zooplankton and benthos estimations in the Narmada estuary

Plant pigments and zooplankton abundance in the Narmada estuary were studied during the period March-September 1979. The estuary and the river sustain an appreciable quantity of plant pigments. In the pre-monsoon period, the mean total chlorophyll amounted to 31.48 mg/m^3 which decreased to 7.8 mg/m^3 during the monsoon period. The average chlorophyll value showed a rise of 19.3 mg/m^3 at the beginning of postmonsoon season. Zooplankton abundance in the river was not very high. Average zooplankton biomass in Narmada showed variations during the three seasons with maximum during the postmonsoon period (2.72 ml/100$m^{3)}$· In the premonsoon period, average biomass was 1.68 ml/100m^3 and the lowest value (0.4 ml/100 m^3) was during the monsoon period. Like any other estuaries, typical stenohaline species were found during the period of high salinity. Very high density of fish eggs and larvae were recorded in September.

The results of benthic study clearly indicate the dominance of macrobenthos. and meiobenthos along the upper and lower reaches of the river respectively. In general, the upper reaches predominantly had sand and silt while the lower reaches were dominated by sand. The quantity of organic matter in the sediment was moderate. The river at the mouth region has very rich meiobenthic fauna with an average benthic production of 470 mg/$m^{2.}$ In the upper reaches the benthic production was lower (334 mg/m^2).

A.3 Studies on land-sea interaction and nearshore circulation along the coastline and their application to coastal zone management

(i) Oceanographic studies along Gujarat coast

Studies on tides, currents, salinity and temperature structure, bathymetry, etc. were carried out along the coast between Navapur and Umbharat and in the Narmada river and estuary and in the Dahej-Creek. Further detailed studies are in progress.

(ii) Erosion studies at Versova beach

Regular field observations on the littoral parameters are being made and the analysis of the data is in progress.

B. **Sponsored projects**

The centre worked on 3 different projects during the year. These are :

(i) Feasibility of disposal of effluents from Gujarat Narmada Valley Fertilizer Company Plant into Narmada River

(ii) Survey for submarine pipeline from Bombay High and Bassein Oilfields to Tarapur/Hajira

(iii) Location of suitable discharge site for submarine diffuser in the river Par

The progress made under each project has been reported separately under sponsored projects.

2.8.3 Regional Centre, Waltair

The Centre continued to work on the R and D project 'Coastal studies off Waltair and adjacent area'. Besides this the Centre undertook four sponsored projects during the year 1979 with a considerable total financial outlay.

A. R & D Projects

Coastal studies off Waltair and adjacent areas

(i) Marine geophysical and geologcal studies: Magnetic and topographic surveys were carried out along the entire width of the continental shelf between Bhimulipatnam in the north and Appikonda in the south. In total, 16 profiles, each separated by 2 to 4 km were covered. Continuous records of the ocean bottom topography and the total magnetic intensity were recorded along these profiles. The results obtained from the magnetic data have indicated fault-like structures in the nearshore regions and a zone of heavy mineral concentration off Bhimulipatnam. Analysis of topography data determined the existence of reef like structures near the shelf edge and kharstic and terrace like features over the mid-shelf. Theoretical work for some of the models that represent the geological formations has been carried for interpreting the magnetic data. This include 'spectral analysis of magnetic data due to long tabular body' and 'spectral analysis of magnetic data for offshore mineral prospecting'.

Analysis of the sand samples collected from the Visakhapatnam beach has been completed and the results are being interpreted in relation to geomorphological features of the coastline. These studies have been extended from Visakhapatnam to Bhimulipatnam. Beach rock samples were obtained from the Marine Department of Visakhapatnam Port Trust. Studies on these samples have been taken up to determine the percentage of sand and cementing material and other parameters to study the origin of these rock samples. Offshore sediment samples were also collected between Visakhapatnam and Bhimulipatnam. In all, 102 samples were collected along 12 profiles, each profile extending upto 40 m of water depth. Bottom samples were collected at every 5 m depth interval along all the 12 profiles.

(ii) Physical oceanographic studies: Hydrographic studies are being carried out at monthly interval along three transects in the offshore regions between Visakhapatnam and Bhimulipatnam to study the distribution and seasonal variations in temperature, salinity and density. Monthly observations on beach profiles, longshore currents and visual wave measurements which were started in 1978 have been completed for a period of one year. Preliminary analysis of the data reveals that a part of the beach experiences annual net erosion. Detailed analysis of the data is in pro-

gress to demarcate the areas along the beach which are suitable for recreational activities. Visakhapatnam Urban Development Authority have shown a keen interest in these studies. Observations have been made on the beach level changes at Visakhapatnam caused by the cyclone which hit the coast in May 1979. Beach profile studies have been extended to the north of Visakhapatnam up to Bhimulipatnam. In all, 7 transects are selected in this area and monthly observations are being continued.

(iii) Chemical oceanographic studies: Studies on the distribution of nutrients in sea water are being made along three profiles in the offshore regions between Visakhapatnam and Bhimulipatnam. Water samples are being collected at monthly intervals. Preliminary studies on the distribution of nutrients such as phosphorus and nitrogen reveal that the maximum concentrations occur in March-April which may be due to upwelling. Studies on temperature, salinity and dissolved oxygen during the period also support this view. Observations are also being made on the levels of trace metals like Cu, Fe, Mn and Zn and other nutrients like ammonia, urea, nitrate, nitrite, silicate etc. These data would form an index of the problems related to marine pollution.

B. Sponsored Projects

The Centre has worked on four projects sponsored by public and private undertakings during the year. These are : i) Studies for determining point and mode of discharge of treated effluents into the sea ii) Echosounding and bottom sampling at Nagarjunasagar Reservoir iii) Side scan sonar and shallow seismic survey in the nearby areas of Visakhapatnam Port iv) Current measurements in the harbour area of Visakhapatnam Port. The progress under these projects is reported separately under the section 'sponsored projects'.

2.9

Sponsored Projects

2.9.1 MONEX-79

2.9.2 Seabed surveys for a submarine pipeline route for effluent disposal off Karwar

2.9.3 Survey for the development of offshore oilfields on the western shelf

2.9.4 Hydrobiological survey of the Gurpur river. New Mangalore Harbour and the sea off Mangalore

2.9.5 Survey for a submarine pipeline route for effluent disposal off Mangalore (Phase I and II)

2.9.6 Mass culture of the brine shrimp, Artemia in salt pans

2.9.7 Feasibility studies on the disposal of waste from GNFC plant into the Narmada river

2.9.8 Survey for a submarine pipeline route from Bombay High/Bassein to Tarapur Hajira

2.9.9 Studies on the location of suitable discharge point for a submarine diffuser in the River Par

2.9.10 Studies on determining a point and mode of discharge of treated effluents into the sea

2.9.11 Echosounding and bottom sampling at Nagarjunsagar Reservoir

2.9.12 Side scan sonar and shallow seismic profiler survey of the outer harbour area at Visakhapatnam

2.9.13 Current measurements in the outer harbour area of Visakhapatnam Port

2.9.14 Development of oceanographic instrumentation system

2.9.15 Environmental studies on the development of a recreational beach resort complex at Vaiguinim

2.9.16 Sorting of zooplankton samples

2.9.17 Seaweed resources of the Maharashtra coast

2.9.18 Pharmacologically active substances from marine sediments

2.9.19 Evaluation of chemical dispersants concentrates for their suitability to Indian conditions

2.9.20 Consultancy services

The Institute gives a high priority to sponsored research as it is of direct help to the users. Sponsored projects form the best ways to utilise the know-how and technology developed at the Institute. The most important role of the Institute during the year was active participation in the Monsoon Experiment of 1979 (MONEX-79) as a part of the First Garp Global Experiment (FGGE) under the Global Atmospheric Research Programme (GARP). The following list gives the clients of the NIO during the year :

1. Ballarpur Industries Ltd., Karwar
2. Bharat Salt & Chemical Industries, Bombay
3. Commonwealth Scientific and Industrial Organization, Sydney, Australia
4. Electronic Commission of India, New Delhi
5. Environmental Engineering Consultants, Bombay
6. Gomantak Land Development, Panaji
7. Government of Maharashtra
8. Government of Tamil Nadu
9. Gujarat Narmada Valley Fertilizers Ltd., Baruch
10. Hoescht Pharmaceuticals Ltd., Bombay
11. Kudremukh Iron Ore Ltd., Bangalore
12. Oil & Natural Gas Commission, Bombay
13. Steel Authority of India Ltd., Visakhapatnam
14. Visakhapatnam Port Trust, Visakhapatnam

The findings under each project are summarised as follows :

2.9.1 MONEX - 79

The Institute participated in the programme of Monsoon Experiment 1979 (MONEX-79) which was organized as a part of the First Garp Global Experiment (FGGE) under the Global Atmospheric Research Programme (GARP). Considerable oceanographic and meteorological data were collected from the Arabian Sea and Bay of Bengal on various phases of the development of monsoon in the Indian Ocean. R.V. Gaveshani undertook six cruises (four in Arabian Sea and two in Bay of Bengal) as NlO's contribution to MONEX-79.

2.9.2 Seabed surveys for a submarine pipeline route for effluent disposal off Karwar

This project was undertaken at the request of Ballarpur Industries Ltd., Karwar. Seabed surveys (echosounding, side scan sonar and shallow seismic profiling followed by grab and core sampling) comprising of more than 100 line km., were carried out on a number of routes in the nearshore region between Baitkal and Binge Points.

A route between Binge and Baitkal Points was identified because of the presence of fewer rocks and greater thickness of clay.

A suitable outfall and a diffuser. with a proper anchoring system, have also been designed. Besides, consultancy services on the laying and burying of the pipeline are being extended to M/s. Hydronauts Ltd., who are laying this pipeline.

2.9.3 Surveys for the development of offshore oilfields on the western shelf

This project was sponsored by the Bombay Offshore Project of Oil and Natural Gas Commission (ONGC) and the work was undertaken in three different phases.

(i) Survey of a submarine oil pipeline route to Gujarat: This project was a. continuation of the earlier surveys carried out by R.V. Gaveshani. The survey included 3 lines from South Bassein to Navapur and Daman. Over 448 line km of of echosounding, 285 line km of side scan sonar and 425 line km of sub-bottom profiling were carried out.

(ii) Surveys of drilling structures on Kori Bank : Two parallel and two cross lines on a structure termed by ONGC as 1 and three parallel and three cross lines on the another structure called D were surveyed for drilling sites. About 330 line km of echosounding. side scan sonar and shallow seismic profiling were carried out and a grab and core samples were collected.

(iii) Surveys for the jacking up site for the Drilling Vessel Gettysberg on Direction Bank and adjoining areas: More than 90 line km of echosounding. side scan sonar and 80 line km of shallow seismics were carried out. The surveys indicated that the depth in the area varies from 45-60 m.

Shallow seismic records indicate that clay is thick at R 12-2. which is the proposed site for jacking up of **D. V. Gettysberg** and therefore it appears to be suitable. Further analysis of the data is in progress.

2.9.4 Hydrobiological survey of the Gurpur river, New Mangalore Harbour and the sea off Mangalore

This project was undertaken at the request of Kudremukh Iron Ore Co., Ltd. (a Government of India Enterprise). Bangalore. Investigations included current and tide observations, chemical characteristics and biological parameters of bottom populations and bioassay studies. A report incorporating the recommendations was submitted to the sponsoring agency.

2.9.5 Survey for a submarine pipeline route for effluent disposal off Mangalore (Phase I and II)

This project was undertaken as per the request of Kudremukh Iron Ore Co. Ltd., Bangalore to suggest a suitable outfall in the sea. The work included the finalization of a report on Phase 1 including the evaluation of oceanographic and geotechnical data; hydrographic survey in the vicinity of the outfall and along the submarine pipeline route; seismic survey; beach contour survey; current measurements and water quality sampling. This work has already been submitted. The Phase II of the project included studies on bottom populations, including bacteria, fouler- and borers in the vicinity of the outfall and along the submarine pipeline route to include both prc and post-discharge of effluents and monitoring of bioia. The work is in progress.

2.9.6 Mass culture of the brine shrimp, Artemia in salt pans

Work on this project was started in January 1979 at the request of Salt Work. Mundra, Gujarat State. Artificial culture of brine shrimp was tried in one acre high

salinity condenser pond and by the end of March 1979 nearly 15 kilograms of brine shrimp cysts were harvested. With the very promising results obtained from the **pilot** scale experiment, a larger area of nearly 3 hectares has been selected for mass culture of brine shrimp in salt pans.

2.9.7 Feasibility studies on the disposal of waste from GNFC Plant into the Narmada River

The project was sponsored by the Gujarat Narmada Valley Fertilizers Company Limited. Hydrographic survey of the Narmada River and adjoining water bodies was undertaken from February to September 1979 to select a site for the discharge of treated waste of the fertilizer industry.

From the data collected on physical, chemical and biological features, it was observed that the treated effluents can be released at least 30 km downstream from the factory site. The alternative site for the discharge has been found to be Dahej Creek which is subjected to tidal influence and has excellent flushing characteristics. Any release of the effluents in this creek, therefore, is expected to be washed out into the sea during each ebb tide.

2.9.8 Survey for a submarine pipeline route from Bombay High Bassein to Tarapur Hajira

This project was sponsored by the Oil and Natural Gas Commission. Tides were recorded at Akkarpatti (Navapur), Nani Daman (Daman), Umersadi (Tithal) and Machiwada (Umbharat) in 1978. These tidal observations were carried out for more than 30 days continuously during the calm season (Premonsoon). Currents were measured at 4-5 stations within about 150 km between Navapur (Maharashtra) and Umbharat (Gujarat). Other hydrographic data were collected from the anchored stations of average depth of 20 m off Navapur. Umergaon, Daman, Tithal and Umbharat. Analysis shows that the tidal currents follow the bottom contours. However, the influence of rivers and creeks near the stations were clearly evident. Chemical investigations showed well mixed nature of the coastal water at each location from the measurements of nutrients. DO, BOD, pH. It was concluded that the environment in this region is unpolluted.

2.9.9 Studies on the location of a suitable discharge point for a submarine diffuser in the River Par

The project was sponsored by Environmental Engineering Consultants, Bombay. A large chemical complex comprising of Atul Products Ltd., ATIC Industries Ltd., Ciba-Atul Ltd. and Cyanamide Ltd., located near Valsad releases a very large quantity of highly acidic industrial waste in the Par River estuary at a point which is 6 km upstream from the mouth. Earlier studies (hydrographic and pollution survey of the River Par) revealed the adverse effect of industrial waste on the estuary. It was suggested that neutralized and properly treated effluents should be released at least 3 km downstream from the present discharge site.

2.9.10 Studies on determining a point and mode of discharge of treated effluents into the sea

This project was taken up at the request of Steel Authority of India Ltd.,

Visakhapatnam. Monthly oceanographic data for a period of one year, off Appikonda and Gangavaram, have been collected. These include current measurements cover-in» the spring and neap tidal cycles, circulation studies using floats and the measurements of physical, chemical and biological parameters. Analysis of the data is in progress..

2.9.11 Echosounding and bottom sampling at Nagarjunsagar Reservoir

At the request of Naval Science and Technical Laboratory. Visakhapatnam. continuous echosounding and bottom sampling were done at some parts of Nagarjunsagar lake to study its bottom features. The report incorporating the findings has been submitted to the sponsoring authority.

2.9.12 Side scan sonar and shallow seismic profiler survey of the outer harbour area at Visakhapatnam

This project was sponsored by the Visakhapatnam Port Trust for the study of the nature of the sea bed in relation to the construction of offshore structures. Geophysical surveys in the outer harbour area of Visakhapatnam were completed.

2.9.13 Current measurements in the outer harbour area of Visakhapatnam Port

This project was also sponsored by the Visakhapatnam Port Trust. Current measurements for a period of one year in the outer harbour region were undertaken to study-their effect on the navigation of ships within the port area.

2.9.14 Development of occanographic instrumentation system

The development of CTD system, wave and tide gauge and multiparameter telemetry buoy system were undertaken under a grant received from the Electronic Commission of India. Of the three instruments, CTD system and wave and tide gauge system were completed. The CTD system, having a 500 m capability developed at the Institute was tested successfully during one of the R.V. Gaveshani cruises. A comparison with the guildine CSTD system was made and the output agreed very well. A wave and tide gauge utilising a strain gauge pressure transducer manufactured by ISRO, Bangalore was developed and tested successfully. Tests were carried out at Versova, Bombay and these tests were used to obtain tidal information using a high frequency cut off filter. The instrument was also used from an anchored boat for recording waves. Both these tests were very successful.

2.9.15 Environmental studies on the development of a recreational beach resort complex at Vaiguinini

This project was undertaken at the request of Gomantak Land Development Ltd., Panaji. Analysis of soil samples of Vaiguinim beach was completed and a report has been submitted to the sponsoring authority. More work is in progress.

2.9.16 Sorting of zooplankton samples

Regional Centre, Cochin completed the sorting of about 30000 ml samples received from the Commonwealth Scientific and Industrial Research Organization (CSlRO), Sydney, Australia during the year. Further sorting is in progress.

2.9.17 Seaweed resources of the Maharashtra coast

Survey of marine algal resources of Maharashtra coast was completed during the year. It has been estimated that the total seaweed yield from the entire coast would be about 20000 tonnes (wet wt.) or/and 3000 tonnes (dry wt.) per season. Findings of the survey along with the recommendations in the form of a report has been submitted to the Science and Technology cell of the Government of Maharashtra.

2.9.18 Pharmacologically active substances from marine sediments

Collection of sediment samples from different marine and estuarine areas was continued at the request of Hoescht Pharmaceuticals Ltd., Bombay. The analysis of the samples is in progress.

2.9.19 Evaluation of chemical dispersant concentrates for their suitability to Indian conditions

This project was sponsored by Environmental System Engineering Section of Bombay Oftshore Project of Oil & Natural Gas Commission. 18 chemical dispersant concentrates were tested at dilutions of 4, 8, 15 and 25%. The properties examined were solubility. BOD, COD, efficiency in oil removal, emulsion stability, toxicity (LC_{50} values using prawns) and biodegradability.

2.9.20 Consultancy services

(i) Selection of a site for an ocean thermal energy conversion (OTEC) plant along the Tamil Nadu coast: At the request of Tamil Nadu Electricity Board, some base line information on the sea bottom profile, geology of the sea bottom, life at the sea bottom, composition of sea water, meteorological conditions etc. required for the selection of a site for the ocean thermal energy conversion plant (OTEC) were collected. A report incorporating all the findings has been submitted to the sponsorers.

(ii) Analytical services: Free analytical services were rendered to many universities and government institutions at their request for the analysis of organic and inorganic constituents.

(iii) Development of single manned submersible : A preliminary report was prepared in collaboration with IIT Madras for obtaining funds from the Department of Science and Technology.

2.10

International Projects

2.10.1 Integrated Global Ocean Station System (IGOSS)

Monitoring of three components under the project Marine Pollution (Petroleum) Monitoring Pilot Project (MAPMOPP) along the oil tanker routes, from the Gulf Ports to the Far East and Japan, across the Arabian Sea and Bay of Bengal was taken up during the year. Some of the preliminary findings are given below:

Observations on oil spills and Heating (petroleum) pollutants were carried out during the cruises of R.V. Gaveshani every day at local noon (sun's meridian passage) by looking through a binocular while the ship was underway or on station. The area under survey was found to be comparatively free from oil slicks which could be observed only occasionally.

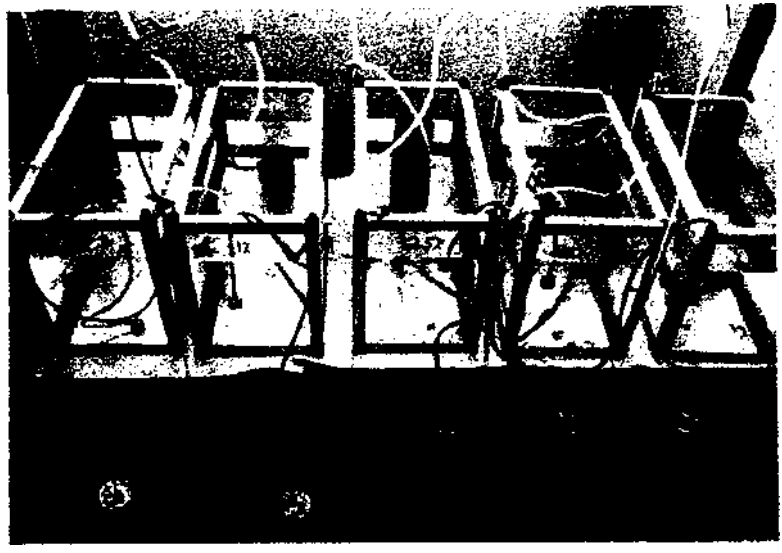
The concentration of paniculate petroleum residues (tar balls) varied much with the season and currents. Near the Indian coast, the concentrations were observed to be fairly high during the monsoon season.

Dissolved /dispersed hydrocarbon concentration varied widely but it was lower than those reported from many other oceanic seas.

A sampling device for the collection of uncontaminated water samples for dissolved/ dispersed petroleum hydrocarbons has been developed. Art analytical method using the UV-absorption spectrophotometer with a chromatographic clean-up step was also developed.

2.10.2 International Foundation of Science, Stockholm

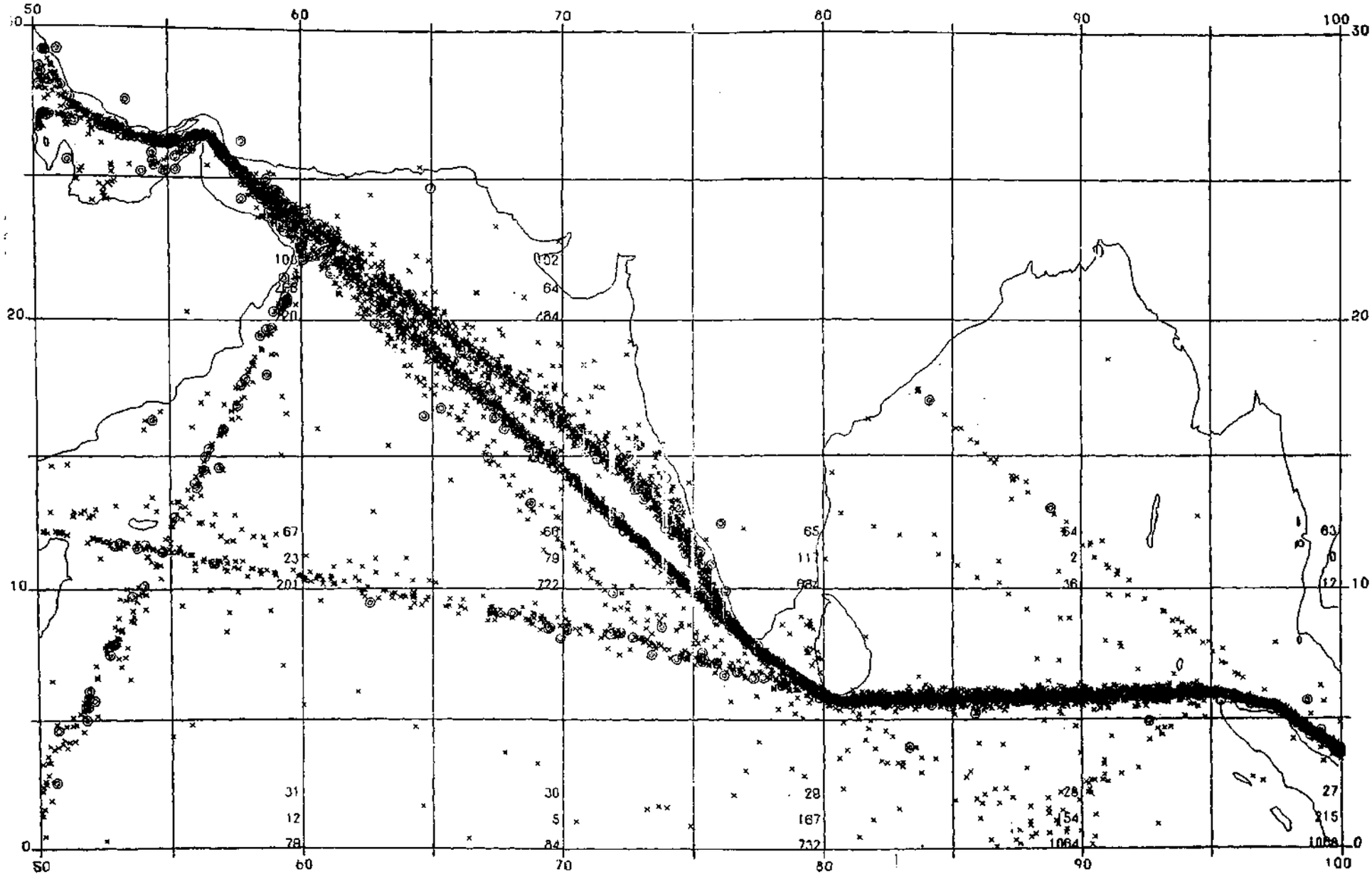
(i) Culture of mussels, oysters and prawns using treated domestic sewage : Experiments were continued to determine a sea-water-sewage dilution at which optimum growth of phytoplankton is obtained. Optimum proportion of sewage-seawater mixture to culture sufficient quantity of phytoplankton which would be used for growing of the bivalves has been determined. It has been observed that an increase in the dilution rale per day enhances the growth rate uniformly avoiding the peak-mimima-peak-near asymptotic relations. The growth at 10% sewage-sea water mixture with natural phytoplankton, after 30-40 days, seems to be adequate for the growth of the green mussel, **Mytilus viridis.**



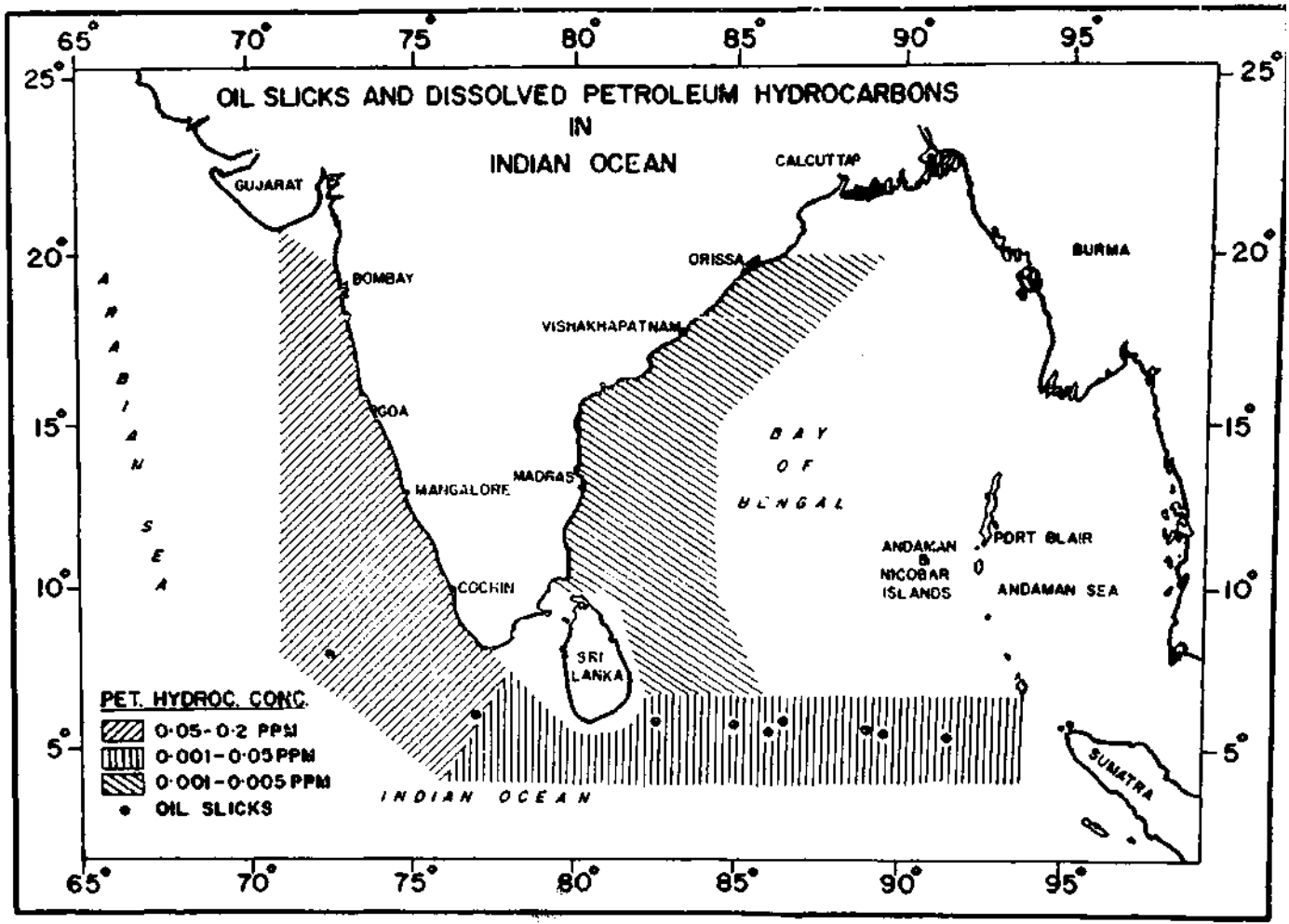
Algal culture in treated sewage and seawater medium to be used for the aquaculture of bivalves, crustaceans and fishes under the project "Food from waste"

Experiments are being continued and it is planned to start the aquaculture of green mussel by utilizing the phyloplankton culture in higher concentrations of sewage-seawater mixture at increased rates of dilution per day so as to reduce the period required to reach maximum growth rate. Plans are also underway to culture detritovorous fishes alony with the green mussel.

(ii) **Culture of brine shrimp:** A survey along the Gujarat and Maharashtra coasts is being carried out to get an idea of the regional and seasonal occurrences of **Artemia.** The survey would also provide information on the total quantities of cysts available in the media through natural population of brine shrimp.



Computer plotting of observation points of oil pollution monitoring in the Indian Ocean. Shipping lane can easily be identified in the plot.


OIL SLICKS AND DISSOLVED PETROLEUM HYDROCARBONS
IN
INDIAN OCEAN
65°
70°
75°
80°
85°
90°
95°
25°
20°
15°
10°
5°
GUJARAT
BOMBAY
GOA
MANGALORE
COCHIN
MADRAS
VISHAKHAPATNAM
ORISSA
CALCUTTA
BURMA
BAY
OF
BENGAL
ANDAMAN
&
NICOBAR
ISLANDS
PORT BLAIR
ANDAMAN SEA
SRI
LANKA
SUMATRA
ARABIAN SEA
INDIAN OCEAN
PET. HYDROC. CONC.
0·05-0·2 PPM
0·001-0·05 PPM
0·001-0·005 PPM
OIL SLICKS

3

Infrastructure Services

3.1 Library

The Library added 361 books, 486 technical reports and several documents on microfilms. With these additions, the stock position of books and technical reports has reached 8356 and 2281 respectively. The Library received 117 Indian and foreign periodicals through subscription and 80 periodicals against the exchange of Institute's publications. Besides these, the Library continued to receive reprints, standard reports from all over the world.

The documentation services such as new arrivals (monthly) and Aquatitles (fortnightly) were continued. A new service 'Oceanic Digest' (bi-monthly) was started during the year which was appreciated by the scientists. A state of art report on "Oceanographic Research in India 1974-78" has been prepared.

The Library also received linguaphone cassettes and records in French, German, Portuguese and Greek languages which were given on loan to the scientists. Library service was extensively used by the scientists of the Institute and by many outside scientists and organisations.

Libraries of the Regional Centres (Cochin, Bombay and Waltair) were further strengthened both in respect of journals and books.

3.2 Geotechnical laboratory

The Ocean Geotechnical Laboratory has started functioning. The equipment which were installed last year have been tested and these arc being used extensively for the analysis of soil samples. Spar buoys have been designed and developed using locally available material. These would be useful in the collection of visual wave data from nearshore regions.

The Dutch wave rider buoys, which were obtained under the NORAD programme, have been used to obtain continuous wave data from Bombay High and Mormugao Harbour.

3.3 Prototype service

The CTD system, wave and tide gauge, electromagnetic flow meter, rotar current meter and echosounder, which were designed and fabricated by the Institute were taken up by the prototype group. Besides, the group has successfully fabricated fibreglass sensors for electromagnetic flow meters, fibre-glass encasing for the rotar current meter and echosounder. In addition, the repairs of fibreglass boat and fibreglass joints for the exhaust chimney were also undertaken during the year.

3.4 Service and maintenance

Electroplating, drawing, photography and workshop have continued to give their full support in the form of regular service and maintenance of all sophisticated instruments. Fabrication work of piston gravity corers, grabs etc., was completed by the workshop. Jobs related to sponsored projects and several outside jobs were also undertaken and completed during the year.

3.5 New equipment

During the year Institute as well as R. V. Gaveshani were equipped with highly sophisticated equipment | apparatus to carry out analytical research work.

Equipment installed in the Institute

1. Atomic absorption spectro-photometer
2. Gas chromatograph
3. High performance liquid chromatograph
4. Spectrofluorometer
5. CHN analyser
6. Underwater camera with flood light unit
7. Spectronic 20
8. Transocean Atlantica-Radio telephone

Equipment installed in R. V. Gaveshani

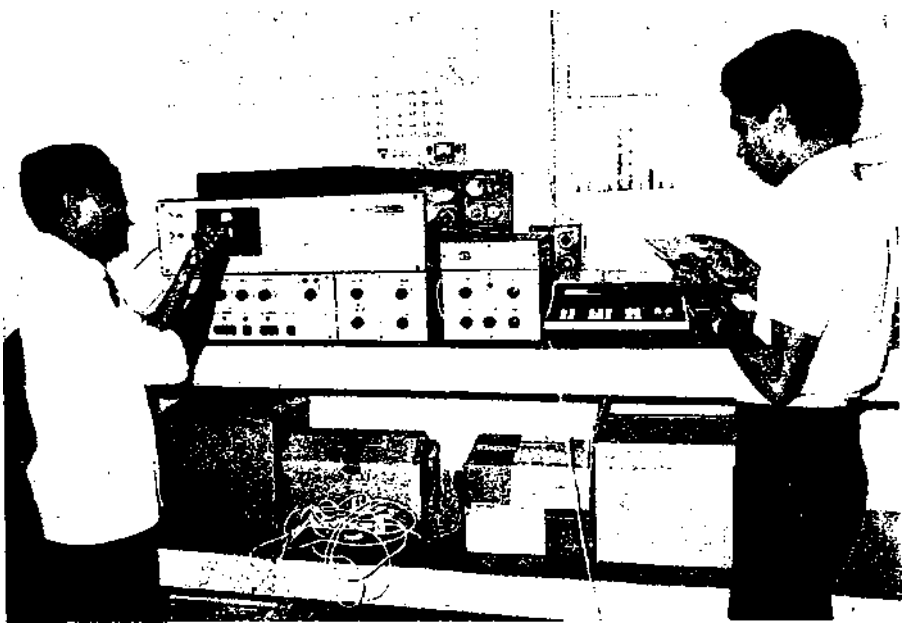
1. Omega Sonde
2. CSTD Probe
3. Expandable bathythermograph (XBT)

Equipment received under NORAD Assistance Programme

1. Simrad deep water echosounder EKS-12
2. ORE mud penetrator
3. Motorola miniranger MRS III
4. EG & G boomer-sparker system
5. Side scan sonar winch and heavy duty marine coring winch.

INSTRUMENTS INSTALLED IN THE INSTITUTE

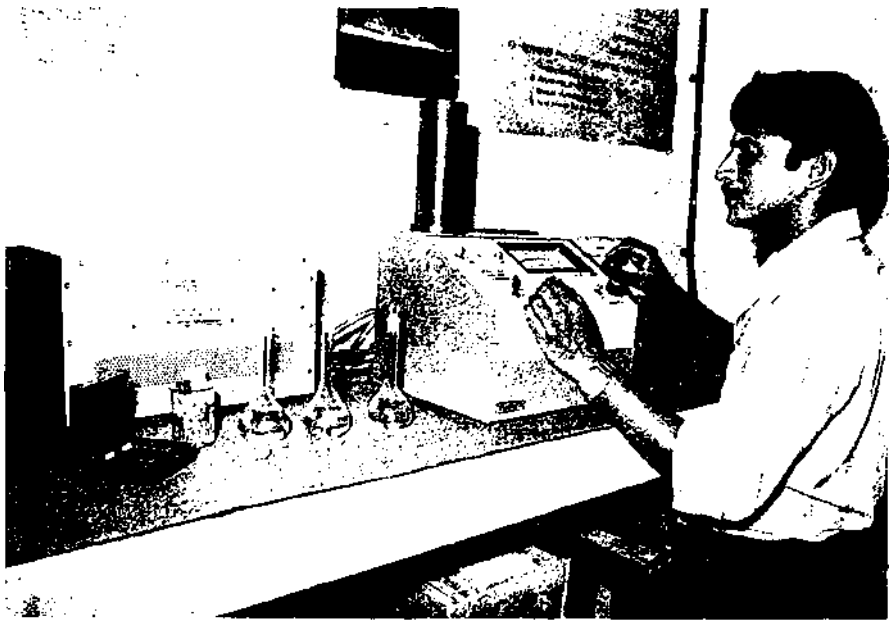
Atomic absorption spectro-photometer (Hilger & Watts U.K.)



Gas chromatograph (Perkin Elmer, U. S. A.)

INSTRUMENTS INSTALLED IN THE INSTITUTE

High performance liquid chromatograph (Spectra physics U. S. A.



Spectrofluorometer (Turner Associates U. S. A.)

4

Administrative Set-up

4.1 CRUISE PLANNING AND PROGRAMME PRIORITIES COMMITTFE FOR R. V. GAVESHANI

1.	Director General CSIR & Secretary to the Department of Science & Technology New Delhi	Chairman
2.	Capt. M. Sethi Shipping Corporation of India, Head Office Bombay	Member
3.	Mr. S. N. Batra Technical Manager Shipping Corporation of India Calcutta	,,
4.	Mr. Ananthakrishan Director (Development) Ministry of Shipping & Transport New Delhi	,,
5.	Mr. V. R. Venkoba Rao Geological Survey of India Calcutta	,,
6.	Capt. V. Ravindranath Director (OPS) Coast Guard H. Q. New Delhi	,,
7.	Mr. R. K. Kutkar Asstt. Wireless Adviser Ministry of Communication New Delhi	,,
8.	Mr. P. Satyanarayana Naval Hydrographic Officer Dehra Dun	,,
9.	Mr. K. R. G. K. Murty Naval Physical & Oceanographic Laboratory Naval Base, Cochin	,,
10.	Dr. V. L. N. Sastry Chief Geophysicist ONGC Offshore Project Bombay	,,
11.	Dr. K. L. Kaila Project Coordinator Deep Seismic Survey Project National Geophysical Research Institute Hyderabad	,,

12.	Dr. D. K. Rakshit Department of Science & Technology New Delhi	Member
13.	Dr. V. V. Bhartiya Principal Scientific Officer Department of Science & Technology New Delhi	,,
14.	Mr. K. N. Johry Head, International Scientific Collaboration CSIR, Rafi Marg New Delhi	,,
15.	Dr. D. Shankar Narayan Additional Secretary University Grant Commission New Delhi	,,
16.	Prof. D. Lal Director Physical Research Laboratory Ahmedabad	,,
17.	Mr. S. P. Jagota Joint Secretary and Legal Adviser Ministry of External Affairs New Delhi	,,
18.	Dr. E. G. Silas Director Central Marine Fisheries Research lnstitute Cochin	,,
19.	Dr. A. K. Ganguly Bhabha Atomic Research Centre Bombay	,,
20.	Commodore I. K. Puri Adviser NIO CSlR, Rafi Marg New Delhi	,,
21.	Dr. S. Z. Qasim Director NIO, Goa	Convener

4.2 EXECUTIVE COMMITTEE

1.	Dr. S. Z. Qasim Director National Institute of Oceanography Dona Paula (Goa)	Chairman
2.	Vice Admiral O. S. Dawson, AVSM Flag Officer, Commanding Southern Fleet Naval Base, Cochin	Member
3.	Dr. V. V. Sastri Director R & D Institute of Petroleum Exploration (ONGC) Kaulagarh Road Dehra Dun	,,

4. Dr. V. K. Iya — Member
Director, Isotopes Division
Bhabha Atomic Research Centre
Trombay-Bombay.

5. Shri H. N. Siddiquie — ,,
Head, Geological Oceanography Division
National Institute of Oceanography
Dona Paula (Goa)

6. Dr. B. U. Nayak — ,,
Head, Ocean Engineering Division
National institute of Oceanography
Dona Paula (Goa)

7. Shri L. V. Gangadhara Rao — ,,
Scientist. Physical Oceanography Division
National Institute of Oceanography
Dona Paula (Goa)

8. Administrative Officer — ,,
National Institute of Oceanography
Dona Paula (Goa)

9. Finance & Accounts Officer — ,,
National Institute of Oceanography
Dona Paula (Goa)

10. Permanent Invitee to the Executive Committee
(i) Director-General. SIR or his nominee and (ii) Chairman. Coordination Council of Physical and Earth Sciences Group of Laboratories, CSIR.

4.3 SCIENTIFIC ADVISORY COMMITTEE

1. Dr. S. Z. Qasim — Chairman
Director
National Institute of Oceanography
Dona Paula (Goa)

2. Commodore V. A. Dhareshwar — Member
General Manager
Goa Shipyard Ltd., Vasco-da-Gama (Goa)

3. Mr. T. Tholasilingam — ,,
Officer-in-charge
CMFRI Sub-station
Egmore. Madras

4. Dr. L. U. Joshi — ,,
Senior Scientist, Modular Laboratories
Bhabha Atomic Research Centre
Trombay-Bombay

5. Director of Industries — ,,
Government of Goa, Daman & Diu
Panaji

6. Chairman — ,,
Mormugao Port Trust, Mormugao

7. Deputy Director — ,,
National Institute of Oceanography
Dona Paula (Goa)

8.	Head, Biological Oceanography Division National Institute of Oceanography Dona Paula, Goa	Member
9.	Head, Geological Oceanography Division National Institute of Oceanography Dona Paula, Goa	"
10.	Head, Chemical Oceanography Division National Institute of Oceanography Dona Paula, Goa	"
11.	Head, Ocean Engineering Division National institute of Oceanography Dona Paula, Goa	"
12.	Head, Planning & Data Division National Institute of Oceanography Dona Paula, Goa	"
13.	Head, Instrumentation Division National Institute of Oceanography Dona Paula, Goa	"
14.	Scientist-in-Charge Regional Centre of NIO, Cochin	"
15.	Scientist-in-Charge Regional Centre of NIO, Bombay	"
16.	Scientist-in-Charge Regional Centre of NIO, Waltair	"

4.4 BUDGET

The Budget of the Institute for the year 1979-80 is as follows:

(Rs. in lakhs>

	Non-Plan	Plan	Total
Recurring	45.070	74.643	119.713
Capital	2.648	48.882	51.530.
Total	47.718	123.525	171.243.

4.5 SCIENTIFIC & TECHNICAL STAFF

(As on 31 December, 1979)

Director

Dr. S. Z. Qasim

Deputy Director

Dr. V. V. R. Varadachari

Advisor NIO (Ship matters)

Commodore I. K. Puri, Chief Hydrographer, Indian Navy (Retired)

A. Divisions at the Headquarters

1. Physical Oceanography Division

Head of the Division

Dr. V. V. R. Varadachari

Scientists

Dr. J. S. Sastry
Shri L. V. G. Rao
Dr. C. S. Murty
Dr. R. Mahadevan
Dr. D. Panakala Rao
Shri M. J. Varkey
Shri C. K. Gopinathan
Shri K. K. Varma

Senior Scientific Assistants

Shri P. S. Joseph
(on deputation to Japan)
Shri V. Ramesh Babu
Shri V. Kesava Das
Shri A. F. Anto
Shri A. D. Gouveia
Shri P. V. Sathe
Shri D. V. Rama Raju
Shri Y. K. Somayajulu

Senior Research Fellows

Shri K. Premchand
Shri V. V. Gopalakrishna

2. Chemical Oceanography Division

Head of the Division

Shri C. V. G. Reddy

Scientists

Dr. R. Sen Gupta
Shri S. P. Anand
Shri S. Y. S. Singbal
Dr. S. Y. Kamat
Dr. A. Rajendran
Shri S. N. De Souza

Senior Scientific Assistants

Mrs. Solimabi
Shri S. P. Fondekar
Shri S. B. Kamat
Shri M. D. George
Shri S W. A. Naqvi
Shri N. B. Bhosle
Shri M. D. Rajagopal
Shri R. S. Topgi

Junior Scientific Assistants

Miss S. S. Naik
Shri P. K. Mittal
Mrs. C. D'Silva
Shri K. Sawkar
Shri T. W. Kureishy
Miss S. M. Sanzgiri

Senior Research Fellow

Mrs. L. D'Souza

Junior Research Fellows

Miss A. Braganza
Shri M. Dilip Kumar

Junior Technical Assistants

Miss C. F. Moraes
Mrs. B. Das

3. Geological Oceanography Division

Head of the Division

Shri H. N. Siddiquie

Scientists

Dr. M. G. A. P. Setty
Shri P. S. N. Murty
Shri R. R. Nair
Shri Ch. M. Rao
Shri D. Gopala Rao
(on deputation to West Germany)
Dr. M. Veerayya
Shri G. V. Rajamanickam
Shri R. M. Kidwai
Shri B. G. Wagle
Shri M. V. S. N. Guptha

Senior Scientific Assistants

Shri F. Almeida
(on deputation to Japan)
Shri A. Narendranath
(on lien to NRSA)
Shri N. H. Hashimi
Shri G. C. Bhattacharya

Shri A. L. Paropkari
Shri L. V. S. Raju
Shri K. H. Vora
Shri A. R. Gujar
Shri R. Nigam
Shri S. M. Karisiddaiah
Shri A. Mascarenhas
Shri M. V. Ramana

Junior Scientific Assistant

Shri V. Subramaniam

Senior Technical Assistants

Shri K. L. Kotnala (Marine Surveys)
Shri M. C. Pathak (-do-)

Junior Technical Assistant

Shri S. K. Nanyasi

Junior Mechanical Assistant

Shri A. V. Sonawane

4. Biological Oceanography Division

Head of the Division

Dr. T. S. S. Rao

Scientists

Dr. A. H. Parulekar
Dr. A. G. Untawale
Shri V. P. Devassy
Shri S. C. Goswami
Dr. (Miss) Aditi Pant
Dr. (Mrs) Sumitra Royan
Shri P. M. A. Bhattathiri

Senior Scientific Assistants

Shri S. A. Nair
Shri C. T. Achuthankutty
Shri S. N. Harkantra
Dr. M. Madhupratap

Junior Scientific Assistants

Mrs. L. Krishnakumari
Shri Z. A. Ansari
Shri S. R. Sreekumaran Nair
Miss S. S. Bukhari
Mrs. S. Achuthankutty
Shri X. N. Verlencar

Research Associates

Dr. (Mrs.) U. Goswami
Dr. J. P. Royan

Senior Research Fellows

Shri T. G. Jagtap
Shri V. V. Agadi

Junior Technical Assistants

Shri V. K. Dhargalkar
Miss M. Menezes

5. Ocean Engineering Division

Head of the Division

Dr. B. U. Nayak

Scientists

Shri N. M. Anand
Dr. A. K. Jain
Shri S. G. Diwan
Shri T. Balasubramaniam

Senior Scientific Assistant

Shri B. A. Ramesh
(on deputation to Norway)

6. Instrumentation Division

Scientist-in-Charge

Dr. E. Desa

Scientists

Shri M. R. Nayak
Shri M. Manoharan
Dr. E. S. Desa

Senior Scientific Assistants

Mrs. V. B. Peshwe
Shri H. Srikantan
Shri H. R. Prabhu Desai

Senior Technical Assistants

Shri E. Dias
Shri V. Subramaniam
Shri A. Paneersalvam

Junior Technical Assistants

Shri Md. Wahidullah
Shri V. M. Date
Shri S. Chellam
Shri O. D'Souza

Junior Mechanical Assistant

Shri S. B. Tengali

7. Planning and Data Division

Scientist-in-Charge

Dr. V. S. Bhatt (till 24th Nov. 1979)
Shri R. M. S. Bhargava
(from 3rd Dec. 1979)

Statistical Officer

Shri S. G. Dalal

Senior Scientific Assistants

Shri J. S. Sarupria

Shri Avinash Chandra
Dr. R. K. Sharma
Shri P. V. S. S. R. Sarma

Junior Scientific Assistants

Shri S. R. Bhat
Shri P. G. Patil

Proof Reader

Shri S. P. Sharma

8. Library

Junior Technical Assistant

Mrs. Rosy Thomas

Junior Documentation Officer

Shri M. P. Tapaswi

9. R. V. Gaveshani

Executive Officer

Dr. A. B. Wagh

B. Regional Centres

1. Regional Centre of NIO, Cochin

Scientist-in-Charge

Dr. M. Krishnan Kutty

Scientists

Shri V. S. Rama Raju
Dr. R. V. Unnithan
Dr. V. N. Sankaranarayanan
Shri P. Udaya Varma
Dr. P. Sivadas
Shri U. K. Gopalan
Shri P. Gopala Menon
Shri K. J. Peter
Shri B. M. Panikkar
Dr. M. Saraswathy
Shri P. N. Aravindakshan
Dr. George Peter
Shri V. T. Paulinose
Shri T. Balachandran
Mrs. C. B. Lalithambika Devi
Shri K. Kameshwara Rao
Shri P. S. Gore
Shri T. C. Gopalakrishnan
Dr. (Mrs.) V. Santhakumari
Shri K. K. C. Nair

Senior Scientific Assistants

Mrs. **P. P.** Meenakshi Kunjamma
Mrs. Rosamma Stephen
Shri P. Haridas

Junior Scientific Assistants

Shri T. Balasubramanian
Mrs. U. P. Saramma

Post Doctoral Fellow

Dr. K. N. Remani

Senior Technical Assistant

Shri P. Venugopal

Junior Technical Assistants

Shri Abraham Pylee
Shri B. Narayanan
Mrs. K. Sarala Devi
Shri O. Raveendran

2. Regional Centre of NIO, Bombay

Scientist-in-Charge

Dr. B. N. Desai

Scientists

Dr. M. D. Zingde
Shri G. N. Swamy
Shri S. A. H. Abidi (on deputation)
Shri V. Josanto (on deputation)
Dr. (Mrs.) V. R. Nair

Senior Scientific Assistants

Dr. K. Govindan
Shri M. M. Sabnis
Shri R. V. N. Sarma

Junior Scientific Assistant

Miss V. M. Kolhatkar

Junior Technical Assistants

Shri S. M. Gajbhiye
Shri P. V. Narvekar

3. Regional Centre of NIO, Waltair

Scientist-in-Charge

Shri T. C. S. Rao

Scientist

Shri K. S. R. Murthy

Junior Scientific Assistants

Shri P. Chandra Mohan
Shri K. Subrahmanyam
Shri M. M. Malleswara Rao
Dr. V. V. Sarma
Shri P. Seetharamaiah

Senior Scientific Assistant

Shri T. V. Narasimha Rao

Senior Research Fellow

Shri T. B. Babu

Junior Research Fellows

Shri G. R. K. Raju
Shri T. S. Shahul Hameed

5

Awards, honours and membership of various committees

Dr. S. Z. Qasim acted as

— Chairman, Working Committee for Training, Education and Mutual Assistance (TEMA) in Marine Science of Intergovernmental Oceanographic Commission of UNESCO, 1976 onwards.

— President, Society for Offshore Engineering and Underwater Technology of India (SOEUTI), 1978 onwards.

— Member, Advisory Committee of Ocean Engineering Centre, Indian Institute of Technology, Madras.

— Member, National Committee on Environmental Planning and Coordination.

— Member, Indian National Commission for Cooperation with UNESCO.

— Member, Board of Governors of the Regional Engineering College, Calicut.

— Member, Groupe Magellan (devoted for Ocean Research and Development), Paris.

Dr. V. V. R. Varadachari acted as

— Member Secretary of the Indian National Committee for SCOR.

— Member, Board for Ocean Engineering Centre, TIT, Madras.

— Member, Board of Studies in Meteorology and Oceanography, Andhra University, Waltair.

— Member, Board of Studies in Physical Oceanography, University of Cochin. Cochin.

— Member, Marine Sciences Advisory Committee for Centre for Earth Science Studies, Trivandrum.

Dr. B. U. Nayak served as Member of the National Society of Fluid Mechanics and Fluid Power.

Shri H. N. Siddiquie

— Was awarded the Shanti Swarup Bhatnagar Prize for the year 1978 in Earth Sciences.

— Continued to serve as a Member of Studies in Marine Science, Cochin University.

Dr. J. S. Sastry acted as

— Member, Indian Ocean Panel, SCOR Working Group 47.

— Member, ISI Thermometers Sub-Committee. CDC-33.2.

Shri C. V. G. Reddy has been recognised as a guide for Ph.D. in Marine Chemistry by Andhra University.

Dr. R. Sen Gupta has been

— Recognised as a guide for Ph.D in Inorganic Chemistry by Bombay University.

— Nominated as a Member of Editorial Board of Indian Journal of Marine Science.

Dr. B. N. Desai acted as

— Member, Advisory Panel to the Planning Commission. Government of Gujarat.

— Member, Science and Technology Advisory Committee, Government of Maharashtra.

— Member, Advisory Committee, Water Pollution Prevention Board of Maharashtra.

— Member, Committee on Marine Disposal, Indian Standards Institution.

— Member, Board of Studies in Environmental Biology, University of Jodhpur.

— Member. Board of Studies in Environmental Science, University of Bombay.

— Member, Study Group to go into various aspects of the problem of fisheries in the Bombay Metropolitan Region and recommend suitable measures.

Dr. M. G. A. P. Setty elected as a Member of the American Association for the Advancement of Science, Washington. U.S.A.

Shri T. C. S. Rao served as

— Member, Association of Exploration Geophysics

— Member, Accoustical Society of India

— Member, Organising Committee of Marine Geophysical Technology.

Dr. V. S. Bhatt served as

— Member, FAO/IOC Panel of Experts for Aquatic Sciences and Fisheries Information System (ASFIS).

— Member, IOC Working Group on Marine Environmental Data and Information (MEDl).

— Member, Steering Group for International Oceanographic Data Exchange (IODE) of the 1OC.

— Member, IODE/WC Ad-hoc Group on Marine Information Management.

— Invited Member of Joint Working Group on Scientific and Technical Information of the Indo-US Sub-commission on Science and Technology.

— National Coordinator for International Oceanographic Data Exchange (IODE) to-deal with matters connected with IOC on this subject.

— National Coordinator for Training, Education and Mutual Assistance (TEMA).

Shri S. P. Anand has been recognised as a specialist in the field of Solar Energy of Tata Energy Research Institute, Bombay.

Shri L. V. Gangadhara Rao served as an alternative member of the ISI-Thermometers Sub-Committee CDC-33.2.

Shri V. N. Sankaranarayanan was awarded Ph.D. degree by the Kerala University for his thesis 'some physical and chemical studies of the waters of the Northern Arabian Sea'.

Shri U. K. Gopalan continued to serve as

— Member, Executive Council, Marine Biological Association of India.

— Member, Kerala Sasthra Sahitya Parishad.

— Member, Cochin Chapter of the Friends of Trees.

— Member. Board of Studies in Environmental Science, University of Cochin.

— Secretary, Cochin Science Association.

Dr. A. H. Parulekar served as

— Member, High Level Committee on Science and Technology Utilization. Government of Maharashtra.

— Member, Konkan Agricultural University Committee on Fisheries Education and Development.

— Sectional Editor (Marine Sciences) Vishwakosha (encyclopaedia in Marathi), Government of Maharashtra.

— Member, Regional Advisory Committee on Exploratory Fishery Project (Goa base), Government of India.

Dr. A. G. Untawale served as

— Member Secretary, Seaweed Research Utilisation Association of India.

— Member, Board of Studies of Nagpur University, Nagpur.

Shri M. V. S. Guptha, G. V. Rajanianickam and Rajiv Nigam were elected as fellows of the Geological Society of India.

Shri T. Bosu Babu was awarded Ph.D. degree by the Andhra University on his thesis entitled 'Some studies on the species and analytical applications of Molybdenum (III) in aqueous medium'.

Mrs. K. N. Remani was awarded Ph.D. degree by the University of Cochin for her thesis 'Studies on the effect of organic pollution with special reference to benthos in Cochin backwaters'.

Shri K. S. Purushan was awarded M.Sc. degree on his thesis 'Ecological studies of edible oyster — **Crassostrea** sp. in Cochin backwaters' by Cochin University.

Miss Maria Menezes was awarded M.Sc. degree by the Bombay University for her thesis on 'Morphometry and serology of some fishes from the Goa region'.

Shri P. V. Narvekar was awarded M.Sc. degree in Inorganic Chemistry by Bombay University.

Shri S. N. Gajbhiye was awarded M.Sc. degree in Zoology by Bombay University.

6

Deputations

Dr. S. Z. Qasim was deputed to

— Participate in the Eleventh Session of the Executive Council of Intergovernmental Oceanographic Commission (IOC) of UNESCO held in Mexico from February 26 to March 3, 1979.

— To attend the Eleventh Session of the Assembly of the IOC (UNESCO) at Paris from October 15 to November 3, 1979.

Dr. R. Sen Gupta was deputed to participate in the third meeting of Global Investigations of Pollution in the Marine Environment (GlPME) of IOC held in Malta from 28 May to 2 June, 1979.

Dr. V. S. Bhatt was deputed to participate in the Preparatory Meetings of the two 1OC Subsidiary Bodies (MEDI and ASFIS) and the XI Session of IOC Working Committee Meeting of IODE in New York from 10-19 January, 1979.

Shri S. N. D'Souza was deputed to Liverpool, U.K. to attend the second training course in Marine Pollution Chemistry.

Shri B. A. Ramesh was deputed to Norway to undergo training in wave data analysis and wave forecasting using advanced computer techniques.

Shri K. H. Vora was deputed for training to Norway under the NORAD Programme.

Shri F. Almeida was deputed to Japan on a Japanese Government Scholarship for higher studies in marine geology.

Shri E. Dias was deputed for training to Norway under NORAD Programme.

Shri S. P. Anand was deputed to attend the Summer School on Applied Solar Energy sponsored by University Grant Commission at IISC, Bangalore from 9-22 April, 1979.

Shri D. Gopala Rao was deputed to West Germany under the DST/ORV Programme for higher training in marine geophysics.

Shri T. Balasubramanian and **V. Kesava Das** were deputed to Central Water & Power Research Station (CWPRS), Poona to attend a short term course on 'Sediment transport in estuarine and coastal environment'.

Shri Albert Gouveia was deputed to Electronics Corporation of India Ltd., Hyderabad in December 1979 for training and maintenance of XBT System.

Shri S. G. Dalal was deputed to attend a summer school on the use of electronic computers in R and D at Bangalore from June 2-14, 1979 organised by Indian Statistical Institute, Calcutta.

Shri R. G. Prabhu Desai was deputed to Bhabha Atomic Research Centre (BARC), Bombay for training in Microprocessor-aided instruments in December. 1979.

Shri Y. K. Somayajulu was deputed to Indian Institute of Science. Bangalore from 5-16 March, 1979 to attend a short term course on 'Sound transmission in the Sea'.

Shri S. Hanif and **Shri Milton Fernandes** were deputed to M/s. Blue Star Ltd., Bombay for training in air-conditioning plant from 19 May to 9 November, 1979.

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Meetings, exhibitions, seminars, symposia and special lectures

Dr. S. Z. Qasim attended a meeting from 19-20 January 1979 at Kerala Agricultural University, Trichur on the establishment of a Fisheries College-cum-Research Centre at Trichur.

— Attended a meeting from 7-10 December 1979 on the construction of fishing harbour and fish based industries at Sasoon Dock. Bombay at the request of the Ministry of Agriculture and Irrigation.

— Delivered a series of lectures at the Station Biologique, Roscoff, France from 3-5 November, 1979.

— Delivered a lecture on 'Resources from the sea' at Engineering College. Farmagudi (Goa) on December 26, 1979.

Dr. B. U. Nayak delivered a lecture on the 'Geotechnical a.spects of the sea bed at CE-DEEP Seminar on 'National Strategy for Civil Engineering Research for the Deeper Continental Shelf held at Indian Institute of Technology, Delhi during 4-6 October, 1979.

Shri H. N. Siddiquie delivered lectures at the University of Mysore, Mangalore for post-graduate students in marine geology in May 1979.

— Delivered lecture at College of Engineering, Farmagudi (Goa) in December, 1979.

— Attended a meeting of the Indian National Committee for the IUGG at the Indian National Science Academy.

— Attended a meeting of the Organizing Committee for the short-term specialist course in marine geophysics at Waltair in April, 1979.

Dr. B. N. Desai participated in

— Seminar organised by Indian Science Congress Association, Bombay and delivered a lecture on the studies of waste disposal in aquatic environment.

— Lab to Land Programme of ICAR at CIFE, Bombay.

— Brackish Water Fish Culture Programme at Kakinada organised by CIFE.

— Workshop on pollution in Mahim Creek organised by the World Wild-life Fund at Bombay.

— Delivered a lecture on 'Problems of disposal of waste in aquatic environment in World Environment Day' organised by Indian Institute of Technology. Bombay.

Dr. M. G. A. P. Setty delivered lectures on marine micropaleontology at Department of Marine Science, Cochin University in September 1979.

Dr. M. Krishnankutty, Shri V. S. Rama Raju and **P. Udaya Varma** delivered a series of lectures to post-graduate students of Industrial Fisheries of the University of Cochin.

Shri P. S. N. Murthy delivered lectures in May 1979 at Mysore University, Mangalore for post-graduate students in marine geology.

Shri P. S. N. Murthy and **Shri Ch. M. Rao** delivered lectures at Department of Marine Science, Cochin University in July 1979.

Shri S. P. Anand attended the National Seminar on 'Role of Mechanical Engineers in rural development' from 10-12 March, 1979 held at Annamalai University, Annamalainagar and presented a paper entitled 'Concerted efforts for conversion of solar still into a solar drier'.

— Attended the National Solar Energy Convention held at IIT Bombay from 13-15 December 1979 and presented a paper entitled 'Concerted efforts to improve the efficiency of multi-surface solar still'.

— Delivered a talk on 'Utilization of solar energy' at Government Polytechnic Panaji on July 27, 1970.

Shri V. S. Rama Raju attended the fourth meeting of the Working Group on coastal erosion. Government of Kerala held at Trivandrum in May 1979.

Shri T. C. S. Rao attended the Seminar on Motorola Mini Ranger III System at Bombay organised by M/s. Rotax Aviation Corporation in January 1979.

— Attended the Meeting on Specialist Course in Marine Geological Technology held at Geophysics Department. Andhra University, Waltair in April 1979.

Dr. A. H. Parulekar participated in 'Lab to land programme and Workshop on ocean management' held at Central Institute of Fisheries Education (ClFE), Bombay (5-6 April, 1979) and presented a paper on 'Economics of Mussel Culture'.

Dr. A. G. Untawale, Dr. (Miss) A. Pant, Shri V. K. Dhargalkar, Shri V. V. Agadi and Shri T. G. Jagtap attended the International Symposium on 'Marine Algae of Indian Ocean Region' held on 9-12 January 1979 at CSMCRI, Bhavnagar and presented the papers.

Dr. A. G. Untawale delivered a lecture on 'Mangrove ecology' at Central Crocodile Breeding and Management Research Institute, Hyderabad on March 3, 1979.

Dr. (Miss) A. Pant delivered talks on 'Ultrastructure of algae 1 and 11 at Botany Department of Shivaji University, Kolhapur.

— Delivered lecture on 'Pollution and role of algae, at Karad College of Science. Karad, Maharashtra.

Shri U. K. Gopalan delivered lectures on

— Waste recycling and coastal aquaculture at Government Ayurveda College, Tripunithura.

— General aspects of pollution at Maharaja College, Ernakulam.

— Indian Fishery and Fisherman to Community Organization Centre, Trivandrum..

— Human Environment at Kishat Club, Tripunithura.

— On the Importance of World Environment Day at Women's Association Hall, Ernakulam.

— Waste Utilization at Palace Girls High School, Tripunithura.

— Human environment at Law Department, Cochin University.

— Industrialization and environment at Public Club of Cochin East, Ernakulam.

— Ecology of evergreen forest at YMCA, Ernakulam.

Shri S. G. Diwan and S. G. Dalal participated in the Seminar on Patent filing and documentation held at NCL, Poona in March 1979.

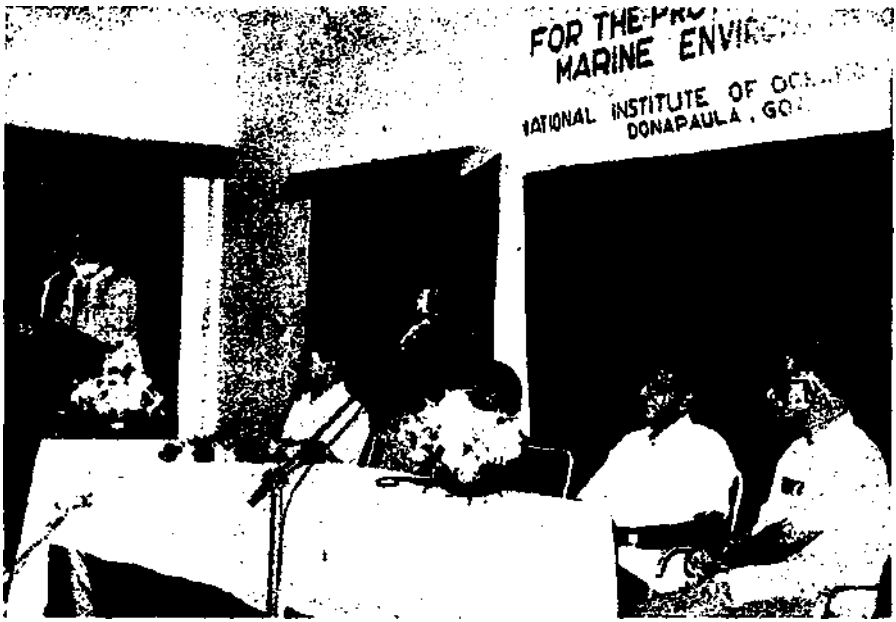
Shri N. H. Hashimi attended the Second Symposium of Sedimentologists held on 26-28 Dec, 1979 at Mysore and presented a paper.

Dr. R. K. Sharma participated in the Workshop on Aerobiology organised by NBRI Lucknow from 12-14 November 1979.

Shri S. W. A. Naqvi attended a Seminar on HPLC techniques organised by M/s. Spectra-Physics, USA and M/s. Toshniwal Bros., Bombay at Bombay on 21 and 22 November 1979.

The Institule participated in the Exhibition "Progress through Science" at New Delhi organised by International Indian Trade Fair. NIO's solar still and mussel culture techniques attracted much attention and appreciation of the people.

The National Seminar on Protection of the Marine Environment and related ecosystems held at NIO from 13-15 November, 1979 was organised through the active participation of NIO. Ministry of Shipping and Transport and the Department of Science and Technology It was attended by a total number of 73 participants from 37 Institutes/lndustries in India. A team of 8 delegates representing Economic and Social Commission for Asia and the Pacific (ESCAP) and Swedish Environmental Protection Services (SEPS). also participated. 42 scientific papers covering a wide range of subjects like marine pollution (studies and surveys), inshore and offshore technology, economy and legal aspects were presented. At the end of the seminar, 27 recommendations were adopted and were addressed to the Government of India. Perhaps, the most important of these recommendations is for the creation of a separate Ministry or Department of Environment at the Centre. The Seminar also addressed four recommendations to ESCAP; SEPS suggesting among others, to explore the possibility to establish a suitable regional institute to meet the requirements of technical manpower for effective protection of the marine environment.



Lt.Col. P. S. Gill. Lt. Governor of Goa, Daman & Diu inaugurating the National Seminar *on Protection of Marine Environment and Related Ecosystem,* sponsored by Department ot Science & Technology. Left to right - Dr. S. Z. Qasim, Shri Brij Kishore, Deputy Secretary, DST, Shri S. Venkatesh, Joint Secretary, DST, Dr. A. K. Mukerjee, Director, IMP

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Colloquia

	Speaker	Subject	Date
1.	Prof. Elizabeth Percival, U.K.	Techniques in use in carbohydrates chemistry in particular on the isolation and purification of polysaccharides	29.1.79
2.	Prof. J. M. Pollock U.K.	Why not study science?	5.3.79
3.	Dr. W. Majewski, Poland	i) General information about Poland Gdausk and the Institute of Hydro-engineering	8.3.79
		ii) Thermal processes in water bodies connected with heated water discharges	12.3.79
4.	Dr. T. Basinski, Poland	i) Maritime Hydraulics Division and its activity — Research Institute in Poland dealing with various problems of oceanography	8.3.79
		ii) Measuring techniques of hydro-dynamic processes in natural conditions of coastal zone	9.3.79
5.	Prof. T. V. Desika-chary, India	Marine diatoms	17.3.79
6.	Prof. V. Krishna Murthy, India	Culture and utilization of marine algae	17.3.79
7.	Prof. S. R. Qasim, U.S.A.	Use of freeze dried bacteria in waste water treatment	10.8.79
8.	Prof. Francis A. Richards, U.S.A.	Studies on oxygen deficient and sulphide bearing marine environments	18.9.79
9.	Prof. H. Sharat Chandra, India	Genetics mosaics in the analysis of mammalian development	15.12.79
10.	Dr. Kenneth Wood, U.S.A.	Significance of pH measurements in lake and sea water	18.12.79

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Radio Talks

	Speaker	Subject
1.	Dr. S..Z. Qasim	Bermuda triangle mystery
2.	Dr. V. V. R. Varadachari	Is the world weather changing ?
3.	Dr. B. U. Nayak	A house in the sky
4.	Dr. M. G. A. P. Setty	i) Diamonds, rubies and pearls ii) What if mineral oil becomes extinct ?
5.	Dr. A. B. Wagh	i) Ethology of fish (in Marathi) ii) The monsoon experiment (in Marathi)
6.	Dr. E. Desa	Beeps from the sky
7.	Dr. A. H. Parulekar	i) Cloning — Are the human duplicates possible ? ii) Modern techniques in aquaculture
8.	Shri P. K. Das	Whales tale
9.	Shri S. Y. S. Singbal	Biochemicals from the sea (in Konkani)
10.	Shri Ayyappan Nair	Aboard a floating laboratory
11.	Shri M. V. Mudhol	Reading habits and libraries

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Visitors

During 1979 many distinguished scientists/Professors and very important persons visited the Institute. Some of them are:

Dr. M. A. Qureshi, Executive Vice-President (I.F.C.), World Bank Group

Shri H. M. Patel, Union Home Minister, Government of India, New Delhi.

Dr. D. J. Jassawalla, Director, Tata Memorial Cancer Centre, Bombay.

Prof. S. S. Wodeyar, Vice-Chancellor. Karnatak University, Dharwar.

Prof. O. Kinne, Director, Biologische Anstalt Helgoland. West Germany.

Dr. M. R. Raman, Joint Director (Science), Planning Commission, New Delhi.

Shri P. G. Momin, Minister of Agriculture, Government of Meghalaya.

Dr. C. Kempanna. Dy. Director-General, ICA.R.. New Delhi.

Shri Dharma Veer, Chairman, National Police Commission, New Delhi.

Prof. Elizabeth Percival, Royal Holloway College, University of London.

Mr. R. M. McDowell, Alginate Industries Ltd., London.

Prof. K. W. Golmbitza, Institute fur Pharmazeutische Biologie der Universitat Bonn, West Germany.

Mr. Arne Forsman — Head, Hydrology Department. Swedish Meteorological and Hydrological Institute Norrkoping.

Prof. F. A. Richards, Chemical Oceanography Division, University of Washington Seattle and Editor of Deep Sea Research, U.S.A.

Shri V. K. S. Vardhan, former Director-General, Geological Survey of India.

Dr. G. R. Udas, Director, Atomic Mineral Division, Department of Atomic Energy, Government of India, New Delhi.

Mr. John Dog Hutchson, Secretary (Development), Royal Norwegian Embassy, New Delhi.

Mr. H. Hjelde, Councellor Development. Royal Norwegian Embassy, New Delhi.

Mr. O. E. Faraasensen, Geophysical Engineer, Geoteam, Norway.

Mr. K. Aubert, Geoteam, Norway.

Prof. O. Eldholom, Department of Geophysics, University of Oslo, Norway.

Dr. J. Thiede, Department of Geology, University of Oslo, Norway.

Prof. P. Bruun, Department of Port and Ocean Engineering, Norwegian Institute of Technology. Trondheim. Norway.

Prof. O. G. Houmb, Department of Port and Ocean Engineering, Norwegian Institute of Technology, Trondheim, Norway.

Dr. T. Basinski, Head, Maritime Hydraulics Division, Institute of Hydroengineering, Gdansk, Poland.

Dr. Majewski, Head, Inland Hydraulics Division, Institute of Hydroengineerintg Gdansk, Poland.

Dr. N. Seshgiri, Director, IPAG, Electronics Commission, New Delhi.

11

Publications

11.1 Scientific papers

Achuthankutty, C.T. and R.A. Selvakumar, 1979. Larval distribution of sergestid shrimp **Acetes** in the estuarine system of Goa. **Mahasagar — Bull. natn. Inst. Oceanogr., 12:** 169-174.

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11.2. Popular articles

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