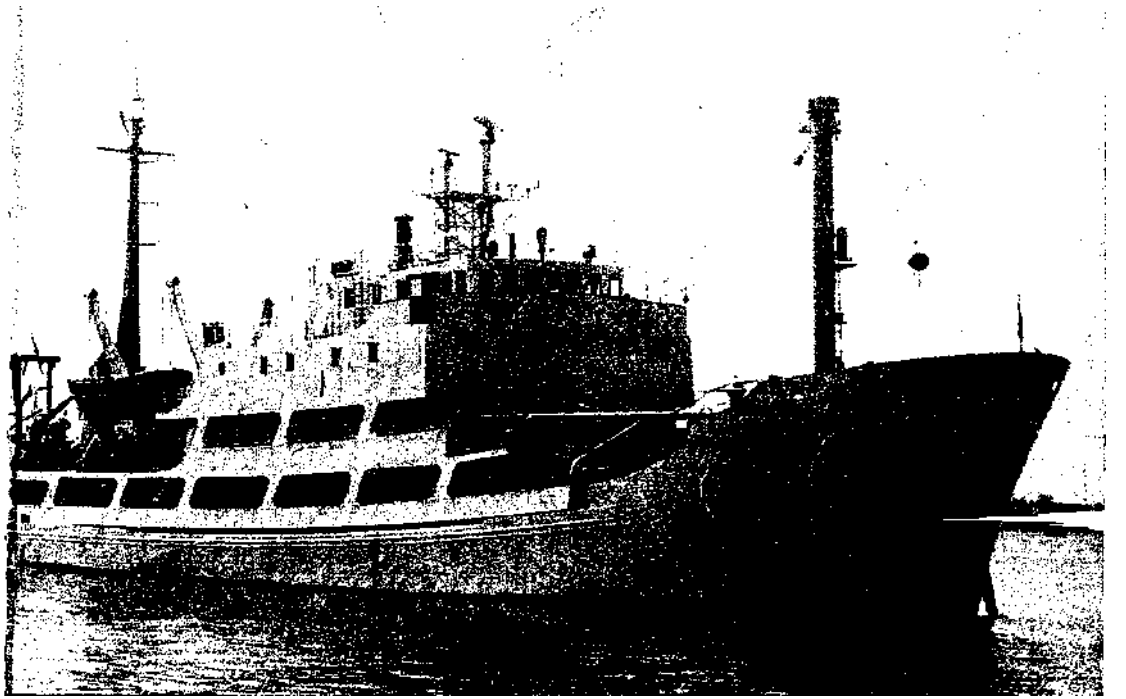
ANNUAL REPORT 1983



NATIONAL INSTITUTE OF OCEANOGRAPHY

(COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH)

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Institutes Research Vessel **Gaveshani**

ANNUAL REPORT

1983

19

NATIONAL INSTITUTE OF OCEANOGRAPHY
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Director's Report

The 19th Annual Report of the National Institute of Oceanography, which covers the period January to December, 1983, highlights the major achievements in the Research and Development activities of the Institute and also focusses briefly on some of the important events that have taken place during the year.

The acquisition of the research vessel, **Sagar Kanya** in 1983 by the Government of India, is a landmark in the history of oceanography in India. We would like to thank the Department of Ocean Development, Government of India and the Council of Scientific and Industrial Research for entrusting this Institute with the responsibility of scientific management of the research vessel which is one of the most sophisticated research vessels in the world today.

A. R & D PROJECTS

Antarctic programme was continued and most of the samples collected during the Ist and IInd Expeditions to Antarctica have been analysed and the findings incorporated in the Technical Report brought out by the Department of Ocean Development. NIO contributed 23 out of a total of 35 papers in this report.

The Cassette left at the unmanned weather station-the **Dakshin Gangotri-** in 1982, recorded meteorological data from 16 January to 13 June, 1982 and it was recovered during the Second Expedition to Antarctica. The data has been analysed and the results are discussed in the report of the First Expedition.

Five scientific personnel from this Institute have been included in the IIIrd Expedition to Antarctica, which left Goa on December 3, 1983. Another scientist from this Institute is presently wintering at the Australian Station Port Davis, from November 1, 1982 and has collected several species of marine algae from the area.

Data collection on various aspects of oceanography has increased enormously since the arrival of the research vessel **Sagar Kanya.** 21 cruises were completed during this year-15 by RV **Gaveshani** and 6 by ORV **Sagar Kanya.**

ORV **Sagar Kanya** paid a good will visit to Mombasa and worked in Kenyan waters with two Kenyan scientists on board, on her first cruise undertaken during the period July to September, 1983. Similarly, RV **Gaveshani** with Sri Lankan scientists on board carried out survey in the Sri Lankan waters during the year under report.

The chartered vessels MV **Skandi Surveyor** and MV **Farnella** were utilised exclusively for the survey of polymetallic nodules in the Indian Ocean. About 3,00,000 sq. km. area has been surveyed.

The new areas of activities in physical oceanography during the year were numerical modelling, remote sensing of oceanic features from space and development of acoustic tomographic system for obtaining synoptic oceanic properties. Comprehensive field programmes have been undertaken to study the physical oceanography of the Arabian Sea and Bay of Bengal by simul-

taneously covering these areas, using the two research vessels, **Sagar Kanya** and **Gaveshani,** during the post monsoon season.

In the field of chemical oceanography, one of the main findings was the identification of polysaccharide fraction from seaweed-**Codium elongatum.** This polysaccharide is polygalactan in nature and it exhibited an anti-viral activity against Ranicket virus. Detailed studies are in progress.

The Marine Pollution Studies Group developed into a fullfledged Division in June, 1983, and initiated new investigation on "the Chemistry of the sea surface microlayer" to understand the nature of chemicai transformation and the adverse effects of pollutants. In addition, the regular data collection on the floating tar balls in the Central Indian Ocean, Western Indian Ocean, Western Arabian Sea and the Somali Basin was continued. Under the area of environmental protection and pollution, monitoring, a speical cruise of RV **Gaveshani** was undertaken in the Bombay High region. The investigations indicated that the region has recovered from the effects of oilwell blowout which- took place in July, 1982.

A new species of red algae **Bangia fuscopurpunea** has been recorded for the first time in the tropical region, by our biologists. The alga **Cladophora** has been found to harbour two parasitic phycomycetous fungi viz. **Cladochytrium** and **Sirolpidium,** both of which are reported for the first time in India.

Migration studies of zooplankton undertaken during the maiden voyage of **Sagar Kanya** belied, beyond doubt, the general belief regarding the maximum, abundance of planktonic organisms within the upper 200 m of the water column of the sea. It was interesting to note that much of the plankton migrates below the depth of 300 m during the daylight hours.

Studies on the long term changes in the structure and composition of commercial clam beds in Mandovi-Cumbarjua Canal-Zuari estuarine complex indicated a great deterioration in the qualitative and quantitative features. The average standing crop observed was less than 0.1 kg/m^2 in i982-83 as compared to 13 kg/m^2 during 1971-72.

Data collection on biofouling and corrosion was continued by the Group on Biofouling and Corrosion at some estuarine stations. The panels received from a West-German Shipyard were exposed in the Mormugao Harbour for comparative studies of biofouling settlements. This section has also handled several sponsored projects worth more than Rs. 15 lakhs, for organisations such as Oil & Natural Gas Commission (ONGC), Ennore Thermal Power Station, Tamil Nadu, etc., and has also interacted with sister laboratories like National Metallurgical Laboratary (NML).

A long term data collection programme on waves and currents was initiated off Kakinada and Machilipatnam and at the Bombay High in May, 1983. A sponsored project on beach erosion at one of the beaches of Goa (Miramar beach) was undertaken and a suitable measure to check erosion was suggested by the Ocean Engineering Division.

The Marine Instrumentation Group successfully designed and developed a tide gauge-one of the first of its kind in country. This has been designed around the INTEL 8085 microprocessor with data storage on soild state memories. Another instrument, which is also microprocessor based and successfully developed, is the current meter. Attracted by its versatility, the Calcutta Port Trust placed an order for 6 prototypes for current measurement in the Hooghly river.

An attempt was made to collect the real time data via Argos System. The drifting buoys fitted with satellite transmitters were deployed in the Indian Ocean.

The Bombay Regional Centre of N.I.O. continued its activities on the assessment of waste assimilation capacity of coastal waters along the west coast and the impact of pollution on the ecosystem. The Regional Centre at Cochin in addition to its regular R & D activities embarked upon a new investigation on the 'saline water intrusion' to a distance of 21 km upstream from Cochin Harbour. Magnetic and topographic surveys undertaken by the Regional Centre, Waltair in the Lawson's Bay showed magnetic anomalies. Modelling studies have indicated that one of the anomalies is due to near surface accumulation of placer deposits and another one with more than 500 gammas is due to the uplift of the basement layer which is partially faulted.

B. SPONSORED WORK

During the year under report new sponsored projects were undertaken including grant-in-aid projects. Most of the projects undertaken this year were of multidisciplinary nature. Consultancy services have also been provided to various agencies.

C. SERVICES

The Planning and Data Division continued to provide computer facilities to the staff of the various Division and Sections of the Institute. Regular publications and information literature were brought out.

The Institute participated in two exhibitions at New Delhi and highlighted there the activities of the Institute in the area of ocean studies.

The library services were continued and extended to outsiders also. Besides routine services and bibliographies under documentation services, a fortnightly and monthly list of publications procured in the Library, were brought out regularly. During the year, a total number of 1780 books and 253 technical reports were added.

The Workshop facilities were enhanced with the acquisition of HMT Radial Drilling machine. The other services provided by the Workshop included, fabrication of instruments like rotor current meter, tide gauge and data buoy besides other auxiliary jobs, such as electroplating, equipment spare parts fabrication, etc.

The facilities like drawing, printing, binding, reprography and photography were well utilised. The Photographic Section also provided facilities of colour processing and development of colour prints and slides.

The Institute provided supporting facilities to the Department of Ocean Development in bringing out the scientific report on the First Indian Expedition to Antarctica.

D. MAJOR EVENTS

The significant event during the year under report was the memorable visit of the President of India, Giani Zail Singh. On 30th December, 1983, the President spent more than two hours going through the R & D activities of the Institute and also visited the research vessel **Sagar Kanya** on 31st December 1983.

Shri Shivraj Patil, Union Minister of State for Science and Technology, visited the Institute and the newly acquired research vessel **Sagar Kanya,** on July 1 and 2, 1983. This was followed by the visit of Shri Ram Nivas Mirdha, Union Minister of Irrigation on 18 September, 1983.

Dr. M. Ferrari, Minister of Planning and External Relations, Seychelles made a brief visit to the Institute on 27 November, 1983 and discussed about the possibilities of collaboration between the two countries in the area of marine sciences.

The Institute hosted the 53rd Annual Session of the National Academy of Sciences, Allahabad, during October 1983. Two Seminars - one on "Oceans and Climate" and the other on "Marine Plants" were organised at the Institute, from 28 to 29 October, 1983 and from 30 October to 1 November, 1983, respectively.

Dona Paula, Goa
March, 1984

V.V.R. Varadachari
DIRECTOR

2.1

Oceanographic Cruises

During the year, 21 oceanographic cruises were completed, 15 by **RV Gaveshani** and 6 by **ORV Sagar Kanya.** A good amount of data on various aspects of oceanography was collected during the maiden voyage of RV **Sagar Kanya** from Germany to India. These surveys have increased considerably our knowledge of Carlsberg ridge and Centre of spreading. Several stations in the international waters were also occupied during this voyage.

Two cruises-one each of **Sagar Kanya** and **Gaveshani** were undertaken in the Kenyan and Sri Lankan waters respectively. Four cruises of RV **Gaveshani** (Nos. 125-128) were in the Bay of Bengal aimed to study the oceanographic conditions during the north east monsoon.

Several participants from universities of Andhra, Berhampur and Annamalai and Naval Physical and Oceanographic Laboratory, Cochin, were also trained in the operation of various equipment and methods of sample collection.

CRUISES OF RV GAVESHANI

Cruises of RV Gaveshani

Cruise 115 (Chief Scientist: Dr. S.Y.S. Singbal)

A cruise of 13 days duration which commenced from Mormugao on 18th Jan., 1983 was devoted mostly to pollution studies with a view to have an assessment of present state of oil pollution in the Bombay High region after the blow-out in July-August, 1982. Five transects perpendicular to the Bombay coast between lat. 18° and 20.5° N and long. 70° 40' and 72°30'E were covered, with the western station 165 nautical miles away and eastern station about 50 nautical miles away from the shore. Samples were collected from 28 stations for the analysis of petroleum hydrocarbons besides the collection of supplementary data on chemical and biological aspects. In addition to this, sediment samples were also collected for the analysis of petroleum hydrocarbon residues and for SEM studies.

Cruise 116 (Chief Scientist: Dr. C.S. Murty)

A cruise which started on 10th February from Mormugao was planned to study the flora & fauna and collect baseline data on thermal structure for the proposed OTEC plant in the Lakshadweep Sea.

During this cruise which lasted for 22 days, a total of 34 stations were occupied· At all the stations thermal structure upto a maximum depth of 1000 m was studied with digital bathythermograph. Water samples from 6 standard depths were analysed for nitrates, nitrite, urea and ammonium phosphate and dissolved organic nitrogen. Studies were also carried out on primary production and to understand the microbiological characteristics of the waters. The thermal structure in the vicinity of Kavaratti and Minicoy islands showed interesting features, the details of which are being examined.

The ship paid a goodwill visit to Male, Maldives Islands and to Colombo, Sri Lanka. At Colombo the Scientists attended a seminar on 'Marine Mammals'.

Cruise 117 (Chief Scientist: Dr. S.Y.S. Singbal)

117th cruise of 23 days duration was undertaken to study oceanographic conditions around Sri Lanka with special reference to the areas off Kalpitiya (Gulf of Mannar), Dondra Head (south of Sri Lanka) and Trincomales Bay. **Gaveshani** which sailed from Mormugao on 18th March, occupied 41 stations around Sri Lanka. In addition, observations were also carried out at 10 stations in the Wedge Bank. From Sri Lanka 4 scientists were also trained in handling the gears for the collection of samples and in the methods of anajysis of various parameters on board the ship.

Cruise 118 (Chief Scientist: Dr. Miss Aditi Pant)

The objectives of this 19 day multidisciplinary cruise were to investigate the occurrence of oxygen minima and nitrite maxima in the Arabian Sea with reference to water mass interactions, to find out the bacterial organisms likely to be associated with the nitrite maxima and to discover the existence of any correlation between surface primary production and the presence of subsurface nitrite maxima.

RV **Gaveshani** which left Mormugao on 17th April, occupied a total of 27 stations between Lat. 15-21°N and Long. 63-74°E, all deeper than 3000 m except for the two, and well beyond the Indian continental shelf. Hydrographic, chemical and biological sampling were done at all stations. Nitrite maxima were located at 200-300 m and only one oxygen minimum of this track was observed between 200 to 500 m. Preliminary investigation on bacterial studies indicated that these are capable of reducing NO_3 to N_2 in some areas of track.

Cruise 119 (Chief Scientist: Shri C.K. Gopinathan)

A 14 day cruise was planned in the month of May as it was found ideal for studying the variation of temperature with depth for Ocean Thermal Energy Utilisation. RV **Gaveshani** which sailed from Mormugao on 8.5.1983 completed 6 hydrographic stations between Lat. 7-15°17'N, Long. 72-80° 50'E and one station for air-sea interaction studies. The surface meteorological observations such as wind speed, direction, atmospheric pressure, dry and wet bulb temperatures, sea surface temperature and vertical thermal structure upto a depth of 1000 m were noted at all the stations. In all 17 stations were worked out.

Air-sea interaction studies included measurements of horizontal wind and temperature at different levels above the sea. Observations for air pollution studies were also carried out at all the stations. Sea truth data at 2 stations were collected when **Bhaskara** II passed over RV **Gaveshani** on 18.5 1983.

Cruise 120 (Chief Scientist: Dr. S.Y.S. Singbal)

The cruise, started from Madras harbour on 24th May, was of 14 days duration and was aimed to collect hydrographic data along the two east-west sections across the Bay of Bengal between Lat. 11-17° N and Long. 81-92° E for the acoustic tomographic experiment, besides the data collection on different parameters such as nutrients, primary production, meteorology etc. 15

deep hydrographic stations were occupied between Madras and Port Blair which formed the first of the two east-west sections across the Bay of Bengal. 15 MBT/XBT stations were also covered along the track to study the thermal structure in the upper layer in detail. The second section between Port Blair and Visakhapatnam consisted of 12 deep hydrographic stations and 12 MBT/XBT stations.

Cruise 121 (Chief Scientist: Dr. T.C.S. Rao)

A multidisciplinary cruise was undertaken with major emphasis on marine geophysics of the continental margin of Visakhapatnam between 16-18° 5'N and 81-85°E. RV **Gaveshani** started its 12 day cruise from Visakhapatnam harbour on 10 June, 1983. During the cruise, data on echosounding over 860 lkm, uniboom/sparker array over 200 lkm and hydrography/sediment samples at 20 stations were collected.

Interesting sub-surface features such as intrusives faults and folds have been recorded.

Cruise 122 (Chief Scientist: Dr. C.S. Murty)

A cruise of 8 days duration was planned for hydrographic studies off, the river mouths of Krishna, Godavari, Mahanadi and in the lower reaches of the Hooghly river. The cruise started from Visakhapatnam on June 30, 1983.

In all, 3 stations were occupied in Hooghly and measurements of currents in intermediate depths for varied duration (40-48 hrs) were made. Expendable BT observations at every 3 hours were carried out from Visakhapatnam to Mahanadi. A sediment sample was also collected off Mahanadi for demonstration purposes to the trainee scientists.

Cruises 123-129 (Chief Scientist: Dr. D.P. Rao)

Cruise **123**

A cruise of 7 days duration from Calcutta to Visakhapatnam was planned to study the oceanographic conditions in the coastal and nearshore waters of Orissa. A total of 19 stations were occupied and a distance of 900 nm was covered.

Cruise 124

This cruise, started from Visakhapatnam on 17th September, 1983, was aimed at studying the oceanographic conditions between Visakhapatnam& Port Blair and between Port Blair & Madras with special reference to Acoustic tomography. During the cruise the ship called at Port Blair where Shri A.L. Kampani, Lt. Governor of Andaman & Nicobar Islands and Rear Admiral R.R. Sood visited the ship. A total of *59* stations were occupied covering a distance of 2000 nm. Besides NIO scientists, 4 research scholars from Andhra University also participated in the cruise. The cruise terminated at Madras on 9th October, 1983.

Cruises 125-128

Cruises 125-128 were conducted with the aim of studying the oceanographic conditions, in the Bay of Bengal during the North East monsoon es-

pecially from 6° to 20° N at 2° interval tracks, between the east coast of India and Andaman and Nicobar Islands. Besides covering stations in the open sea, observations were made in the coastal waters also.

Cruise 125 started from Madras on 18th October and terminated at Madras on 1 November, 1983 after carrying out observations at 38 stations covering a distance of 2140 nm. In this cruise one research scholar from Andhra University also participated.

Cruise 126 started from Madras on 6 November, 1983 and terminated at Madras on 16 November, 1983 after data collection at *27* stations and covering a distance of 1660 nm. Three research scholars from Andhra University and one from IIT, Madras also participated in the cruise.

Cruise 127 started from Madras on 21 November, 1983. A total of 60 stations were occupied during the cruise and covered a distance of 2320 nm. The cruise terminated at Visakhapatnam on 9 December, 1983. Three scientists from Annamalai University and 2 from Andhra University also participated in the cruise.

Cruise 128 staried from Visakhapatnam on 14 December, 1983. Observations were made at 18 stations and a distance of 870 nm was covered during this cruise. Four scientists from Andhra University, one each from Annamalai University, Berhampur University and NPOL, Cochin participated in the cruise. Ship returned to Visakhapatnam on 19 December, 1983.

Cruise 129

This cruise was specially organised for making current measurements at a stationary location off Visakhapatnam where the depth was 100 m. Besides current measurements, time series observations of other oceanographic parameters were also carried out at this station. Ship left Visakhapatnam on 21 December and returned on 27 December, 1983. One research scholar from Andhra University and two from NPOL. Cochin also participated in this cruise.

During these cruises, strong surface currents directed southeasterly were encountered along the east coast of India during Nov-Dec period. The current speeds estimated from the ship's log were of theorder of 3-4 knots.

CRUISES OF ORV SAGAR KANYA

A. Trial cruise of ORV Sagar Kanya

Trial Cruise I (Chief Scientist: Dr. V.V.R. Varadachari)

The first trial cruise was undertaken in the Baltic Sea from 28 March to 1 April, 1983, to test various scientific equipment on the research vessel. This was also a familiarisation cruise for the officers and crew of the Shipping Corporation of India, who operated the research vessel, for the first time after the vessel was handed over to the Government of India (on 25th March, 1983) at Travemunde, Federal Republic of Germany.

ORV **Sagar Kanya** with Indian and a few German scientists on-board left Travemunde on its cruise, around 1900 hrs. on 28th March, 1983 and proceeded towards the first station of the cruise located at lat. 55°02'N and long. 13° 53'E. The vessel arrived at the location (location 1) around 0424 hrs. on 29 March, 1983 and after testing equipment, proceeded towards the station located at lat. 55° 29' N and long. 15° 55'E (location II). The vessel

arrived at the station at 0948 hrs. on 29 March, 1983. After testing various scientific equipment at location II, the vessel left the station around 2000 hours on 31 March, 1983 and arrived at Travemunde around 0800 hours on 1 April, 1983.

Various physical, chemical, biological, geological, geophysical and meteorological equipment on board the research vessel were tested and operated during the cruise. The Magnavox Integrated Navigation System was used for position fixing. A meteorological data buoy was launched, tested and retrieved. Meteorological balloons were also launched.

The vessel performed well throughout the cruise and it was quite stable even when waves of about 3 metres height and winds exceeding 40 knots were encountered during the cruise, due to a storm located a little north of the track of the cruise.

Trial Cruise II & III (Chief Scientist: Dr. T.S.S. Rao)

The trial cruises II and III of **Sagar Kanya** were undertaken as part of the maiden voyage of **Sagar Kanya** from Travemunde (in F.R.G.) to India. The vessel with German and Indian Scientists on board, left Travemunde on 12th April, 1983 and reached the Indian Port at Goa on 27th June, 1983. During this 77 days cruise, research activities were carried out in Atlantic ocean, Strait of Gibraltar, Mediterranean Sea, Red Sea, Gulf of Aden and the Arabian Sea.

During this voyage 220 stations were occupied and core sampling, bathymetry, gravimetry, seismics and zooplankton migration studies were carried out.

A hydrochemical study of Red Sea was carried out along its central axis at 40 m intervals. The results indicated that the nutrients are low in the Red Sea as compared to the Arabian Sea. Bathymetric and other geophysical surveys were carried out at an area of unknown depth and was named after **Sagar Kanya.** In the Ethiopian section of this sea a meteorological buoy was moored for 3 days to study the energy flow between the sea surface and atmosphere.

After working in the Red Sea, meteorological observations were carried out continuously for 120 hours at a station north east of **Error Seamount** in the Arabian Sea past Socotra Island. Hydrographic and geophysical surveys near **Owen fracture zone** were also carried out. Dredge samples from **Error Seamount** showed coral reef carbonates and phosphorite fragments which probably indicate that the summit of the **Error Seamount** was shallower than the present.

The Zooplankton samples collected all along the western side of the Chain Ridge in the Somali Basin were extremely rich and appeared to indicate that the area may be the spawning grounds for pelagic and benthic organisms in the Arabian Sea.

The Geophysical surveys carried out both at the **Owen fracture zone** and the **Carlsberg Ridge** in the area 2° to 3°N and 63-64°E revealed classical distribution of magnetic anomalies characteristics of the rift valley systems. The rock samples obtained in the rift valley and slopes of the ridge clearly revealed the young age of the ridge. The presence of hydrothermal manganese and other mineral encrustations is an evidence of the centre of spreading as well as significant rise of the water temperature near bottom.

B. Cruises of **ORV** Sagar Kanya after its arrival in India

Cruise 1 (Chief Scientist: Shri L.V.G. Rao)

Sagar Kanya left Mormugao Harbour on its first scientific cruise on 12 July, 1983. This cruise was mainly devoted for studying on monsoon energetics, watermass structure and environmental conditions in the north-western Indian Ocean.

During this cruise the ship was called at Mombassa (Kenya) on 10 August, 1983 on a goodwill visit. Ship sailed from Mombassa on 16 August, 1983 and conducted a joint oceanographic study in the sea off Kenya with two Kenyan scientists for 3 days. The joint programme was planned as a collaborative work between the National Institute of Oceanography (CSIR) and Kenya Marine and Fisheries Research Institute (KMFRI). Sagar Kanya returned to Mormugao Harbour after traversing the scheduled track on 2 September, 1983.

Apart from this, **Sagar Kanya** completed three zonal sections along 10°N, 5°N & 4°S and three meridional sections along 68°E, 63°E and 52°E before reaching Mombassa and three sections along equator, 10° N and 15°N and two meridional sections along 57°E and 68°E while returning to Mormugao.

She also carried out side scan sonar and magnetic surveys off Cochin for Indian Navy.

A total 100 stations were occupied covering a distance of 14700 line km. Altogether 33 scientists from 8 organisations in India and 2 scientists from KMFRI (Kenya) participated in the cruise.

Cruise 2 (Chief Scientist: Shri V.S. Rama Raju)

This cruise started from Mormugao on 13 September, 1983 and was planned to study mainly the circulation pattern in the northeast Arabian Sea. Apart from NIO scientists, five scientists from India Meteorological Department and one from Naval Hydrographic Office, Dehradun participated in the cruise. A total of 33 stations were worked out during the cruise.

Cruise 3 (Chief Scientist: Dr. B.U. Nayak)

This cruise started on 30 September, 1983. The cruise was organised to train various scientists from NIO, India Meteorological Department (IMD) and Indian Navy in the operations of various oceanographic equipment on the **ORV Sagar Kanya** and to collect data on the oceanographic and atmospheric conditions in and over the Central Arabian Sea (15-20°N) during the withdrawal phase of the south-west monsoon. The aim of these observations was mainly to study the oceanic response to retreating monsoon, oceanic circulation and radiation budget. Thirtyone stations were occupied and data on biological and chemical parameters were also collected during the cruise. Ship called at Bombay on 13 October, 1983.

Cruise 3A (Chief Scientist: Dr. B.U. Nayak)

Cruise 3A was organised mainly to acquaint the scientists with various deck facilities on board **Sagar Kanya** and carry out experiments to learn techniques for deployment and retrieval of Meteorological Data Buoy and the instrumented moorings. The cruise started from Bombay on 20 October and terminated at Mormugao on 25 October, 1983. Current measurements were carried out at Bombay High. The water samples collected near the coastal waters off Bombay were rich in phytoplankton populations.

Cruise 4 (Chief Scientist: Dr. J.S. Sastry)

Sagar Kanya sailed from Mormugao on 30 October, 1983. The main objective of the cruise was to study the general circulation pattern in the southern Arabian Sea along 13°N and 11°N latitudes during the transition period between summer and winter monsoons. In addition to this, observations were carried out on biological productivity along with microbiological investigations. In all 36 stations were covered and the ship returned to Mormugao on 17 November, 1983. Four scientists from IMD and one from Naval Hydrographic Office also participated in the cruise.

Cruise 5 (Chief Scientist: Shri Ch. Madhusudan Rao)

Sagar Kanya carried out geological and geophysical surveys along the western continental margin of India. During the cruise about 6810 line km echosounding, 7652 line km magnetic, 5308 line km gravimetric, 2111 line km seismic and 80 line km side scan sonar surveys were completed. In addition to these surveys, sediment samples were also collected at 22 stations. Some of the core samples collected from the slope region off Bombay exuded H_2S smell. The cruise started from Mormugao on 28 November and ended at Mormugao on 27 December, 1983.

2.2

Physical Oceanography

2.2.1 Theoretical and numerical modelling studies.
2.2.2 Studies on physical processes in the seas around India.
2.2.3 Remote sensing of oceanic features / parameters.
2.2.4 Coastal zone management.
2.2.5 Energy from sea.

The activities of the Physical Oceanography were continued in areas of theoretical and numerical modelling studies, remote sensing of oceanic parameters from space, feasibility studies on the development of an oceanic tomographic system for the Indian Ocean and field based oceanographic studies in the Bay of Bengal, Arabian Sea and West Indian Ocean. The salient features of these are summarised below:

A. R &D Projects

2.2.1 Theoretical and numerical modelling studies

Under this project the following investigations were carried out during the year.

(a) **Bi-spectrum and wave propagation**

The bi-spectrum of sea surface displacements (which is a Fourier decomposition of triple product of local displacements) is found to be real, but, it has bad variance properties and the quantitative conclusions found in leterature need modification.

A study on the propagation of edge waves on a beach uniformly sloping in the offshore direction and with small random perturbations along shore, revealed that the edge wave decays in amplitude as it propagates and that its phase speed decreases non-uniformly in the direction normal to the shore. Under these conditions, the wave front turns towards the beach. A Fokker-Plank technique was used to obtain the probability distributions of the amplitude and phase processes on a stretched space scale. The probability density of the logarithm of the amplitude and the phase are found to be independently normally distributed for both the edge and the planetary waves. Further, it is found that they suffer a wave number shift. The bottom randomness affects the shorter planetary waves so strongly that their influence cannot be analysed by the present technique. The long planetary waves are found to decay in the direction of phase propagation with an e-folding length proportional to the fourth power of the wave length.

(b) **Circulation**

(i) Coastal circulation: Monthly mean wind stress along the coast of the north Indian Ocean was computed using resultant winds. Estimated shipdrifts were used to determine the coastal circulation in the region. These two sets of data were examined from the point of view of the classical Ekman-Thorade model, which takes into account only the local wind forcing. The model predicts a linear relationship between the longshore components of wind stress and

current. A comparison between the theoretical and the observed curves revealed the following:

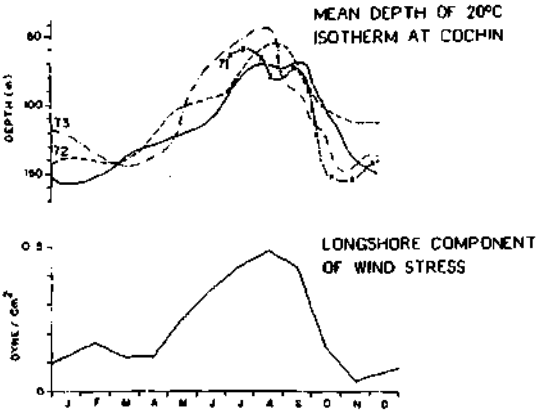
1. The observed alongshore velocity component lies closest to the theoretical curve for the areas off Arabia which implies that the Ekman-Thorade model is best suited for this region.

2. A northward surface current, in addition to the locally forced one, appears to be present off Somalia. Such a current might be caused in response to a southward Sverdrup flow in the open ocean to the east of the coast.

3. Currents off the west coast of India are relatively weak. Though wind is the major driving mechanism here, thermohaline forcing too, influences the currents during the phase of weak winds.

4. The Ekman-Thorade model fares worst off the east coast of India. In this region, the locally forced flow appeared to be significantly modified by a remotely forced current. Sverdrup transport induced by the curl of the wind stress over the Bay of Bengal could be one possible mechanism for generating such a current.

The mean monthly longshore component of the wind stress and the mean topography of the isotherms off the south-west coast of India are found to follow the same pattern of variation in time as depicted in Fig. This observation suggests that the coastal processes off this coast are controlled mainly by local winds, in accordance with the classical theory of coastal upwelling.



Monthly mean depths of 20° isotherm and of longshore component of wind stress off Cochin.

(II) Oceanic circulation: The wind driven circulation of the Bay of Bengal, using observed monthly mean wind data as input parameter was simulated by employing two-dimensional vertically integrated hydrodynamical equations. Work on the simulation of circulation using constant south-westerly wind was also completed. The simulated circulation pattern agree fairly well with the observed circulation pattern during the south-west monsoon. A steady circulation pattern has been obtained after 60 hrs. of numerical integration of the model equations.

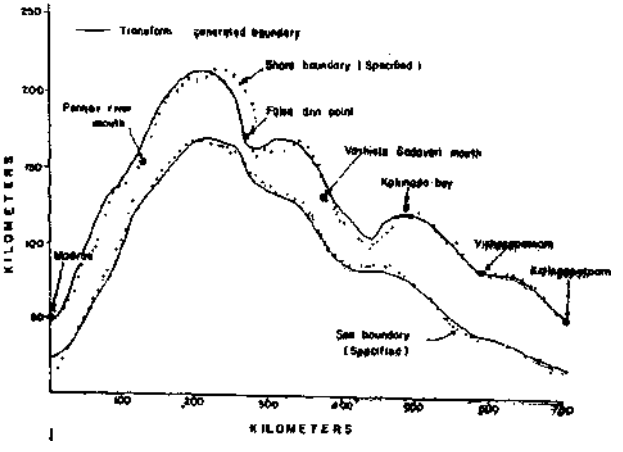
An estimate of the Sverdrup transport for the Bay of Bengal showed that for the month of January, there is a maximum northward transport of 4 Sverdrups upto 10°N along east coast of India while for the month of July, for the same area, the transport is towards southward and is of the order of 7 Sverdrups supporting the view expressed earlier.

(iii) ***Vertical circulation in the Indian Oceans:*** The vertical velocity field in the geostrophic interior of the ocean is computed with the mean wind-stress, observed density field and bathymetry as inputs to the computation. A formal solution of the equation for bottom pressure was obtained with the assumption that horizontal transport normal to the eastern boundary vanishes. The vertical velocity field is then expressed using the bottom pressure field. It was found that bathymetry plays a significant role in determining the vertical velocity distribution.

In *yet* another study, the vertical circulation in the equatorial western Indian Ocean was computed by numerically solving the turbulent diffusion equations of temperature and salinity using the hydrographic data collected onboard USSR Research vessels in 1977. The analysis yielded encouraging results in the identification of zones of equatorial convergence and divergence.

(c) **Storm surges along the Indian Coasts**

Storm surge profiles were computed using numerical filters from the sea level data recorded at five stations along the east coast of India during 1968-73. Using the bathystrophic storm tide theory, nomograms for the estimation of wind induced surge for the selected stations along the east coast of India have been prepared. A few case studies of surge hindcasting were made and the results were comparable with observations. The storm surge generated by the cyclone which hit Andhra coast in 1977 is being simulated by means of two dimensional numerical model which permits the use of realistic bathymetry and coastline configuration. The co-efficients of the transformation function to map two overlapping shelf regions between Madras and Visakhapatnam have been determined.



Specified and transform. generated shelf region between Madras and Kalingpatnam.

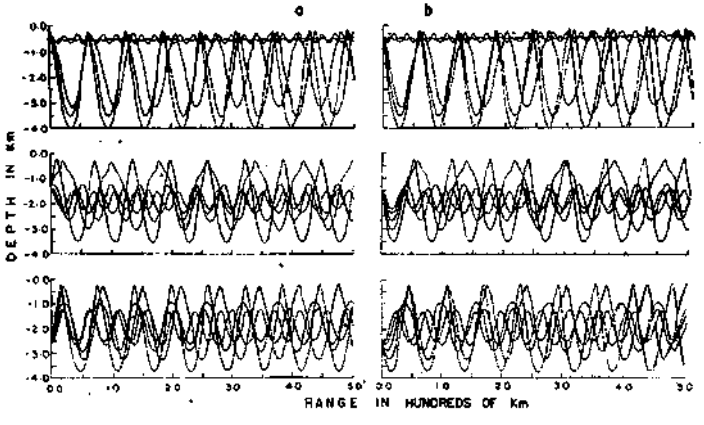
(d) Mixed layer studies

A theoretical one dimensional model for the mixed layer of the Arabian Sea is being developed to understand the behaviour of sea surface temperatures in the Arabian Sea which is relevant to the study· on monsoon.

2.2.2 **Studies on physical processes in the seas around India**

(a) Acoustic tomography

The ray geometry for a hypothetical sound velocity profile and a source located at a depth of 1500 m in Bay in Bengal worked out earlier has been modified. A range dependent profile construction is incorporated representing the real situation. Using this programme, sound velocity profiles have been constructed at every 20 km distance from the observed profiles along the propagation path and acoustic ray paths along four meridional section and two zonal section in the Indian Ocean have been computed. A typical ray path diagram along 10°N in the Arabian Sea is shown in Fig. Prediction for each parameter is in progress for delineating the influence of temperature, salinity and density on the ray path. Study of the ray path geometry in Bay of Bengal along two sections (Madras-Port Blair, Port Blair-Visakhapatnam) is in progress to find probable locations and configurations of source and receivers for carrying out field studies during 1984.



Ray path diagram for sound located at depths 500, 1500 and 2500 m in the Arabian Sea, depicting positive rays (a) and negative rays (b).

The inverse technique is being developed for obtaining the velocity perturbations to a reference sound speed making use of travel times of sound along 'n' paths. With a fixed travel time and known grid areas (either in the horizontal or in the vertical), the system leads to simultaneous equations from which the velocity perturbations can be obtained in the sea water. A computer programme is being developed to solve these equations for the prediction of the oceanic properties as a part of the development of an acoustic tomographic system.

(b) **Physical processes of the oceans**

(i) Summer cooling of the Arabian Sea: The summer cooling of the Arabian Sea was studied based on the mean monthly climatic data. The analysis gave the following results:

1. The quantum of summer cooling is more in the coastal regions off Africa and India rather than in the central portions.

2. The differences in the magnitude in summer cooling have been attributed to the variations in the strength of coastal upwelling along the respective coasts.

3. In the central portions of the Arabian Sea, the thickness of the surface layer and the thermal structure appeared to be governed by the baroclinic adjustment to the complex gyral motions and by mixing of cold waters entrained into the surface layer in association with the deepening of current shear zone.

(ii) Watermasses: Data collected during 118th cruise of RV **Gaveshani** in April-May 1983 indicated two salinity maxima in the Arabian Sea with an intermediate salinity minimum. The first salinity maximum occurred between 30 and 100 m with salinity values of 36.61 - 36.74 ppt lying between steric levels 360 and 280 cl/t while the secondary salinity maximum (salinity between 36.00 and 36.16 ppt) occurred at 250 to 400 m with steric values between 160 and 140 cl/t. The intermediate salinity minimum occurred at 200-240 m with salinity lying between 35.82 and 36.01 ppt lying on the steric values between 220 and 180 cl/t indicating a hypothetical watermass embedded between two salinity maxima north of 15°N latitude supporting earlier studies.

(iii) ***Heat budget:*** The heat content computed upto a depth of 200 m revealed that the quantum of heat along 15°N latitude is more than the heat content along 20° 30'N. The variation of heat content is in consonance with the variations of mixed layer depth, total heat in the 200 m column in the area does not appear to vary significantly, revealing that during the period the horizontal advection is low.

(c) **Wave climate over the north Indian Ocean**

A study of the monthly and seasonal wave characteristics and their interannual variations in the north Indian Ocean was taken up by analysing recorded wave data. Records analysed for various months over several years indicated that March, April, September and October are calmest months with an average wave height of *0.75* m and June-August are the roughest months with the average wave heights exceeding 2 m in the Bay of Bengal. However, during monsoon depressions, with high wind speeds of the order of 40 knots which is a common phenomenon in the Bay, the wave characteristics substantially change from the normal. Arabian Sea is very calm during months other than the southwest monsoon period. Average wave heights exceed 3.0 m during June-August. Data collected during a cyclone in July 1979 on board RV **Gaveshani** showed a wave height of 11.0 m. An analysis of 17 wave records collected during July showed that the formation of wave groups of 3 to 4 waves with same period was a common feature.

In a study on analysis of wave data for the estimation of the significant wave height, an attempt has been made to assign certain energy levels to each major peak. Major spectral peaks are often found due to independent wave trains. The steepness and relative depth criterion have been applied to the spectra to find out the presence of different wave trains.

2.2.3 **Remote sensing of oceanic features/parameters**

Data on brightness temperature from SAMIR were analysed for 16 orbits for the north Indian Ocean for the period from November 1981 to June 1982, to obtain an empirical relationship between brightness temperature and wave height. The wave data used in the study included both recorded with the ship borne wave recorder onboard RV **Gaveshani** and visual observations reported in the Indian Daily Weather Reports. A linear relation between significant wave height and brightness temperature at 19 GHz and a multiple correlation at 19 and 22 GHz were studied and the following empirical relation has been derived

$$Hs = -8.7135 + 0.06314T_{B19}$$

where Hs is the significant height and TB19 is the brightness temperature at 19 GHz.

2.2.4 **Coastal zone management**

Land-sea *interaction:* Under this project, work has been carried out on the studies on dynamics of the waters of the coastal boundary zone particularly in the vicinity of estuary entrances along the east coast of India. The current data collected using Aanderaa current meters upto March 1983 gave the following results:

1. The tidal component of the mainflow along the east coast north of Krishna river showed a progression of tide towards north during the rising phase. This flow was mainly in the north-south direction off Sand Heads, while it was directed towards northwest off New Moore Island. In general, during the flood tide, the flow converges at the head of the Bay.

2. The oscillatory nature of the observed flow was primarily due to the component resulting from wind stress. This component is very irregular with a wide range of frequency.

.3. The currents in the vertical have variable shear.

4. The general flow field showed fair consistency in the direction for two periods, the one prior to and the other during the maximum fresh water discharge into the coastal boundary region. However, the magnitude indicated significant changes.

5. Prior to the commencement of large fresh water influx (June/July) the vertical water column appeared to be quite stable. The spatial changes in the stability was less conspicuous except for the stations off New Moore Island,

6. The onshore component of the flows was determined by the short period wave influence while the alongshore components present linear flows parallel to the isobaths.

Analysis of temperature, salinity and current data collected at a fixed point in Bay of Bengal during June-July 1982 showed the existence of a low frequency temperature oscillations of periodicity of about 1.5 to 2.0 hours at subsurface depths. Similar oscillations were found in the alongshore components of the flow in the area. Some of the derived properties like Brunt Vaisala frequency vertical current shear and the Richardson Number revealed that these oscillations were due to internal waves.

Work carried out under this project by Regional Centre, Cochin is reported under Section 2.11.1.

2.2.5 **Energy from the sea**

A comparison of the performance of the computer simulated solar pond with the performance of the experimental one has been made. This has helped to identify the factors adversely affecting the performance of the experimental solar pond. The defects noticed in the earlier experimental one are being corrected.

B. Sponsored Projects

Details of work carried out is given under Chapter on 'Sponsored Work'.

2.3

Chemical Oceanography

2.3.1. Chemical studies in the coastal and offshore waters of the Arabian *Sea and Bay of Bengal*
2.3.2 Organic chemicals (drugs) from the sea

The activities in chemical oceanography increased particularly in marine pollution and monitoring studies, which necessitated the creation of a new Division to take up these activities exclusively. A new Division (MPSD) was created, and hence under Chemical Oceanography, the activities were confined to the above mentioned two projects, only.

A. R & D Projects

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

(a) Studies on nutrients and dissolved oxygen

During the first cruise of ORV **Sagar Kanya** (July-September, 1983) 100 stations were worked out in Arabian Sea and Northern Indian Ocean. Chemical analysis even upto a depth of 1500 m suggests the presence of undecomposed organic matter due to incomplete biological oxidation. Nitrite was almost absent along the equatorial region at all the depths. From 2°N primary nitrite maximum showed its presence at 100 m depth at concentrations of about 0.3 µg at/1. Nitrite showed maximum concentrations between 6° and 8°N, ranging from 0.7 to 1.0 µg at/l; while the secondary nitrite maximum appeared at 300 m. Around 13°N the primary nitrite disappeared at 300 m. Around 13°N the primary nitrite disappeared while the secondary nitrite maximum showed maximum concentration of 5.4 µg at/1.

During the cruise IV of ORV **Sagar Kanya** (Nov. '83) relatively high concentrations of nutrients were observed in north eastern and north western coastal waters of the Arabian Sea whereas its central region showed normal concentrations.

Mandovi esturary: Sediment of phosphorous of core samples from Mandovi estuary were subjected for fractionation into saloid bound calcium phosphate, aluminium phosphate, iron phosphate, reductant soluble (iron coated), and occluded aluminium phosphate based on the selective solubility of various extractants.

Iron and calcium phosphate were dominant and constituted 53 and 31% respectively. The amount of saloid bound phosphate was maximum when the pH of the sediment was acidic and the quantity of which decreased as the sediments were found more alkaline.

The core sample studies indicated that the available nitrogen occurs in the sediment in the form of organic nitrogen, ammonium in pore waters, exchangeable ammonium and dissolved nitrate. Total nitrogen ranged from

2.03 to 6.38mg/g (dry weight) and organic nitrogen ranged 73 to 96% of the total nitrogen. The concentration of (NO_3+ NO_2) nitrogen was low throughout the core except at the oxidised sediment water interface where a maximum of 18 µg (NO_3 + NO_2) N/g of sediment was found. In contrast exchangeable ammonium was very low at the surface and increased with depth in samples collected from the freshwater region whereas a reverse trend was noticed in the samples collected from the mouth of the estuary. Fixed ammonium values ranged from 3 to 9% of total nitrogen and the values increased from the sediment water interface to 30 m depth.

(b) Studies on Boron

Boron in coastal and estuarine water (Mandovi) varied from 3.04 to 4.48 mg/kg and from 0 to 5.83 mg/kg respectively. Interstitial water showed a variation in boron concentration from 1.79 to 6.11 mg/kg. Studies on seasonal variations showed its high concentration during monsoon, low during post-monsoon and almost nil during monsoon period. Observations indicate that boron in this estuary does not give a very clear picture of its conservative behaviour as is observed in the open sea.

(c) Studies on Fluoride

The fluoride ion pairing was studied in Bay of Bengal, Northern Arabian Sea including Bombay High region. This study showed that the iron pairing of fluoride was apparent to be mostly with magnesium 48.6-52.4%) than calcium (1.9-2.2%) whereas the free fluoride was found to be between 48.3 and 51% of the total fluoride.

(d) Chemical speciation of some important metals

The labile and non-labile forms of dissolved and particulate fractions were studied in estuarine waters by differential pulse anoidic stripping voltammetry. The observations are indicated in the table.

Fractions	Cadmium (µg/l)	Lead (µg/l)	Copper (µg/l)
Dissolved labile	0.09-0.33	2.0-8.0	5.0-11.0
Dissolved non-labile	0.18-0.29	3.0-16.0	4.0-7.0
Particulate labile	0-0.31	0-9.0	0-4.0
Participate non-labile	- -	0-23.0	- -10.0

(e) Organic constituents in the marine environment

Lipids in surface* waters *of Arabian Sea: Gravimetric studies on lipids in Bombay High region showed a varied concentration from 165 to 293 µg/l. Total lipid concentration decreased as the distance of the sampling station from shore increased. Polar fraction (mathanol) was the major constituent (57-85%) of the total lipid.

Alkaline phosphatase activity in the sediment of the Bombay High region: Organic carbon content in the shell sediment varied from 2 to 12.07 mg/g

whereas the total phosphate ranged from 554 to 1200 µg/g. Inorganic and organic phosphates varied from 169 to 940 µg/g and 84 to 592 µg/g respectively. Organic carbon and total phosphate content showed, good correlation (r=0.8). Alkaline phosphatase activity ranged from 20 to 125 µg PO_4- P/ hr/ g dry sediment. Organic carbon, phosphate and alkaline, phosphatase activity showed spatial variation. However, there was no correction observed between enzyme activity and phosphate content in the area sampled.

Variations in* dissolved *carbohydrate and particulate organic matter in Mahi-estuary: Dissolved carbohydrate variation during a tidal cycle, were Investigated at six stations in a highly polluted Mahi estuary. Values for surface varied from 1.48 to 31.47 mg/l, and for bottom from 3.71 to *25* mg/1. Observations showed a direct proportional relationship of carbohydrate, with phytoplankton biomass. Release of carbohydrates was maximum in the morning which decreased as the day proceeded. Some irregularity observed in the distribution of carbohydrate could be due to the industrial effluent.

Particulate organic carbon (POC) varied from 0.20 to 8.80 mg/1 in the surface whereas, in the bottom water it varied from 0.36 to 15 mg/l. Particulate organic nitrogen (PON) ranged, from 0.049 and 4.20 mg/l in surface and from 0.09 and 0.095 mg/l in the bottom. There was good correlation between POC and PON and the correlation coefficient for the entire estuarine region varied from 0.51 to 0.95. No relation was observed between suspended load, Chlorophyll a POC and PON. Mostly, the POC is of detritus nature which is confirmed by the presence of high C/N ratio. The detritus content increased from riverine region to the mouth of the estuary.

(f) **Studies on factors regulating sea water composition**

Ionic potential dependence of rare earths: Linear relationships were observed between ionic potentials and enthalpies, of hydration, concentrations in manganese nodules, sea water-crustal rock partition coefficients, sedimentation rates and residence times for rare earth elements in sea water. Empirical relations are found among various parameters considered.

Significance of oxygen as oxides and hydroxides: Using ΔO^2-M free energy of an oxide minerals from the respective aqueous cation) a model was proposed which signified the role of oxygen in controlling the seawater composition. Using the regression equations, concentrations and residence times of unknown elements can be estimated. The predicted oceanic residence times for Am, Ir, Ra and Rh are 3.6×10^2, 2.2×10^5 and 6.4×10^2 years respectively.

(g) **Chromium species in the marine environment**

Chromium speciation study showed the metastability of Cr(II) and Cr(III). Cr(III) - inorganic complexes are more stable than Cr(II) and Cr (III) - inorganic complexes. This study reveals the tendency of strong adsorption of Cr(III) onto suspended particulate matter, the feasibilty of reduction of Cr-O^2 species by organic ligands via complexation and the predominance of $Cr(OH)_3$ over $Cr(OH)_2^+$ above a temperature of 71.5 + or -1.0°C in seawater. The transformation of $Cr(OH)_2^+$ and $Cr_2O_7^{2-}$ (stable species in river water having a pH of 6.0 for Cr(III) states respectively) to $Cr(OH)_2^+$ and CrO^{2-}_4 (more stable species in seawater occurs during the estuarine mixing.

2.3.2 Organic chemicals (drugs) from the sea

(a) Screening of marine organisms

During this period 30 new species were collected mainly from Malwan, Ratnagiri and Andamans and the concentrated extract parepared from them were sent to Central Drug Research Institute (CDRI), Lucknow for screening for biological activities.

Fractions of **Acanthus ilicifolius** (analgesic), **Corallina officinalis** and **Acanthophora specifera** (antifertility) were sent to CDRI, Lucknow for the confirmation of the activity observed earlier.

(b) **Chemical investigation of marine extracts**

The polysaccharide fraction of **Codium elongatum** which is polygalactan in nature showed an antiviral activity against Ranicket Disease virus. An acid hydrolysate of this polysaccharide contained galactose and arabinose. The petroleum-ether fraction of red seaweed **Acanthophora specifera** exhibiting antifertility activity, yielded methyl palmitate, cholestrol and a fatty acid, hepta decanoic acid, while from **Stoechospermum marginatum** in addition to the compounds reported earlier (stoechospermol; its acetate and fucosterol) two more fatty acids, palmitic and oleic acid (Cis) have been isolated.

The seaweed **Padina tetrastromatica** was found to be a rich source of fatty acids and the major acid being palmetic. Other compounds isolated from the fatty acid fractions included hexadecanoic acid and its methyl ester, octadecanoic acid, dedecanoic acid, oleic acid (Cis) and its methyl ester. The presence of methyl heptadecanoate and methyl octadecanoate was also detected in this fatty fraction. Besides these fatty acids, four sterols from **P. tetrastromatica** viz. cholesterol, 24-ethyl 24-(25)-dehydrocholesterol and trace amounts of fucosterol, dihydrofucosterol 24-methyl cholesterol and glycoside whose structural elucidation is in progress, were isolated.

Marine alga-*Codium elongatum*

The major constituents of lipid fraction detected from seaweed **Gelidiela acerosa** were hexadecanoic acid, trace amount of its methyl ester and 24-methyl cholesterol. Other fatty acids isolated are oleic acid (Cis), dodecanoic acid and octadecanoic acid.

Investigations on the lipid fraction from **Porites lutea** a stony coral found to contain methyl esters of hexadecanoic, heptadecanoic, octadecanoic acids and free dodecanoic acid, besides other sterols and batyl alcohol reported earlier.

The characterisation of other constituents from above marine organisms is in progress.

2 4

Marine Pollution Studies

2.4.1 Protection of marine environment and monitoring of pollutants along the Indian coast

A new "Marine Pollution Studies Division" (MPSD) has been created from June 1983 with a nucleus of 12 staff members. The task of this Division is to continue investigations under the following projects:

i. Protection of marine environment and monitoring of pollutants along the Indian coast

ii. Characteristics of estuarine regions of major rivers in India.

The later project which is a part of a grant-in-aid project from Department of Environment, is now merged with the project **"Coastal zone management".**

R & D Projects

2.4.1. Protection of marine environment and monitoring of pollutants along the Indian coast

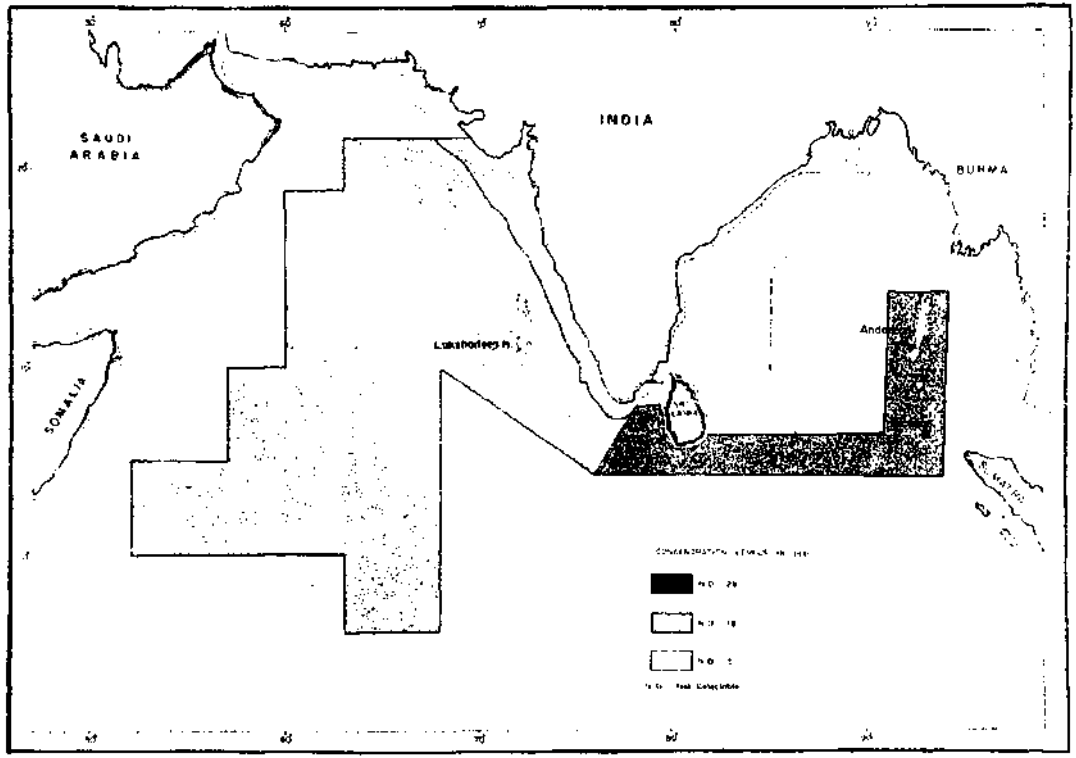
(a) Petroleum hydrocarbons

(i) Dissolved /dispersed petroleum hydrocarbons: A special cruise (No.115) on board RV Gaveshani was planned in January, to examine the recovery of the Bombay High region after the blow-out in July-August 1982. Five transects perpendicular to the Bombay Coast and around the rig **"Sagar Vikas"** were investigated. In all, 52 water samples at three depths (surface, 10 and 20 m) were collected and analysed for petroleum hydrocarbons. The concentration varied from non-detectable to 70 µg/l This indicated that the Bombay High region has recovered from the effects of the blow-out.

37 water samples from different depths were also collected from regions around Sri Lanka on board RV Gaveshani and were analysed for petroleum hydrocarbons. The values ranged between 26.2 and 65.5 µg/l.

In addition to the above, 175 water samples were collected from The Arabian Sea on board ORV Sagar Kanya and analysed for, petroleum hydrocarbons. The concentration ranged between ND (not detectable) and 18 µg/l.

With the available data from the western Arabian Sea, an attempt was made to compute the amount of the dissolved/ dispersed petroleum hydrocarbons in the upper 20 m. The total computed volume of dissoved oil between 0 and 25°N latitude and 48° and 80°E longitude was about 3.3 x 10° tonnes.



Dissolved petroleum residues in Indian Ocean.

(ii) Floating petroleum residues/tar balls: Several observations for floating tar balls were made in the Central Indian Ocean, Western Arabian Sea and the Somali basin utilizing the Catamaran-type neuston net (30 cm x 16 cm, 300 µm mesh) available on board ORV **Sagar Kanya.** The net was towed for 15 minutes at the surface with the ship steaming at 2 knots. Out of 55 tows, floating tar which was insufficient for separation and weighing was observed only in a few of them. These observations were taken during the monsoon months of June, July and September when the surface flow at the Arabian Sea is directed towards the Indian West Coast and consequently little floating tar can be expected on the western Arabian Sea.

Several neuston tows were also made during the cruises of **RV Gaveshani** in the eastern Arabian Sea and Sri Lankan waters.

Based on the recent and earlier data it is computed that about 8400 tonnes of floating tar can be expected to be present on the surface Arabian waters at any time of the year.

Applying the relation that the average input of oil to any marine area is 0.36% of the total transport across it and that 1% of this input will end up as floating tar, it has been calculated that tar on Northern Indian Ocean has "residence time" of 30-90 days.

(b) Toxic and non-toxic metals

***i). Analysis of sediment* samples:** Analysis of some sediment and core samples from the east and west coasts of India were carried out for toxic heavy metals such as Pb, Cd and Hg. The values for Pb and Cd were low throughout. Available methods for Hg indicated recoveries below the detection limit of the analytical instrument. Organic carbon content of the sediments were also analysed for correlation studies.

(ii) Analysis of water samples: About 100 water samples collected during cruises of ORV **Sagar Kanya** in between 10° and 22°N Lat. and 55° and 75°E Long in the Arabian Sea were filtered on board and the filterate and suspended matter have been preserved separately for onshore laboratory analysis which is in progress.

(c) Chemistry of sea surface microlayer

Many of the processes that determine the chemical transformations and adverse effects of pollutants and influence their transfer between environmental compartments, takes place at an interface or surface. For example, the so-called surface microlayer present on oceans and fresh waters accumulates both organic and inorganic pollutants and controls their aquatic atmospheric change. This is a new investigation undertaken by the Division. Available literature on the subject have been collected extensively and a surface microlayer sampler has been designed and is under fabrication for sea trial.

2.5

Geological Oceanography

2.5.2 Geochemistry of the sediments of the continental margins and deep sea.

2.5.2 Regional geology and manganese nodules deposits in the Arabian sea and Central Indian Basins of the Indian Ocean.

2.5.3 Foraminifera as indicators of pollution in the marine environment.

During the year, the work in geological oceanography was carried out on the above mentioned projects with major emphasis on the survey of Polymetallic Nodules deposits in central Indian Ocean. Two projects viz., "Geological and geophysical surveys to decipher the regional geology and assess the petroleum and mineral prospects of the continental margins of India" and "Paleoclimatic studies on the nature of the summer monsoon over India during the past 10,000 years" were suspended since August 1982 to redeploy the manpower for the project on polymetallic nodules.

The findings of each project are as follows:

A. R A D Projects

2.5.1 **Geochemistry of the sediments of the continental margins and deep sea**

Geochemical studies of the western shelf and upper slope sediments have been completed while studies of the eastern shelf sediments are in progress. Studies on the sediment cores of the western equatorial Indian Ocean have also been completed. The geochemical data of the sediments of western shelf was statistically analysed to identify the factors responsible for the incorporation of various elements in the sediments. The important findings are as below:

(a) **Western Continental Margin (Ratnagiri to Cochin)**

(i) The calcium carbonate varied from 5 to 85% in sediments of the western shelf and upper slope. However, the higher "content (75 to 85%) is encountered on the outershelf between Ratnagiri and Mormugao while the sediments south of this region contained lower (< 68%) $CaCO_3$ The lowest concentration of $CaCO_3$(5-30%) were encountered all along the inner shelf.

(ii) The average organic matter content of the shelf and upper slope sediments (3.%) is higher than the world average of 2.5%. In the shelf sediments the range of organic matter content was small due to the oxic conditions and it poorly correlate with biological productivity. In the upper slope sediments due to the anoxic conditions the organic carbon content was higher and varied widely.

(iii) Analysis of bulk samples and partition studies of phosphate indicated higher concentration (> 2.28%) of phosphate association with the carbonate fraction of the outershelf and slope sediments.

(iv) Grater portion (> 75%) of the major elements (Si, Al, Fe, Ti, Mg, K, Na) and trace elements (Mn, Ni, Co, Cu, Zn, Li) were associated with the lithogenous component of the sediments. However, influence of lithogenous and non-lithogenous contributions varied from element to element. A major portion of these elements enter the lattice positions of the clays at the site of weathering. Calcium, phosphorus and strontium were mostly concentrated in the non-lithogenous fraction of the sediments. This was confirmed from the partition data, the co-variance of elements with Al and correlation matrix.

(v) The partition data of the trace elements viz., Cu, Co, Zn would serve as. the base line data for pollution in view of the increasing urbanization and industrialization of the the coastal areas.

(vi) The reducing conditions in the slope region inhibits oxidative precipitation of manganese and might even induce manganese to go into solution from the sediments.

(vii) In the slope region Ni and Zn exhibited more affinity to organic matter than to other trace elements.

(viii) The R-mode factor analyses indicated the importance of three factors in controlling the dispersal of elements in the sediments. These are (a) fine grained alumino-silicate, (b) carbonate and (c) the organic matter.

(b) **Western Equatorial Indian Ocean**

Geochemical investigation on sediment cores showed that the core from the Arabian. Sea basin has a greater terrigenous influence than the cores from the Somali basin. Among the Somali basin cores, depth appears to influence the variable distribution of metals in the sediments. Iron, aluminium and titanium appear to have come from terrigenous source, manganese from authigenic source while the remaining elements (Ni, Zn, Cu) from a variety of sources including submarine volcanic activity.

2.5.2 **Regional geology & manganese nodules deposits in the Arabian Sea & Central Indian Basins of the Indian Ocean**

The project was largely funded by the Deparrment of Ocean Development, Government of India, New Delhi. Detailed surveys for polymetallic noduies were continued in the Central Indian Ocean during this year. Two chartered vessels MV **Skandi Surveyor** from Norway and MV **Farnella** from UK, were deployed for these surveys. MV **Skandi Surveyor** completed six, 45 days cruises before the vessel was handed back to the owners, in October, 1983. MV **Farnella** completed seven cruises of 45 days and the eighth cruise was in progress. Samples from more than 700 stations were collected and over a hundred thousand line km of echosounding and magnetic data were collected.

2.5.3 **Foraminifera as indicators of pollution in the marine environment**

Studies of one ecosystem affected by the acidic pollutants (inshore area of Trivandrum) and one ecosystem affected by alkaline pollutants (inshore area of Karwar) revealed a variation in the effects of effluents on the foraminifera. In the former, the effect was morphological anomaly **(Operculina, Cibicides)** such as severe abrasion along peripheries, induced growth in the last few chambers, inferred dissolution and destructions of small thin-walled forms thus leaving behind only the larger sized species in the entire area. In the

latter, pollution caused diversity with a decrease in population, reduction in size, test-wall thinning and increase in the agglutinated spices.

The planktonic foraminiferal assemblages show effects of climatic control on water masses. The dominant presence of certain species represent a climatic index and the movement of specific water masses in the region. Thus the abundant presence of **Globigerinoides succulifer** and **Globigirindella siphonifera** signifies the waters of the Central and Southern Arabian Sea; **Globigerina bulloides** and **Neogloboquadrina pachyderma dextralis** signifies cold Antarctic waters and upwelling; while **Globigerinoides ruber** and **Globorotalia cultrata** signifies warm highly saline Red Sea and Persian Gulf Waters.

An aberrant species of **Spiroloculina** sp. developing two apertures instead of the usual one was observed in Recent sediments of Bombay-Daman Coast. The aberration is considered to have been resulted from regeneration/repair by which the damaged portion of the last chamber required healing and so a second aperture was formed with a neck.

Discocyclinid limestone-upper Marlstone of Pondicherry formation (upper Paleocene-lower Eocene) of South India is characterised by the presence of **Discocyclina boetonesis** reported earlier by Setty (1964) and the trigonal **Discocyclina** sp. (Setty 1968). As **D. ramaraoi** Samanta n. sp. 1967 is Con-specific with and only a junior synonym of **D. boetonensis** and is suppressed on the Law of Priority.

The Cores from Arabian Sea presented 12 genera and 42 species of which 1 genera and 25 species were found to be new. **Inapertisporites** was the most common element of the assemblages in all the Cores.

B. Sponsored Projects

Details of work carried out is given under chapter on "sponsored work."

2.6

Biological Oceanography

2.6.1 Assessment and evaluation of living resources of the seas around India.

2.6.2 Coastal aquaculture.

2.6.3 Marine microbiological studies in the seas around India.

R & D Projects

2.6.1 Assessment and evaluation of living resources of the seas around India

(a) Primary Production

Productivity studies of the Lakshadweep Sea undertaken during cruise 116 of **RV Gaveshani** showed mean chl a value of 4.8 mg/m^2, and primary production 200 mg C/m^2/d in the euphotic zone. Enrichment experiments with urea, ammonium and nitrate, though varied, showed an increased carbon fixation. Similar studies with ma]or emphasis on ATP, POC, Chl a and extracellular products were undertaken in the northern Arabian Sea during cruise 118. Investigations on heterotrophic activity below euphotic zone a)so continued using labelled organic substances.

Curing the 117th cruise of RV **Gaveshani,** coastal waters of Sri Lanka were studied for biological productivity. Chlorophyil content was observed to vary from 0.76 to 8.88 mg/m^2. Paniculate Organic Carbon (POC) content ranged between 5.58 and 12.90 gC/m^2.While the seston varied from 42.8 to 204.8 m^2/day. Results indicate that the coastal waters of Sri Lanka are moderately rich in biological productivity and thus are comparable with the coastal waters of India and the seas around Lakshadweep group of islands.

Seasonal changes in organic production with reference to nutrient salts as well as dissolved and the paniculate components, were observed in the coastal and estuarine waters of Goa. Nitrate, ammonia and phosphate concentration in the coastal waters varied from 0 to 2.4 µg at N/l; 0.23 to 2.50 µg at N/l and 0.1 to *2.4* µg at P/l, respectively. Chlorophyll content and primary productivity ranged from 0.4 to 6.94 mg/m^3 and 380.0 to 1231.3 mg C/m^2/day respectively. Phytoplankton bloom in the estuarine waters was found to be induced by sudden changes in salinity at the onset of monsoon in June, and again after the cessation of monsoon, in October. Assimilation ratio (N:P) of NO_3- and PO_4^{3}-, which was 11, indicated that the nitrate are in short supply and the deficiency, thereof, is probably compensated by urea nitrogen 0.29 µg at N/l) and by the decomposition of high levels of total organic nitrogen, present in the water. Surface POC values were observed to be linearly correlated with chlorophyll content, thus suggesting that the POC in the coastal and estuarine waters, is mainly of autochthonous origin.

(b) Secondary production

Zooplankton samples collected during the First and Second Indian Expeditions to Antarctica (1981-83) and during cruises of ORV **Sagar Kanya** and **RV Gaveshani** (cruise 116) in the Maldive and Sri Lankan waters were analysed for spatial distribution, abundance and zooplankton community structure. The zooplankton biomass values in the waters of Sri Lanka and Maldives fluctuated between 3.4 to 14.0 ml and 3.0 to 60 ml 100-3espectively. Dense aggregations of mysids were obtained at a station (SK 150) in the north Arabian Sea during ORV **Sagar Kanya** Cruise 11. Zooplankton excretion experiments carried out at 21 stations during ORV **Sagar Kanya** Cruise **III** gave mean excretion rates of 0.50 µg at N/mg dry wt/g of ammonia and 0.32 µg at N/mg wt/d of urea. Faunal and species distribution studies of zooplankton in Antarctica waters showed a low species diversity compared to the tropical and temperate oceanic realms. Common copepod species encountered were **Calanus simillimus, C. propinquus, Calanoides acutus** and **Rhincalanus gigas.** Latitudinal variations in the distributions of copepod species were also noticed. Geographical variations in distribution of major groups and species of zooplankters in Antarctica was found to be mainly due to temperature and availability of food.

During the First Research Cruise of ORV **Sagar Kanya** from Travemunde to Malta, biological investigations were carried out with objectives to study the oceanic sills as ecological barriers and experimental ecology of oceanic gelatinous zooplankton. Preliminary studies on the biological observations at seven stations showed *a* drastic change in composition of the Atlantic and Mediterranean species of zooplankton within a distance of less than 90 nautical miles. Studies during the IIIrd test cruise from Malta to Bombay, an extensive area of .Mediterranean Sea. Suez Canal, Red Sea, Gulf of Aden. Central Indian Ocean and the Arabian Sea was covered. The studies in this area included pelagic fishery resources in Somali Basin area, diurnal vertical migration of zooplankton and distribution of benthos, and plankton, in Error Sea Mount area and productivity and zoogeography of flora and fauna in Red Sea. In all 75 stations were occupied and more than 750 observations were made. Zooplankton were rich in Somali Basin. The area may be spawning grounds for Pelagic fishery. Studies on diurnal vertical migration of zooplankton has belied the general understanding about the maximum abundance of planktonic organisms within the upper 200 m of the water column. This necessitated a serious reconsideration about the reliability of Indian Ocean Standard Net (IOSN) collections for productivity estimates and distribution studies.

Red alga-Bangia fuscopurpurea.

(c) Marine algae

Monostroma sp. Thuret and **Porphyra vietnamensis** Tan. et Ho. occurring along Central West Coast were studied for their major biochemical constituents. Total calorific value of **P. vietnamensis** was observed to be 3164 cal/g (ash free dry weight) and that of **Monostroma** sp. 1941 cal/g.

A new species of red algae **Bangia fuscopurpurea** has been recorded for the first time from whole tropical region including India and its ecology and distribution has been studied.

(d) Mangroves

Under the investigation on littoral flora of Andaman Islands, undertaken during the year a total of 40 genera and 64 species of marine algae, 17 genera and 22 species of mangroves and 3 genera and 3 species of seagrasses have been reported.

Growth of two mangrove species of **Rhizophora mucronata and Kandelia kandel** was studied with respect to the shoot height, production of leaves, buds, flowers and fruits for a period of 13 months. Growth of both the plants was continuous with bimodal leaf formation. Average life period of **R. mucronata** leaves was 6-7 months and 5-6 months for **K. kandel.** Maximum leaf-fall was found in January and February respectively. Ecological studies on the mangroves along Goa Coast were further continued. The dominant mangroves observed were **Rhizophora mucronata, Avicennia officinalis, Sonneratia alba, S. caseolaria, Acanthus ilicifolius** and **Acrostichum aureum.**

Seagrass **Halophia beccarii** was observed to be very commonly associated with **Sonneratia alba** in Zuari, Mandovi, Chapora and Terekhol estuaries. However, **Halophila ovalis** was observed only in the Mandovi estuary. The seasonal distribution of brackish water algae was also studied in the mangrove swamp and it was observed that **Caloglossa leprieurii, Catnella repens, Enteromorpha** spp., **Chaetomorpha** sp. and **Monostroma** sp. were dominant.

Several fishfarms were observed in the mangrove swamps along Mandovi and Zuari estuaries. These mangroves areas were also observed to support economically important members of algae such as **Monostroma** sp. (April-Dec.) and **Gracilaria verrucosa** (Dec-Feb).

(e) Benthic production

Deep sea benthos: Studies on distribution, relative abundance, community structure and standing crop of abyssal benthic fauna, were continued. Area surveyed was between 1 to 10°S lat. and 70 to 83°E long. In all 47 stations, in the depth range of 2000 to 5400 m were occupied and sampling for meiofauna, macrofauna and epifauna was carried out. Infauna, represented by 3 meiofaunal and 12 macrofaunal taxa, was rich and equally diverse. Faunal population was rich ($5500/m^2$) and biomass production was relatively high ($2.5g/m^2$) for abyssal depths. Varied epifauna, represented by 8 species of fishes and 2 species of prawns, was also recorded.

(f) Ecology of inter tidal benthos

Goa beaches: Qualitative and quantitative changes in relevance to environmental variability in an estuarine (Siridao) and an open sea (Candolim) sandy beach, showed striking faunal heterogenity, in space and time. Estuarine beach, with a mean annual standing crop of 870 g/m^2 was far more productive than

the moderately high production of 333.97 g/m^2, observed at open sea beach, 47 species of macroin vertebrates, belonging to 32 families, formed the community. A comparison, based on the presence and absence of fauna at both the beaches, exhibited a dissimilarity to 70.21% extent.

In a 16 months study along another beach (Dias beach, Dona Paula) characterised by silty sand, 70 species were observed to form a macrofauna. Amphipods (40.73%) and polychaetes (31.61%) were the important taxa, with **Prionospio pinnata (25.75%), Periocolodes megapleon** (21.82%) and **Cyathura** sp. (11.08%) as dominant species. Community analysis, by cluster technique indicated that the 'zones' varied in size with time. Observations corroborate the continuum concept of bottom living communities.

Andaman beaches: Meiofauna, inhabiting the interstices of 4.sandy beaches in Andaman Group of Islands, was studied. Distribution and abundance varied with sediment-particle size and the beach gradient. Nematodes and harpacticoid copepods dominated respectively the silty-sand and fine-sand prevalent beaches. Mayabundar beach was found to be productive than the other 3 beaches located at Corbyn's Cove, Hare Island and Marina, respectively.

East African beaches: Macrofauna and meiofauna of 2 sandy, beaches at Mombasa (East Africa), having medium to fine grain-size distribution, were investigated, quantitatively. Macrofaunal density was highest around high water mark (HWM) and progressively decreased downshore. Abundance of meiofauna, was maximum around HWM on the sheltered beach at English Point. The more exposed Nyali Beach displayed the aggregation of meiofauna downshore and the highest population density was recorded between mid and low water mark. However, on both the beaches, the fauna was dominated by nematodes and harpacticoid copepods.

Benthic watch-environmental impact assessment

Biological monitoring off Bombay: Analysis of data generated from a decade-197V83, a long study on the shallow water bottom living communities, in relation to water quality characteristics in the coastal zone of the metropolitan city of Bombay, indicated drastic changes in the distribution, composition, relative abundance and standing crop of benthic populations.

Dissolved oxygen concentration, which on an average, was 4.77 ml/l in 1974 progressively decreased to almost depletion level of 0.76 ml/1 by the year 1983. Organic carbon content of the sediments, increased from 0.8% in 1974. to 2.1% in 1983. Consequently, population density decreased from 1260 to 173/m^2 in the time span of 10 years, with total depletion of fauna, in the most severely affected nearshore region of less than 40 m depth. Similar decreasing trend in biomass production, ranging from 42.2/m^2 in 1974 to 9.14/m^2 in 1983, was observed. Tolerant species of polychaetes, were the sole faunal components in later years, as against the rich and diversified benthic fauna of earlier years. Time bound deterioration in the water quality, has resulted in the disappearance of many species.

Domestic sewage and beach fauna: Meiofauna of a sewage polluted sandy beach in Goa was monitored. Numerically, nematodes followed by harpacticoid copepods dominated the fauna. Most of the faunal components were restricted in distribution, to top 5 cm. Temporal variations in the faunal distribution were noteworthy. Faunal density variations were a consequence of high concentration of organic input via sewage.

Mining refuse and clam beds in Goa estuaries: Long term changes in the structure and composition of commercial clam beds in the Mandovi-Cumbarjua

Canal-Zuari estuarine complex of Goa were investigated. As compared to 1971-72, a great multitude of deterioration in the qualitative and quantitative features of clam populations at Verem, old Goa (Mandovi), Banastarim (Cumbarjua Canal) and Chicalim (Zuari) were noted. Drastic changes in the nature and composition of substratum from sandymud to cobble-sand has adversely affected the exploitable clam resources and has resulted in the decline of average standing crop from 1.3 kg/m^2 in 1971-72 to less than 0.1 kg/m^2 in 1982-83. Origin of cobble is traceable to mining refuse.

Biochemical studies

Soluble eye lens nuclei proteins of flying fishes, collected during the 3rd cruise of ORV **Sagar Kanya,** from the Central Arabian Sea were studied by cellogel electrophoresis. Three distinct patterns characterised by the number of bands mobility and staining intensity were observed at all the 3 sampling Stations. Morphological studies of the fishes showed that they belonged to species **Exocoestus volitaus** and **Cypsilurus speculiger.** The eye lens proteins of **C. speculiger** however showed 2 distinct electrophoretic patterns. The study suggests the occurrence of the populations of **C. speculiger** which can be differentiated externally by the length of the pectoral fin and the depth of the body.

Antarctic krill resources

In an attempt to assess the resource potential of the Antarctic krill, a series of 37 stations were occupied during the Second Indian Scientific Expedition (1982-83). The resource, mainly represented by swarming of **Euphausia superba,** Dana showed high biomass values, fluctuating between 22 and 120 mg/m^3 Stock was represented, by commercially important size range of 30-45 mm. Analysis of length-weight data, as an indicator of growth progression showed a high degree of correlation (r=0.995) between length and weight. Value of 'b' being less than 3, suggested that the body weight of **E. superba** increases at a lower rate than the cube of the length. Such a deviation from isometric growth, reflects on the overall slow growth progression-a characteristic feature of organisms, inhabiting the super-cooled polar waters.

2.6.2. Coastal Aquaculture

(a) Aquaculture in Goa waters

Mass culture of feed organisms: Turbellarians, harpacticoid copepods, nematodes and rotifers were cultured on large scale, as food for higher organisms, especially finfishes. Purified cultures are maintained and studied for nutritional quality and propagation behaviour. While the turbellarians and nematodes thrive well in nutrient rich media, the harpacticoid copepods and rotifers prefer moving prey.

Marine algae: Cultivation of economically important algal spp. like **Hypnea, Sargassum, Gracilaria** at Malwan and that of **Monostroma** sp. at Dona Paula and Terekhol, by net cultivation method has shown encouraging results.

Studies on the life cycle of **Monostroma** sp. are being made in the laboratory, to find out the spore liberation and settlement from cultivation point of view.

Mussel culture: Growth of green mussel, **Perna viridis** L. was studied in the laboratory seawater circulating system. Maximum growth coincides with maximum abundance of phytoplankton. Other hydrological parameters did not show any marked correlation with the growth rate. Highest growth

progression (92.36%) was recorded in young mussels followed by a sharp decline to 5.78% in older individuals. Average annual growth was 89 mm, as against 60 mm in natural beds and 92.7 mm in rope culture on floating raft. This indicates that in the laboratory seawater circulating system, the mussels adapted well to change in water quality and the growth was comparable to mussels grown commercially under raft cultures.

Growth of black clam: As deduced from the growth equation Y =0.4970 +0.9148 X (shell length/shell breadth), and Y=0.3055+1.6318 X (shell length/shell breadth) an isometric pattern of growth was observed in the black clam, **Villorita cyprinoides,** Grey. Shell length-shell weight ($Y = 0.4144 \times 10^{-5} \times 1.8315$) and shell length-shell volume ($Y = 0.3895 \times 10^{-5} \times 1.8315$) exhibited an exponential relationship. Average monthly growth was 1.66 mm. Maximum growth of 69.49% in young stages declined to 30.40% in older individuals.

Bioenergetics: In a continuing study on the effects of heavy metal pollution on the biochemical composition of bivalves, analysis of heavy metal concentration (Cu, Mg, Fe and Zn) and proximate composition (protein, carbohydrates, lipid and ash content) of 3 bivalves species i.e. **C. cucullata, Cerethrium** sp. and **Tellina** sp. have been completed.

Work carried out under this project by Regional Centre Cochin, is'reported under section 2.11.1.

2.6.3 Marine microbiological studies in the seas around India

As a part of the continuing programme, more water samples and zooplankton samples were analysed for the density and distribution of **Vibrio parahaemolyticus** like organisms (VPLO) in the Indian Ocean and Arabian Sea. During the 116th cruise of RV **Gaveshani** nearly 400 strains were isolated and their biochemical and physiological properties were studied. The results indicate that VPLO are more common near the Laccadive islands than the offshore areas. This observation was further confirmed during the 4th cruise of ORV **Sagar Kanya,** where 56 water samples were examined with the aid of special media. The density of these bacteria varied from 19 to 712/100 ml on an average. With increasing depth their population decreased. The occurrence of typical **V. parahaemolyticus** in Arabian Sea is less than 2%.

In the metal-microbe interaction studies, nearly 50 bacterial strains were obtained from different sources including deep sea sediments and polymetallic nodules which can tolerate higher concentrations of Ni, Cu, and Co than the ambient levels. These strains will be trained to tolerate high levels of these metals and to concentrate them through adaptation techniques.

Another area where considerable progress was made is the ecology of sulphur metabolising bacteria. During the second cruise of ORV **Sagar Kanya,** about 48 samples from 5, 100, 200 and 300 m depths were analysed for the occurrence and distribution of **Thiobacillus denitrificans** like organisms (TDLO). The most probable number (MPN) of these organisms ranged from 8 to 900/1 at 5 m and from 18 to 900/1 at 300 m. About 140 isolates are being screened to asses their ability to denitrify under strictly autotrophic and oligotrophic conditions. In addition to these denitrifiers, the distribution of heterotrophic denitrifying bacteria (NO_3 and NO_2 reducers) and ammonifiers in seawater was studied during the 118th cruise of RV **Gaveshani** in the northern part of Arabian Sea. Totally 41 samples from 12 stations were analysed. NO_3 reducers were the most common compared to NO_2 reducers and their MPN ranged from 35 to 14,000/100 ml. NO_2 reducers could be recorded only in 9 samples and their MPN ranged from 3 to 450/100 ml. Ammonifiers were present in thirty samples and their MPN ranged from nil to 300/100 ml.

Studies were also conducted to estimate the sulphate reducing activity in core samples collected from Dias beach. **In Vitro** studies showed that the activity ranged iron 0.1 mM S/g sediment in August to 3.4 m.M S/g in September. The number of sulphate reducers ranged from almost nil to 676 χ 10^2/g dry sediment. The heterotrophic flora from these sediments have been grouped into numerical profiles to study their diversity.

During the first cruise of ORV **Sagar Kanya,** 97 water samples from 23 stations from various depths were collected and analysed. The total heterotrophic bacterial population ranged from 200 to 2.56 χ 10^4 cells/l in these oceanic water. Generally, water column above thermocline harboured a higher population. It was interesting to note that high cell counts were recorded in all six samples collected between 2000 and 4000 m. More than 500 isolates were obtained from these samples and nearly 300 have been characterised. An attempt was made to employ numerical profiles to understand the heterotrophic diversity in offshore waters.

(a)

Phycomycetous fungus (a) Sitrolpidium and (b) Cladochytrium

Techniques to isolate and quantify thraustochytrids on solid media were standardized after extensive experimentation. This is a notable achievement for this group of true marine fungi. These were isolated from coastal waters around Goa and during the first cruise of RV **Gaveshani** from the Arabian Sea and Kenyan coast. Totally 21 stations were examined. **Labyrintholoides yorkensis** and **Ulkenia amoeboidea** were found to be most common in these waters, whereas, **Schizochytrium sp., Thraustochytrium motivum** and **U. visurgensis** were predominant on detritus from the Kenyan coast. Physiology of these organisms is being studied. Several lignicolous fungi **(Halosphaeria quadricornuta, H. galerita** and **Periconia prolifica)** from decaying weeds were isolated. In addition to these, several species of fungi involved in active degradation of mangrove leaves were also isolated and identified.

Work on marine algal pathology was initiated recently and the results so far obtained indicated that there are a number of parasites on marine algae which are hitherto unreported in India. Regular collection of algae from rocky shores around Goa and from intertidal zones were made. The marine alga, **Cladophora** was found to harbour two parasitic phycomycetous fungi, **Cladochytrium** and **Sirolpidium** both of which are reported for the first time in India. During the 3rd cruise of ORV **Sagar Kanya** in Arabian Sea, intensive phytoplankton collection was made. Many of the diatoms were found to harbour thraustochytrids. From the survey so far conducted, 3 species out of 20 species of diatoms examined were parasitised by thraustochytrids. With regard to macro algae, out of 12 species examined 2 were found to be infected with Phycomycetes. During the period of this report, 8 diatom species were successfully brought under pure-culture for host-parasitic interaction studies.

2.7

Biofouling and Corrosion Studies

A. R & D Project

R & D activities of the Biofouling and Corrosion Section on project "Studies on marine fouling, wood preservation and corrosion along the Indian coast" were continued. Besides a project sponsored by ONGC was taken-up during the year. The details of this project are as under.

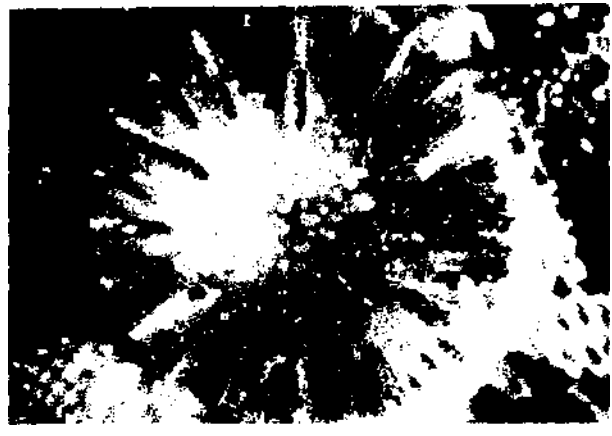
During the year activities on biofouling involved, the exposure of aluminium panels in cyclic fashion at three stations in Zuari estuary. At two stations, viz., Cortalim and Harbour Jetty, few specimen of scleractinian coral- **Astrangia** sp. were found on the panels, which is the first record from Indian waters. This coral is originally found from Atlantic coast. Data collection on extent and pattern of biofouling is continuing.

Continued studies on corrosion of mild steel in estuarine stations have indicated a maximum corrosion rate (59.6 mpy) in Mandovi estuary and minimum (46.8 mpy) at Oil Jetty in Zuari estuary in June. It was also noted that the corrosion rate enhanced by 40-50% due to macrofouling.

Data collection on timber destruction in Zuari estuary was continued.

B. **Sponsored Project**

Details of work carried oui is given under chapter on "Sponsored Work".



Scleractinian coral-Astrangia sp.

2.8

Ocean Engineering

2.8.1. Ocean engineering studies related to coastal and offshore development.

2.8.2. Marine geotechnical engineering studies.

2.8.3. Energy from **the** *sea.*

Studies in ocean engineering under different projects were continued. Longterm data collection programme on waves, current etc., to create a data bank for offshore design and operations was initiated during the year. The details of the activities are briefed below:

A. R & D Projects

2.8.1. Ocean engineering studies related to coastal and offshore development

(a) Development of moorings, deployment and retrieval techniques

Using a mechanised boat of about 15 m length with winch capacity of about 2 tonnes, operations of mooring and retrieval of wave rider buoys were successfully carried out in the Bay of Bengal at 20 and 80 m water depths during severe monsoon and non-monsoon periods. The wave rider buoy mooring functioned very well withstanding even two cyclones occurred in the Bay of Bengal during May to October 1983. 'Buoy First Method of deployment was perfected for installation of Wave Rider Buoys at different depths of water.

Wave Rider buoy was also deployed at Bombay High on the West Coast of India at 75 m depth. ORV **Sagar Kanya** was used for deployment and retrieval of the meteorological data buoy and the recording currentmeters at Bombay High during 1983. The strength degradation of the mooring lines exposed to marine environment for different durations are being studied with the test facilities available at Strength of Materials Laboratory, College of Engineering, Farmagudi.

Studies are in progress to make use of indigenous ropes, subsurface floats and locally available sinkers to replace the imported components of the mooring system. Literature survey has been done to design trial deep water mooring.

(b) Long-term data collection and analysis

Wave data: A time series data collection programme on waves and currents along the Indian Coasts was initiated and carried out off Kakinada and Machilipatnam and at Bombay High to create a data bank for offshore design and operations including coastal developments. Three wave rider buoys have been deployed one each, off Kakinada, Machilipatnam and at Bombay High at depths of 88, 20 and 75 m respectively. The wave receiving/recording station in the former two stations is being operated in remote coastal village, while in the last it is on the offshore drilling vessel **Sagar Samrat.** Wave records for 20 minutes is obtained for every 3 hours both on the chart paper and digital magnetic tapes. The data collection programme commenced from May 1983 and is continuing.

Current data: Two day current data (22-23, October, 1983) from moored Aanderaa current meters at 15 m depths using ORV **Sagar Kanya** at Bombay High was collected.

Weather data: Aanderaa weather station (self recording type) has been installed at Manganapudi near Machilipatnam from May-November 1983 and at Yanam, Andhra Pradesh from December 1983 and observations are continuing. Time series data on wind speed and direction, air temperature, radiation, humidity, rainfall etc. are being recorded at hourly intervals.

The digital wave records obtained on cassette tapes are being analysed using software package at DEC-10 computer of the Tata Institute of Fundamental Research (TIFR), Bombay. The ABC 80 Micro-computer system procured under NORAD Assistance Programme is also being used for analysis of wave, currents and surface meteorological data.

Wave data are being analysed by using Tucker's 'Zero upcrossing and spectral methods'. Distributions of various wave parameters including wave persistence diagrams are prepared. Detailed analysis for fitting the theoretical wave spectra to the observed wave spectra are being carried out to determine the best theoretical spectra to fit the observed spectra.

Typical wave parameters computed for the different stations during the southwest monsoon (June - September) are given below:

Off Kakinada : Hs=1.0-2.7 m; Hmax -*1.3-4.5* m; Tz=-4.7-9.8 sec.
Off Machilipatnam : Hs=0.7-1.6 rn; Hmax =0.9-2.5 m; Tz =4.3-11.0 sec.
Bombay High : Hs=1.4-5.0 m; Hmax =2.1-9.0m T_z=5.8-8.6 sec.

Wave *hind-cast and storm surge models:* Studies are being undertaken to develop storm surges and wave hind casting models under the NORAD assistance. The above two numerical models developed at Delft Institute of Technology, Netherlands are being procured.

Computer programmes were developed and implemented at NIO's TDC-316 computer for undertaking numerical wave refraction littoral transport. A numerical model was developed for studying the shoreline changes caused due to the construction of a shore-connected breakwater and a case study has been undertaken to evaluate the shoreline changes at Visakhapatnam in the vicinity of breakwaters.

2.8.2 Marine geotechnical engineering studies

Seabed samples collected from mid Indian Ocean from about 5000 m water depth are being analysed for engineering properties. The samples are brown in colour, soft with predominantly clay fraction with natural water content exceeding 100%. Also the seabed samples collected using box and piston gravity corers, from western continental shelf are subjected for similar studies. Consolidated tests are also being carried out on these samples.

Fabrication of negative pore pressure apparatus is being developed. Literature on submarine seabed stability and slope failures is being collected to develop necessary background to understand the complex seabed stability problems faced in the Godavari Basin on the east coast.

2.8.3 Energy from the sea

The fabrication of a turbine and generator fore a laboratory OTEC model being developed at NIO, is completed by NAL and now is under testing. OTEC model will be put on test, soon after these components are received from NAL.

From the extensive instrumental wave data collected from offshore areas on the east and west coasts of India, wave energy computations are being carried out to assess the feasible energy that can be tapped from the waves.

B. Sponsored Projects

Details of work carried out is given under chapter on "sponsored Work".

2.9

Marine Instrumentation

2.9.1 Development of marine instruments
2.9.2 Development of multiparameter buoys

The primary activity of Marine Instrumentation is designing, development and fabrication on instruments for oceanographic research. This Division also undertakes Sponsored projects for related maritime agencies and maintains and services computer-based instruments on board oceanographic vessels run by the Institute.

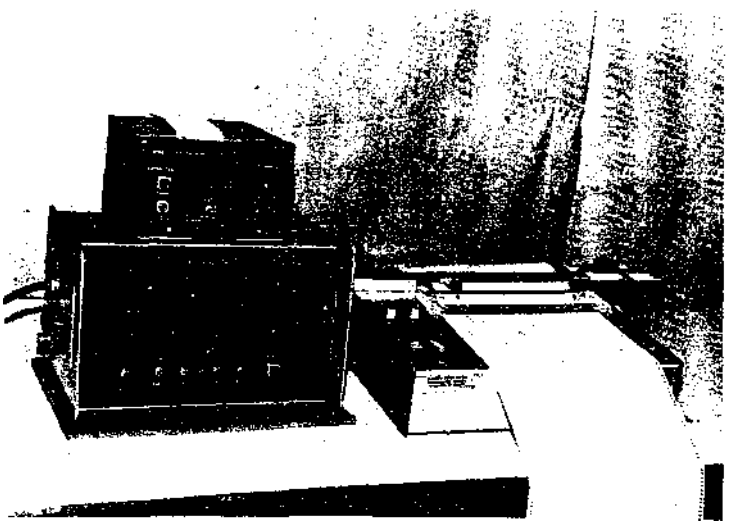
Λ. R & D Projects

2.9.1 Development of marine instruments

(a) Microprocessor based Tide gauge

The tide gauge, one of the first of its kind developed in the country, is designed around the INTEL 8085 microprocessor with data storage on solid state memories. Novel teatures built into the system include:

(i) the use of floating point arithmetic- operation to produce an error free linearised engineering output:



Tide Gauge -designed and developed at the institute

(ii) playback of recorded data on site or in the laboratory;
(iii) data storage on erasable programmable read only memories (EPROMS);
(iv) user friendly interfaces to a printer/seven segment display/ and a chart-recorder.

The system compared favourably with the mechanical tide gauges of Calcutta Port Trust.

(b) Geological Data Logger

The data logger was designed with the aim of logging data from commonly used ship instruments such as the Satellite Navigator, Magnetometer and Deep Sea Echosounder. For this purpose a software program written in INTEL 8085 assembly language polls these devices and writes incoming data on 1/4" cassette tape. A CRT interfaced to the instrument enables the user to enter heading labels for data, log reports and observations and to view acquired data on a video screen.

Geological data logger.

(c) Rotor Current Meter

Based on the design evolved last year, the first prototype of microprocessor based rotor current meter was developed and successfully demonstrated for Calcutta Port Trust (CPT). Attracted by its versatility the CPT has placed an order to fabricate and supply 6 prototype current meters for current measurements in the Hooghly river.

The current meter uses an Aanderaa rotor, a magnetic compass and pressure sensor to measure speed, direction and depth, respectively. The circui-

try employs the INTEL 8748 single chip micorcomputer programmed to compute and dispjay the measured parameters on seven segment LED displays. A parallel interface to an indigenous KELTRON is available on the display unit.

Specifications are as follows:

*Speed: 0-5m/sec; Accuracy:±2% F.S.
*Direction: 0-360°: Accuracy:± 5°
*Depth: 0-70 m: Accuracy:± 1% F.S.

(d) Electronic Bathythermograph

This microprocessor based bathythemograph initiated last year consists basically of 2 inter-connected units. The sea-unit employs an INTEL 8085 microprocessor and acquires temperature and depth data for storage on CMOS Rams. The deck unit, also microprocessor based, connects to the sea unit via and RS-232C link to allow the inspection of acquired data on LED display, in addition, a keypad built into the deck unit permits the entry of heading labels for each cast of the instrument. The electronics and mechanical parts of the system are under completion, and will shortly be ready for sea trials against conventional bathythermographs.

2.9.2 Development of Multi-parameter Buoys

(a) Data Buoy

The work on the first indigenously designed oceanographic data buoy, initiated last year has been completed. The buoy was tested by deploying off Mormugao Harbour and data was collected for about two months from November 1982.

(b) Drifting buoys

Four drifting buoys fitted with satellite transmitters were procured from the Polar Research Laboratory, USA and deployed near the polymetallic nodule sites in the Central Indian Basin from the survey ship MV **Skandi Surveyor** and **MV Farnella.** Environmental data transmitted by the buoys were received on the Institute's telex facility by accessing the data processing computer at **Service Argos** in Toulouse, France. This is the first attempt in the country to routinely collect near real time data via satellite.

B. Sponsored Projects

Details of work carried out is given under chapter on "Sponsored Work."

2.10

Planning and Data

2.10.1. Planning, Monitoring and Evaluation

The activities involved under this section are project formulation, budge tary requirement for each project and their monitoring, costing and evaluation.

Twentynine ongoing research projects were regrouped into 19 projects. Two more new projects were taken up during the year. The Annual Plan document for the year 1984-85 comprising of revised estimates for 1983-84 and budget estimates for 1984-85 has been prepared for the 19 projects as well as for two new projects, infrastructure and services. At the end of the year, a draft document was prepared on Seventh Five Year Plan of the Institute under the title 'Ocean Science and Technology' which is one of the areas identified by CSIR for the Seventh Five Year Plan. A document on 'R & D' projects for 1983 was also brought out.

Costing of all research projects was initiated. Expenditure under various sub-heads for each project for April to December was compiled. This information was very much helpful for monitoring of the expenditure of each project.

This group also attended to the work on patents, technical utilisation and liased with CSIR and other industries from time to time.

2.10.2 Publication and Information

The activities under 'Technical Information and Publication Services' (TIPS) in Oceanography were continued. The following publications were brought out.

1. Mahasagar-Bulletin of the National Institute of Oceanography-4 Nos.
2. Annual Report 1982.
3. NIO Newsletter.
4. Collected Reprints: The collected reprints for the year 1981 have been compiled while for 1982 the compilation is underway.
5. Annual Cruise Report 1980
6. Cruise Reports of RV **Gaveshani** (Cruises 115-129)

As was decided to publish the papers presented in the Estuarine symposium held in 1981 in regular issues of **Mahasagar,** 54 papers on various disciplines of oceanography were scrutinised and edited for publication and sent to the press.

The Information activities included popularisation of oceanography, dissemination of technical information, compilation of bibliographies, and brochures on research activities etc.

A bibliography on aquaculture has been compiled and computerised.

A list of patents on polymetallic nodules has been compiled.

Various media were used for dissemination of oceanographic work. The number of visitors showed a very sharp increase and they were attended to and showed the various activities. These include VIPs, scientists, research scholars and students.

The practice school for students of Birla Institute of Technology and Science, Pilani was coordinated in NIO for 6 weeks. A number of technical enquiries on research activities, achievements, educational facilities were

Sectional view of the display, highlighting NIO's activities in marine sciences, at the exhibition held at Tirupati.

attended to in consultation with research scientists. Information brochures on NIO, Sponsored Projects, ORV **Sagar Kanya** and **RV Gaveshani** were published for distribution.

The Information group also participated on behalf of the Institute in the following exhibitions.

1. 'Man and the Oceans - Resources and Development' held in January 1983 at Tirupati during 70th Session of Indian Science Congress. The main visitors were VIPs, scientists from research organisations and universities from India and abroad.

2. 'Science for Productivity' - this was organised in February 1983 at Parliament Annex, New Delhi mainly for the Members of the Parliament. In this 10 days exhibition NIO's contribution in Polymetallic Nodules and Antarctica Research were main attractions. The same exhibits were shown to the participants of the members of the Non-Aligned Meet (NAM) in another exhibition.

3. 'Ocean and Its Resources' - organised by Department of Ocean Development at Teen Murty House, New Delhi in November 1983. This exhibition was inaugurated by the Prime Minister Smt. Indira Gandhi. During the same period NIO also displayed the exhibits in CSIR Pavillion at the International Trade Fair at New Delhi.

At the end of the year, the various display charts, models depicting activities and achievements of the Institute were updated and prepared.

Printing, binding and reprography facilities were continued to be provided and were utilized to a very large extent.

2.10.3. Indian National Oceanographic Data Centre (INODC).

The Centre's main activities are acquisition, processing and dissemination of oceanographic data with reference to the seas around India and keep in touch with the activities of IOC Working Committee for International Oceanographic Data Exchange (IODE).

Recognising the capability and facilities available at the Centre, the Unesco and the International Oceanographic Commission (IOC) selected this centre for implementation of pilot project for enhancement of data activities in the countries bordering Indian Ocean. In this connection, Dr. Mario Ruivo, Secretary, IOC; Dr. M. Haq, Asst. Secretary, IOC, Dr. G.L. Kestevam and Dr. W. Koch, Unesco Experts, visited the centre and had discussions. A work plan was prepared and work has been initiated. Under this programme, UNESCO will provide a Rainbow-100 micro computer.

(i) Data acquisition

The data consisting of MBT from 62 stations collected during RV. Gaveshani cruises, CTD of 3 trial and 2 regular cruises of ORV Sagar Kanya were acquired. Besides this, data tapes on Deep Sea Drilling Project from National Geophysical Data Centre, USA were procured. These tapes contain 1091 records of geological properties of hard rocks and sediments. The CTD, Wave and Current data formats on GF-3 were acquired from Marine Information Advisory Service (MIAS) of UK.

(ii) Data Processing

During the year, preparation of station inventories for ORV **Sagar Kanya** and RV Gaveshani was taken up. About 3460 entries were coded which covers 74 cruises.

Abundance and Chemical analysis data of manganese nodules, current and wave data for ONGC and for NTPC were processed.

(iii) Implementation of New Practical Salinity Scale

As per the recommendations of the tenth session of the Working Committee on IODE, the Centre informed to all marine based institutions in India to switch over to new salinity scale. A document prepared by IODE (Technical Paper No.36) was also sent to them for their ready reference.

At the centre, two sub-routines have been developed for calculation of salinity using equation of practical salinity and seawater density using international equation of seawater (1980). The work has also been initiated to prepare the tables to calculate new practical salinity at 27°C from conductivity ratio between 0.01 to 1.12 at an interval of 0.0001.

(iv) **Implementation of the IOC General Magnetic Tape Format for the International Exchange of Oceanographic Data (GF-3)**

The centre prepared a GF-3 sub-set for nansen cast which was prepared and discussed at the second session of the Group of Experts on Format Development of IODE held in 3une at Wormley, U.K.

(v) **EEZ Charts**

During the year, 16 charts showing oceanographic data in the Exclusive Economic Zone (EEZ) of India were updated and prepared using data collected during 1960-81. These charts depict data during different seasons at 3 depths.

(vi) **Development of Computer Program**

The following programs were developed:

1. Eleven programs for processing and retrieval of manganese modules data for chemical characteristics.
2. Four programs for retrieval and corrections of Oceanographic data.
3. Programs for Nansen Cast thermometric correction with five subroutines for smoothening of depth.
4. Four programs for calculation of new practical salinity and density.
5. Three programs for processing of Antarctic weather station data.

(vii) **Development of formats**

As per the need and suitability the following new formats have been developed.

1. ***Station Inventory:*** This has the station details such as ship's name, cruise No., position, depth and the parameters observed. The parameter codes have been retained as those of ROSCOP forms of international standards.

2. ***Cruise Inventory:*** This format is based on station inventory format. It is a summary of the cruise based on station details. This format contains ship's name, cruise No., period of the cruise, depth range, parameters and number of stations where particular parameter was observed.

3. ***Current meter data:*** This format is designed to code data collected by Aanderaa Current Meter. The parameters included in this format are temperature, Salinity, direction and speed and vertical and horizontal component of the currents.

4. ***Station data for polymetallic nodules:*** This format is designed to store the station and abundance data of polymetallic nodules such as ship's name, cruise No., position, sampling device, core-length and coverage of nodules.

5. ***Chemical data of nodules:*** This format is developed to contain the concentration of Mn, Fe, Cu, Zn, Pb, Al, Si, Ca, Co, Ni, H_2O and other related information.

(viii) **Data dissemination**

During the year, 39 data enquiries were received from different research institutes/organisations. Most of the enquires related to the hydrographic and current data. These data were supplied at no cost. The beneficiaries included Indian Navy, University Scientists from Waltair, Cochin and Cuttack, and other research organisations.

2.11

Regional Centres

2.11.1 Regional Centre, Cochin

Regional Centre, Cochin continued its R & D activities such as assessment and evaluation of biological resources, coastal aquaculture, pollution monitoring, oceanography of Lakshadweep etc. Details of all the activities under these projects including one on the newly taken up investigation on "Saline water intrusion studies, under coastal zone management" are summarised below:

(i) **Coastal Aquaculture in Cochin waters**

(a) Ecological investigations of the Cochin backwater

Detailed ecological studies were undertaken in two different areas of the backwater, one exposed to the effluent discharge of a fertilizer factory and another region relatively free of pollution. For purposes of comparison environmental data from the main entrance of the Cochin backwater to the sea and a prawn field in the vicinity of this region were also collected.

(b) Experimental shrimp farming and resources survey for shrimp seeds

A field study was carried out to assess the growth rate, survival and commercial feasibility of using hatchery reared seeds of the penaeid shrimp **P. indicus** in the traditional paddy-cum-shrimp culture system of Kerala. Seventeen-days old post-larvae obtained from a local hatchery were acclimatised and stocked in a series of culture enclaves set inside a 7-hectare paddy-cum-shrimp culture field at Narakkal. The larvae were initially maintained on minced crustacean tissue and **Skeletonema.** The length range of the larvae was 10-17 mm with a mean length of 12 mm. A survival of nearly 70 percent was recorded. On an average, these shrimps weighed 125-130 per kilogram and fetched Rs.40/-.

In the open field where the seeds trapped and concentrated in the traditional manner, attained an average length of 126.84 mm with length range 115 - 145 mm. These weighed 70 - 80 numbers per kilogram and fetched a price of Rs. 80/- per kilogram. Hatchery reared seeds could not attain the size of naturally ingressed seeds as the culture period was comparatively shorter.

Survey of shrimp seeds resources was obtained during the current year. An average catch per hour of 1276 seeds was obtained in a 2-metre velon dragnet from Cochin backwaters. The highest catch was 2200 per hour in the first week of January.

(c) **Survey of cultivable bivalves**

A round-the-year survey was carried out to study the population of edible and cultivable bivalves in Cochin backwater. Construction of reclamation

walls and constant dredging seem to have adversely affected the edible bivalves in Cochin harbour area.

(ii) **Systematics, Zoogeography, Ecology and Experimental Studies on Zooplankton of the Indian Ocean**

Pelagic Polychaetes: The preparation of the monograph on the pelagic polychaetes of the world is completed except for the portion awaiting the English translation of a few foreign publications. Most of the relevant publications have been reviewed and the complete list of synonymy, taxonomic comments, type description of all the species, location of type specimens and the general distribution are discussed.

The monograph brings together the species belonging to the exclusively pelagic families namely **Lopadorhynchidae, Pospitidae, Pontodoridae,Alciopidae, Tomopetridae** and **Typhloscolecidae.** References to species like **Driechia pelagica,** of which very little is known are also cited. So far 101 species of pelagic polychaetes have been recognised. Thirty five species of pelagic polychaetes have been recorded from the Indian Ocean during the IIOE. The distributional aspects of these species in the Indian Ocean with reference to the environmental parameters have been studied and that forms the second part of the monograph.

Copepods: During the studies on Copepods, collected from different stratified layers during the first **Sagar Kanya** cruise from Mormugao to Mombasa (Kenya), the copepod distribution pattern was observed with reference to different layers.

Haloptilus longicirrus is recorded for the first time in the Indian Ocean in the haul from 1000 - 800 m.

Decapod larvae: Identification and description of most of the species of the penaeid prawn larvae from the IIOE including samples taken during some of the RV **Gaveshani** cruises were completed, besides the analysis of 75 plankton samples taken from RV **Sagar Kanya** during its first multidisciplinary cruise. More than 26 species were identified and described.

Fish larvae: Studies on the catch composition of the fish larvae in the Bay of Bengal and Arabian Sea revealed that next to **Myctophidae** the most represented family was **Gonostomatidae** contributing 12% of the total larval collection. Within the group, **Vinciguerria** and **Cyclothone** formed the major portion of the taxa followed by **Maurolicus.**

Mysidacea: Studies on the plankton samples from the west coast of Australia between lat. 33° 14' and 35°16'S and long. 114°28' and 119°29'E revealed certain interesting features regarding the distribution of **Mysidacea.** Genus **Anisomysis** is confined to the Indo-West Pacific and the two species of this genus, **A. gracilis** and **A. robustispina** observed in the samples were both new to science. Presence in these samples of **A. bipartoculata,** previously recorded only from Japan and China Seas extended considerably the range of distribution of this species. Two new species, **Leptomysis longisquamosa** and **L. brevicauda** were identified from this region in addition to two others reported earlier. Samples also showed the presence of a very interesting member belonging to the genus **Boxomysis.** All these species were from the upper 50 m of the surface layer.

Planktanic foraminifera: Fifty two plankton samples collected from the eastern Arabian Sea were analysed. In all 28 species were identified and their abundance per 1000 m^3 of water ranged from 2997 to 378224. Among these **G. acquilateralis, G. ruber, G. sacculifer** and **G. glutinata** were the most

dominant species while **G. theyeri, G. anfracta, C. nitida** and **T. humilis** were rather rare.

Ellobiospidae: The geographical distribution of the parasitic protozoans belonging to the family Ellobiospidae from the IIOE material showed that except for one station near the Gulf of Oman this family was exclusively found south of the equator upto 30'S latitude.

Meroplankton: Index of mean seasonal amplitude expressed as percentage of the annual mean (coefficient of variation), varied from 100% for fish larvae to over 400% for the larval groups of actinotrochs, tornaris, sipunculoidea, phyllosoma and brachiopods. Tropical zone fish larvae and bivalve larvae showed higher noctural values. The study revealed that the seasonal amplitude along 110°E to be low but none the less significant. Preliminary studies of the bivalve larvae from the plankton samples collected during cruise 1 of ORV **Sagar Kanya** showed that in some samples they were most dominant. Generally they were abundant in inshore waters with decrease in numbers and increase in size in samples away from the shore.

Other Studies

(a) Investigation on the evolution of Thar Desert: Eighty two species of foraminifera belonging to 18 families and 32 genera were identified from 48 dune sand samples covering a wide area of Thar desert. **Quinqueloculina, Ammonia, Elphidium, Cibicides, Nonion** and **Hanzawaia** were the most dominant genera of the foraminiferal assemblage. Also a detailed study has been made with regard to frequency distribution of species at different locations in the desert. This study has a bearing on the marine origin of desert sands. An interesting feature of the fauna is that it is almost similar to that of the Arabian Sea.

(b) Statistical Analysis: Studies on the hyperid amphipods of the Indian Ocean showed that **Symorhynchotus antennarius** was most abundant in Arabian Sea while **Leptocotis teneurostris** in Bay of Bengal, eastern and western Indian Ocean. Almost all correlations between the different species in the different regions were found to be inverse. Salinity was the most important factor controlling the abundance in four regions as a whole followed in the order by oxygen and temperature. Statistically significant sexual differences in size were noticed for this species in samples collected during the southwest monsoon.

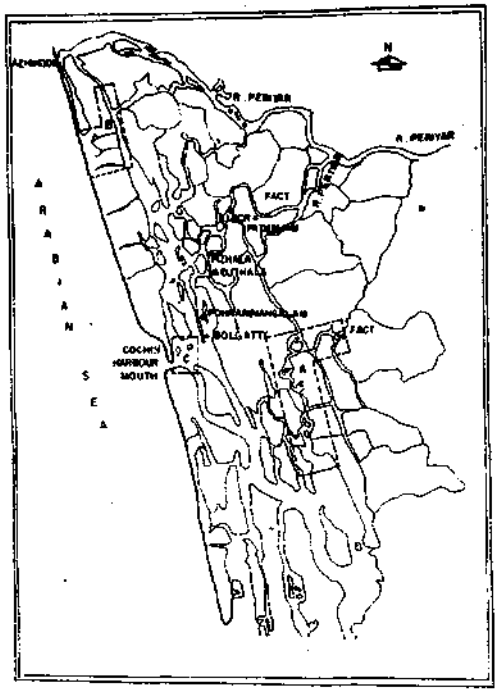
Empirical relationship between phytoplankton and zooplankton biomass of Saudi Arabian coast, Bay of Bengal and Agulhas Current region was examined after grouping the data into three levels of abundance i.e. 0.10 µg/1, 0.11 - 0.25 µg/l and >= 0.26 µg/l. There were significant correlation between zooplankton and temperature, zooplankton and phytoplankton, zooplankton and PO_4-P and phytoplankton and PO_4-P.

(iii) **Coastal *Zone* Management**

Studies on the dynamics of the Cochin backwaters estuarine system

During the period of this report, field surveys were conducted in the Cochin backwaters estuarine system to study the mixing and diffusion processes in the estuarine environment. Data were collected on temperature, salinity, light penetration, current etc. Simultaneously time series observations were also taken, over a complete tidal cycle during spring tide from two locations.

Studies carried out so far indicate that the salinity regime of the Cochin backwater system is mainly under the duel influence of tidal flow and the fresh water discharges from the rivers. Because of the deepening of the entrance channel the inner channels at Cochin and the regulated reduced fresh



Map of Cochin backwater system.

water discharges from the rivers joining the backwaters, the saline water (S > 20‰) seems to intrude about 20 km upstream of the harbour mouth during the premonsoon period. In the monsoon season, however, the saline water (S < l0‰) extends only upto 10 km upstream of the harbour mouth.

(iv) **Protection of the marine environment and monitoring of pollutants along the Indian Coast**

(a) Bacteriological Studies

Beach pollution studies were extended to Tamil Nadu coast with four stations viz., Nagercoil, Neyyar beach estuary and Cape Comorin. To the north, the study was extended to Karnataka coast with five stations viz., Kasargod and Kumbala estuary (Kerala coast) and Ullal, Netravathi estuary and Mangalore Port. Three collections and observations from each station were made to cover pre-monsoon, postmonsoon and monsoon periods. It is observed that the eastern part of Cape Comorin and the Kasargod beaches being fish landing centres are polluted considerably as evidenced by high counts of indicator bacteria and presence of pathogens. Ullal, which has potential to be developed as a tourist centre is free from bacteriological contamination.

(b) **Aquatic Pollution**

A study of the benthic fauna from the fresh water dominated industrial belt to further down the estuary has shown that fauna was most diverse and dominated by polychaetes at the barmouth region. From barmouth there

was a progressive decrease in the number of species towards upstream. While as many as 15 species were recorded upstream of the industrial belt in the fresh water dominated zone, only 2 were recorded in the industrial region and 10 species 4 km downstream. A similar trend was noted at the river Chaliar.

Phytoplankton communities were dominated by diatoms in the estuaries of Veli, Thottappilly, Neendakara, Cochin, Kallai, Beypore, Korapuzha and Mahe. Thirty three species of diatoms and five of dinoflagellates were collected from these estuaries. Fresh water algae and blue green algae made only brief appearance. **Skeletonema costatum** and **Nitzchia closterium** were the most successful species in all estuaries being present throughout the year. The polluted Kallai estuary showed higher chlorophyll levels with fewer species.

Eventhough the zooplankton composition was largely similar in all the estuaries relative species abundance was not identical. **Acartia centrura,** a calanoid copepod was the most versatile, being present in all the estuaries.

(c) **Experimental Studies**

The marine uni-algal cultures were maintained in the laboratory. Of these a few species were effectively made use of in waste water treatment containing high nutrient concentrations. The static bioassay experiments have demonstrated that biological system including marine plankton is capable of removing virtually all inorganic nitrogen in the solution. However, when culture media of different volumes of industrial water diluted with sea water was used, diatoms couid grow only in 10 and 20% mixtures while in all higher concentrations ranging from 30 to 100% cyanophytic species have grown utilising the nutrients (Phosphates and nitrates) and hence purifying the waste water.

Bioassay were conducted using different concentrations of crude oil, petroleum and kerosene to study the effect of oil and its products on marine micro-algae. It was observed that marine diatoms were more susceptible to oil and its products than blue green algae. The "safe concentration" varied with species and the type of oil and its products, which ranged between 10^{-3} ml/1 - 10^{-4} ml/l.

(v) **Oceanography of the waters around Lakshadweep**

(a) Ecology of the benthic macro-fauna of the lagoon of Kavaratti

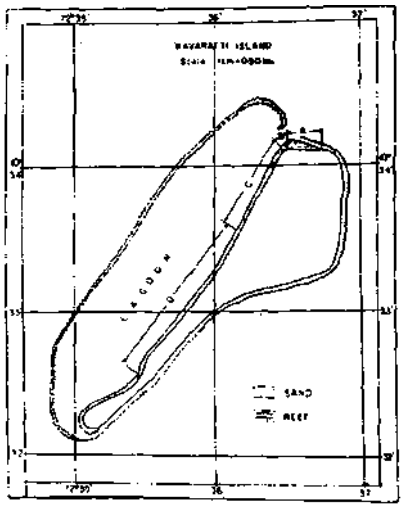
Lagoon floor has scattered living and dead corals. The sea grass bed consists of **Thalassia hemprichi** and **Cymodocea isoetifolia.** They extend up to 100 m inside the lagoon from througnout the length of 2 km beach. Molluscan and crustacean forms viz., **Cypraea moneta** and **C. tigris** inhabit this zone. Connes such as **Conus marmoreus, C. frigidis** and **C. coronatus** were abundantly found in the non-algal zone. The benthic gastropods include **Cylincna protracta, Acteocina townsendi** and **Pupa solidula.** The giant clam **Tridacna cumingii** were spotted in the crevices of submerged corals near the reef area. Another bivalve **Mesoderma glabratum** is usually found to occur near the beach area and is widely distributed. Polychaetes are also rich in the bottom fauna, **Nereis** sp. and **Phyllodoce** sp. being the common forms.

(b) **Benthos of Wadge Bank**

During the 96th cruise of RV **Gaveshani** along the Wadge Bank (6°40' - 8°15'N lat. and 77°00' - 68°l0'E long.) benthic samples were collected from five stations. Sand grain analysis of the bottom samples revealed well sorted sand particles with slight abundance of clay over the others. Shell fragments were also present giving an ideal substratum for the settlement of gastropods, which was abundantly present in the samples.

(c) Topographic changes of the sandy beaches of Kavaratti

The sickle-shaped Kavaratti has 4 km sandy beach on the western side and 1/2 km on the northern side of the island. The beach consists mainly of unconsolidated finely powered coral, lesser amount of shell fragments and coral pieces. Based on the erosion and accretion during different seasons of the year it has been found convenient to arbitararily divide the beach into four parts, A, B, C and D (Fig.). Shifting of beach material from zone A to B takes, place in premonsoon conditions thereby reducing the width of the beach at zone A and building up of the beach in zone B, the reverse process takes place during the monsoon season. This effect is due to the 180° phase shift in the littoral current during the two seasons. The part C of the beach does not show conspicuous seasonal change though a slight addition or reduction in premonsoon and monsoon periods respectively were observed. In the zone D the beach width gradually decreases southward and finally forms storm beach with large pieces of dead corals, shell fragments and coral rocks.



Map of Kavaratti Island showing various sections of beach (A, B, C & D) under observation

(d) Sediment distribution of Kavaratti Lagoon

Bottom sediment samples of the lagoon were subjected to grain size analysis. The data were statistically treated for parameters like mean dispersion, skewness and kurtosis. The study revealed that the coarser sediments were found towards the reef with gradual increase in fineness while nearing the beach. Mud concentration in sediments is less than 1%. The most widely dispersed, the most strongly coarse-skewed and the most platykurtic sediments were seen in the near reef samples.

(vi) Chemical oceanographc studies in the coastal and offshore waters of the Arabian Sea and Bay of Bengal and the adjacent seas of the Indian Ocean

During the first cruise of RV **Sagar Kanya,** data on pH, dissolved oxygen, inorganic phosphate, total phosphorus, nitrate, nitrite, total nitrogen, silicate and fluoride were collected from 43 stations up to a depth of 4000 m in the Northern Indian Ocean, south of 15°N covering the equatorial region up to 5°S. Data is being analysed, and will be reported shortly.

2.11.2. Regional Centre, Bombay

A. R & D Project

The multidisciplinary project on "waste assimilation capacity of coastal waters along the west coast of India and the impact of pollution on the marine ecosystem", started in 1981 was continued. The various observations and findings are given below.

Physical Oceanography

Studies pertaining to general hydrography, circulation and waste dispersion capacity of the receiving waters were conducted off Dabhol (Maharashtra) and off Hajira (Gujarat). Studies for littoral drift and bottom sediment movement were also conducted at Dabhol to understand the mechanism of formation of the bar at the entrance of Dahol creek.

Chemical Oceanography

(i) Oil Spill

A heavy oil slick on the coastline off Napean sea road was observed during the last week of August 1982. The occurrence of well blow-out in the Bombay High, region a few days earlier made people to believe that the spill had a source in Bombay High. An investigation was, therefore, undertaken to identify the actual source of the spill.

Several petroleum crudes imported through Bombay port were resolved in finger print patterns by gas chromotography and their infrared spectra were carefully studied. Based on gas chromotographic pattern and ratios of selected infrared absorptions it was concluded that the spill was from the Bombay High crude. Further studies to pinpoint the source is under progress.

(ii) **Hydrocarbon and fatty acids in sediments**

Estimation and correlation studies of hydrocarbons and fatty acids in core samples of Thana Creek and Bombay High were carried out to evaluate the changes in levels, if any, over the period of past years or so. The extracts of sediment sections were separated to yield total hydrocarbons and fatty acids.

Locations	Hydrocarbons (µg/g)	Fatty acids µg/g)
Bombay High	1-792	8-552
Thana Creek	i) 200-1948	111-720
	ii) 63-963	12-520

Although, Thana creek receives voluminous discharge from refineries, the concentration of the above said components in sediments was lower than expected. This may be due to the appreciable tidal currents which perhaps carried the floating petroleum products away before they could settle. The vertical profile of distribution of hydrocarbons in the Bombay High did not reveal increase in a concentration in the surface layers due to exploitation of oil in the region.

(iii) **Trace elements in sediments**

Sediment cores from Thana creek and Bombay harbour region were analysed for Al, Fe, Mn, Co, Ni, Cu, Zn, C and P to evaluate the enrichment if any of sediments due to industrialization. The elements Mn, Ni, Cu and Zn were rich in these sediments compared to the average shale. The sedimentation rate by Pb-210 dating tehnique has been estimated to be 1.6 cm/yr. The depth distribution of these elements as well as element/Al ratios indicate considerable variation which may be due to the variable inputs of elements over past 30 years.

Biological Oceanography

(i) **Phytoplankton pigments**

Estimation of phytoplankton pigments in four estuaries of South Gujarat viz., Auranga, Ambika, Purna and Mindola indicated that all are fairly productive systems. Mean surface values of total chlorophyll for Auranga, Purna and Mindola were 12.38, 11.7, 13.98 and 33.46 mg/m^3 and the average concentration of carotenoids were 5.03, 7.32, 6.03 and 19.87 m-SPU/m^3 respectively. Effect of pollution on phytoplankton production was discernible only at Mindola where the relatively higher level of nutrients stimulated enhanced growth of phytoplankton. Auranga and Ambika estuaries behaved indentically while the other two showed specific pattern of distribution of their own.

(ii) **Zooplankton Studies**

Variation in zooplankton biomass and composition in the Malad creek, Bombay was studied in relation to the prevailing hydrographical conditions by collecting samples from the creek mouth at regular intervals. The creek was highly polluted by sewave discharge. The adverse effect of pollution was more during the ebb tide with relatively low values of salinity and high values of dissolved oxygen. Zooplankton biomass varied from 0.01 to 13.2 ml / 100m^3 Abundance and diversity of zooplankton was found directly correlated to the prevailing tide and pollution load.

(iii) **Benthic Studies**

Benthic population was estimated in Mahi estuary, and the nearshore coastal regions of Porbandar and Mithapur. Mahi estuary had a sandy bottom at the upstream and mouth region with a silty-clay bottom, with a sandy bottom sandwitched between them this estuary showed a very poor macrofauna (av. 109/m^2) due to industrial pollution, particularly at the upstream regions. The fauna was dominated by polychaetes and copepods.

The nearshore coastal regions off Porbandar showed good benthic productivity. A higher macrobenthic population density in post monsoon (av. 14608/m^2) as compared to pre-monsoon (av. 7786/m^2) was recorded. Foraminiferans, polychaetes and crustaceans were the dominant groups.

The nearshore coastal regions of Mithapur showed a higher density (1975 to 59375/m^2) of macrofauna particularly towards inner Gulf regions than towards the mouth of the Gulf. Foraminiferans, amphipods and polychaetes were the major constituents of the benthic population.

(iv) **Bioassay studies**

Tolerance limits for selected species of phytoplankton to sewage were obtained by conducting bioassay tests. **Oscillatoria chlorina** was found to be more tolerant to sewage than **Navicula distans** and **Navicula pelagica**.

The toxicity of an oil dispersant was evaluated for three different typos of marine animals viz., prawan, clam and fish. The toxicity of the oil dispersant was relatively more for the clam and fish than the prawn.

B. Sponsored Projects

Details of work carried out is given under chapter on 'Sponsored work'.

2.11.3 **Regional Centre, Waltair**

The Waltair Centre continued its work on the project entitled "Coastal studies of Waltair and adjacent areas". The various aspects investigated are as below:

Geology and Geophysics

Detailed magnetic and topographic surveys were carried out in the Lawson's Bay area near Waltair to contour the steep magnetic anomaly that was earlier recorded in the preliminary surveys. The data was recorded along 12 profiles at the water depths varying between 4 and 25 m. The contour map of the magnetic anomalies as well as the stacked profiles has clearly indicated two types of anomalies. The one recorded near to the coast between 4 and 15 m water depth was sharp, narrow and negative having peak to peak values of nearly 300 gammas at 4 m water depth and almost disappears at about 15 m water depth. Modelling studies indicated that it is due to the near surface features representing the accumulation of placer deposits. The other anomaly extending into deeper sea was much broader with the peak to peak value more than 500 gammas. Two dimensional modelling has indicated that this anomaly is a structural and associated with the uplift of the basement layer which again is partially faulted.

Continuous data on echosounding along 860 lkm and seismic profiles along 200 lkm using the uniboom were recorded over the central margin of east coast of India during cruise of RV **Gaveshani.** Several surface and subsurface features recorded by uniboom include a bar formation that extends all along the coast of about 100m water depth. It is buried under the sediments of the river mouths and outcrops over the ocean bottom in other areas. Isolated bell shaped subsurface features off Godavari mouth and off Narsapur point, the basement layer has sharply faulted and broken into isolated parts. Hydrographic data were also collected from 20 stations off the river mouths of Godavari, Vamsadara and Nagavali.

Physical Oceanography

Measurements of currents and vertical thermal structure at monthly intervals along three transects one each off Errayyapalam, Waltair and Pudimadaka and also in the Visakhapatnam harbour were continued upto March,

1983. The preliminary analysis of data indicated that during Feb.-Apr., the currents flow towards North-East and the thermal structure exhibited significant gradients indicating the upwelling. In May and June, the surface flow was towards North-East but at depths it was variable with its predominant direction being Southwest. The weak thermal gradients during the said period indicated the absence of upwelling. In July and August the current direction both at the surface and deeper levels was variable and inconsistent. In November the surface flow was mainly towards Southwest and at deeper levels it was towards East and Southeast. Sinking of water masses was inferred from the positive thermal gradients at sub-surface levels. In December the surface flow was towards Southwest whereas in January it was variable. Distinct isothermal layers have been recorded indicating the vertical dynamic mixtures of water masses.

Chemical Oceanography

The monthly data collected from 3 stations along the main channels of the Visakhapatnam harbour covering the tidal cycle was analysed to study the seasonal and tidal variations in hydrochemical characteristics of harbour water. The distribution of dissolved oxygen has shown that in the surface layer it increased at the flood slack and decreases as the ebb slack approaches. It showed an appreciable gradient from surface to bottom in the premonsoon and postmonsoon seasons whereas there was not much change during the monsoon period. The seasonal variation of the nutrients showed two major peaks in the premonsoon and postmonsoon seasons consistent with the two plankton peaks. The distribution of nutrients in the nearshore and offshore waters of Bay of Bengal has been studied from the samples collected during cruise 121 of RV **Gaveshani.** The vertical distribution of iodate at offshore stations has recorded the maxima at the depths where the thermocline and oxycline occur. The depletion of iodate in the surface waters down to 150m is accounted for the involvement of iodate in the biological activity. The distribution of iodate in the nearshore waters is very much complex becuase of suspended organic and inorganic particulates. The studies on the distribution of tracer metals like Fe, Cu, Mn etc. in the dissolved and particulate fractions in the estuarine regions of Godavari and Vamsadara are in progress.

2.12

Sponsored Work

Besides the new sponsored projects undertaken during the year, the consultancy services and the work on projects taken-up in previous years were continued. A brief summary of the work done under new/ continuing projects/ consultancy is given below.

A. SPONSORED/GRANT-IN-AID PROJECTS

Wave measurements (a) off Kakinada, Machilipatnam on the east coast and (b) at Bombay High on the west coast of India

Under these two projects, sponsored by ONGC, wave data collection using wave rider buoys at different depths was carried out. The data collection programme on east coast and at Bombay High commenced from May 1983. Analysed data from all the locations are being submitted to the sponsors on a monthly basis.

Development of microprocessor based rotor current meter

This project was sponsored by the Hydrographic Department of Calcutta Port Trust, Calcutta (estimated cost Rs. 2.05 lakhs) in October 1983. The project work envisages the development and fabrication of 6 rotor current meters for studying the vertical current distribution in Hooghly river. The duration of this project is just 6 months. The first prototype developed was successfully demonstrated to the sponsors.

Oceanographic studies at Dabhol Creek for harbour planning and development

At the request of Government of Maharashtra, a project (estimated cost Rs. 1.55 lakhs) involving the studies on general hydrography, sediment characteristics etc., was undertaken in February-April 1983. The investigation was aimed to find out the possibilities of development of Dabhol port by dredging the sand bar at the entrance, so as to maintain a channel suitable for navigation of larger ships under all tide and weather conditions.

The studies at the Dabhol Creek indicated homogenous and unpolluted water characteristics. At the lowest reaches of river Vashisthi the creek exhibited a typical characters of a well mixed tidal estuary. The dominant direction of flow in general was East-West at creek while it was North-South at the offshore stations.

Water quality determination and waste water disposal studies for Tapti estuary

This project sponsored by ONGC in November 1983 (estimated cost Rs. 9.28 lakhs) involves a detailed survey to delineate the base water quality of Tapti estuary, and a suitable point for effluent release from the gas separation plant that ONGC propose to set at Kawas near Hazira on the northern

bank of the estuary. Studies on various aspects along the 60 km of this estuary is under progress.

Rihand hydrometeorological studies

This project was sponsored by the National Thermal Power Corporation Limited, New Delhi (estimated cost Rs. 11.7 lakhs). The objective of the project is to provide basic information on hydrometeorological parameters of the Rihand lake near Singrauli, Uttar Pradesh, for locating the coolant water intake and warm water outlet for the proposed thermal power station.

The field observations were carried out during May-June, 1983. The data on the thermal structure of the lake waters, current patterns, mixing characteristics and surface meteorological parameters have been processed. The report incorporating data and information, is being finalised.

Studies on biofouling of offshore structures

This project was sponsored by the Oil and Natural Gas Commission (ONGC) (estimated cost Rs. 12.5 lakhs) and the work was initiated in April 1983. The data on various environmental parameters and also on the extent of settlement of fouling organisms on offshore structures of ONGC is being collected every month and reported to the sponsors. An additional work (estimated cost Rs.5.24 lakhs) for studying the environmental pollution using fouling organisms as indicators has been entrusted by the sponsors and was taken up since December 1983.

Bathymetric, side scan sonar and shallow seismic survey in Tuticorin Harbour

Under this project (estimated cost Rs. 1.5 lakhs), sponsored by Tuticorin Port Trust, about 160 line km of echosounding, 120 line km of side scan sonar and 90 line km of ORE subbottom profiling was carried out and grab samples were collected in the approach channel and the harbour basin of the Port. Processing and analyses of the data have been completed and the report is under preparation.

Location of well heads in Palk Strait

This project (estimated cost Rs. 0.575 lakhs) was sponsored by Oil and Natural Gas Commission (ONGC) and under this project 58 line km of side scan sonar survey was carried out at the two locations given by the ONGC. The results are positive but need to be confirmed by divers.

Shallow seismic surveys in Dabhol Creek, Maharashtra

This project (estimated cost Rs. 1.5 lakhs) was sponsored by the Intercon Maritime Consultants Private Limited, New Delhi. The Dabhol Creek was surveyed for the development of the port and the surveys comprised of echosounding (40 lkm), shallow seismic profiling (40 lkm) followed by seabed sampling. The collected data were analysed and report is under preparation.

Shallow seismic surveys in Rajapuri Creek, Maharashtra

This was sponsored by Intercon Maritime Consultants Private Limited, New Delhi. Under this project (estimated cost Rs. 1.75 lakhs) the Rajapuri Creek was surveyed for the development of the port. The surveys comprised of echosounding (80 lkm) and shallow seismic profiling (80 lkm) followed by sea bed sampling. The data are being analysed and the report is under preparation.

Studies on beach erosion and remedial measures along the coast from Campal to Cabo, Goa

Under this project, sponsored by Government of Goa, Daman and Diu, data on waves, currents, tides, beach changes, etc· were collected along Campal, Miramar and Caranzalem beaches. Studies on wave refraction and bar formation were also undertaken. The causes for the beach erosion at Youth Hostel were identified and the suitable remedial measures to be taken up have been suggested to the sponsors.

Development of microprocessor based marine instruments

This was a grant-in-aid project for 3 years and was funded by the Electronics Commission of India. The work on this project commenced in 1980, and till now, microprocessor based tide gauge, CSTD and Wave digitizer have been completed. The Electronic bathythermograph is nearing completion.

Seaweed cultivation

Under this project sponsored by Government of Maharashtra, work on standardization of Seaweed cultivation techniques at Malwan was continued. Seaweed species such as **Monostroma, Hypnea** and **Gracilaria** have been studied for growth, spore formation and liberation. Culture techniques using coir and nylon rope nets, wooden settlement frame and also tank culture in laboratory using running seawater system were tried.

B. CONSULTANCY SERVICES

Several consultancy services were provided to various organisations. The services provided during the year are tabulated below.

Beneficiary/service requested by	Service offered
Department of Science, Technology & Environment, Government of Goa, Daman and Diu.	Studies on the stability of the nearshore waters for aquatic sports and to ascertain the beach quality on the eve of CHOG(M).
Directorate of Health Services, Government of Goa, Daman & Diu.	Chemical and biological analysis of samples of dead fishes washed ashore at Velsao beach as a result of the breakdown of the NH_3 stripping plant of M/s Zuari Agro Chemicals Limited.
Mormugao Port Trust, Goa	Analysis of water samples from a Japanese ship's drinking water store for petroleum hydrocarbons.
M/s Ciba-Geigy Limited, Corlim, Goa.	Analysis of effluent samples for suspended solids.
College of Engineering, Farmagudi, Goa.	BE Final year students were guided in developing a microprocessor based speech synthetiser.

Department of Ocean Development, New Delhi and Gujarat Tourism, Gandhinagar.	A field survey was undertaken to find out the feasibility for establishing an Oceanarium at Porbander.
Indian Navy	Survey for the location of the wreckage off Cochin with the help of ORV Sagar Kanya & INS Gej.
Department of Science & Technology, Government of India, New Delhi.	Preparation of a state-of-knowledge report on biological resources of Bengal deep sea fan area.

2.13

International Programmes

Indo-Sri Lankan Research Programme

1. As a spin off of the India-Sri Lanka conference on "Development of Marine Resources, Science and Technology", held at Colombo from 18th to 21st February, 1983, a cruise with 4 Sri Lankan scientists on board RV **Gaveshani** was undertaken in the territorial waters of Sri Lanka from March 18 to April 4, 1983. Intensive studies in chemical, biological and pollution aspects were carried out in Kalpitiya (Gulf of Mannar), Dondra Head (South of Sri Lanka) and Trinocomalee Bay. Data from 41 stations from standard depths were collected.

At the end of the cruise the Sri Lankan Scientists were imparted 15 days training on various analytical techniques and processing of data in the shore laboratory.

2. Under Indian Technical Economic Co-operation Programme with the Government of Sri Lanka, the Institute has deputed two scientists Dr. (Mrs) Sumitra Vijayaraghavan and Dr. Joseph P. Royan to the National Aquatic Resources Agency, Colombo, Sri Lanka, for a period of 18 months.

Dr. Sumitra Vijayaraghavan, will be helping the Sri Lankan scientists in developing aquaculture techniques for commercially important marine and brackish water fishes and shrimps. While Dr. Royan will conduct survey of coastal areas for distribution of brine shrimp **Artemia** and to identify suitable site for its large scale culture. He would also be engaged in developing the air-water lift raceway system for controlled culture of this shrimp.

Indo-Australian Research Programmes

1. One marine biologist from this Institute, Dr. Vinod Dhargalkar, was selected by the Department of Ocean Development, Government of India, for the winterization in Antarctica, under a collaborative programme between Government of India and Government of Australia (DST). Dr. Dhargalkar, after a brief training at Mawson, Australia, is now at an Australian Antarctic-Station, Port Davis. He would be studying the distribution, association and role of various algal members in Antarctic waters.

2. Studies on the microfossil of Vestfold Hills, Antarctica, were undertaken in collaboration with the scientists of the Antarctic Division, Department of Science and Technology, Australia. Under this programme, planktonic and benthic samples were received from Australia for expert study. The various aspects such as distribution, abundance and taxonomy of foramimfera and ostracods have been completed. Possible explanations tor disparity in abundance of ostracods and foraminiferas have been proposed. These are: differential deposition after ice ablation and physiographic variations. Similar studies on diatoms are now in progress.

Data and Information Management

In June 1983, the INODC was represented at the Second session of the Group of Experts on Format Development of the Working Committee on International Oceanographic Data Exchange of IOC/UNESCO.

The Data Centre submitted a project on the development of Data and Information services of NIO to UNESCO through CSIR and Government of India. Two UNESCO consultants visited the Institute and Data Centre and prepared a technical report and UNESCO agreed to provide funds for such a project. Under this project, 2 to 4 consultants would visit Data Centre and collaborate in software, hardware, data and information management, in 1984. UNESCO will also provide a Mini Desk Top Computer under this programme.

International Intercalibration Exercises

In 1982, MO, as representative of India, participated in the international intcrcalibration exercise for Hg. Cd, Pb, Cu and Zn in biological samples organised by GEMSl of GIPME (IOC). The results indicated that all our values, excepting Pb in two samples, are within the acceptable standard diviation of 5%.

In 1983 NIO, again as representative of India, participated in the international intercalibraton exercise for petroleum hydrocarbons in biological samples organised jointly by IOC and ICES.

3

Infrastructure

INSTRUMENTATION DIVISION

During the year three communication terminals (MX-211) were procured under Polymetallic Nodules Project, of the Institute from Magnavox, U.S.A., mainly for shipborne data transmission. The terminals are capable of establishing telephonic or telex contact world wide and have been fitted with a slow scan TV system for picture transmission and reception. These terminals are presently being used to communicate and for transmission of picture to and from Indian, manned station at Antarctica.

COMPUTER CENTRE

Two units of floppy based data entry system have been procured to replace the punch card system. Computer Centre continued to provide its services and extended all the facilities to the Institutional staff. Data requests mostly from Indian Navy, Andhra and Cochin Universities and few other organisations were attended to. Computer time was also provided to outside organisations like Mormugao Port Trust, Engineering College, etc.

RV GAVESHANI

The Research Vessel Gaveshani was deployed for regular Institutional R & D work, and during the year it completed 15 cruises. On board facility was extensively utilised by research scholars from Universities like Annamalai, Cochin, Andhra, Berhampur and Naval Physical Oceanographic Laboratory, Cochin. In one of the cruises 4 Sri Lankan participants were also trained for onboard collection and analysis and processing of oceanographic data. The ship was also utilised for imparting onboard training to 40 trainee scientists.

ORV SAGAR KANYA

During the year, the Institute also carried out the responsibilities of planning and execution of oceanographic cruises of newly acquired research ship **Sagar Kanya** as directed by DOD. This ship was also deployed for familiarisation and training of scientists from various research organisations including NIO.

LIBRARY

During the year 1983, 1780 books including bound volumes and 253 technical reports were added bringing the total to 14,000 books and 3653 technical reports. 220 journals were subscribed and 80 journals were received on exchange and complimentary basis. Besides about 400 Institute's staff, there were more than 50 outsiders who availed the library facilities. The library continued to receive from and send the books and periodicals on loan to other Institutes. This service was very popular and benefitted many users.

The library, under current awareness services, brought out the following:

New Arrivals - I	-	Books & others (monthly)
New Arrivals - II	-	Technical Reports (monthly)
Aquatitles	-	Journals (fortnightly)

Besides these, four bibliographies were also brought out (listed at the end of the report).

OTHER SERVICES

The workshop facilities were extended by adding an HMT Radial Drilling Machine. The facilities were extensively utilised particularly for the fabrication of current meter, data buoy, tide gauge and other instruments.

The photography section was further upgraded and during this year, processing and development of colour prints and slides was started. Reprographic, Printing, Drawing and Binding facilities were continued to be provided.

IInd Phase of NIO Laboratory and Residential Quarters

The IInd phase of the laboratory building was completed. This phase on three floors consists of 4297 sq.m. area. This has been occupied by various Divisions and provided more working area.

During the year, construction pf 36 residential quarters and a Hostel with 28 rooms was completed.

4

Budget

The budget of the Institute for the 1983-84 (Rs. in lakhs)

[1]A[1] Recurring	PLAN	NON-PLAN	TOTAL
Salaries	11.270	62.752	104.022
Contingencies	13.210	10.913	24.123
Maintenance		1.966	1.966
Chemicals & Glassware	21.815	8.611	30.426
Boat operation	44.653	81.122	125.775
Total (A)	120.948	165.364	286.312
[1]B' Capital			
Works	10.259	-	10.259
Services	5.914	-	5.914
Equipment	101.940	-	101.940
Furniture	5.930	-	5.930
Books	4.809	4.336	9.145
Vehicles		0.864	0.864
Exhibition	0.318	-	0.318
Total (B)	129.170	5.200	134.370
Grand Total (A+B)	250.118	170.564	420.682

5

Composition of Various Committees of NIO

5.1. CRUISE PLANNING AND PROGRAMME PRIORITIES COMMITTEE FOR RV GAVESHANI AND ORV SAGAR KANYA

1.	Dr. S.Z. Qasim, Secretary to the Govt. of India, Department of Ocean Development, South Block, Room No.235-B, New Delhi.	Chairman
2.	Dr. G.S. Sidhu, Director General of Scientific and Industrial Research, Rafi Marg, New Delhi.	Member
3.	The Deputy Director General (Marine Geology), Geological Survey of India, Ratnakar Building, 4, Chowringhee Lane, Calcutta.	"
4.	Adviser, L & T Division, Ministry of External Affairs, Patiala House, Tilak Marg, New Delhi.	"
5.	Legal Adviser, Ministry of External Affairs, Patiala House, Tilak Marg, New Delhi.	"
6.	Director (Operations), Coast Guard Head Quarters, E. Block, D.H.Q.P.O., New Delhi.	"
7.	Director, Naval Physical & Oceanographic Laboratory, Naval Base, Cochin.	"
8.	Director, National Geophysical Research Institute, Uppal Road, Hyderabad.	"
9.	Shri K.N. Johry, Head, International Scientific Collaboration C.S.I.R., Rafi Marg, New Delhi.	"

10.	Secretary, Department of Mines, Shastri Bhavan, New Delhi.	Member
11.	Shri S.N. Batra, Shipping Corporation of India, 229/232, Madame Carna Road, Bombay.	
12.	Dr. T.K. Datta, Council of Scientific and Industrial Research Rafi Marg, New Delhi.	
13.	Director General India Meteorological Department, Lodi Road, New Delhi.	
14.	Chief Hydrographer, Naval Hydrographic Office, Rajpur Road, Dehra Dun.	"
15.	Director, Institution of Petroleum Exploration, Oil and Natural Gas Commission, 9, Kaulagarh Road, Dehra Dun.	"
16	Chairman, Commission for Addl. Source of Energy, C/O. CASE, D.S.T., Shastri Bhavan, New Delhi.	"
17.	Director, Centre of Earth Science Studies, Saikrishna Building, TC No. 9/1421, Sasthamangalam, Trivandrum.	"
18.	Director, Central Electrical Authority, Govt. of India, Bikaner House, New Delhi.	"
19.	Chairman, Oil and Natural Gas Commission, Tel Bhavan, Dehra Dun.	..

20. Member Offshore Oil and Natural Gas Commission, Nariman Point, Bombay.	Member
21. Chairman, University Grants Commission, Bhadur Shah Zafar Marg, New Delhi.	"

5.2 RESEARCH ADVISORY COUNCIL

Dr. S.Z. Qasim, Secretary to the Govt. of India. Department of Ocean Development, New Delhi.	Chairman
Dr. V.V. Sastri, General Manager (Spl Duties), Institute of Petroleum Exploration, Dehra Dun.	Member
Dr. D. Srinivasan, Director, Naval Physical & Oceanogrpahic Laboratory, Cochin.	"
Commodore A.G. Moraes, Chief Hydrographer to the Govt. of India, Naval Hydrographic Office, Dehra Dun.	"
Dr. Supriya Roy, Professor of Geology, Department of Geological Sciences, Jadavpur University, Calcutta.	"
Dr. P.V. Dehadrai, Fisheries Development Commissioner, Ministry of Agriculture, New Delhi.	
Vice Admiral R.H. Tahiliani, A.V.S.M. Flag Officer Commanding, Western Naval Command, Bombay.	
Prof. M.N. Sastri,, Professor in Chemistry, Andhra University, Visakhapatnam.	
Dr. P.K. Das, Director General of Meteorology, India Meteorological Department, New Delhi.	

Dr. M.K. Ghosh Roy, Professor & Head, Indian Institute of Technology, Madras.	
Shri C.K. Tandon, Manager of Projects, Engineers India Limited, New Delhi.	"
Dr. V.V.R. Varadachari, Director, National Institute of Oceanography, Dona Paula, Goa.	"
Dr. T.S.S. Rao, Deputy Director, National Institute of Oceanography, Dona Paula, Goa.	"
Shri H.N. Siddiquie, Deputy Director, National Institute of Oceanography, Dona Paula, Goa.	"
Dr. E. Desa, Head, Marine Instrumentation Division, National Institute of Oceanography, Dona Paula, Goa.	..

Ex-Officio Members,
i. Director-General, SIR or his nominee and
ii. Chairman, Coordination Council of Physical and Earth Sciences Group of Laboratories, CSIR.

5.3 EXECUTIVE COMMITTEE

Dr. V.V.R. Varadachari, Director, National Institute of Oceanography, Dona Paula, Goa.	Chairman
Vice Admiral R.H. Tahiliani, A.V.S.M Flag Officer Commanding, Western Naval Command, Bombay.	Member
Dr. Supriya Roy, Professor of Geology, Department of Geological Sciences, Jadavpur University, Calcutta.	"
Dr. P.V. Dehadrai, Fisheries Development Commissioner, Ministry of Agriculture, New Delhi.	"

Dr. T.S.S. Rao, Deputy Director, National Institute of Oceanography, Dona Paula, Goa.	Member
Shri H.N. Siddiquie, Deputy Director, National Institute of Oceanography, Dona Paula, Goa.	"
Dr. E. Desa, Head Marine Instrumentation Division, National Institute of Oceanography, Dona Paula, Goa.	"
Shri Lakhbir Singh, Administrative Officer (SG), National Institute of Oceanography, Dona Paula, Goa.	Member (Ex-Officio)
Shri A. Rajachandran, Sr. Finance & Accounts Officer, National Institute of Oceanography, Dona Paula, Goa.	Member (Ex-Officio)

Permanent Invitees

1. Director-General, SIR or his nominee
2. Chairman, Coordination Council of Physical & Earth Sciences Group of Laboratories, CSIR.

5.* FINANCE AND BUILDING COMMITTEE

Dr. T.S.S. Rao, Dy Director, National Institute of Oceanography, Dona Paula, Goa.	Chairman
Dr. S.P. Deshpande, Director, Environmental Planning & Design Consultancy Services, Government of Goa, Daman & Diu, Panaji, Goa.	Member
Shri H.N. Siddiquie, Deputy Director, National Institute of Oceanography, Dona Paula, Goa.	
Shri R.S. Panesar, Head Engineering Division, New Delhi.	"
Dr. B.N. Desai. Scientist-in-Charge, Regional Centre of NIO, Bombay. "	"
Administrative Officer, National Institute of Oceanography, Dona Paula, Goa.	

Finance & Accounts Officer, National Institute of Oceanography, Dona Paula, Goa.	Member
Civil Engineer, National Institute of Oceanography, Dona Paula, Goa.	Convenor

5.5. SHIP COMMITTEE

Shri H.N. Siddiquie	Chairman
Dr. R. Sen Gupta	Member
Shri C.V.G. Reddy (upto 10th Oct.)	
Dr. A.H. Parulekar	"
Dr. E. Desa	"
Dr. A.B. Wagh	"
Dr. D. Panakala Rao	"
Shri S.G. Diwan	"
Shri 3.S. Sarupria	"
Shri Lakhbir Singh	"

6

Scientific, Technical and Administrative Staff

The staff (upto the level of JSA/JTA/Assistant) as on December 31, 1983.

Director
Dr. V.V.R. Varadachari

Deputy Directors
Dr. T.S.S. Rao
Shri H.N. Siddiquie

Adviser Ship matters
Rear-Admiral, D.S. Paintal,
(Stationed at New Delhi),

A. Divisions at the Headquarters

1. *Physical Oceanography Division*

Head of the Division
Dr. J.S. Sastry

Senior Scientific Assistants
Mr. A.A. Fernandes
Mr. M.S.S. Sarma

Senior Technical Assistant
Mr. G. Nampoothiri

Scientists
Mr. L.V. Gangadhara Rao
Dr. C.S. Murty
Dr. D. Panakala Rao
Mr. P.K. Das
Mr. M.J. Varkey
Mr. C.K. Gopinathan
Mr. G. Narayana Swamy
Mr. V. Ramesh Babu
Dr. M.K. Antony
Mr. A.F. Anto
Mr. A.D. Gouveia (on deputation to FRG)
Mr. P.V. Sathe
Mr. D.V. Rama Raju (on deputation to France)
Mr. Y.K. Somayajulu
Mr. V.V. Gopalakrishna
Mr. R.J.K. Charyulu
Dr. (Miss) S. Sathyendranath
Mr. V.S.N. Murty
Mr. P. Vethamony
Mr. A. Suryanarayana
Mr. M.R. Ramesh Kumar
Mr. Prasanna Kumar
Mr. S.S. Shenoi
Mr. Y.V. Sarma
Dr. Y. Sadhuram

Junior Technical Assistants
Mr. R. Nagarajan
Mr. Almeida A. Michael
Mr. Kasturi Santanam
Mr. Damodaran Sundar
Mr. M.T. Babu
Mr. G. Selvan Michael
Mr. Krishan Kumar

Research Associates
Dr. N. Bahulayan
Dr. Satish R. Shetye
Dr. T.V. Ramana Murty

Senior Research Fellow
Mr. D. Sen Gupta

Junior Research Fellows
Mr. N.K. Viswambharan
Mr. M.V.S.S. Seshagiri Rao
Mr. M. Venkateshwar Rao

2. *Chemical Oceanography Division*

Head of the Division
Mr. C.V.G. Reddy (Upto 10 October)

Scientist-in-Charge

Mr. S.P. Anand

Scientists

Dr. S.Y. Kamat Mr. P.V. Narvekar
Dr. A. Rajendran Mr. S.T. Kannan
Mr. M. Manoharan

Dr. C.G. Naik Senior Scentific Assistan
Mr. S.N. De Souza
Mrs. Solimabi Wahidullah Mrs. A. Mesquita
Mr. M.D. George

Mr. S.W.A. Naqvi

Dr. N.B. Bhosle Mr. M.D. Rajagopal
Mrs. C. D'Silva **Senior Research Fellow**

Mr. M. Dileep Kumar
Mr. P. Parameshawaran
Mr. S.R. Murthy
Miss. S.S. Naik

Senior Scientific Assistants

Mr.R.S. Topgi
(on deputation to France)
Dr. K. Sawkar Mr. S. Upadhyay

Mrs. L. D'Souza (Both Stationed Bhubaneshwar)

Senior Technical Assistants Senior Stenographer

Mrs. C. Dias Miss Milagrine Cardoz
Mrs. B. Das

Junior Technical Assistants

Mr. P. Shirodkar
Mrs. A. Rao Mr. H.N. Siddiquie
Mr. D.A. Jayakumar
Mr. K. Somasundar

Pool Officer

Dr. Anil Kumar

Senior Research Fellow

Dr. (Miss) F. D'Souza Mr. D. Gopala Rao

Junior Research Fellow

Mrs. V.J. Ghosh Mr. B.G. Wagle

3. ***Marine Pollution Studies Division***

Head of the Division

Dr. R. Sen Gupta Mr. A.R. Gujar

Scientists

Dr. S.Y.S. Singbal
Mr. S.P. Fondekar
Mr. T.W. Kureishy
Miss Sujata Sanzgiry

Junior Technical Assistant

Mr. K. Hanumantha Rao

Junior Research Fellows

Mr. B.C.Roy
Mr. P.B. Ghosh
(Both stationed at Calcutta)
Mr. A.K. Prusty

4. Geological Oceanography Division

Head of the Division

Dr. M.G. Anantha Padmanabi Setty

Scientists

Mr. P.S.N. Murty
Mr. R.R. Nair
Mr. Ch. Madhusudana Rao
Dr. M. Veerayya
Dr. G.V. Rajamanickam
Mr. M.V.S. Guptha
Mr. N.H. Hashimi
Mr. F. Almeida
Mr. G.C. Bhattacharya
Mr. A.L. Paropkari
Mr. L.V. Subba Raju
Mr. K.H. Vora

Dr. R. Nigam
Dr. S.M. Kansiddaiah
Mr. M.V. Ramana
Mr. A. Mascarenhas
(on deputation to France)
Mr. V. Subrahmanyam
Dr. A.B. Valsangkar
Mr. V. Purnachandra Rao
Mr. V.N. Kodagali
Mr. J.N. Pattan
Mr. R.K. Sharma
Mr. V.K. Banakar
Mr. M. Shyam Prasad
Mr. B. Nagender Nath
Mr. N. Purnachander Reddy
Mr. T. Ramprasad
Mr. Ranadip Banerjee
Mr. Shyam Murti Gupta
Mr. Randhir Mukhopadhyay
Miss Pratima Jauhari
Mr. P. Sivasankara Rao
Mr. S. Nagendra
Mr. Govind Ranade
Mr. Sanjeev Afzulpurkar
Mr. S. Sekar
Mr. V. Ramaswamy
Mr. M. Sudhakar
Mr. K.A. Kamesh Raju
Mr. Iyer Sridhar D.
Mr. K.J. Daniel
Dr. D.V. Borole
Mr. O.S. Chauhan

Technical Officer

Mr. M.C. Pathak

Senior Technical Assistants

Mr. K.L. Kotnala
Mr. E. Dias
Mr. P. Marathe
Mr. S.K. Nanyasi

Junior Technical Assistants

Mr. N.V. Ambre
Mr. A.S. Muralinath
Mr. P.G. Mislankar
Mr. P. Ganeshan
Mr. P.R. Vijayan
Mr. Ashis Gosh
Mr. N. Prabhakaran
Mr. S.M. Pakale
Mr. K.M. Sivakholundo
Mr. J. Kamalakar
Mr. N. Athiaman
Mr. Gavin A. Walker
Mr. S.5. Gaonkar
Mr. S.S. Pattanshetti
Mr. T.J. Thottam
Mr. B. Umamaheswara Rao
Mr. G.M. Phadte
Mr. T. Sudhakar
Mr. B. Sudhakar Rao
Mr. Y. Satyanarayana Raju
Mr. J. Kannaiyan
Mr. C. Uthayasankar
Mr. V.D. Khedekar
Mr. D. Gracias
Mr. K.L. Naik
Mr. R.R. Luis
Mr. T. Srinivasa Rao
Mr. G. Janakiraman
Mr. Fernando Vijayan
Mr. V.S. Rajaraman
Mr. V. Venkatesan
Mr. R.C. Agarwal
Mr. B. Ramalingeswara Rao
Mr. B. Vijayakurmar
Mr. V.K. Chidambara Rao
Mr. K. Srinivas
Mr. C. Prakash Babu
Mr. G. Parthiban

Junior Mechanical Assistant

Mr. A.V. Sonawane

Senior Research Fellows

Mr. M. Suresh Raj
Mr. C.S.M. Birajdar

5. *Biological Oceanography Division*

Head of the Division

Dr. T.S.S. Rao

Scientists

Dr. A.H. Parulekar
Dr. A.G Untawale
Mr. V.P. Devassy
Dr.(Miss) Aditi Pant
Dr. S.C. Goswami
Dr. (Mrs) Sumitra Vijayaraghavan
(on deputation to Sri Lanka)
Dr. D. Chandramohan
Mr. P.M.A. Bhattathiri
Dr.(Miss) Loka Bharathi
Dr. Joseph Royan
(on deputation to Sri Lanka)

Dr.(Mrs) Usha Goswami
Dr. M. Madhu Pratap
Dr. R.A. Selvakumar
Mr. C.T. Achuthankutty
Mr. S.N. Harakantra
Mr. Z.A. Ansari
Mr. S.R.S. Nair
Dr. M.V.M. Wafar
Dr. A.K. Chatterjee
Mr. N. Ramaiah
Dr. V.K. Dhargalkar
(wintering at Antarctica)
Mrs. L.K. Wariar

Senior Scientific Assistants

Mrs. Shanta Achuthankutty
(on deputation to Japan)
Mr. X.N. Verlencar
Mrs. Sayeeda Wafar
Mr. T.G. Jagtap

Senior Technical Assistants

Dr.(Miss) Maria Menezes
Mr. S.G.P. Matondkar
(wintering at Antarctica)
Mr. V. Subramanian

Junior Technical Assistants

Mr. J.I. Goes
Mr. B.S. Ingole
Mr. J. Roy

Junior Mechanical Assistant

Mr. M.G.K. Goudar

Research Associates

Dr.(Mrs) M.S. Shailaja

Pool Officers

Dr. S. Raghu Kumar
Dr.(Mrs) Lata Raghu Kumar

Senior Research Fellows

Mr. C.L. Rodrigues
Miss H.R. Gomes

Junior Research Fellows

Miss J. Patel
Miss Geeta Deshmukhe
Miss Joan Lobo

6. *Biofouling & Corrosion Section*

Scientist-in-Charge

Dr. A.B. Wagh

Junior Technical Assistant

Mr. S.S. Sawant

Senior Research Fellow

Mr. A.C. Anil

Junior Research Fellows

Mr. T.V. Ravindran
Mr. V.P. Venugopalan
Mr. Lakshmikant Bhat

7. Ocean Engineering Division

Head of the Division

Dr. B.U. Nayak

Scientists

Mr. N.M. Anand (on study leave)
Dr. P.S. Renukaradhya
Mr. S.G. Diwan
Mr. P. Chandramohan
Mr. S. Mandal
Dr. K. Kodandaramaswamy
Mr. A.K. Suryavanshi
Mr. R. Sabapathi

Junior Technical Assistants

Mr. P Pednekar
Mr. K.C. Pathak
Mr. H.C. Mandal

Senior Personal Assistant

Shri V.N.N. Menon

8. *Marine Instrumentation Division*

Head of the Division

Dr. E. Desa

Scientists

Mr. M.R. Nayak
Dr. E.S. Desa
Mr. R.G. Prabhu Desai
Mr. E.J. D'sa
Mr. A. Joseph
Mrs. V.B. Peshwe

Senior Technical Assistants

Mr. A.P. Selvam
Mr. Md. Wahidullah
Mr. V.M. Date

Senior Mechanical Assistant

Mr. S.B. Tengali

Junior Technical Assistant

Mr. O. D'Souza

Junior Mechanical Assistant

Mr. V.N. Chodankar

9. ***Planning & Data Division***

Scientist-in-Charge

Mr. R.M.S. Bhargava

Scientists

Dr. R. Mahadevan
Mr. J.S. Sarupria
Mr. V. Kesava Das
Mr. G.R. Itigi
Mr. T.V. Narasimha Rao
Mr. G. Venkata Reddy
Mr. G. Banerjee
Mr. S.J.D. Varaprasad
Mr. S.R. Bhat

Statistical Officer

Mr. S.G. Dalal

Senior Scientific Assistant

Mr. Arvind Ghosh

Senior Technical Assistant

Mr. S.P. Sharma

Junior Technical Assistants

Mrs. R. Thomas
Mr. Andrew Menezes
Miss Vilma Vaz
Mr. K. Raghavan

10. Ship Cell

Scientist

Shri P.V.S.S.R. Sarma

11. Library

Junior Documentation Officer

Mr. M.P. Tapaswi

Senior Librarian

Mrs. S.H. Oka

Library Assistant

Mr. G.H. Sainekar

12. Administrative Officer (SG)

Mr. Lakhbir Singh

Establishment & General Sections

Section Officers

Mr. K.P. Rajaram
Mr. K.R. Das
Mr. K. Ramamoorthy

Assistants

Mr. I. D'Souza
Mr. Peter D'Silva
Mr. R.K. Duggal
Mr. Paul D'Souza

Sr. Stenographer

Miss Juliana Remedios

13. Accounts Section

Sr. Finance & Accounts Officer

Mr. A. Rajachandran

Section Officer

Mr. C.M. Dias

Assistants

Mr. M.G. Dalvi
Mrs. Nancy Mascarenhas

14,* Purchase *&. Stores Section

Purchase & Stores Officer

Mr. R.K. Nair

Assistant

Mr. T.C. Fernandes

Stores Supervisors

Mr. C.K. Gaur
Mr. P. Gopinathan
Mr. K.S. Naik
Mr. T.K. Ramankutty

15. Works Section

Civil Engineers

Mr. T.N. Sharnappa
Mr. George Philip

Junior Engineers

Mr. R.B. Kubsad
Mr. K.B. Kulkarni
Mr. Mathew P. Chacko

16. Boats

Bosun

Mr. R.R. Garudi

17. NIO Dispensary

Resident-Medical Officer

Dr. (Mrs) Lakshmi V. Bhandare

B. Regional Centres

1. *Regional Centre, Cochin*

Scientist-in-Charge

Dr. M. Krishnankutty

Scientists

Mr. V.S. Rama Raju
Dr. R.V. Unnithan
Dr. V.N. Sankaranarayanan
Dr. P. Sivadas
Mr. P. Udaya Varma
Mr. U.K. Gopalan
Dr. K.J. Peter
Mr. B.M. Panikkar
Dr.(Mrs) M. Saraswathy
Mr. P.N. Aravindakshan
Dr. V.T. Paulinose
Dr. T. Balachandran
Mrs. C.B. Lalithambika Devi
Mr. K. Kameswara Rao
Mr. P.S. Gore
Dr. T.C. Gopalakrishanan
Dr.(Mrs) V. Santhakumari
Mr. K.K.C Nair
Mrs. U.P. Saramma
Mrs. Rosamma Stephen
Mrs. P.P. Meenakshi Kunjamma
Mrs. K.V. Jayalakshmy
Mr. P. Haridas
Dr. George Peter
Mr. P. Venugopal
Mr. T. Balasubramanian

Senior Technical Assistants

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

Senior Draughtsman

Mr. V.N. Mohanan

Junior Technical Assistants

Mr. S. Kumaran
Mrs. Thresiamma Joseph
Mr. K.R. Shyam
Mr. K.K. Balachandran

Precision Mechanic

Mr. T.R. Valson

Pool Officer

Dr. M. Vijayan

Junior Research Fellows

Mr. T. Pradeep Kumar
Mr. K.V. Sanil Kumar
Mr. M. Viswakumar

Senior Personal Assistant

Mr. C.S. Krishna Pai

Senior Stores/Purchase Assistant

Mr. P.V. Raphael

Senior Stenographer

Mr. K.K. Gopinathan

Assistant

Mr. P.B. John

2. Regional Centre, Bombay

Scientist-in-Charge

Dr. B.N. Desai

Scientist

Dr. S.A.H. Abidi
(on deputation to DOD, New Delhi)
Dr. M.D. Zingde
Mr. V. Josanto
Dr.(Mrs) Vijayalakshmi R. Nair
Dr. K. Govindan
Mr. M.M. Sabnis
Mr. R.V. Sarma
Dr. S.N. Gajbhiye
Dr. A.N. Kadam

Junior Scientific Assistant

Mr. CV. Vijayakumar

Junior Technical Assistants

Mr. A.V. Mandalia
Miss. Prabha D. Gore
Mr. Prashant Sharma
Mr. Jiyalal Ram
Mr. M.A. Rokade

Research Associate

Dr. P.K. Varshney

Pool Officer

Dr. A.A. Nomani

3. *Regional Centre, Waltair*

Scientist-in-Charge

Dr. T.C.S. Rao

Scientists

Dr. K.S.R. Murthy
Dr. V.V. Sarma
Mr. A.A. Subrahmanyam
Mr. M.M. Malleswara Rao
Mr. K. Subrahmanyam

Senior Scientific Assistants

Mr. B. Prabhakara Rao
Mr. P. Vijayakumar Rathod
Mr. K. Mohana Rao
Dr. K.V.L.N.S. Sarma

Junior Technical Assistants

Mr. S. Kannan
Mr. M.K. Prema Kumar
Mr. S. Lakshminarayana

7

Visitors

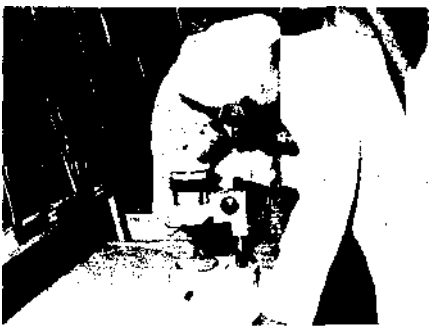
Visitors at Headquarters

President of India, Giani Zail Singh, visited the Institute on 30 December, 1983. He was received here in the Institute by Dr. G.S. Sidhu, D.G, SIR and the Director, Dr. V.V.R. Varadachari. On the following day, he also paid a visit to the research vessel **Sagar Kanya.**

A

B

C



D

Giani Zail Singh, the President of India visits NIO, A - Or. G.S. Sidhu, DG SIR with President & Lt.Governor, Goa, Daman & Diu; Shri K.T. Satarawala, B - The President viewing a biological sample, C - The President viewing the posters depicting; the activities of the Institute and D - viewing a sample through a binocular microscope.

The President looking at a sample of Polymetallic Nodule.

The Ship Officers are being introduced to the President on board ORV **Sagar Kanya.**

President showed keen interest in the activities of the Institute, particularly in the exploration of polymetallic nodules, Antarctica research, Oceanographic instruments and sea farming. He spent nearly 2 hours in going through the display charts and models.

• **Shri Shivraj Patil, Union Minister of State for Science and Technology,** visited the Institute on 1st July, 1983 and the research vessel **Sagar Kanya** on subsequent day. He was received by the Director NIO, Dr. V.V.R. Varadachari and was explained the various activities in marine sciences. The minister foresaw a great and important role of NIO in the development of ocean sciences and its resources.

Shri Shivraj Patil (second from left) discussing with the Director and other senior scientists.

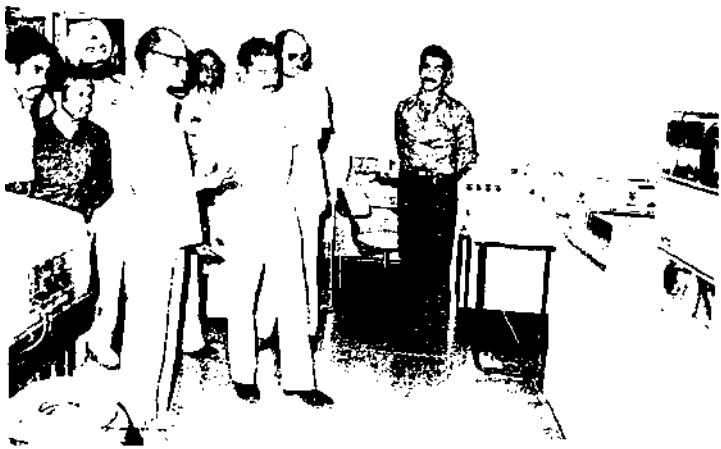
Shri Ram Nivas Mirdha, Union Minister of Irrigation, visited the Institute on 18 September, 1983. The minister was appraised of the various research activities of the Institute by the Director, Dr. V.V.R. Varadachan. Shri Mirdha appreciated the contributions, made by the scientists in the advancement of knowledge in marine sciences.

Shri Ram Nivas Mirdha viewing the posters depicting the activities of the Institute.

Shri Digvijay Singh, Dy. Union Minister of environment, keenly listening to the Director NIO, Dr. V.V.R. Varadachan.

Shri Digvijay Singh, Deputy Union Minister of Environment along with **Shri E. FaJeiro, Member of Parliament from Goa** and **Mrs. Sulochana R. Katkar, President, Goa Pradesh Congress (I)** visited the Institute on May 24, 1983· The minister was taken around the Institute. He showed keen interest in the activities of the Institute particularly in the studies of mangroves and polymetallic nodules. While appreciating the work, he made several suggestions also.

(a)



(b)

Shri K.P. Singh Deo, Minister of Stale lor Defence (during his visit to the Institute on 27/10/83) is appraised of the (a) the data activities of the Computer Centre and (b) various instruments that are designed and fabricated at the Institute.

Dr. M. Ferrari, Minister of External Relations, Seychelles, being received by Dr. V.V.R. Varadachari, Director of the Institute, on his visit (27.11.1983).

Other distinguished visitors were:
Mr & Mrs Troy Elster, Oslo Norway.
Jose I. Furtado, Commonwealth Secretariat, London.
Air Chief Marshal, Idris H. Latif, Governor of Maharashtra.
Dr. D.C. Krause, Director, Unesco, Paris.
Dr. Raja Ramanna, Chairman, Atomic Energy Commission.
Prof. Ruth D. Turner, Museum of Comparative Zoology, Harvard University U.S.A.
Dr. Mario Ruivo, Secretary, IOC, Paris.
Prof. Dang Ngoc Thanh & Dr. Le Trong Phan, National Centre for Scientific Research, Vietnam.
Shri Kanti Chaudhari, Vice Chancellor & Prof. G.P. Agarwal, Jabalpur University, Jabalpur.
Dr. P. Koteshwaran, Emeritus Professor of Meteorology, Andhra University Waltair.
Shri Paulo Alberto Soares, Embassy of Brazil,New Delhi.
Dr. S.Z. Qasim, Secretary, Department of Ocean Development, New Delhi.
Dr. T. Van Wevis, Netherlands Institute of Sea Research, Netherland.
Dr. *T.S.* Murty, Institute of Ocean Sciences, London.
Dr. O.G. Houmb, Ship Research Institute, Norway.
Prof. Luigi Cavaleri, Institute Studio Dinamica, Grandi Masse, Venice, Italy.
Prof. C. Druet, Director, Institute of Oceanology, Sopot, Poland.
Prof. M.I. Singh, I.I.T., New Delhi.
Dr. Kouperchtok, Chief Soviet Expert, R.D.C.I.S. Bhilai Steel Plant, Bhilai.
Mr. M.W. Pohray, Dy. Chief (Technology Development), Bhilai Steel Plant, Bhilai.
Mr. S.K. Mukherjee, R.D.C.I.S. (SAIL) Ranchi.
Dr. A.F. Maurin, CFP, France.
Dr. S.F. Rubbi, CSIR, Bangladesh. U.N.U. Fellow at C.F.T.R.I., Mysore.

Prof. H. Gundlach, Federal Institute of Geological Sciences and Natural Resources, Hannover, F.R.G.
Dr. A.S. Naidu, University of Alaska, U.S.A.
Dr. V.K. Nayak, University of Saugar, Saugar.
CoL(Dr.) M.G. Arur, Director, Geodetic & Research Branch, Survey of India.
Dr. Rajan Misra, Head of the Fisheries Project, S.T.C., New Delhi.
Dr. S.N. Talukdar, Member (Exploration), ONGC, Dehra Dun.
Shri L.L. Bhandari, Director, Institute of Petroleum Exploration. ONGC, Dehra Dun.
Shri K.L. Goyal, Joint Director, Institute of Petroleum Exploration ONGC, Dehra Dun.
Dr. M.S. Srinivasan, Banaras Hindu University, Varanasi.

Visitors at Regional Centre, Cochin

Dr. H.S. Matharu, Central Pollution Control Board, New Delhi.
Dr. CM. Campbell, Dr. Lorne Hume & Dr. S.T. Roude Selva, Newfoundland Ocean Resources Development Corporation, Canada.
Prof. Dang Nagoc Thanh, National Centre for Scientific Research, Vietnam.
Dr. L.E. Trong Phan, Director, Oceanographic Institute, Nhatrang, Vietnam.
Sqn. Ldr. B.K. Banerjee & Flt. Lt. N. Gopalan, AFAL, Coimbatore.
Dr. G. Thygarajan, Director, RRL, Hyderabad.
Dr. B.L. Bayne, Institute for Marine Environmental Research, Plymouth, U.K.
Dr. Hans Lassen, Danish Institute for Fishery and Marine Research, Charlotten Lund, Denmark.

Visitors at Regional Centre, Bombay

Prof. C. Druet, Director, Institute of Oceanology, Sopot, Poland.
Prof. M.M. Taqui Khan, Director, CSMCRI, Bhavnagar.
Dr. S.Z. Qasim, Secretary, Department of *Ocean* Development, New Delhi.
Dr. G.S. Sidhu, D.G.S.I.R. & Secretary to Government of India, New Delhi.
Prof. M.N. Sastry, Andhra University, Waltair.

8

Colloquia

Date	Speaker	Subject
08-02-1983	Dr. K.S. Valdiya Prof. of Geology Kumaon University	Aspects of environmental degradation of the Himalayan region.
25-02-1983	Prof. Ajay K. Bose Stevens Institute of Technology, U.S.A.	Newer NMR and Mass spectral technique for Structure determination.
26-02-1983	Dr. G. Ruggieri Director, Osborn Laboratories of Marine Sciences Osborn.	Aquatic animals in biochemical research.
26-02-1983	Prof. 3. Bakus, University of Southern California, California.	Ecological studies on toxicity in Marine organisms.
05-03-1983	Dr. P. Koteshwaran Emeritus Professor of Meteorology, Andhra University Waltair.	Tropical cyclones.
25-03-1983	Dr. Gero Hillmer Prof, of Geology Humburg University West Germany.	Modern tidal flats (German Bay) and fossil coastal environments.
12-04-1983.	Dr. Mario Ruivo Secretary, IOC Paris.	Marine scientific research under the new Ocean regime and role of IOC.
05-05-1983	Commander B. Lobo A.V.S.M.	Ocean Development and Ocean Research Institute.
21-06-1983	Prof.Dang Ngoc Than National Centre for Scientific Research Vietnam.	Marine Research and exploration of biological resources in the Socialist Republic of Vietnam.

06-09-1983	Dr. B.F. Chhapgar Bhabha Atomic Research, Centre, Trombay.	Aqua-lung diving for submarine biological observations in India.
24-09-1983	Dr. S. *H.* Gruber Prof. of Zoology Rosential School of Marine and Atmospheric Sciences, University of Miami, Florida.	Twenty years of Shark research.
11-11-1983	Dr. Maurice Schwantz Prof. of Geology Western Washington University, U.S.A.	Coastal erosion and protection in Washington State, U.S.A.
18-11-1983	Dr. C. Druet Director, Institute of Oceanology, Sopot Poland.	The structure and dynamic features of the wind waves in the coastal zone.
21-11-1983	"	Oceanographic studies in Poland.
23-11-1983	"	The density microstructure and their dynamics in relation to plankton concentration in the sea.
01-12-1983	Prof. Luigi Cavaleri Institute studio Dinamica, Grandi Masse Venice, Italy.	Wind wave models and their applications.
"	"	Beach model for shore-line evolution and wave set-up.

9

Radio Talks

Speaker	Topic
Dr. R. Sen Gupta	Oil pollution in Indian Seas.
Shri S.P. Anand	Desalination of sea water.
Dr. A.H. Parulekar	(i) Deep sea life. (ii) Fish famine in Goa.
Dr. A.G. Untawale	Deep sea plants.
Dr. D. Chandramohan	Marine research in modern India.
Miss Sujata Sanzgiry	Marine life.

10

Awards, Honours and Membership of Various Committees

Dr. V.V.R. Varadachari
Elected as Vice-Chairman of the Joint SCOR/IOC Committee on Climatic Changes and the Ocean (CCCO) and continued to serve as

Member of Scientific Review Board of IOC.

Member, Board of Ocean Engineering, IIT, Madras.

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

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

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

Dr. T.S.S. Rao served as

Member, Committee on Coral Reefs, Department of Science and Technology, Government of India, New Delhi.

Member, Committee on "Protection and Management of Beaches", Dept. of Environment, Govt. of India, New Delhi.

Member Secretary, Committee on Sea Aquarium, Govt. of Goa, Daman & Diu, Panaji-Goa.

Member, Marine Biological Association of India.

Member, Fisheries Co-ordination Committee(Goa), Ministry of Agriculture, Govt. of India, New Delhi.

Member, Editorial Board, Indian Journal of Marine Sciences, published by PID, CSIR, New Delhi.

Adviser, Marine Ecology Progress Series, published by International Research, Federal Republic of Germany.

Member, Board of Studies, Department of Life Sciences, Andhra University, Waltair.

Member, Working Group on Western Ghats Eco-Development Research Programme, Department of Environment, Government of India, New Delhi.

Member, Working Group on Department of Ocean Development Plan, Govt. of India.

Shri H.N. Siddiquie was

Awarded **Padma Shri** by the President of India on Republic Day 1983 for his scientific contributions in Marine Geology particularly in the field of offshore mineral exploration and surveys of sub-marine pipeline routes.

Elected Fellow of the Indian National Science Academy.

Member of the Commission on Marine Geology of the International Union of Geological Science.

Member of the National Committee for the IUGS.

Member of the Earth Science Committees of the INSA.

Member of Advisory Committee CSIR for Earth Sciences for Sir Shanti Swarup Bhatnagar Prize.

Member of the Working Group on Marine Electromagnetism of the Indian Institute of Geomagnetism.

Continued to serve as a Member of the Committee in the Panel of Physico-Chemical and Earth Sciences of Bureau of Promotion of Urdu, Ministry of Education, New Delhi.

Dr. J.S. Sastry served as

Member, Working Group on Indian Ocean Panel of CCCO of IOC/UNESCO.

Member, Working Group on 'Indo-US Workshop on Air-Sea Interaction.

Dr. B.N. Desai served as

Member, ICAR Committee on Fishery Resoruces Group.

Member, DST Committee on Ganga Alluvial Projects.

Member of the Committee of Department of Agriculture on Evaluation of Exploratory Fisheries.

Member of the Board of Studies, Central Institute of Fisheries Education, (I.C.A.R) Bombay.

Member, Advisory Group-Gujarat Water Pollution Prevention Board.

Dr. R. Sen Gupta served as

Member of the Committee, Govt. of Goa, Daman & Diu, for Protection of Beaches from Pollution.

Member of the Expert Group on Environmental Problems for the Proposed Oil Refinery at Managalore of Hindustan Petroleum Corporation Ltd.

Dr. M. Krishnan Kutty served as

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

Dr. M.G.A.P. Setty

Served as a Member of Working Group on Non-Ferrous Metals, Sub-group IV-Exploration, Department of Mines, Ministry of Mines & Steel, New Delhi.

Recognised as Guide/Examiner for Ph.D. in Marine Geology, Bombay and Andhra Universities, respectively.

Dr. A.H. Parulekar served as

UGC Visiting Professor in Aquatic Biology at Shivaji University, Kholapur.

Organising Secretary, 53rd Annual Session of the National Academy of Sciences of India.

Chief Co-ordinator, 3rd Indian Expedition to Antarctica (1983-84).

Member, Consultative Group, Exploratory Fisheries Project, Govt. of India.

Expert Member (Biological Resources), Committee on Gangetic, Dept. of Science and Technology, Govt. of India.

Member, Board of Examiners, Marine Biology & Fisheries, Karnataka University, Dharwar.

Dr. E. Desa served as

Member, the Joint IOC / WMO Working Committee for IGOSS in the Sub-group of Experts on Operations and Technical Applications.

Member, Department of Electronics, NRC Working Group and Underwater Electronic Systems.

Member, Project Review and Steering Group for an Electronic Commission funded project on 'Echosounders' and 'Electromagnetic Speed Log'.

Member, Technical Advisory Council, Economic Development Corporation of Goa, Daman & Diu.

Shri S.P. Anand served as

Member, Solar Energy Society of India.

Member, Solar Thermal Energy Group, CSIR, New Delhi.

Dr. R.V. Unnithan

Continued as Senate Member, University of Cochin.

Shri P.S.N. Murty served as

Member, Special Committee for the School of Environmental Sciences, Jawaharlal Nehru University, New Delhi.

Shri L.V. Gangadhara Rao served as

Member of the ISI Hydrometer Sub-Committee COS 33.3.

Member, Peer Group VI (Marine Resources, Oceanography and Coastal Engineering) of Standing Working Group on National Natural Resources Management System.

Member, IODE/IOC Task Team on Ocean Data Management for Climatic Studies.

Member of IOEE/IOC Task Team on Measured Wave Data Management.

Member of Indian Meteorological Society.

Shri R.M.S. Bhargava served as

Indian National Co-ordinator for the International Oceanographic Data Exchange (IODE) of IOC/Unesco.

Member, Group of Experts on Format Development of the Working Committee on International Oceanographic Data Exchange of IOC / Unesco.

Member, Task Team on Marine Biological Data of IODE of IOC/Unesco.

Member, Task Team on Development of IODE Data Centre Services of IOC/Unesco.

Dr. A.G. Untawale served as

Member, Wildlife Advisory Board, Govt. of Goa, Daman & Diu.

Hon-Secretary, World Wildlife Fund, India, Goa Branch.

Member, Estuarine Development Committee, Govt. of Goa, Daman & Diu.

Member, Executive Committee, Seaweed Research & Utilization Association of India.

Organising Secretary, All India Symposium on'Marine Plants'.

Shri U.K. Gopalan served as

Member, Executive Committee, Marine Biological Association of India.

Member, Society of Fisheries Technologists, India.

Member, Kerala Natural History Society.

Member, Southern Regional Committee, WWF, India.

Convenor, Cochin Science Association.

Member, Executive Committee, Agn-Horticultural Society, India.

Dr. D. Chandramohan served as

Expert Member, Board of Studies in Life-Science, Rani Durgavati Vishwavidyalaya, University of Jabalpur, Jabalpur.

Expert Member, Doctoral Cormnittee on Marine Sciences, University of Cochin, Cochin.

Shri G. Narayana Swamy served as

Member of the Executive Council of Society for Offshore Engineering and Underwater Technology of India, Bombay and- Editor of its Bulletin.

Shri B.M. Panikkar served as

Member, American Fisheries Society.

Member, Marine Biological Association of India.

Dr. A. Rajendran served as

Member, Board of Examiners in Chemical Oceanography, Andhra University, Waltair.

Dr. Rajiv Nigam was

Elected as Fellow of Paleontological Society of India, Lucknow.

The following were awarded the degree of Ph.D.

Shri P.K. Varshney - for his thesis, entitled "Effect of pollution on biological productivity of Bombay waters" by the University of Bombay under the guidance of Dr. S.Z. Qasim.

Shri Victor Rajamanickam - for his thesis, entitled, "Ilmenite placers off Northern Konkan Maharashtra" by the Indian School of Mines (ISM) Dhanbad, under the guidance of Dr. O.P. Verma of ISM and Shri H.N. Siddiquie.

Shri K.V.L.N.S. Sarma - for his thesis, entitled, "Physical and Elastic properties of ophiolitic rocks from Indus suture zone (Dras-Sanko-Kargil) of Kashmir Himalaya" by Andhra University.

Miss Francisca P. De Souza - for her thesis, entitled, "Chemistry of halogen compounds other than chlorine in some marine and estuarine regions" by University of Bombay, under the guidance of Dr. V.N. Kamat Dalal.

Shri Rajiv Nigam - for his thesis, entitled, "A study of the Recent foraminifera from beaches of Western India" by Aligarh Muslim University, under the guidance of Dr. S.N. Bhalla.

11

Deputations

Dr. V.V.R. Varadachari was deputed to

West Germany, to attend the ceremony of handing over of **Sagar Kanya,** on 25 March, 1983, and to lead the first trial cruise of **Sagar Kanya.**

France, to attend a meeting of Experts held from 25 to 30 July, 1983, at Unesco, Paris, for preparation of a project proposal for Inter-governmental Oceanographic Commission (IOC), for detailed studies and observational programme on 'Tides and Storm Surges in the Bay of Bengal'.

United Kingdom, to attend the Vth Session of the Joint SCOR/IOC 'Committee on Climatic Changes and the Ocean' held at Abingdon (U.K.), from 5 to 9 December, 1983.

Shri H.N. Siddiquie was deputed to

Denmark, from 1-7 January, 1983 to discuss and finalise the scientific equipment to be installed in the Fisheries Oceanographic Research Vessel.

Bangkok, from 11-17 January, 1983 to attend a meeting at the ESCAP Secretariat, regarding the mechanism for Cooperation in the Field of Offshore Exploration and Prospecting for Mineral Resources.

Sri Lanka, from 18-21 February, 1983 to attend the Indo-Sri Lanka Conference on Marine Resources, Science and Technology.

Seychelles, from 24-28 July 1983 as a member of the Govt. of India delegation to Seychelles, for setting up a Collabarative Programme in Marine Resources Survey.

Egypt, from 3-7 September, 1983 to attend and to present paper at the Mabahiss/John Murray International Symposium on "Marine Sciences of the North-West Indian Ocean and Adjacent Waters".

Dr. J.S. Sastry was deputed to Paris, to attend the meeting of Working Group of the Indian Ocean Panel of Committee on Climatic Changes and the Ocean (CCCO) from 20-23 March, 1983.

Dr. R. Sen Gupta was deputed to Sri Lanka, to attend the India-Sri Lanka Conference on 'Marine Resources, Science and Technology' held from 18-21 February, 1983.

Paris, to attend the fourth meeting of the Programme Group for the Southern Oceans, as a member of the Indian delegation, from 6-13 March, 1983.

Honolulu, Hawaii to participate at the Expert Meeting of 'Mussel-Watch-II' on an invitation from United Nations Environment Programme, from 7-13 November 1983.

Dr. E. Desa was deputed to Denmark, from Jan. 1-7 as a member of Government of India delegation to discuss and finalise the scientific equipment to be installed in the Fisheries Oceanographic Research vessel.

Seychelles from 24-28 July as a member of Government of India delegation for setting up a collaborative programme in Marine Resources Survey.

Shri R.M.S. Bhargava was deputed to United Kingdom, to attend the second session of the Group of Experts on Format Development of IODE/IOC for the Exchange of Oceanographic Data, from 7-16 June, 1983.

Dr. D. Panakala Rao was deputed to West Germany on 29 January for coordinating the work of ORV **Sagar Kanya** and to participate in the subsequent cruises.

Dr. A.G. Untawale was deputed to Dacca, Bangladesh to participate in ESCAP /SACEP Conference from 21-25 August, 1983. He presented a country report on 'Mangroves, Corals and Islands'.

Dr (Mrs) Usha Goswami was deputed to University of Houston, Texas and other laboratories in USA for a study tour, from 30 March -28 June, 1983.

Shri A.D. Gouveia was deputed to the Federal Republic of Germany for a period of 18 months under DAAD programme, from June 1983.

Shri G. Ranade and B. Umamaheswara Rao were deputed to USA, for training in operations, servicing and maintenance of Acoustics Navigational System at SATNAV from 10-24 July, 1983.

Shri Sridhar Iyer and B. Sudhakar Rao were deputed to France, for training in the operations, servicing and maintenance of the Electron Probe Micro Analyser at M/s CAMECA, Paris, from 1 October-2 December, 1983.

Shri B. Nagendra Nath, R. Mukhopadhyay, Ashis Gosh and V.N. Kodagali were deputed to participate in the ORV **Sonne** cruise from Singapore to Mauritius, from 2 October-11 November 1983.

Mrs. Sayeeda M. Wafar was deputed to Penang, Malaysia for a special training on 'Productivity, food webs and nutrient cycling in mangrove' organised by UNESCO/UNDP at the University, Sains, Pennang, from 18 September to 3 October, 1983. She also participated in the workshop on "Productivity of mangrove ecosystem: Management implications" from 4-6 October, 1983.

Shri T.G. Jagtap was deputed to Thailand, for a special training on Remote Sensing applications for mangrove research organised by UNDP held at the Thailand Remote Sensing Centre, Thailand, from 28 November-16 December, 1983.

Shri Sanjeev Afzulpurkar and R.A.A. Luis were deputed to USA and Preussag, West Germany for training in underwater camera system, from 10-12 January, 1983.

12
Meetings, Exhibitions, Seminars, Symposia and Special Lectures

A review paper on 'Summer cooling of the Arabian Sea' contributed by Dr. 3.S. Sastry and Shri V. Ramesh Babu was presented at the symposium on Climate Dynamics and Long Range Prediction held at Physical Research Laboratory, Ahmedabad from 22-25 Feb. 1983.

A paper on 'Mapping of oil pollution in the Northern India Ocean' contributed by Dr. R. Sen Gupta and Shri S.P. Fondekar was presented at the International Seminar on Environmental Maps and Atlases held at Calcutta, from 1-3 December, 1983.

Dr. B.U. Nayak attended the 70th session of the Indian Science Congress at Tirupati from 3-8 January, 1983 and presented a paper on 'Ocean engineering research and development in India-an appraisal'.

Dr. E. Desa, Shri M.R. Nayak, Shri R.G. Prabhu Desai, Dr. E.S. Desa, Shri A. Joseph and Mrs. V.B. Peshwe attended the symposium on 'Microprocessor Based Systems held at Central Electronics and Engineering Research Institute Pilani, from 5-6 May, 1983 and the following papers were presented:

'Microprocessor based systems' contributed by Dr. E. Desa, S/Shri M.R. Nayak, R.G. Prabhu Desai, Dr. E.S. Dssa, Shri A. Joseph and Mrs. V.B. Peshwe.

'Microprocessor system design aspects for oceanographic instruments' contributed by Dr. E. Desa, S/Shri M.R. Nayak and R.G. Prabhu Desai.

'Microprocessor based tidal data logger' contributed by Shri A. Joseph and Dr. E. Desa.

'An electronic bathythermograph' contributed by Mrs. V.B. Peshwe and E. Desa.

A paper on 'Marine Instrumentation in India and its possible relevance to Sri Lanka' contributed by Drs. E. Desa, & E.S. Desa, Shri R.G. Prabhu Desai and Mrs. V.B. Peshwe was presented at Sri Lanka.

Dr. T.C.S. Rao presented a paper on 'Marine magnetic surveys in offshore exploration-A case study' at the seminar organised by the Association of Exploration Geophysicists at I.I.T., Bombay during December, 1983.

A paper on 'Climate of North Indian Ocean and associated productivity' contributed by Shri C.K. Gopinathan and Dr. J.S. Sastry was presented at the International Conference on Biometeorology, held at New Delhi during 26-30 Dec. 1983.

Shri S.P. Anand presented a paper on

'Role of lamp balck in the free form for improving efficiency of solar stills' at the National Solar Energy Convention held at Vadodara from 16-18 December, 1983.

'Design and economical aspects of a solar dryer-cum-cooker useful for farmers, fisherman and factory workers' at the National Workshop-cum-Exhibition on Solar Cooker held at New Delhi, during March, 1983.

A paper on 'Development and ecodisaster-a lesson from Cochin backwater-system' contributed by K.P. Balakrishnan and C.B. Lalithambika Devi was presented at the International Symposium on Integration of Ecological Aspects of Coastal Engineering Projects, held at Rotterdam, June 6-10, 1983.

A paper on 'Numerical simulation of depth dependent wind driven circulation in Bay of Bengal' contributed by Drs. N. Bahulayan and V.V.R. Varadachari was presented at the 70th session of Indian Science Congress, held at Tirupathi during 3-8 Jan. 1983.

Dr. N. Bahulayan presented a paper on 'On certain aspects of numerical modelling of oceanic processes' at the Symposium on 'Mathematical Aspects of Ocean Studies' held at Jadavpur University, Calcutta during June, 1983.

Dr. Satish R. Shetye presented the following papers on

-'Note on the seasonal variability of the temperature field of the South-west coast of India' at the National Symposium on Climate Dynamics and Long Range Forecasting, held at Ahmedabad during 22-26th February, 1983.

-'Oceanic surface mixed layer' at the IISc-ISRO workshop on Satellite Meteorology and one day Symposium on Sea Surface Temperature held at Bangalore during 4-9 July, 1983.

Shri B.S. Ingole attended and presented the following 3 papers at the National Symposium on Shrimp Seed Production and Hatchery Management, organised by MPEDA & ICAR, at Cochin during January, 1983.

-Studies on mass culture of euryhaline harpacticoid copepod **Amphiascoides subdebilia (**Willey 1935)'

-Further observations on artificial mass culture of a species of macro-stomid turbellanan, **Macrostomum orthrostylum** (M.Braun 1885) under varying salinities and feed conditions'.

-Continued observations on reprodutive behaviour of macrostomid turbel-larian, **Macrostomum orthrostylum** (M. Braun 1885) correlated to fecundity and different feeding conditions'.

Dr. R. Sen Gupta attended the 70th session of Indian Science Congress Association at Tirupati and gave a lecture on 'Health of the/Indian Ocean and the First Indian Expedition to Antarctica', during 3-8 Jan., 1983.

Dr. B.U. Nayak attended the

-Engineering Science Seminar organised by DST at Baroda from 18-20 February, 1983.

-12th Congress of the World Energy Conference, held at New Delhi from 18-23 Septemeber, 1983.

Dr. B.U. Nayak, Dr. P.S. Renukaradhya, Shri S. Mandal and Shri R. Sabapathy attended 'Second Indian Conference on Ocean Engineering' held at CWPRS, Poona from December 14-16, 1983.

Dr. A.G. Untawale participated in the symposium on Goan Environment held at Panaji, sponsored by Government of Goa, on 29th Sept., 1983.

Dr. P.S. Renukaradhya attended

-A conference on Application of Remote Sensing to Natural Resources, Environment, Land Use and Problems, Relating to Training and Education, at IIT, Bombay from 3-4 March, 1983.

-A workshop on 'Utilisation and Regulation of Waves' at IIT, Madras from 14-17 March, 1983.

Shri P.Chandramohan attended a seminar on 'Beach Processes and Data Analysis' at CWPRS, Poona from 28-29 January, 1983.

Dr. R. Sen Gupta and Shri S.W.A. Naqvi contributed a lecture note on 'Chemical Oceanography of the Indian Ocean-north of the equator' at the Mabahiss/John Murray Alexandria, (Egypt) International Symposium on 'Marine Sciences of the North West Indian Ocean and Adjacent waters' held from 3-7 September, 1983.

Dr. A.H. Parulekar, as an invited speaker, presented a paper on 'Biological investigations in Antarctic ecosystem' at the 49th Annual Session of the Indian Academy of Sciences (Bangalore) held at National Chemical Laboratory, Pune from 7-9 Nov., 1983.

Dr. A.G. Untawale

-delivered a lecture on 'Elements and review of research in Botany' at the Centre of Post-graduate Research & Instructions, Panjim-Goa.

-delivered a lecture on Seaweeds at St. Xavier College, Mapusa, during January, 1983.

Shri U.K. Gopalan delivered lectures on

-Law and Conservation of Estuaries', at the University of Cochin.

-On 'Aquarium keeping' at the Dept. of Industrial Fisheries, University of Cochin, Ernakulam.

Dr. D. Chandramohan delivered a series of lectures on 'Marine Microbiology' to M.Sc. (Marine Biology) students at Marine Biology Centre of Karnataka University, Karwar.

Shri J.S. Sarupria delivered lectures on 'Management planning for computer feasibility study and selection' at the seminar on Role of Computer for commercial Banks on September 28, 1983 and on 'Recent development in software' at the seminar on "Computer Assisted Financial Management on November 17, 1983. Both the seminars held at Goa were organised by the Management Development Institute of New Delhi.

Dr. Rajiv Nigam delivered a lecture on Role of microfossils in oceanographic studies with special reference to foraminifera' at the Geology Department of D.S. College, Aligarh (Agra University) on 24th March, 1983.

Dr. R. Sen Gupta

-attended the meeting of National Committee for Environmental Planning on behalf of the Director, NIO at Dept. of Environment, New Delhi on 10th February, 1983.

-attended the meeting of the Working Group of Bengal Fan, at Dept. of Science & Technology, New Delhi, on 11 February, 1983.

-attended the meeting of the Working Group of Govt. of India for UNESCO programme at Dept. of Ocean Development, New Delhi on 18th July, 1983.

Dr. B.U. Nayak attended

-the 10th meeting of the Beach Erosion Board at Visakhapatnam from 14-16 February, 1983.

-meeting of 8th Sub-Committee on Coastal Erosion held in the Chambers of Chief Engineer, M.I. Bangalore, on June 30, 1983.

-Coordination Council meeting held *at* Delhi on July 27, 1983.

Dr. M.G.A.P. Setty, Shri M.V.S. Gupta, Dr. Rajiv Nigam and Shri S.M. Birajdar were deputed to attend the International Seminar and a short course on Recent Advances in Quantitative Stratigraphic Correlation at the IIT, Kharagpur from 12 to 17 December, 1983.

Shri V.S. Rama Raju participated in the Panel Discussions held at the Centre of Earth Sciences Studies, Trivandrum, from *2-4* March, 1983.

Shri G.C. Bhattacharya attended the XIIth meeting of the Koyna Tremor Committe at Bhatsa Dam Site on 5.9.1983.

Shri S.G. Dalal and Shri S.R. Bhat represented NIO at the exhibition on Science for Productivity organised by Science Forum in Parliament House to depict achievements of CSIR, held at the Parliament House Annexe, New Delhi from 23 February to l March, 1983.

Shri S.R. Bhat represented NIO at the special exhibition on Man and the Oceans - Resources and Their Development, organised during the 70th Session of the Indian Science Congress Association, at Tirupati from 3-8 January, 1983.

Dr. (Miss) P.A. Lokabharathi participated in the Genetic Manipulation Course conducted by the Institute of Microbial Technology and Indian Institute of Chemical Biology, at Calcutta in collaboration with the Biotechnology Centre, University of Guilford, U.K. from 20 Nov. to 10 Dec. 1983.

Shri R.G. Prabhu Desai attended a 2 day course on Parallel Processing, organised by IETE, held at Hyderabad in September, 1983.

Shri S.P. Fondekar participated in the training programme on Oil Spill Control Equipment organised by Coast Guard Organisation at Bombay from 28 Nov. - 3 Dec, 1983.

S/Shri R. Mukhopadhyay, S. Sekar and A.V. Mudholkar were deputed to attend the Common Wealth Training Workshop on Coastal, Estuarine and Offshore Resource Exploration at the IIT, Madras from 12th June to 23rd June, 1983.

Mrs. S.H. Oka attended the fifth orientation course on Geoscience Information and Documentation, conducted by Geological Survey of India, at Calcutta from 3-31 January, 1983.

53rd Annual Session of the National Academy of Sciences (NAS)

NIO hosted the 53rd Annual Session of the National Academy of Sciences, India, from 27 to 29 October, 1983. The session was inaugurated by Shri K.T. Satarawala, Lt. Governor of Goa, Daman and Diu and was addressed by the President of the NAS, Dr. S.Z. Qasim, Secretary, Department of Ocean Development (DOD). Initially, Dr. V.V.R. Varadachari, Director, NIO, welcomed the guests and Prof. H.C. Khare, General Secretary of the Academy presented the Annual Report.

Dr. V.V.R. Varadachari, Director NIO, welcoming the delegates of National Academy of Sciences.

Shri K.T. Satarawala, Lt. Governor of Goa, Daman & Diu delivering the inaugural address. Seated on dias are (from left) Prof. H.C. Khare, Dr. V.V.R. Varadachari, Dr. S.Z. Qasim and Dr. T.N. Khoshoo.

Focal theme of discussion in the physical science session was 'Energy crisis and non-conventional energy resources'. Dr. Raja Ramanna, Chairman of Atomic Energy Commission, who presided over this session indicated that the solution to the energy crises lies only in the fast breeding nuclear reactions.

In the biological session, interest was mainly concentrated on the new methods of plant protection such as hormonal control of insects and environmental protection.

A seminar on Oceans and Climate was also organised as a part of the NAS session on 28-29 October. The seminar recommended

1. The formation of a national committee for oceanic and atmospheric research;
2. to lay more emphasis on oceanographic and low level atmospheric studies;
3. the creation of infrastructure facilities at NIO for remote sensing studies and
4. to have NIO as repository for oceanographic and marine meteorological data.

Following papers contributed by the staff of NIO were presented;

1. Variability of temperature structure of the eastern Arabian Sea along 13-15°N Lat. belt in relation to southwest monsoon - L.V. Gangadhara Rao and Y.K. Somayajulu.
2. Water masses and circulation in the east central Arabian Sea during monsoon season - V. Ramesh Babu, 3.S. Sastry, V.V. Gopalkrishna and D.V. Rama Raju.
3. On the behaviour of the monthly mean surface currents in the coastal region of the North Indian Ocean - Satish R. Shetye and S.C. Shenoi.
4. Some physical oceanographic features of North Western Indian Ocean during Summer Monsoon of 1983 - M.S.S. Sarma, P.V. Sathe and L.V. Gangadhara Rao.
5. Acoustic Tomography - A new observational system for ocean measurements - Y.K. Somayajulu, S. Prasanna Kumar, T.V. Ramana Murty and 3.S. Sastry.
6. Wave climate over the North Indian Ocean - P. Vethamony and J.S. Sastry.
7. Wind and wave conditions over the north-western Indian Ocean during summer monsoon of 1983: Preliminary view - M.R. Ramesh Kumar, M.J. Varkey, R. Nagarajan and L.V.G. Rao.
8. 'Estimation of sea surface height from Bhaskara-II SAMIR data' -M. Venkateswara Rao, N.K. Viswambaran and L. V. Gangadhara Rao.

Symposium **on Marine Plants**

An all India symposium on 'Marine Plants - their biology, chemistry and utilisation' was held at the Institute from 30th October to 1st November, 1983. During this symposium sponsored by CSlR (NIO, Goa) and CSMCRI (Bhavanagar), Department of Science and Technology (DST), New Delhi, Department of Ocean Development (DOD), New Delhi, Department of Environment (DOE), New Delhi, National Science Academy (NAS), and the University Grants Commission (UGC). Several recommendations emerged and some of the important ones are: conservation and proper utilisation of mangrove ecosystems, detailed study of Indian seagrasses and declaration of certain coastal areas as biological preserves.

Following papers contributed by the staff of NIO were presented:

1. 'A new record of the occurrence of the red alga **Bangia fuscopurpurea** from the Malwan coast, Maharashtra' - A.G. Untawale.
2. Observations on the foliage production in some mangrove species of Goa' - Sayeeda Wafar.
3. 'Littoral flora of Andaman Islands' - T.G. Jagtap.
4. 'Major metabolites from **Porphyra vietanamensis** Tan. et Ho and **Monostroma** sp. Thuret' - T.G. Jagtap.

Workshop-cum-seminar on Sagar Kanya

The West German built and recently acquired research vessel of the Department of Ocean Development (DOD), Government of India, **Sagar Kanya,** arrived at Mormugao on 27th June, 1983. On its arrival, one day seminar was organised in the Institute and was inaugurated by Dr. S.Z. Qasim, Secretary, Department of Ocean Development, Government of India, New Delhi. Both Indian and German Scientists who participated in the maiden voyage of **Sagar Kanya** from Germany to India, presented, preliminary findings of this cruise. On board facilities and capabilities of the research vessel were also highlighted.

NIO's participation in Indian Expeditions to Antarctica

The second Indian Expedition organised by the Department of Ocean Development (DOD), Government of India, to Antarctica, returned on 28 March, 1983. The team headed by Shri V.K. Raina, of Geological Survey of India (GSI) spent about 60 days on the Antarctic continent. From NIO, Shri S.G.P. Matondkar was the only scientist to participate in this 2nd expedition. He participated in first expedition and is also the member of third expedition which left Goa in December 1983.

The other four scientists from NIO who are participating in the IIIrd expedition are Dr.(Miss) Aditi Pant, S/Shri M.R. Nayak, M. Manoharan and S.W.A. Naqvi. Mr. S.G.P. Matondkar would be wintering at Antarctica for conducting experiments over 12 months.

13

Publications

(a) Scientific Papers

Abidi, S.A.H., B.N. Desai and Jiyalal Ram. Studies on the hydrography and plankton studies off Akarpati near Navapur, West Coast of India during February-March. **Mahasagar - Bull.natn. Inst. Oceanogr.,** 16 91-94.

Achuthankutty, C.T. and S.R. Sreekumaran Nair. Larval migration and growth of marine prawns in the estuarine habitat **Mahasagar - Bull. natn. Inst. Oceanogr.,** 16 : 243-250.

Anil, A.C. and A.B. Wagh. Observations on the behaviour of timber in Zuari estuary of Goa. **3. Indian Acad. Wood Sci.**, 13 : 7 5-83.

Ansari, Z.A. and B.S. Ingole. Meiofauna of some sandy beaches of Andaman Islands. **Indian J. mar. Sci.,** 12 : 245-246.

Bhosle, N.B., C.V.G. Reddy and C. D'Silva. Lipid content in surface waters of Arabian Sea. **Indian J. mar. Sci.**, 12 : 242.

Bhosle, N.B. and A. Row. Effect of dispersants on the growth of indigenous bacterial population and biodegradation of crude oil. **Indian j. mar. Sci.,** 12 : 194-196.

Chandra, A., R.K. Saxena and M.G. Anantha P. Setty. Palynological investigations of the sediment cores from the Arabian Sea : 1. Fungal spores. **Bio Vigyan,** Poona, 15 : 92-109.

Chatterji, A., B.S. Ingole and A.H. Parulekar. Seawater circulating system in an aquaculture laboratory. **Mahasagar - Bull. natn. Inst. Oceanogr-** 16 : 81-86.

Cronan, D.S., P.S.N. Murty, Ch. M. Rao, A.L. Paropkari, R.S. Topgi, M.V.S. Guptha and N. Cooley. Geochemistry of sediment cores of the western equatorial Indian Ocean **Mahasagar - Bull. natn. Inst. Oceanogr.,** 16:9-30.

Desa, E., M.R. Nayak, R.G. Prabhu Desai and A.P. Selvam. The Antarctic Winter as recorded at **Dakshin Gangotri. Scientific Report of the First Indian Expedition to Antarctica** (Technical Publication No. 1), Department of Ocean Development, New Delhi, p. 30-40.

Desa, E., A.P. Selvam, R.G. Prabhu Desai and S. Tengali. An automatic weather station. **Scientific Report of the First Indian Expedition to Antarctica** (Technical Publication No. 1), Department of Ocean Development, New-Delhi, p. 18-29.

Desai, B.N., S.N. Gajbhiye, M. Jiyalal Ram and V.R. Nair. Comparative account on zooplankton in polluted and unpolluted estuaries of Gujarat. **Mahasagar - Bull. natn. Inst. Oceanogr.,** 16 : 281-291.

De Souza, Francisca P. and R. Sen Gupta. On fluoride, bromide and iodide in the southwestern Indian Ocean sector of the Southern Ocean. **Scientific**

Report of the First Indian Expedition to Antarctica (Technical Publication No. 1), Department of Ocean Development, New Delhi, p. 78-86.

De Souza, S.N. Studies on the behaviour of nutrients in Mandovi estuary during premonsoon. **Estuarine Coastal Shelf Science,** 16: 299-308.

Devassy, V.P., P.M.A. Bhattathiri and K. Radhakrishna. Primary production in the Bay of Bengal during August 1977. **Mahasagar - Bull. natn. Inst. Oceanogr.,** 16: 443-447

Dileep Kumar, M. Ionic potential as a controller of sea water composition. **Indian J. mar. Sci.,** 12: 233-235.

Dileep Kumar, M. The significance of oxygen as oxides and hydroxides in controlling the abundance and residence times of elements in sea water. **Mar. Chem.,** 14: 121-131.

D'Silva, C. and A. Rajendran. Vitamin B_{12} concentration in Mandovi and Zuari estuaries. **Mahasagar-Bull. natn. Inst. Oceanogr.,** 16: 153-159.

Gajbhiye, S.N., Vijayalakshmi Nair, L. Krishnakumari and B.N. Desai. Effect of the tide on the variability of zooplanktori in the nearshore waters of Thal, Maharashtra. **Indian J. mar. Sci.**, 12:166-173.

Goes, J.I. Adenosine triphosphate, chlorophyll **a** and particulate oxidisable carbon in some marine diatoms. **IndianJ. mar. Sci.**, 12:45-47.

Goes, J. I. and V.P. Devassy. Phytoplankton organisms collected during the First Indian Antarctica Expedition. **Scientific Report of the First Indian Expedition to Antarctica** (Technical Publication No. 1), Department of Ocean Development, New Delhi, p. 198-201.

Gopalan, U.K. Need for specific legal provision for the protection of estuaries. **Proc. Natl. Seminar on Environment,** Dept. of Law, Univ. of Cochin, paper 30, 1-4.

Gopinathan, C.K. and J.S. Sastry. Thermal energy conversion coupling solar pond and sea. **Proceedings of the Second Indian Conference on Ocean Engineering,** Pune, 14-16, December, II: 1226-1239.

Goswami, S.C. Production and zoolplankton community structure in the lagoon and surrounding sea at Kavaratti Atoll (Lakshadweep). **Indian J. mar. Sci.,** 12:31-35.

Goswami, S.C. Zooplankton incidence in a abnormally high sea surface temperature in the Eastern Arabian Sea. **Indian J. mar. Sci.,** 12:118-119.

Goswami, S.C. Coexistence and succession of copepod species in the Mandovi and Zuari estuaries, Goa. **Mahasagar-Bull. natn. Inst. Oceanogr.,** 16: 251-258.

Goswami, S.C. Swarms of ***Creseis acicula*** Rang (Pteropoda)in the coastal waters of Goa. **Mahasagar-Bull. natn. Inst. Oceanogr.,** 16:459-462.

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OBITUARY

It is with deep sorrow that we record the sad demise of our colleague Shri C.V.G. Reddy, Scientist and Head of the Chemical Oceanography Division of the Institute on 10th October, 1983.

S.hri Reddy, born on 29-11-1930 joined CSIR in 1963 during the International Indian Ocean Expedition (UOE) and later the NIO in 1966. Prior to this he had also served in the Central Marine Fisheries Research Institute (CMFRI) at Mandapam.

Shri Reddy nurtured the Chemical Oceanography Division during the past 10 years and he was deeply associated with the identification of vital organic chemicals mainly of pharmaceutical importance from various marine organisms.

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