

NATIONAL INSTITUTE OF OCEANOGRAPHY



ANNUAL REPORT

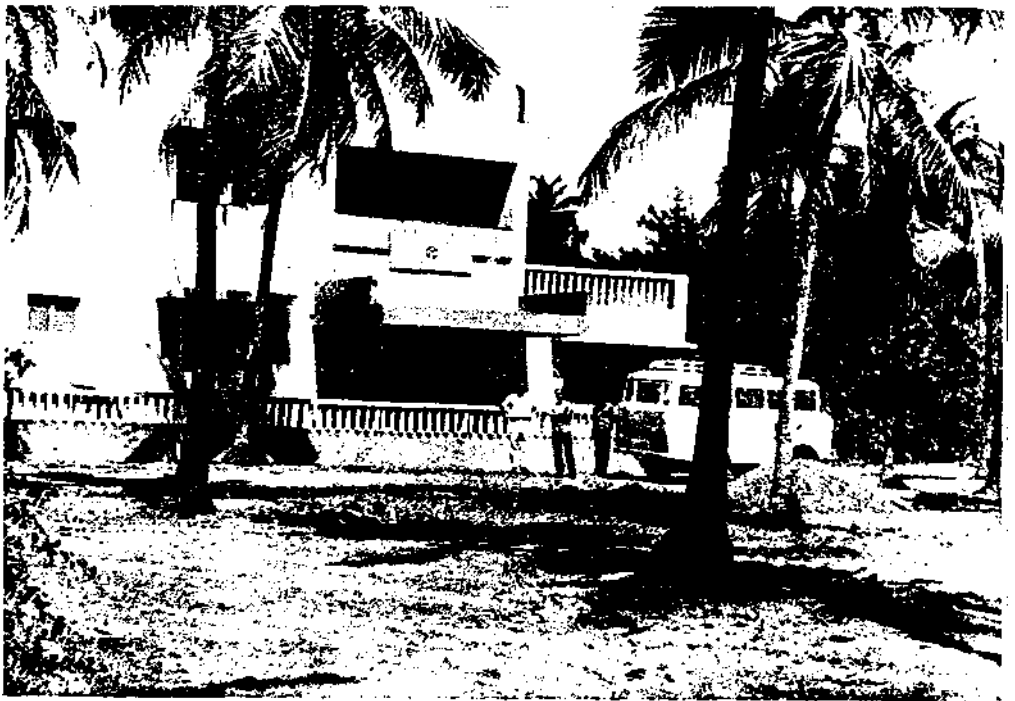
1967-68



NATIONAL INSTITUTE OF OCEANOGRAPHY

(Council of Scientific & Industrial Research)

NEW DELHI



View of the building housing the Field Unit of the National Institute of Oceanography
Miramar, Panaji, Goa.

INTRODUCTION

The Annual Report of the National Institute of Oceanography for the year 1967-68 is the third in the series and gives an account of the progress in the scientific programmes of the Institute carried out in its various divisions and units.

The Planning and Data Division of the Institute at New Delhi which is in the process of being organized as the Indian National Oceanographic Data Centre continues to receive oceanographic data relating to the Indian Ocean from different sources. In addition to receiving, classifying and storing the data, the Division has taken up processing of the data in respect of a few parameters like oxygen and phosphate for the whole of the Indian Ocean. Pooling and analysis of these data in one-degree squares have been taken up as a first step.

At the Indian Ocean Biological Centre, Ernakulam, the preliminary sorting of the international collection of zooplankton is nearing completion. The preparation of plankton atlases based on the preliminary analysis has made good progress. The first fascicle of the General Properties Atlas—Biomass distribution—has been released during the year. The second one is expected to be released shortly. Research programmes and specialized studies on the sorted groups have been planned and the sorted consignments are being loaned to specialists both in India and abroad.

The Biological Oceanography Division, Ernakulam has shown considerable progress in studies relating to Productivity and Ecology of the backwaters and the shore areas around Cochin. Scientific papers pertaining to these studies have started appearing. Studies have also been taken up on the ecological conditions of Sandy beaches of Cochin, the bottom faunal distribution and theoretical yield computation of certain types of fishes.

Coastal and nearshore oceanographic studies carried out at the Physical Oceanography Division, Ernakulam have led to an understanding of the main physical factors responsible for the various types of shore processes along the Kerala Coast. Further investigations are in progress to gain a clearer picture on the role of these various factors and to attempt their measurement in more precise terms. The report from this division also gives some of the results of the geochemical and sedimentological studies carried out on the continental shelf sediments collected during the International Indian Ocean Expedition.

Studies on the foraminifera in the bottom sediments collected from the Gulfs of Cambay and Kutch during the cruises of I.N. Survey ship DARSHAK are in progress in the Bombay and Goa Units of the Institute.

Land for the permanent Headquarters of the Institute at Goa has been acquired and plans for buildings are in progress.

N.K. Panikkar
Director

2. NATIONAL INSTITUTE OF OCEANOGRAPHY, ITS DIVISIONS & UNITS

The National Institute of Oceanography comprises of four full divisions and two field units. These are given below:

<i>Divisions/Units</i>	<i>Telephone Number</i>	<i>Telegraphic address</i>
1. Planning & Data Division, (Indian National Oceanographic Data Centre) B-7, Hauz Khas, New Delhi-16.	73353	Oceanology New Delhi
2. (a) Indian Ocean Biological Centre Ravipuram Sannidhi Road, Ernakulam-6.	3384	Oceanology Ernakulam.
(b) Indian Ocean Biological Centre University Oceanographic Laboratory Foreshore Road, Ernakulam-6 (Kerala)	3306	-do-
3. Physical Oceanography Division, Karikkamuri Road, Ernakulam.	3538	Geophysics Ernakulam
4. Biological Oceanography Division, Karikkamuri Cross Road, Ernakulam-I.	814	-do-
5. Bombay Unit of National Institute of Oceanography, Hornbill House, Bombay-1 BR.	257277	Hornbill Bombay
6. Goa Unit of National Institute of Oceanography Lalit Niwas, Miramar, Panaji.	2923	Oceanology Panaji

2.1 PLANNING & DATA DIVISION (Indian National Oceanographic Data Centre, New Delhi)

During the year under report the Indian National Oceanographic Data Centre continued to receive Physical and Chemical Oceanographic Data from the IIOE Cruises of

some of the Indian and foreign ships. These data were received on request from the World Data Centres A & B. In addition, the Centre has also received data from Australia, collected by the ships HMAS *Diamantina* and HMAS *Gascoyne* from the Pacific Ocean. These two ships worked both in the Indian Ocean and Pacific Ocean and hence the Oceanographic Station List and Data are inclusive of the Pacific and Indian Oceans.

Details of the data received are given below :—

<i>Country/ Ships</i>	<i>Cruise No.</i>	<i>Period</i>	<i>Track/Region</i>	<i>Stn. No.</i>	<i>Type of data</i>
1	2	3	4	5	6
INDIA					
<i>INS Kistna</i>	21	15/1/65 22/1/65	Vizag.- Vizag. (Bay of Bengal)	541-569	T,S,O ² , Sigma-t, S,T.
„	22	28/1/65 6/2/65	Vizag.-Cochin. (Bay of Bengal & Gulf of Mannar)	570-614	„
„	25	22/3/65 28/3/65	Bombay-Cochin, (Arabian Sea)	638-671	„
„	26	1/4/65 8/4/65	Cochin-Madras, (Gulf of Mannar & Bay of Bengal)	672-711	„
„	27	14/4/65 21/4/65	Madras-Calcutta. (Bay of Bengal)	712-729	„
„	28	29/4/65 5/5/65	Calcutta-Vizag. (Bay of Bengal)	730-764	„

AUSTRALIA

HMAS Diamantina

Dm1/59	16/7/59 19/11/59	Sydney-Fremantle. (Indian Ocean)	1-134	T,S, O ₂ , O ₂ % Sat. Sigma-t, PO ₄ -P, Primary Production, Pigments.
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Dm1/60	2/2/60 23/3/60	Fremantle- Fremantle. (Indian Ocean)	1-114	T, S, Sigma-t, O ₂ , O ₂ % sat., PO ₄ -P, Primary Production, pigments, Phyto- plankton.
Dm2/60	11/7/60 26/9/60	Fremantle- Djakarta-Fremantle. (Indian Ocean)	115-349	T,S, Sigma-t, O ₂ , O ₂ % sat. PO ₄ -P, Primary Production, pigments, phytoplankton, zooplankton.
Dm3/60	16/10/60 1/11/60	Fremantle-Cocos- Fremantle. (Indian Ocean)	350-441	T, S, Sigma-t, O ₂ , O ₂ % sat. PO ₄ -P, NO ₃ -N.
Dm1/61	14/2/61 10/3/61	Fremantle- Fremantle. (Indian Ocean)	1-48	T, S, Sigma-t, O ₂ , O ₂ % sat. PO ₄ -P, NO ₃ -N, Primary Production, Pigments, phytoplankton, zoo- plankton.
Dm2/61	1/5/61 12/6/61	Fremantle- Fremantle. (Indian Ocean)	49-140	T, S, Sigma-t, O ₂ , O ₂ % sat. PO ₄ -P NO ₃ -N, Primary Production, pig- ments, zooplankton, phytoplankton.
Dm3/62	24/9/62 6/10/62	Fremantle- Fremantle. (along 110°E meridian-Indian Ocean).	102-125	T, S, Sigma-t, O ₂ , NO ₃ -N, Primary Production, pigments zooplankton, phyto- plankton. micronekton.
Dm4/62	15/10/62 13/11/62	Fremantle- Singapore- Fremantle. (Indian Ocean)	126-161	T, S, Sigma-t, O ₂ , O ₂ % sat. PO ₄ -P, NO ₃ -N, Primary Production, pigments zooplankton, micro- nekton.
Dm1/64	24/3/64 21/4/64	Fremantle-Penang- Fremantle. (Indian Ocean)	62-103	T, S, Sigma-t, O ₂ , O ₂ % sat, PO ₄ -P, NO ₃ -N.

HMAS *Gascoyne*

G1/60	2/2/60 8/3/60	Sydney-Sydney (Pacific)	1-88	T, S, Sigma-t, O ₂ , O ₂ % sat., PO ₄ -P, Primary Production, Pigments, phytop- lankton.
G2/60	17/3/60	Sydney-Sydney. (Pacific)	89-190	
G3/60	8/11/60 4/12/60	Sydney-Sydney (Pacific)	201-313	T, S, Sigma-t, Ben- thos, Phytoplankton.
G1/61	12/1/61 13/2/61	Sydney-Melbourne (Pacific)	1-42	T, S, Sigma-t, O ₂ , O ₂ % sat., PO ₄ -P, NO ₃ -N, Primary Production, Pigments.
G3/61	14/8/61 12/10/61	Cairns-Honolulu- Sydney. (Pacific)		-do- Zooplankton
G1/62	13/1/62 16/2/62	Sydney-Sydney. (Pacific)	1-53	-do-
G4/62	19/8/62 16/9/62	Fremantle— Singapore- Fremantle (Indian Ocean)	181-217	-do- Micronekton.
G5/62	30/9/62 10/10/62	Melbourne-Sydney (Pacific)	218-273	T, S, Sigma-t, O ₂ , O ₂ % sat. PO ₄ -P, NO ₃ -N
G2/63	4/3/63 9/3/63	Adelaide- Port Lincoln (Indian Ocean)	36-75	T,S, Sigma-t, O ₂ , O ₂ % sat. PO ₄ -P.
G5/63	7/11/63 15/11/63	Melbourne-Sydney (Pacific)	182-224	T,S, Sigma-t, O ₂ , O ₂ % sat., PO ₄ -P.
G3/64	5/3/64 25/3/64	Adelaide-New South Wales. (Indian Ocean)	116-160	T,S, Sigma-t, O ₂ , O ₂ % sat. PO ₄ -P.
G4/64	5/3/64 13/8/64	Sydney-Brisbane (Pacific)	162-193	T,S, Sigma-t, O ₂ , O ₂ % sat. PO ₄ -P, NO ₃ -N
G6/64	16/9/64 27/9/64	Brisbane-Sydney. (Pacific)	235-283	T,S, Sigma-t, O ₂ , O ₂ % sat. PO ₄ -P.

PORTUGAL

<i>Almirante</i>	1	27/4/64	South Indian	11-42	T,S, Sigma-t, O ₂ ,
<i>Lacerda</i>		7/5/64	Ocean.		PO ₄ -P, SiO ₃ -Si.

Indexing, tabulation and processing of these data are in progress. Quality checking of the INS *Kistna* data for the IIOE cruises 14-17; 19-22; and 25-28 in respect of parameters such as temperature and salinity has been done. The oxygen data are being examined individually for quality with reference to original log sheets and the areas and times of operation.

The checked data are in the process of transfer to standard W.D.C. data cards. The grouping of the data for the various regions as well as for the various seasons will be done and filed as soon as the transfer to standard format is completed.

One of the major items of work undertaken is to group the various physical and chemical parameters working out averages for every 1° square and carry out detailed processing on these with a view to obtaining patterns of distribution of these parameters for the whole of the Indian Ocean. Based on these the undermentioned projects have been initiated:

1. Hydrographic features of the Bay of Bengal

The project comprises of:

- (a) The investigations on the vertical and horizontal distribution of temperature, salinity, density and oxygen concentration and their seasonal variations in the upper mixed layer.
- (b) A systematic classification of permanent and transient water masses and evaluation of their properties and behaviour.
- (c) Studies on the pattern of circulation and its relation to the characteristics and stratifications of water masses.

Under the above project, compilation, quality checking and interpolation of available data at standard depths for about 92 stations occupied by the U.S. R/V *Anton Bruun* (1st cruise) have been done. Simultaneously computation of dependent variables like density, thermocline anomaly and specific volume anomaly have also been carried out.

The above work is being continued in respect of data collected by other research vessels.

2. Depths of occurrence of oxygen maxima and minima in the upper 500 m. of the Indian Ocean

For these studies preliminarily the region between 8°N and 25°N, latitude, and 50°E and 77°E longitude in the Arabian Sea has been taken. Available data collected by all ships in the region on oxygen maxima, minima and the corresponding depths have

been compiled and grouped season-wise for every one degree square. Charts for the depths of occurrence of oxygen maxima and minima are being prepared.

This type of studies will be extended to other parts of the Indian Ocean.

3. Integral mean concentrations of inorganic phosphate and total phosphorus in the upper 100 m. column and their distribution.

Under this project a summary of the nutrient data available from July 62 to Dec. 65 of various ships that participated in the IIOE programme was prepared with the help of WDC data catalogues. For about 105 stations occupied by USSR R/V. *Vityaz*, the mean integral phosphate values have been computed. The computed values have been plotted on seasonal charts. The work is being continued. It is intended to extend such studies in case of other nutrients also.

4. Time and spatial variation of density discontinuity layer and vertical stability parameter in the equatorial Indian Ocean.

The WDC data catalogues have been studied and the ship data records have been grouped season-wise. Compiling of data regarding surface temperature, salinity, density, oxygen concentration and depth of thermocline and sea water characteristics at that depth for about 700 stations in the equatorial region have been completed. The stability parameter is computed for standard depth intervals from surface to maximum depth of sampling. The work is being continued.

2.2 INDIAN OCEAN BIOLOGICAL CENTRE, ERNAKULAM

The Indian Ocean Biological Centre, established in November 1962 is now in its fifth year of existence and since the starting of the Institute has been functioning as a full division of the National Institute of Oceanography. Its main function of handling standard samples of zooplankton collected by the research ships of the countries participating in the International Indian Ocean Expedition has been almost completed and it has now emerged as an active centre of research pertaining to Indian Ocean plankton. Dr. Edward Brinton continued as the UNESCO curator of the International Collections till May 1967. Mr. D. J. Tranter who was appointed by the UNESCO to succeed Dr. Brinton took charge of his duties in Nov. 1967.

(a) Plankton sorting

The progress in sorting work is indicated below :

Number of sorted samples on 31-3-1967	1571
Number of samples sorted during 1967-68	248
Total number of sorted samples on 31-3-1968	1819
Number of unsorted samples on 31-3-67	362
Total number of IIOE plankton samples at IOBC.	2181

About 250 samples collected by R/V *Africana* and R/V *Gascoyne* have been kept separately for the present owing to special features of their geographical coverage. The most salient feature of the year was the increasing scope of programmes of subsorting of major categories such as Fish-eggs and larvae, Copepoda, Decapod Crustacean larvae and so on.

(b) Plankton research

Dr. R. Raghu Prasad completed his study of zooplankton biomass in the Arabian Sea and Bay of Bengal. The paper is being published. The charts relating to biomass have also been separately published by the Institute as the first fascicle of the "General Properties Atlas" under the editorship of Dr. N. K. Panikkar and Dr. E. Brinton. Dr. Brinton, assisted by Shri K. Gopalakrishnan (JSA) continued his studies on Euphausiacea of the IIOE Collections till May 1967. After this date the studies are being continued at Scripps Institution of Oceanography, since Dr. Brinton has returned to his parent laboratory and the Euphausiid material also has been transferred to his care. Shri M. Krishna Menon, Scientist, continued his studies on Decapod larvae; the programme of sub-sorting of these larvae from each station into about two dozen groups was continued under his supervision till he completed his term of appointment in October 1967. A total number of 1442 samples has been sub-sorted by his team from 1966 to 1968. Shri L. R. Kasturirangan, Scientist and Associate Curator continued his special interest in the Copepoda of the IIOE Collections and plans for sub-sorting of this group. Dr. R. V. Unnithan, Scientist began studies on the Platyhelminthes from the IIOE Collections, besides continuing his work on microassociates of marine fishes. Detailed studies, including sub-sorting are being made by members of the staff whose names and the groups which they are specialising in, are given below:—

- | | | |
|------------------------------------|---|----------------------------|
| 1. Shri P. Gopala Menon | — | Decapod Crustacean larvae |
| 2. Shri M. Sakhivel | — | Mollusca, Thecosomata |
| 3. Shri K.J. Peter | — | Fish eggs and larvae |
| 4. Shri P.N. Aravindakshan | — | Mollusca, Heteropoda |
| 5. Shri Jacob George | — | Ostracoda |
| 6. Shri V.T. Paulinose | — | Decapod, crustacean larvae |
| 7. Smt. Vijayalakshmi R. Nair | — | Chaetognaths |
| 8. Shri T. Balachandran | — | Pelagic Anthozoa |
| 9. Shrimati CB. Laithambika Devi | — | Flatfish larvae |
| 10. Dr. M. Saraswathi | — | Lamellibranch larvae |
| 11. Dr. N. Ravindranatha Menon | — | Cyphonautes Larvae |
| 12. Shri S.C. Goswami | — | Oithona (Copepoda) |
| 13. Shri K.K. Chandrasekharan Nair | — | Amphipoda. |

Among the Scientists who visited IOBC during current year, a few well known specialists devoted their valuable time examining the collections at the centre. They examined the sorted material, provided useful guidance and extended necessary advice to the sorting assistants engaged in studies on special groups.

Professor T.S. Rass of the Institute of Oceanology, Mosow who was nominated by IOBC Consultative Committee as the senior specialist for the "Fish egg and larvae" component of the IIOE collections visited the centre in December, 1967 for eight weeks. He examined and evaluated the collections and proposed a team of specialists to work on the various groups of "Fish egg and larvae", and train the IOBC staff engaged in sub-sorting of the group. Dr. D.I. Williamson of the Marine Biological Station (University of Liverpool), Port Erin, Esle of Man, England visited IOBC in Feb. 1968 as a nominated senior specialist for Decapod larvae. He devoted four weeks to examining and evaluating the sorted and sub-sorted groups and framing a list of specialists to study different sections of the material.

Professor R.B. Clark, Director, Dove Marine Laboratories, University of New Castle-upon-Tyne, England visited the centre in the first week of December 1967 and examined the sorted pelagic polychaeta of the IIOE collections.

Distribution of pending material

Some of the groups which were awaiting distribution till last year have been loaned to the following specialists.

Platyhelminthes	To Dr. Unnithan (IOBC Staff)
Stomatopod Larvae	To Shri. K.H. Alikunhi, Central Instt. of Fisheries Education, Bombay.
Cubomedusae (Together with Scyphomedusae)	To Dr. Ralph (New Zealand)
Chaetognatha	To Dr. T.S.S. Rao at Bombay Unit of NIO

Hand book on IOBC Collections

The preparation of hand book which so far was in the charge of Dr. Brinton, has been taken over by the present Curator Mr. D.J. Tranter. The mimeographed station list is being revised and got ready for printing. The maps of cruise tracks and a section on collection methods are also under preparation which will be printed as a part of the Handbook.

Zooplankton atlases

The "General Properties Atlas" under the co-editorship of Dr. N.K. Panikkar and Dr. E. Brinton is being published in fascicles by the CSIR. Fascicle 1 presents the maps of total zooplankton biomass for the Arabian Sea and the Bay of Bengal, prepared by Dr. R.R. Prasad, and has been already published. Fascicle 2, presenting the maps of biomass for the Indian Ocean as a whole prepared by the same author, is shortly to go to press. Further fascicles relating to the total Copepoda, fish larvae, chaetognaths etc. have been prepared and would be revised to final form as soon as the basic sorting programme comes to an end.

Sixth meeting of the Consultative Committee for IOBC

The sixth meeting of the Consultative Committee for IOBC was held at Ernakulam from 22nd Feb. to 3rd March 1968. The following is the list of participants:-

Prof. J. Krey	—	Chairman
Dr. A. Fleminger	—	Member
Dr. M. Anraku	—	”
Dr. V.N. Grezc	—	”
Dr. (Prof.) S. Krishnaswamy	—	”
Prof. B. Kimor	—	”
Dr. N.K. Panikkar	—	Member-Secretary
Dr. S. Tewfik	—	Unesco, Chief of Mission, New Delhi.
Dr. O.J. Ostvedt	—	Unesco, Office of Oceanography, Paris.
Dr. P.N. Ganapathi	—	Member, Indian Advisory Board to IOBC.
Dr. A.N. Bose	—	-do-
Dr. R.R. Prasad	—	-do-
Mr. D.J. Tranter	—	Curator, IOBC.
Mr. L.R. Kasturirangan	—	Associate Curator, IOBC.
Dr. S.Z. Qasim	—	NIO, Ernakulam.
Dr. T.S.S. Rao	—	NIO, Bombay.

Dr. N.K. Panikkar, Director, IOBC presented a brief report on the working of the IOBC, drawing attention to the steady progress in plankton sorting and the development of plankton research activities. He referred to augmentation of laboratory facilities and efforts to secure additional accommodation. He made special mention of the papers and maps presented by scientific staff of IOBC at the Symposium on Indian Ocean at New Delhi in March 1967 and to the publication of fascicle 1 of vol. 1 of the "General Properties Atlas", prepared by Dr. R.R. Prasad. He made special reference to the visits of Prof. Rass and Dr. Williamson to advise on allocation of material to specialists and to the appointment of research fellows for work on IOBC material.

The Unesco Curator, Mr. D.J. Tranter, in his report emphasized that the work of the IOBC is entering a new phase. Specialists are ready to study sections of the collections assigned to them and regular despatch of material is being made to various specialists as basic sorting draws to a close. Specialists are visiting the Centre more frequently and sub-sorting programmes are gathering momentum. He touched on some of the handicaps experienced at IOBC and suggested ways to remove them. Provision of facilities for better care to optical equipment, a work boat to enable field work to be attempted and provision of draughting and workshop facilities were emphasized by him as urgent. He also referred to parts of the International collection being in a state of unsatisfactory preservation and outlined the steps being taken to control the problem.

The meeting of the committee on the forenoon of Saturday 24-2-68 was attended by a number of invited Scientists and extensive discussions took place on problems of plankton preservation as experienced in various institutions.

Recommendations of the Consultative Committee

The Consultative Committee recommended:—

1. That the Unesco Curator be requested to prepare a report on the original plan of the aims and functions of IOBC along with the present stage of achievements, to be got ready before Feb. 1969.
2. That an airconditioned dehumidified chamber be set up in the main laboratory for keeping the optical instruments.
3. That the reports submitted (or to be submitted) by Dr. Ahlstrom, Professor Rass and Dr. Williamson after assessing the collections at IOBC be published by UNESCO.
4. That the lists of specialists prepared by Prof. Rass (with suitable condensations), Dr. Fleminger and Dr. Williamson be printed out as appendices to the Report of the Sixth Meeting 1968 and that the specialists recommended in these lists be approved pending receipt of acceptance of responsibility by the Scientist and his institution.
5. That primary responsibility of the IOBC should be to examine and study the International Collections through the co-operation of world specialists, the local staff and the Curator.
6. That steps be taken to augment the IOBC collections in the following manner:-
 - (a) Attention of National Coordinators be invited to the large gaps in the distribution of IOSN samples in several areas of the Indian Ocean and they be requested to secure coverage for plankton collection in these areas when future cruises are planned.
 - (b) Request for samples from the Indian Ocean during future expeditions be renewed through SCOR and IOC.
 - (c) Steps be taken by UNESCO to secure ship-board fellowships in ships working in Indian Ocean to IOBC staff as a definite move towards giving them field training and experience.
 - (d) Opportunities be given to the IOBC staff to make plankton collections in order to enable them to compare fresh material with the IOBC samples, particularly with reference to certain groups of organisms which are currently under study by certain members of the IOBC staff.
 - (e) Collaborative Programmes with other local Institutions like the Oceanographic Department of the University, Central Marine Fisheries Institute and other divisions of the NIO, be developed.
7. The Consultative Committee resolved to repeat the recommendation of 1967, that the Curator, guided by the UNESCO-CSIR Contract should request

UNESCO for the microscopes, Camera lucidae and other necessary equipment in order of priority to meet the present and future needs of the centre. The Committee further recommended that a small, fast, safe, shallow-draught workboat be purchased for the use of IOBC in routine collection and research programmes arising out of the International Collections, and for the use of visiting planktologists. Attention was drawn to the de Havilland Hercules workboat made in Australia for a variety of purposes and adapted by CSIRO for hydrological work on the continental shelf. This work boat is made of aluminium with Polyurethane foam floatation and is fitted with twin 40 hp. out-board motors, winch, davit, radio, echosounder, life jackets and so on.

8. The Consultative Committee nominated the Director of IOBC, the Curator and Prof. S. Krishnaswamy to form a sub-committee entrusted with the responsibility of suggesting names of specialists for groups in future or to fill gaps in lists of specialists, which will be circulated to all the members for their comments.
9. The Consultative Committee recognized that research in plankton methodology (more especially improvement in techniques for the study of tropical plankton) is a field of activity in which the IOBC could profitably engage with programmes of other institutes and recommended that a demonstration workshop for plankton methodology should be organized at IOBC in 1969, with UNESCO support.

2.3 BIOLOGICAL OCEANOGRAPHY DIVISION, ERNAKULAM

During the period under review research activities on various estuarine and marine biological aspects initiated in previous years were continued. These investigations and the progress made during the year are briefly reviewed below :

1. Physical factors of the environment.

(i) Comments on "International Oceanographic Tables"

The new International Oceanographic Tables on the electrical conductivity-chlorinity relationship in sea water published by UNESCO in 1966 have been based on the work of late Dr. R. A. Cox and his co-workers, at the British National Institute of Oceanography.

While working on the relationship between electrical conductivity and chlorinity of Cochin backwaters, we found that the salinity conversion from the conductivity ratio given in the first part of the International Oceanographic Tables give high degree of accuracy. The data, however, pertaining to the 2nd part of the table (Table IIa) give a greater discrepancy in the lower ranges. The chlorinity estimates in the range of 1.6-15 ‰ from the International Oceanographic Table and from the actual data given by Dr. Cox and his co-workers [Deep-Sea Research 14, pp. (203-220) give a root-mean-square deviation of 0.007‰ (0.0135‰)]. Similarly the salinity below 27‰ given in the 1.0 tables are slightly higher than those computed from the actual data.

(ii) Solar radiation and its penetration in Cochin backwaters.

The Cochin backwater which is an estuarine area on the west coast of India receives maximum solar radiation from December to March and minimum from June to September. During the monsoon months due to the inflow of considerable amount of freshwater the estuary becomes highly turbid. Seasonal changes in the attenuation coefficient showed that the light penetration is small throughout the year and least during the monsoon months. No relationship was found between attenuation coefficient and suspended matter. The upward-scattering of light in the estuary ranged from 2-8% of the incident illumination and the transmission of surface light at secchi depth was about 23%. The compensation depth in the estuary varied from 2.5-5.0 meters and the zone where optimum illumination for maximum photosynthesis is available lay between zero and 1.5 meters.

(iii) Tidal cycle and the environmental characteristics of Cochin backwaters.

Recent observations on the magnitude of variations in the environmental features with reference to tide have shown that there is no well marked tidal rhythm in the changes of temperature. The salinity, however, induced by the flood and ebb tides undergoes very well marked changes. Similar variations have been recorded in dissolved oxygen, pH, nutrients, seston, chlorophyll, phytoplankton and zooplankton crops with the tidal changes.

2. Chemical and biological factors

In the Cochin backwater which is a turbid and polluted estuary, the C^{14} assimilation is nearer to net production and the diurnal rhythm in photosynthesis is associated with the increase and decrease in daily illumination. There is no decline in the rate of photosynthesis at peak light intensity but the difference between forenoon and afternoon production is significant. Photosynthesis measured in relation to light intensities gave different light saturation optima on different days probably due to highly variable nature of phytoplankton population.

Estimates of gross and net primary production were made for the thin euphotic zone, the latter after computing the respiratory losses occurring during day and night which were large and inconsistent. Seasonal changes in the production rate were less marked and showed only 3-4 fold increase in certain months. For most of the year, primary production seemed non-existent at depths greater than about 4 meters.

None of the factors such as temperature and nutrients seem to be limiting in the estuary. Monthly variations in total solar radiation are not sufficiently large to affect seasonal changes in production, but the light penetration is greatly reduced which limits column production. Seasonal variations in salinity and nutrients, primarily induced by the monsoon cycle, initiate a succession of brief pulses of bloom. The stability of the euphotic zone is important for maintaining plant population within the narrow zone of

illumination and for favouring production. The range in carbon assimilation to chlorophyll ratio was large which signifies that photosynthesis and chlorophyll optima are non-synchronous. From the assimilation ratio determined experimentally the estimates of production were made from radiation and chlorophyll data.

The inter-relationship between carbon assimilation, chlorophyll and detrital material has been worked out and the annual estimates of gross and net production have been made. The efficiency of the environment to convert solar energy into chemical energy was about 0.4%. A general lack of zooplankton grazers in the estuary leaves behind a considerable surplus of unconsumed basic food, much of which seems to be lost by sinking below the narrow euphotic zone.

Initial studies of the sediments in the marine and brackish water regions of the Cochin backwater with special reference to phosphate regeneration were also conducted in the laboratory. Significant differences in the regeneration capacities of the sediments with corresponding changes in the redox potential and pH were noticed. While the regeneration was slow in the mud from the marine zone it was high in the sample from the less saline brackish water zone which is an area of high primary production and also harbours a rich bottom fauna.

In general the regeneration was associated with lower redox potentials and pH of the sediment as well as the water immediately above. In the mud from the less saline brackish water zone processes of adsorption seem to be more active. Further studies on these characteristics of the sediments are in progress.

3. Hydrography of inshore and off-shore waters.

The work on hydrography of inshore waters which began in October 1966 is being continued and data on various aspects are being collected.

4. Fish and Fisheries.

(i) Studies on theoretical models

Investigations on the fish-population models were made during the period under review, mainly by using the Beverton and Holt yield equation. A method of approximate integration of the above yield equation has been described which enables an investigator to make a fairly accurate estimate of yield even when the main population parameters are not constant. Another advantage of this method is that it does not involve laborious computation when growth and mortality rates are not constant. Methods have also been developed for estimating accurately the potential yield and the best ages of exploitation required for maximising the yield at a given fishing mortality. These methods are applicable both under isometric and allometric growth i.e. when the exponent in the length-weight relationship is either a cubic function or when it deviates from being a cubic function.

The estimation of potential yield and the best age of exploitation are particularly important from the point of view of maximising the yield, since the ratio between the actual catch and the potential yield can be used as an index of fishing efficiency.

(ii) Theoretical yield studies on the large-scaled tongue sole, *Cynoglossus macrolepidotus*

By taking into consideration, the changes in the yield with different mortality rates and ages of exploitation, it has been demonstrated that the population of the large-scaled tongue sole is at present underfished and that it can withstand considerable increase in fishing pressure.

5. Ecological studies on the bottom fauna around Cochin

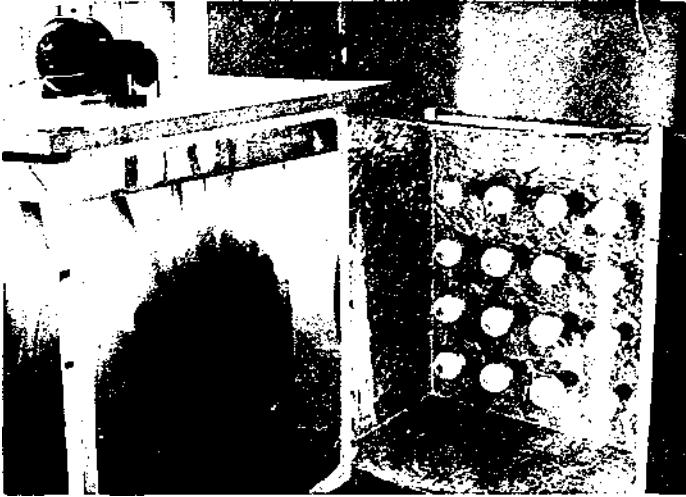
The investigations on the bottom fauna around Cochin harbour have shown that, among the meiofauna, foraminiferans and nematodes were the dominant groups. The macrofauna was mostly represented by molluscs and polychaetes and the former comprise a substantial portion of the benthos, both in the backwater and in the sea, especially in sandy areas. The biomass was greatest in the confluence region of the backwater with the sea. It is lower in some areas of the backwater as compared to the biomass of the near-shore region. This is because of the fact that in the backwater, both salinity and the nature of substratum are less uniform than in the nearshore region. Nevertheless the relatively low value for the biomass even in the inshore region seems mainly to be due to the muddy substratum. Salinity and nature of substratum are the two primary factors governing the abundance of the bottom fauna in this region.

The samples of bottom fauna showed high sampling variability. This is mainly due to the non-random distribution of the organisms and probably also due to the deficiencies in sampling. Comparison of the sampling efficiency of the Van Veen and the Foerst 'Petersen' type bottom-samplers which were used during the present study have shown that under identical conditions, a heavier grab is more efficient than a lighter one. The data is suggestive of the superiority of the Van Veen over the 'Petersen' type grab.

6. Ecology and productivity of sandy beaches

Sand samples collected from (a) Backwater beach (b) Cochin beach (c) Thottappally beach were analysed for chlorophyll and organic matter throughout the year. Both chlorophyll and organic matter showed a seasonal cycle. The chlorophyll was maximum in April-May, at almost all tidal levels. This was followed by a similar peak in the organic matter in the following months, May-June. The maximum interstitial fauna corresponded to the peaks in the organic matter. The dominant groups of the interstitial fauna were the foraminiferans, nematodes, harpacticoids, etc.

Detailed studies on the quantitative and qualitative aspects of the beach fauna were also initiated by this Division in collaboration with two visiting scientists from the Marine Laboratories of Millport and Aberdeen and the work is in progress.



Equipment for Carbon-14 Assimilation Studies
(Biological Oceanography Division, Ernakulam)

7. Physiological studies : (Work of Research Fellows, Dr. K. R. Menon & Shri P. Sivas)

The eye-stalk of *Scylla serrata* has been shown to contain hypercalcemic and hyperglycemic factors. The hypercalcemic factor is responsible for the rise in blood calcium of crabs during acclimatisation to low salinities. In the absence of this factor the blood calcium falls and such animals are unable to survive in 20% sea water for more than 48 hrs. Hypoglycemia sets in 24 hours after the eye-stalk ablation. Glucose loading experiments have revealed that the rate of disappearance of injected glucose is faster in the eye-stalkless crabs than in normal crabs. Insulin injections have indicated that another hyperglycemic factor may be present in *S. serrata* outside the eye-stalks.

During the proecdysis both calcium and sugar levels are high in *S. serrata* and the eye-stalk ablation during this period also leads to a fall in the blood calcium and sugar. This observation gave rise to a hypothesis that the premoult rise in sugar and calcium in higher decapods is not direct influence of the moulting hormone but rather due to hyperactivity of hypercalcemic and hyperglycemic factors induced by moulting hormone. To test this hypothesis the eye-stalks were ablated in a set of crabs of different carapace width and their moulting behaviours observed. It was found that in *S. serrata*, the eye-stalk ablation prepares the animals towards moulting, like in other crabs, but the crabs cannot moult successfully as the calcium withdrawal is affected and these crabs die at the time of moulting because of their inability to come out of the old exoskeleton. The calcium regulating factor has been observed for the first time in decapods and its effect in moulting demonstrated.

2.4 PHYSICAL OCEANOGRAPHY DIVISION, ERNAKULAM

The main research activities of the Physical Oceanography Division for the year under review cover four aspects which are detailed below:

1. Physical studies of the waters of the North Indian Ocean

As a preliminary step towards an understanding of the areas of upwelling and productivity in the North Indian Ocean, temperature data of about 1000 stations relating to the cruises of *Anton Bruun*, *INS Kistna* and other research vessels have been studied. Studies on the vertical stability of the waters in the upper 300 meters at selected regions around the Indian peninsula are also being undertaken.

As a continuation of the studies of the sea water sample scheme data, the distribution charts of temperature, salinity and density of the surface waters of the Bay of Bengal have been prepared for a few months. The seasonal march of surface temperature and salinity have also been worked out at thirteen zones along the west coast of India between Veraval and Cape Comorin in order to study the meridional variation of these parameters. The annual range of surface temperature has been found to vary from 6° C in the northern most part to about 2 ° C at Cape Comorin. The minimum temperature in the northern zone occurs in winter and in the southern zone during the south-west monsoon.

2. Coastal and nearshore oceanographic studies

These studies include beach profile measurements, nearshore current measurements, wave refraction studies for waves of different periods approaching the coast, beach material studies, and studies on mud banks.

(i) Beach profile studies

The beach profile measurements at the eight selected points along the Kerala coast are being continued. In all about 182 beach profile measurements were made during the year as per the details given below:

Narakkal	— 22
Elankunnapuzha	— 15
Ochanthuruth	— 11
Saudi	— 20
Manassery	— 14
Thumboli	— 33
Punnapra	— 33
Purakkad	— 34

The essential characteristics of the beaches for the year under report are given in table 1.

TABLE 1

<i>Sl. No.</i>	<i>Station of the beach</i>	<i>Range of width of the beach (in metres)</i>	<i>Stable portion of the beach from the reference point (in metres)</i>	<i>Maximum vertical variation on the beach (in metres)</i>
1	2	3	4	5
1.	Narakkal	25-50	Nil	2.1
2.	Elankunnapuzha*	5-30	Nil	2.1
3.	Ochanthuruth	35-60	15	2.0
4.	Saudi+	20-35	5	1.75
5.	Manassery	12.5-32.5	Nil	1.2
6.	Thumboli	55-80	20	2.7
7.	Punnapra	80-140	45	4.1
8.	Purakkad	55-75	20	2.6

The reference point at Elankunnapuzha was shifted since the construction of sea wall in 1966.

Profiles at Saudi were measured only on the seaward side of the sea wall since its construction.

(ii) Current measurements

The programme of current measurements commenced during the previous year has been continued. Currents were measured periodically over complete tidal cycles from the pier ends at Trivandrum and Alleppey using self-recording current meters. The measurements are also made from anchored boats using current meters and drifters or floats beyond the breaker zone. No generalisations can be made regarding the exact direction of flow in different months from the data obtained so far. The observations from the piers show that the flow is northerly for a period of about two or three months from December-January and for the remaining period of the year it is southerly along the coast. The speeds of the currents vary from 0.1 to 0.25 Knots.

(iii) Wave refraction studies

Wave refraction diagrams for waves of 4 to 10 seconds periods were constructed for Thottapally region and the energy distribution along the coast was studied. Work on refraction diagrams for the higher period waves is in progress.

(iv) Beach material studies

Calculation of the cumulative percentages and the computation of statistical parameters like median and sorting arc in progress in respect of the samples collected at Elankunnapuzha and Thumboli stations in order to understand the variations in the characteristics of the beach material in response to the changes in the beach profiles.

(v) Studies on mud banks

X-ray diffraction analysis of the mud bank samples near Cochin was undertaken. The study reveals the presence of *Kaolinite*, *Montmorillonite* (10-15%), and *Illite* (10-15 %) in the decreasing order of abundance, *quartz*, *calcite*, *gypsum* and occasional amount of *apatite* are also noticed. It is found that *Kaolinite* constitutes more than half of the clay minerals (65%).

3. Physical and Chemical studies on the shelf sediments off the coasts of India

(i) Trace element studies in the west coast shelf regions

The distribution pattern for Manganese has been worked out at various places along the west coast of India. The values are given below in the table 2.

TABLE 2

<i>Off Alleppey</i>		<i>Off Cochin</i>		<i>Off Mangalore</i>		<i>Off Karwar</i>		<i>Off Bombay</i>	
<i>Stn. No.</i>	<i>Mangan-ese%</i>	<i>Stn. No.</i>	<i>Mangan-ese%</i>	<i>Stn. No.</i>	<i>Mangan-ese%</i>	<i>Stn. No.</i>	<i>Mangan-ese%</i>	<i>Stn. No.</i>	<i>Mangan-ese%</i>
672	0.032	670	0.028	657	0.045	656	0.055	638	0.077
673	0.032	671	0.031	658	0.037	655	0.061	639	0.072
674	0.028	669	0.030	659	0.032	654	0.058	640	0.064
675	0.021	668	0.024	660	0.033	653	0.046	641	0.055
676	0.016	667	0.024	661	0.039	652	0.029	642	0.037
677	0.014	666	0.014			651	0.017	643	0.028
678	0.020			650			0.027	645	0.009
679	0.033								

An analysis of the data shows the following distribution for the Manganese.

1. There is a progressive increase in the manganese content from south to north.
2. In any given section the manganese content decreases in a direction seaward from the coast in the shelf region.
3. Except off the Bombay coast, the sediments in the slope region are slightly more enriched in their manganese content than in the immediately adjacent shelf sediments.

Estimation of Titanium, Nickel and Cobalt is in progress.

(ii) Particle size analysis of the shelf sediments between Swatch of no-ground and Madras

Size analysis has been completed in respect of all the samples collected during the 17th and 18th cruises of *INS Kistna* between Swatch of No-Ground (Ganges Submarine

Canyon) and Madras. In all 77 stations were covered on these two cruises and the region-wise details are given below.

Ganges-Mahanadi Shelf	11
Visakhapatnam-Godavari Shelf	19
Godavary-Pennar Shelf	40
Pennar-Madras Shelf	7

Sediments of the Ganges-Mahanadi shelf have their medians either in the fine silt range or in the clay range. Samples drawn from the Ganges trough showed the largest median value of 7.8 microns. The top, middle and bottom portions of the cores drawn from the trough walls and centre were studied. The particle size distribution of these samples revealed that the median diameter increases gradually from bottom to the top. Across the Visakhapatnam-Godavary shelf, the median diameter varies from medium sand range to fine silt. Nearshore samples off the Godavari, Krishna and Pennar deltas have their medians in the fine silt and coarse clay range. In these areas samples from the outer shelf do not contain sand size material. These have their medians in the fine clay range. The median diameter for the samples between Pennar-Madras varies from medium sand to fine sand. In general the particle size analysis for both top and bottom portions of the cores revealed that the bottom portion of the cores are coarser than the top portion.

(iii) Oolites

A study of the oolites present in the shelf sediments off the west coast of India has been undertaken. Depth-wise, these oolites are found between 40 and 100 fathoms and are actually distributed between Bombay and Mangalore diminishing in quantity to the south. In sections South of Mangalore, they are totally absent. The oolites in the Bombay section are pale brown to buff in colour while the oolites in the southern section are black and shiny. In size, they range between 0.3 mm to 0.25 mm. Thin section studies show these oolites to consist of Cellophane (an amorphous hydrated phosphatic mineral) enclosing calcite nuclei.

(iv) Estuarine studies

The observational programme at the Boat Pen, Cochin Port and M.E.S. Jetty was continued during the year under report. About 800 water samples were collected and analysed.

Using the data obtained at Boat Pen for the period 59-67, seasonal variations in salinity and temperature were studied. Both salinity and temperature were found to be maximum in April and minimum in July. A steady increase in salinity of the waters was noticed from October to April.

Studies on standing waves were undertaken using the tide gauge data for Cochin Port for the year 1963-64 and 65.

2.5 BOMBAY UNIT OF NATIONAL INSTITUTE OF OCEANOGRAPHY

Analysis of the Plankton and mud samples collected during the March/April 1967 cruises of the INS *Darshak* have been completely processed and the papers on the distribution of Chaetognatha and Foraminifera are under preparation.

The unit received Chaetognatha samples of the International Indian Ocean Expedition Cruises from the Indian Ocean Biological Centre, Ernakulam and also from the Smithsonian Institution, Washington, D.C. Some of the interesting results from the studies on the Chaetognatha collections and Foraminifera of the mud samples are given below:—

Studies on the Chaetognatha (Gulf of Cambay)

Analysis of the Plankton samples collected from Cruise 1 of INS *Darshak* during the period 8th April 1966 to 17th April 1966 indicates the occurrence of relatively large number of Chaetognaths in the Gulf. *Sagitta neglecta* is the most abundant species. The other species occurring are *Sagitta bombayensis*, *S. bedoti*, *S. pulchra* & *S. robusta*. Most of the forms are either immature or in stage I of maturity. The mature specimens of *Sagitta bombayensis*, *S. pulchra* were observed. Since the collections were only from the surface waters, it is possible that mature specimens of other species may occur at sub-surface levels.

Studies on the Foraminifera (Gulf of Kutch)

With the sediment samples of I.N.S. *Darshak* collected during one of the cruises January 1967, a detailed study has been undertaken with regard to the nature and distribution of foraminiferal fauna of the Gulf of Kutch.

Eighty species of Foraminifera belonging to 28 genera of 12 families viz. Astro-rhizidae, Textulariidae, Valculinidae, Miliolidae Ophalmidiidae, Lagenidae, Nonionidae, Bulminidae, Globigerinidae, Globorotaliidae, Anomalinidae were collected and reported from the Gulf of Kutch. Most of the species are characteristic Indo-Pacific forms; Several others have been recorded for the first time from Indian waters.

The number of foraminifera decreases landward and is relatively poor in the interior of the Gulf. The area of greatest abundance is the mouth of the Gulf. Planktonic foraminifera occur throughout the Gulf and arenaceous foraminifera are dominant at the mouth of the Gulf. Foraminifera with porcellaneous tests are most abundant in the Gulf of Kutch suggesting warm, shallow water. A typical distribution of foraminifera at one of the stations covered in the Gulf of Kutch is as follows:

Station 21-Geographic position: 19 °7' N. Lat., 72°2' E. Long., Depth: 35 fms. Sediment: Sandy mud.

Millioliids are dominant followed by Rotaliidae, Nonionidae and Textulariidae in the order of abundance. Lagenids are common in the sample. Rotalids are represented by genera such as *Rotalia*, *Cibicides* and *Discorbis*. Among the Miliolids the most common genera are *Spiroloculina*, *Quinqueloculina* and *Triloculina*. Planktonic foraminifera like *Globigerina bulloides* and *G. dubia* are most dominant and *Globigerinoides rubra* is very rare.

In general, specimens of foraminifera are in a good state of preservation.

Work on further identification of species and distribution of some groups of foraminifera is in progress.

2.6 GOA UNIT OF NATIONAL INSTITUTE OF OCEANOGRAPHY, PANAJI

The research activities undertaken at the Goa unit of National Institute of Oceanography are two-fold (A) Geological and (B) Biological. These are summarised below.

1. Geological Studies

The samples of shelf sediments collected during the cruises of I.N.S. *Darshak*—No. 2 & 3 are under detailed mineralogical and textural investigation with a view to evaluating the characteristics viz. grain size, composition, organic content, the nature of the source area and the mineralogical constituents of the sediments.

The studies on distribution and variation of various mineralogical, structural, textural and the sedimentological features of the Miramar, Colva, and Calangute beaches are underway. Beach erosion cycle, land and sea interaction, sedimentary features, grain size and distribution of the sediments are also under detailed investigation.

Navigational problems connected with Mandovi and Zuari river estuaries have also been taken up for study since the post-monsoon, and monsoon periods are not navigable in these waters due to silting and as such dredging operation becomes a necessity for safe navigation during the post-monsoon period.

Paleontological and particularly micropaleontological studies of the foraminifera, ostracoda, diatoms and other microfossil assemblages of the shelf sediments and the deep sea cores are underway with particular reference to their distribution, ecology and geological/geographical variations, stratigraphic significance and sedimentological association.

2. Biological Studies

(i) **Biological productivity studies** — The aim of these studies is:

1. Critical appraisal and characterisation of the waters off the Goa Coast with respect to biological productivity.

2. Size and structure of the standing crop in the waters near Panaji.
3. Possible effects of freshwater drainage on biological productivity.
4. Effects of physical and chemical factors such as tidal variations, extinction coefficient of light, temperature, salinity, pH, dissolved oxygen, turbidity etc. on the biological productivity.
5. Effects of suspended matter on the transparency of water and its effect on the biological productivity.
6. Effects of tides on the abundance of certain plankton species.

Since March 1968, weekly observations at Dona Paula Bay near the mouth of river Zuari, using light and dark bottles method are yielding data on the rate of photosynthesis, respiratory coefficient and primary productivity at surface waters and at two meters depth.

Weekly recordings of temperature, pH, turbidity, salinity, electrical conductivity, secchi disc readings, dissolved oxygen and total solids, are being made.

Also regular weekly collections of plankton by filtering 25 litres of water through No. 21 bolting silk plankton net are being made to study the qualitative and quantitative aspects of plankton populations.

Yearly data on the above mentioned aspects of biological oceanography would indicate their seasonal changes in relation to three marked seasons i.e. summer, rainy season and the winter in Goa territory. To support the yearly data, the study on the diurnal variations of the various physical and chemical parameters as well as the fluctuations of plankton population and the difference in the day and night biological productivity in the waters at Dona Paula Bay is undertaken.

Study of the biological productivity of the Mandovi River estuary near Panaji using light and dark bottles method during the winter months showed the rate of productivity to be 200-500 mgC/m³/hr under the varying light conditions.

(ii) Biological and Physiological studies on *Boleophthalmus*.

Boleophthalmus spp. available in the intertidal zones have been examined to study the diurnal and tidal rhythmicity in its routine activity. It is the only recorded airbreathing marine teleost and hence the study of its respiratory metabolism would be valuable.

Measurements of its gill area in relation to its body size compared with that of other purely aquatic teleosts would form the preliminary observations.

(iii) Studies on physiological rhythms in marine invertebrates

A preliminary study of the behaviour, feeding habits and adaptations for a few species of intertidal and estuarine crabs during high tide and low tide hours was made. The commonly occurring fiddler crab of these regions, *Uca* sp., was selected for a detailed analysis of its behavioural responses to the stages of the habitat tides and time of day.

Experimental evaluation of the complex of physiological rhythms in the fiddler crabs is now underway. The spontaneous locomotory activity of the crabs under captivity and constant conditions of the laboratory is being kymographically recorded. The overt and persistent cycles of muscular activity obtained can be resolved into two major components — the solar day or circadian component and the lunar day or tidal component. Experiments were conducted during the several phases of the moon (such as New Moon, First Quarter, Full Moon and Last Quarter) and the related tides.

A series of experiments has been planned to study the light relations of the rhythmic system in *Uca* sp. Previous work has thrown little if any light on the phase responses of the rhythmic system in this animal. Hence a 'phase response curve' is sought to be obtained for the circadian component. This would further clarify how the circadian and tidal components interact to result in cycles of semilunar and lunar durations. An understanding of this interaction is vital in explaining the breeding cycles of marine invertebrates which too are of semi-monthly and monthly periods. Knowledge of this nature has obvious implications in the exploitation of marine crustaceans and molluscs for the market.

3. ADMINISTRATIVE SET-UP

3.1 Executive Council

1. Dr. D. N. Wadia, FRS
National Research Professor of
Geology & Geological Adviser,
Department of Atomic Energy,
Government of India, South Block,
NewDelhi-II. Chairman
2. Dr. A.N. Bose,
Professor and Head of the Department of
Food Technology and
Biochemical Engineering,
Jadavpur University, Calcutta-32. Member
3. Prof. S.P. Chatterjee,
Head of the Dept. of Geography,
Calcutta University, and Director,
National Atlas organisation, Calcutta. Member

- | | | |
|-----|---|-------------------|
| 4. | Shri CV. Gole,
Director,
Central Water & Power Research Station,
Government of India,
20, Bombay Poona Road,
Poona-3. | Member |
| 5. | Commodore D.C. Kapoor, I.N.,
Chief Hydrographer to the
Government of India,
Naval Hydrographic Office,
Post Box No. 75,
Dehra Dun-1. | Member |
| 6. | Dr. L.S. Mathur,
Director-General of Observatories,
India Meteorological Department,
Lodhi Road, New Delhi-3. | Member |
| 7. | Prof. R. Ramanadham,
Professor & Head of the Department of
Meteorology and Oceanography,
Andhra University, Waltair (A.P.). | Member |
| 8. | Shri S.K. Ranganathan,
Director of Scientific Research (Navy)
Naval Headquarters,
New Delhi-22. | Member |
| 9. | The Director-General,
Scientific & Industrial Research,
Rafi Marg,
New Delhi-1. | Ex-Officio-Member |
| 10. | The Financial Adviser to CSIR. | |
| 11. | Director, National Institute of Oceanography,
CSIR Building, Rafi Marg, New Delhi-i. | —do— |

3.2 SUB-COMMITTEES OF THE EXECUTIVE COUNCIL

1. SCIENTIFIC SUB-COMMITTEES

A. Physical & Chemical

1. Dr. M.S. Krishnan
 2. Dr. P.R. Pisharoty
 3. Shri C.V. Gole
 4. Shri S.K. Ranganathan
 5. Dr. A.N. Bose
 6. Prof. D. Lal
 7. Dr. C.B. Murty
 8. Dr. R. Viswanathan
 9. Director, NIO
- Convener

B. Biological

1. Dr. D.V. Bal
 2. Shri R. Madhavan Nair
 3. Dr. R. Raghu Prasad
 4. Dr. B.S. Bhimachar
 5. Prof. P.N. Ganapati
 6. Dr. B. Patel
 7. Director, NIO
- Convener

C. Geological

1. Dr. D.N. Wadia
 2. Dr. Hari Narain
 3. Director-General, Geological Survey of India
 4. Director, NIO
- Convener

II. BUILDING & FINANCE

1. Dr. D.N. Wadia
 2. Capt. N. S. Tyabji
 3. Secretary, CSIR
 4. FA to CSIR
 5. Chief Engineer, PWD, Goa Admn.
 6. Development Commissioner, Goa Admn.
 7. Director, NIO
- Convener

III STAFF SUB-COMMITTEE

1. Dr. C.V. Kulkarni
2. Shri R. Madhavan Nair

3. Dr. A.N. Bose
4. Director, NIO

Convener

The Executive Council also decided that the Heads of various divisions in the Institute will also be ex-officio Members of the Scientific Sub-committees.

3.3 BUDGET

The Budget figures for the year 1967-68 are as follows :

	<i>Sanctioned</i>	<i>Actual</i>
	(Rs. in lakhs)	(Rs. in lakhs)
1. Recurring	9.650	9.095
2. Capital	11.000	8.678
Total	20.650	17.773

3.4 SCIENTIFIC AND TECHNICAL STAFF—(Including Research fellows)

1. Headquarters and Planning and Data Division

DIRECTOR

Dr. N.K. Panikkar

Scientist-in-Charge

(Planning & Data Division)
Shri R. Jayaraman

Junior Scientific Assistant

Shri S.A. H. Abidi

Senior Documentation Assistant

Scientists

Shri Krishan Kumar
Dr. S.N. Dwivedi
(on deputation to Laos)
Shri S. P. Anand Senior Draughtsman
Dr. V. S. Bhatt Shri D.R. Mongia

Senior Scientific Assistant

Shri D. Panakala Rao

Senior Research Fellow

Shri L.V.G. Rao

Senior Technical Assistant

Shri R.M.S. Bhargava

Junior Research Fellow

Shri P.G. Kurup

2. Indian Ocean Biological Centre, Ernakulam

Chief Scientist-in-Charge

Dr. R. Raghu Prasad (Part Time)

Scientist-in-Charge

Shri L.R. Kasturirangan

Scientist

Dr. R.V. Unnithan

Senior Scientific Assistants

Shri P. Gopala Menon

Shri M. Sakthivel

Shri K.J. Peter

Pool Officer

Dr. C. Sankarankutty

Junior Scientific Assistants

Shri P.N. Aravindakshan

Shri Jacob George

Shri George Peter

Shri V.T. Paulinose

Smt. Vijayalakshmi R. Nair

T. Balachandran

Smt. Lalithambika Devi

Shri T.C. Gopalkrishnan

Smt. Dr. M. Saraswathy

Senior Research Fellows

Dr. N. Ravindranatha Menon

Shri S. C. Goswami

Junior Research Fellow

Shri K.K. Chandrasekharan Nair

3. Physical Oceanography Division, Ernakulam

Scientist-in-Charge

Dr. V.V.R. Varadachari

Scientist

Shri V.S. Rama Raju

Senior Scientific Assistants

Shri C.S. Murty

Shri P. Udayaverma Thirupad

Junior Scientific Assistants

Shri P.K. Das

Shri V. Harihann

Senior Research Fellows

Shri P.S.N. Murty

Shri R.R. Nair

Shri Ch. Madhusudana Rao

Shri V. Narayana Pillai

Junior Research Fellow

Shri Thomas Cherian

4. Biological Oceanography Division, Ernakulam

Scientist-in-Charge

Dr. S.Z. Qasim

Senior Technical Assistant

Shri U.K. Gopalan

Scientists

Dr. B.N. Desai
Dr. M. Krishnan Kutty
Shri CV. Gangadhara Reddy

Junior Scientific Assistant

Smt. N. Santhakumari

Senior Scientific Assistants

Shri S. Rajan
Shri B.M. Panikkar
Shri P.M.A. Bhattathiri

Senior Research Fellows

Shri V.N. Sankaranarayanan
Shri P. Sivadas
Shri V.P. Devassy

5. Bombay unit of National Institute of Oceanography**Scientist**

Dr. T.S.S. Rao

Junior Scientific Assistant

Shri K. Kameswara Rao

6. Goa unit of National Institute of Oceanography, Panaji**Scientists**

Dr. M.G.A.P. Setty
Dr. N.K. Srivastava
Dr. P. V. Dehadrai
Dr. M.K. Chandrasekharan

Junior Scientific Assistant

Shri R.M. Kidwai

4. LIBRARY

The Library facilities are available at all the divisions and units of the Institute. At Eenakulam there is a common Library for all the divisions. At present National Institute of Oceanography Library is having 2957 books on various disciplines of oceanography. Library is subscribing for 25 journals and periodicals.

The library receives and issues books and periodicals on inter-library loan basis with the libraries of the various Institutions in the country. The copies of acquisition list (consisting of newly purchased books) are periodically distributed among the scientific staff to keep them informed of the additions to the library.

Documentation

Documentation work has been started in NIO on the following lines

1. Survey of the articles published on various disciplines of Marine Sciences by Indian authors from 1957-67 to explore the possibilities of starting a Journal of Marine Sciences.

2. Collection of bibliographical details of articles on Indian Ocean by Indian and foreign authors for the years 1967 & '68.

5. AWARDS, HONOURS & MEMBERSHIP OF VARIOUS COMMITTEES

1. Dr. N.K. Panikkar, Director, National Institute of Oceanography was elected as the President of Zoological Society of India.
2. Dr. S.Z. Qasim, Scientist, and Head of the Biological Oceanography Division participated as member of the SCOR/ IBP working group.

6. DEPUTATIONS

Dr. N.K. Panikkar Director, NIO, attended the meeting of the SCOR/ACMRR Working Party of the U.N. Resolution on the Resources of the Sea at Rome from 16th to 22nd July 1967.

Shri R. Jayaraman, Scientist and Head of the Planning and Data Division, was deputed to the U.S.S.R. for six weeks From 14th May 1967 under the Indo-Soviet Cultural Exchange Programme. During his stay in the Soviet Union, Shri Jayaraman visited the various laboratories of the Institute of Oceanology, Hydrometeorological Institutes in Moscow and Leningrad and the World Data Centre 'B' in Moscow.

Dr. V.V.R. Varadachari, Scientist and Head of Physical Oceanography Division:

- (i) Participated in 10-day Cruise in the Arabian Sea on board the U.S. R/V *Oceanographer* from 13th to 23rd June 1967.
- (ii) Visited U.K. under the CSIR-British Council Exchange agreement and spent three months from October 1967 to January 1968 at the Marine Science Laboratories at Menai Bridge, Anglesey, N. Wales. He also visited a few other Marine Laboratories during his stay to acquaint himself with the Oceanographical studies carried out there.

Shri P. Udaya Varma Thirupad, JSA, was deputed to USSR for 6 months for advanced training in Physical Oceanography with particular reference to waves and nearshore studies. Shri Varma spent his time at the Oceanographic Instt. of the Hydrometeorological Service, Moscow and the Instt. of Oceanology, Academy of Sciences, USSR, Moscow.

Sarva shri V.N. Sankaranarayanan, Senior Research Fellow, and K.J. Peter, Senior Scientific Assistant were deputed to Denmark to attend the Unesco-sponsored Advanced Training Course in Marine Biology in Copenhagen (May-June 1967). After completing the course Shri Peter visited Moscow, USSR, and spent some time at the Institute of Oceanology examining fish larval collection (with Special reference to Scombroid larvae) under the guidance of Prof. T.S. Rass. Shri Sankaranarayanan visited the Oceanographic Laboratory in Edinburgh and Marine Laboratory, Aberdeen to acquaint himself with the productivity studies.

7. DISTINGUISHED VISITORS

1. Dr. CV. Kulkarni, Director of Fisheries, Maharashtra.
2. Dr. Harinarain, Director, National Geophysical Research Institute, Hyderabad.
3. Prof. P.N. Ganapati, Professor of Zoology, Andhra University, Waltair.
4. Mr. Michael R. Ince, American Peace Corps, Cannanore.
5. Dr. John D. Costlow, U.S. Office of Naval Research, London Branch.
6. Dr. Aubrey W. Pryce, -do-
7. Mr. Wynford Davis, Washington D.C., U.S.A.
8. Dr. W. Aron, Smithsonian Institution, Washington, D.C, USA
9. Prof. H.A. Bern, University of California at Berkeley, USA.
10. Mr. Chi-yun Pao, Offshore Fishing Station, Cochin.
11. Prof. R.B. Clark, University of Newcastle upon Tyne, England.
12. Madame Madeleine Olivereau, Institute Oceanographique, Paris 5e, France.
13. Prof. Teodor S. Rass, Institute of Oceanology of the Academy of Sciences of the USSR, Moscow J. 387.
14. Dr. Alan D. Ansell, Marine Station, Millport, Scotland.
15. Dr. Ann Ralph, Marine Laboratory, Aberdeen, Scotland.
16. Dr. Anna M. Bidder, Cambridge University, England.
17. Dr. M.C. Merler, Fisheries Research Board of Canada, Biological Station, St. Johns, New Foundland.
18. Dr. J.B. Burch, University of Michigan, Ann Arbor, Mich., USA.
19. Dr. Ralph W. Dexter, Kent State University, Kent, Ohio, USA.
20. Dr. Alan J. Kohn, University of Washington, Seattle, Washington, USA.
21. Dr. F. Starmuhlner, Universitat Wien, Australia.
22. Shri S.H. Sathananthan, University of Ceylon, Colombo-3.
23. Shri D.H. Atapattu, University of Ceylon, Colombo-3.
24. Dr. P.I. Chacko, Deputy Director of Fisheries, Madras-6.
25. Dr. D.I. Williamson, Marine Biological Station, Port Erin, Isle of Man, U.K.
26. Dr. D.L. Fuller, Science Attache, U.S. Embassy, New Delhi.
27. Mr. P. Sandven, F.A.O., Rome, Italy.
28. Mr. G. Saetersdal, F.A.O. Rome, Italy.
29. Dr. H. Kasahara, United Nations Development Programme.
30. Dr. O.J. Ostvedt, Office of Oceanography, UNESCO, Paris.
31. Prof. J. Krey, Universitat Kiel, West Germany.
32. Dr. Vladmir N. Greze, Institute of Biology of South Seas, USSR.
33. Prof. B. Kimor, Sea Fisheries Research Station Haifa, Israel.

34. Dr. A. Fleminger, Scripps Institution of Oceanography, California, U.S.A.
35. Dr. Masateru Anraku, Seikai Regional Fisheries Research Laboratory, Japan.
36. Prof. S. Krishnaswamy, Madurai University, Madras State.
37. Dr. Bains Prasad, Former Fisheries Development Adviser of the Govt. of India, Ministry of Food and Agriculture, New Delhi.
38. Dr. T.N. Srivastava, President, Forest Research Institute & Colleges Dehra Dun, U.P.
39. Dr. A. Purushotham, Director of Biological Research, F.R.I. Dehra Dun,
40. Dr. S. Tewfik, Unesco Chief of Mission, New Delhi.
41. Dr. W. Eigeon Jones, Marine Science Laboratory, Menai Bridge, U.K.
42. Mr. Yasumasa Matsuzaka, Japanese Colombo Plan Expert, MPPTC, Mangalore.
43. Mr. Kaoru Okabe, " " "
44. Dr. Peter D.V. Savage, Deptt. of Oceanography, The University of Southampton U.K.
45. Dr. W. Koch, Visiting Professor from Germany at I.I.T. Madras.

8. EXHIBITION, SEMINARS, SYMPOSIA ETC.

- 8.1 Seminars (held at the Indian Ocean Biological Centre, Ernakulam)

<i>Name of the Speaker</i>	<i>Subject</i>
1. Shri M. Sakthivel	Distribution of the species of the genus <i>Desmopterus</i> (Mollusca, Pteropoda).
2. Shri K.J. Peter	General aspects of the study of fish eggs and larvae.
3. Prof. T.S. Rass	Taxonomy and identification of fish eggs and larvae.
4. Shri Jacob George	Appendages of Halocypridae (Crustacea, Ostracoda).
5. Dr. Alan Ansell	Biology of the Sandy beaches.
6. Shri V.N. Sankaranarayanan	Hydrology of Cochin backwaters.
7. Dr. D.I. Williamson	Excuses for studying Decapod larvae.

9. COLLOQUIA AND SPECIAL LECTURES

Lectures by visiting scientists at Ernakulam.

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<i>No. Name of the Lecturer</i>	<i>Deptt./Country</i>	<i>Subject of Lecture</i>
1. Prof. H. A. Bern	University of California at Berkeley, California, U.S.A.	Endocrines in fishes

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| 2. | Prof. R.B. Clark | University of Newcastle upon Tyne, U.K. | Reproductive Biology of Polychaeta |
| 3. | Prof. J. Krey | Marine Institute, University of Kiel, West Germany | Biological variability and heterogeneity in the sea. |
| 4. | Prof. J. Krey | | Drafts for an atlas of chemical biology of the Indian Ocean. |
| 5. | Prof. B. Kimor | Sea Fisheries Research Station, Haifa. | Plankton affinities between the Red Sea & the eastern Mediterranean Sea. |
| 6. | Dr. V.N. Greze | Institute of Biology of South Seas, Sevastopol, USSR | Trophic Composition in the Plankton Community. |
| 7. | Dr. M. Anraku | Seikai Regional Fisheries Research Lab. Japan | Hydrodynamical study of the high-speed plankton sampler. |
| 8. | Dr. A. Fleminger | Scripps Institution of Oceanography, University of California at La Jolla, California, USA. | Speciation in the pelagic environment. |

10. PUBLICATIONS

10.1 Publications of the Institution

1. National Report for India (1963-1966) *Physical Oceanography*
2. Oceanography in India (1962-66)
(Report of Indian Participation in the International Indian Ocean Expedition)
3. Annual Report, NIO, 1966-67.

10.2 Papers published by staff members

29. Desai, B.N. and M. Krishnan Kutty, 1967.
Studies on the benthic fauna of Cochin backwater. *Proc. Indian Acad. Sci. 46 (B)* 123-142.
30. Jayaraman, R., 1967.
Symposium on Coastal and Nearshore Oceanography. *Jour. Set. Ind. Res. 26 (1)*: 99-100.

31. Jayaraman, R., 1967.
Symposium on Indian Ocean. *Jour. Sci. Ind. Res.* 26 (5): 190-195.
32. Menon, K.R. and P. Sivadas, 1967.
Blood sugar regulation in the crab. *Scylla serrata*. 1. Effect on injecting eye stalk extract. *Indian Journ. Exp. Biol.*, 5(3): 176-78.
33. C.V.G. Reddy, Murty, P.S.N. and Sankaranarayanan, V.N., 1968.
An incidence of very high phosphate concentration in the waters around Andaman Islands, *Curr. Sci.*, 37(1): 17-19.
34. Panikkar, N.K., 1967.
Marine Fishery Possibilities of the West Coast of India. *Sea Food Trade Jl.* 2(1): 24-29.
35. Panikkar, N.K., 1967.
Osmotic Behaviour of Prawns in relation to their biology and culture. FAO World Symposium on *World Shrimp and Prawn Resources and their Culture, Mexico*. 1967.
36. Prasad, R.R., 1968.
I.I.O.E. Plankton Adas, Vol. I, Fascicle 1: Maps on total zooplankton biomass in the Arabian Sea and the Bay of Bengal (Issued by IOBC (NIO), CSIR, New Delhi.)
37. Peter, K.J. 1968.
A note on the record of *Rastrelleger* (mackerel) larvae from Indian Ocean, *Curr. Sci.* 36 (10): 273-74.
38. Varadachari, V.V.R. & G.S. Sharma, 1967.
Circulation of the surface waters in the North Indian Ocean. *Journ. Ind. Geophys. Union*, 4 (2): 61-73.
39. Rama Raju, V.S. and V. Hariharan, 1967.
Sea level variation along the west coast of India. *Bulletin NGRI*. 5(1 &2): 11-20.

