

**national institute of
oceanography india**

1968-69



ANNUAL REPORT

4

1968-69



NATIONAL INSTITUTE OF OCEANOGRAPHY

(Council of Scientific. & Industrial Research)

PANAJI, GOA.

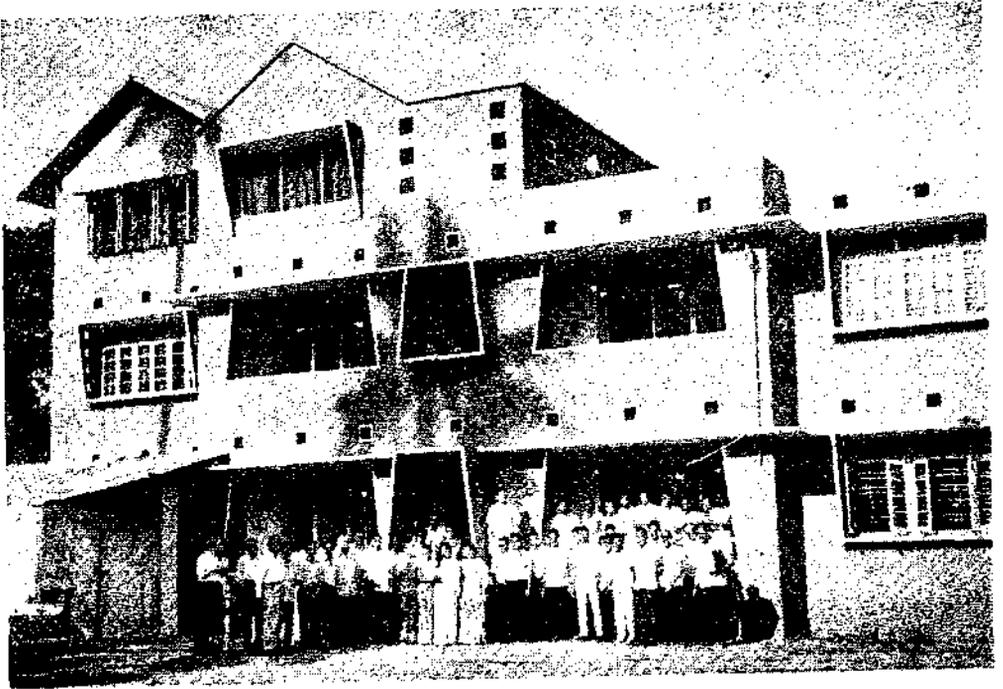
INDIA.

As we were going to press we have learnt with deep regret the death of Dr. D. N. Wadia, F.R.S. Chairman, Executive Council of the National Institute of Oceanography. Dr. Wadia died after a brief illness on 15th June, 1969.

He was the Chairman of the Indian National Committee on oceanic research and the first chairman of the executive council of the National Institute of Oceanography ever since its inception in 1966. Dr. Wadia's role in the development of Oceanography in India will long be remembered. A fuller account of his association with Indian Oceanographic programmes will be given in our next annual report.

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Photograph taken on the Occasion of the Workshop on
Plankton Methodology at Cochin, at the new Premises
of the Indian Ocean Biological Centre

Introduction

The report for 1968-69 is the fourth in the series of the Annual Reports of the National Institute of Oceanography since its inception. The current year's activities are highlighted in the report.

The Data Division which is functioning as the Indian National Oceanographic Centre is continuing to receive the Indian Ocean data from the World Data Centres A and B and also published data from individual countries like Australia and Japan. Apart from classifying, indexing and storing the data, the centre has initiated two projects based on the data collected during the International Indian Ocean Expedition. These relate to the distribution of dissolved oxygen and of nutrients in the Northern Indian Ocean. Oxygen distribution studies in the upper 500 meters of the north western Indian Ocean are in the stage of completion and a paper on the results is under preparation.

The highlights of the activities of the Indian Ocean Biological Centre are the completion of the basic sorting and taking up of detailed taxonomical and distributional studies on some of the important groups, the utilization of the results for the preparation of Indian Ocean Zooplankton Atlases and the release of the first and second fascicles of Vol. I of the General Properties Atlas giving charts of Total Zooplankton biomass in the Indian Ocean. In February of this year a workshop-cum-seminar on Plankton Methodology has been held at the centre and a brief account of this as well as the seventh meeting of the Consultative Committee, held about the same time finds mention in the report.

The Coastal and Nearshore investigations comprising beach profiles, wave refraction patterns and nearshore current measurements taken along the Kerala coast by the group at Cochin have provided valuable information on land-sea interaction processes involved in Coastal erosion along the coast. The need for more

quantitative measurements and also for extending the studies to some more areas has been indicated.

In addition to the existing investigations on productivity cycles and ecological conditions in the Cochin backwaters and nearshore areas off Cochin, studies of similar type have been started in the Laccadive seas, with a view to obtaining data on the productivity of waters in the Offshore island region and Coral lagoons. Some of the preliminary results of these studies are given in the report.

Brief mention is also made in the report of the collections and observations made in the Gulf of Cambay on board INS Darshak and the field programmes undertaken in the waters of the Goa region. The material collected in these surveys are under study by the different units of the Institute.

N. K. PANIKKAR
Director

2. NATIONAL INSTITUTE OF OCEANOGRAPHY, ITS DIVISIONS AND UNITS

As also reported in the previous annual reports, the National Institute of Oceanography, India is comprised of four full divisions and two field units which are detailed 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 Sannithi Road, Ernakulam-Cochin-18.	3384	Oceanology Ernakulam
(b) Indian Ocean Biological Centre University Oceanographic Laboratory, Foreshore Road, Ernakulam-Cochin-16.	33306	-do-
3. Physical Oceanography Division Karikkamuri Road, Ernakulam-Cochin-I I.	33538	Geophysics Ernakulam
4. Biological Oceanography Division, Karikkamuri Cross Road, Ernakulam-Cochin-I I.	31814	-do-
5. Bombay Unit of NIO, 169-170, BPT Buildings, Sassoon Docks, Colaba, Bombay-5.	213597	Oceanology Bombay
6. Goa Unit of NIO, Lalit Niwas, Miramar, Panaji (Goa)	2923	Oceanology Panjim

21 PLANNING & DATA DIVISION, NEW DELHI (Indian National Oceanographic Data Centre)

The work relating to data receipts, classification and indexing is in progress at the Indian National Oceanographic Data Centre. During the year under review, the centre

has received physical and chemical data relating to the Indian Ocean from the World Data Centre 'A', Washington, D.C. and World Data Centre 'B', Moscow, USSR. These data have been collected from 670 stations by five ships belonging to three countries viz. USA, USSR, and France. In addition to these data, oceanographic station lists and cruise reports from C.S.I.R.O., Australia, data relating to Cooperative Study of Kuroshio, Data of Oceanographic observations and exploratory fishings from the Shimonoseki University, Japan have been received. The centre has also received oceanographic data catalogues, volumes 1 to 6 from the World Data Centre 'A'.

The quality checking and plotting of data (physical and chemical) of INS KISTNA in respect of IIOE cruises 14 to 17, 19 to 22 and 25 to 28 have been completed and the corrected data have been transferred to standard cards. These are still to be exchanged with the World Data Centres. As a preliminary step to indexing and tabulation, data are being grouped into one degree latitude and longitude grids. Further processing will be under-taken after the work of grouping and transferring of data are completed.

Two projects have been undertaken in the Centre and are in progress :

- 1) Depths of occurrence of oxygen maximum and minimum in the upper 500 meters of the Indian Ocean. For these studies, preliminarily, the northwest Indian Ocean i.e. the region between the equator and 25° N latitude and 50-80° E longitude has been selected (this includes the Arabian Sea and Laccadive Sea). The data collected by various ships during the International Indian Ocean Expedition were pooled into one degree grids and analysed for getting patterns of distribution-seasonally and regionally.

The studies reveal that there is much variation in the depths of occurrence of oxygen maxima and minima in different areas and different seasons in the northwest Indian Ocean. Along the continental shelf all over the Arabian Sea, biological activity appears to play a predominant role in controlling the oxygen content, while in the open parts of the ocean the depths of occurrence of oxygen maxima and minima mainly appear to be governed by the water movements, circulation and mixing. One of the important observations is the existence of stagnant or near-stagnant conditions in the more central parts of the Arabian Sea, restricting the exchange of water masses with the adjoining seas.

After completing these analysis in the region, similar studies will be extended to southwest Indian Ocean, For this purpose, the area bounded between equator and 40° S upto Antarctic convergence zone and 20-80° E longitude has been selected. The grouping up of the data-seasonally and grid-wise is being in progress. The analysis part will be taken up after grouping up the data.

- 2) Concentration of total available nutrients in the upper 100 m. from the IIOE data.

The objective is to assess the total quantity of the nutrients in the upper 100 metres column and then to work out areas of potential productivity.

Initially the work was started on the available inorganic phosphate. For 160 stations occupied by R/V "VITYAZ" (USSR), the mean integral phosphate values were processed and plotted seasonwise. Data collected by R/V "ANTON BRUUN" (USA) are being screened, processed and computed. Likewise data collected by other ships would also be analysed and studied.

Later on it is also intended to extend similar studies to other nutrients like nitrates and silicates.

Data and Publications pertaining to Oceanographic Data and Catalogues received at Indian National Oceanographic Data Centre during 1968-69 from various sources.

1. Data received from World Data Centre 'A', Washington, USA.

<i>Country</i>	<i>Ship</i>	<i>Particulars of data</i>	<i>No. of stations</i>
FRANCE	NORSEL	Physical	15
		Physical	119
	COMM. R. GIRAUD		98
U.S.A.			120
		Physical	101
U.S.S.R.	SERRANO	Physical & Chemical	63
			79
		Physical & Chemical	14

2. World Data Centre 'B' Moscow, USSR (Microfilm Data)

U.S.S.R.	ORLIK	Physical & Chemical	60
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- 3) Data Report : Physical, Chemical and Current measurement data of Lusiad Expedition by R/V ARGO (USA) - Scripps Institution of Oceanography Ref. No.68-14.
- 4) Catalogue of data : Oceanography : Published by world Data Centre 'A', Washington, D.C., USA, Vols. 1-5.
- 5) Oceanographical cruise Reports from Division of Fisheries and Oceanography, CSIRO. Australia.

<i>Report No.</i>	<i>Ship</i>	<i>Cruise No.</i>	<i>Particulars of Data</i>
3	HMAS DIAMANTINA	Dm2/60	Physical.Chemical & Biological.
4	"	Dm3/60	Physical & Chemical
7	"	Dm1/61	Physical, Chemical & Biological

9	HMAS DIAMANTINA	Dm2/61	Physical, Chemical & Biological.
10	HMAS GASCOYNE	G2/61	-do-
11	HMAS DIAMANTINA	Dm3/61	-do-
12	HMAS GASCOYNE	G3 / 61	-do-
13		G1 / 61	-do-
14	HMAS DIAMANTINA	Dm1/62	-do-
15		Dm2/62	-do-
16	HMAS GASCOYNE	G2/62 & G3/62	-do-
20	HMAS DIAMANTINA	Dm4/62	-do-
21	HMAS GASCOYNE	G1/63	-do-
22		G2/63	Physical & Chemical
		Dm1/63	Physical, Chemical &
23	HMAS DIAMANTINA		Biological.
		Dm2/63	Physical, Chemical &
24	HMAS DIAMANTINA		Biological.
		Dm3/63	
25		G3 / 63	
26	HMAS GASCOYNE	G4/63	Physical & Chemical
29	HMAS GASCOYNE	G1/64	
32		G2/64	
34		G4/64	
39		Dm4/64	Physical, Chemical &
40	HMAS DIAMANTINA		Biological.
41	HMAS GASCOYNE	G5/64	Physical & Chemical
43		G2/65	Physical & Chemical
46		G5/65	

- 6) Oceanographical Station List : Investigations made by the Division of Fisheries and Oceanography, CSIRO, Australia.
vols. 54, 56, 57, 58, 59, 60, 61, 63, 65, 66, 69, 71, 74, 76, 79, 81 and 85
- 7) Preliminary Data Report of CSK published by the Japanese Oceanographic data centre, Tokyo, Japan.
Nos. 64, 65, 73, 75, 82, 86, 89, 90, 92, 94, 96, 97, 98, 99, 100, 103, 104, 105, 106, 108, 109, 110, 111, 113, 114, 116, 117, 124, 125, 126, 127, 128, 130, 133, 134, 136, 138, 139, 142, 145, 154, 157, 161, 162 and 163,
- 8) C.S.K. News letter published by Japanese Oceanographic Data Centre, Tokyo, Japan.
No. 16 only.
- 9) Data Oceanographic Observations and Exploratory Fishings : by Shimonoseki University of Fisheries, Shimonoseki, Japan.

- i) No. 3 - Eastern Pacific Ocean Cruise and Central Atlantic Ocean Cruises, Feb. 1968.
- ii) No. 4 - Oceanographic Surveys of the Kuroshio and its adjacent waters 1965 and 1966, March. 1968.

2.2 INDIAN OCEAN BIOLOGICAL CENTRE, COCHIN-18

Founded in November 1962, the Indian Ocean Biological Centre is now in its Seventh year of Scientific activity. In June 1968 it completed its main function of basic sorting of the standard samples of zooplankton lodged in this Centre to form the "International Zooplankton Collections" and has followed up with a programme of advanced sorting and research on various individual categories of zooplankton. It is now widely known in India and in other countries as a centre of active marine plankton research. Mr. D. J. Tranter, Unesco Curator of the International Collections, who took charge in November 1967, continued during the period, 1968-69.

(a) Plankton Sorting

Number of sorted samples on 31-3-1968	1815
Number of samples sorted, April to June 1968	- 112
Number of samples set aside for regional study	- 234

The present number, 2161, which is less by 20 as compared to figures given in the earlier years, is the final figure. It was arrived at after full checking-up of the entire collections and elimination of duplicate samples, in the course of the preparation of the station list for publication in part I of the Handbook to the International Collections.

The 234 samples set aside, are all from a very restricted coastal area to the east of South Africa and will form a part of a separate study. They do not contribute to the picture of geographical distribution over the Indian Ocean, presented by the 1947 sorted samples.

(b) Plankton Research

The year just concluded saw the publication of the first and second fascicles of the "General Properties Atlas". These two fascicles were prepared by Dr. R. R. Prasad and they contain charts of Total Zooplankton Biomass in the Indian Ocean. The first fascicle includes charts relating to the Arabian Sea and the Bay of Bengal, while the second fascicle includes charts for the Indian Ocean as a whole.

The Programme of work on Crustacea, decapoda (larvae) initiated by Shri M. Krishna Menon, who retired in October 1967, was continued in 1968-69 by Sarvashri P. Gopala

Menon and V. T. Paulinose. Shri L. R. Kasturirangan, Scientist and Associate Curator continued his interest in the Copepoda of the IIOE Collections and he is planning his programme on the Harpacticoid copepoda which have been assigned to him for study. Dr. R. V. Unnithan, Scientist is proceeding with examination of the Platyhelminthes of the IIOE Collections and his studies on the micro-associates of marine fishes. Research studies are being carried out along with advanced sorting by the following persons on groups indicated :—

- | | |
|-------------------------------------|---------------------------------------------------------------------|
| 1. Shri P. Gopala Menon | - Decapod Larvae : Solenocerinae and Aristaeinae |
| 2. Shri M. Sakthivel | - Euthecosomes (Mollusca, Pteropoda) |
| 3. Shri K. J. Peter | - Fish larvae : Clupeidae, Engraulidae, Scombridae |
| 4. Dr. M. Saraswathy | - Copepoda : Pleuromamma, Gaussia; Lamellibranch Larvae of the IIOE |
| 5. Shri P. N. Aravindakshan | - Heteropoda (Mollusca) : Carinariidae Pterotracheidae |
| 6. Shri Jacob George | - Ostracoda |
| 7. Shri George Peter | - Pelagic Polychaeta |
| 8. Shri V. T. Paulinose | - Decapod larvae : Penaeinane |
| 9. Mrs. Vijayalakshmi R. Nair | - Chaetognatha |
| 10. Shri T. Balachandran | - Pelagic Anthozoa |
| 11. Smt. C. B. Lalithambika Devi | - Fish Larvae : Pleuronectiformes |
| 12. Shri T. C. Gopalakrishnan | - Pelagic Foraminifera |
| 13. Shri K. K. Chandrasekharan Nair | - Amphipoda : five families of Hyperideida |
| 14. Smt. K. Sarala Devi |) - Copepoda : Haloptilulus |
| 15. Smt. Rossamma Stephen | |
| 16. Dr. C. Sankarankutty | - Brachyura larvae (3 families) |
| 17. Dr. N. R. Menon | - Cyphonautes larvae |
| 18. Shri S. C. Goswami | - Copepoda : Oithonidae |
| 19. Dr. Saramma Abraham | - Copepoda : Acartiidae & inshore Centrepagidae |
| 20. Dr. R. V. Unnithan | - Platyhelminths of the IIOE |
| 21. Shri. L. R. Kasturirangan | - Copepoda : Harpacticoida |

Among the Scientists who visited IOBC during 1968-69 to examine IIOE sorted material and advise on their further study, the following may be mentioned. Dr. R. V. Nair examined the Salps and other tunicate material in April 1968. Dr. Richard Hamond of Cronulla (April-May 1968) had suggestions for designing zooplankton identification sheets. Dr. H. E. Gruner of the Zoological Museum of Berlin and Dr. T. E. Bowman of the Smithsonian Institution, Washington, D. C, U.S.A. were at IOBC for eight weeks' stay (October-November 1968) and examined the sorted Amphipoda and gave reports on this taxon for its further sub-sorting and distribution to specialists. Dr. M. Vannucci

from Sao Paulo. Brazil was at IOBC from December 1968 to March 1969, examining and reporting on the IIOE Hydro-medusa. The visits of these Scientists afforded stimulus to various sections of the IOBC staff to attain further progress in their work.

(c) Distribution of material to Specialists

The following are the major items sent out for study.

Siphonophora	- Mrs. Ruby Daniel, Calcutta-12.
Mysids (additional stations)	- Dr. N. Krishna Pillai, Trivandrum.
Decapod Larvae	- Dr. Makarov, Moscow
Decapod Larvae	- Dr. A. L. Rice, London
Decapod Larvae	- Dr. Dechance, Paris
Leptocephalus larvae	- Dr. Castle, Copenhagen
Cephalopoda (juveniles)	- Dr. Taki, Japan
Isopoda	- Dr. E. Naylor, Swansea (UK)
Phyllosoma larvae	- Shri P. R. S. Tampi Madras
Nudibranchiata	- Dr. H. Lemche, Copenhagen.
Brachiopod larvae	- Dr. S. H. Chuang, Singapore

(d) Handbook to the International Zooplankton Collections

Part I of this Handbook, containing introductory information and station list has been published in January 1969. Further parts of this Handbook are in preparation. The second part will be devoted to environmental data associated with the stations of part I.

(e) Workshop on Plankton Methodology

The high-light of the year's work at IOBC was the Workshop organized by its members during 17th to 22nd February, 1969 with participation by a number of distinguished scientists from outside India. The workshop (the name implying emphasis on actual operations in the field besides formal discussions and reading of papers) was held in the Seminar-room of the newly occupied building of the IOBC on Pullepady Road, in Ernakulam, Cochin. One full day, (19th February) was devoted to a demonstration cruise on the "Blue fin" (a vessel belonging to the C.I.F. Operatives) during which all the field trials with gear and collection techniques were demonstrated. Papers were read by the following persons from IOBC :

T. Balachandran	M. Sakthivel
T. C. Gopalakrishnan	M. Saraswathy
S. C. Goswami	K. Sarala Devi
C. B. Lalithambika Devi	Rosamma Stephen
N. R. Menon	D. J. Tranter
K. J. Peter	P. Venugopal

In addition to above, the following scientists presented papers and participated in the discussions.

Dr. M. Anraku	Dr. B. Kimor
Dr. Allan W. H. Be	Dr. S. Krishnaswamy
Dr. J. H. S. Blaxter	Dr. O. J. Ostvedt
Dr. D. M. Damkaer	Dr. S. Z. Qasim
Dr. A. Daniel	Dr. G. R. Seth
Dr. V. N. Greze	Dr. M. Vannucci

Seventh Meeting of the Consultative Committee for IOBC:

The seventh meeting of the Consultative Committee for IOBC was held at Ernakulam from 24th February, 1969 to 1st March 1969. Following participated.

1. Prof. J. Krey	Chairman
2. Prof. S. Krishnaswamy	Member
3. Dr. Masateru Anraku	Member
4. Dr. V. N. Greze	Member
5. Dr. B. Kimor	Member
6. Prof. J. E. Smith	Member
7. Dr. N. K. Panikkar	Member - Secretary
8. Dr. G. F. Humphrey	SCOR Observer
9. Dr. O. J. Ostvedt	UNESCO, Paris
10. Dr. D. A. Boutaev	UNESCO, New Delhi
11. D. J. Tranter	UNESCO, Curator at IOBC
12. Mr. L. R. Kasturirangan	Associate Curator at IOBC
13. Dr. R. R. Prasad	Indian Advisory Board
14. Prof. P. N. Ganapathi	Indian Advisory Board
15. Dr. K. K. Tiwari	Indian Advisory Board
16. Dr. S. Z. Qasim	N.I.O. (India)
17. Dr. T. S. S. Rao	N.I.O. (India)
18. Dr. Marta Vannucci	Visiting Scientist
19. Dr. Alan Be'	Visiting Scientist
20. D. M. Damkaer	Visiting Scientist

Dr. N. K. Panikkar, Director, IOBC, presented an account of progress made by IOBC in 1968-69, and referred to the successful conclusion of the basic sorting programme, the developing research activities, the additional facilities provided for research work, the new home of the IOBC in the rented building at Pullepady, the allotment of building-site for IOBC on the foreshore etc. He drew attention also to the publication of two fascicles of the Plankton Atlas, "The Handbook to the International Collections" Part I and to other publications taking shape. He also referred to the visits of Dr. Gruner, Dr. Bowman and Dr. Vannucci.

The UNESCO Curator, Mr. D. J. Tranter in his report emphasized the changing character of different types of work at IOBC, the increase in field activities, In discussions and seminars, to the need for further facilities in library, care of optical instruments, care of collections etc. He reviewed progress in distribution of material to specialists and to the complexities in programmes of advanced sorting, and the intricate problems they pose.

Recommendations of the Consultative Committee:

(1) The consultative Committee noted with satisfaction the progress reviewed in the reports for 1968-69 of the Director and Curator and recommended that they be published in full, in the IIOE Information Paper.

(2) The Consultative Committee requested the Curator to prepare a guide-book to the IOBC for the Secretariat of the IOC before May 1969 in accordance with the lines given in the report discussed at the seventh meeting of the Consultative Committee, and necessary consultations with the Director.

(3) The Committee, noting the operation of the Plankton Sorting Centre for the Co-operative study of Kuroshio (CSK) at the Regional Marine Biological Centre in Singapore established under an agreement between UNESCO and the Singapore Government; recommended that the Unesco should encourage close collaboration between IOBC and the Singapore Centre with regard to sorting and curatorial procedures through exchange of information and visits of staff between the two centres.

(4) The Committee noted with satisfaction that basic sorting of 1927 samples was already completed. The more difficult and complicated task of subsorting and specific sorting had now become a priority. The Committee, therefore, recommended that Research Fellows may participate in the sorting programme of the Centre and all qualified staff be given opportunities for research.

(5) (a) The Consultative Committee recommended that owing to the urgency to finish sub-sorting of fish eggs and larvae in a short time, two specialists from the Institute of Oceanology Moscow be invited to come to IOBC for 2 to 3 months in 1969 to collaborate in subsorting. This could possibly be arranged under the bilateral agreement between India and USSR for exchange of specialists.

b) The Committee recalling the report by Dr. Alhlstrom, further recommended that the team under Mr. K. J. Peter be authorised to give a general account on the distribution of fish eggs and larvae arising out of the basic and subsorting programmes and that the report be made available as soon as possible.

(6) The Consultative Committee, having considered the progress made in the basic sorting and subsorting of samples and recognising the special difficulties that arise in the subsorting of the group Copepoda, recommended that Prof. Krishnaswamy be

invited, in collaboration with Dr. J. E. Smith to discuss by correspondence with Dr. Fleminger, the alternative methods of processing samples to expedite subsorting and distribution of the group to the specialists.

(7) The Consultative Committee, noting the need for Mr. Gopala Menon to collaborate with Dr. Williamson (Port Erin) and for Mr. Paulinose to collaborate with Dr. Dechance (Paris) on working up taxa from the International collections, recommends that UNECSO provide the necessary facilities for them to do this.

(8) The Consultative Committee recommended that the Curator to invite the following specialists to examine material from the International Collections :

Cirripede Larvae	Daniel (Alternative - Wagh)
Pelagic Tunicata	Nagabushanam (Alternative - Godeaux)
Cladocera	Delia Croce (Possible collaborators : Tiwari, Kimor Mordulay, Boltovskoy)
Tornaria	K. P. Rao
Trochophore	Thorson
Meroplanktonic Gastropoda	Pilkington
Tanaidacea	Karl Lang (Alternatives - Batescu, Kurian)
Echinoderm Post-larvae	L. Fenaux (Alternative - Tortonese)
Actinotrocha Larvae	Wilson (Alternative - Thorson)
Halobates	Hinton

(9) The Committee took note of the reports by Dr. Gruner (Berlin Zoological Museum, G. D. R.) on Amphipoda; by Dr. Allen Be (Lamont Geological Observatory, USA) on Foraminifera and Dr. M. Vannucci (San Paulo, Brazil) on Hydromedusae, and recommended that the three reports be printed in the IIOE Information Paper.

(10) The Committee reviewed the present position regarding the material distributed on loan to institutes and recommended that the Curator may send a letter to each specialist (with a copy to the Institute) for a periodical progress report in accordance with the Rule of Procedure. Copies of progress reports would be distributed at regular intervals to the members of the Committee and to UNESCO.

(11) The Committee recorded its approval and appreciation of the Workshop on Plankton Methods organized at the IOBC from 17 to 23 February 1969, and complimented the Curator and the staff on the success of the workshop. It recommended that similar activities be organized at 2 to 3 year interval and agreed to the suggestion that "Taxonomy of Tropical Plankton Organisms" was a suitable topic for the next workshop to be held in 1971.

(12) The Committee noted the important use which would be made of the first and second fascicles of Volume I of the Plankton Atlas issued by IOBC and made some suggestions how these could be improved. The Committee requests the General Editor of the series to give a report to IOC on the progress of work and a detailed proposal for further parts of the Atlas including those on special categories of organisms and involving the use of computer plotting.

(13) The Committee welcomed the publication of the "Handbook" to the International Collections Volume I, Station List: commended on the high quality of the production of work at low cost. It recommended that the next volume be published describing methods used on the International Collections at IOBC along with the relevant information at the workshop on Plankton Methods (February 1969).

(14) The consultative Committee noted the original aim of the IOBC to build up reference collections at the Centre and endorsed the proposal of the Curator that a start should now be made by the staff at IOBC towards this end.

(15) The Consultative Committee recognized the need for identification sheets of tropical zooplankton in research and teaching and recommended the proposal of Dr. Hamond (CSIRO, Australia) concerning such sheets for close consideration by UNESCO,

(16) The Consultative Committee presumed that the basic sorting and despatch of the International Collections to specialists will be completed in 1969 and that the present UNESCO-CSIR (India) agreement will end in December, 1970. The Committee recognised the commendable contribution made by the Indian Ocean Biological Centre to the International Indian Ocean Expedition, and realized the need for further training and research projects proposed for the region, the Committee recommended that before the next meeting of the Committee, UNESCO should give active consideration to the role which the Indian Ocean Biological Centre, in its present or in an altered form, could play in the marine science activities in the region and elsewhere.

(17) The Consultative Committee requested the Chairman and Secretary of the Committee and the UNESCO Curator to keep the committee members of the National Institute of Oceanography informed of matters relating to the IOBC which fall within the terms of reference of the Committee. The files of correspondence relating to International Collections will be maintained at the IOBC.

2.3 Physical Oceanography Division, Ernakulam

The research activities of the divisions may be broadly divided into the following four categories :

- a) Physical studies of the waters of the Indian Ocean.
- b) Coastal and Nearshore Oceanography Studies.
- c) Physical and Chemical Studies of the shelf sediments off the coasts of India.
- d) Estuarine studies.

Details of studies :

a) Physical studies of the waters of the Indian Ocean :

Vertical stability parameters were evaluated for the waters in the shelf region along the west coast of India and at a few selected stations in the open ocean regions of the Arabian Sea, using the temperature and salinity data obtained during the International Indian Ocean Expedition.

Studies on the seasonal and space variations of the stability of the waters in the Equatorial regions show that large variations in stability occur in the upper 25 meters and the stability maximum occurs at a depth of 100 meters which is associated with the thermocline. North of 8° N. Latitude the surface waters show unstable conditions while south of it more or less stable conditions prevail.

Studies on the sea water sampling scheme data were continued. These studies show that along the east coast of India the annual range of temperature of the surface waters increases from 3.6° C at Madras to 5.8° C at Sandheads. There is a progressive increase in the range of surface salinity along the coast and the range is more on the east coast as compared to the west coast.

b) Coastal and Nearshore Oceanography Studies :

The programme of beach profile measurements, nearshore current measurements at selected stations along the Kerala Coast, wave refraction studies for waves of different periods and directions of approach, beach material studies and studies on the mud banks along the Kerala coast were continued.

Beachprofile studies : Altogether 151 beach profile measurements were made during the year at the selected points along the Kerala Coast as per the details given below :

Narakkal	22
Elankunnapuzha	21
Saudi	18
Manasserry	16
Thumboli	25
Punnapra	24
Purakkad	25

The General variations and some important features at these stations are given in the table below.

Studies on the beach changes along the coast during the year show that erosion took place over a vast stretch of the coast in June '68 resulting in a considerable damage to life and property. The beaches have recovered during the subsequent months and there is no major annual change in the beaches during the year.

TABLE

<i>Station</i>	<i>Range of width of the beach during the year (in meters)</i>	<i>Stable portion of the beach from the ref. point (in meter)</i>	<i>Max. vertical variations on the beach (in meters)</i>	<i>Vol. changes from 1-4-68 to 31-3-1969 in cubic meters per unit length of the coast line.</i>
Narakkal	30 to 60	15	1.3	6.95
Saudi	50 to 70	nil	1.2	10.75
Manasserry	25 to 45	nil	0.8	4.05
Thumboli	70 to 85	45	2.5	2.95
Punnapra	60 to 110	35	2.3	120.0
Purakkad	45 to 70	30	2.4	28.45

ELANKUNNAPUZHA:—Stable portion of the beach at this place could not be determined as the observations fall on the seaward side of the seawall.

OCHANTURUTH :—The observations were not being made since September, 1967.

Current measurements: Observations on the coastal currents at a few selected stations along the Kerala coast were continued and these observations were extended to Mangalore region also. These observations show that the southerly current prevails along the coast from February to October and the northerly current exists from November to February. While the currents have in general, speeds less than 0.5 Kts. a few observations during the monsoon period revealed strong currents.

Wave refraction studies : Studies on wave refraction in relation to beach erosion at Thotapally were continued. From the refraction diagrams the refraction functions and the direction functions were evaluated and from these values the percentages of the deep water wave energy available at the shore line were computed. Also the stabilities of different sections of the coast line were determined taking into consideration the direction function and the mode of littoral transport. These studies show that for waves approaching from 200°, 220°, and 240° the littoral transport is towards the north; for those approaching from 280° and 300° the transport is towards the south. However for waves coming from 260° the transport along the shore is variable in direction and shows diverging

littoral currents at certain places and converging currents at other places. The energy distribution is uniform for low period waves and is more variable from point to point for higher period waves.

Breaker heights and wave energy computation : Attempt has been made to compute the breaker heights, breaker depths, Kinetic energy and solitary wave energy in respect of deep water waves of periods 4 to 6 secs, and height varying between 2', approaching the coastline from 270°, along the coast of Kerala. The studies show that a higher proportion of the total energy appears to be available in the form of solitary wave energy for lower period waves as compared to higher period ones.

Studies on Mudbanks: As part of the investigations on the mudbanks along the Kerala coast, laboratory experiments were conducted and it was found that the property of flocculations is an important and affective mechanism in bringing about the settlement of the colloidal size sediments. The studies indicate that the sediments are liable for greater transport in waters of low salinity than those of higher salinities. Laboratory studies were also made to assess the role of organic matter as stabilizing agent for colloidal mud particles. It was found that the samples free from less organic matter had slightly higher flocculation rates than those containing less organic matter. It is thus possible that in a region of mudbanks organic matter in the sediment may also help in preventing flocculation and keeping the material in suspension.

Studies are being made of the wind and wave conditions prevailing in the mudbank regions, from direct observation as well as from computations from isobaric charts. Sediment samples were collected from Narakkal and Neerkunnam mudbank region during different seasons and the calcium carbonate and the organic carbon content are being studied in order to understand their variations :

Sedimentation in the Cochin harbour: In order to understand the problem of sedimentation in the Cochin Harbour regular collection of water samples and sediment samples were being made at eight stations fixed along the Ernakulam Channel and the channels around the Wellington Island and the Entrance channel to the harbour. The bottom sediments were analysed for their grain size and other physical parameters like median diameter, sorting coefficient and skewness etc. The variation of quantity of suspended particles in relation to tide is also being studied.

C) Physical and Chemical Studies of the shelf sediments off the coasts of India.

Studies on the trace elements in the marine sediments along the west coast of India:

In continuation of the studies on the manganese as part of the programme aimed at understanding the nature and distribution of different trace elements in the marine sediments along the west coast of India the distribution pattern of cobalt, nickel and titanium were studied. These trace elements were estimated in the sediments colorimetrically using

the methods described by Sandell, and the measurements were made by using the UNICAM SPECTROPHOTOMETER. The titanium content was determined in the total as well as slit-clay fraction. Cobalt and nickel were estimated in the sediments in the slit-clay fraction and clay fraction separately.

The studies show that titanium content decreases along the coasts from south to north and also seaward from the coast. Cobalt and nickel show an increasing trend from south to north. The values for cobalt and nickel vary from 8 to 40 parts/mill, and 12 to 62 parts/mill, respectively.

d) Estuarine Studies :

The observational programme at the three stations established in the Cochin backwaters was continued. An analysis of the data collected over a number of years show that the salinity is greatly influenced by the rainfall and run off during the southwest monsoon season. The month to month total river flow changes are closely reflected in the monthly means of the variations in salinity of the backwaters during the monsoon. While the dilution of the backwaters takes place quickly at the onset of the monsoon the recovery of the salinity in the post monsoon season is rather slow. High salinity water is noticed at the bottom in the October and November months of all the years, with much lower values of surface salinity.

Studies on the extinction coefficients show that the monthly mean extinction coefficient in these backwaters is high as compared with the values of the coastal waters. Highest values of extinction coefficient were noticed in the months of July and August associated with the muddy waters present.

The investigations also show that the mixing of the waters is predominantly influenced by the tidal flow during the summer months and by land drainage and river flow during the monsoon.

2.4 BIOLOGICAL OCEANOGRAPHY DIVISION, ERNAKULAM :

The research activities of the Biological Oceanography Division have been intensified considerably. While some aspects of the programmes which were initiated in earlier years have reached completion, several new programmes have been started during the current year. The investigations and the progress made are briefly reviewed below :

A. STUDIES ON THE COCHIN BACKWATERS:

(1) Nutrients of Cochin Backwaters: The distribution of nutrient in the Cochin Backwater was studied at six stations throughout the year. The depth profiles of

phosphorus (inorganic and organic), nitrogen (nitrate and nitrite) and silicon showed a marked seasonal rhythm, induced by the local precipitation and land run-off. Changes in other environmental features such as temperature, salinity, dissolved oxygen, pH and alkalinity were small during the pre-monsoon period when the system remains marine-dominated, and large during the monsoon period when the estuary becomes freshwater dominated. Seasonal changes in the hydrographical conditions of the adjoining coastal waters of the Arabian Sea have a marked influence on the nutrient distribution and environmental characteristics of the backwater.

(2) Detritus of Cochin Backwater: For regular sampling of detritus settling in shallow water, an apparatus was designed which could be anchored in an up-right position. A vessel which could be closed, brought to the surface and replaced was incorporated in the apparatus. The apparatus was operated at the selected site in the Cochin backwater which varied in depth between 1.5m to 2.5m at low and high tides respectively. The collections of detritus were made every month. In the laboratory the material was centrifuged, washed with distilled water and dried to constant weight at 50°C. Since the mouth area of the collecting vessel was known it was expressed as dry weight/cm² / month. Suitable sub-samples were taken for the analysis of organic carbon and chlorophyll of the detritus before drying the material. The range in the total quantity of the detritus was 0.30—1.80 g/cm²/month. The values of organic carbon ranged 33.9—42.3 mg/g. detritus and of chlorophyll from 3.10—15.0/μg/g detritus.

(3) A problem related to the food chain in Cochin Backwater.

The average daily net production of the backwater as determined by C¹⁴ assimilation is approximately 124 gC/m²/Yr. The estimated annual consumption by the zooplankton herbivores as determined by the daily metabolic requirement in terms of carbon (12% of their dry weight) is only about 30gC/m². This indicates that the zooplankton herbivores leave behind a large surplus of basic food in the estuary. From the general composition of the zooplankton crop, however, there seems no evidence to suggest that the herbivores population is largely kept at a minimum because of the presence of a large number of carnivorous forms.

The "apparent wastefulness" of the primary production, however, may not remain so well marked, if we consider that the unconsumed material is used more efficiently by the other members of the estuarine eco-system. This raises the possibility of several "alternate pathways" in the food chain. One such pathway is directly linked with the herbivorous fishes (mulletts) which are always present in the estuary in appreciable numbers. Another link from the basic food is with prawns and shrimps through detritus, as the backwater is well known for its rich crustacean fishery. Finally, a substantial portion of the food which keeps sinking to the bottom is utilised directly by the sedentary animal communities. The small depth of the euphotic zone greatly increases the sinking rate and thus

prevents an excessive outburst of the phytoplankton bloom at any one time of the year. The unconsumed food, which, on reaching the bottom becomes a part of the sediment, is chemically and biologically altered by the decomposers, but still remains in the system to take part in the cycle of events over and over again.

(4) Studies on the regeneration of nutrients in Cochin Backwater

Laboratory experiments were conducted on the process of regeneration of nutrients by obtaining mud samples from three different locations in the backwater. One site was in the marine zone whereas the other two were in brackish water zone. The mud samples were kept in three different aquarium tanks and the phosphorus concentrations in the water just above the mud (mud-water interface) were determined in relation to time as an index of regenerative activity of phosphates in the sediment. Changes in the redox potential and pH of water and mud were also measured simultaneously. The results indicate that in the marine zone it is relatively faster. In such brackish water areas, however, where freshwater remains predominant the process again becomes slow.

B. FISH AND FISHERIES:

Studies on the theoretical models: The estimation of optimum conditions of exploitation with special reference to tropical fish populations were examined during the period under review. Since age-determination is difficult in tropical fish populations, it is thought that any such methods which do not directly involve the element of time would be more suitable to the tropical environment. This was made possible through appropriate substitutions in the basic equation. Hence, in the light of these modifications the applicability of some of the existing methods for determining (a) the optimum size-limit and the maximum yield for a given fishing intensity (b) the corresponding parameters for a fixed mesh size and (c) the potential yield when age-reading is not possible were examined. These derivations not only include the usefulness of limited information on some vital parameters but are also applicable to allometric growth conditions and overrule the graphical methods of estimation.

C. STUDIES ON LARVAL STAGES OF BRACHYURA.

Attempts were made to rear the larvae of Brachyuran crabs in the Laboratory and so far two species have been reared upto the first stage. This has made the correct identification of the larval stages possible as the eggs were obtained from the adults and reared in an aquarium tank.

D. BEACH STUDIES.

The Sandy beaches of Kerala are subject to considerable erosion with the result that continual reclamation and engineering works of different types are going on consis-

tently. The problem of coastal erosion in certain areas has become so acute that each year it threatens the life and property of hundreds of inhabitants. While the Physical Oceanography Division has undertaken a long term study of the problems of coastal erosion, the Biological Oceanography Division has considered it very desirable to study the ecology of the fauna of some rapidly changing sandy beaches. This study is particularly important with reference to food chain as some young demersal fishes are well known to migrate to the sandy beaches for food during the high tide. The aim of this study is to estimate the biomass of the macro and micro-invertebrate fauna, and to study a few important species in more details for respiration, growth rate, reproduction, biochemical composition and behavior. The following two beaches were selected for these studies :

1) Sherthallai: This beach has an extensive berm with shallow slope, having an exposure of about 40m at low tide, substrate of fine sand overlying a layer of coarse shell fragments. The depth of the fine sand layer varied and this was reflected in the quantity of material retained in the 1mm mesh sieve used in collecting macro-benthic samples. Beach profiles were made throughout the year and marked changes in the profile were found affecting the height of the berm and the depth of fine sand from time to time.

2) Cochin Beach (Fort Cochin)—Extensive berm, but beach with a much steeper slope and fairly coarse sand. Exposure at low-water 10-12m.

Both beaches are exposed to continuous surf action with a time frequency of 1 wave/6-9 seconds. Water temperature, air temperature and temperatures at various depths in the sand along traverses of the beaches were taken throughout the year. The temperature of the exposed sand near the surface is generally higher than that of the sea water but decreases with depths to approximately that of the sea surface temperature at the level of the water level. The sea temperature and air temperature in the shade ranged 30-32°C during the pre-monsoon months and 26-28°C during the monsoon months. The temperatures in the sun and on the surface of dry sand were up to 50°C. A slight breeze caused rapid changes in surface temperatures with a drop of 5 to 10°C. Other studies were carried out as under :

i) Chemical measurements : Regular determination of chlorophyll and organic carbon in the sand and phosphate, salinity and oxygen in the surface water for Sherthallai have been made throughout the year. Determinations of C^{14} uptake by sand and surf water were also carried out.

ii) Macrofauna:

Distribution of benthos: A programme of routine sampling of the beach fauna was started in January 1968 which was continued till december 1968. 1/10 sq. m samples were taken at 2m intervals along fixed vertical transects. The samples were sieved through 1 mm mesh sieve and the retained material preserved in neutral formalin for sor-

ting identification and measurement in the laboratory. The numerical abundance and biomass (based on formalin fixed wet weight) were estimated throughout the year.

Sherthallai : Ocyropa sp. and cirrolanid isopods both occur near the high water mark. Eight Polychaetes showing zonation in the middle and lower parts of the beach have so far been collected. The bivalves, **Cardium sp.** and **Mactra sp.** occur near low water. Again, tidal migrants from the major element of the fauna, in this case consisting of a larger species of the bivalve **Donax**, the mole crab, **Emerita emerita** and the gastropod **Bullia sp.**

Fort Cochin : At and above high water there are many burrows of the ghost-crabs, **Ocyropa sp.** A cirrolanid isopod also occurs around high water mark and below this are four species of polychaetes. The major elements of the fauna are however, the active tidal migrant forms, the bivalve **Donax sp.** and the mole crab **Emerita emerita.**

iii) **Interstitial fauna** (Fort Cochin beach) :

The total abundance of animals showed a marked seasonal variation. Maximum number of animals were found during the pre-monsoon months (Feb.-May). There was a sudden decline of the total fauna during the monsoon months (June-Sept) followed by a gradual increase during the post-monsoon months (Oct.-Jan). Of all the organisms, ciliates showed the maximum numbers. Foraminiferans were next in abundance followed by nematodes, harpacticoids, gastrotiches, turbellarians, polychaetes, archiannelids, oligochaetes and isopods in the order of abundance. Occasionally molluscan veligers, kinorhynches, ostracods, developing stages of insects, nauplii and copepodites were also found. Even though ciliates and foraminiferans constituted the largest number, nematodes and harpacticoids contributed to the highest biomass being larger in size.

Although all categories of animals occurred at all tidal levels, their highest density was obtained at mid-tide level. Isopods were more abundant at the high-tide mark and were absent at the low-tide mark.

(iv) **Biochemical cycle and growth :** Routine samples of the dominant organisms constituting the macro-fauna were collected at Sherthallai and Fort Cochin for biochemical analysis and for size-frequency distribution. Body-weight determinations of **Donax** and **Bullia** have been made and samples were freeze dried for later biochemical analysis.

(v) **Respiration:** Numerous determinations of oxygen consumption were made for a variety of beach-animals at laboratory temperatures by means of an oxygen electrode. **Bullia** and **Donax** were suspended in the vessel by means of a thread. The current of the water caused by stirring stimulated activity and it was thought that this situation was comparable with the animals being moved in the surf on the beach. Oxygen consumption

of **Emerita** was measured with the animal buried in a small container of sterile sand within the main vessel. There was a considerable degree of uniformity in the results of the measurement of oxygen amongst the species in terms of their dry weight.

(vi) **Predation** : The major predator of the shore molluscs, especially at Sherthallai seems to be Man. The fishing community collects all shell-fish for food, especially **Donax**. It is difficult to see how the effect of this could be assessed.

At both Sherthallai and Fort Cochin fishing operations take place from the shore, providing a useful method of collection, especially of demersal fish from the close inshore waters. Catches appear to consist several species mainly of mackerel and sardines, but small rays and flatfish (**Cynoglossus**) are moderately common. A number of species of crab occur, probably indicating a further potential predation on the shore. The stomatopod crustacean, **Squilla** is also abundant in the catches which probably occurs lower down the shores.

E. OCEANOGRAPHY OF THE WATERS AROUND LACCADIVES - NEW PROGRAMME.

So far three cruises have been undertaken to the Laccadives Islands. The investigations carried out during each cruise are summarised below :

1 1st cruise by M. V. Laccadive, April 1968.

During the first cruise which lasted 6 days, the bloom of the blue-green alga, **Trichodesmium erythraeum** was noticed over a stretch of more than 100 miles. While the bloom was found all along the ship's track and the fusiform colonies of the alga could be seen from shipboard, the intensity of the bloom varied from place to place. In some areas the clumps of the algae appeared to be less dense, but in other vast sheets of water were virtually covered by the fine sand-coloured algae. At Kavaratti Island thick pads of algae were washed ashore in between tidal marks and over the fringes of the coral reef. Further observations on the nature of environment during the bloom were made at Kavaratti Island. Measurements of Physical and chemical parameters showed that while the sea temperature, salinity, oxygen were not subjected to much change and were typical of tropical open ocean water, the nutrient concentration particularly inorganic-P and silicate were fairly high and the nitrate-N was strikingly low. Measurement of phytoplankton and zooplankton crops showed that the bloom of **Trichodesmium** occurs during a time when the sea is nitrogen impoverished and does not sustain much of phytoplankton and zooplankton.

2 2nd Cruise by M. V. Laccadives, November, 1968.

During this cruise, observations on the organic production were started

at Calicut, which was the first halt of the vessel "Laccadives". Measurements of light penetration was made by a Secchi disc, the depth of which was 2.75 m. Water samples were collected at three different depths of the euphotic zone and incubated with C¹⁴ on board the vessel using sunlight as a source of illumination. C¹⁴ assimilation was found to be 2.88 gC/m²/day. No further observations on the primary productivity was made on the way as the vessel left Calicut in the afternoon and reached Kavaratti at about 1300 hours the next day. Further observations on productivity of the atoll were made from :

- I Changes in the oxygen cycle at two stations in the lagoon.
- II C¹⁴ assimilation in the lagoon and outside the lagoon.
- III Measurements of physical and chemical parameters such as temperature, salinity, inorganic phosphate and nitrate-nitrogen throughout day and night along with the diurnal changes in the oxygen and chlorophyll.
- IV Primary production measurements by the macrophyte in the lagoon.
- V Primary production by the corals themselves which would account for the production by the zooxanthellae.
- VI Increase in the primary productivity with time in a large container after removing the zooplankton grazers.

The production of organic matter by phytoplankton around Kavaratti Island was found to be extremely low. The concentrations of inorganic - P ranged from 0.2 to 0.5 µg at/l, of nitrate - N from 0.00 to 1.00 µg at/l and of chlorophyll from 0.013 - 0.33 µg/l. The reef community, on the other hand, consisting of attached algae was found to be self supporting. Gross production of the coral reef as determined by the oxygen changes was 10.00 gC/m²/day and the losses by respiration over a day amounted to 4.00 gC/m²/day. This indicates that the reef is autotrophic and supports much greater primary production than the surrounding sea. Gross production of the algae and of corals combined together agreed closely with the gross production measured by the oxygen changes of the reef as a whole.

3. 3rd Cruise by M. V. Laccadives, December, 1968.

During this cruise in addition to regular measurements of physical and chemical parameters, special emphasis was laid on the determination of organic carbon, chlorophyll and C¹⁴ assimilation in the lagoon, coral-reef-region and the surrounding sea. There was not much difference in the chlorophyll and C¹⁴ assimilation in the three different areas. The organic carbon, on the other hand,

was much higher in the coral-reef-region than there in the lagoon or in the surrounding sea. This indicates that small organic aggregate in suspension play an important role in supporting the massive animal communities in the region of the coral reef.

2.5 BOMBAY UNIT OF NIO, BOMBAY

Analysis of Plankton and bottom samples collected from the Gulf of Cambay were continued during the period under review. Identification of Chaetognatha from the Bay of Bengal sent by the Indian Ocean Biological Centre has been completed by Dr. T. S. S. Rao, and an account of taxonomy and distribution of the Chaetognatha from the region is under preparation. A monograph on the distribution of Chaetognatha in the Indian Ocean is also under preparation.

Shri Kameswara Rao visited marine biological laboratories on the south-east coast of India, and spent sometime at Waltair, Porto Novo and Madras where he studied the latest techniques in marine biology and also collected mud samples from the sea bottom at these places for the study of distribution of foraminiferans on the east coast of India. The analysis of the samples is in progress.

Dr. T.S.S. Rao and Shri Kameswara Rao took part in the 4th cruise of INS DARSHAK during the first week of January 1969. IOSN plankton net samples, water and mud samples were collected at different stations and are being analysed now.

Dr. B. N. Desai, joined as Scientist 'C' in July 1968 on transfer from Biological Oceanography Division, Ernakulam. He visited Gulf of Cambay area to investigate the possibilities of initiating a research project on the Physico-chemical and ecological environment of the Gulf. Grab and core samples collected from this area during the INS DARSHAK cruises are being examined by Dr. Desai for the study of Macrofauna. The collection and examination of grab, dredge and core samples will be continued during the INS DARSHAK Cruises arranged during the current year.

2.6 FIELD UNIT OF NATIONAL INSTITUTE OF OCEANOGRAPHY, PANAJI GOA:

The work started earlier in 1967 is carried out in 1968 and in addition some new projects are undertaken. They are :

A. Geological Oceanographic work :

- i) Physical, Mineralogical and Geochemical studies of the shelf sediments.

- ii) Paleontological, Micropaleontological and Stratigraphical studies of the shelf and deep sea sediments and Cores.
- iii) Structural, sedimentological and erosional variations of the beaches and beach sediments of Miramar, and Calangute beaches.
- iv) Bathymetry and Oceanographic profile studies and collection of sediment samples along the West Coast of India especially from Bombay to Gulf of Cambay area.
- v) Estuarine studies of Mandovi river (river environment) with emphasis on silting and navigational problems.

B. BIOLOGICAL OCEANOGRAPHIC WORK :

- i) Studies on yearly, seasonal and diurnal variations of the biological productivity of waters around Panjim (using oxygen method and C¹⁴ method) in relation to various physical and chemical parameters and nutrients in the ambient environment.
- ii) Simultaneous recordings of water temperature, pH, turbidity, salinity, etc. are also being conducted to assess the seasonal changes in the productivity of the estuaries.

C. Physical Oceanography Work :

- i) The first phase of the Project 'Hydrographic features of the Bay of Bengal' is completed. The compilation of the actual data for temperatures, salinity and dissolved oxygen data collected in the various research ships is completed.
- ii) The Second phase of the above project is under way. This Involves, among others, the computation of dependent variables like density, thermosteric anomaly, and specific volume anomaly.
- iii) Under the project work 'Sea water sampling scheme' tabulation of surface temperature and salinity is completed.

3. ADMINISTRATIVE SET UP

3.1 Executive Council

- I. Dr. D. N. Wadia, F. R. S. Chairman
National Professor and Geological
Adviser to the Govt. of India,
Department of Atomic Energy
South Block, New Delhi - I.

- | | | |
|----|--------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 2. | Dr. A. N. Bose,
Professor and Head of the Depct. of
Food Technology & Biochemistry,
Jadavpur University,
Calcutta - 32. | Member |
| 3. | Prof. S. P. Chatterjee
Director, National Atlas Organization,
No. 1, Acharya Jagdish Chandra Bose Road,
Calcutta - 20. | .. |
| 4. | Shri C. V. Gole,
Director, Central Water and Power
Research Station,
Khadakvasla,
Poona 24. | .. |
| 5. | Commodore D. C. Kapoor, I. N.
Chief Hydrographer to the Govt. of India
Naval Hydrographic Office,
Rajpur Road,
Dehra Dun (UP.) | .. |
| 6. | Dr. L. S. Mathur,
Director- General of Observatories,
India Meteorological Department,
Lodi Road, New Delhi - 3. | .. |
| 7. | Prof. R. Ramanadham,
Head of the Deptt. of Meteorology &
Oceanography,
Andhra University,
Waltair. | .. |
| 8. | Shri S. K. Ranganathan,
Director of Scientific Research (Navy)
Naval Headquarters,
New Delhi. | .. |
| 9. | The Director-General,
Scientific & Industrial Research,
New Delhi. | .. |

10. The Financial Adviser to CSIR **Member**

11. The Director, NIO ..

3.2 SUB-COMMITTEES OF THE EXECUTIVE COUNCIL

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. Dr. R. Raghu Prasad
3. Shri R. Madhavan Nair
4. Dr. B. S. Bhimachar
5. Prof. P. N. Ganapathi
6. Dr. B. Patel
7. Director, NIO **Convener**

C. Geological

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

II. Building & Finance

1. Dr. D. N. Wadia
2. Cap. N. S. Tyabji
3. Secretary, CSIR.
4. FA to CSIR

5. Chief Engineer, PWD, Panjim. (Goa)
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

3.3 BUDGET

The budget figures of the Institute for the year 1968-69 are given below :

<i>Budget Item</i>	<i>Sanctioned</i>	<i>Actual</i>
	(Rs. in lakhs)	(Rs. in lakhs)
1. Recurring	10.172	10.351
2. Capital	<u>2.970</u>	<u>2.904</u>
Total:-	13.142	13.255

3.4 SCIENTIFIC & TECHNICAL STAFF

Headquarters and Planning & Data Division, New Delhi.

DIRECTOR

Dr. N. K. Panikkar

Scientist in charge

Shri R. Jayaraman

Scientists

1. Dr. S. N. Dwivedi
(on deputation to Laos)
2. Shri S. P. Anand
3. Dr. V. S. Bhatt
4. Shri P. S. N. Murty

Senior Scientific Assistants.

1. Shri D. Panakala Rao
2. Shri S. A. H. Abidi

Senior Technical Assistant

Shri R. M. S. Bhargava

Senior Draughtsman

Shri D. R. Mongia

Senior Documentation Assistant

Shri Sri Kishan Kumar

Field Unit of National Institute of Oceanography, Goa:**Scientist-in-charge**

Dr. M. G. A. P. Setty

Senior Scientific Assistant

Shri V. Hariharan

Scientists

1. Dr. N. K. Srivastava
2. Dr. P. V. Dehadrai
3. Shri L. V. Gangadhara Rao
4. Shri R. R. Nair

Junior Scientific Assistant

Shri R. M. Kidwai

Bombay Unit of National Institute of Oceanography**Scientist-in-charge**

Dr. T. S. S. Rao

Junior Scientific Assistant

Shri K. Kameswara Rao

Scientist

Dr. B. N. Desai

Biological Oceanography Division, Ernakulam, Cochin**Scientist-in-charge**

Dr. S. Z. Qasim

Sr. Technical Assistant

Shri U. K. Gopalan

Scientists

1. Dr. M. Krishnan Kutty
2. Shri C. V. G. Reddy

Junior Scientific Assistant

Smt. N. Santhakumari

Senior Scientific Assistants

1. Shri B. M. Panikkar
2. Shri P. M. A. Bhattathiri

Research Fellows

1. Shri V. N. Sankaranarayanan
2. Shri P. Sivadas
3. Shri V. P. Devassy

Physical Oceanography Division, Ernakulam, Cochin

Scientist-in-charge

Dr. V. V. R. Varadachari

Scientists

1. Shri V. S. Rama Raju
2. Shri C. S. Murty

Senior Scientific Assistant

Shri P. Udaya Varma Thirupad

Research Fellows

1. Shri Ch. Madhusudana Rao
2. Shri V. Narayana Pillai
3. Shri Thomas Cherian
4. Shri P. G. Kurup

Junior Scientific Assistant

Shri P. K. Das

Indian Ocean Biological Centre, Cochin

Scientist-in-charge

Shri L. R. Kasturirangan

Junior Scientific Assistants

1. Shri P. N. Aravindakshan
2. Shri Jacob George
3. Shri George Peter
4. Shri V. T. Paulinose
5. T. Balachandran
6. Smt. Vijayalakshmi R. Nair
7. Smt. C. B. Lalithambika Devi
8. Shri T. C. Gopalakrishnan
9. Shri K. K. Chandrasekaran Nair
10. Smt. V. Santhakumari
- II. Shri Pramod Kumar S. Gore

Scientist

Dr. R. V. Unnithan

Senior Scientific Assistants

Shri P. Gopala Menon

Shri M. Sakthivel

Shri K. J. Peter

Dr. (Smt.) M. Saraswathy

Research Fellows

Shri R. A. Selvakumar

Dr. Ravendranatha Menon

Shri C. S. Goswami

Shri C. Subramaniam

Pool Officer

Dr. C. Sankaran Kutty

4. LIBRARY

The library facilities are available at all the divisions of the Institute. At Ernakulam there is a common library for all the divisions. At present National Institute of Oceanography Library is having 3500 books on various disciplines of marine science. Library is subscribing for 75 (Indian and Foreign) 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. This has been continued for the year 1968 and 1969.
- 2) Collection of the bibliographical details of articles on Indian Ocean by Indian and foreign authors for the year 1968-69. The selected bibliography on the Indian Ocean, 1967-68 was compiled and was published in 'MAHASAGAR' Bulletin of NIO Vol. 4(1). 1968.
- 3) Collection and preparing an abstracts of scientific papers on Indian Ocean published in various Journals.

5. AWARDS, HONOURS AND MEMBERSHIP OF VARIOUS COMMITTEES

Dr. N. K. Panikkar, Director was awarded the Sir Dorab Tata Gold Medal for the period 1961-63 by the Zoological Society of India for his contribution to the Science of Zoology and in the Field of Fisheries in India. Dr. Panikkar was also nominated as a member of the "Beach Erosion Board" constituted by the Ministry of Irrigation and Power.

Dr. S. Z. Qasim, was awarded the degree of D. Sc. by the University of Wales, U.K. in October, 1968.

6. DEPUTATIONS

Dr. N. K. Panikkar, Director went on deputation to USA on 12th June 1968 under the Exchange Programme of the CSIR & National Science Foundation of the United States. During his visit to USA discussions on Oceanographic problems were held at different Oceanographic Institutions of the USA. He also attended the Scientific Committee on Oceanic Research meeting on 17th to 21st June at La Jolla, California, USA.

Dr. S. Z. Qasim, Scientist-in-charge, Biological Oceanography Division of NIO, Ernakulam went on deputation to participate in the Symposium on Marine Food Chain held in Denmark in July 1968. He later participated in the SCOR/IBP meeting held at Southampton and visited the Marine Laboratory Aberdeen on a special invitation.

Dr. V. V. R. Varadachari, Scientist-in-charge, Physical Oceanography Division of NIO was deputed to UK on study tour under the Exchange Programme with British Govt. He visited various marine science laboratories for three months and gave two lectures at the Marine Science Laboratory, Menai Bridge, Wales.

Shri P. N. Aravindakshan, Junior Scientific Assistant, Indian Ocean Biological Centre, Ernakulam. attended the UNESCO sponsored Advanced Training Programme in Marine Biology in Copenhagen, Denmark in April-May, 1968. Later, he also visited the Zoological Museum in Copenhagen to examine Heteropoda in the "Dana" collections, and the British Museum in London.

7. VISITORS

- April, 1968 Dr. R. Hamond, CSIRO, Cronulla, Australia.
- May, 1968 Dr. S. Jones, Director, Central Marine Fisheries Research Institute, Mandapam Camp.
Dr. A. G. Jhingran, (Former) Director-General, Geological Survey of India and Professor of Geology, Delhi University.
- June, 1968 Dr. Roy I. Jackson, Asstt. Director-General (Fisheries) FAO, Rome.
Dr. G. M. Gerhardsen, FAO Fisheries Expert, Govt. of India, Min. of Food & Agriculture, New Delhi-1.
Dr. S. Raphi Jonssen, FAO Fisheries Expert, Ernakulam, Cochin.
Dr. Chi Yun Pao, FAO Fisheries Expert, Ernakulam, Cochin.
Dr. A. I. George, Director of Fisheries, Kerala, Trivandrum.
Mr. M. C. Perumal, Director, CIFO, Ernakulam.
- July, 1968 Dr. B. V. Hamon, CSIRO, Cronulla, Australia.
Dr. D. A. Ritz, CSIRO, Cronulla, Australia.
- September, 1968 Dr. Wyman Harrison, Director, Land & Sea Interaction Laboratory, Norfolk, Virginia. USA.
- October, 1968 Dr. H E. Gruner, Zoologisches Museum, Berlin, Germany.
Dr. Thomas E. Bowman, Smithsonian Institution, Washington, USA.
- November, 1968 Prof. Evold Nielsen, Karnataka Regional Engineering College, Surethkal, South Kanara, Mysore.
- December, 1968 Mr. Annasahib P. Shinde, Union Minister of State for Food & Agriculture.
- January, 1969 Dr. N. V. Thitsin, Moscow Main Botanical Grdens, USSR.
Dr. P. J. Pain -do-
Dr. Marta Vannucci, Instituto Oceanografico, Cx. 9075, San Paulo, Brazil.

Dr. R. R. C. Edwards, Marine Laboratory, Victoria Road. Aberdeen, UK.

Dr. J. H. S. Blaxter, Zoology Department, University of Aberdeen. Scotland, UK.

Dr. William Aron, Smithsonian Institution, Washington, USA.

Dr. Richard H. Benson, -do-

Dr. Y. Y. Kim, Asstt. Regional Representative, UNDP, New Delhi.

Dr. Edward Brinton, Scripps Institution of Oceanography, La Jolla, California, USA.

Dr. F. H. Talbot, The Australian Museum, Sydney, Australia.

February, 1969 Dr. M. Anraku, Seikai, Regional Fisheries Research Laboratory, Nagasaki, Japan.

Dr. V. N. Greze. Institute of Biology of South Seas, Sevastopol, USSR.

Prof. S. Krishnaswamy, Head of the Deptt. of Zoology, Madurai University, Madurai.

Dr. B. Kimor, Sea Fisheries Research Station, Haifa, Israel.

Dr. D. M. Damker, Smithsonian Institution, Washington, USA.

Dr. G. F. Humphrey, CSIRO, Division of Fisheries and Oceanography. Cronulla, Australia.

Dr. J. E. Smith, F. R. S., The Laboratory, Plymouth.

Dr. D. A. Bootaev, Unesco, New Delhi.

Dr. G. R. Seth, Statistical Adviser, ICAR Institute of Agricultural Research Statistics, New Delhi.

Prof. P. N. Ganapati, Andhra University, Waltair.

Prof. J. Krey, Kiel University, West Germany.

March, 1969 Dr. B. D. Nag Chaudhuri, Member for Science, Planning Commission, New Delhi.

8. EXHIBITIONS, SEMINAR, SYMPOSIA, ETC.

8.1 Seminars, held at the Indian Ocean Biological Centre, Ernakulam.

<i>Sl.</i>	<i>Name of Speaker</i>	<i>Date</i>	<i>Subject</i>
1.	Dr. R. Hamond	27.4.1968	A proposed new series of Plankton Sheets for Indo-west Pacific area.
2.	Dr. S. Abraham	8.5.68	Food and Feeding habits of some selected fishes.
3.	Mrs. C. B. Lalithambika Devi	22.5.68	Rearing in General.
4.	Mr. P. Venugopal	5.6.68	Standard Samples.
5.	Dr. N. R. Menon	10.7.68	Some aspects of brackish water ecology.

6.	Mr. D. J. Tranter	18.9.68	Seminar on Zooplankton methodology.
7.	-do-	29.10.68	Condition of International collections.
8.	Dr. S. Z. Qasim	14.11.68	Laccadives Programme.
9.	Mr. D. J. Tranter	12.12.68	Preliminary report on Laccadive Cruise 3/68 and results of Laccadive Cruise 2/68.

9. COLLOQUIA AND SPECIAL LECTURES

Lectures by visiting Scientists at IOBC, Cochin-18.

<i>Sl.</i>	<i>Name</i>	<i>Date</i>	<i>Country</i>	<i>Subject of Lectures</i>
1.	Prof. T. S. Rass	17/1/68	USSR	Basic Principles of the recent Systematics of fish eggs larvae.
2.	Dr. Alan Ansell	9/2/68	Millport Scotland, UK	Biology of the Sandy Beaches.
3.	Dr. B. V. Hamon	23/7/68	CSIRO. Australia.	General aspects of Circulation in the Indian Ocean.
4.	Dr. D. A. Ritz	31/7/68	-do-	Temperature from a barnacle's point of view.
5.	Dr. T. Bowman	24/11/68	USA	Modern Taxonomy.
6.	Prof. J. Krey	3/3/69	Kiel, W. Germany	A multi-water bottle.
7.	Dr. M. Vannucci	20/3/69	Brazil	Methods in plankton research.
8.	Dr. G. R. Seth	21/2/69	India	Sampling techniques.
9.	Dr. Wyman Harrison		USA	Circulation studies of continental shelf waters using drifter techniques.
10.	-do-		-do-	(a) Model of inlet sedimentation.
11.	-do-		-do-	(b) Prediction of beach changes. Longshore current velocity, wave, run up etc.

10. PUBLICATIONS:

10.1 Publications of the institute.

1. Annual Report 1967-68.
2. Bulletin of the Institute 'MAHASAGAR' Vol. I No. 1 to 4.
3. Handbook to the International Zooplankton Collections. Vol. I : Station List.

10.2 Papers Published by Staff Members.

Krishnankutty, M. 1968

Estimation of optimum age of exploitation at a given fishing mortality. **J. Fish Res. Bd. Canada. 25:** 1291-1294.

Krishnankutty, M. & B. N. Desai 1968

A comparison of the efficiency of the bottom samplers used in benthic studies off Cochin. **Marine Biology. 1: 168-171.**

Menon, K. R. and P. Sivadas, 1968.

The hormonal control of blood calcium sugar level in the estuarine crab, se **Sceylla serrata** (Forskål). **Proc. Indian Acad. Sci. 67:** 132-140.

Murty, P. S. N., Reddy C. V. G. & V. V. R. Varadachari, 1968.

Distribution of total phosphorus in the shelf sediments off the West Coast of India. **Proc Natn. Inst. Sci. India. Vol. 34 (B):** 134-141.

Murty, P. S. N., CH. M. Rao and C. V. G. Reddy, 1968.

Manganese in the shelf sediments off the West Coast of India. **Curr. Sci., 37:** 481-483.

Murty, P. S. N. & Reddy C. V. G.. 1968.

Distribution of phosphorus in the marine sediments off the east coast of India, 1968. **Bull. N.I.S.I. 38. (Pt. I)** 405-510.

CH. M. Rao and P. S. N. Murty, 1968.

Studies on the shelf sediments off the Madras Coast. **Bull. N.I.S.I. No. 38. (Pt.I) :** 442-448.

Nair, R. R. & A. Pylee, 1968.

Size distribution and carbonate content of the sediments of the Western Shelf of India. **Bull. N.I.S.I. 38 (Pt. I):** 411-420.

Nair R. R. & P. S. N. Murty, 1968.

Clay Mineralogy of the Mudbanks of Cochin. **Current Sci., 37 (20):** 589-590

Murty, C. S. & V. V. R. Varadachari, 1968.

Upwelling along the East coast of India. **Bull. N.I.S.I. No. 38 (1):** 80-86.

Prasad, R. R., 1968.

IIOE Plankton Atlas Vol. I, Fascicle I. Maps on Total zooplankton Biomass in the Arabian Sea and Bay of Bengal. Issued by IOBC, NIO, CSIR, New Delhi.

IIOE Plankton Atlas Vol. I, Fascicle II. Maps on total zooplankton Biomass in the Indian Ocean. Issued by IOBC, NIO. CSIR, New Delhi.

Qasim, S. Z. 1968.

Some problems related to the food chain in the tropical estuary. **Proc. Symp. Marine Food Chains. Denmark. No. 21 (Mimeo.)** 13pp.

- Qasim, S. Z., P. M. A. Bhattathiri and S. A. H. Abidi, 1968.
Solar radiation and its penetration in the tropical estuary. **J. Exp. Mar. Biol. Ecol.** **2**: 87-102.
- Qasim, S. Z., S. Wellarshaus, P. M. A. Bhattathiri and S. A. H. Abidi, 1968.
Organic production in a tropical estuary. **Proc Indian Acad. Sci.** **59** : 51-94.
- Ramaraju, V. S., 1968.
Observation on the Scattering layers over the continental shelf off Konkon coast. (India). **Bull. N.I.S.I. No. 38 (1)** : 319-323.
- Rao, L. V. G & Jayaraman, R., 1968.
Vertical distribution of temperature, salinity and density in the upper 500 meters of the north equatorial Indian Ocean during the north-east monsoon period. **Bull. N.I.S.I. No. 38 (1)** : 123-147.
- Hydrographical features of the southern and central Bay of Bengal during the transition period between winter and summer. **Bull. N.I.S.I. No. 38 (1)** 184-205.
- Reddy, C. V. G., P. S. N. Murty and V. N. Sankaranarayanan, 1968.
An incidence of very high phosphate concentration in the waters around Andaman Islands, **Curr. Sci.** **37** : 17-19.
- Reddy, C. V. G. & V. N. Sankaranarayanan, 1968.
Distribution of phosphates and silicates in the central western North Indian Ocean in relation to some hydrographical factors. **Proc. Symp. Indian Ocean Bull. Natn. Inst. Sci. India No. 30 (1)**: 103-122.
- Reddy, C. V. G. and Sankaranarayanan, 1968.
Distribution of nutrients in the shelf waters of the Arabian Sea along the west coast of India. **Proc. Symp. Indian Ocean. Bull. Natn. Inst. Sci. India No. 38 (1)**: 206-220.
- Sankaranayanan, V. N. & C. V. G. Reddy, 1968.
Nutrients of the north western Bay of Bengal. **Proc. Symp. Indian Ocean Bull. Natn. Inst. Sci. India No. 38 (1)** : 148-163.
- Sen Gupta, R. & Paylee, A., 1968.
Specific alkalinity in the northern Indian Ocean during the south west monsoon. **Bull. N.I.S.I. No, 38 (1)** : 324-333.
- Unnithan, R. V., 1968.
On the functional morphology of a new fauna of monogenea on fishes from Trivandrum and environs. Part IV. **Microcoteslidae-sensu sticto** and their repartition in subsidiary taxa. **Am Midland** (Press)
- Varadachari. V. V. R., C. S. Murty & C. V. G. Reddy. 1968.
Salinity maxima associated with some subsurface water masses in the upper layers of the Bay of Bengal **Proc. Symp. Indian Ocean. Bull. Natn. Inst. Sci. India No. 38 (1)** : 338-343.

Varadachari, V. V. R., C. S. Murty & P. K. Das, 1968.

On the level of least motion and the circulation in the upper layers of the Bay of Bengal. **Proc. Symp. Indian Ocean Bull. Natn. Inst. Sci. India. No. 38 (1):** 301-307

Varadachari, V. V. R., R. R. Nair & P. S. N. Murty, 1968.

Submarine Canyons off the Coromandel Coast, **Proc. Symp. Indian Ocean. Bull. Natn. Inst. Sci. India No. 38 (1) : 457-462.**

10.3 REPORTS PREPARED BY THE STAFF MEMBERS :

<i>Contributor</i>	<i>Collaborators</i>	<i>Report</i>	<i>Year</i>	<i>Sponsored by</i>
Dr. N. K. Panikkar	ACMRR/ IBP Sub-committee on Productivity of marine communities.	First report to the IRP Planning Committee.	Jan. 1964	FAO, Rome.
Dr. N. K. Panikkar	ACMRR/ SCOR / WMO (AC) Working Group on the implementation of the United Nations Resolution on the Resources of the Sea (July '67)	International Ocean Affairs (A special report)	Sept. '67	SCOR(ICSU)
Dr. N. K. Panikkar	ACMRR Working Party on FAO Regional Fisheries Councils and Commissions.	Advisory Committee on Marine Resources Research (Fisheries) Report No. 56 Suppl. 2.	Sept. 1968	FAO, Rome.
Dr. S. Z. Qasim	SCOR Working Group on Primary Production specialised Environments.	SCOR W.G. 24 on Estimation of Primary Production under special conditions.	1969	SCOR / IBP.

