

Symposium on Indian Ocean

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THE International Indian Ocean Expedition (IIOE), which is a multi-national project for the scientific exploration of the Indian Ocean and in which 19 countries took part with 38 ships, completed its field programme on 31 December 1965. India has been an active participant in the IIOE not only because of its geographical position but also because several phenomena occurring in the Indian Ocean directly affect the lives of the Indian people. During IIOE, a number of scientists of different countries belonging to different disciplines participated in the expedition and collected a vast amount of data. It was, therefore, considered necessary that the results of the studies should be brought to light either during the expedition itself or as early as possible after the conclusion of the field programme. During the expedition period itself a number of seminars and symposia were held by several participating countries where the preliminary results were discussed. In India also a number of seminars were held whenever any of the foreign participating ships called at our ports. In these seminars, which were more of the nature of informal discussions, an opportunity was provided for our scientists to come into contact with oceanographers of other countries and to discuss scientific problems relating to the Indian Ocean. In addition to these informal seminars, two symposia were held in India during the period of the expedition. The first was organized in December 1964 during the International Geological Congress in Delhi when group discussions were held on the geological and geophysical results of the IIOE and a number of interesting findings were brought to light. [Prior to this, in November 1964, the Royal Society, England, also held discussions on the Geological Results of the IIOE.] The second symposium was convened in July 1965 on the Meteorological Results of the IIOE in Bombay, and it was organized jointly by the Unesco and WMO. As the data collection and processing were still continuing, there was not much time for detailed studies on these data and hence the results presented in all the symposia should be considered as more or less tentative. During the Second International Oceanographic Congress held in Moscow during May-June 1966 a number of papers were presented on the scientific results of the IIOE.

In the Indian programme of the IIOE, 1962-65, scientists from several organizations and government departments in the country participated in the cruises of both the Indian as well as some of the foreign research ships, and collected a large amount of data under the various disciplines of oceanography. In order to provide a common forum for discussing the results of all the Indian workers, the Indian National Committee on Oceanic Research, at its meeting held on 3 April 1964, strongly recommended that a symposium on the results of

the IIOE be held jointly with the National Institute of Sciences of India (NISI).

The symposium, organized jointly by the National Institute of Sciences of India and the Indian National Committee on Oceanic Research (CSIR), was held from 2 to 4 March 1967 at the auditorium of NISI, New Delhi, under the following five sections: (1) Physical and chemical oceanography including geochemistry and radiochemistry; (2) Geology and geophysics; (3) Marine biology including productivity; (4) Fisheries; and (5) Maritime meteorology. One hundred and fifteen scientific papers were presented at the symposium.

Dr Panikkar, Director, National Institute of Oceanography (NIO) and Secretary, NISI, welcoming the delegates reviewed the work done in the Indian programme of IIOE where a number of young scientists from different organizations and government departments have participated and contributed to the scientific programme. He expressed satisfaction that most of these scientists who had participated in the Indian programme and some of the senior scientists have come to present their results. It was also gratifying, the speaker said, to find scientists from USA, USSR, West Germany and Japan, and also members of the Indian Ocean Biological Centre's Consultative Committee participating in the symposium on our invitation and giving us the benefit of their scientific experience. The Indian Ocean Expedition has brought about a general awareness and has created a great amount of enthusiasm for the study of oceanography in India.

Dr Atma Ram, Director-General, Scientific & Industrial Research, who spoke next, stated that the CSIR has deep interest in the development of oceanography as one of the scientific activities in the country. He expressed the hope that the science of oceanography would make material contribution to the country through the study of living resources and the mineral resources, and provide basic information of value in meteorology and oceanic transportation.

In his inaugural address, Dr D. N. Wadia, National Professor and Chairman of the Indian National Committee on Oceanic Research, stated that the International Indian Ocean Expedition, 1960-65, was a great event of the decade and said that everyone who had something to do with the expedition is looking forward to the publication of the results. Referring to the symposium Dr Wadia said that it was an important day in the history of oceanography in India, as more than a hundred young Indian disciples in this new science were taking part in collaboration with reputed foreign scientists. He also referred to two important cooperative projects that have been developed in connection with the expedition. The first was the International Meteorological Centre in Bombay which dealt with the large volume of meteorological

data collected during the expedition, and the second was the Indian Ocean Biological Centre in Cochin, established to handle the large amount of zooplankton collections taken with the Indian Ocean Standard Net. He also expressed satisfaction that the members of the Consultative Committee for the Indian Ocean Biological Centre were taking part in the symposium.

From the geologist's point of view, Dr Wadia said that the expedition work is very notable in revealing new features of the bottom topography of the Arabian Sea and the Bay of Bengal. The work during the expedition has brought to light several interesting bottom features such as submarine volcanoes, mid-oceanic mountain ridges, submarine valleys and canyons. But, according to the speaker, the most notable achievement would be the light it would throw on the vexed controversy of modern geology regarding the continental drift. Elaborating further on the problem of continental drift, Dr Wadia said, the bottom sediments and the cores obtained during the expedition's investigations is bound to throw some light on the question whether the subcontinent of India has been stationary, detached from Africa or Australia by the foundering of the portions of the old Gondwana continent, or whether after its separation from that continent, India has wandered some thousand miles from south of the equator into its present position in Eurasia. It is the belief of some geologists that India has come all the way from south of the equator and is, therefore, an intruder in Asia. Referring to the development which have taken place in oceanography since the start of the International Indian Ocean Expedition and comparing it with the earlier studies, Dr Wadia said that oceanography has now been put on the map of Indian science. From this small beginning it is yet to grow into a substantial national effort. He felt very happy that he has been associated with the oceanographic group since 1960 and he hoped that as a result of the discussions which would be taking place during the symposium much new knowledge would emerge out and would contribute to further development of oceanographic studies.

Prof. T. R. Seshadri, President, National Institute of Sciences of India, stated that he was very happy that this symposium on Indian Ocean has been organized under the auspices of the NISI. Apart from many benefits the study of ocean would bring to India, he said he would particularly emphasize on one aspect, viz. the study of organic chemistry of the ocean waters and the various plant and animal material contained therein, and he hoped that such studies would enable discovery of new types of biochemicals.

With the proposal of vote of thanks by Dr Ganguly of the Bhabha Atomic Research Centre, Bombay, the inauguration function concluded and the symposium was continued in different scientific sessions.

Physical Oceanography

The first session on physical oceanography was presided over by Dr E. C. LaFond (US Navy Electronics Laboratory), who in his paper dealt with

the oceanic circulation in the Bay of Bengal. He dealt mainly with the work carried out by the US research vessel, *Anton Bruun*, during her first IIOE cruise in the Bay of Bengal during March-May 1963, and stated that in the early part of the cruise the prevailing NE monsoon winds gave rise to upwelling along the Burmese coast, while in the latter part of the cruise there was upwelling along the east Indian coast. Influence of tides and internal waves on the circulation patterns was also discussed by him. The resulting effect of upwelling on the organic production and chlorophyll content based on the data of the *Anton Bruun* was also indicated in the paper.

Dr LaFond's paper was followed by four more papers on the Bay of Bengal. The first one by L. V. G. Rao and R. Jayaraman (National Institute of Oceanography), presented by Jayaraman, gave an account of the general hydrographical features of the central and southern Bay of Bengal based on INS *Kistna* data for 1962-63. The presence of certain typical water masses, particularly one of low density formed by the mixing of dilute waters from off the Burmese coast with those of the Pacific origin entering the Bay of Bengal through the Malacca straits was indicated, based on T-S relationships. The papers by Varadachari, Murthy, Thirupad and others from the Physical Oceanography Division, NIO, dealt with water masses, internal waves and thermocline features in the Bay of Bengal, and also the circulation patterns in the upper layers of the bay. The choosing of level of no-motion at 500 metres for dynamical computations, existence of long-period internal waves, of wavelengths varying from 150 to 500 km., and the effects of these waves on the dynamic computations of currents were discussed. The authors also discussed the methodology adopted by them in choosing the reference level. Variations in thermocline levels and the probable causes were also examined by these authors. Two interesting papers giving the results of direct current measurements were presented by scientists from Health Physics Division of the Bhabha Atomic Research Centre, Bombay. The first one by Nair, Neralla and Ganguly presented results of current measurements off Mormugao harbour in January 1967 and the second one by Nair and Bhattathiri on current measurements at the Angria bank late in 1965. An Ekman-Merz current meter was used in these studies. The current measurements off Mormugao showed that the currents were mostly towards the north-west with practically no southerly component. The speeds ranged from 0.04 to 0.60 knot. The tidal currents were also found to be very weak. The current measurements in the Angria bank region over a 26 hr period covering two tidal cycles showed current speeds ranging between 0.17 and 0.75 knot, in general, in all the three depths measured — surface, mid-depth and bottom. The directions were mostly west to west-south-west. The current measurement data were found to be in accordance with computations based on salinity-temperature measurements.

On Arabian Sea also there were a number of papers, the chief being one on water masses of the

Arabian Sea in the upper 500 metres by K. V. S. Ramam and coworkers from the Indian Naval Physical Laboratory, Cochin. Geostrophic currents in the Arabian Sea, and transparency measurements were also discussed by the same authors. There was a paper on the scattering layers over the continental shelf off Konkan coast by Rama Raju of the Physical Oceanography Division, NIO, wherein the author showed that the scattering layers are not due to the physical discontinuity (thermocline). One of the most interesting papers in the series was that presented by Balakrishnan of the Indian Naval Physical Laboratory, Cochin, on equipment and facilities designed for the calibration and checking of bathythermographs at the Naval Physical Laboratory.

Maritime Meteorology

The session maritime meteorology, which was held on the afternoon of 2 March 1967, was presided over by Dr K. R. Ramanathan of the Physical Research Laboratory, Ahmedabad. The major discussions were about the monsoons, theories in regard to their origin and their main features. The paper by B. N. Desai was on the air masses over the Arabian Sea during the south-west monsoon season and this discussed in great detail the earlier views held on the origin of the monsoon. According to the author one of the most favourable conditions for the onset of the vigorous monsoon on the west coast of India is the characteristic air mass stratification over the Arabian Sea with moist deflected trades in the lower levels and the dry unstable air from Arabian Sea and the neighbourhood. The strength of the deflected trades and their normal component to the Western Ghats govern the rainfall on the west coast of India. The observations by Pisharoty, which are somewhat different from those of Desai's, were presented in a paper by him entitled 'Cross-equatorial airflow over the Indian Ocean'. According to him, as the cross-equatorial flux is transported eastwards mostly south of 10°N, a significant part of the monsoon water vapour flux across peninsular India consists largely of water vapour evaporated from the Arabian Sea itself.

Y. P. Rao and Raghavendra (India Meteorological Department) discussed the variation of rainfall across the equator. The data are based on ship's reports in the Indian Ocean in the year 1964. The authors showed that there is no appreciable tendency for dry weather near the equator. Another interesting paper was by Rama of the Tata Institute of Fundamental Research on radon in the monsoon current. The paper gave an account of radon measurements in sea level air at Bombay, and also in surface air over the Arabian Sea and the Indian Ocean. Low values, characteristic of south-east trades, were observed up to a few degrees north of the equator. The implications of such measurements in terms of interaction between the south-east trades and continental air masses during the monsoon season were discussed. Another paper of special interest was by Ramamurthi and Jambunathan of the India Meteorological Department (Indian Ocean & Southern Hemisphere Analysis

Centre, Poona). This paper is based on the information collected by the use of automatic picture transmission (APT) sub-system installed at the International Meteorological Centre, Bombay, in December 1963. Interesting features were revealed of cloud developments associated with the first burst of the south-west monsoon over the Kerala coast of India. A paper presented by C. Ramaswamy on weather routing of ships gave an account of an important application of meteorology to navigational aspects in the Indian Ocean.

Chemical Oceanography Including Geochemistry and Radiochemistry

The session on chemical oceanography was presided over by Dr A. K. Ganguly of the Bhabha Atomic Research Centre, Bombay. Thirteen papers were presented at this session which included such varying topics as distributional studies on the various chemical factors such as oxygen, carbon dioxide and nutrients in the various areas of the Indian Ocean; geochemical, radiochemical and trace element studies on sea water and marine sediments; methods and techniques; application of radio tracers to the study of water and sediment movement, etc. The paper on the distribution of phosphorus in the northern Indian Ocean by R. Viswanathan and A. K. Ganguly of the Bhabha Atomic Research Centre, presented by Viswanathan, gave data on inorganic and total phosphorus in the upper 500 metres in the northern Indian Ocean and the Bay of Bengal. Valuable data were presented on the integral mean concentration values of phosphates in the upper 100-metre column (which is an index of available phosphorus for biochemical and biological activities and for organic production to take place) in the various areas and it was shown that there was considerable regional variations in the mean concentrations which could be used to characterize areas of high and low productivity. This paper was followed by papers giving the distribution and cycle of other nutrients like nitrates and silicates by C. V. G. Reddy and V. N. Sankaranarayanan (NIO). These authors presented data relating to nutrient chemistry collected from Arabian Sea, Bay of Bengal and northern Indian Ocean during the cruises of the INS *Kistna* and *R.V. Varuna*. The interesting variations in the pattern of distribution and the influence of upwelling and other types of circulation on the distribution in the upper layers was discussed. The nutrient enrichment due to upwelling was also pointed out by the authors. The patterns of distribution of oxygen discussed in the papers by Anand *et al.* and Garg *et al.* of the Directorate of Scientific Research (Navy) provided additional supporting data for the regional and seasonal variations in upwelling indicated earlier from other physical data. Krishnaswamy of the Tata Institute of Fundamental Research presented a paper on 'Trace elements geochemistry' by Bhat *et al.*, wherein he described a technique of concentrating cosmic-ray produced isotopes from sea water by dragging from a ship underway a container containing sponges impregnated with ferric hydroxide and subsequent elution of the adsorbed material.

The quantitative aspects of the technique were discussed and it was stated that the method has 95 per cent efficiency. In a paper on geochemical studies off Tarapore coast by Sarma and others of the Bhabha Atomic Research Centre, information regarding concentration and dispersal of radio-nuclides from the atomic reactor wastes and the role played by marine organisms and the circulatory and mixing processes in the sea were discussed. The paper on heavy water content of sea water concentrates and salt bitterns by Chaudhuri of the Central Salt & Marine Chemicals Research Institute, Bhavnagar, and the paper on osmium in sea water by Sharma and Parikh of the same institute provided interesting and valuable information.

Geology and Geophysics

Under the session geology and geophysics, 15 papers were presented. The session was presided over by Prof. Wolfgang Schott of Bundesanstalt für Bodenforschung, Hannover, West Germany. Prof. Schott first presented his paper on the 'Recent sedimentation in the Indian Ocean' (first results of *Meteor* in the Indian Ocean Expedition). In this paper he discussed the various aspects of the facial change of sediments from shore-line to the oceanic basin. According to him a number of different facies zones can be distinguished running parallel to the coast. Off East Africa five and off the Indo-Pakistan coast seven zones have been found. These first results are in agreement with observations in other shell areas, for instance, off the Indian east coast.

The paper by Prof. M. S. Krishnan on the geological evolution of Indian coastline dealt in detail with the origin of western coast of India up to the Kathiawar and Kutch regions. He brought out evidence to show that the island of Madagascar separated from India leading to the formation of Indian west coast in the Upper Cretaceous.

An interesting paper on the origin of the Indian Ocean by F. A. Ahmed (Aligarh Muslim University) discussed two hypotheses, one based on continental drift and the other which states that the continents have been where they are and only minor changes have taken place. According to the author, the fact that mountain ranges are continuous from Assam to Turkey shows that India has not drifted *independently* from Africa, as a linear translation of the Indian land mass would have resulted in a distinct break in the mountain ranges.

A paper by Varadachari, Nair and Murthy (NIO) on 'Submarine canyons off the Coromandel coast' was presented by R. R. Nair. This paper is based on echogram data obtained on board the *INS Kistna* during her cruise along the east coast of India during 1965. Three sets of submarine canyons on the continental slope and shelf between Cuddalore in the south and the mouth of Palar river were indicated in this survey and the geomorphological features of these canyons were discussed.

Another paper on the bathymetric features of the Bay of Bengal was presented by T. C. S. Rao of Indian Naval Physical Laboratory. Rao presented his analysis of echograms from the *INS Kistna* cruises in the years 1963 and 1964. The

main features revealed in the study are an oceanic rise along 83°E meridian between 11° and 15°N, a trench along the east coast of Ceylon and India (with the greatest depth of 4400 metres) and submarine valleys off the mouths of Mahanadi, Godavari and Krishna rivers on the east coast of India. The extensions of the Ganges submarine canyon in the Bay of Bengal basin down to 9°N were also indicated.

Four papers were presented on marine sediment characteristics off the east coast of India and three off the west coast. M. Poornachandra Rao's (Andhra University) paper was on oolites from the continental shelf sediments off the east coast of India. Subba Rao and Vedantam (Andhra University) presented a paper on distribution of foraminifera in the shelf sediments off Visakhapatnam, based on the data collected during the geological cruise (18th cruise) of the *INS Kistna*. Madhusudana Rao and Murthy (NIO) gave more detailed account of shelf sediments off the Madras coast. Papers on the characteristics of west coast marine sediments included one by Prabhakara Rao (Atomic Minerals Division, Department of Atomic Energy) on the nearshore sediments of the Neendakara-Kayankulam coast, Kerala, the second one by R. R. Nair and Pylee (NIO) on the size distribution and carbonate content of the sediments of the western shelf of India, and the third one by Chatterjee and Gururaja (Geological Survey of India) on the foraminifera of Mangalore coastal sediments. C. Karunakaran [Geological Survey of India (GSI)] presented two papers of more or less general interest, one bearing on mineral exploration possibilities on the Indian continental shelf, and the other on revision of the stratigraphy of the Andaman and Nicobar Islands. The paper on the mineral exploration possibilities dealt with in a general way the possible occurrence of different types of mineral deposits like phosphatic deposits, ilmenite and monazite, calcareous deposits and highlighted a proposed scheme of studies at the GSI on mineral exploration from marine sources. Most of the papers being more or less descriptive and in view of the relatively large number of papers, the discussions were mainly restricted to a few papers where some theories and hypotheses were put forward.

Marine Biology Including Productivity and Indian Ocean Plankton

The largest number of contributions were in the session on marine biology, the total number being 33. This session was, therefore, divided into two sub-sessions, one on Indian Ocean plankton and the other on marine biology (general) including productivity.

The sessions under Indian Ocean plankton and productivity were chaired by Dr M. Anraku from Japan. The first three papers were of an introductory character. Prof. Krey from West Germany presented a paper on plans and first draft for the atlas on chemical biology of the Indian Ocean. He discussed the type of projection used for this type of atlas and indicated the various steps leading to the preparation of these atlases. The atlas is

to consist of sections like primary production, chlorophyll and carotenoids, biomass of phytoplankton, seston, particulate carbon, etc. Prasad (IOBC, NIO) gave an account of the preparation of atlases on displacement volumes in respect of zooplankton at the Indian Ocean Biological Centre (IOBC), Ernakulam. The basic work leading to the preparation of the atlases was highlighted by the speaker. He also showed some atlases which have already been prepared, indicating the monthly distribution of zooplankton volumes for the Arabian Sea and the Bay of Bengal.

The paper by Prasad was followed by 11 detailed papers on the various aspects of specialized studies carried out on the international collection of zooplankton at IOBC. The introduction to this series of papers was given by E. Brinton, Unesco Curator at the centre. While introducing these papers, Brinton briefly summarized the sorting and research programmes at the IOBC and the specialist studies undertaken on the sorted samples. Following this introduction, he presented a paper by Vijayalakshmi Nair on the quantitative aspects of the distribution of chaetognaths in the Indian Ocean during both the south-west and north-east monsoon periods. The next paper was by Kasturirangan on 'Zooplankton atlas' with particular reference to copepods. He dealt with the processing of data relating to this large group of organisms with a view to incorporating them in the plankton atlases currently in preparation at IOBC. The special studies on the various sorted groups were indicated by a number of persons from IOBC. George Peter gave a paper on pelagic polychaetes, K. J. Peter on fish eggs and larvae, Jacob George on planktonic ostracods, Gopalakrishnan on decapod larvae, both a general survey and special studies on Penaeidae, Sakthivel on pteropoda, Aravindakshan on Carinariidae, and Balachandra Menon jointly with N. K. Panikkar on planktonic anthozoa (Coelenterata) — all from the IIOE collections. Apart from the papers by the group from IOBC, there were a few other interesting papers by Daniel and others based on the work carried out during the IIOE. The paper by A. Daniel and R. Daniel was on siphonophores collected during the 35th cruise of the Soviet research ship *Vityaz*, wherein the authors described a new genus and species of Physonectae. Daniel, Nagabhushanam and Daniel gave a very interesting paper on the organisms constituting the sonic scattering layer in the Bay of Bengal and eastern Indian Ocean, also based on *Vityaz* collections. The organisms were those sampled using an Isaacs-Kidd midwater trawl and the group consisted of siphonophores, pelagic tunicates, euphausiids, fishes, shrimps and medusae with a few squids, copepods and heteropods. The variations in the depths of the sonic scattering layer in relation to other oceanographic parameters were also discussed by these authors.

A few papers were also presented on phytoplankton pigments, primary production, and phytoplankton composition. Among these, mention may be made of one by Shah (Kerala University Oceanographic Laboratory) on the diurnal variations in chlorophyll content at a single station off Cochin

in the Arabian Sea, and the papers by Ramamurthy, Krishnamurthy and Venugopalan on primary production and phytoplankton composition in the nearshore waters off Porto Novo on the east coast of India. The only paper on marine bacteria was presented by Velankar of Central Institute of Fisheries Education, Bombay. The author, while reviewing the Indian work on the subject, dealt with qualitative and quantitative aspect of marine bacterial distribution in the Indian waters, the various physiological groups of marine bacteria, including those responsible for fish spoilage and also the role of bacteria in the ecology of the ocean with particular reference to bacteria-phytoplankton relationships.

In the next session, which dealt with papers on marine biology and productivity (general aspects), and which was presided over by Prof. P. N. Ganapati of Andhra University, Waltair, 12 papers were presented which included such varied topics as: Reproductive and nutritional cycles in a few vertebrates from the east coast of India by S. Krishnaswamy of Madurai University; Fouling organisms in Bombay harbour by Karande of the Naval Chemical and Metallurgical Laboratory, Bombay; Radioactivity and trace elements levels in marine organisms by Patel and Pillai of the Bhabha Atomic Research Centre, Bombay; and Seaweed drift on Indian seashore by V. Krishnamurthy of the Central Salt & Marine Chemicals Research Institute, Bhavnagar. Based on the work at the Zoology Department of the Andhra University, two papers were presented at this session. The first one was on the fauna of Kakinada Bay by Radhakrishna and Ganapati, and the second one was on quantitative studies on zooplankton of the Godavari estuary by Chandra Mohan. Benthic faunal studies in the nearshore regions off the south-west coast of India were discussed in two papers, the first one by Desai and Krishnan Kutty of the Biological Oceanographic Division, NIO, and the other by Kurian of the Kerala University Oceanographic Laboratory. Theodore Srinivasagam from Madurai University presented an interesting paper on a 'New approach to settlement studies' wherein he highlighted the role played by some nitrogenous substances including amino acids in conditioning sea water and making it favourable for the settling of some types of larvae, particularly the larvae of the serpulid, *Hydroides norvegica*. Although somewhat outside the scope of the symposium, the importance of the paper lay in the fact that studies of this type would help characterization of some of the dissolved organic constituents in the ocean, particularly of those described as 'ectocrines' which play an indirect role in the economy of the sea. Thus the marine biology sessions provided extensive coverage of scientific topics.

Fisheries

The last of the scientific sessions was on fisheries — both dealing with resources as well as special topics including methodology and techniques. There were 14 papers in this session which was chaired by Prof. T. S. Rass of the Institute of

Oceanology, Academy of Sciences, USSR, Moscow. Prof. Rass presented first his paper on 'Ichthyological studies by Soviet participants in the IIOE'. According to Rass, deep sea fish fauna in the Indian Ocean seem to be under-investigated as compared with other oceans. He outlined the studies made by the Soviet group as a whole and stated that oceanic ichthyofauna of the pelagic and the deep sea realms formed the subject of investigations by a number of groups of workers. Reproduction and life history studies have also been undertaken by these scientists. The author has also listed the various groups of fishes which have both scientific as well as commercial importance in the Indian Ocean region. Panikkar's paper on the fishery resources of the Indian Ocean, Berry's on clupeoid resources and Dwivedi's on tunia resources were three important papers on the resource aspects of fisheries of the Indian Ocean. Panikkar discussed two broad patterns in the distribution, the south temperate fisheries represented along South African and Western Australian coasts and tropical and subtropical fisheries of the rest of the Indian Ocean. He indicated that there is considerable scope for the increase of production from the present yield of about 2.5 million tons to 10 times its value by intensive oceanographic studies to locate new resources and also newer techniques in fishing. The importance of the Arabian Sea as a region calling for special attention in increasing fisheries production and for intensive oceanographic studies owing to the unstable conditions was specially emphasized by the author in his paper and during discussion.

Berry's paper on the clupeoid resources and research in the Indian Ocean region laid stress on the need to improve our knowledge concerning the systematics of this important group. He gave an account of the work undertaken by him in collaboration with the research teams in Andhra University and the Porto Novo Marine Biological Station of the Annamalai University.

On the subject of fishery biology including techniques and methodology mention is made of the paper by Dwivedi (NIO) on the identification of fish populations with particular reference to the pelagic stocks of the Indian Ocean region; the one

by Alikunhi and George of Central Institute of Fisheries Education on 'Mark-recovery studies on commercially important marine fishes of India'; Gopalan's (NIO) paper on the silver pomfret, *Pampus argenteus*; and Pradhan's (Deep Sea Fishing Station, Government of India, Bombay) paper on the Indian Ocean flat fish, *Psettodes erumei*. Dwivedi's paper dealt with a new modification of starch gel electrophoresis method for the identification of populations in respect of clupeoid, scombroid and other pelagic fishes of the Indian Ocean. The paper by Alikunhi and George gave a description of the tagging experiments carried out by them on the sardines and mackerel in December 1966, conducted from Goa. In the same paper they have indicated the possibility of carrying out similar tagging studies on fishes like pomfrets and demersal fishes like scienids, etc. This has apparently been the first large-scale attempt at tagging marine fish in India.

The relationship between hydrographical factors and fisheries was given in the paper by Qasim and Sankaranarayanan with reference to Cochin region. In regard to studies on fishery yields, the theoretical yield studies on *Cynoglossus macrolepidotus* by Krishnan Kutty and Qasim and the more practical one based on trawling operations by Joseph (off-shore Fishing Station, Mangalore) deserve mention. On the subject of fish eggs and larval studies, K. J. Peter's paper on the larvae of *Rastrelliger kanagurta*, the paper by Balasubrahmanyam *et al.* (Porto Novo) on larval and juvenile stages of the flying fish *Exocoetus volitans* Linn. and *Hirundichthys coromandelensis* (Hornell), and the paper on distribution of fish eggs and larvae in Bay of Bengal by Solomon Raju and Ganapati deserve mention. A. G. K. Menon and Rama Rao (Zoological Survey of India) described in a paper the first occurrence of the flying fish, *Hirundichthys speculiger* (Valenciennes) in the Indian Ocean. The paper by Peter on the larval stages of the Indian mackerel was specially noteworthy as being the first account of these larvae from the Indian Ocean.

The scientific sessions were concluded with an appreciative reference by Dr Panikkar to the fine response to this symposium. The contributions will be issued as a special Symposium Bulletin of the National Institute of Sciences of India.