

# THE INDIAN OCEAN EXPEDITION\*

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**T**HE Indian Ocean Expedition which is a multinational project for the systematic exploration of one of the least known oceanic regions of the world started in 1962 and during the coming three years nearly forty ships belonging to some twenty countries are expected to join this large-scale effort in oceanology. First discussed and organised by the Special Committee on Oceanic Research of the International Council of Scientific Unions, the project found support from the national academies and scientific institutions of many countries. With further planning and organisation the project has grown considerably during the last three years and is being co-sponsored by the UNESCO and the recently formed Intergovernmental Oceanographic Commission. The concept of co-ordinated efforts to study global scientific problems was one of the contributions of the International Geophysical year but the Indian Ocean Project is the first attempt in the realm of oceanography to bring together many countries and scientists of various disciplines all over the world under one project, with a common basic programme; which has been developed by some of the world's leading oceanographers participating in the various working groups of the SCOR. At a time when much is heard of space research, interest in the oceans which occupy about 70% of the earth's surface is also a welcome sign that the "inner space" as something near to man is worthy of much closer study than has been attempted in the past. The study of the Indian Ocean on whose fringes live nearly 25% of the world's population in a very low stage of economic development, may help to locate and utilise resources in food and minerals and at the same time give a more precise idea of the natural phenomena like the monsoons which have such close impact on the economy and well-being of bordering countries. These considerations apart, studying an oceanic region to fill in the many gaps in our knowledge is itself a sufficiently strong incentive for undertaking such a venture. The theory of the monsoon, formation of tropical cyclones, presence or otherwise of the equatorial counter current, the nature of the Indian Ocean floor as compared

with the Pacific, sea circulation in an ocean which is half land-locked: these are all questions of absorbing interest whose answers oceanographers all over the world are eager to seek.

India has special interest in this Expedition because of her geographical location. Many problems in the field of marine sciences in which we are interested are amongst the basic scientific investigations which will be taken up by the participating teams. The Government of India set up the Indian National Committee on Oceanic Research in 1960 under the Chairmanship of Dr. D. N. Wadia. Through this Committee and its various Working Groups Indian scientists and Institutes connected with oceanography have been brought together in a common forum and a national programme has been drawn up which, although a modest one, takes note of all important fields of modern oceanology.

## SHIPS AND PERSONNEL

Four ships have been earmarked for the Expedition from India. These are—INS KISTNA, a 300 ft. frigate of the Indian Navy, specially refitted for oceanographic work; a 92 ft. Fisheries Research Vessel R.V. VARUNA of the Indo-Norwegian Project, built in Norway specifically for fisheries oceanographic work in India; a 50 ft. vessel R.V. CONCH belonging to the Kerala University equipped for coastal oceanographical observations; and a 57 ft. purse-seine fishing vessel M.F.V. BANGADA of the Deep Sea Fishing Station of the Union Ministry of Food and Agriculture. The main observations will be from INS KISTNA and R. V. VARUNA. KISTNA can accommodate about 20 scientists while R.V. VARUNA can take 5 scientists. Both these vessels have been provided with all essential oceanographic equipment. The absence of a heavy-duty-winch on KISTNA excludes geophysical observations for the time being but it is hoped to have this installed before long. The personnel for participating in the Indian Programme are drawn from Indian Scientific Institutions of the Ministry of Defence (Defence Science Organisation and Hydrographic Department of Navy); Ministry of Transport and Communications (India Meteorological Department); Ministry of Food and Agriculture

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(Central Marine Fisheries Research Institute, Mandapam, and the Deep Sea Fishing Station, Bombay); Ministry of Scientific Research and Cultural Affairs (C.S.I.R., The Survey of India, the Botanical and the Zoological Surveys of India); Ministry of Mines and Fuel (Geological Survey of India) and the Department of Atomic Energy. Some of the State Fisheries Departments are also joining the programmes. Apart from the Government Departments, the Universities of Kerala and Andhra, and the Tata Institute of Fundamental Research at Bombay are also active participants. The responsibility for co-ordination and direction of the Indian

main areas of observation will be the Arabian Sea and the Bay of Bengal with the equatorial region as the rough southern limit. A large number of stations will be occupied in these regions, some of them will be deep water stations up to 3,000 meters and the remainder shallow stations up to 500 meters. Cruising plans have been so worked out that intervals between the stations will not exceed sixty miles. The hydrographic data from these stations will be used for circulation studies and for dynamical computations of ocean currents. Direct observations of ocean currents are not being made at present but this programme will be develop-



FIG. 1. 'INS Kistna'—Indian Navy's frigate fitted for oceanographic work. Principal ship in Indian participation.

Programme of the Expedition has been entrusted to the Council of Scientific and Industrial Research under whose aegis the National Committee on Oceanic Research functions as the policy-making body to advise the Government of India in the field of oceanology.

#### PROGRAMMES

The Indian Programme will include almost all branches of research in modern oceanography. The physical properties of the water masses and the process of vertical and horizontal circulation will be studied and all relevant data collected for this purpose. The

ed within the course of this year. Wave and tidal observations from existing and new tidal observatories are being developed.

In the field of chemical oceanography observations cover salinity, phosphates, nitrates, silicates, oxygen and total phosphorus. Full coverage has not been secured in the earlier cruises. Primary production studies will be carried out by  $C^{14}$  Technique. The Atomic Energy Department at Trombay is paying special attention to radiometry. The geochemical behaviour of certain elements is being taken up for special investigations at the Tata Institute of Fundamental Research.

The importance of locating new fisheries resources being one of the major objectives of the Expedition, the Marine Biology and Fisheries Programme is oriented to understand the productivity of the seas, the location of spawning grounds of commercial fishes and the location of areas capable of intensive fishing. Critical studies of plankton production and distribution of the major components of marine plankton will be taken up from selected areas. Plankton sampling for the Expedition as a whole

being developed by the C.S.I.R., with technical assistance from the UNESCO.

The Marine Geology and Geophysics Programme includes magnetic, seismic and gravity studies but the Indian Programme is likely to be slow in implementation owing to inadequate instrumentation. Regular Echo-Sounding with the precision depth recorder will, however, be made for getting profiles of the ocean bottom all along the routes taken by the ships, so that the data collected could be used to develop accurate bathymetric charts.



FIG. 2. 'R. V. Varuna'—Indo-Norwegian Project Fishery Research Vessel. Second participating ship in the Indian Programme.

is being made through the Indian Ocean Standard net which has been developed by the SCOR working group in biology as a basis for the comparison of results obtained in different areas by different ships. The large volumes of plankton material collected by this standard method by all the ships are proposed to be brought to the Indian Ocean Biological Centre established in Ernakulam near Cochin, from where this material will be sorted and placed in the hands of world specialists for further studies, the bio-mass estimations being made at the Biological Centre itself. This centre is

By far the most ambitious programme from the Indian side is in the field of Meteorology. The studies will include the sequence of events and the spatial relations between those events which make up the large-scale monsoon circulation in the Indian Ocean, which although known from ancient days to the mariners is still a very imperfectly understood atmospheric phenomenon. The complete reversal of ocean currents and air circulation when the South-West Monsoon changes to the North-East is a factor which has far-reaching consequences in the oceanic phenomena and the heat budget of this part of

the earth. The South-West Monsoon, whose onset is a remarkable example of the effect of differential heating of land and water, probably originates in areas south of the equator and evidence is gradually accumulating to show that what is now considered as one monsoon may be the combination of several monsoons having different sequences in geographically separated areas. To study all these phenomena in a systematic manner and to take advantage

of weather phenomena in the Indian Ocean would have been subjected to the closest study. Not since the Valdivian Expedition of 1898-99 has any such attempt been made to study Indian Ocean Meteorology. The India Meteorological Department has done much preparatory work towards the understanding of these complex forces and recently as part of the expedition effort, systematic radiosonde observations have been initiated for oceanic regions from

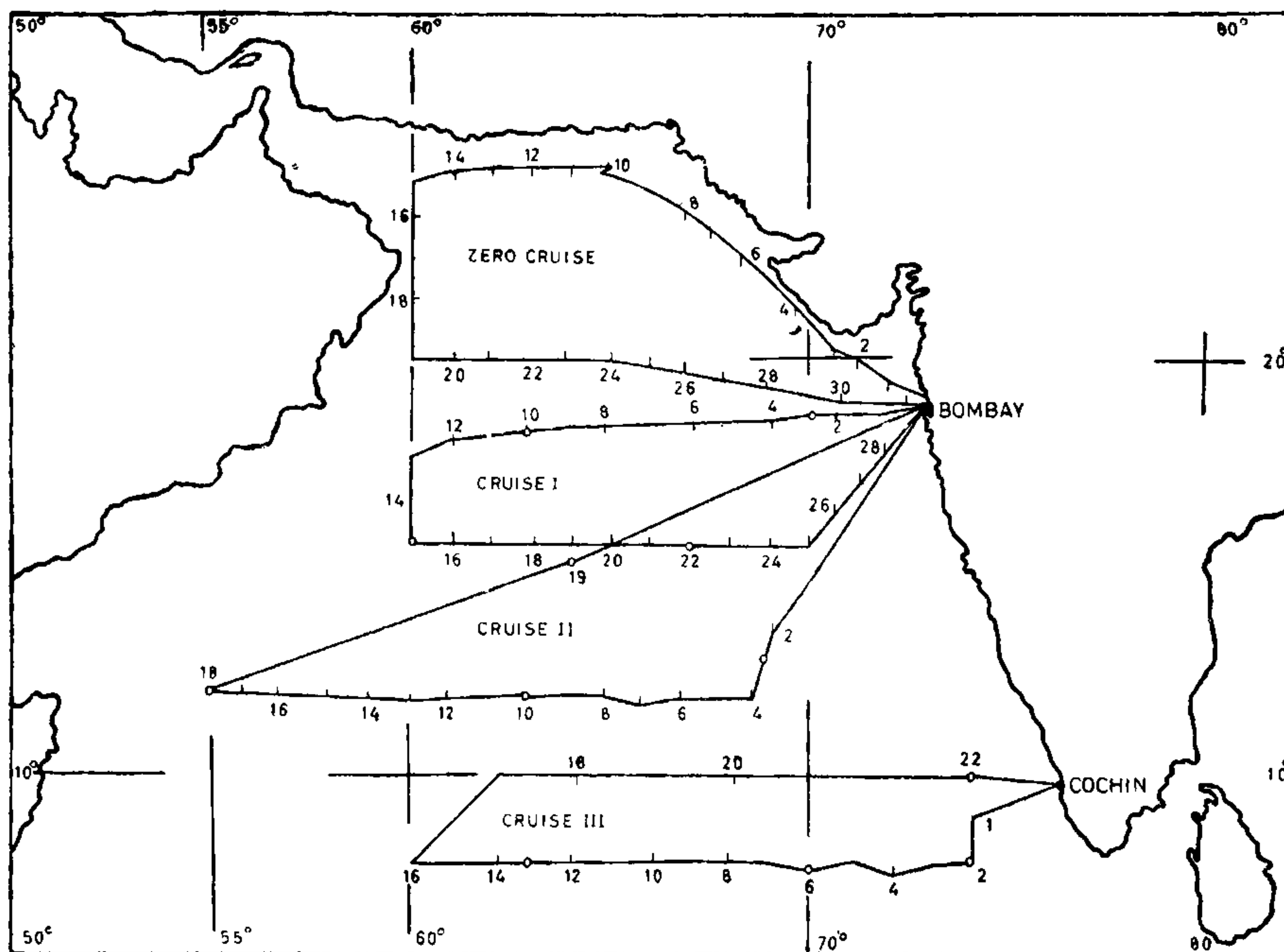


FIG. 3. Track chart of 'INS Kistna' and the station positions where oceanographic observations have been carried out during 1962.

of the large volume of atmospheric and oceanographic data that would be accumulated as a result of the Expedition, an International Meteorological Centre is being established in Bombay by the Government of India with the assistance of the U.N. Special Fund. Advanced computer techniques will be employed for quantitative treatment of the data. The U.S. Weather Bureau is collaborating with this Centre in a bilateral programme of weather studies aided by special aircraft. It is hoped that by the time the Expedition is over the whole range

INS KISTNA in the Arabian Sea. During the Expedition period it is also proposed to establish first class ocean weather observatories at Minicoy, Amindivi and Port Okha.

The problem of oceanic circulation of the Arabian Sea is a matter of special importance to India. The fact that over two-thirds of the total annual production of about a million tons of sea fish in the country is obtained from the west coast obviously points to a higher productivity of the Arabian Sea Waters as compared with that of the Bay of Bengal. But the

exact reasons for this increased productivity in terms of oceanographic conditions still remain to be elucidated. Many former observers have conjectured the possibility of nutrient laden deep waters coming to the surface through the influence of (a) bottom drifts striking against sub-marine ridges; (b) upwelling of water associated with the prevailing current systems; (c) large-scale turbulence caused by strong monsoon winds which pile the water against the west coast of India; and (d) coastal eddies resulting from the local wind effects.

Recent studies made by researchers of the Central Marine Fisheries Institute and of the Indo-Norwegian Project have clearly shown that deep water of low temperature and low oxygen content occur considerably higher up near the surface on the west coast of India. Indications of low temperature water in coastal regions are also available from surface temperature and salinity charts for the Arabian Sea published by the Dutch Meteorological Institute. A number of observations showing high values of phosphates for the Arabian Sea coastal waters of the west coast have been reported as against the Bay of Bengal coastal waters. Intensive studies on the standing crop of plankton have also shown substantially high organic production off the Malabar coast. The correct understanding of the forces responsible for this upwelling and indeed whether it is upwelling in the classical sense or a combined effect of several factors will be one of the problems whose solution will be sought by Indian workers because of the very close relation which these phenomena have on the movements and shoaling of the sardines and the mackerel which form the backbone of Indian Marine Fisheries. Valuable data in this direction have already been obtained by the work of R. V. VARUNA. Oceanography team work-

ing at the Andhra University has shown upwelling in the Waltair Coast but its relation to fisheries of the Bay of Bengal remains to be investigated. Indian ships and the U.S. Research Vessel ANTON BRUUN will be devoting some time to this problem.

Oceanography is a very young science in India. Pioneer work was accomplished by the "INVESTIGATOR" during the beginning of this century and in the series of later investigations on surface temperature and salinities by Col. Seymour Sewell who led the John Murray Expedition to the Arabian Sea in 1933-34. Some of the earliest observations on the optical properties of sea-water were made by Sir C. V. Raman during 1920. In recent years the notable advances have been the growth of two schools of oceanography since 1950, one associated with the Central Marine Fisheries Institute at Mandapam and its Substations and the other associated with the Andhra University under the leadership of the late Prof. Mahadevan and Prof. E. C. LaFond. The Naval Physical Laboratory at Cochin has come to the fore recently in certain aspects of physical oceanography and many other institutions are newly entering this field. Inadequacy of research vessels for work which cramped earlier efforts has now been overcome. It is hoped that Indian participation in this expedition will result in substantial advancement to oceanological studies in the country and the development of applied marine sciences based on a solid foundation of fundamental work. A country with over three thousand miles coastline and a pre-eminent geographical situation in the Indian Ocean will require a number of trained oceanographers and a vigorous marine sciences programme towards which Indian participation in this Expedition can only be just a beginning.

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## PROBLEMS OF OPERATING RESEARCH SHIPS\*

C. S. RAMAGE

**T**HIRTY or forty years ago, when few oceanographic cruises were undertaken, planning, execution, research and publication were expertly and exhaustively carried out by first-class scientists. Today, although the number of research ships has greatly increased, the number

of interested scientists has not increased proportionately. Consequently the data from many voyages have not been analysed nor disseminated, wasteful duplication occurs and oceanographers are so busy planning and participating in new voyages that they have little time to conduct research on the results. No oceanographic cruise should be undertaken unless competent scientists make themselves available for all aspects of data collection and processing, research and publication. Since the supply of

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