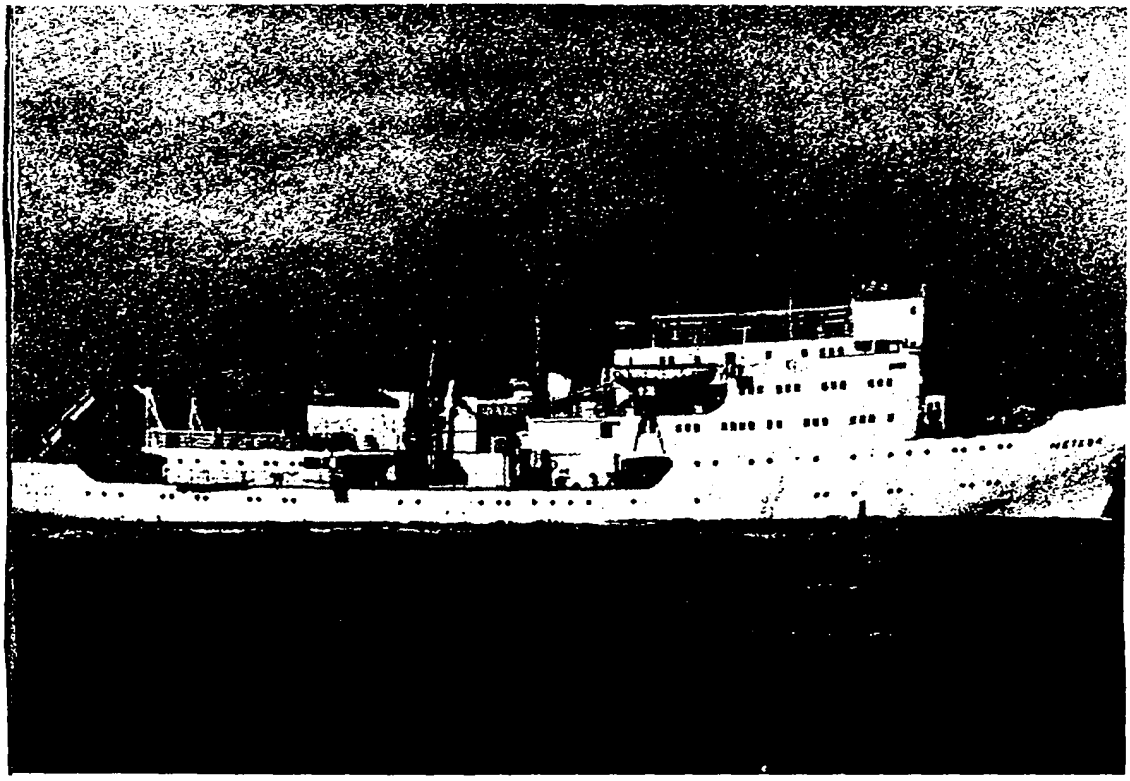
INTERNATIONAL INDIAN OCEAN EXPEDITION

NEWSLETTER

INDIA

Vol. II No. 3 December, 1964



R. V. METEOR

Issued by

THE INDIAN NATIONAL COMMITTEE ON OCEANIC RESEARCH
COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
NEW DELHI

COVER PHOTO

The new research vessel Meteor built in a Hamburg shipyard is the seventh ship to bear that name in Germany. "A wishdream of German Oceanographers" came true when she was commissioned for participation in the International Indian Ocean Expedition on 29-10-1964. Arriving in Cochin on 10-2-65 Meteor will carry out a joint programme of Seismic studies with I.N.S. Kistna in the Arabian Sea.

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IN THIS ISSUE

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INDIAN PROGRAMME

Scientific Cruises of INS KISTNA

One of the highlights of the Indian Programme during 1964 was the visit of *INS Kistna* to Singapore. This was the first time that this ship has been able to visit a foreign port during her participation in the International Indian Ocean Expedition cruises.

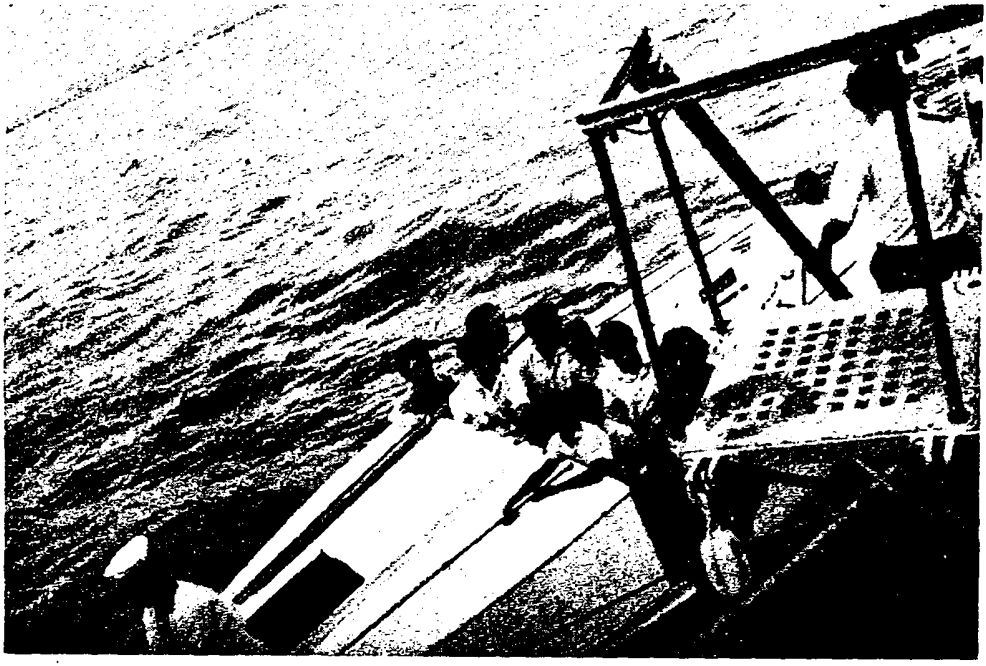
The ship left Madras on her 19th Scientific cruise on 17th August, 1964 with a complement of 15 scientists under the leadership of Dr. N.K. Panikkar, Director of the Indian Programme. After a brief halt of about a day at Port Blair, Andamans, *en route,* the ship reached Singapore on the 27th August, 1964. In this cruise 12 stations were occupied in the eastern Bay of Bengal and the Straits of Malacca, among which 6 stations were worked to depths exceeding 1000 metres and three stations were worked upto a depth of 2000-2500 metres.

The following observations were carried out during the cruise:–

Hydrography ..	12
BT Lowerings ..	24
Indian Ocean Standard Net hauls ..	12
Vertical closing plankton net hauls ..	9
Submarine photometer observations (Mid-day stations) ..	5
Phytoplankton samplings from the euphotic zone ..	9
Surface meteorological observations ..	12
Radio-sonde ascents ..	3

Dr. Serene, Unesco Marine Science Expert (National Museum, Singapore) visiting INS Kistna at Singapore.

During the ship's stay at Singapore from 27th August to 1st September, 1964, contacts were established between the Indian scientists on board the ship and the Malaysian scientists interested in Oceanography. The ship held an open-house and nearly 200 scientists and students from Malaysia visited the ship. Dr. Panikkar gave a talk on the Indian Ocean Expedition at the University of Singapore and the scientific members of the group visited the various science departments of the University. The Indian film on the Indian Ocean Expedition was shown at two places and portions of it together with interviews with Dr. Panikkar, Dr. Srivastava and Commander Maitra, the Commanding Officer of *INS Kistna* were televised in the Singapore Television. At the invitation of Malaysian National Committee on Oceanic Research, Dr. Panikkar participated in their meeting held at Kuala-Lumpur and visited the University and the Fisheries Departments at the capital.



At Singapore: University Students visiting INS Kistna

The 20th Scientific Cruise of the ship commenced from Singapore on 2nd September, 1964 under the leadership of Dr. S.S. Srivastava. A total number of 18 stations were occupied in this cruise; in the first three of them only BT lowerings were made, while in the rest all the routine observations and collection of data were made.

The main items of work in this cruise are listed below:-

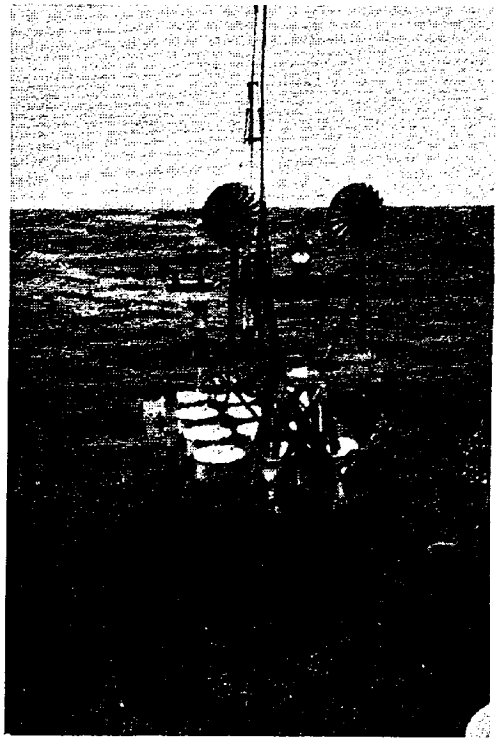
Hydrographic casts (very shallow < 100 meters—4; very deep 2000—3000 meters—4; the rest 1000—1500 meters) 3000 meter station is the reference station.	.. 15
Indian Ocean Standard Net hauls—	.. 11
Vertical closing Bolting silk Plankton net	.. 13
Submarine light penetration	.. 7
Phytoplankton sampling (Filtration of large volume of water)	.. 9
Surface meteorological Observations	.. 18
Radio-sonde ascents	.. 4

In addition to these observations, during the 19th and 20th cruises, wave observations were made daily and in a few stations collections of water samples were made for geochemical studies. The Edo-echo sounder was run almost continuously during both the cruises and profiles of bottom obtained in the different areas of the eastern Bay of Bengal.

Among the interesting bathymetric features recorded, mention is made of a submarine ridge between Rhondo Island and Edge Island in the Straits of Malacca. The echograms showed the ridge rising from a depth of 700 fathoms (1260 metres) to 250 fathoms (450 metres). At the same position continuous belt of tide drifts were observed indicating that the ridge connected the two islands. About 80 miles north of this ridge another underwater mountain was observed rising from a flat sea bottom of 1320 metres to a height of 540 metres. A few other interesting finds recorded in these cruises are also presented here.

Visual observations of sea and swell made during these cruises showed that near the northern tip of Sumatra, tidal rips were observed extending over large areas. The radiosonde ascents have been able to reach heights of 65,000 to 70,000 feet and obtain very useful upper air data. Measurements on penetration of light into the sea using the submarine photometer indicated depths of penetration of 60-75 meters in the Bay of Bengal and 30-50 meters in the straits of Malacca. The standing crop of plankton was moderately rich in many stations. A vertical haul from 1000 meters to surface brought in large siphonophores and a few colonies of Pyrosoma. Deep scattering layers were observed in the echo records obtained from a number of places in this eastern part of the Bay.

One of the important items of work carried



NOMAD as seen from INS Kistna during XX Cruise.

out by *INS Kistna* during the 20th cruise, besides the scientific observations was the search for the NOMAD buoy which had suddenly stopped transmitting weather messages. *INS Kistna* which had been particularly directed to keep a sharp look-out for the automatic buoy and locate its presence, was able to locate the buoy on 9 September, 1964 at 1630 hrs. more or less in the same position where it had been installed. It was observed that the power unit on the automatic buoy had completely broken down resulting in the failure of both flash light signals and radio transmissions. The India Meteorological Department and the International Meteorological Centre were promptly informed of it and the instruments are now being set right.

R.V. VARUNA

Details regarding the inorganic nutrient distribution studies carried out in the cruises of *R.V. Varuna* during September-November, 1963 are now available. The sampling stations and other particulars are given below:-

Date	Cruise No.	Area	No. of Samples	Depths (Metres)	Details of the Analysis
6.9.63	100/V 37	Off Quilon	15	0–200	Phosphates; Silicate and Nitrates.
20.9.63	101/V 38	Off Ratnagiri	34	,,	,,
25.10.63	103/V 40	Off Mangalore	48	,,	,,
1.11.63	104/V 41	Off Quilon	20	,,	,,
4.12.63	106/V 43	Off Ratnagiri	46	,,	Phosphates and Silicates only.
18.12.63	107/V 44	Off Mangalore	20	,,	,,

The results of the analysis are given below :—

1. OFF QUILON Lat. 8°53′ N Long. 76°35′E

During monsoon the inorganic phosphate content in the upper 10 meters ranged from 1.0 to 1.4 μg-at./L. in the inshore region decreasing to 0.5-0.8 μg-at/L in the more offshore areas. Nitrate values ranged between 1.6 and 2.7 μg-at/L. The post monsoon values showed further increase of both phosphates and nitrates in the nearshore areas. The presence of upwelled water is detected near the coast.

2. OFF MANGALORE Lat. 12°51′N; Long. 74°50′E

Concentrations of phosphates ranging between 0.8 and 1.5 μg-at/L have been found in the surface waters upto a distance of 15 miles from the shore and decreased to 0.4-μg at./L further offshore. Values greater than 2.0 μg-at/L were obtained in about 200 metres. In the case of silicates, the range of values was 4-10 μg-at/L nearer shore and less than 4 μg-at/L further offshore. Similar distribution was seen in the case of nitrates, the nearshore and offshore concentrations being respectively 1.0-4.5 μg-at/L and 0.4-1.0μg-at/L. Vertical distribution patterns of all the nutrients show an upslope shoreward indicating upwelling. The December values for all these nutrients are low as compared with monsoon and early post-monsoon values.

3. OFF RATNAGIRI Lat. 16°57′N Long. 73°17′E

The pattern of distribution of nutrients is

similar to the other two areas, but the values are lower. The range of concentrations are:

Phosphate : 0.8–1.3 μg-at/L-inshore
0.6–0.8 μg-at/L-offshore
(Monsoon period values.)
Concentrations decrease to 0.2-0.6 μg-at./L in December.
Silicates : 2.8–9.6 μg-at/L-inshore
5.6–6.0 μg-at/L-offshore
(Monsoon period.)

Thus an increasing trend is seen from shore seawards. Values decrease to 0.5–2.0 μg-at L in December. The shore-seaward trend, however, remains the same (C.V. Gangadhara Reddy & V.N. Sankaranarayanan).

INDIAN OCEAN BIOLOGICAL CENTRE, ERNAKULAM :

The Centre has received a total number of 1484 plankton samples from various participating countries by the middle of December, 1964. The receipt of samples since April 1964 comes to a total of 416. About 87% of the samples are of Indian Ocean Standard Net hauls and the remaining taken by nets more or less similar to Indian Ocean Standard net. The contributions from *RRS Discovery* (U.K.) comes to 160 samples and from *Pioneer* (US) 40 samples. Recent receipts from *Anton Bruun* include 1 sample from station 263-324 of cruise V.

Samples are being sorted at the Centre at an added pace, adhering to the procedure approved by the Consultative Committee for the Indian Ocean Biological Centre. By the close of November 1964, 524 samples have been completely sorted. A table showing the country-wise receipt of Indian Ocean Standard Net (IOSN) and other samples is given below:

TABLE I

Country	Total No. of samples*	No. of samples taken with	
		I.O.S.N.	Other nets
Australia	206	190	16
India	353	236	117
Japan	109	109	—
Pakistan	22	22	—
South Africa	166	102	64
United Kingdom	206	206	—
U. S. A.	372	372	—
U.S.S.R.	50	45	5
Total	1484	1282	202

*Samples destroyed during transport are not included.

The Sorting laboratory at the Indian Ocean Biological Centre, Ernakulam.

Till December 1964, the location of 1338 plankton samples have been plotted on a map* thus showing their distribution in 5 degree squares. The rest of the samples could not be plotted on the map as the details regarding their exact location are yet to be ascertained. However, the map reveals a good spatial coverage of plankton sampling in Indian Ocean. Regions inadequately sampled are expected to be covered satisfactorily before the close of the expedition period.

INTERNATIONAL METEOROLOGICAL CENTRE, BOMBAY

At the International Meteorological Centre (IMC) data processing into various forms useful for research is proceeding rapidly. Excellent pictures were obtained by the ground equipment at the IMC from the short lived NIMBUS weather satellite. The research aircraft from the Woods Hole Oceanographic Institution returned to United States after successfully completing its third mission in Indian Ocean.

Map plotting of 1963 data is now almost complete. A microfilm camera provided under UN Special Fund programme has been put into operation. It will be used primarily to photograph analysed IIOE weather charts beginning from January, 1963. Microfilmed copies of this will be distributed on request to meteorological services which have supplied data to International Meteorological Centre.

Ships' data for 1963, now entered on punch cards have been given preliminary processing. Similar processing of upper air data has begun. The Japan Meteorological Agency has sent nearly 7,000 punch cards containing data from research and other vessels operating in the Indian Ocean, the first such consignment to be received under Intergovernmental Oceanographic Commission-sponsored arrangements. Manuscript copies of aircraft reports continue

*See on cover page 3.

to be received in increasing quantities. The Pakistan Meteorological Service sent a consignment of over 5000 reports on microfilm covering the period February 1963 to April 1964. The current analysis programme of IMC uses aircraft reports intensively. Fascimile charts which are now being received for four levels, twice-daily from Guam are also helping analysis. During the daily map discussion, computer calculated divergence and vorticity for the northern Indian Ocean are compared with the distribution of other meteorological variables. Two oceanographers and International Meteorological Centre programmers wrote a Fortran programme for detailed computation based on physical and chemical observations made on board *Anton Bruun*. Approximately 36,000 complex computations have been made from 4,500 observations taken at different ocean depths.

Research aircraft of the Woods Hole Oceanographic Institution under the direction of Mr. A. F. Bunker, observed winds, temperatures humidities, clouds, turbulence, and turbulent fluxes over the Indian Ocean during a period when south-west monsoon was decreasing in strength. Most of the flights were made from Bombay during August-September. The western part of the Arabian Sea and in particular the region of Somali Current was surveyed at a time when the *RRS Discovery* was also investigating the currents. The 13 scientific flights totalled 108 hours during which 57 successful dropsoundings were made. The observations were mainly supplemented by excellent time-lapse movies made on Royal Air Force transport aircraft flying between Aden, Gan and Singapore and also by superb television photographs relayed from the NIMBUS weather satellite. The pictures received at the APT equipment in Bombay from NIMBUS showed well defined cloud distribution over southern Asia, and as far south as the equator. These significantly contributed to the analysis programme at International Meteorological Centre.

Shri C. R. V. Raman, Chief Research Forecaster was invited by World Meteorological Organisation to be the Chief Consultant to the Inter-regional Seminar on Advanced Tropical Meteorology held in Manila.

INDIAN OCEAN PHYSICAL OCEANOGRAPHY CENTRE, ERNAKULAM

The Indian Ocean Physical Oceanography Centre (IOPOC) (formerly Oceanographic Research Wing of the Indian Ocean Expedition situated inside the Naval Base, Cochin until January, 1964) was shifted to its present premises at Ernakulam. The former accommodation at Naval Base is now being utilised as a field station for daily observations in the backwaters.

A team of ten scientists is working at this centre on various aspects of Physical Oceanography, such as Physical and dynamical studies on the sea water, studies on the bottom topography and geology, beach erosion, accretion and sand movements, coastal currents, storm surges and sea level variations, wave refraction and statistical studies on the chemical and physical characteristics of sea water.

Details of studies:

Present studies include daily observations in the Naval Base and weekly observations at the stations in the back waters around Willingdon Island. Secchi disc observations, tide level and speed of surface current are the parameters for the daily observations. Water samples are collected at one meter intervals from surface to bottom and analysed to determine the salinity and chemical characteristics. Statistical analysis of the data collected during the past five years has been done and the monthly averages and seasonal variations of physical features of backwaters studied.

The carbon-dioxide cycle of the Indian seas

is being investigated. Statistical analysis of the surface water temperature of the Bay of Bengal and the eastern part of the Arabian Sea is being carried out and charts showing the general distributions of the surface water temperature salinity and density are under preparation. Seasonal variation of the hydrographic features of major ports of the west coast of India is being studied. Wave refraction studies in relation to beach erosion along the Kerala coast were continued. Echograms obtained from *R. V. Varuna* of Indo-Norwegian Project are also being analysed.

Regular observation on beach profiles and erosion, accretion and movement are being made at five representative stations near Cochin. The mudbanks off the Kerala coast and their role in beach erosion or accretion are being investigated in close collaboration with engineers of the Engineering Research Institute, Kerala.

REPORTS FROM OTHER COUNTRIES

Cruise IV of R. V. ANTON BRUUN (U.S.)

The Cruise IV of *Anton Bruun* was undertaken in two parts, IVA and IVB in order to facilitate the carrying out of three-month multi-disciplinary exploration of the Arabian Sea during the fall of 1963. The interest of participants ranged from chemistry and microbiology to taxonomy, distribution and biochemistry of the large invertebrates and fishes.

A brief summary of the report of cruise IV of US Research Vessel *Anton Bruun* is presented below:

CRUISE IV A

Cruise IVA was planned for the basic biological programme of hydrography, chemistry and plankton biology with extra sampling time provided for additional work in chemistry and microbiology.

The ship departed Port Louis, Mauritius on September 25, 1963 and the cruise was terminated at Bombay on November 8, 1963. *Enroute* she visited Port Victoria, Seychelles, Aden and Karachi and occupied 40 stations (161-200).

Though the main object of this cruise was to make a series of sections normal to the coast around the periphery of the Arabian Sea, across the continental shelf and into the deep central basin, she had to confine her work, due to shortage of time to western side where three sections were made normal to the Arabian coast and two short sections across the Gulf of Aden and Gulf of Oman respectively. In addition the outer stations of the three sections which run out of the coast were interspersed with deep stations producing a section along central basin of the Arabian Sea parallel to the Arabian coast. Complete hydrographic study with measurements of temperature salinity, dissolved oxygen, phosphate, nitrite, nitrate and silicate were made at all 40 stations on the southern part of the cruise. Observations were extended up to 2000 m except the last 20 stations which were extended to the bottom.

Productivity was measured by the C^{14} technique at every station by collecting water samples from depths to which 100, 50, 25, 10 & 1% respectively of the incident sunlight penetrated. Two-litre productivity samples were filtered for pigment determinations for which three extra samples were also obtained from 125, 200 & 300 metres.

In addition at stations, 175—200 three additional depths were sampled between the surface & bottom of the euphotic zone in all stations for measurements of primary production and pigment determination. Thus eight depths were sampled within the euphotic zone for carbon assimilation and pigment determinations.

Additional portions or same water samples collected for productivity and pigment determinations were also used for the following measurements:

Particulate Carbon	–	348 samples
Particulate Phosphorus	–	348 „
Dissolved Organic Carbon	–	591 „
Dissolved & Particulate Iron	–	600 „
Dissolved Molybdenum	–	At selected stations.
Particulate & Dissolved Nitrogen	–	276 samples from 34 stations.

Carboy-size samples obtained with plastic water samplers from various depths were utilised for determinations of the rate of assimilation of nitrogenous compounds by inoculating with N^{15} tagged nitrogen gas, ammonia & nitrate.

Trichodesmium picked out of the plankton tows from varius depths where water is rich in the blue-green algae, were inoculated into filtered surface water of which N^{15} tagged nitrogen compounds were added.

Samples of surface waters far from the influence of land were collected & enriched with various combinations of nitrogen, phosphorus, iron, trace metals and silicate and vitamins (B_{12}, thiamine, biotin). These enriched samples inoculated with C^{14} and then carbon assimilations were measured.

Vertical plankton tows from 200 m to the surface were made at every station with the Indian Ocean Standard Net. At five stations (184-186, 192, 194) a series of horizontal tows were made with 20 mesh nets spaced at 10m intervals from the surface to 40 or 50 metres, in order to determine the vertical distribution of phytoplankton in general and blue green alga *Trichodesmium* in particular. At 19 stations oblique pankton samples were taken with Be′ prersure-operated multiple-oblique samplers at depth intervals of O-125-250, 250-500-1000 and 1000-2000 metres. But the operational records of Be′ samplers were not impressive.

In shallow water paired plankton nets of coarse mesh (#3) mounted one over the other were employed for oblique plankton tows.

As usual all the Indian Ocean Standard Net samples were sent to Indian Ocean Biological Centre, Ernakulam (Cochin), India and rest to Smithsonian Oceanographic Sorting Centre, Washington, D.C.

The following gives some of the preliminary results and conclusions in brief arrived at the completion of certain analyses both shipboard and at the Woods Hole Oceanographic Institution:

> Sections made normal to the Arabian Coast in October-November after the monsoon had ceased, revealed no evidence of upwelling. There is an indication of a clockwise gyre in the central part of the Arabian Sea.
>
> The nutrients which were brought up into the euphotic zone by divergence gave rise to extremely high rates of primary productivity. The resulting phytoplankton populations in south-westerly direction was characterized by blue-green alga, *Trichodesmium*, the dinoflagellate *Noctiluca* and of diatoms notably of the genera *Rhizosolenia, Chaetoceros*, and *Skeletonema*. A sharp thermocline in the central Arabian Sea present at about 50 m below which the concentrations of nutrients (phosphate, nitrate, silicate) increased sharply. At depths of 1000-1500 *m* concentrations were measured of > 3.0 μg-A/1 Po_4-Pand $> 40\mu$g-A/1 No_3N, values which approach the highest levels known for these substances in any ocean—Silicate too, reached exceptionally high concentration (> 160 μg-A/1) and increased steadily to bottom rather than passing through a maximum at mid-depts

as did phosphate and nitrate. There was a rapid decrease in dissolved oxygen concentrations to less than 1.0 ml/l at 100m and to less than 0.1 ml/l at mid-depths of 500-1000 m at some stations. Although concentrations increased again below 1000 m, they never approached the saturation in bottom waters.

It is noteworthy that not even a trace of hydrogen sulphide could be detected in the samples which contained low (<0.1 ml/l) concentrations of oxygen. This is in contrast to the situation reported by the *Vityaz* during her cruise in the same area in November, 1960. The presence of unusually high levels of nutrients and low oxygen concentrations at or in close proximity to the euphotic zone (50-75 m for most stations) is indicative of a situation which is potentially both highly productive and biologically unstable.

Dissolved carbon decreased from 1 gram/m^3 or more at the surface to about one third of the amount in deep water. Particulate carbon values were about one tenth of those for the dissolved fraction were also highest at the surface. These figures are typical of the values observed throughout the Arabian Sea.

No apparent correlation was observed between the concentration of dissolved organic carbon and rate of primary production. In the Arabian Sea while rate of primary production varied by two orders of magnitude, the dissolved crabon varied by about three-fold. This fact suggests that the dissolved carbon is not an immediate bye–product of phytoplankton growth. The significant variations in the concentrations of dissolved organic carbon in the deeper water may be correlated with different water masses in the Arabian Sea as distinguished by temperature–salinity characteristics. The preceding evidence leads to the conclusion that dissolved organic carbon in the ocean is extremely stable and refractory to decomposition and may be considered as one of the more conservative properties of sea water.

CRUISE IV B

The cruise began on November 12, 1963 from Bombay and ended at Karachi on December 10, 1963. Hydrography, chemistry, primary production and plankton studies were taken up in this part. Another major objective of the cruise was the studies on the distribution and relative abundance and taxonomy of the benthic fauna on the continental slope in the Arabian Sea. Studies on fish parasites, biochemistry of invertebrates, meteorological phenomena, radiological properties of sediments and selected fish and invertebrates were also conducted during this cruise.

Bottom sampling was carried out primarily with a 42 feet Mexican shrimp trawl. Samples were also collected by means of biological dredge, trolling lines, set lines, hand lines, and dip nets. Most of the trawling operations were conducted inside the 100 fathom line owing to the precipitous and uneven nature of the continental slope. Plankton samples were taken at 17 stations. Mr. J. R. Naidu, guest investigator from India, carried out phosphate determination of both surface and bottom. Bathythermograph lowerings were made at all trawl stations and stations between an interval of 3 hrs.

A preliminary analysis reveals some of the exciting results during this cruise, especially as regards trawling operations. A total of 16000 lbs of fish, 209 lbs of shrimp and 1840 lbs of swimming crabs (Portunidae) were caught in 86 hauls. Fish catch comprised of species from about 80 families. One 30-minute haul yielded 1700 lbs of fish and 1800 lbs of swimming crabs off Muscat and Oman, Arabia. This strikingly high catch in this region suggests the potentiality for a substantial fishery.

Unusually rich hauls of shells were obtained in the Gulf of Oman, between 26 and 51 fathoms. A 5-minute haul in 45 fathoms yielded 200 lbs of shells. The shell catch comprised of a few rare species like *Strombus listeri* Gray, *Tibia delicatula* Nevill and genus Clementia belonging to family Veneridae. Two dredge samples were collected from off North west Inlia and 7 each off west Pakistan and the Gulf of Oman, and one off Muscat and Oman. Surface trolling during daylight hours yielded 25 skipjacks, 5 yellowfin tunas, 12 dolphin fishes (*Coryphaena hippurus*) and one wahoo (*Acanthocybium Solandri*). Handline stations near Astola Island yielded 5 Balistidae 2 Lutjanidae, 14 Serranidae, 2 Sparidae and 20 Carangidae. Set line gear yielded 3 relatively large Lethrinidae.

Of the 17 plankton hauls one sample taken off North West India provided about 16 lbs of material mainly comprising of ostracods. Three small sea snakes were also caught in the plankton net.

Rotenone was used to obtain intertidal collections of fishes and invertebrates on the west end of Astola Island and west Pakistan and several species were collected. A series of excellent slides were prepared by photographing freshly caught specimens retaining their natural colouration. 80 bottom sediment and 250 biological samples were oven dried for radiological analysis which will be made in the laboratories of India Atomic Energy Commission.

Besides Mr. J.R. Naidu from India, Dr. C.V. Kulkarni and Dr. H.G. Kewalramani of the Directorate of Fisheries, Maharashtra State, were also on board as guest scientists.

AUSTRALIA

H.M.A.S. Diamantina had planned to undertake three cruises: Dm1/64, Dm 2/64 and Dm 3/64, during the first half of 1964. The summary reports of the first two are available at present. One of the major objectives of cruise Dm 1/64 was to study the distribution and growth of west Australian cray fish (*Panulirus cygnes*) and the vessel occupied 10 stations for Indian Ocean Standard Net (IOSN). Studies on the sediments on the continental shelf and the hydrological conditions of water massess on and adjacent to continental shelf were the other aspects taken up during the cruise which commenced from Fremantle on 28.1.64 and ended at the same port on 18.2.64.

Cruise Dm 2/64 was undertaken between 24.3.1964 and 21.4.64, from Fremantle to Penang and back. The objective of the cruise was to study the detailed hydrographic structure in the equatorial region along 92° and 95° E and to examine suggestions based on recent studies in the region on the Indian Ocean undercurrent. 42 stations were occupied during this cruise and at every station sub-surface hydrological observation and bathythermograph lowerings made.

D. Rochford (Leader), F. Davies, N. Dyson and J. Prothero were the scientific party on board, during Cruise Dm 2/64.

SOUTH AFRICA

Cruise Programme of S.A.S. Natal

According to the information available the South African Ship *Natal* was to undertake four cruises during August-November, 1964.

The vessel is expected to cover about 36 hydrography, 28 current measurement and 9 mid-water trawling stations. In addition scoop netting, current measurements and additional observations were planned to be done near Watter's Shoal.

PLANS FOR SCRIPPS EXPEDITION

Information has been received from Scripps Institution of Oceanography regarding the plan for the following expeditions.

I. *Expedition Kayak*

According to the plan the research vessel *Oconostota* was expected to leave on expedition Kayak from San Diego on July 10,1964. It was expected to be completed in two legs lasting for about one and a half months. G. Shor. Jr. was to lead the scientific party on board during leg I and Joseph R. Curry during the leg II of this cruise.

The major objective was to conduct investigations of sea floor structure in the gulf of Alaska and off the coast of northern California using seismic reflection methods. The equipment included Rayflex Arcer Ewing Seismic profiler and Sono probe. In addition, tests were expected to be conducted of a VLF radio navigator system tried out abroad *Atlantis* and anticipated to be shipped to *Argo* for use in Indian Ocean.

II. *Expedition Ursa Major*

This was planned to commence from the beginning of August, 1964 and to complete by the opening of October. The primary intention was to make two transects of the sub-arctic convergence and the North-Pacific, Drift, in order to collect data on the biological and physico-chemical aspects of this region at closely spaced stations, as the faunal boundry being a major feature of Pacific requires detailed study.

The cruise was expected to be undertaken in three legs: (1) San Diego–Kodiak, (2) Kodiak–Honolulu (3) Honolulu-San Diego. Brown and McGowan were to be leaders for the first and second leg. During the third leg observation will be limited to deep hydrographic casts and 300 meter oblique net tows at few stations.

EXTRACTS FROM SCIENTIFIC PAPERS

Geophysical studies in the Indian Ocean

It is in the last ten or twenty years that fascinating features of ocean bottom have been recognised. The crust which is the outer layer of the solid earth overlying the more dense and more uniform layer called the mantle has different structure and composition under the oceans, from those under the continents. The oceanic crust is made up of sediments underlain by basaltic rocks. The total thickness is about 10 km with an increase under the oceanic mountains. Granite rocks are normally completely absent although there is one notable exception, the Seychelles Islands.

Broadly speaking all the oceans are similar in having a rough topography as it moves away from the continents towards the mid ocean. Topography becomes rougher until a mountain ridge is encountered with rugged peaks and deep valleys. This ridge follows medium line of oceans round the world and represents the longest mountain chains on earth, parts occasionally reach above the sea surface giving rise to islands such as the Azores. Curved chains of islands with a deep trench and a large negative gravity anomaly in the convex side of the arc is interesting. Most of the ocean bottom physiographical features are present in the north-western Indian Ocean. There are two fully developed abyssal plains and abyssal hills that merge with the mid ocean ridge. The *Carlsberg Ridge* is an impressive chain of mountain over 400 km long. It emerges from a complicated and little known area of rough topography, somewhere south of Mauritius and stretched to the entrance of the Gulf of Aden. The ridge was first recognized by Dana expedition in 1930. Above the ridge

magnetic anomaly shows a disturbed field with generally poor correlation between magnetic bathymetric profiles. It is impossible to say from the magnetic profile what causes the anomaly and this is still a mystery.

Two hypotheses have been put forward to explain the abyssal plain anomalies based on convection currents—one of them rising under the ridge flowing under the crust away from the ridge and sinking under the continents. The upper boundary of the flow might not be smooth, indeed it is more likely to be undulating so that the depth of the isothermals is variable. This would imply a variable depth of materials at temperature below the curie point, which would acquire a magnetisation that would manifest itself on the observed magnetic anomaly. This hypothesis remains to be tested with dense profile of heat flow stations.

Seychelles Bank & Amirantes Trench

Seychelles is the only known mid-ocean island group composed of granite which is typically continental, whereas usually oceanic crust is made up of sediments underlain by basaltic rocks, and this supporting the theory of continental drift. If there are general re-arrangement of Indian Ocean that opened up the Indian Ocean as we know it today, it is natural to say that continental part of the Seychelles has dropped off and was left behind, but where did it belong? Seychelles bank is bounded by a lowlying ridge of coral islands called the Amirantes. Repeated crossing with shipborne magnetometer have indicated that the ridge is underlain by highly magnetic rocks close to the surface underneath the coral. This ridge is directly in fall with Madagascar fault.

Recently a trench called the Amirantes trench has been noticed in this area. This exhibits gravitational anomaly comparable to any other trench. Together with east coast of the Madagascar fault, the Amirantes trench is the most important new evidence for tectonic activitiy in this area. If strike-ship origin of this trench could be proved the riddle of the Seychellés could be solved and their ancient connection with Africa reconstructed by moving them south to east coast of Madagascar.

Many 'fascinating puzzles' on the Indian Ocean floor are yet to be investigated. New tools and techniques will have to be applied on a large scale.

(B.D. Loncarevic, Endeavour, Volume XXIII–Number 88, January, 1964).

The "Hadal Fauna"

Dr. Anton Bruun the leader of the Galathea expedition proposed the word "Hadal" for the trench zone and its fauna. Since the end of second World War the secrets of the deep sea trenches began to reveal gradually and today the existence of over 20 ocean trenches having depths more than 7000 metres and 5 exceeding 10000 metres of depth have been known. Of these the fauna of 11 trenches with depth exceeding 7000 metres have been fairly investigated following the first exciting dredging by *Galathea* in July, 1951.

So far, 280 hadal species have been studied among which 115 are described by *Galathea* and 57 by *Vityaz*. Out of the 155 species named, 98 are endemic to hadal zone and most of them belonging to the same genera are known to be restricted to the hadal zone. The prominent groups of hadal fauna so far recorded include actinians, bristleworms, amhipods, isopods, gastropods, lamellibranchs and sea cucumbers. Species usually occuring below 6000 metres, are Pogonophora, echinoids, worms, holothurians and isopods. Of these, Pogonophores, are of special interest as they are mouthless tubiculous animals, absorbing food through

the skin of tentacles. Decapod crustaceans are never found in hadal depths and less important groups like branchiopods and turbellarian worms are also seem to be absent while sponges, bryozoans, barnacles (stalked) tunicates and fishes are rare. Only three species of hadal fish have been known.

Hadal species have peculiar adaptations to the environment of eternal darkness and extraordinary pressure. They are often greyish or whitish in colour, and always completely blind. Crustaceans having unusually long legs might be an adaptation for walking on soft sediment on bottom. Regarding the origin of hadal fauna Dr. Torben Wolf expresses doubt whether they were there before the ice age or they did move subsequently to take over from less adaptable species.

(Dr. Torben Wolf, New Scientist, Vol. 24, No. 414, October, 1964)

Mass fish mortality due to Asphyxiation.

Dr. John Ryther, U.S. Marine Biologist recently put forward a theory explaining the cause for the death of millions of tons of fish in certain areas of the Indian Ocean. He suggested the theory following his return from a research cruise in the Arabian Sea as part of U.S. Programme in Biology for the International Indian Ocean Expedition. It was near this area that a Russian merchant ship in 1957 reported passing through millions of tons of dead fish floating in an area 125 miles wide and about 600 miles long. The fish probably died from being suddenly exposed to water lacking in dissolved oxygen and paradoxically the mass deaths might have taken place in water heavy with natural fish food.

Elucidating the factors involved in these wholesale deaths Dr. Ryther says that the nutrient-rich water brought to the surface by the upwelling process causes a rapid growth of plankton which use these nutrients and sunlight to produce organic matter through photosynthesis; and the subsequent sinking of the organic matter beneath the surface where it decomposes depleting further or exhausting the oxygen supply of the water. The presence of such unusually high levels of nutrients and low oxygen concentrations at or near the base of the photosynthesis zone indicates a situation that is potentially both highly productive and biologically unstable.

The organisms produced in the surface water die, sink and decompose. This decomposition uses up the remaining oxygen in the water already low in oxygen. Further, upwelling to the surface of such anoxic water traps masses of fish in an oxygenless environment and they became asphyxiated.

Large areas of upwelling of nutrient laden water were found by Dr. Ryther and other scientists participating in the International Indian Ocean Expedition. No anoxic water was found in this cruise, however, though the presence of such water was reported by Russian research vessel *Vityaz* in the same area in 1960 (National Science Foundation—May 13,1964).

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NOTES AND NEWS

Composition of Deep Scattering Layer

Existence of a strange layer giving answering echos from several hundreds of feet below the surface of the sea were recorded since the inception of echosounders. Sometimes it appears on the recording graph so well pronounced as the actual sea floor even though the true bottom may lie many fathoms deeper. The diurnal vertical movement of this layer had led to the detection of its biological origin as early as 1945, but its exact composition remained a mystery.

A recent accouncement from the International Oceanographic Foundation, Miami says that scientists have now determined the exact composition of Deep Scattering Layer The layer according to the announcement is mainly composed of Siphonophores. But unlike the well known Siphonophore, the Portuguese man-o-war, the species in question is able to regulate the buoyancy in order to sink and rise at will.

Deep scattering layers were observed by Indian scientists on board *INS Kistna* in the eastern Bay of Bengal during August, 1964. Vertical plankton haul from 1000 meters to surface which brought large siphonophores and few colonies of Pyrosoma from the said region is significant in this context.

Mass Expulsion of Zooxanthellae from the Jamaican Reef Communities

Very extensive bleaching of coral reef communities occurred after severe flood rains over eastern Jamaica. The loss of colour was due to the mass expulsion of zooxanthallae from the tissues of Millipora, Seleractinia, Zooanthidea and Actiniaria living in shallow reef zones.

It is believed that this physiological injury was caused by the lowered osmotic pressure on the surface of the sea rather than by sedimentation or fouling. Regeneration of the depleted zooxanthellae was very slow. Many of the bleached colonies survived well despite the absence of zooxanthellae for about 2 months.

("Science" Vol. 145, No. 3630 July, 1964)

Seismic ship continues oil survey

Soviet Seismic Ship *'Akademic Arkhangelsky'* left Madras on December 10,1964 to Kandla after about 4 months survey along the Coromandal coast. On her way to the west coast the ship made a survey in the Gulf of Mannar and is expected to make another survey off Kerala coast. The chief scientist on board said that hopeful results could be expected of the present survey. In the Gulf of Kutch survey is expected to continue up to April 1965 and the ship is scheduled to leave India by October, 1965.

Cigar shaped sea-going Laboratory

A 355 foot cigar shaped laboratory bigger than a foot ball field floats on end in the sea. This strange looking craft called "Spar" is a platform for the marine acoustical research and is designed to make exact measuring of sound transmission under water.

Spar is an automatic laboratory collecting data from clusters of gyrocompasses, direction finders, hydrophones, and radio transmitters. It sends its information by a floating cable to a nearby ship and simultaneously makes a recording for later use. Construction of spar was completed by Aerojet Shipyards and launched in July 1964 for the use of U.S. Navy.

(Science News Letter, April, 1964)

A new Under water current meter based on doppler effect

A dual channel self-calibrating under water current meter designated Model MCV-1, has been devised by the Gulton Industries, Metuchen, New Jersey. This novel instrument uses Doppler effect to determine the current velocity and the direction of the current flow.

The system consists of a deck unit housed in a portable water tight case and an under water transmitter and two receivers for hull mounting. The deck unit provides two simultaneous signals for each channel, an A.C out put signal that varies in frequency with changes in velocity and a D.C. out put sig-

nal that varies in amplitude with changes in velocity. The direction is ascertained by mounting the two receiving heads at right angles to each other. The D.C. signal may be used to drive an X-Y recorder. The deck instrument has two meters with four ranges each –0.3, 1,3 and 10 knots–(Jour. Frank Inst. 1964 277, 375).

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Oceanographic Studies in Kerala University

Department of Marine Biology and Oceanography of Kerala University consists of four laboratories–the Oceanographic Laboratory at Ernakulam, the Marine Biology Laboratory and Aquarium at Trivandrum, Estaurine field station at Ayiramthengu and Fisheries Technology Laboratory at Trivandrum.

The Research Vessel *Conch* of this department completed four cruises as part of her programme in connection with International Indian Ocean Expedition in addition to the routine scientific work on the continental shelf off Cochin. Of the biological collections made in these cruises, plankton samples have been deposited at the Indian Ocean Biological Centre, Ernakulam. A number of problems have been taken up for detailed investigation, based on the biological collections. Collection of physical and hydrographic data has been done from selected stations.

The Oceanographic Laboratory participated in the investigations on silt movements using radio isotope tracing technique in the Cochin Port area conducted by the port authorities, in the oil survey made by the Oil and Natural Gas Commission and the sea erosion survey conducted by Dr. George M. Watts, U.S. Beach Erosion Expert (Kerala University Annual Report for 1963).

Launching Ceremony of "DISCOVERER" (OSSO-2)

Launching ceremony of the newly built U.S. Coast and Geodetic Survey Ship *DISCOVERER* took place at Jaksonville, Florida on October 29, 1964. The vessel was built at the Aerojet-General shipyards for United States Maritime Administration under the sponsorship of Mrs. Donald F. Haring.

Symposium in Mombasa

A symposium was held on November 11, 1964 during the visit of R. V. Anton Bruun to Mombasa. It was arranged through the National Science Foundation and Woods Hole Oceanographic Institution as part of United States participation in the International Indian Ocean Expedition. Local arrangements for this symposium was made by John Hagan of the American Embassy in Nairobi.

Symposium on International Indian Ocean Expedition

A national Symposium entitled "The preliminary results of the South African research during the International Indian Ocean Expedition" was held in Cape Town during 29 June to 1 July, 1964. This was sponsored by the South African co-ordinating Committee for Oceanographic Research.

Summer Course in Physical Oceanography

An International Summer Course on "Some aspects of Oceanology in Shallow Seas" was organised by the Netherlands Universities Foundation for International Co-operation. Dr. V.V.R. Varadachari and Shri C.S.N.

Murthy of Indian Ocean Physical Oceanography Centre, Ernakulam, India attended this seminar held at Lunteren, Netherlands.

Seminar on Earth Sciences

Indian Geophysical Union and Osmania University have jointly organised a Seminar on "Earth Sciences" sponsored by the University Grants Commission. Geology Department, Osmania University Hyderabad, was the venue for the Seminar which was held from 27th to 29th December, 1964.

Symposium on the Geological and Geophysical results of the International Indian Ocean Expedition

A symposium on the Geological and Geophysical Results of the International Indian Ocean Expedition was convened by the Indian National Committee on Oceanic Research in connection with XXII International Geological Congress which was held in Vigyan Bhavan, New Delhi from 14–22 December, 1964. The first suggestion for utilising the occasion for an exchange of information on the Indian Ocean Geology came through the Royal Society, London from the British Council on Oceanic Research.

Dr. D.N. Wadia, Chairman, Indian National Committee on Oceanic Research inaugurated the discussions which were held under five separate groups from 15–18 December, 1964.

GROUP–I – Crustal structures on the Indian Ocean
Chairman –J. H. Taylor

GROUP–II – Geophysical studies in the Indian Ocean
Chairman –E. Siebold

GROUP–III – Submarine Geology of the Indian Ocean
Chairman –J. H. Taylor

GROUP–IV – Sediments and sedimentation in the Indian Ocean. Chairman–L.A. Weekes

GROUP–V – Islands in the Indian Ocean & Continental margins of the Indian Ocean.
Chairman – N. K. Panikkar

Thirtieth Annual Meeting of the Indian Academy of Sciences

The Thirtieth Annual Meeting of the Indian Academy of Sciences took place at Poona University during 25-27 December, 1964. Dr. N.V. Gadgil, Vice-Chancellor, Poona University welcomed the participants and Sir C. V. Raman delivered the presidential Address on 'Vision and Nature of Light'.

Scientific meetings in section A was presided over by Sir C. V. Raman and Dr. N. K. Panikkar presided over the Section B. Shri P. R. Krishna Rao presided over a symposium on 'Meteorology' in which eleven papers on various aspects were presented.

A public lecture was given on 26th by Dr S. Bhagavantam on "Lasers and the Raman Effect" and another on 27th by Dr. N. K. Panikkar on "Indian Ocean'. In his lecture Dr. Panikkar referred to the recent observations by R.R.S. *Discovery* on the Somali current which is found to flow at a speed of 7–8 knots, thus forming one of the fastest ocean curents ever known. He also referred to the discovery of a counter equatorial current below the surface in the Indian Ocean, similar to ones existing in Atlantic and Pacific Oceans. The Arabian Sea, Dr. Panikkar said, was comparatively far more productive than the Bay of Bengal and he attributed this to the extensive upwelling. The living and mineral resources located on the floor of the Arabian Sea, he added, held great promise and indicated possibilities of their industrial

exploitation.

Training in Ocean current measurements

Shri C. Madhavan, Junior Scientific Officer of Indian Naval Physical Laboratory, Cochin resumed duty after a six months,' (February-August 1963) deputation to National Institute of Oceanography, U. K. for training in the measurement of Ocean Currents under Dr. J. C. Swallow.

UNESCO Training Course in Plant Physiology

A UNESCO sponsored Regional Training Course in Plant Physiology was inaugurated at the Botany Department, Delhi University on 10.12.64. Shri A.H.V. Sarma (Senior Research Fellow, INCOR) was deputed to attend this course which lasted for six weeks.

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Tax-Free Fuel for Visiting Ships

Government of Kerala has issued an order No. GO. MS/650/64/Re. dated 29.9.64 exempting the tax payable on the sale of diesel oil and other fuel oils to the authorities of the visiting ships participating in the International Indian Ocean Expedition.

PROCEEDINGS OF THE ELEVENTH MEETING OF THE INDIAN NATIONAL COMMITTEE ON OCEANIC RESEARCH (18th September 1964)

The eleventh meeting of the Indian National Committee on Oceanic Research was held at the Council of Scientific and Industrial Research, New Delhi on 18th September, 1964 under the chairmanship of Dr. D. N. Wadia. While according welcome to the participants, the Chairman expressed satisfaction over the progress of Indian participation in the International Indian Ocean Expedition. He stressed that the Planning Body (Indian National Committee on Oceanic Research) should be ready with the blue print of the proposed National Institute of Oceanography with budgeting and phasing of the programme before March, 1965. Referring to the International Geological Congress planned to be held in Delhi, Chairman pointed out the need for fully participating in the symposium on the geological and geophysical results of the IIOE organised at the instance of Royal Society, London and convened by the Indian National Committee on Oceanic Research.

The Secretary presented his report on the progress made in Indian participation in the expedition with special emphasis on the scientific cruises of *INS Kistna* and the interesting findings. He pointed out some of the short-comings faced during these cruises due to the inadequacy of equipment and expressed the hope that these would be overcame in future. Reference was made in his report to (a) the meeting of the Telecommunication Experts, Meteorologists, Oceanographers and Fishery Scientists held on 25.4.64 in connection with the allocation of Radio-frequencies in ocean data service (b) the report on the sub-committee meeting concerning the installation of Wave Recorders and (c) Indian National Committee's recommendation of holding a symposium on the meteorological aspects of International Indian Ocean Expedition.

Secretary's report on his participation in the Inter-governmental Oceanographic Commission

Secretary gave a report on his participation in the Intergovernmental Oceanographic Commission meeting held in Paris. The Committee congratulated Dr. Panikkar on his elec-

tion as the Chairman of the Intergovernmental Oceanographic Commission. Highlighting the resolutions adopted by the Intergovernmental Oceanographic Commission, the member-Secretary said that the "General Scientific Framework" for world ocean study was a most valuable document prepared by Scientific Committee on Oceanic Research for the Intergovernmental Oceanographic Commission through the joint efforts of Prof. Revelle of USA, Dr. Kort of USSR and Dr. Deacon of U.K. He added that this draft document provides much useful material for developing and furthering oceanographic research in countries like India. He also drew the attention of the members to the resolutions pertaining to the International Biological Programme, Exchange of Oceanographic Data, Fixed Oceanographic Stations and others. He requested the members to study the resolutions and communicate their views so that the national standpoint on these resolutions could be stated after discussion by the Indian National Committee on Oceanic Research.

Considering the programmes of other participating countries Member-Secretary said that the immediate interest is in the participation of the new German Ship *Meteor*, which was expected to visit India during February, 1965. *INS Kistna* is expected to participate in a joint Seismic Exploration programme with *Meteor*. The status of participation of other neighbouring countries was also reviewed by the Member-Secretary.

International Meterological Centre

A detailed report on the activities of International Meteorological Centre (IMC) was presented before the Committee by Mr. C. Ramaswamy. He referred to the progress of the kinematic analysis, the preparation of divergence and vorticity charts, the computer programmes and the investigational programmes taken up at the centre.

Geological Programme

Chairman said that the geological programmes have not been progressing satisfactorily and stressed the need for added effort in that direction. Dr. Panikkar briefly reviewed the geological work carried out during the various cruises of *INS Kistna* with special reference to XVIII cruise which was exclusively meant for geological studies. Among the findings he highlighted the discovery of some canyons between the mouths of Godavari and Krishna rivers. The Committee while considering the reconstitution of Geology and Geophysics Working Group agreed to the proposal to include Dr. Harinarain and Dr. D.P. Kharkar in the Working Group.

Progress towards the setting up of National Institute of Oceanography

Member-Secretary stated that the working party of the Planning Committee for National Institute of Oceanography have so far held two meetings in which the various items proposed for the setting up of the Institute have been discussed and a detailed project plan would be ready by Jan-Feb, 1965.

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SCOR EXECUTIVE MEETING-*Paris, June-9, 1964*

Report on the proceedings of Executive Meeting of the Scientific Committee on Oceanic Research held in Paris (June 8-9, 1964) has been received. Besides the members, 22 representatives from National Oceanographic Institutions and other organizations participated in the meeting. Agenda covered a number of important items concerned with the activities of Scientific Committee on Oceanic Research.

The report says that a Symposium will be held in connection with the annual meeting and Humphrey will ask SCOR Members, Braarud, Motoda, Panikkar and Parin and perhaps other scientists to present papers in this Symposium entitled "Effects of variation in Oceanic Circulation on distribution of Marine Organisms". The Committee desired the continuation of following working groups:—

1. *"Joint panel of experts on Oceanographic Tables and standards"*—in collaboration with IAPO, ICES and UNESCO. Dietriech, Miyake, Hermann, Ivanov-Frantzkevich, Carrit and Fofonoff are the members and Cox is the Chairman of this group.
2. *"Atlases"*: Reid is the Chairman of this group in which Bezrukov, Motoda, Hansen (Ex-officio as Curator, Indian Ocean Biological Centre) and Ramage (Ex-officio-Scientific Director, International Meteorological Centre) are members.
3. *"Abstracts and Bibliography of use in Marine Science"*. Kesteven, Meyer-Uhlenried Model and Scattergood are the members and Saila is the Chairman.
4. *"Zooplankton Sampling Methods"* in collaboration with ICES and UNESCO. There are four sub-groups to cover all zooplankton. Fraser, Humphrey and Parsons met on June 4, 1964 to select scientists mainly from lists provided by National Committees. As soon as Fraser obtained ICES agreements, the scientists will be asked to serve.
5. *"General Scientific Framework for the Comprehensive study of world oceans.* This group includes Revelle (Chairman) Deacon and Kort. Cushing (ACMRR) is also a participant. The draft prepared by Revelle has been presented at the Third IOC Session at Paris.
6. *"Photosynthetic Radiant Energy"* in collaboration with IAPO and UNESCO. The working group is headed by Tyler and Jerlov, Steele, Jitts, Saijo, Steemann-Nielsen are members. Angot-Madagascar National Committee, Terada-FAO, Prasad-Indian National Committee on Oceanic Research; Oosthuizen-South African National Committee are the other participants.
7. "General Problems of Inter-calibration *and standardization.'* Jayaraman-Indian National Committee is a participant in this group headed by Carritt.
8. *"Determination of Photosynthetic Pigments"*. This group is in collaboration with UNESCO. Krey is the Chairman of the group; Viswanathan, Indian National Committee, is also a participant.
9. *"Biological Data"* in collaboration with ACMRR. This group is to list the kinds of biological data which might be considered for inventory and/or storage in regional, specialised, world data centres. This will also co-ordinate scientists in matters related to the transmission and storage and will also consider the reliability and practical implication of storing biological and other related data in the same or different centres. The group will advise on the compilation and indexing of source lists of publications containing biological data and also advise on the question whether the data centres should process the biological data.

Oceanographic Congress at Leningrad

The Oceanographic Congress has been planned to be held in Leningrad in early May 1966. A Soviet Arrangements Committee has been formed with Fedorov as Chairman. Millionshikov, Chekurov and nominees from Institutes and agencies will be members in this committee.

Indian Ocean Biological Centre

The executive agreed with the terms of reference as stated at the second meeting of the

Consultative Committee for the Indian Ocean Biological Centre, that it should be responsible for the international collections and also asked Humphrey, Panikkar and Parsons to include in the terms of reference a statement about terms of office and maximum number of members of the Committee.

Report on the SCOR Working Group on Atlases

SCOR Working Group on Atlases headed by J. R. Reid has presented a detailed report on various oceanographic Atlases. This report prepared by correspondence was presented to the third Session of the Intergovernmental Oceanographic Commission by Wooster. An extract from the report is given below:

Scientific requirements and principles

The report says that the first purpose of an atlas is to display in a clear and accurate manner the various properties of its subject, so that the investigators with various interests may turn to it to gather information pertinent to their particular problems. Marine atlases are very few and the making itself is an exploration as it might show unexpected features new and different from old ones. High quality data with adequate distribution in space and time are the primary requirements towards this. It seems reasonable to assume that for some time to come atlases of many oceanic properties will continue to be based on scanty and perhaps in part doubtful data. The preparation of the map should be supervised by an interested scientist for it is likely that a mere clerical treatment, however technically correct will not be able to separate good and bad data. In any case the varying quality and quantity of materials would require a different set of standards for each property. As a result it is best not to write down specific criteria and instead, each map prepared should be examined on its own merits. It is much better to appoint competent people and trust to their good judgement.

ATLAS RESULTING FROM INDIAN OCEAN EXPEDITION

Meteorological Atlas

An outline for IIOE Meteorological atlases has already been prepared by Dr. Ramage and distributed for comments. These atlases will be one of the most significant and potentially useful products of IIOE. Two meteorological atlases are visualized, one describing the upper air specifically for use by meteorologists, the other embodying near-surface data and designed with the needs of physical oceanographers, meteorologists, biologists and fisheries scientists in mind.

Prof. Ramage has distributed a chart of the suggested scale and projection showing areas for the upper air and surface charts and also showing the number of useable observations made in each 5 degree square during the typical month of June 1963 by ships (upright figures) and at small island stations (Sloping figures).

Data from all available IIOE and other sources for two calendar years 1963 and 1964 within each 5 degree square will be plotted at the point and not at the centre of the square. For upper air atlas the area will be 45° N to 50° S; 20° E to 155° E and for surface atlas, the ocean area enclosed between the east coast of Africa, the southern Asia, Southern Indonesia, west Australia, 20° E and 145° E and 50° S. They will have mercator projection on the scale 1:40 million and a format, lithophotographed from automatically printed out, hand analysed data in loose leaf binding to facilitate changes and intercomparisons. All the units will be in metric system apart from knots for wind speeds.

Content: Upper Air Atlases

Plotted data—Monthly mean resultant wind and steadiness at all upper wind sounding stations and monthly mean pressure heights, temperatures and dew points at all radiosonde stations plotted on charts for standard pressures of 850, 700, 500, 200 mb. (amended to include 100 mb.

Analysis—streamlines of the resultant wind directions

Auxiliary charts—monthly mean atmospheric cross-section for the meridians of 30° E; 73° E and 140° E (amended to include about 105-115 E) to 50° S on the same distance scale as the standard charts and on the convenient vertical scale.

Plotted data—monthly mean N-S and E-W components of the wind at all upper wind sounding stations and monthly mean pressure heights, potential temperature and dew points at all radiosonde stations on or near 30°E to 73° E and 140° E for as many pressure level as possible.

Analysis—Isotaches of Zonal wind components isentropes.

Totally there will be 156 charts in the atlas.

Comments—Since no upper air atlas of Indian Ocean region exists, one is being prepared at the International Meteorological Centre utilising monthly means of all existing upper wind data. On charts of the area projection and scale proposed a preliminary version will soon be given limited distribution and final version incorporating IIOE, data should appear in about two years' time. By using it, investigators would readily be able to determine the anomalousness of IIOE months.

Surface atlas—For every month the sequence of charts, the type of data and method of analysis will be the same. The chief data source will be the observations made from merchant ships and research vessels, however, whenever possible, observations made at stations on small islands will be incorporated, care being taken to select only those times of observations at which the local distorting effects of the island are negligible.

Background information

Chart I plotted: Tracks and dates of all research vessel cruises and research air craft flights made during the month; tracks and dates of all cyclonic system which occurred during the month; classified according to the following intensity and scale:

Depression—maximum winds less than 33 knots;

Storm—maximum winds between 33 and 64 knots;

Hurricane—maximum wind above 64 knots.

Frequency of weather satellite photography for each 5 degree square; number of observations made in 5 degree square of (1) sea temperature (2) dew points (vapor pressure), air temperatures, surface wind, pressures, cloudiness, weather.

Analysis : Isopleths of the duration of civil day light.

Directly observed variables

Chart II plotted data : Monthly mean resultant winds and steadiness; monthly mean pressure.

Analysis—Streamlines, isobars.

Chart III plotted data : Monthly mean air temperature, monthly mean sea surface temperature.

Chart IV Plotted data: Monthly mean cloudiness, percentage frequency of observations recording rain.

Analysed data; Isodiabatics; isopleths of total number of hours.

Derived Data:

Chart V plotted data: Total monthly incoming radiation (insolation minus reflected radiation); number of hours per month in which the incoming visible radiation exceed 400 lux.

Analysed data; Isodiabatics; isopleths of total number of hours.

Total number of charts : 144.

Comments

Dr. Ramage comments that several possibilities for special charts remain to be explored. He desires to learn reactions to the idea of plotting frequency curves for all sub regions with high density of meteorological observations or of observations in other disciplines. Special needs such as those of fisheries scientists for semi-monthly average, might be met by issuing a set of charts independent of the atlas and in less expensive form.

Atlas of Physical and Chemical Properties—

Mr. Reid has prepared a tentative outline for an atlas of maps and sections and distributed to the concerned working group for comment.

Physical and Chemical material

After viewing the available station patterns and taking into consideration the number of completed cruises, it is possible to list some maps and vertical sections, and to speculate about the feasibility of others, but the adequacy and accuracy of the data can be finally evaluated only as the maps and sections are being prepared. Mr. Reid has arbitrarily selected a number of properties, maps and vertical sections that might be included in a conventional sort of atlas; however, he feels that the atlas maker should be free to make his own choices in these matters

A—*Deep Oceans*

The depth of seasonal variation may differ between one ocean and the other and therefore it is not possible to state how far below the sea surface this "steady state" atlas may begin perhaps the upper limit will be between 500 and 100 m, in any case it must be determined by whoever prepares the atlases and not by a committee.

Maps—

Beneath the critical depth it will certainly be possible to prepare the following conventional maps and other maps of geostrophic flow.

Maps of properties at intermediate and greater depths in which all data can be used regardless of season.

Depth	Property	No. of levels.
Abyssal (3500 m and greater), where distribution and circulation are severely limited by bottom topography.	Temperature, Salinity, density, oxygen and other chemical measurements as available	about 6 levels
Greater depths (2500-3500 m) distribution and circulation still limited by topography.	—do—	About 3 levels
Intermediate (700-2500 m) with distribution and circulation less affected by topography.	Same, plus geopotential anomaly.	About 5 levels

Vertical Sections

The complete and self-contained sections laid out systematically should be drawn to a common scale with the interpretation and contouring of each done after comparison of

all the sections. The exact number of these and their locations can only be settled as the work progresses. The seasonal aspects need not be considered on a few good long, deep sections, but it should be possible to make seasonal vertical sections of the upper 1000 m (or as deep as seasonal effects are noted) for much of the ocean.

The Upper Ocean

Maps: In the upper layers season must be taken into account. In some areas, for e.g. Arabian Sea, seasonal data seem to be adequate. In others for e.g. Bay of Bengal, situation is doubtful at best and may depend not only upon all planned cruises being carried out but upon some means of adding to the planned coverage.

Prof. Tchernia has indicated a severe shortage of data in the western equatorial region in summer. This may be taken care of by the *Argo* cruises in the summer of 1964. It seems reasonably sure that by grouping the data in 6-month seasons they will give reasonable coverage in most areas. The upper layer might be represented by about five levels, with maps at each level showing temperature, salinity, oxygen, phosphate and other chemical properties as available with calculated values such as density and geopotential anomaly also.

Vertical Sections

Vertical sections of the upper few hundred meters in different seasons should be used to augment the deep vertical sections. They will be available in many parts of the Indian Ocean. Indeed, in the Arabian Sea there will be perhaps more sections than can be included usefully in a general atlas. The sections should include to same properties as in maps.

Estimate of number of maps and sections

1. The deep water atlas might include about 14 levels with atleast 6 properties, or 84 + maps. The number of vertical sections might be about 14, with about three of them filling as much space as one map. This would be 28 + map equivalents.
2. The upper layer atlas might include 5 levels in two seasons, or 60 + maps. The number of vertical sections might be about 20 in two seasons, but they might be smaller with about 6 of them filling as much space as one map. This would be 40 + map–equivalents.
3. The total number of maps and map equivalents would be 212 + for 6 properties. If the atlas size is such that one map fills a page this means 212 pages.

Biological Atlases

Discussions were held between Vagn Hansen, Curator, Indian Ocean Biological Centre, Ernakulam and Motoda of Japan and they have written up about the materials that are available and might later become available.

1. The following data of biological parameters may be available without much delay. They are (a) Zooplankton volume (b) chlorophyll (these observations are and will be from Australia, United Kingdom, Germany, USA, USSR and India. (c) C^{-14} *Assimilation*: as various methods are used it will be necessary to recompute the results from the expedition, which can probably, be done by participants of IIOE. The distribution of the aforesaid properties can be illustrated by:—

I. Surface maps: The three properties converted into units per unit for the monsoon and intermonsoon periods.

II. Detailed maps of selected areas with sufficient, dense grid of stations. (Arabian Gulf, the western part, and eas-

tern part of Indian Ocean E of 90° E-

III. Vertical sections from selected areas: Prof. Krey, Subject Leader for IIOE has compiled all plankton stations and should be a consultant for this aspect and Mr. D.N.F. Hall, Fisheries Subject Leader for the IIOE should be consultant for the fishery data (d) observations of shoals of scombriform (tuna) fishes (e) observations of whales (f) observations of birds.

2. One of the important types of atlases for biologists will be concerned with zoogeography and a considerable delay is involved in processing the IIOE biological data which may take at least the coming five years. However, one important problem at the initial stage of preparation is the procuring of published literature on the taxonomy and distribution of marine organisms in the Indian Ocean.

According to Hansen the problem of preparing atlases on zoogeography is a future task on which individual experts will have to be depended. On the other hand it is very advisable that one or more biologists inform and advise the physical and chemical oceanographers and meteorologists what type of atlases will be of greatest benefit for the biologists.

Geological and Geophysical Atlases

Prof. Bezrukov has examined the availability of materials for atlases in these fields and has noted that the exchange of data on the results of the International Indian Ocean Expedition is still inadequate. Exchange of this sort of data is of course more complex than merely distributing tabulations of temperature, salinity etc. It is difficult to state in what areas data are lacking for the compilation of geological and geophysical maps. He believes it expedient to include maps of bathymetry (one map has already been published) geomorphology, a tectonic map and maps of bottom sediments and some of the main components such as calcium carbonate. Bathymetry could be represented by profiles as well as maps. It is too early to make sugestions about geophysical maps for items such as heat flow.

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VISITORS

Mr R.S. Glover, (Oceanographic Laboratory, Edinburgh) Chairman of the Consultative Committee for Indian Ocean Biological Centre visited India—3—5 November 1964. He had discussions with Dr. Panikkar, Dr. Vagn Hansen and other senior scientists of the Directorate of Indian Ocean Expedition.

Dr. L.A.E. Doe, Acting Director, Bedford Institute of Oceanography, Nova Scotia arrived in New Delhi on 5.12.64.

Prof. Ilmo Hela (Finland) Prof. Bezrukov (USSR) and Prof. Sugawara (Japan) visited the Directorate of Indian Ocean Expedition during their stay in Delhi in connection with the Symposium on the Geological Results of the International Indian Ocean Expedition convened during the International Geological Congress (14—22 December 1964). Prof. Hela visited the various centres of Indian Ocean Expedition Directorate at Ernakulam and delivered lectures on Fisheries Oceanography and the geophysical Methods of Exploring the Ocean Bottom at the Lecture Hall of the Kerala University Oceanographic Laboratory. He gave another series of lectures on the same topics at Delhi University on 2.1.1965. At Hyderabad he participated in the seminar on "Earth Sciences" held during the last week of December, 1964.

Prof. B. Kimor (Haifa) and Miss Ruth Lerner (Jerusalam) arrived at Ernakulam by the end of August, 1964 and stayed there for 6 weeks working at the Indian Ocean Biological Centre.

PUBLICATIONS RECEIVED

1. Data Report–Equalant I (NODC) Vol. I and II.
2. NODC Newsletter No. 8|9-64.
3. Results of Marine Meteorological and Oceanographical observations J.M.A. No. 31, January 1964.
4. Oceanographical Magazine (J.M.A.) Vol. 15 No. 2 January, 1964.
5. Collected Reprints Vol. II (N.I.O. England).
6. C.S.I.R. News Vol. 14 & 15 August 10, 1964. C.S.I.R. News Vol. 16 August 29, 1964. C.S.I.R. News Vol. 17 September 14, 1964.
7. International Marine Science (UNESCO) Vol. II No. 3 August, 1964.
8. Journal of Scientific & Industrial Research (C.S.I.R.)
   Vol. 23 No.7 July, 1964.
   Vol. 23 No.8 August, 1964.
   Vol. 23 No.9 September, 1964
   Vol. 23 No.10 October, 1964.
9. Indian Journal of Pure and Applied physics.
   Vol. 2 No.8 August, 1964
   Vol. 2 No.9 September, 1964.
10. Research and Industry (C.S.I.R.)
    Vol. 9 No.6 June, 1964.
    Vol. 9 No.7 July, 1964.
    Vol. 9 No.8 August, 1964.
11. Journal of Indian Geophysical Union Vol. I No. 3 July, 1964.
12. Bulletin of the National Geophysical Research Institute
    Vol. 2 No. 1 March, 1964.
    Vol. 2 No. 2 & 3 June-September, 1964.
13. Tellus Vol. 16 No. 1 February, 1964
    Vol. 16 No. 2 May, 1964.
14. OPSEARCH Vol. I No. 3 July, 1964.
15. ISI Bulletin Vol. 166 No. 8 August, 1964.
16. IOC Information Paper Nos. 8 and 9.
17. Directory of Indian Scientific Periodicals (INSDOC) 1964.

INCOR Publications

Publication Nos. 2 and 3 of Indian National Committee on Oceanic Research are the following:–

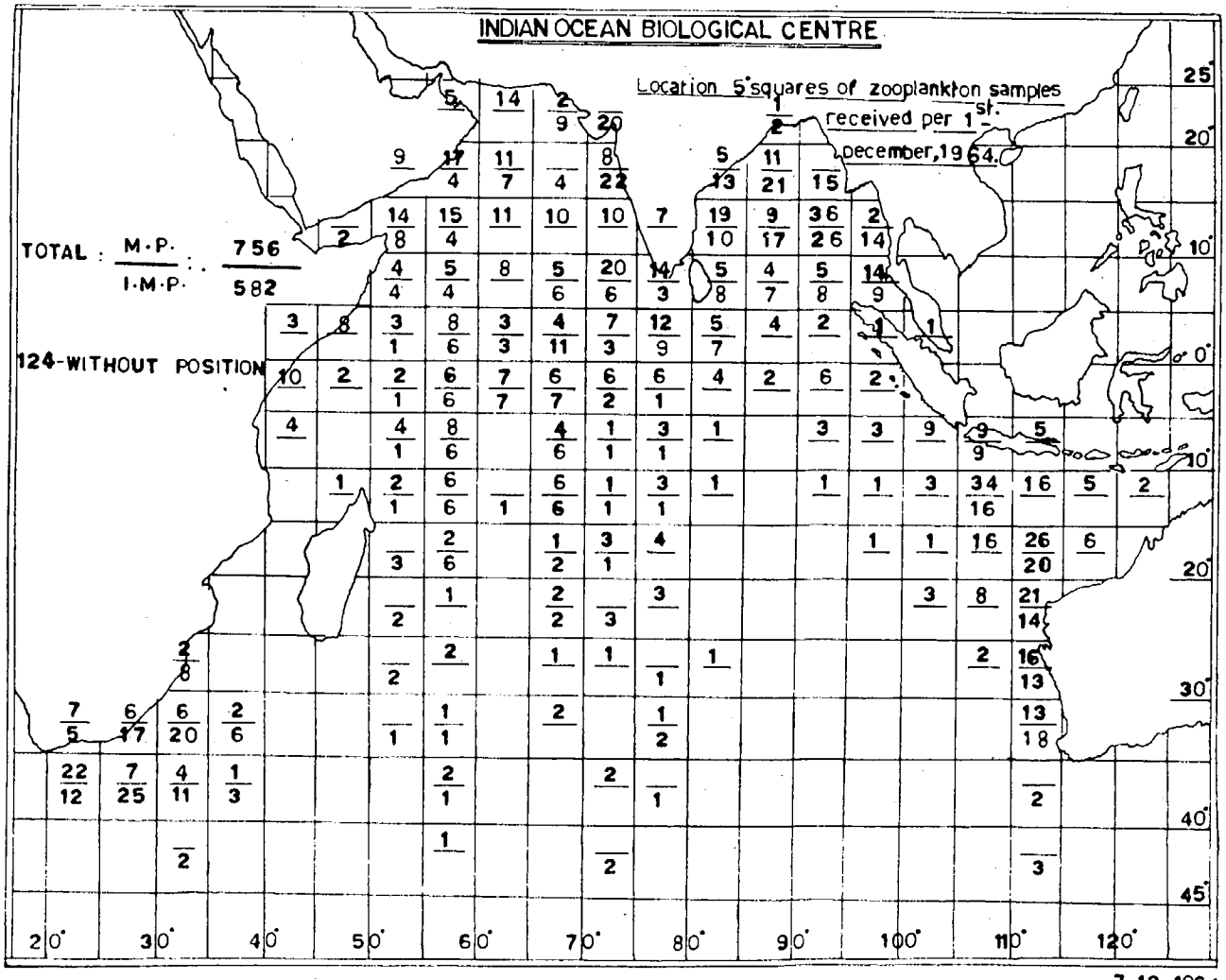
No.2 A Key for the Identification of More Common Copepods of Indian Coastal Waters. by L. R. Kasturirangan Pp. 87, Price Rs. 7/- (inland) 14s. or $2/- (foreign).

The book is a handy manual for the identification of marine copepods in Indian waters. The forms occurring in Indian Seas are described here together with key for easy identification.

No.3 A Bibliography of Plankton of the Indian Ocean by R.R. Prasad Pp. 86, price Rs. 4/- (Inland) 6s. or $1/- (foreign)

This is an up-to-date bibliography useful to students of marine biology and particularly to research workers on Indian Marine Plankton.

Copies of these are available from:
The Data Centre
Indian Ocean Expedition (CSIR)
B-7, Hauz Khas Enclave,
New Delhi-16.



7-12-1964

Distribution of Plankton samples of International collections received at Indian Ocean Biological Centre, Ernaculam.