INTERNATIONAL INDIAN OCEAN EXPEDITION

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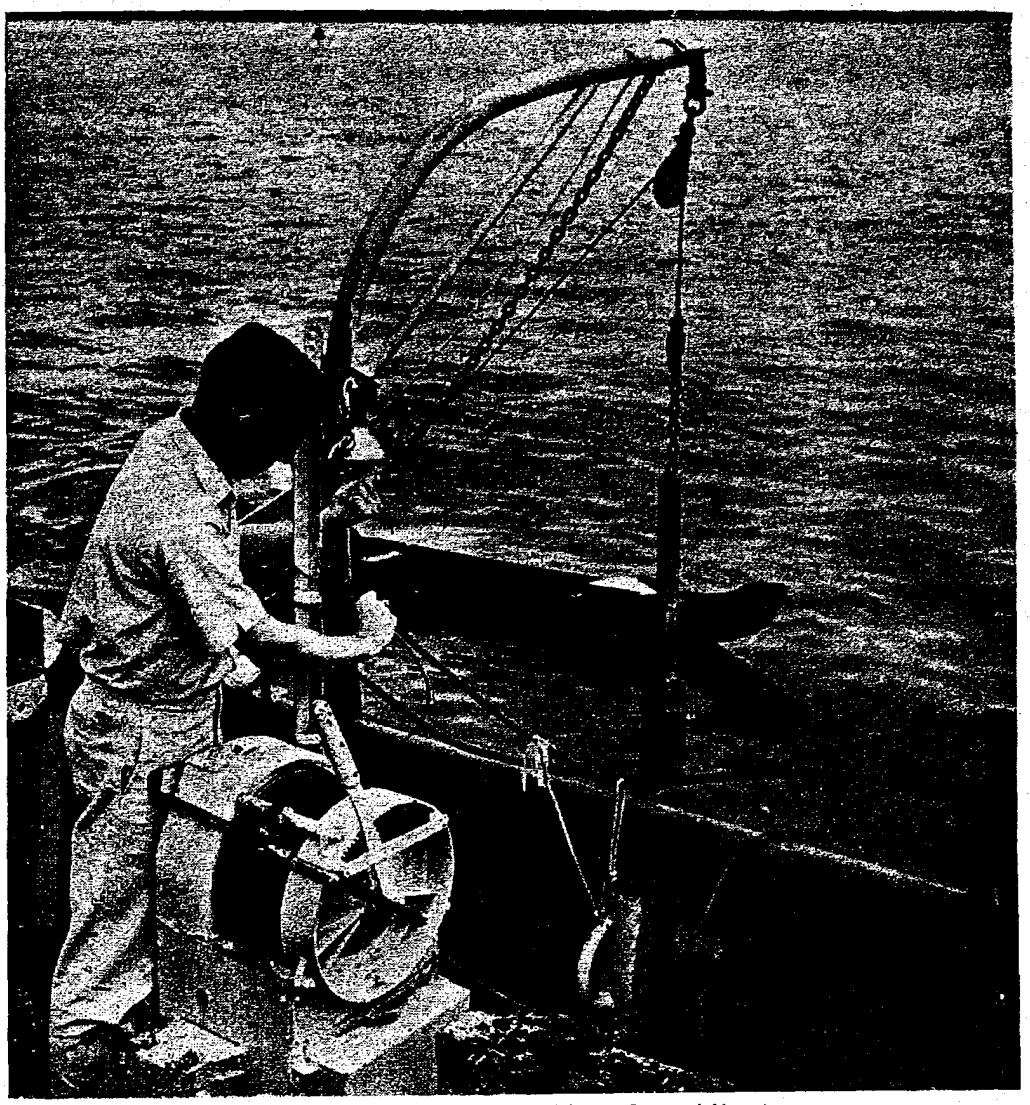
INDIA



Bathythermograph being lowered from a Research Vessel.

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INTERNATIONAL INDIAN OCEAN EXPEDITION

NEWSLETTER

INDIA

Vol. III No. 1 JUNE, 1965

INDIAN PROGRAMME

Scientific Cruises of INS Kistna

The XXIV Cruise of INS *Kistna* was undertaken exclusively for seismic studies under the leadership of Dr. D. Srinivasan of Indian Naval Physical Laboratory, Cochin in the Gulf of Kutch and Gulf of Cambay in collaboration with the German Research Vessel *Meteor*. The cruise commenced from Bombay along with *Meteor* on 26th February, 1965 and after the successful completion of the joint programme *Kistna* returned to Bombay on 9th March 1965 when *Meteor* sailed for Karachi according to her itinerary.

Five profiles in the Gulf of Cambay and four profiles in the Gulf of Kutch were completed. The length of the profiles varied between 30 and 60 km. During the operation, charges varying between 20 and 100 kg. were detonated from INS *Kistna* and the recordings were made by scientists on board *Meteor*. Altogether 375 charges were fired in nine profiles whose records have given interesting results. A preliminary examination of the recorded data indicates refracted and reflected signals from the mantle (M-discontinuity). Dr. Guha of the Central Water and Power Research Station, Poona and Shri T.C.S. Rao of the Directorate of Scientific Research (Navy) were the Indian Scientists on board *Meteor* during these operations. The data recorded with the equipment they had, are being processed.

XXV Cruise

The major objective of the XXV Cruise was to study the pre-monsoon hydrographic conditions of the waters along the west coast of India between Bombay and Cochin. INS *Kistna* left Bombay with 19 scientists on board on 22nd March, 1965 and arrived at Cochin on 28th March, covering 34 stations in all. During this cruise observations were made under different disciplines as follows:

Meteorological: Observations on rainfall, wind, temperature, pressure, visibility, weather phenomena and clouds were taken at 3 hrs. interval beginning from 1730 hrs. on 22nd March, 1965 to 0230 hrs. on 28th March, 1965. Radiosonde ascents were made around 1630 hrs. to record the temperature, pressure, and humidity at different levels in the atmosphere, on all days from 23-3-65 to 27-3-65. The balloon went up to heights of 9.5, 9.8, 6.4, 9.8 and 18 km. on successive days.

Physical: Surface Water temperature and bathythermograph observations were obtained at all stations. Both shallow and deep bathythermograph lowerings were made at most of the stations. Nansen casts were made at all stations. Observations on wave height, period, length and direction of the waves at 15 stations gave the following ranges for the various parameters:

Height: 1 to 3 feet
Period: 1 to 4 seconds
Length: 20 to 70 feet.
Direction: mainly N–W.

Chemicals Estimation of oxygen and salinity was made on board the ship for all the samples obtained on this cruise. Nutrient samples were kept in deep freeze for analysis in the shore laboratories. Samples from different depths were collected from 18 stations for the estimation of calcium and strontium contents in the Health Physics Division of the Atomic Energy Establishment, Bombay. Air samples were collected at 10 stations for Radon studies in the laboratories of the Tata Institute of Fundamental Research, Bombay.

Biology: Vertical plankton hauls were made from 200 meters depth to surface at 9 stations using Indian Ocean Standard Net. At 5 stations vertical hauls were also made from depths ranging from 100 to 50 meters.

Geological: The bottom topography was obtained almost continuously throughout the cruise using Edo–Echosounder. Sediment samples were collected from the bottom at 25 stations by means of corer and/or snapper. A few samples were obtained from beyond the edge of the shelf.

A preliminary analysis of the data collected during the cruise indicates that the waters off Bombay and Karwar are fairly isothermal or they have weak negative gradients up to a depth of about 75 meteres. The thermocline is found below 100 metres. A fairly strong southerly current of about 1 knot was noticed at almost all the stations. A very low swell was observed throughout and the wave height was mostly below 3 ft. with a period less than 4 seconds. Most of the time the wind was northerly, with a velocity of about 10 knots.

Discolouration over a wide area was observed at station 654 off Karwar from where the samples of organisms responsible for this have been collected and preserved for subsequent examination. The surface salinities were higher near-shore and they decreased slightly off-shore. Surface salinities for the nearshore stations gradually decreased from about 35.8‰ near Bombay to 34.8‰ near Cochin. High salinity water was found at a depth of about 100 meters beyond the continental shelf in all the sections of the cruise.

The oxygen values in the surface layers vary between 4.2 and 5 ml/litre. The values generally increase from 10 to 30 meters depth. The minimum oxygen zone exists at about 300 meters depth in deep stations and the minimum oxygen value is around 0.4 ml/litre. Between 800 and 1500 meters depth the oxygen content again increases from about 0.4 ml/litre to 1 6 ml/litre.

XXVI Cruise

The XXVI Cruise began from Cochin on 1st April, 1965 with a complement of 15 scientists on board and after occupying 40 stations according to the itinerary, terminated at Madras on 8th April, 1965. Ten stations were occupied off Pondicherry with a view to studying the canyons of that region in detail. Observations were taken under the different disciplines of oceanography as has been done in the previous cruise.

Detailed traverses were made of the canyons off Pondicherry with continuous running of the Echosounder to obtain the profiles of these canyons.

Observations during this cruise reveal isothermal waters or waters with weak gradients of temperature over the entire shelf off Alleppey and down to 100 meters outside the shelf. Off Karaikkal on the east coast the thermocline is found below 50 meters depth.

The surface current was southerly on the west coast whereas on the east coast it was found to be northerly in direction and was quite strong (about 2 knots) between Pondicherry and Madras. The transparency of the water in the near-shore areas off Alleppey was very low according to observations recorded from 15 to 20 miles from the coast. Several slick bands were found off Karaikkal oriented roughly in a north-east to south-west direction.

The surface salinity is in general higher near-shore and decreases outward from the coast at these places. A core of high salinity water appears off Alleppey beyond the continental shelf at a depth of about 75 meters. The oxygen values in the surface layers varied from 4.7 to 5.3 ml/litre. The decrease of oxygen starts at a depth of about 100 meters and the oxygen minimum exists at about 300 meters at the deep stations. The minimum values lie around 0.25 to 0.35 ml/litre. The oxygen content of the waters increase again between 800 and 1500 meters from 0.8 ml/ litre to 1.10/litire

The examination of the bottom sediments collected from cruises 25 and 26 show quite interesting features. The main characteristics of the sediments as revealed by gross visual observation are tabulated below:

Area	Depth	Nature of sediments	Colour
Off Bombay	—	Clayey with shell fragments	Greyish Black (Nearshore) Greenish black (offshore)
—	bet. 40 and 90 m.	sand with little clay and silt.	—
Off Karwar	—	Clays	Greenish black (Nearshore)
	55-65 m.	Coarse sand and pebbles	Brownish black (edge of shelf)
Off Mangalore	30-40 m.	Clays and silt up to edge of shelf	Greenish black Grass Green
Off Cochin	30-120 m.	Silty sand or clayey	Black
	25 m.	Sticky mud	Black
Off Alleppey	upto 48 m.	Clay	Olive green
	beyond that	Coarse sand, silty sand with shell fragments	Olive green to greyish green
	on the slope	fine to medium sand with shell fragments	—
Off Karaikkal	upto 28 m.	medium to fine sand	—
	28-54 m.	little clay	Brownish on the slope
	beyond that	silty clays and sandy silts	—
Off Madras	Middle of edge of shelf	Coarse sand with shell fragments	—
	nearshore	Sandy clay	Olivegreen
		medium to fine sand	—

Both XXV and XXVI cruises were under the leadership of Dr. V.V.R. Varadachari of the Indian Ocean Physical Oceanography Centre, Ernakulam.

XXVII Cruise

The XXVII scientific cruise of INS *Kistna* commenced from Madras on the 14th April, 1965 and terminated at Calcutta on the 21st April, 1965. 15 scientists from different organizations participated in this cruise under the leadership of Shri R. Jayaraman of the Indian Ocean Expedition Directorate, Delhi.

The ship left Madras at 0530 hrs. on 14-4-65 and after a north-easterly course upto the 20 fathom line, altered course to 354° (a little west of north) parallel to the coast. By 1200 hrs. the ship was off the mouth of the river Pennar and started sounding the canyon off this river mouth. Three traverses were made across this submarine canyon whose deepest part was found to be a little more than 600 fathoms. A fairly detailed profile of this canyon was thus obtained. After completing the canyon survey the ship continued the same course (354°) and by about 1900 hrs. reached the first station on the shelf at 15°N 80°10.5'E. The course was altered to east after completing this station. Two more stations were occupied on the shelf along the 15°N.Lat. the last one being almost on the edge of the continental shelf. The ship proceeded eastward along 15°N and the first deep station was occupied at 15°N 81°E. From here stations were worked at intervals of 1°E upto the UNESCO-SCOR reference station 15°N 90°E. After completion of observations at the reference station, the course was altered to north and a meridional section along 90°E consisting of 6 stations at 1°Lat. intervals was worked, the last station in the series being at 20°N 90°E. A total number of 18 stations were worked in all during this cruise. The weather was fine throughout the cruise and there were no mishaps to equipment during the collections.

After completing the station, the ship proceeded to the Swatch of No-Ground (the Ganges submarine canyon) and commenced the first of the five traverses which had been planned across this submarine canyon. The first traverse was completed and the work had to be suspended after this, because of defects developed in the boiler of the vessel. The ship steamed straight to Sandheads off Hooghly. After taking pilot, the ship steamed to Calcutta and reached there on the afternoon of 21 April '65.

The details of work at the stations are:

Hydrographic casts	— 34
BT Lowerings	— 32
IOSN Samplings	— 32

Wave Observations: at all day stations.
Surface Meteorological Observations: During synoptic hrs. all days.

Radiosonde ascents: Each day at 17 hrs.
Canyon traverses: 3+1.

During the ship's stay at Calcutta, ship held an open house and nearly 200 persons visited the ship. The visitors included mostly scientists from University and other scientific institutions in the city. The scientists on board took the visitors round and explained the working of the various instruments.

On the 26th April, 1965, an informal seminar on the scientific problems of the Bay of Bengal was organised by the Indian National Committee on Oceanic Research in collaboration with a few other scientific institutions at Calcutta, such as the Geological Survey of India, Zoological Survey of India and the Central Inland Fisheries Research Institute. The seminar was held at the Birla Industrial and Technological Museum (CSIR) in which a number of papers were presented. A film on the oceanographic work of the U.S. Coast & Geodetic Survey

Ship *Pioneer* (during her IIOE Cruises) produced by the United Nations Films Unit was also shown during the seminar.

INS *Kistna* remained at Calcutta till the 28th April 1965 and on 29th morning she left on her 28th Scientific Cruise under the leadership of Dr. C. Balaramamurty of the Directorate of Scientific Research (Navy).

R.V. VARUNA

In the Arabian Sea R.V. *Varuna* continued her work on the continental slope between Cape Comorin and Karwar, with special emphasis on exploratory fishing, but also collecting necessary basic oceanographic data.

A short cruise exclusively for oceanographic work was undertaken between Cape Comorin and Cochin during 4-8 February. The Oceanographic cruise was continued up to Karwar till the 12th of February after that, the vessel spent some time searching for fish shoals, off Karwar. As soon as some indication was obtained in the echosounder, bottom trawling was tried at positions 12°50'N, 74°25'E, 12°40'N, 74°11 E and 12°25 N 74°14'E, but the catches were not very encouraging. On 12th afternoon huge shoals of dolphins were sighted and four of them were caught by harpooning. The vessel returned to Cochin on 15-2-1965.

During the quarter January-March, 1965 *Varuna* completed six cruises with a total steaming of 5,600 nautical miles spending about 61 days at sea.

INDIAN OCEAN BIOLOGICAL CENTRE ERNAKULAM

Plankton samples from the research vessels belonging to various countries participating in the International Indian Ocean Expedition continued to flow into the centre where the sorting work has been progressing steadily under the supervision of Shri L. R. Kasturirangan, Assistant Curator. By the close of May, 1965, 837 samples have been fuliy processed while the unprocessed samples in the stock came to a total of 898. Among the processed samples 32 are from R.R.S. *Discovery* (U.K.), 48 from *Umitaka Maru* (Japan) and 76 from H M.A.S. *Diamantina* (Australia). Of the 95 samples (IOSN) collected during the first phase of R.V. *Meteor's* cruise, 27 have been received at the Centre early in April and the remaining are expected to be received shortly. 39 samples from INS *Kistna* and 13 samples from *Oshuromaru* (Japan) were also received during the period March-May 1965.

Some further work was found necessary on the samples received for contract sorting from CSIRO, Australia and these have been returned to Australia on completion of the same.

INTERNATIONAL METEOROLOGICAL CENTRE, BOMBAY

The Centre has completed two and a half years of observation period by the end of June, 1965. Collection and processing of data are steadily progressing at the centre and special meetings are being planned for the presentation of the research results.

The IBM 1620 computer successfully completed a trial computation of monthly mean resultant winds from aircraft observations. An expanded programme should produce information of value in the compilation of the IIOE atlases. The Geophysical Fluid Dynamics Laboratory of the U.S. Weather Bureau, under the direction of Dr. J. Smagorinsky is preparing to test numerical methods of analysis and forecasting on global scale. International Meteorological Centre has contributed to this by sending a set of rawinsonde checked punch cards for the Indian Ocean region to Washington. The cards comprise observations made at 00 and 12 GMT for the period of 14-20 January, 1964.

During the German Research vessel *Meteor's* cruise in the Arabian Sea 155 rawinsonde ascents were made, reaching on an average height of 30 kilometers.

The proceedings of the Symposium on Tropical Meteorology held in Rotorua from 5-13 November, 1963, included several Papers on Indian Ocean Meteorology. At the Fourth Western National Meeting of the American Geophysical Union held in Seattle between 28 and 30 December, F. I. Badgely and C.A. Paulson presented a paper: *"Energy Exchange at the Surface of the Indian Ocean, winter, 1964"*, in which they discussed findings from the University of Washington's *MENTOR* Programme. A symposium on IIOE Meteorology was held on 19 April 1964 during a combined American Geophysical Union—American Meteorological Society meeting in Washington. The Government of India is at present organizing a Symposium on the Meteorological results of IIOE. WMO and UNESCO are the co—sponsors of this symposium which is planned to be held in Bombay in the last week of July, 1965.

Microfilming of the 1963 and 1964 synoptic charts analysed at IMC is almost complete. Duplicates of the microfilm set have been asked by the co-operating meteorological services of Mauritius, Pakistan, United Arab Republic, United Kingdom and Vietnam.

REPORTS FROM OTHER COUNTRIES

R.R.S. DISCOVERY (U.K.)

R.R.S. *Discovery* completed her third cruise in the Indian Ocean during 15 February, 1964 to 28 September, 1964, thus carrying out her mission in the Indian Ocean as part of the U.K. contribution to the International Indian Ocean Expedition. The vessel returned to Plymouth by the end of September 1964. Available reports indicate the amount of work accomplished during this cruise, even though the results are not discussed in detail. During this cruise the change to north-south sections and increased efforts south of equator allowed the work to be concentrated on more clearly defined physical features. More effort was devoted this time to the equatorial undercurrent and Somali current, especially at a time when the upwelling off the Somali coast was conspicuous.

During 1964, *Discovery* occupied 291 water sampling stations in 164 days at sea. Alternate deep and shallow stations were worked, with 32 sampling depths to 4,000 meters and 22 depths to 1,200 meters.

The itinerary of the third cruise of R.R.S. *Discovery* is as follows:

Leg No.	Track	Period	Station occupied
1	Plymouth-Aden	16—2—64 / 4—3—64	5239—5250
2	Aden-Mauritius	7—3—64 / 5 —4—64	5251—5316
3	Mauritius-Cochin	10—4—64 / 8—5—64	5317—5375
4	Cochin-Seychelles	12—5—64 / 9—6—64	5376—5427
5	Seychelles-Mauritius	12—6—64 / 3—7—64	5428—5479
6	Mauritius-Mombasa	9—7—64/28—7—64	5480—5522
7	Mombasa-Aden	2—8—64/23—8—64	5523—5565
8	Aden-Aden	26—8—64 / 7—9—64	5566—5577
9	Aden-plymouth	7—9—64/28—9—64	5578—5583

The highlights of the observations made at various legs have been briefly summarised here. During the first leg at station 5247 the ship located a deep basin just south of the position where the *Atlantis* II had found abnormally hot salty water near the bottom in 1963. Slight but significant departures in temperature and salinity of the bottom water

from the normal Red Sea deep values, indicated overflow and mixing from the small basin sampled by *Atlantis II* into the larger basin to the south.

During the second leg, the vessel occupied the SCOR/UNESCO Reference Station No. 12 and obsevations similar to a deep station were made. A small party landed on Hasikiya the most westerly of Kuria Muria Islands to collect biological specimens. The shore party observed a few nesting birds, very little guano, but made a small collection of excellent rock oysters. South-east of this, the inshore water was still quite green and about 1°C cooler than the offshore surface water. There were signs of plenty of life in the water near the coast though the plankton volumes were only about 1/3rd of those found in the upwelling season in 1963. During the southerly course of this leg the vessel occupied an extra deep station in the trench near 12°30'N, 58°15'E found by H.M.S. *Owen* Of the current measurements the most striking were those in the equatorial undercurrent, where eastward speed of over two knots were measured at 75 metre depth with a 1 knot westward surface current. The deep current measurement using neutrally buoyant floats of this section showed movements in various directions with an average speed of about 6 cm/s at 1000 and 2000m. Silicate estimates again confirmed the presence of very high concentrations in the deep water of the Arabian sea, some 40 μg at. Si/l greater than the deep waters further south. In the surface layer, however the nutrients were at very low concentrations and at many stations nitrate appeared to be completely absent from the water. Biologically the section was noteworthy for the paucity of life. One particularly interesting and very rare find on this leg was a large pyrosoma–like egg mass belonging to oegopsid squid. Much near the surface, zooplankton had a deep blue colour and an abundant haul of *Pontella fera* afforded an opportunity for study of the blue pigment.

During the third leg the longtitude 67°30' was chosen for the second north-south section since it passes well clear of any shallow water and crosses the Vema Trench, the deepest known part of western Indian Ocean. South of Vema Trench a deep cast of water bottles showed adiabatic conditions below 4600 m. with a potential temperature of about 1.25°C and relatively high oxygen ($\geqslant$ 4ml/l). The current measurements showed little sign of south equatorial current. There was still an equatorial undercurrent with an eastward maximum velocity at 70 m. depth centred on 1°S with maximum speed exceeding 2 knots and 1½ knots in the same direction at the surface.

The quantities of plankton on this section were again low, particularly south of 10°S. On this section the chemical estimations of dissolved oxygen were supplemented by *in situ* measurements made with a lead-silver oxygen electrode; profiles were taken to a depth of 150 m. at about 15 stations and good agreement was found between the methods. The profiles showed a small but distinct maximum of oxygen content on the north side of equatorial undercurrent.

Routine measurements were conducted during the fourth leg. The temperature-salinity-depth recorder was used at nearly all stations and showed many small features in the salinity profiles not revealed by water sampling especially in the near-surface high salinity water but also throughout its depth range of 1500 m. Biological observations were intensified from 15°N, 58°15'E. Plankton hauls which had increased in size steadily across the Arabian Sea were relatively rich in the inshore waters.

Around 10°N the current shear observations showed eastward relative movement at the surface; possibly this indicated an eastward extension of Somali current which by

then has started to flow. A telemetering current meter and TSD were designed to be used on the ordinary hydrographic wire transmitting their data acoustically to hydrophones connected to recorders in the ship. This combination of instruments was brought into use on most deep stations from 5404 onwards.

On the second crossing of the equator a weak under current centred at about 1°30'S was observed.

An extensive Trichodesmium bloom was encountered on the way north from the Seychelles and samples were collected for chemical analysis. Two sections of alternate shallow stations and TSD dips were quickly made across the equator 58°E (2°S to 1°N) and at 60°E (1°N to 1°S). There also seemed to be a decrease in the quantity of plankton eastwards along the equator. The south equatorial current more clearly defined than before was encountered between 6° and 7°S. The exceptional deep current observation was one of 22 cm/sec. eastward at 1000 m depth at 8°S, about three times the r.m.s. speed at that depth. The only comparable observation was the 16 cm/sec. eastward current found at 9°S, the previous time their section was worked. Perhaps there is a significant eastward flow at about 1000 m. depth round the southern end of Chagos bank. From the salinity conditions it is presumed that it might be a mixture of Gulf of Aden and Antarctic Intermediate water.

The current shear measurements in the region 13°S showed large fluctuations as if strong internal waves were present. As in the previous month on 67°30'E. the south equatorial current was observed this time also and found running in North-West direction with a surface speed of 2 knots decreasing to about 1 knot at 200 m.

At several trawling stations trials were made of an experimental catch-dividing bucket. Approaching the coast, vertical sampling was intensified as it was in these stations that the first significant increase in plankton volume from the low oceanic levels took place. While sailing from Mombasa to Aden *Discovery* worked with *Argo* in the region of Somali current. A quick passage was made form Mombasa 1°N with favourable current increasing from 2 to over 3 knots according to GEK. At first station, within ten miles of the coast combined current meter observations and radar fixes indicated a surface currrent of 4.2 knots.

At 4°30'N there was a relatively weak current at the inshore station, but ten miles farther out the current was running at 6 knots with four knots of shear between the surface of 100 m. depth. Surface drogues there moved at about 1 knot towards the north-east and a neutrally-buoyant float at 1000 m. showed a south-eastward current of about 0.4 knot. The current shear increased as the coast was approached, being strongest about 20 miles offshore where radar fixes were just possible. The surface current there, was 7 knots with 5 knots of shear between surface and 200 m. Approaching the coast the current decreased and at the same time the sea temperature dropped to 15°C.

The absence of upwelling and well developed thermocline farther south meant that the surface waters there contained very low concentrations of nutrients; yet there is no doubt that the average biomass of both phytoplankton and zooplankton were substantially greater than the general oceanic level. In the cold water, however, the nutrient levels at the surface inshore were much higher, consistent with the depth of origin of the upwelled water. On the way northward along Ras Mabber many fish were seen floating in long lanes and samples were collected. It seems likely that they had been killed by a sudden invasion of cold water. *Argo* was met off Ras Mabber and plans were made for the survey of cold water area. It was agreed

that *Discovery* should continue northwards to Ras Hafun and make sections north-eastwards from there towards Socotra and then back westward to Cape Gaurdafui.

In the region of coldest water there was little evidence of much growth of plankton and indeed it was only further north in the region where the cold waters coming from the Cape Gaurdafui from the Gulf of Aden that abundant quantities of plankton were found. Clupeoid larvae occurred in large numbers in the plankton hauls. An interesting feature of this area was the almost complete absence of sea birds which generally are characterically abundant in upwelling regions.

The original plan during the eighth leg was to study the upwelling in the Arabian Sea, specially near Kuria Muria Islands. According to the change in plan *Discovery* returned to the cold water area by way of reference station in the Gulf of Aden previously worked in March. Seven station positions were chosen spread throughout the cold water from north to south where it was hoped to find successive stages in the chemical and biological cycles associated with the upwelling. As before coldest water was found near Ras Mabber but temperatures were slightly higher than before. At station 5551 the speed of the current was 7 knots but deep waters showed very little movement. Beyond 53°E slightly south-east surface current of 4-7 knots was encountered. The cold water seemed to be drawn out into a narrow filament near 9°30'N, 54 E. with opposing currents in warm water on either side.

During the last phase of this cruise from Aden to Plymouth three stations were occupied in the Red Sea in the deep basins near 20° and 21°N where abnormally hot salty water was expected.

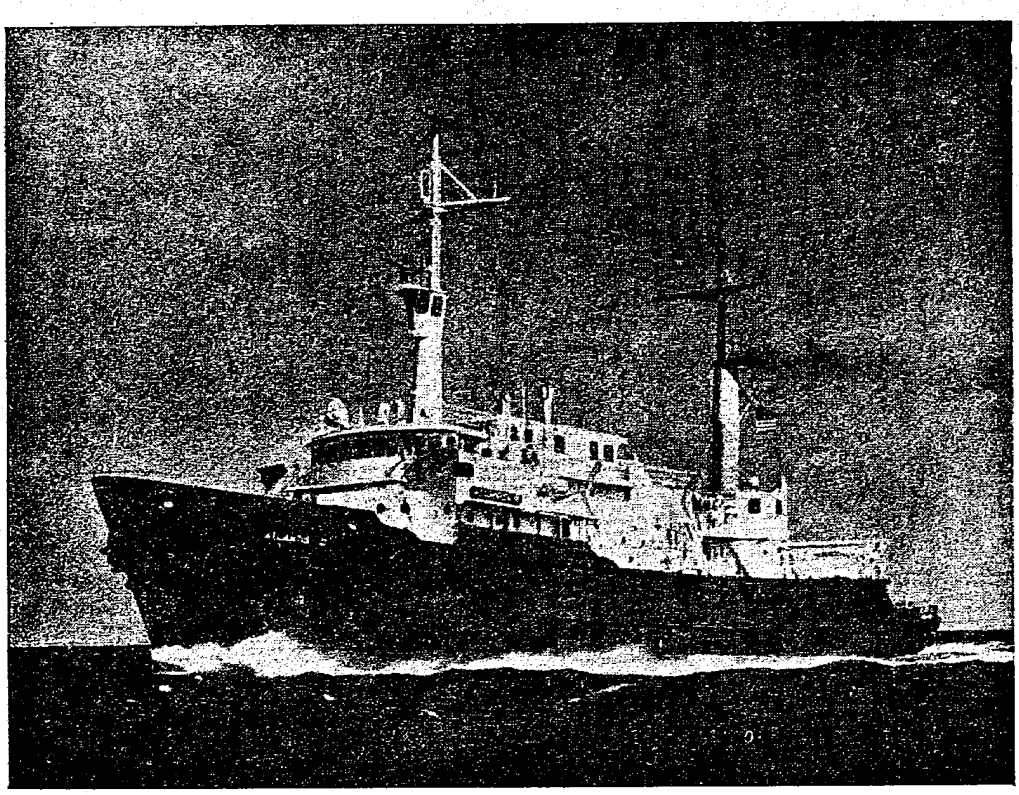
The first two stations were quite normal but at the third one, (station 5580) extremely high temperatures and salinities (over 44°C, 270 parts per thousand) were found in the lowest 150 m. in a small basin some 2200 m. deep. Chemical analysis of the water is continued at Liverpool and at the National Institute of Oceanography. Probably it may be due to the solution of salt deposits in the sea floor as the possibility of its volcanic origin appears to be remote.

In all, 344 stations were occupied during this cruise with water sampling and current observations at 306 and biological observation at 275 stations. Details of various observations and number of scientists under various disciplines participated in whole or part of this cruise, have been given in the original report published by the Royal Society London.

ATLANTIS II (U.S.)

The U.S. Research Vessel *Atlantis II* is currently on a cruise round the world and according to the programme she is expected to make an extensive coverage in the Indian Ocean, as part of the U.S. Participation in the International Indian Ocean Expedition. This is a very well equipped research vessel specially built for Woods Hole Oceanographic Institution for all-weather observation. Atlantis II is 210 feet in OAL, 44 feet wide with a displacement tonnage of 2300 and a cruising range of 8000 miles at 12 knots speed. A crew of 30 and 25 scientists are accomodated on board.

Among the special features are an underwater observation chamber, a bow manoeuvring device, antirolling tanks, a stern ramp and a central well to permit oceanographic experiments in adverse weather. Important equipment on board include the satellite signal receiving equipment and the general purpose computer. The ship receives signal from navigational satellites orbiting the earth in outer space and this gives better naviga-



U. S. Research Vessel *Atlantis II.*

tional accuracy than the conventional equip ment. Another is an expendable bathyther mograph which relays temperatures over a wire connected to the equipment in ships laboratories. A new device has to be used for each temperature recording and it can get results from as deep as 700 fathoms.

On the present cruise (Voyage No. 15) which began from Massachusetts on 20 January, 1965 the ship steamed through the Mediterranean and has already carried out surveys in the Red Sea and the Arabian Sea. *Atlantis II* arrived in Bombay on 16th March, 1965 when hospitality was extended to the scientists on board jointly by the Indian National Committee on Oceanic Research and the United States Information Service. Mr. Arthur Miller, Chief Scientist aboard indicated some of the outstanding observations made by the vessel during the completed part of the cruise. The work on board was mostly centred on the physical and chemical aspects, though occasional biological sampling like plankton hauls were made. Mr. Miller referred to the discovery of two unusual ly warm water holes in the middle of Red Sea at 2000 metres with temperature 55.29°C, pH around 5. Silicate of the order of 500 μg at/l and extremely high salinity. Thus the conditions were almost the same as in the other two warm water pockets investigated by *Meteor* and *Discovery.* The most important

aspect here was the rich deposit of iron as evidenced by its high concentration in the area, the implications of which are "tremendous" according to Mr Miller.

Mr. A. R. Miller, Chief Scientist on board **Atlantis II** describing the working of the computer to the Indian Scientists Dr. R. Viswanathan and Dr. T. S. S. Rao (at Bombay)

No upwelling was noticed along Indian Coast as a result of NE Monsoon. Regarding the productivity, the U.S. Scientist said that Somali coast was found to be as high as the Benguela current area and could be considered as one of the richest of the world oceans. Another interesting find according to him was beach-worn pebbles and shells found far offshore in the bottom sediments the significance of which might lead to some surprising phenomena. The peculiar current pattern in the western Indian Ocean, Mr. Miller remarked, has its correlation with the S.W. Monsoon.

Atlantis II left Bombay on 20-3-1965 with plans to call at the following ports in the Indian Ocean according to the itinerary shown below:

PORT	ARRIVAL	DEPARTURE
Bombay	16—3—65	20—3—65
Colombo	5—4—65	9—4—65
Mombasa	26—4—65	29—4—65

PORT	ARRIVAL	DEPARTURE
Nossi Be, Madagascar	4—5—65	6—5—65
Diego Suares, Madagascar	7—5—65	7—5—65
Victoria, Mahe Island, Seychelles Island.	25—5—65	28—5—65
Diego Suares, Madagascar	2—6—65	2—6—65
Durban	22—6—65	27—6—55

From Durban *Atlantis II* will survey eastward to Australia, then north through the Banda and China Seas to Japan. Intensive survey of the lower reaches of Kuroshio Current will be undertaken for two weeks in cooperation with Japanese Oceanographers. Thus, circumnavigating the globe the 50,000 mile cruise will come to its close at Woods Hole on 6th November, 1965.

THE SIXTH CRUISE OF ANTON BRUUN (US)

The sixth cruise of the U.S. Research Vessel *Anton Bruun* was undertaken during the period 15th May—16th July, 1964, in the Central Indian Ocean south along 65°E meridian from 18°N to 40°S. On this cruise between Bombay and Durban the ship called at Mauritius and spent about 10 days there. The objectives of the cruise were to study further the biology and ecology of the western Indian Ocean and to collect bathypelagic organisms for zoological and systematic studies. Mostly the collections and observations as planned have been done from stations at two-degree intervals along 65°E, 18°N to South of 40°S. Plankton sampling, productivity measurements, analysis of certain physical and chemical factors and the Issacs-Kidd midwater trawling were the major activities at each "standard" station.

Hydrographic casts were made at different depths and samples taken from various depth ranges. Analyses were made for temperature, salinity, dissolved oxygen, nitrite, nitrate, phosphate and silicate and a sample was saved for subsequent determination of organic carbon. Water samples were also collected in plastic samplers for the analysis of primary productivity using C-14 technique, for phytoplankton pigments and for particulate organic carbon. Two vertical tows—one for microplankton and another with IOSN—were made at each station. Series of vertical hauls were made at twelve stations with the British NV-70 closing net, from various depths. Samples of this as well as microplankton collections will be deposited at Smithsonian Oceanographic Sorting Centre and the IOSN samples at Indian Ocean Biological Centre, Ernakulam. A catch dividing device designed to separate shallow from the deep catch during a single lowering was tried along with Issacs-Kidd midwater trawl.

Detailed observation and figures of the luminous organs of deep sea stomiatioid and ceratioid fishes were made during this cruise. Ecological, systematic and zoogeographic findings of this cruise are under examination. The important results of these cannot be predicted at this stage. The capture of a leptocephalus larval stage of a deep sea eel which is bright orange red in colour in contrast to the absolute transparency of all well-known eel larvae is obviously one of extraordinary zoological interest. The second exciting specimen captured during this cruise is a metamorphosing eel over a metre long, which resembles the "giant leptocephalus" (caught years ago by the Danish Expedition: DANA) Important shore collections of fishes were also made in India and Mauritius by the permanent and visiting scientists.

Radiosonde balloon was released daily

and the resulting data were telegraphed to the appropriate shore stations. A summary of the scientific activities of this cruise are given below:

Hydrographic casts and water sampling for various analyses	...	27stations (upto 2000 m)
Studies on Primary Productivity with C-14 technique, pigment and particulate organic carbon.	...	28 stations (at 100, 50, 25, 10 and 1% of the incident solar radiation.
Microplankton (200 m—O m, vertical hauls)	...	21 stations
Indian Ocean Standard Net hauls:	...	21 ,,
NV-70 closing net (at several intervals to bottom)	...	12 ,,
Issacs-Kidd midwater trawl	...	61 ,,

R. V. METEOR (GERMANY)

The routine programme of observation started in the Red sea on the first cruise of R. V. Meteor. The following instruments were used for continuous recording in the surface water.

1. Thermograph
2. Salinograph
3. Continuous turbidity recorder
4. Magnetometer with towed electrodes
5. Continuous recorder for Radio-activity.

Satisfactory results were obtained from trials with "Bathysonde" for registration of temperature and electrical conductivity down to 2000 m, with registration of vertical distribution of oxygen down to 400 meters. The deep sea echograph with extremely narrow beam used for the registration of steep slopes of submarine volcanoes and narrow submarine trenches and folds.

In the Red Sea special interest was shown to the geological and geophysical studies of its young tectonics and to the stratification of temperature, salinity, pH, oxygen alkalinity and organic and inorganic components like silicates, nitrate, nitrite, phosphate, ammonia and calcium Off Djedda, in the Red Sea, *Meteor* also recorded the highly saline hot water, earlier found by R. R. S. *Discovery*. The nutrient content in the surface water of the Red Sea is three to four times higher than in the North Atlantic, but at greater depths a thin layer with very low oxygen content (0.4 ml/l) were found and catches of midwater fauna were accordingly poor. For measurement of chlorophyll and seston, the spectrophotometric analysis and chromatography gave very consistent results and a new method for measuring particulate organic carbon was successfully applied and gave readidgs of 20-40 $\mu g/l$. Ichthyological and plankton studies were carried out using IOSN, Heligoland larvae nets, closing nets Gulf-III Sampler with closing device, Agassiz trawls, dredges and bottom trawls. Special attention was paid towards the diurnal movements of scattering layers. In the Gulf of Aden and Strait of Bab-elMandeb continuous registration of currents at various depths by anchored buoys and gradient current meter lowered from the vessel gave a good picture of the vertical distribution, speed and direction of currents. The meteorological station on board recorded the radiation and heat exchange between atmosphere and surface water.

After the initial phase of the programme in the Red Sea and the Gulf of Aden an intensive study of Somali current was done from mid-December to mid-January. The current running in the upper 100 metres parallel to the coast reached velocity of 1.5 m/sec

which was followed from the surface to a depth of 200 m. The bathysonde revealed a very complicated vertical structure with narrow layers of "Red Sea Water" which could be traced even south of the Equator in 400-800 m. depth. In the western part of the Arabian Sea, layers between 150 and 1000 m depth are very poor in oxygen (1 ml/l). In surface waters nitrate seems to be limiting factor for plankton development. The total amount of organic matter per surface area was increasing from north to south and is of the same order in the North Atlantic. The horizontal and vertical distributions of particulate organic carbon, total organic carbon of nannoplankton, seston, chlorophyll and albumen were determined in about 700 samples. Geological studies on sedimentation and sediments in the Somali Basin were co-ordinated with biological studies of benthos. The echosounder showed a sea-mount of 3000 m elevation in the very flat Somali Basin at depth of 5000 m.

Meteorological studies in the Somali region included, permanent use of a long-range weather radar and radio-sonde twice daily. *Meteor* left Mombasa on January 21, and worked the last section along African coast before crossing the western Indian Ocean to Cochin. The equatorial undercurrent was observed at 1°N with a velocity of 1.5m/sec. The oxygen content of the deeper layers of the tropical waters decrease from west to east and off India values of 0.2 ml/l were found. 95 plankton samples taken with Indian Ocean Standard Net will be delivered to IOBC Ernakulam. The cruise continued a survey of waters off India, Pakistan, and Arabian Peninsula.

AUSTRALIA

Cruise Plan of H.M.A.S. Diamantina

The plan for the cruise Dm. 2/65 of H.M.A.S. *Diamantina* has been drawn up with the objective of examining the chemical and physical environment during the South Australian tuna season. The cruise was expected to commence from Sydney on Feb. 1,1965 and to complete at Port Lincoln on February 12,1965; working on way in the Vincent Gulf, continental shelf and adjacent areas off Cape Catastrophe, the Investigator group of islands and Spencer Gulf.

Hydrographical samplings upto 1500 m, for temperature, salinity, oxygen and inorganic phosphate were planned in this cruise. Continuous echosounding and meteorological observations were the other activities proposed to be undertaken. Cowper was nominated as the Cruise Leader and Bradley, Brown, Klye, and Prothero were the other scientists to be on board *Diamantina* in this cruise.

EXTRACTS FROM SCIENTIFIC PAPERS

The Grand Bank Earthquake and the Instantaneous Cable Failures:

The instantaneous cable failures associated with the Grand Bank earthquake in 1929 have attracted the attention of marine geologists and attempts were made to explain the event in the light of various phenomena. Systematic cable failures for a period of 13 hrs and 17 min. have been interpreted by Heezen and Ewing (1952) as a result of turbidity current dislodged by the initial shock. In a recent publication Heezen and Drake attributed the virtually instantaneous cable failure around the epicentre (30 miles radius) of the quake to an initial slump triggered by the shock. But the cause behind the almost instantaneous failures of six cables lying 150-1800 fathoms down on the continental slope remained unexplained. Similarly the southernmost cable which broke instantaneously, lay but 10 miles away from the cable which broke 59 min. later. Therefore it becomes apparent that the instantaneous breaks were caused by

a phenomenon somewhat different and faster than the turbidity current which damaged the other cables at progressively increasing times from 59th minute of the shock.

In a most recent paper on this topic Supriya Sen Gupta (1964) agrees with initial slumping supported by Drake's reflection profiles but at the same time, considering the extensive area affected by gravity slumping the author feels that some phenomenon faster than the postulated gravity slumping could only explain the events satisfactorily.

Surface wave disturbances in experimental seismograms are quite commonly experienced by the explosion seismologists. These waves (particularly Rayleigh or the so called 'ground roll') travelling along the free solid surface with about nine-tenths the velocity of the shear wave, progressively hit the geophones at successively greater distances from the explosion. Supriya Sen Gupta suggests that a similar phenomenon might explain at least part of the cable failures outside the epicentral area. From the available information it can be seen that along the free surface of the sediment, these Rayleigh waves would traverse a distance of about 60 miles in about 2.98 min. The farthest cable broke in Grand Bank earthquake lay at a distance of about 60 miles from the epicentre.

The feasibility of large scale 'damage in unconsolidated sediments by elastic wave propagation becomes evident from the so-called "Jelly theory" which indicates that displacements in unconsolidated medium may be two to ten times greater than displacement from similar shocks in solid rocks. Thus the author points at a specific mechanism which might be responsible for the initial gravity slumping within and around epicentral area and an almost extensive cable breaks in an area outside the epicentral zone. (Nature, Vol. 204, No. 5959, November 14, 1964).

Suspended Matter in Deep Ocean Water

Results of the optical studies of suspended matter in sea water samples have been reported by Ewing in 1965. Further information about the amount and distribution of suspended material in oceans is needed to appraise the geological importance of it. Seismic reflection surveys reveal that majority of deep sea sediment bodies of the world are adjacent to continents and were for the most part laid down as homogeneous deposits having level surfaces at every stage of accumulation.

It appears that some process played the same role in the distribution of clay-size sediments as turbidity currents play in the distribution of sands and silt. Observations of ripples and currents' scour marks in parts of deep sea floor have shown the importance of studying sediment content of deep water, and measuring of light scattering of these water masses.

Nephlometer, a meter for measuring light scattering *in situ*, offers the best possibility of rapid and effective search for suspended particles. The nephlometer used for the present study is a photographic instrument designed by Thorndike. It is made from components of deep sea camera system. The light source is an electronic flash tube, that produces short flash each 10 sec. giving a measurement at depth intervals of 10 m. at normal speed of raising order. The recorder is a shutterless deep sea camera modified to give constant film transport speed. The camera holds approximately 8 m. of 35 mm. film and provides a photograph on each 6 m. film. This apparatus gives information about nephloid (cloudy) layer near surface at night only and the penetration of day light into the sea also provides photograph of deep sea organisms.

Two possible assumptions for explaining the observed distribution of nephloid water are (1) cloudiness is associated with sus-

pended matter which has remained more or less permanently in that layer (2) it results from sediment stirred up from sea floor by the turbulent flow of water. The nephloid layer has been observed by optical means in the lower part of the water column in the continental slope. By sampling, it has been found to be a suspension lutite, apparently in sufficient quantity to induce downslope flow of sediment transported in the nephloid layer. This may be a major component of deep sea sediment bodies.

[Ewing, M. Thorndike—Science, 147, 1291–94, 1965]

Inorganic Nutrient Anions in Deep Ocean Waters

In this paper are described the distribution patterns for the inorganic nutrients like silicates, phosphates and nitrates in the various deep ocean waters of the world. Among these are included the data collected by *Lusiad* (1962-63) in equatorial Indian Ocean and *Dodo* (1964) in the Somali current region of the Indian Ocean. (both these constituting the various phases of the Scripps Institution's participation in the IIOE as part of the U.S. participation). In the equatorial Indian Ocean the concentration of silicates found were 90 μg-at./l at 2000 meter level and 110 μ g-at/l. in the 2000-6000 meter levels. These values are similar to those of the Pacific Ocean, but much higher than those of the Atlantic.

In the case of phosphates of the surface waters excepting in the upwelling areas, uniformly low phosphate concentrations were observed. The values increased with depth and in the oxygen minimum zones the concentrations have reached as high as 2.7 μg at./l, in the Indian Ocean; for the Pacific, it is higher, being 3.0 μ g-at.p/l. At the 2000–6000 meter level, the phosphate concentration in the equatorial Indian Ocean is 2.4 μ g-at./l. In the Atlantic Ocean, the maximum concentration was found to be 2.0 μ g-at./l. while at 2000- 6000 meteres it was found to be 1.6 μ g-at/l. which is lower than that found in the Indian Ocean. As regards nitrates no significant data for the Indian Ocean deep water have so far been reported.

The authors have also examined the silicate–phosphate ratios and showed that in the surface layers the silicate-phosphate ratio was usually less than 10. Below the surface layers, the silicate phosphate ratio increased with increasing depth and at the oxygen minimum zone in the Indian Ocean, the ratio reached a figure of 25. With the decreasing phosphate and increasing silicate, the ratio reached a figure of 40 to 50 in the Indian Ocean at 2000-6000 meters as compared with 55-65 for the same levels in the Pacific.

[T.J. Chow and A.W. Mantyla Nature, London Vol. 206, (4982): 383–385, April 1965]

NOTES AND NEWS

The Equatorial Under Current in the Indian Ocean

As part of the International Indian Ocean Expedition, the Scripps institution of Oceanography of the University of California carried out three multi-programme investigations in the Indian Ocean: "*Monsoon*" (1960-61), *Lusiad* (1962-63) and *Dodo* (1964). Under the expedition *Lusiad*, one of the research vessels of the Scripps Institution of Oceanography, *Argo* worked out a programme of direct current measurements to determine the nature of the ocean currents during the two phases of the monsoon i.e. late June to late September and mid-February to mid-May.

Preliminary shipboard analysis of the data collected under the above programme, has indicated the existence of the Equatorial un-

dercurrent in the Indian Ocean also, with many of its properties associated with the undercurrent of the Pacific and Atlantic The equatorial undercurrent in the Indian Ocean is found to be having maximum development during the end of the north-east monsoon. The tendency for its formation appeared to be more marked on the eastern side of the ocean than on the western side. It could not be traced at 53°E during both the phases of the monsoon.

The core of this eastward flowing undercurrent is found in the middle of the thermocline with the maximum eastward speeds centred at the equator. On the meridional section at 92°E, the speed at the core of this eastward flow in the month of April was 80 cm./sec. which compares with 125 cm/sec. for the speed at the core of the undercurrent in the Pacific. This undercurrent is found to be continuous in the equatorial Indian Ocean from 61°E to 92°E during the March and early April. The zonal flows associated with it are found to be stable over periods of weeks and the magnitude of the eastward velocity maximum increased from 57 cm/sec. at 61°E to 81 cm/sec. at 92°E. Most of the regions which have shown the development of this undercurrent in the Indian Ocean, have also indicated the spreading of the thermocline at the equator, which is characteristic of the thermal structure of the undercurrent.

However, the observed current structure of this under current in the Indian Ocean is different from that typically observed at the equator in the other oceans. The amplitude of the eastward flow in the undercurrent is only half that of the Pacific. Although the eastward velocity component does appear to be steady over periods of weeks when the under current is developed and can be traced over half of the width of the ocean, there were times at which the undercurrent was either weakly developed or not present, indicating that the undercurrent undergoes fluctuations of longer periods. One peculiar feature of this undercurrent is that it is associated with an eastward pressure-gradient even though the pressure-gradient at the sea surface is westward unlike the other oceans.

(From 'Preliminary Results of Scrips Institution of Oceanography Investigation in the Indian Ocean, 1963-64', University of California, San Diego, 1964).

In 1964, R.R.S. *Discovery* of U.K. while on cruise 3 in the Western Indian Ocean found the presence of the Equatorial undercurrent on 58°E meridional section from 1½°N to 1°N with eastward speeds of over 2 knots (100 cm/sec.) at 75 m. depth associated with a 1 knot (50 cm./sec.) Westward surface current in mid March. During subsequent work on the same meridional section (58°E) in the month of June, the undercurrent was found to be slightly weak (about 1½ knots: 75 cm./sec.) and centred at about 1½°S. It was found to be more or less the same at 60E. But it appeared to be slowing down towards further east.

On 67½°E meridional section (worked in the last week of April the undercurrent was found to be centred at 1°S with an eastward maximum velocity exceeding 2 knots (100 cm/sec.) at 70 meters depth associated with a surface current of about 1½ knots in the same direction.

During her recent investigations in the Indian Ocean the German Research Vessel *'Meteor'* reported the presence of the Equatorial undercurrent with a velocity of the order of 1.5 m/sec. (150 cm/sec.) at about 1°N 58°E during early February, 1965. But, in contrast to 'Cromwell-type' currents in the Pacific and Atlantic, this current does not result in a lowering of surface temperatures or an increase of nutrients on the surface.

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Uranium from Sea

Among the sixty elements known to be dissolved in sea water Uranium is the 29th, in its concentration. Four of these elements extracted commercially in any quantity are Sodium, and Chlorine in the form of Common salt, Magnesium and some of its compounds and Bromine. Patents have also been granted for the extraction of Iodine, Potassium, Calcium Sulphate Gold and Silver, (John L. Mero. 1965).

Recently British Atomic Energy authority have succeeded in extracting Uranium, the basic fuel for nuclear power stations, from sea water by a simpler process. Little power is necessary—the sea itself can supply most of it.

Investigation with artificial sea water enriched with Uranium have shown that inorganic absorbents mopped up Uranium as the sea water flowed over them. The absorbent Titanium hydroxide was precipitated on glass wool, muslin, or pumice and mounted on a frame under a vessel in the harbour. The absorbent on drying broke into granules, which were easy to handle for the removal of Uranium from them.

The amount of Uranium in the sea is enormous, calculated to be more than 4000 million tons in the world oceans—a limitless store for all practical purposes. A simple equipment of only one frame was able to uptake 60 millionths of a gram/a day of Uranium showing thereby, the workability of the process on a large scale. Further direction of work for large scale extraction of Uranium from the sea lies in using tidal power, relying on ocean currents for the transport of Uranium to the plant using two lagoons, the upper one filling at high tide and running out into the lower one, with beds packed with absorbent in between the lagoons [Jour. Mines. Metals and Fuel, 12 (No. 10) 1964.]

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Arabian Peninsula Drifting from Africa

Studies on the geological and geophysical aspects during the IIOE have brought to light a number of exciting facts regarding the bathy-orographical features of the Indian Ocean. One of these is the evidence produced by Dr. A.S. Laughton of National Institute of Oceanography to prove that Arabian Peninsula is drifting from African continent. The drift began more than 20 million years ago and is now occurring at a rate of two millimeters each year. The Gulf of Aden having similarities in the north and south is gradually becoming wider. The wadis (dry river beds) which start from south coast of Arabia continue in Somali-land in Africa. According to Laughton a counter clockwise rotation of eight degrees has apparently occurred since Arabia was joined to Africa at one time.

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Vast Undersea Valley Discovered Beneath Indian Ocean

A vast undersea valley, 600 miles long, 25 miles wide, and surrounded by towering mountain peaks, has been discovered by American scientists beneath the Andaman Sea in the Indian Ocean. It lies buried one to three-miles under the sea.

The valley, far larger in places than the Grand Canyon of the Colorado, extends from the northern tip of Sumatra in the Indonesian Archipelago to Narcondam Island, about 250 miles southwest of Rangoon, Burma.

The discovery was made by oceanographers of the Coast and Geodetic Survey, U.S. Deptt. of Commerce, during a voyage last year by the C & GS Ship *Pioneer*, participating in the International Indian Ocean Expedition. This announcement followed a detailed and painstaking analysis of the data assembled during the trip.

Based on the soundings taken from aboard

the ship, the Coast and Geodetic Survey scientists who conducted the study—marine geologist L. Austin Weeks, of Willemstadt, Curacao; marine geologist Reginald N. Harbison, of Hebbronville, Tex.; and geophysicist George Peter, of Budapest, Hungary—located the valley as lying east and parallel to the Nicobar and Andaman Islands, almost connecting Sumatra and Burma.

To oceanographers this undersea phenomenon is known as a rift valley. In essence, a rift valley is caused by collapse of the earth between fractures. The Andaman Sea rift valley is similar to that extending down the middle of the Mid-Atlantic Ridge, a mountain range which lies beneath the Atlantic Ocean. The rift valleys in the Atlantic and Indian Oceans resulted from the fracturing of the mountain ranges after the volcanic action died down. Volcanic action caused the earth to rise. When the action subsided, the earth settled and a rift valley was created.

Based on their findings, Weeks, Harbison and Peter drew the following conclusions concerning the Andaman Sea valley:

1. It runs down the middle of a mountain range which begins 1100 miles inland in Sumatra (where it is known as the Semangko Rift Zone), extends 600 miles beneath the sea to Narcondam Island, and probably continues from there through Burma, perhaps as the Burma-Indian border. The valley is a part of the volcanic section of the earth's greatest island arc, the Indonesian Arc.
2. The undersea valley is parallel on each side by many mountain peaks. Some protrude several thousand feet above the surface, while others are entirely submerged, some almost a mile below the surface.
3. The width of the valley averages 20 to 25 miles between peaks. The valley floor is about five to ten miles across. The deepest point found was estimated to be 15,000 ft. or almost three miles, under the sea.
4. An adjacent peak, the highest discovered towered 12,000 feet above the valley. It is covered by 3,000 ft. of water. This huge mountain was discovered about 80 miles east of the northernmost island of the Nicobar Islands just northwest of Sumatra.
5. The floor of the valley is covered with more than a half-mile of muck and ooze. It is doubtful that man will ever tread its surface, regardless of the equipment he wears.
6. The valley probably continues from Narcondam Island through the Irrawaddy River in Burma. If so, it has been filled in by sand and mud deposited by the river over hundreds of thousands of years. The proven length of the valley is approximately 1,700 miles. The valley is part of the volcanic arc which includes Krakatoa, famous for its catastrophic explosion in the last century.

The investigation by Weeks, Harbison and Peter aboard the *Pioneer* covered six weeks, last spring and summer. It was followed by more than six months of painstaking geological studies, including detailed analysis of profiles of the ocean bottom and geophysical data taken aboard the ship.

The Coast and Geodetic Survey scientists found that the mountain range beneath the Andaman Sea is analogous in many ways to the central portion of the Mid-Atlantic Ridge, although the latter is much longer. The Mid-Atlantic Ridge begins generally north of Iceland and continues to the South Atlantic and further around the globe.

The oceanographers said the following similarities existed in the two undersea mountain ranges, divided though they were by thousands of miles:

1. Both are active earthquake zones and the peaks adjacent to the valley are basaltic type rocks. In each instance, the most prominent feature to marine geologist is the central rift valley.
2. Both under sea valleys are more than a mile below the surface of the sea. The floor of the Mid-Atlantic Rift in the North

Atlantic is on the average about 12,000 ft. approximately 2½ miles below the sea, while the deepest point found in the Andaman Sea Rift is 15,000 ft. down.

3. The Andaman Sea valley is 20 to 25 miles wide between peaks; that of the Mid-Atlantic valley averages 15 to 30 miles.

4. Both valleys were apparently caused by fracturing of the mountain ranges, or faulting, after the volcanic action died down.

5. Each mountain range is visible at some points above the sea, including the Azores and Iceland in the Atlantic and Sumatra, Java, Timor and Narcondam islands in the Indian Ocean.

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Oceanography Seminar in Calcutta

An informal seminar on oceanography was organised under the sponsorship of Indian National Committee on Oceanic Research at Calcutta on 26–4–65. The discussions were mostly on the scientific problems of the Bay of Bengal. Dr. N.K. Panikkar presided over the seminar in which the following papers were presented by the participants belonging to different scientific organizations.

1. R. Jayaraman : General Oceanographic problems of the Bay of Bengal.
2. Y.P. Rao : Meteorology of Bay of Bengal.
3. A. Daniel : Siphonophores of the Bay of Bengal and their role in Deep Scattering layer (based on the data collected on Vityaz.
4. H.N. Siddique (Dr. M.V.N. Murthy) : Studies on the Bay of Bengal sediments
5. T.K. Mallick : Preliminary studies on the heavy minerals in clay samples from the Bay of Bengal between Visakhapatnam and Masulipatnam.
6. P.R. Chandra : Preliminary note on the Ecology of recent Bryozoans from the Bay of Bengal and their relation to the sediments.
7. K. Venkajee (Dr. A. N. Choudhury) : Chemical data on samples collected during the 18th cruise of INS Kistna.
8. B. Das Sarma : Redox Measurements on the sea water samples collected during 18th scientific cruise of INS Kistna.
9. S. Datta : A report on the geophysical and geological work done on board the Vityaz.

The Second Meeting of the SCIBP

The second meeting of the Special Committee for the International Biological Programme was held in the Food & Agriculture Organization, Rome from 4-5 February, 1965

Reports on the progress of organizational works undertaken in various countries were made by the convenors of Sectional Committees. In general, the indications were that although considerable progress was being made by correspondence, the principal developments in the programme would come after the Sectional Committee meeting and Symposia now being organized in the first phase of the IBP in 1965-66.

The Scientific Director-designate Dr. E.B. Worthington reported on the progress made in the establishment of central Office of IBP in London. He said, it was expected that the Central Office would begin operation

from London not later than July, 1965 and would be fully functional before the end of the year. Until the office is established the temporary secretariat will continue to be at 2 via Sebenico, Rome.

At present, more than twenty countries have constituted National Committees for International Biological Programme and in at least twenty other countries, there are IBP National correspondents prior to the establishment of National Committees. The first and second "International Biological Programme News" have been distributed to National Committees of ICSU, National members of SCIBP and to other interested organizations and individuals. Plans are in hand for the publication of hand books which will include recommended methods, guides to research etc. A number of meetings have already been held to discuss intercomparable methods and the results and proposals from such meetings are being circulated for criticism and amendment.

It was suggested that the next meeting of SCIBP be held immediately prior to the Second General Assembly of the IBP. The tentative place and date for this are: Paris March (1966).

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SCOR representative on SCIBP

Scientific Committee on Oceanic Research (SCOR) has designated Dr. David H. Davies (South Africa) as its representative on the Special Committee of International Biological Programme (SCIBP).

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Marine Biological Studies in Andhra University

Information on two of the research projects completed at the Zoology department of Andhra University has been given in the previous issue of this newsletter. The following are two more items of work completed by the CSIR Research Fellows:

Interstitial Fauna of Waltair coast:

The systematics, morphology and ecology of about 400 interstitial organisms inhabiting the sandy beaches of Waltair coast have been studied by Chandrasekhara Rao. This includes a number of new forms also. These organisms belonging to different phyla are found to exhibit interesting convergence in their evolution owing to their special habitat.

The nature of physico-chemical factors and their influence on the behaviour, density and seasonal distribution of the fauna were studied along with preliminary observation on the bionomics, locomotion, nutrition and reproduction.

Eggs Larve and Juveniles of Marine Fishes.

Solomon Raju has completed the identification and description of eggs, larve, and Juveniles of 50 families of marine fishes. The study is based on routine plankton collection and the materials collected during 53 oceanographic cruises conducted by the Andhra University during 1952-57.

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Meetings and Visits

Dr. N. K. Panikkar, Director, Indian Programme of International Indian Ocean Expedition left here for Paris on 7th June, 1965 and attended the meeting of the International Coordination Group of the International Indian Ocean Expedition held during 7-9 June, 1965. On 10-6-1965 he arrived in Rome from Paris and participated in the following meetings held there, between 10th and 25th of June, 1965.

1. Standardization and Intercalibration.
2. Executive Committee of Scientific Committee on Oceanic Research.
3. Bureau of Intergovernmental Oceanographic Commission.
4. Food and Agriculture Organization, (44th Session of Council.)

Dr. Panikkar arrived in West Germany on 26-6-65 to visit Oceanographic Institutes there for a period of two weeks/and from 10-7-65 he will be in East Germany visiting the Marine Institutes under the German Academy of Sciences and also ship building yards of Rostock.

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International Oceanographic Congress

According to the latest information received from the UNESCO office of Oceanography, Paris, the Second International Oceanographic Congress will be held in Moscow, U.S.S.R. from May 30 to June 9, 1966.

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Fourth Session of the Commission for Maritime Meteorology

A report on the resolutions and the recommendations adapted by the fourth Session of the Commission for maritime meteorology has been published in the WMO Bulletin, April 1965. The Session which was held in Geneva discussed about 90 items and adopted 6 resolutions and 33 recommendations.

Commission recommended continuation of the studies on the measurements of sea surface temperature, precipitation, wind structure, accretion on ship, and the scheme for reporting locusts at sea. Recommendation was also made for a new plan for collection and dissemination of ships reports which will ensure a more efficient transmission of weather reports from ships to coastal stations. Special attention was paid to marine automatic weather stations and it was stressed that these should become operational network at sea, and also recommended that the members should establish one or more mobile ship radiosonde programme aboard ship travelling through sparse data area or should assist other members to establish cooperative programmes.

Members can be responsible for issue of weather bulletins for any given area and there is no objection to overlapping areas of responsibility but all the sea areas should be covered by at least one forecast. The increased use of facsimile broadcasts of meteorological information to shipping and for fishing vessels was encouraged by the commission. The contents of such broadcasts for maritime purposes are: surface analysis charts, surface prognostic charts of the sea conditions, sea surface temperature charts, bathythermograph traces and layer depth charts.

It was considered at the session that application of meteorology to oceanography and to allied fields would benefit considerably from a comprehensive study of ocean-atmosphere interaction. The commission therefore decided to establish a group on ocean–atmosphere interaction to collate available studies, co-ordinate action already initiated and to promote new action in this field. The need for cooperation between Intergovernmental Oceanographic Commission and W.M.O. in this subject was also stressed by the Session.

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TWELFTH MEETING OF THE INDIAN NATIONAL COMMITTEE ON OCEANIC RESEARCH

Proceedings:

As has been given in the previous issue of this newsletter the main item on the agenda for twelfth meeting of the Indian National Committee on Oceanic Research held at CSIR New Delhi on 5-3-65 was the discussion on the Draft Plan of the National Institute of Oceanography which had been drawn up and revised at the meeting of the working

party of the Planning Committee held on 1-3-65. While welcoming the members, Chairman, Dr. Wadia requested them to discuss the various points in the draft plan and offer their suggestions, so that the plan could be finalised and sent to CSIR for being placed before the Governing Body meeting. He also referred to the proposals made in the Indian Programme of participation in the IIOE and also the group discussions on the geological and geophysical results of the IIOE held during XXII International Geological Congress held in New Delhi in December, 1964.

In his report Member-Secretary highlighted the important activities since the last meeting. He referred to the XIX and XX Cruises of INS *Kistna*, the details of which have already been published in the previous issue of this Newsletter. Dr. Panikkar referred to the German Research Ship *Meteor's* visit to Cochin and Bombay, the hospitalities accorded to the scientists on board and the joint seismic programme conducted by *Meteor* and *Kistna*. The short preparatory seismic cruise, prior to this conducted jointly by INS *Kistna* and INS *Konkan* was also referred in his report.

Regarding the NOMAD failure, Shri Ramaswamy mentioned about the action taken by the India Met. Dept. towards the repairs of the instrument. He said that *in situ* repairs would be difficult and hence the buoy should be transferred to Madras on board and light house tender M. V. *Sagar* Deep which is at present undergoing repairs and expected to be commissioned for this work soon after repairs.

The Member-Secretary mentioned that a summary report on the discussions on the Geological and Geophysical results of the Indian Ocean Expedition, held in Delhi would appear in the eighth number of the IIOE Newsletter which was then in press and a full text of the discussions would be published by the organisers of the XXII Geological Congress.

Chairman drew the attention of the members to the recommendation made by the Third Reviewing Committee of CSIR headed by Dr. Ramaswamy Mudaliar, that the setting up of the National Institute of Oceanography under CSIR should be given high priority. The members unanimously agreed that the Institute should have its own research ship and for the manning and maintenance of the ship, the expertise of the Navy could be availed of. In regard to the ship specifications there was considerable discussion and it was agreed that the present material circulated could form the basis for further study.

Regarding the present status of the expedition Dr. Panikkar said that cruise plans have already been drawn up for detailed surveys along the west and east coast of India, upto the end of September after which INS *Kistna* would go for a major refit. He said the cruise programme furnished by the Geological Survey of India is also being considered for the coming series of cruises.

Dr. Panikkar referring to the recent disaster to the Rameswaram area as a result of the sudden unexpected storm wave mentioned to the Committee about a communication he had from Dr. Hansen (Head of the German Hydrographic Institute, University of Hamburg and a specialist in the field of storm surges) stating that his institute could be of assistance to us in working out a proper warning system for this region. National Committee decided to welcome this offer from the German Institute and support taking up this project.

The Committee nominated Dr. C. B. Murty of the Directorate of Scientific Research (Navy) as a member of the working group on Physical Oceanography and Meteorology.

VISITORS

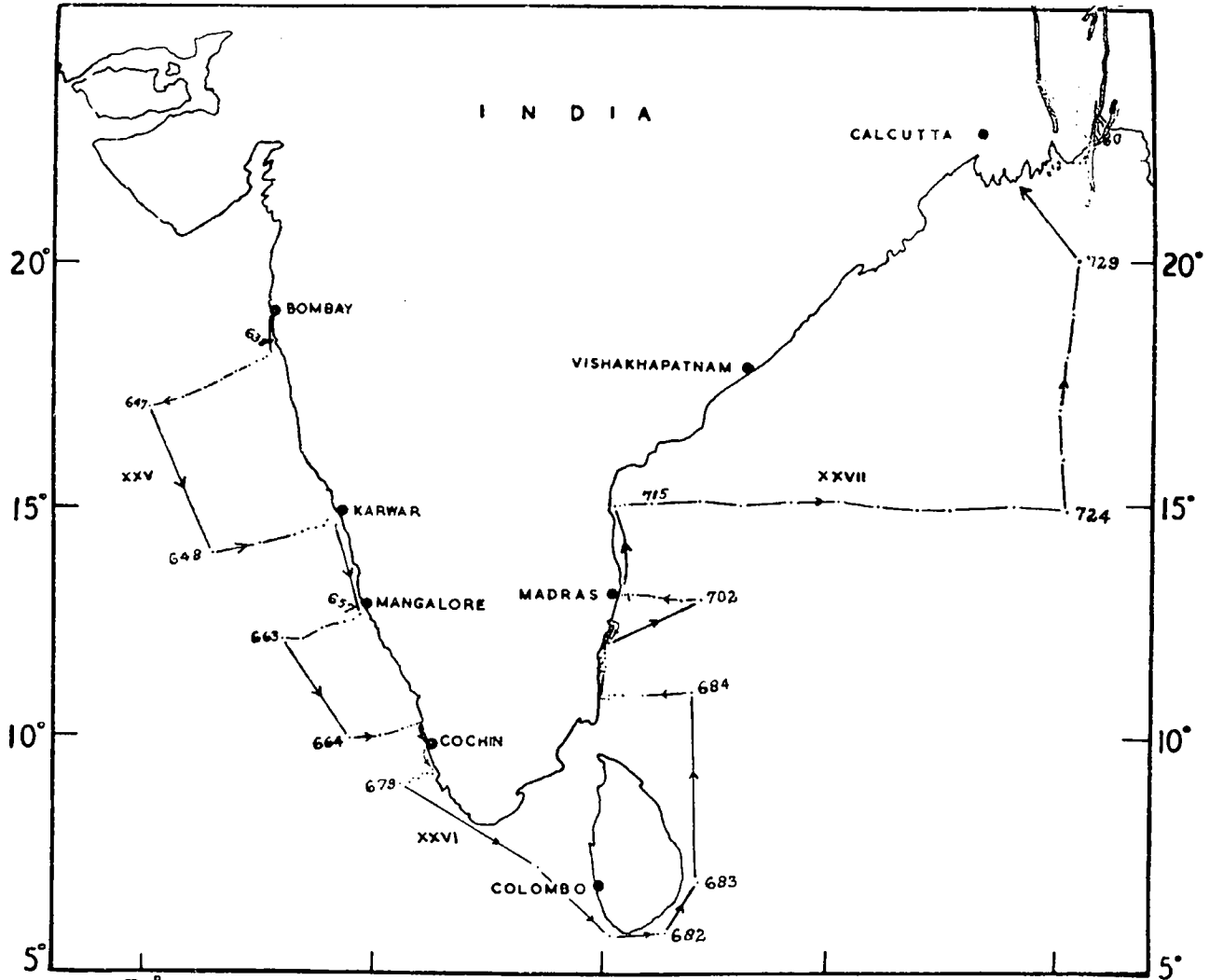
During the period, March-May, 1965 the following persons visited the Indian Ocean Biological Centre and other Centres of the Indian Ocean Expedition Directorate at Ernakulam.

1. Prof. J. A. Birstein, Biological Faculty of the Moscow State University.
2. Prof. Fritz Gessner, of the Institute fur Meereskunde, Kiel.
3. Dr. Martin Tveit, Director, Indo-Norwegian Project.
4. Shri A. I. George, Chief Project Officer, Indo-Norwegian Project.
5. Mr. R. S. Glover, Oceanographic Laboratory, Edinburgh.
6. Dr. G. Hempel, UNESCO Office of Oceanography, Paris.
7. Dr. A. Evstafiev, UNESCO, New Delhi.
8. Dr. M. E. Vinogradov, Institute of Oceanology, USSR.
9. Dr. R. Serene, UNESCO, Expert, National Museum Singapore.
10. Dr. K. K. Tiwari Zoological Survey of India, Calcutta.
11. Shri C. S. Nayar, Under Secretary, Indian National Commission for UNESCO, Ministry of Education, New Delhi.
12. Mr. K. Larssen, Indo-Norwegian Project, Ernakulam.
13. Mr. S. J. Overaa, The U.N. Association, Norway.
14. Dr. J. A. Mc Gowan, Scripps Institution of Oceanography, U.S.A.
15. Dr. S Motoda, Hokkaido University Japan.
16. Dr. Husain Zaheer, Director-General, CSIR, New Delhi.
17. Mr. E. S. Combs, "U. S. S. Greenwich Bay".

Dr. Roger Revelle, the eminent U.S. Oceanographer and former Director, Scripps Institution of Oceanography, U.S.A., had discussions with Director, Indian Programme of International Indian Ocean Expedition during his visit to Delhi in March, 1965. On 19-4-65 Dr. Hempel and Prof. Krey visited the Indian Ocean Expedition Directorate Delhi and had discussions with the scientific workers on several matters relating to oceanographic data.

PUBLICATIONS RECEIVED:

1. IOC—Information paper No. 11 Feb. 1965 No. 12 April 1965.
2. International Marine Science Vol. III No. 1 March, 1965.
3. Acta Adriatica:
4. Indian Journal of Experimental Biology. Vol. 3 No. 1 January, 1965.
5. CSIR News—
   Vol. 15 No. 5, March 15, 1965.
   Vol. 15 No. 6, March 30, 1965.
   Vol. 15 No. 7, April 15, 1965.
   Vol. 15 No. 8, April 30, 1965.
   Vol. 15 No. 9, May 15, 1965.
   Vol. 15 No. 10, May 30, 1965.
6. Oceanus Vol. XI No. 2 December, 1964.
7. The Sea Horse—Vol. 1 to 4 Nov. 1964.
8. Anton Bruun Cruise Report—IVA, IVB, V, VI and VII.
9. Oceanographic Atlas of Ocean Weather Station.
10. "Papa" 1956-1963. (Fish Res. Board of Canada Report No. 187)
11. Bulletin of the National Geophysical Research Institute, Vol. 3 No. 1 March, 1965.
12. Science Reporter Vol. 2 No. 3 March, 1965.
13. National Metallurgical Laboratory Technical Journal Vol. VII No. 1 Feb. 1965.
14. Vigyan Pragati (CSIR) Vol. 14 No. 5, May 1965.
15. Indian Journal of Biochemistry Vol. 2 No. 1 March, 1965.
16. Research & Industry (CSIR)
    Vol. 10 No. 1, January, 1965.
    Vol. 10 No. 2, February, 1965.



Track and Station Positions of INS Kistna's Cruises XXV, XXVI and XXVII