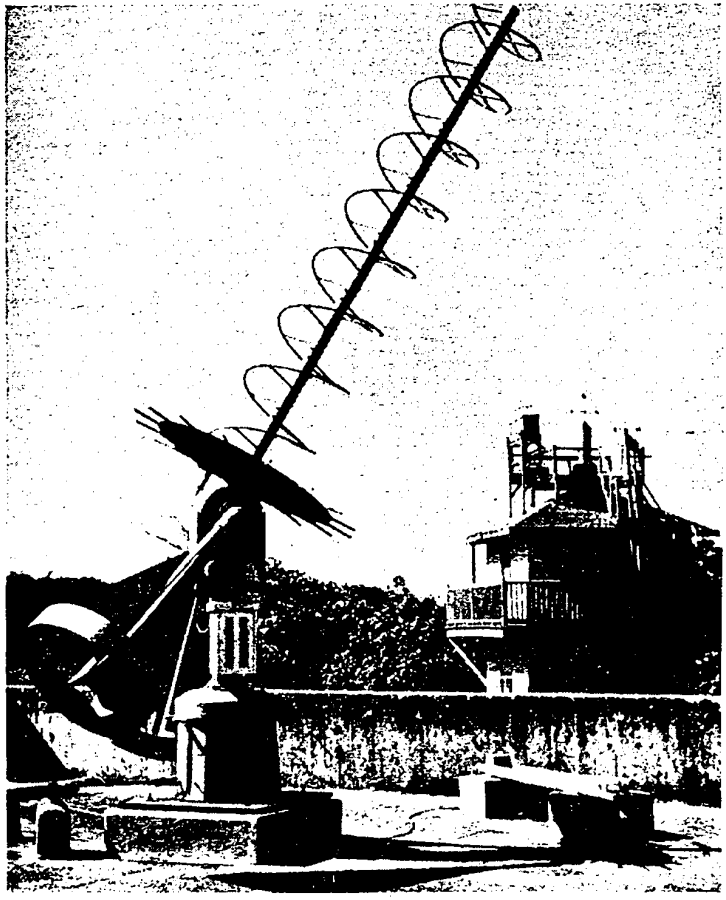
INTERNATIONAL INDIAN OCEAN EXPEDITION

NEWSLETTER

INDIA

Vol. II No. 4 March, 1965



At IMC, Bombay

Issued by

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

COVER PHOTO

Antenna at the International Meteorological Centre, Bombay for receiving pictures of cloud-cover transmitted by Meteorological Satellite.

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IN THIS ISSUE

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INTERNATIONAL INDIAN OCEAN EXPEDITION

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INDIA

Vol. II No. 4 MARCH, 1965

INDIAN PROGRAMME

Scientific cruises of *INS KISTNA*

INS Kistna completed her scientific cruises XXI and XXII during January-February, 1965. The XXI cruise commenced from Visakhapatnam on 15.1.1965 and ended at the same port on 22.1.1965 and the XXII cruise began from Visakhapatnam on 28.1.1965 and completed at Cochin on 6.2.1965. During these cruises the vessel occupied stations along the western Bay of Bengal, around Ceylon and across Gulf of Mannar. A total number of seventy-four stations were occupied during these cruises with the various activities mentioned below:–

Cruise No.	*XXI*	*XXII*
BT stations	4	10
Hydro stations over shelf	11	18
Hydro stations upto 1200 m.	11	14
Hydro stations 1200 and up to 2000 m.	3	3
IOSN Hauls 200–O m.	15	20
IOSN Auxillary hauls	3	6
Radio-sonde ascents	10	17

Besides, surface meteorological observations were made at intervals of three hours on all days.

Certain interesting underway observations were made during these cruises. At position 10°15'N and 89° 40'E about 10' miles south-east of station 550 a full sized uprooted tree of 10m length heavily infested with barnacles and polychaetes was found drifting and subsequently hauled aboard for detailed examination.

While at station 542, position 16° 42' N and 80° 90' E formation and dissipation of four individual funnel type clouds were observed. During both the cruises the surface current was generally southerly to south-westerly. High wire angles, not consistent with the surface current and winds suggest sub-surface currents differing in direction from those at the surface. Surface temperature and salinity were generally found to increase from the coast towards the south. A slight inversion in temperature in the surface layer with more or less uniformly thick mixed layer was observed.

During XXI cruise in the north-western Bay of Bengal, observations revealed sub-surface salinity maximum at depths 400 to 600m and oxygen minimum at depths 300 to 400m. The range of temperature within these two layers is of the order of 12.0 to 9.5° C with the salinity maximum being 35.05 to 35.30 o/oo and oxygen minimum 0.18 to 0.30 ml/l.

At 2000 fm depth the temperature is about 2.5°C and salinity about 34.94 o/oo.

Around 19° 30'N and 85° 50'E off the coast south of Puri a canyon with depths increasing to about 200 fm from about 50 fm of flat shelf was traced by the Edoechosounder. The northern part of the continental shelf was found to be rather flat and wide around a depth 50 fm suddenly dipping to greater depths beyond 50 fm line. There were twenty Scientists on board including the Cruise Leader Dr. C. B. Murty of the Directorate of Scientific Research (Navy).

Seismic Studies

The XXIII cruise of INS *Kistna* was undertaken for seismic study on an experimental basis in collaboration with *INS Konkan* mainly for testing the various items of equipment for seismic exploration work prior to the joint programme with *R.V. Meteor*. B.T. data and bottom sediments have also been collected for a better understanding during the interpretation of seismic waves. During this cruise between 14.2.1965 and 17.2.1965 a track running from Cochin to Kalpeni Island was chosen. Three stations were fixed at different intervals for stationing the recording ship and in addition, 6 stations at more or less equal intervals were selected within the continental shelf for collection of bottom sediments and B.T.

INS Kistna carried ten scientists led by Dr. Sreenivasan of the Indian Naval Physical Laboratory, Cochin, and there were two scientists on board *INS Konkan*. Sediment samples from seven stations are deposited at Indian Ocean Physical Oceanography Centre, Ernakulam, for detailed analysis. The B. T. slides are being processed and the records of the seismic waves have been taken to Directorate of Scientific Research (Navy), Delhi, for study and interpretation.

R. V. VARUNA

R. V. Varuna continued her programme mostly centred on exploring the fishing grounds off west coast especially on the shelf between Cape Comorin and Mangalore. Physico-chemical and biological oceanographic data were regularly collected on all cruises by the scientists on board. Nansen casts, bathythermograph lowerings, echo-sounding and plankton hauls were taken and in addition surface meteorological observations were made. During the quarter June-August 1964 about 160 stations were worked out in spite of equally weather. Operations had to be suspended on certain occasions when the wind velocity ranged between 30 and 45 knots accompanied by high swells. A few plankton nets and trawl nets were badly damaged in these cruises.

During September-October '64 the vessel covered 133 stations making a total steaming of about 2250 miles. By the beginning of November *Varuna* left for Bombay for dry docking and repairs.

INDIAN OCEAN BIOLOGICAL CENTRE, ERNAKULAM

Considerable progress has been attained in the sorting of International collections received at the Indian Ocean Biological Centre, Ernakulam. So far 681 plankton samples have been processed at this centre. About 60% of this has been completed between April, 1964 and February, 1965. All the samples received from Australia for contract sorting have been processed by January this year. During December, 1964, 22 samples have been received from the Pakistan research vessel *Zulum*. Of the 162 samples received during January-February, 1965, 23 are from *Anton Bruun* (US), 44 from *INS Kistna* (India) and 95 from *R.V. Meteor* (Germany).

During Meteor's visit to Cochin
Left to right: Dr. Reichel, Mr. Shah, Dr. Siebold, Dr. Dietrich, Dr. Panikkar, Dr. Kurian.

The existing procedure for sorting:

According to the existing procedure approved by the Consultative Committee for Indian Ocean Biological Centre, the displacement volume of every sample is measured in the beginning. This is followed by the measurement or computation of the displacement volume of 9 groups of organisms. Then sorting is commenced with removal of larger organisms and also fish eggs, fishes and cephalopods. The remaining group which is more or less homogenous in size is subsampled either with a Lea's Plankton divider or Folsom's Plankton splitter, so that a subsample of 3.5 ml. is separated for sorting.

The non-sorted fraction, a maximum of 10% of the sample will be kept as an "archive". Of the 80 plankton groups 11 are identified but left in the residue, 5 are composite and 64 are sorted, counted and stored separately.

A list of experts whose collaboration could be obtained for the future detailed study of the international collections, has already been prepared at the centre as desired by the Consultative Committee. Lists compiled by various national organisations have been received from eleven countries: Australia, Ceylon, East Africa, Finland, India, Japan, Philippines, South Africa, Sweden, USA, USSR.

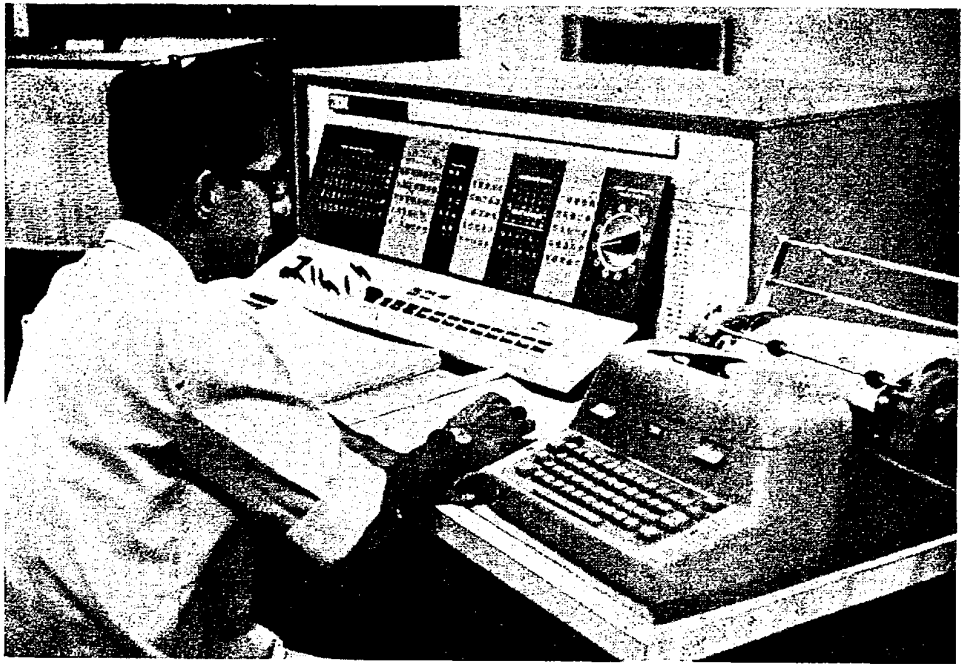
Productivity studies undertaken at the centre have been regularly continued and considerable data have been collected from over 50 stations in the backwaters and inshore area off Cochin. 800 assimilation experiments were carried out from vessels *INP Kalava*, *R/V Conch* and fishing vessels: *Fishtech* No. 2 and *Fishtech* No. 5.

INTERNATIONAL METEOROLOGICAL CENTRE, BOMBAY

Processing of the 1963 and 1964 data is smoothly progressing at the centre although

the increasing flow of the aircraft weather reports may cause some delay in completing the project. Experimental reception of facsimile nephanalyses re-transmitted from Moscow is proving satisfactory. The equipment like Microfilm camera, Verifax, book copying unit, Antara "streamliner" ozalid machine, 16 mm film projector, and the Epidiascope

From the airborne measurements made during February and March 1964 Dr. Bischof has come to the conclusion that Indian sub-continent acts as a source of carbon-dioxide during this season with the vertical distribution off the coast accounted for by the sea breeze circulation. Within the near equatorial convergence zone, however, the troposphere is



IBM. 1620 Electronic Computer at the International Meteorological Centre, Bombay.

brought under the U.N. Special Fund grant has much facilitated in easing the tasks at the International Meteorological Centre.

Sonmiani and Thumba have successfully launched four rockets each, since 19 August and a report on the preliminary findings will soon appear.

well mixed by convection and the carbon-dioxide is therefore generally constant at all higher altitudes.

Microfilmed copies of synoptic charts for 27 August to 23 September analysed at IMC have been sent to the U.S. National Aeronautics and space administration to assist in a

study of meteorological data obtained from NIMBUS I.

Mr. Arif A. Waqif of the University of Michigan returned to the United States in the third week of November after completing installation of the Michigan equipment at various stations in the Indian Ocean. Mr. V. Srinivasan attended the WMO Seminar on Satellite Information Utilization in Tokyo. A scholarship was awarded to Mr. C. M. Dixit under UN Special Fund and he is shortly leaving for United States to study computer application to meteorology. Four papers on the IIOE Meteorology published during this period are:

1. Behrman, D., 1964; *Web of Progress* (chapter 4). Paris, UNESCO, 103 pp.
2. Raman, C. R. V., and T. Ramanathan, 1964: Interaction between lower and upper tropical tropospheres. *Nature*, 204, 31-35.
3. Richardson, I.W., 1964: Research Flight Facility participation in International Indian Ocean Expedition. *Mar. W. Log.* 8, 155-157
4. Suryanarayana, R., and F.R. Miller, 1964: Electronic computer aids research on Indian Ocean Expedition. *Bull. Amer. Meteor. Soc.*, 45, 644-647

INTERNATIONAL BIOLOGICAL PROGRAMME, ERNAKULAM

The organizational activities of the International Biological Programme commenced at Ernakulam (India) in June 1964. The principal objective of this programme as has been indicated by the International Council of Scientific Unions in November 1963, is to conduct world-wide study on the "Biological Basis of Productivity and Human Welfare". At present work has been initiated on the following lines.

(a) To determine the primary production rates of the Cochin backwaters and the offshore waters around Cochin, (C_{14} uptake, oxygen production and pigment determination).

(b) To analyse qualitatively and quantitatively the composition of the animal communities in planktonic, nektonic and benthic biotope.

(c) To work out relationship between indicators and biological productivity, plankton, nekton, benthos and to apply this information on the qualitative and quantitative distribution of life.

(d) To study the seasonal periodicity of reproduction and the number of generation (turn over) in relation to physico-chemical factors like temperature, salinity, light, oxygen, etc.

Routine work at the centre has been initiated with hydrographical observations, collection of plankton, nekton and benthos, analysis of nutrients like phosphates, silicates and the determination of the rate of photosynthesis and chlorophyll. Four scientists are working at the Centre at present.

REPORTS FROM OTHER COUNTRIES

ANTON BRUUN (US)

Information regarding the observations during the cruise V of U.S. Research Vessel *Anton Bruun* has been received. This cruise was undertaken according to the following itinerary, in the western and central Indian Ocean.

Departure	Arrival	Place
26.1.64	—	Bombay
15.2.64	12.2.64	Port Victoria
2.3.64	22.2.64	Port Luis
28.3.64	14.3.64	Port Luis
--	7.4.64	St. Paul Island (stop over)
—	8.4.64	Amsterdam Island (stop over)
27.4.64	24.4.64	Gan Island
1.5.64	1.5.64	Cochin
—	4.5.64	Bombay

During the cruise the collection of physical, chemical and biological data was done as part of the U.S. Programme in Biology, participation in IIOE. Physico-chemical observation included hydrographic casts, usually down to 2,000 metres, taken at 46 stations. In addition to the measurements of temperature of various depths, the water samples collected from the depths were analysed for oxygen, salinity, phosphates, nitrites, nitrates, and silicates. B.T. casts were made routinely at 3-hr. interval between stations. Water samples were collected from depth with incident light of 100, 50, 25 and 10% for pigment determination and C^{14} studies at 46 stations. At 25 stations vertical plankton hauls were made from 200 meters to surface; similarly vertical microplankton hauls from 200 m to surface were taken from 41 stations with No. 25 mesh net. *Bc* multiple plankton sampler was operated at 42 stations for the collection of Zooplankton at depths O-125m. 125-250m, 250-500m, 500-1000m and 1000-2000m. Oblique ½-meter plankton net lows were substituted for the Be' net tows at 4 additional stations.

Surface zooplankton hauls of ½-hour duration were taken on 59 occasions during night at about 2100 hours. Fiftyfour of the surface hauls were accompanied by ½-hr oblique hauls which ranged from the top of the thermocline to the surface.

Long line fishing for pelagic fishes was carried out on 38 stations. At each station 40 or 50 baskets of Japanese type long line gear was set at dawn and hauled by about mid-day. Number of fishes under various sepcies caught are given below.

105 Yellowfin Tuna.
6 Barracuda
54 Bigeye Tuna.
112 Lancet fish
83 Albacore Tuna.
1 Opah (moon fish)
3 Skip Jack Tuna.
4 Mako Shark
4 Blue Marlin.
4 Thresher Shark
7 Striped Marlin
10 Great blue shark
2 Black marlin
4 Silkey shark
3 Broad bill sword fish
11 White tip Shark.
8 Sail fish
2 Mackerel Shark
4 Wahoo
1 Heptrachias Perlo.
3 Dolphin
1 Unidentified shark (family Isuridae).

Data on the Length, weight and sex of the fishes have been recorded and stomach contents, ovaries, blood samples, gut contents and gills (for parasites) were saved for later detailed study. Sampling gears included trolling lines, handlines, rod and reel and a 10 foot midwater trawl which was successfully operated on two occasions.

Ornithological records were maintained during the cruise by a representative of the U.S. National Museum. During the stop at various islands a total of 25 bird specimens were collected and preserved for analysis.

An observer from the U.S. Weather Bureau regularly made weather observations which included 57 radio-sonde ascents for the study of upper atmosphere.

Messrs. C. Sankarankutty (I.O.B.C. Ernakulam) and E.G. Silas (C.M.F.R.I. Sub-station Ernakulam) were the guest scientists on board from India during this cruise.

AUSTRALIA

Reports are available now on the completed cruises Dm 3/64 and Dm 4/64 of *H.M.A.S. Diamantina*. A short summary of activities undertaken during these cruises is presented below.

Dm 3/64 (4 May-15 June 1964)

Bathythermograms	— 34	stations.
Sub-surface hydrology	— 45	„
Primary Production	— 65	„
Pigments	— 65	„
Zooplankton	— 10	„
Phytoplankton	— 52	„

The intention of the vessel to study the development of upwelling in the Java Sea was indicated earlier. (Newsletter Vol. II No 3) Between May 9 and 14, *Diamantina* occupied stations 108-135 south of Java in a pattern of 13 positions within a radius of 52 miles centred at 10° S and 110° E. This was repeated between June 3 and 8 with stations 145-170 occupying all at 0700, 1000, 1300, 1600 or 1900 hrs.

Cruise Dm 4/64 was undertaken between 20-29 July, 1964 from Fremantle. The ship made a series of traverses across the continental shelf between North-West Cape and Cape Naturaliste before returning to Fremantle during this cruise. The objectives of the cruise were to study the distribution and growth of late larval stages of the western Australian cray fish, (*Panulirus Cygnes*) to sample sediments on the continental shelf and to examine the hydrological conditions of water masses on and adjacent to the continental shelf. The following observations were made in a total of 39 stations occupied during this cruise.

Sub-surface hydrology	— 39	stations
Sediment sampling	— 29	„
Bottom photography	— 10	„
Bottom dredging	— 7	„
Midwater trawling	— 8	„
Zooplankton	— 7	„

Zooplankton samples were deposited at IOBC, Ernakulam for sorting. T.R. Cowper was the leader of this cruise and J. Klye, L. Thomas and C. Saunders were the other scientists on board.

Cruise plan for Dm 5/64

Information is available on *Diamantina's* plan for the cruise Dm 5/64 which is expected to have been completed during 10 Aug-12 September. According to the itinerary, the cruise was to commence from Fremantle and to arrive at Singapore via Cocos Island, covering on the way SCOR-UNESCO Reference stations 1 and 2. On return, the vessel was to touch Christmas Island besides working at Position Station 7 and SCOR-UNESCO Reference stations 1 and 2.

The objectives of the Cruise were (1) to study the distribution of suspended particulate material from surface to bottom in the eastern Indian Ocean and the relation of this material to the hydrological system (2) to study the differences in chemical composition of this material in relation to depth and latitude (3) to investigate long and short wave radiation.

B. Newell (Leader), G. Dalpont, J. Klye, J. Prothero and J. Stevenson were nominated as Scientists on board.

H. M. A. S. Gascoyne, has completed her cruise 5/64, during August 19-31, 1964. In this cruise which began from Cairns the vessel steamed through Torres Street and made a series of sections in the Gulf of Carpentaria.

In this cruise, the plan was to study the penetration of phosphate rich upwelled water from the eastern Arafura sea into the Gulf of Carpentaria. Certain techniques for sediment sampling were also to be tested.

D. Rochford (Leader), F. Davies, N. Dyson, K. Fleming, and J. Kaulback were the scientists on board.

GERMANY

According to the revised schedule received here, German Research Vessel *Meteor* has commenced her maiden scientific cruise from Hamburg on 29.9.1964. This is the first German vessel built exclusively for oceanographic research, since all the former research vessels were either converted warships or merchant vessels. *Meteor* is 82 meters in OAL and her

displacement tonnage is 2740. Propelled by a diesel electric engine of 2000 PHF she develops a service speed of 12 knots and her radius of operation is in excess of 12000 knots. The ship is manned by a nucleus crew of 55 and confortable accommodation is available on board for 25 scientists. Ten laboratories provided on board are comparable to any of its kind on land in regard to facilities and equipment. Aquariums, refrigerating rooms, work shops, fish fiinding installations, sonic depth finders, under water television cameras, sea gravimeter and plant for the production of fresh water from sea water are among the important items of equipment.

Joint Programme with INS Kistna

Off the west coast of India the vessel worked for 15 days in collaboration with *INS Kistna* in a joint seismic programme to study the geological structure of the continental shelf off west coast, laying special emphasis on locating the presence of oil bearing sediments and minerals. Detailed itinerary of the cruise programme including the part already completed is given below.

Itinerary of the first cruise of R. V. Meteor

	Naut. *miles*	*Stations*	*Days*	*Date*
Hamburg-Naples	2620	3	11	29.10.64– 9.11.64
Naples	–	–	2	9.11.64–11.11.64
Naples-Suez	1250	3	5	11.11.64–16.11.64
Suez	–	–	1	16.11.64–17.11.64
Suez-Aden	1300	10	6	17.11.64–23.11.64
Aden	–	–	3	23.11.64–26.11.64
Aden-Aden (Bab-el Mandeb)	1000	26	17	26.11.64–13.12.64
Aden	–	–	1	13.12.64–14.12.64
Aden-Mombasa	2760	64	33	14.12.64–16. 1.65
Mombasa	–	–	5	16. 1.65–21. 1.65
Mombasa-Cochin	2800	28	20	21. 1.65–10. 2.65
Cochin	–	–	3	10. 2.65–13. 2.65
Cochin-Bombay	960	17	9	13. 2.65–22. 2.65
Bombay	–	–	3	22. 2.65–25. 2.65
Bombay-Karachi	720	16	15	25. 2.65–12. 3.65
Karachi	–	–	3	12. 3.65–15. 3.65
Karachi-Kuweit	2500	–	26	15. 3.65–10. 4.65
Kuweit	–	–	3	10. 4.65–13. 4.65
Kuweit-Aden	2120	–	9	13. 4.65–22. 4.65
Aden	–	–	2	22. 4.65–24. 4.65
Aden-Suez	1300	–	5	24. 4.65–29. 4.65
Suez-Hamburg	3650	–	13	29. 4.65–12. 5.65
	22980	167	195	

EXTRACTS FROM SCIENTIFIC PAPERS

Biological index of sea level change

The paper entitled "Upper limit of Barnacles as an index of sea level change on the New England coast during the past 100 years" by Clifford A. Kaye (U.S. Geological Survey) reveals the interesting role of Barnacles as nature's tide gauges. The incentive for

this investigation the author derived from an article by J. W. Johnson (1961) showing photographs of rocky casts taken a century apart in 1860 and in 1960. The zonal restrictions of the organisms like barnacles and algae on the inter tidal area has been long recognized.

Dense colonies of the inter-tidal barnacle *Balanus balanoides* occur in many places on rocks and pilings in the north Atlantic coast. The vertical range of the barnacle is from about mean low water to mean high water and its upper limit is commonly sharply defined. The upper limit is controlled by the tolerance of barnacle to continuous exposure to air. This tolerance called the lethal limit was found experimentally to be 150 hours for first year barnacles and about 185 hours for older barnacles. It is shown that the maximum emersion intervals increase progressively from the base of the tidal zone to the top of the zone. The upper limit of barnacle for any given year is determined by the lowest level at which the lethal limit falls, which commonly is intermediate between the levels of annual mean high water and annual high water neap. To this level a small wave factor is added to determine the barnacle limit for a given year at a given locality.

The fluctuations in the upper barnacle limit in reference to the level of the 1962 limit are plotted on a curve of annual mean high water from 1848 to 1961 compiled from tide gauge records from Boston and New York. There is substantial agreement between fluctuations of barnacle limit and annual sea level values. From this it follows that a series of photographs taken in different years can be used to determine an annual sea level curve for the locality in the absence of tide gauge data.

The annual sea level curve and barnacle data also show that sea level at Boston in the mid-nineteenth century was at approximately the same level as in the mid twentieth century. But it was approximately 0.5 ft. lower at the turn of the century (Clifford A. Kaye, Jour. of Geology Vol. 72 No. 5 September 1964. Chicago).

Hydrology of Indian Ocean

General features of the intermediate water mass structure and circulation and of the major hydrological zones within the 50 meter of the south east Indian Ocean have been established from hydrological data of *H.M.A.S. Diamantina* (Rochford 1961 and 1962). However it was suspected that a number of high salinity water masses of probable north Indian Ocean origin were contributing to its rather complicated water mass structure. The characteristics of the high salinity water masses of the north Indian Ocean and their paths of entry into the east Indian Ocean have now been established. The analysis of water mass structure and circulation of the upper 500 meter of the south east Indian Ocean shows to what extent these high salinity water penetrate into the south east Indian Ocean and what seasonal changes in the positions of their paths occur in this region.

Seven water masses have been identified and their distribution traced during several seasons of the year. Based on their origin they are named: The Red Sea Mass, with the same distribution and properties in 1962, as the north-west Indian Intermediate described in 1959-60 is now considered as the source of these intermediate waters. Persian Gulf mass is confined to a region south of Indonesia and is limited in extent of easterly flow by the opposing flow of Banda Intermediate water. Upper salinity maximum mass entering *via* Lombok Strait and moves zonally in the direction of prevailing surface currents, and a secondary movement of this water mass towards north-west Australia is limited by a northern boundary of south-east Indian high salinity water mass. This latter water mass occurs as three separate core layers north of 22-23°S. The deep core layers mix

with the waters of the oxygen maximum below it; the mid-depth core layers mix with Persian Gulf and upper salinity maximum water masses and the upper core layer mixes with the Arabian sea water. The latter water mass spreads eastwards to about 120°E and southwards to north west Australia.

A sixth water mass enters with counter current and is found as a salinity maximum within the thermocline to about 20°S. The seventh water mass characterised by a salinity maximum around temperatures of 28-29°C has limited distribution and an unknown origin. Both of these water masses move in the direction of surface currents.

Thus four water masses of north Indian Ocean have been identified within the south Indian Ocean. They are Red Sea, Persian Gulf, Arabian Sea and Water mass E (counter current). Two other water masses as yet unnamed have been found in the south east Indian Ocean. One major water mass from the south Indian Ocean has been found and has been named the South-East Indian high salinity water mass (D.J. Rochford, Aust. Jour. Mar. Freshw. Res. Vol. 15 No. 1 July 1964)

NOTES AND NEWS

Sonar Device marks ocean location

A new device called a Sonar transponder, makes it possible to mark an ocean station, leave the station, and return months later to reoccupy the exact station, according to the developer. A model has been dependably operated for 40 days while sumberged at 16,000 ft. A radio-isotopic thermoelectric power pack may be used to obtain an operational life of up to 10 years. The model emits a 2-millisecond, 2 kc|s pulse of 150 electrical watts when interrogated at a 1|second rate, or at a rate in multiples of seconds, by standard ship sonar.

(Oil & Gas International, December 1964).

Seismic profiler for Marine Surveys

Equipment for the mapping of underwater geological horizons strikes a topical theme in this era of North Sea "fever". One such item of equipment is a portable continuous underwater seismic profiler developed newly. The profiler is designed to operate with repetitive sound sources such as electrical discharge, gas explosion and mechanical thumper. The sound source and two hydrophone receivers are towed 100 ft behind a boat in which a transistorized receiver unit and a two-channel receiver are mounted. The equipment is powered by a 100 v, 60 c|s generator with an output of 3-5 kw. Repetition rate of the electrical discharge source can be varied from ¼ sec. to 2 seconds Reflections are recorded on the timed graphic sweep recorder, which has a total width of 18 in. The horizontal scale is adjustable to give an even density of signals for all source repetition rates. Scales can be varied horizontally from 1:200,00 to 1:1500 and vertically from 1:6000 to 1:200. Signals from the two hydrophones can be recorded independently on each channel using different filters in order to eliminate side reflections and noise. A survey by this profiler can be operated on a single profile, sets of profiles, or an intersecting network. The equipment records continuously at a boat speed upto 4-5 knots and operates normally in water at least 10 ft. deep. Installed weight is less than 1000 lb.

(IP Review: October 1964 From Oil Commentary, Vol. II No. 12 Feb. 1, 1965—Petroleum).

Mesoscaphe to survey Gulf Stream

A mesoscaphe submarine designed by the Swiss scientist Dr. Jacques Piccard may soon be employed to survey the Gulf Stream. The cylindrical 93.5 ft. long *Auguste Piccard*

named after the designer's father is scientifically equipped well for obtaining physical and biological oceanographic data. The steel-built hull of this can withstand pressure up to 5000 feet below the sea.

Manned by a crew of four the submarine can carry forty passengers each with an individual plexiglass window and search light. Under the sea the ship can stay about six to eight weeks without having to come to the surface. In the summer 1964 at the Swiss National Fair, *Auguste Piccard* was used for scenic under water dives fortyeight times in Lake Geneva.

In the Gulf Stream the Mesoscaphe would be directed by a group of six scientists to about a few hundred feet below the surface and then would start drifting and may come up across the Atlantic opposite New York or Florida.

CALCOMP 670/564

Magnetic Tape Plotting System

National Oceanographic Data Centre Washington had announced about their possession of a high speed CALCOMP 670/564 Magnetic Tape Plotting System, in their No. 8/9–64 issue of Newsletter. From the experience gained, they are now in a position to evalute its actual and potential utility as described here.

The outstanding benefit of this plotter, they say, is its ability to generate quality control tools which will eliminate some of the subjective monitoring of oceanographic station data. Recently all the historical data for the Indian Ocean were plotted as salinity–sigma-t and depth–sigma-t for each 5 square. Using such plots NODC quality control monitor can at a glance study the relationship of water masses. A further quality control plot can be generated by plotting individual stations (with option to plot interpolated values in addition to observed) to show at a glance the continuity or discontinuity of density-depth gradients and water mass functions.

The automatic plotter can also show now how well the originator or the NODC monitors have evaluated the data.

Analysis

In addition to increasing the quality control capability at the NODC, the automatic plotter may be used to produce charts and graphs of other parameters such as station locations, composite BT traces, surface data, vertical sections, isentropic levels, standard depths, standard deviations, frequency histograms etc.

Plotting of atlases or similar product can be considerably speeded and the automated plotter will produce an essentially error-free product. Data which might take weeks to plot by hand can be automatically plotted in minutes. The importance of computor plots of station locations is obvious in connection with the preparation of catalogue and the evaluation and planning of data acquisition and collection programmes. The plots will quickly show geographical areas of high and low density in the acquisition and collection programmes.

NODC has already a number of programmes in hand and has chalked out following future programmes:

1. Sound velocity profiles
2. Frequency histograms
3. Vertical cross section of Nansen casts or BT data.

Indian Ocean Station Plot:

A chart showing the location of NODC–archived hydrographis cast stations in the Indian Ocean has been prepared by machine using CALCOMP 670/564 plotting system. The station locations in the Indian Ocean and South China sea were read from a NODC archive tape showing station holdings as of July 1, 1964. The procedure required one hour on the plotter and 15 minutes on the computer.

NODC plans to use similar technique to cover the world oceans for purpose of inventory, cataloguing and evaluation of data acquisition and collection.

A New Technique for the Extraction of Radio-activc Silicon

A scientist from the University of Rhode Island has announced recently that a new technique has been developed for measuring naturally-occurring radio-active silicon in the oceans. This should help oceanographers in charting the circulatory and mixing patterns of the sea depths. Using this method Dr. David R. Schink successfully extracted about 2 ounces of silicon from more than 40 tons of sea water taken from various selected depths.

About 10 out of every billion billion atoms in this sample is radioactive silicon-32, an isotope of element which is formed by cosmic rays bombarding the upper atmosphere. Since the rate at which Silicon-32 decays is known within broad limits, Dr. Schink's measurements give an indication of the age and movements of the ocean waters. Such knowledge is vital to scientists who are concerned about the dispersal of radioactive wastes in the oceans. The Office of the Naval Research supporting his work has great interest in his finding.

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Marine Biological Studies in Andhra University

Zoology department of Andhra University has been showing since long a keen interest in taking up marine biological problems for research work. The following are two of the completed projects taken up as part of the scheme for "hydrological and faunistic survey of Godavari estuary system" sponsored by the Indian Council of Agricultural Research during 1958-59.

Systematics and Ecology

Systematics and Ecology of Bottom Fauna taken up by Y. Radhakrishna is a study of bottom invertebrates in the lower reaches of the Gautami estuary and Kakinada Bay. The paucity of polychaete and molluscan fauna in the estuary has been considered to be a possible impact of strong currents, lack of suitable substrata and fluctuation in salinity. A predominance of marine element in the fauna was observed in Kakinada Bay where the regions with fine sediment rich in organic carbon are most productive. Systematic studies and seasonal changes in the fauna of different zones have been recorded and in addition the author has identified the sub-littoral forms collected during the oceanographic cruises of Andhra University in the east coast.

Zooplankton of Godavari Estuary

P. Chandramohan has made a comprehensive study of the Zoop'anktonic groups in the Godavari estuary where the hydrographic conditions are highly variable. The fluctuation in the Zooplankton in the estuary has been found directly related to their abundance in the adjacent sea. Copepods, Lucifers, Decapod larvae and Medusae were the major components of the zooplankton which showed a primary peak in November-December and another in May-June, with an intervening period of phytoplankton abundance. Systematics of the important group and their distribution pattern with regard to their salinity tolerance was also studied.

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Hospitalities to the visiting ships

During the recent visit of German Research Vessel *Meteor* at Cochin and Bombay, hospitality was accorded to the scientists on board by the Hospitality Committee of the Indian National Committee on Oceanic Research. This included informal seminars, group discussions and visits to places of scientific interest. Indian National Committee on Oceanic Research arranged usual facilities for customs clearance of the equipment and essential items used on board.

At Cochin harbour the vessel stayed from 11th to 14th and at Bombay from 22nd to 25th February, 1965.

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Twelfth INCOR Meeting

• Indian National Committee on Oceanic Research held the twelfth meeting at CSIR, New Delhi on 5.3.1965 under the Chairmansip of Dr. D. N. Wadia. Fourteen members including five invitees were present. The highlight of this meeting was the discussion on the draft plan of the proposed National Institute of Oceanography which has been drawn up and revised at the meeting of the working party of the Planning Committee held on 1.3.1965.

Detailed proceedings of this meeting will be published later.

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SEVENTH SCOR MEETING

Hamburg, November 30—December 4, 1964.

The Scientific Committee on Oceanic Research (SCOR) held its seventh meeting at the Deutsches Hydrographisches Institut, Hamburg during November 30–December 4, 1964. There were fortyseven participants from SCOR, National Committees and International bodies to actively take part in the discussion on agenda items. An excursion to Kiel on December 2, facilitated the members to visit Institut fur Meereskunde and the Geologisches Institut of the University.

Election of New Executive

A nomination Committee consisting of Deacon (Chairman), Revelle and Hela proposed the following names for the new executive: Humphrey (Retiring President) Capurro (President), Kort and Braarud (Vice-Presidents).

Working Groups

An appraisal was made of the progress of activities of various existing working groups, and suggestions for the establishment of additional working groups have also been examined by the Committee.

a) *Oceanic Tables and Standards*:

It was reported that Cox had circulated draft report on the work that the differences in conductivity between surface and deep water were discussed and that new tables are being prepared. They will be distributed to all laboratories concerned with this problem. It was recommended to ask national bureaus of standards whether other research in this field was known.

b) The working group on *Atlases* has already presented a report and whether this group will need to undertake new work is not known.

c) The group on *Abstracts* met once and prepared a report containing a list of about 30 core journals. The next meeting will take place probably in Italy 1965.

d) *Zooplankton Sampling Methods* is jointly financed by ICES, UNESCO and SCOR. Four working parties are being established on the different size classes of plankton.

e) Chairman introduced the first draft of the document on the *General Scientific Framework for the Comprehensive Study of World Oceans*. After discussion it was agreed that draft paper can be improved in many ways before a final version is reached. It was also agreed that consideration be given to the preparation of chapters on education in Oceanography, means for developing national programmes and an outline of useful oceanographical studies that can be made with limited man-power and facilities. The Committee finally decided that the present draft as a working paper should be given wide and early distribution among marine scientists with request for comments, criticisms and advice on its contents.

f) *Photosynthetic Radiant Energy*. This group met in October 1964 in Moscow and prepared a draft report pointing out the need

for laboratory work by its members before sea-going tests can be made.

g) It was proposed to arrange the first meeting of the *General Problems of Intercalibration and Standardization* in May 1965, just before SCOR executive and IOC Bureau Meetings.

h) The report on the meeting of the Determination of *Photosynthetic Pigments* with results of the meeting in Paris, June, 1964 was distributed in early November.

i) UNESCO, FAO and SCOR have agreed that a member of UNESCO staff may act as Chairman of a non-governmental body and Parsons should be asked to participate in the working group on *Biological Data*.

A new working group on *Micropaleontology* of *Bottom sediments* was proposed by Kort and it was agreed that the new executive should take steps to establish it. Similarly at the suggestion of ICES, the formation of a new working group on *Productivity* was considered and the matter was left for the examination of the new executive.

International Biological Programme:

A summary of the meeting of the Special Committee on International Biological Programme was given by Crisp. It was suggested by Ketchum that man's influence on coastal waters would be an important topic for IBP. He also asked SCOR to ensure that National Committees for Oceanic Research nominate marine scientists to National Committee for International Biological Programme.

Indian Ocean Biological Centre:

After the discussion of an *ad hoc* group, (Humphrey, Panikkar and Fedorov) the following terms of reference were suggested. According to this the consultative committee members should serve for three years, the Chairman should be elected each year, the Committee shohld be responsible for the treatment and loan of international collections, the members of the Committee should give lectures and seminars to young workers and scientists in India, and the Committee should consist of up to six members.

The Symposium

The following papers were presented at the Symposium on "the Effect of Variation in Oceanic Circulation on Distribution of Marine Organisms, presided over by Prof. Dr. W. Hansen"

Prof. D. J. Crisp: Possible effects of climatic changes on the marine fauna and flora of south West England.

Mr. R. I. Currie: Hydrographical changes inducing mass mortalities of marine organisms on the west and east coasts of Africa.

Dr. P. S. Dixon: Changes in the distribution of marine algae.

Dr. Duing: Measurements of short and long periodic variations of the circulation on the example of the Gulf of Naples.

Dr. K. N. Fedorov: Our present knowledge of oceanic currents and its applications to problems of marine biology.

Dr. M. Gillbright: Vertical circulation and Phytoplankton distribution in diffe-

rent years. (East-Greenland and German Bight).

Mr. A. J. Lee:

Hydrographic changes in the region of the North Atlantic Ocean and their influences on fisheries.

Dr. Walter Nellen:

Microbiomass variations depending on fluctuating circulation in the Kiel Bay. 1958-1963.

Dr. N. K. Panikkar:

Biological and Oceanographic differences between the Arabian Sea and the Bay of Bengal as observed from the Indian region.

Dr. R. W. Stewart:

Canadian Research on Biological Effects of Non - Cyclical Ocean Current Variations.

Mr. H. Charnock:

Meteorological Aspects.

The question regarding the continuation of oceanographic work in Indian Ocean after IIOE came up for discussion and it was decided that no action towards this was necessary for the time being.

Oceanographic Forecasting:

Iselin pointed out the increasing need for oceanographic forecasting and requested SCOR to consider the question in a broader sense, keeping in mind new instruments like Satellites. Supporting his views Kort suggested that the forecasting work could be combined best with the question of standard sections. It was also agreed by Iselin to distribute to SCOR. members a statement and to advise the executive on the formation of a small group to suggest SCOR action.

IIOE Co-ordination Group

The question of Atlases was discussed and it was understood that only the meteorological atlas has so far been assigned to scientists. It was thought that the group should attack the problem of publication of results, exchange of information and development of future Indian Ocean work.

At the end of the sessions Captain Capurro took the chair and expressed his gratitude to his predecessors for the work they did for the promotion of the marine science.

GEOLOGICAL AND GEOPHYSICAL RESULTS OF THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Information relating to a symposium on the Geological and Geophysical Results of the International Indian Ocean Expedition held in New Delhi during 15-18 December 1964 in connection with the XXII Geological Congress was given in the previous issue of this Newsletter. A similar symposium held at the Royal Society, London on 12 Nov. 1964 highlighted the geological and geophysical work done in the North-west Indian Ocean during the current expedition. At Delhi, the discussions were held under five separate groups covering the various aspects of the Geology and Geophysics of the Indian Ocean in general.

Dr. D.N. Wadia initiating the discussions gave a brief outline of the major geological problems concerning the Indian Ocean. He said the International Indian Ocean Expedition was the first world-wide international co-operation in the field of science directed towards a single objective namely that of understanding the broad bathy-orographical

features of the Indian Ocean which had hitherto remained so little known. Dr. Wadia emphasised the interesting features of the Indian Ocean which makes it unique among the world oceans. The geological view point with regard to the presence of large continental barrier in the north and its impact on the submarine topography of this sea remains yet to be determined. Indian ocean occupied the very site of the vast mesozoic continent of Gondwanaland and it held the key to the intriguing question of modern geology—the permanance and impermanance of continents and ocean basins.

He also stated that the submarine topographical features on which they were going to have discussions in detail exert potent influence in modifying the circulation and current patterns on the deep waters of the region, particularly the down-drift and upwelling currents along Malabar and Coromandal coasts. The monsoon-induced surface water movements and the deep water movements regulated by bottom topographic features, apart from influencing biological productivity in this area, also regulate what may be called the "geochemical circulation" and influence the rate of marine sedimentation. According to him the most signal contribution of the present expedition would be in shedding light on the geology of the Arabian Sea bottom between the Malabar coast and Eritrea. He hoped that the deep coring and logging might prove the western extension of the Deccan traps on the sea floor and the age, volume and character of sediments that had been accumulating in it, might furnish significant data on the intercontinental connection between these now disjointed parts of the Gondwanaland and on their separation at the end of Cretaceous. The existence of great 2000 miles long fault line from Mekran coast to Cape Comorin has much to say on the conflicting views of the fragmented Gondwana units. Also the granite built Seychelles Island, he said, posed an intriguing question to the geologists of the expedition.

Concluding his speech Dr. Wadia expressed hope that the series of discussions on geological problems would encourage future research in geology, oceanography and interdisciplinary fields of marine sciences.

DISCUSSIONS

Mary Tharp and Bruce C. Heezen presented their paper on "the physiography of the Indian Ocean Floor" in which they dealt with the major physiographic features obtained from the echograms of the various ships which have participated in the Expedition. The Mid-Indian Ocean ridge according to them is a rugged mountain range with axis offset by fractures tending north-northeast and having a left lateral fracture in the South-West. In the Arabian Sea the fractures are right lateral. The huge abyssal cones occupying the Arabian Sea and Bay of Bengal are the result of the discharge of sediments from the Indo-gangetic plain and seaward of these cones lie extensive plains. In low latitudes smooth topography is characteristic of the continental rise, abyssal cones and oceanic rises; whereas near the polar front the features are characterised by 'Swale' topography overlying the normally rugged mid-oceanic ridge which the authors consider to be the result of the higher organic productivity of the Antarctic seas.

Among the features, the micro-continents were considered as unique in the Indian Ocean where they contrast markedly with the broad rugged mid oceanic ridge.

Findings in the North-West Indian Ocean

The papers presented by A.S. Laughton and D. Mathews were based on the result of seismic, magnetic, gravity, heat flow profiles, and allied studies including under

water photography, carried out on board *HMS Owen* in the NW-Indian Ocean. A resume' of their findings are presented here in brief.

The Gulf of Aden which links the African Rift Valley with the Mid-Indian Ocean ridge has a central zone typified by deep troughs at its west end and by rough topography along the rest of its length. The rough topography zone mostly consisting of ridges and valleys runs NE-SW and is characterised by large magnetic anomalies, high heat flow and seismic activity indicating a tectonically active region. The rough topography zone is displaced by NE-SW left lateral fractures running parallel to right lateral Owen Fractures.

The pattern of fractures and geophysical evidence in the Gulf of Aden and the quantity of sediments at the northern end of Somali Basin suggest that the opening up of the Gulf of Aden is accompanied by an anticlockwise rotation of Arabia followed by a SSE movement of Arabian Sea floor and that prior to the opening of the Gulf the northern side of Socotra was adjacent to the Kuria Muria Islands off the Arabian coast.

The Carlsberg Ridge shows similarity to other mid Indian Ocean ridges. Detailed surveys in the region between 10°N, 56°30' E and Socotra show the mountains of the ridge are large and substantially less magnetic and believed to be of continental character. Concerted efforts on certain area like 3°N 60°E have revealed small steep sea mounts notably elongated parallel to the Carlsberg Ridge. The under water photography have revealed the exposed rocks to be thickly coated with manganese and the dredged samples contained manganese nodules and slabs with cores of argillised basaltic rocks. In the area near 5°N 62°E. the median valley was found to be sinuous and partially blocked, but its course is clearly shown by the associated negative magnetic anomaly and negative free-air gravity anomaly. In the same area of survey the valley is interrupted by a minor right lateral tear fault with a throw of 10 miles. Dredged rocks included fresh basalt pillow lavas, dynamically metamorphosed gabros, spilites and hydrothermally altered basalt breccias.

The Carslberg Ridge is believed to be displaced from its original position E of Gulf of Aden by Owen Fracture zone which crosses it near 10°N and 56°30'E. The soundings have shown that the Owen Fracture zone to extend 1800 miles from the continental shelf off Karachi to a point near 5°N 53°E off the Somali coast. The Fracture zone is found to be non-magnetic and aseismic except near its northern end and where it crosses and displaces the Carslberg ridge. At the site of the crossing, the Fracture zone separates magnetic volcanic seamounts SE of the fault, from non-magnetic continental sea-mounts NW of the fault and the Fracture zone is developed as a narrow valley which becomes farther towards the NNE a shallow trough. South of the Carslberg Ridge the Fracture zone appears as a single symmetrical ridge in a section opposite the Gulf of Aden and is marked by two or three parallel ridges and here it truncates a belt of rough topography of the central zone of Gulf of Aden. If this belt is correctly identified as the continuation of Carlsberg Ridge, then the displacement of the fault is for 200 miles right lateral. At its northern end, the zone bifurcates and one branch of which is the well known Murray ridge.

A.K. Snelgrove of USA extrapolated the 600 fathom NNE tending scarp formed as a result of 200 miles right handed dislocation of Carlsberg Ridge into the 500 fathom swatch off the Indus delta and into a 300 ft gap below sea level in the alluvium covered Shahpur ridge 700 miles up the Indo-gangetic Plain. For confirmation of con-

tinuity, additional geophysical work and drilling in the Indo-gangetic plain and more data from the IIOE especially on the basement topography around the swatch are needed.

Work in the Seychelles region by RRS Discovery and HMS Owen

In the survey between Lamu (Kenya) and Seychelles by *Owen* and *Discovery* while the seismic results have indicated moho layer at only a depth of 2 km below the sea floor, the gravity profile indicated a greater depth.

The large magnetic anomaly mapped at sea around Seychelles Island have possibly been related to the Syenite ring complex and other dolerite tertiary intrusions. The anomalies have been found not to extend as far as the edge of the Seychelles bank. The extremely steep slopes of the eastern and northern margins of the bank suggests that the continental fragment is bounded by faults. Between the bank and Carlsberg Ridge the crust has typically oceanic structure and magnetic anomalies there trend NW-SE; parallel to the axis of the ridge. The west of the bank are the Amirantes atolls where only coral rocks are exposed. Towed magnetometer profiles across rocks are relatively thin about 1000m overlying volcanic foundations. Immediately west of Amirantes is an arc shaped trench associated with a negative gravity anomaly which extends between 4°S, 53°30'E to 9°S 54°E.

Marine sediments and bottom communities of the Seychelles.

The shoal-water area less than 80 metre of the Seychelles bank covering about 31,000 sq. km are floored by relatively thin detrital carbonate sediments. Around the granite and coral islands of Seychelles, and on the bank of several submarine and sub-areal platforms which can be correlated with the late post-glacial sea level, the same sediments occur. On the bank of Mahe Island different sedimentary facies have been recognised, based upon the proportions or various organic constituents, differences in grain-size and the presence of quartz. Syngenetic pyrite and collophane occur as minor constituents locally. Except for the shallow platforms a fairly uniform bottom community exists, the main elements being mollusca, and foraminifera. The coral reefs around Mahe Island may be considered as large intertidal pools with many micro- environment and a complex zonation of communities with rapid lateral changes in community composition. The sedimentary facies of the reef can be related to the distribution of bottom communities.

Pioneer's work in and around Andaman and Nicobar Island

The results of the Geological and Geophysical investigations of *Pioneer* (US) were presented in a series of papers by R. E. Burns, G. Peter, L. A. Weeks, and George H. Keller.

Gravity and magnetic anomalies as well as bottom topography indicate the existence of a volcanic arc inside the outer sedimentary arc. This arc was defined by nine crossings of the trend and is continuous between the Burma's Irrawaddy delta and Barisan volcanic range in Sumatra. Additional topography and geophysical trends are indicated parallel to the island arc and the tectonic trends of Thai-Malai Peninsula. Sea bottom heat flow measurements made essentially along the volcanic arc indicate large variability but do not appear to reflect areas of recent vulcanism.

The sub-bottom profile survey showed faulting, folding, sedimentary fill in small basins, unconformities, recent consolidated sediments over more consolidated sediments, buried features in no way reflected by bottom topography, overlap of sediments into

vulcanic arcs, lips, wedge-outs, buried channels etc., in the section made at right angle to the predominently N-S tectonic leviation of the island arc system.

A north-west current essentially tidal prevails throughout the year and is found largely responsible for the hydrographic condition in the Malacca Straits. Surface salinities and temperatures appear to be controlled by the current pattern and are generally lower than in the surrounding seas. A wedge of cold high salinity bottom water extends from Andaman sea into the Malacca Straits. Bottom sediments primarily consists of muddy sands with large areas of mud occurring in the vicinity of debouching rivers and in the Andaman sea basin. Calcium carbonates primarily in the form of mollusc shells and foraminiferal tests and organic carboon occur in minor amounts in the straits. Higher concentration of calcium are generally associated with the fine sediments of the Andaman sea while the concentration of organic carbon are found in the vicinity of debouching rivers. The non-calcareous detrital fraction is composed mainly of light minerals dominated by quartz orthoclase and plagioclase feldspars. The heavy mineral suit is complex with leucoxene, ilmenite, magnetite. biotite and amphiboles predominating in the strait.

Submarine valleys and canyons in the Bay of Bengal

The paper entitled "The Ganges and Ceylonese Canyons in the Bay of Bengal" presented by Stewart, Dietz and Shepard was based on the work done by *Pioneer* in the Bay of Bengal in 1964. The Survey has shown a sloping floor of the Ganges submarine canyon, can be traced down the gentle continental slope of the Bay of Bengal. Similar to fan valleys they develop natural levees on both sides while on one side the valley has terrace, on the other side it is steep. This fan valley bifurcates at axial depth of about 900 fathoms and in some cases the branches join farther down slope much like a braided river valley. The pattern of valleys become more complex about 200 miles from the coast but lines across the Bay of Bengal down to 8°N show widely spaced channels from a few fathoms to as much as 40 fathoms below bordering natural levees. The cores from the axis of the valley from the Shelf are predominently silt and clay with some sand.

Off the east coast of Ceylon a continental slope of greater than 45° was discovered. This is believed to be the steepest continental slope known ever. It is incised by several very large submarine canyons. The canyon entering Trincomalee Bay was traced sea ward as a gorge to depths of 10,000 ft. and at 11,000 ft. has a fan-valley continuation with natural levees. Farther south, three canyons all off major rivers, have walls a mile or more in height. A core obtained at 8000 ft. in one canyon showed fine silt underlain by clean sand with angular gravel and shell fragments. Sub-bottom profiler records indicate that there may be sedimentary beds along a portion of the Trincomalee canyon which dip towards from both sides.

Work on Board Vityaz

Three papers presented by Russian scientists were mainly based on the work done on board R. V. *Vityaz* (1959-62). "The results of the seismic measurements of the earth's crust and thickness of the sediments in the Indian Ocean" were presented by Neprochnov, Covylin and Mikhno. The Arabian Sea, the Bay of Bengal, the Andaman Sea, the Java Trench, the slopes of the Central Indian ridge and the Arabian-Indian ridge and some regions of the Indian-Australian Basin were studied by using seismic reflection method. Studies reveal that the thickness of sediments above basin reflection boundary, which is supposed to correspond to the roof of the crustal rocks is 1-2.5 km in the Arabian Basin, 2-3 km

in the Bay of Bengal and 1.5 km in the Andaman sea, whereas this increases along the axis of Java trench from 1 km near the Zond Strait to 2.5 km to the north-west. The layer of unconsolidated sediments were found revealed nearly in all stations in the ocean basin, and slopes of ridges. The thickness of this layer is 0-400 m. Also the seismic reflection data revealed that the thickness of the earth's crust on the western part of the Indian-Australian basin is 7 km. Here the earth's crust was found to consist of two layers: sediments and basaltic, that is characterised by P-wave velocity 6.4 km/sec.

Bezrukov's paper on the "Sedimentation in the Central and Northern part of the Indian Ocean" was the result of analysis of 270 grab samples and 256 cores collected from the said area including the Arabian sea, the Bay of Bengal and the Andaman sea. Based on their genetic composition it is possible to distinguish the sediments into I Terrigenous, II Volcanogenous, III Organogenous, IV Polygenous and V Chemogenous. More fractional types of sediments are present in each group by their granulomeric composition. Numerous outcrops of hard rocks moinly basalts were found on the ocean bottom and serpentinities were found on the surface of the Arabian-Indian ridge.

Deep sea sedimentation in the Indian Ocean is connected with climatic circum-continental and vertical zonality i.e. it depends on latitude of place, on depth of the ocean and on the distance from land. Combination of these three types of zonality determine the complication and irregularity and distribution of the deep sea sediments especially at the parts of the ocean with uneven topography.

In the central part of the ocean the more sharp changes of sediment composition are connected with vertical zonality at depths of about 4,700 m. where calcareous sediments are replaced by non-calcareous ones. The manganese nodules are widely distributed in the regions with uneven topography and found absent on the abyssal plains. The study of the sediment cores according to Bezrukov indicates the repeated changes in the condition of sedimentation during the quarternary period.

Geomorphology of the North-Eastern Indian Ocean

A paper entitled the "Bottom Geomorphology of the North-Eastern Indian Ocean" was presented by V.F. Kanaev (USSR). The result of the research work carried out by *Vityaz Diamantina, Argo* and others have been discussed in this paper, and the author has proved, the existence of a large meridional ridge (East Indian Ocean Ridge) stretching 4,750 km along 90° E from the Gulf of Bengal upto 34° S. The ridge is 1000-3500 m. high and 90 miles wide, the crest of the ridge is at a depth of 2000-2500 m.

In the south the ridge nearly reaches the Mid-Indian Ocean Ridge, but probably is not connected with the latter. Approximately, along 30°S there is another ridge, the eastern limit of which is at 103° E while the western end of it almost merges with the 'East Indian Ocean Ridge'. Between the Christmas Island and Cocos Island there is a chain of large submarine mountains. In the place where the bank of Mary Augustin is charted depths of more than 5,500 m. were determined by *Vityaz* and not far from there two mountains at the depth of 2,474 m. were sounded. A series of small trenches were also discovered on the ocean floor: the Chagos Trench (maximum depth 5,400 m) at the eastern root of islands of the same name, the Ob trench (5,761 m) along the southern foot of the longitudinal Indian Ocean ridge and the Diamantina Trench (6,857) south-east of Ob Trench. All the trenches have a flat bottom up to 10 miles wide and steep slopes up to 20°. Along the margins of the trenches there are banks 200-1000 m. high and mountains about 4,000 m. high.

In the north-eastern Indian Ocean five basins are distinguished: the Central basin with the Bay of Bengal, the Cocos Basin, the West Australian Basin, the North Australian Basin and the South-west Australian Basin. Near the shores of Asia and Australia abyssal plains are developed on the basins bottom and in the central part of the ocean there is a hill-mountain topography intensively rugged. The planation of the basins bottom is due to the abundant supply of sedimentary material from continents and its displacement along the bottom. This is particularly demonstrated by a great amount of submarine valley with channel banks on the plains of the Central and Cocos Basins.

Meteor's Marine Geological Programme

Dr. Seibold indicated in his paper the proposed plans for German marine geological investigation on board *R. V. Meteor*. He highlighted the use of highly specialised gear the "push-box sampler" on board *Meteor*, in addition to the customary geological and geophysical methods. The push-box sampler which permit the taking of larger well oriented sediment samples is antimagnetically finished in the upper portion so that their orientation can be recorded three dimensionally with a photographically registering compass-instrument. He also described an instrument used on board to squeeze the interstitial water of bottom sediments by the application of graded pressures.

VISITORS

During the period January–February, 1965 a good number of Scientists from various countries visited Indian Ocean Biological Centre and other centres at Ernakulam. Among the scientists arrived at Cochin for participating in the symposium on Crustacea held under the sponsorship of the Marine Biological Association, of India on 12-13 January, 1965, the following visited Indian Ocean Biological Centre and spent some time for discussions with staff and to acquaint themselves with the handling of international collections at the centre:

1. Dr. R. Turner, Harvard University, U.S.A.
2. Dr. R. Serene, National Museum, Singapore.
3. D. J. N. Wickstead, The Laboratory Plymouth, U.K.
4. Dr. W. Noodt, University of Kiel, Germany.
5. Dr. L. R. Fisher, N.I.R.D. Shinfield, U.K.
6. Dr. A. H. Rice, Unilever Research Laboratory, Scotland.
7. Dr. H. G. Stubbings, Admirality Materials Laboratory, Poole, U.K.
8. Dr. L. H. N. Cooper, Marine Biological Laboratory, Plymouth, U.K.
9. Prof. D. G. Frey, Indiana University.
10. Dr. Jocelyn Crane, West Indies.
11. Dr. D. S. Johnson, University of Singapore.

In connection with *R.V. Meteor's* visit to Cochin port on 10.2.65 Dr. and Mrs. Siebold, University of Kiel arrived at Cochin on 19.1.65 and Dr. Kinzer, University of Hamburg arrived on 27.1.65. Among the Scientists from *Meteor* visited Indian Ocean Biological Centre were:

1. Prof. Dietrich, Institut fur Meereskunde Kiel, Germany.
2. Dr. W. Nelle, ,,
3. Dr. Rolf Boje, ,,
4. Dr. Lenz, ,,
5. Dr. Hohendorf, ,,

Besides, Dr. Bogdanov and Dr. Y. Zamensky of All Union Research Institute of Fishery and Oceanography, Moscow visited Indian Ocean Biological Centre on 20.2.65. Dr. (Mrs) Helene Tambs-Liche of the University of Bergen, Norway visited the centres on 26.2.65. A party of 25 trainees from C.I.F.R. Institute, Barrackpore lead by Mr. S. P. Basu visited the cehtre on 27th February, 1965.

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Vol. 16 No. 4 November, 1964.

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I, N. K. Panikkar, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Date

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Name of the Publisher

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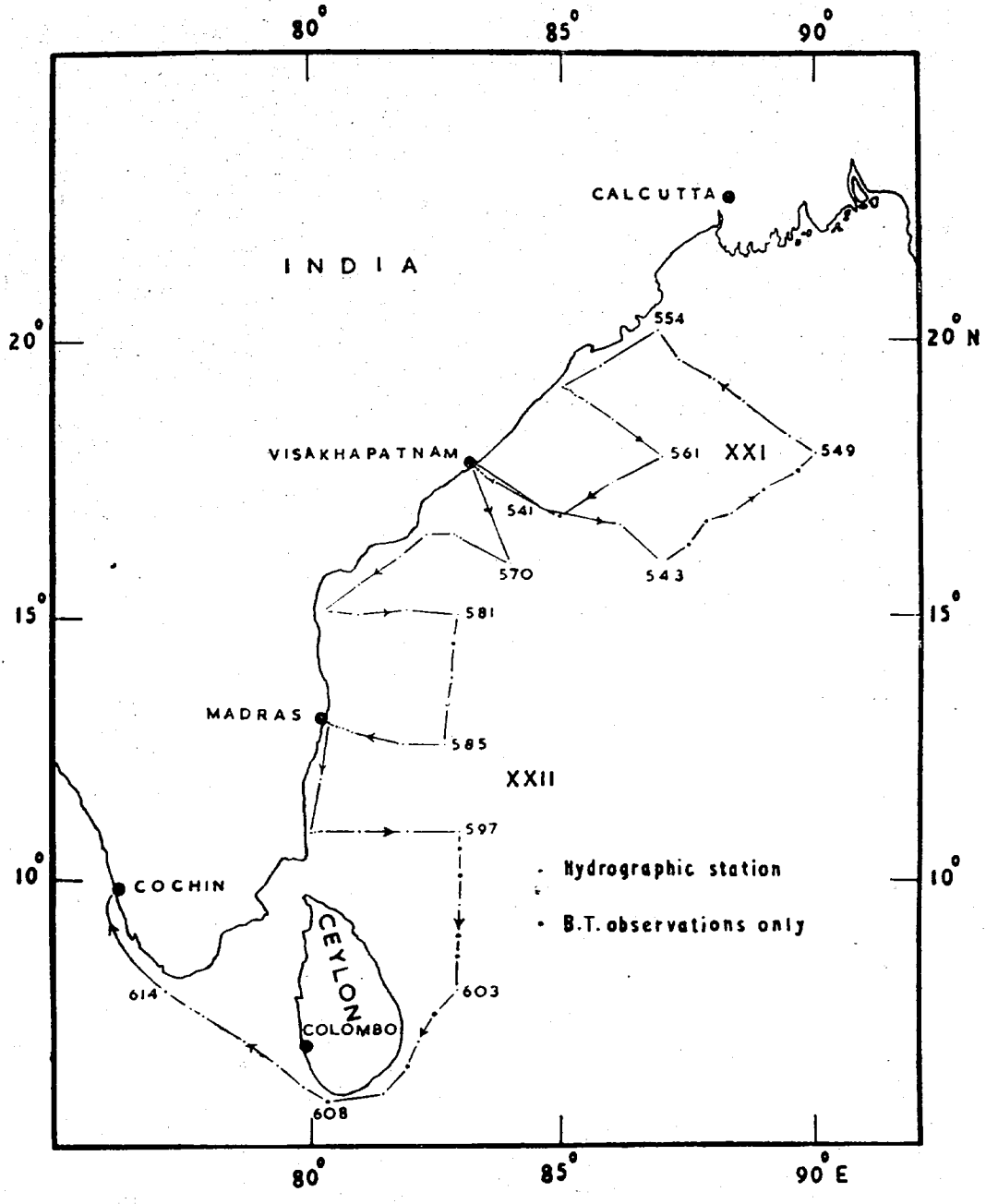

XXI & XXII Cruises of INS Kistna (Jan.-Feb.1965), track with station positions