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VITIAZ EXPEDITION TO THE INDIAN OCEAN*

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'Forasmuch as the main ocean is the Lord's alone, and by nature left free for all men to deal withal, as very sufficient for all men's use, and large enough for all men's industry.'

—DRAKE'S VOYAGE.

THE Indian Ocean covering an area of about 28,000,000 square miles constitutes more than 14% of the earth's surface. Except for the general features of its bottom topography, circulation, water masses and the distribution of its biota, little is known. More than half of this region has had no biological sampling and even in the areas sampled data are only on 1 to 4 observations per 100,000 square miles. As part of the IGY programme to explore the Indian Ocean, the Soviet Union agreed to send an expedition and on October 6, 1959, the Flagship of the Soviet Scientific Research Fleet *Vitiaz* left Vladivostock on her 31st cruise since commissioning as a research vessel and her first to the Indian Ocean.

Before World War II, *Vitiaz* was a German cargo-cum-passenger liner. After the Soviet Union acquired the ship she was transferred to the Institute of Oceanology, U.S.S.R. Academy of Sciences, for its use as a research vessel and in 1949 remodelling was completed. This is the world's largest research vessel and is well equipped for carrying out investigations on all aspects of oceanography. *Vitiaz* is a 5,700-ton diesel vessel with a maximum speed of 14 knots and a cruising range of 18,500 miles. She can accommodate 70 scientists, has a crew of 66 and can carry provisions, fresh water, etc., sufficient for her full complement of 136 persons for 120 days. There are 14 laboratories, viz., hydrology, hydrochemistry, biochemistry, geology, geochemistry, plankton, ichthyology, benthos, isotope, physics, acoustics, electroc-mechanical, marine technical and meteorology laboratories. In addition there is a library, a photographic dark-room and adequate space for storage of scientific equipments and materials collected during the expeditions. Further

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details regarding the ship and her equipments are available in the account of *Vitiaz* by Sysoev (1959).

The aims of the expedition were the study of circulation and distribution of currents ; characteristics of zones of fronts ; temperature balance between water layers and atmosphere ; carbon dioxide in ocean and atmosphere and monitoring changes ; optical properties of sea water ; relief and sedimentation ; suspended particles, cosmic dust, etc. ; chemical processes in the sea ; distribution of fish, plankton and benthos ; primary production ; complex and characteristics of geographical zones of the ocean ; natural radioactivity of sea water, animals and sediments ; development of instruments and methods for studying oceans ; and contact with foreign scientists and organizations.

Invitations were sent to countries bordering the Indian Ocean to participate in the expedition. Government of India accordingly deputed 3 scientists who participated in the cruise to the western half beginning with Cochin.

Figure 1 shows the route of *Vitiaz* with the location of stations. It will be noticed that a vast area was covered and a total of 221 stations were worked up to the time the ship called at Bombay. After a few days' stay at Bombay *Vitiaz* proceeded to Odessa and on her way back to Vladivostock sometime during September-October this year she is scheduled to work in the Arabian Sea and Bay of Bengal thereby covering practically the entire Indian Ocean. Several expeditions have earlier worked in the Indian Ocean but *Vitiaz* has carried out by far the most extensive and intensive work in this area. Plates I and II show the expedition ship *Vitiaz*, some of her equipments and the benthos laboratory.

The following account of the activities of the expedition is based on the experience of the author during the cruise between Cochin and Bombay when data were collected from 97 stations. Throughout the cruise continuous measurements of depth were made to study the bottom contour and at all stations hydrological observations formed an essential part. The time spent at each station varied from 23 minutes to about 32 hours. The programme of work also varied from station to station but at all stations work began with the measurnment of temperature gradient using a bathythermosound. The instrument can be operated up to 200 meters and is considered to be more sensitive than a bathythermograph. The temperature is recorded in the laboratory on board on suitably graduated paper. In general, the work at ' standard stations ' included temperature measurements and collection of water samples from standard depths for chemical, hydrological and geological analyses ; collection of water samples in special plastic bottles from selected depths for the study of optical properties and phytoplankton and measurements of currents from the fore and aft of the ship with the aid of Alexeev current meters. A single vertical haul from the bottom to the surface was taken with a ring trawl for collecting fish eggs, larvae, etc. Sometimes the ichthyo-plankton net also was employed for this purpose. For general plankton studies stratified vertical hauls usually from 300-200, 200-100, 100-50, 50-25, and 25-0 metres were taken with the aid of Juday type closing net. From 100-0 metres two samples with the same net were taken for the study of the chemical composition, total biomass, oil content of plankton, etc. Plankton collecting devices on board included the ' plankton catcher ' designed by Prof. B. G. Bogorov of the Institute of Oceanology. It filters 20 litres of water and is especially useful for the study of vertical distribution of plankton in relation to thermocline and also for collecting quantitative plankton samples from small boats.

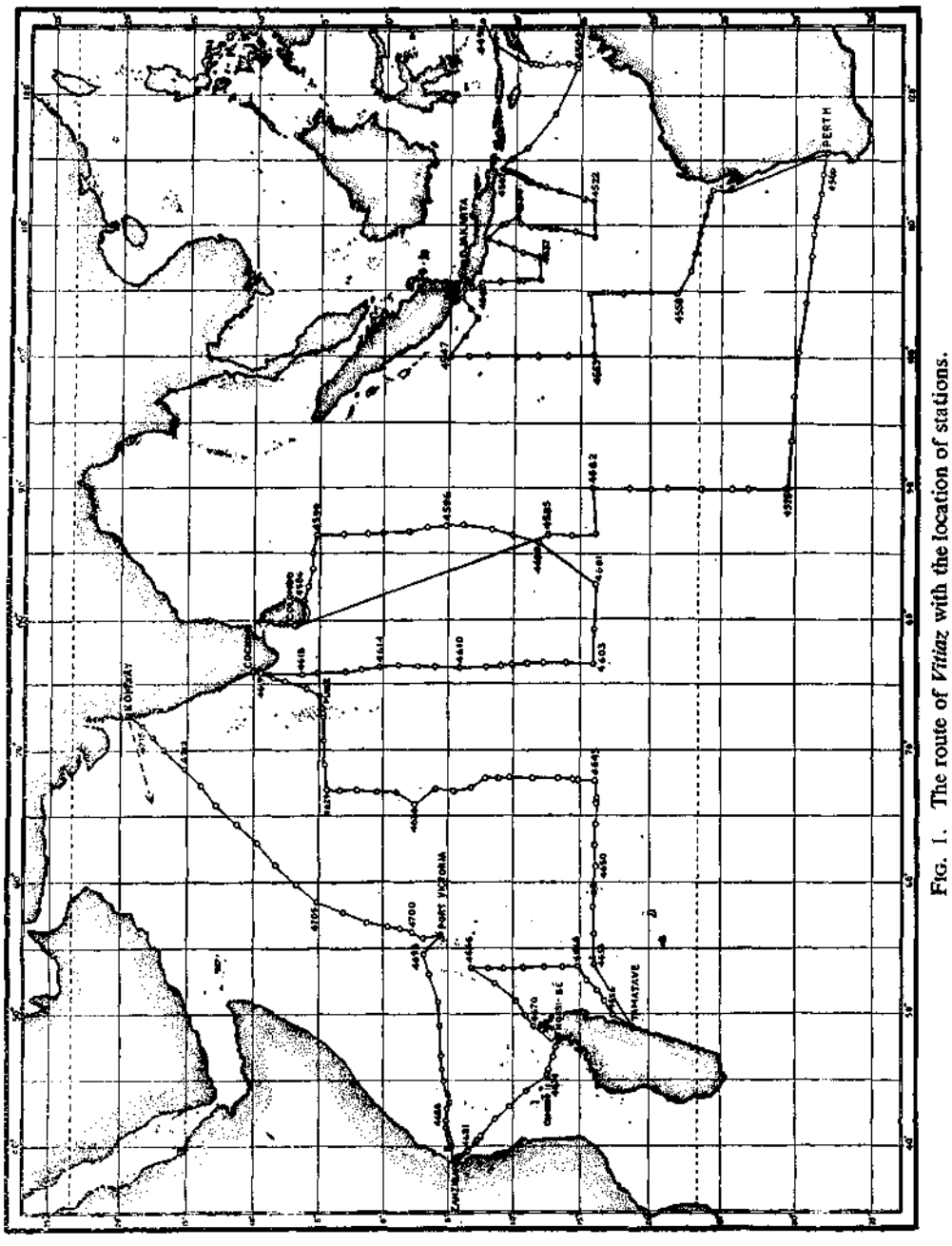


FIG. 1. The route of *Vitiaz* with the location of stations.

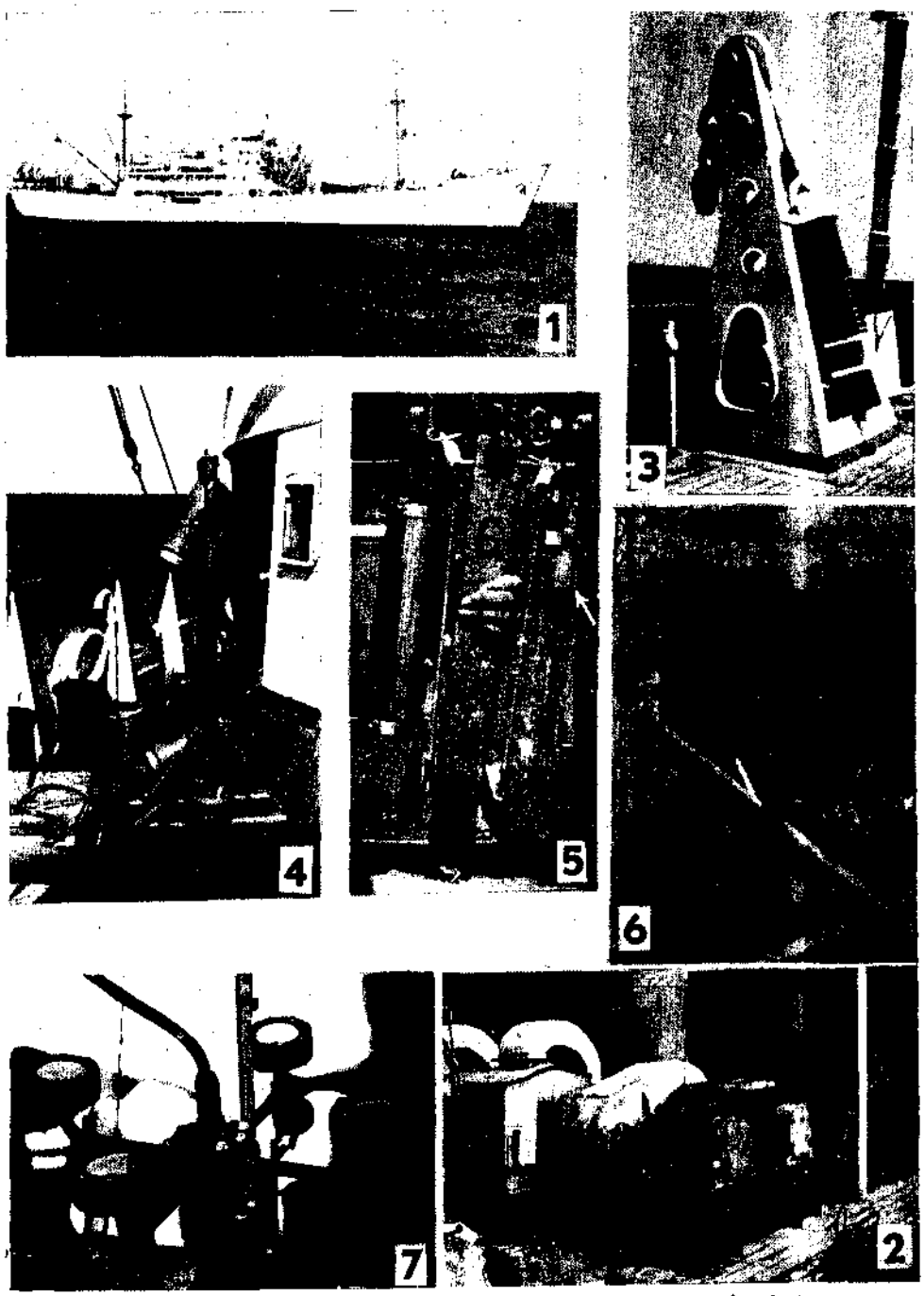
Besides, collection of bathypelagic animals, benthos, sediments and measurement of organic production were conducted at many stations. The bottom fauna were generally collected with a grab. *Galathea* and Sigbee trawl, with devices for measuring the distance trawled, were also employed for the purpose. An ordinary otter trawl was used but only on two occasions. The Isaacs-Kidd mid-water trawl with an acoustical device for recording the depth at which trawling was done, and a big conical net were occasionally used for collecting the larger bathypelagic organisms. Core sampling with the aid of gravity or piston corers was carried out at several stations and in addition seismo-acoustical methods were employed at a series of stations off the coast of Zanzibar to study the sediments. Measurements of organic production by the use of ^{14}C were periodically done at standard depths up to 200 metres. The experiments were generally conducted on board in specially designed barrels but in order to check the values obtained from these, *in situ* measurements at different depths were made occasionally using a series of special plastic clear- and dark-bottles. These bottles are constructed in such a way that when the messenger strikes the closing device, it closes the two ends of the bottle traping a known quantity of water and the upper lids while closing release the ^{14}C kept in a small pipette on the side of each bottle. This arrangement obviates the need to bring on board water samples collected from various depths for adding ^{14}C and then lowering the bottles to the appropriate depths, and thereby eliminates the possibility of subjecting the water samples to different temperature and light conditions. The bottles were left in the sea for 6 hours and then taken on board for estimating the amount of carbon assimilated.

At a few stations photographs of the sea bottom were taken using a deep sea camera. The camera used on *Vitlaz* is designed to expose 20 frames at a time without bringing the camera on board. With its normal lens and at 45° an area of 2.5 m^2 is covered from a distance of 2 metres. When greater areas are to be photographed a wide angle lens is used.

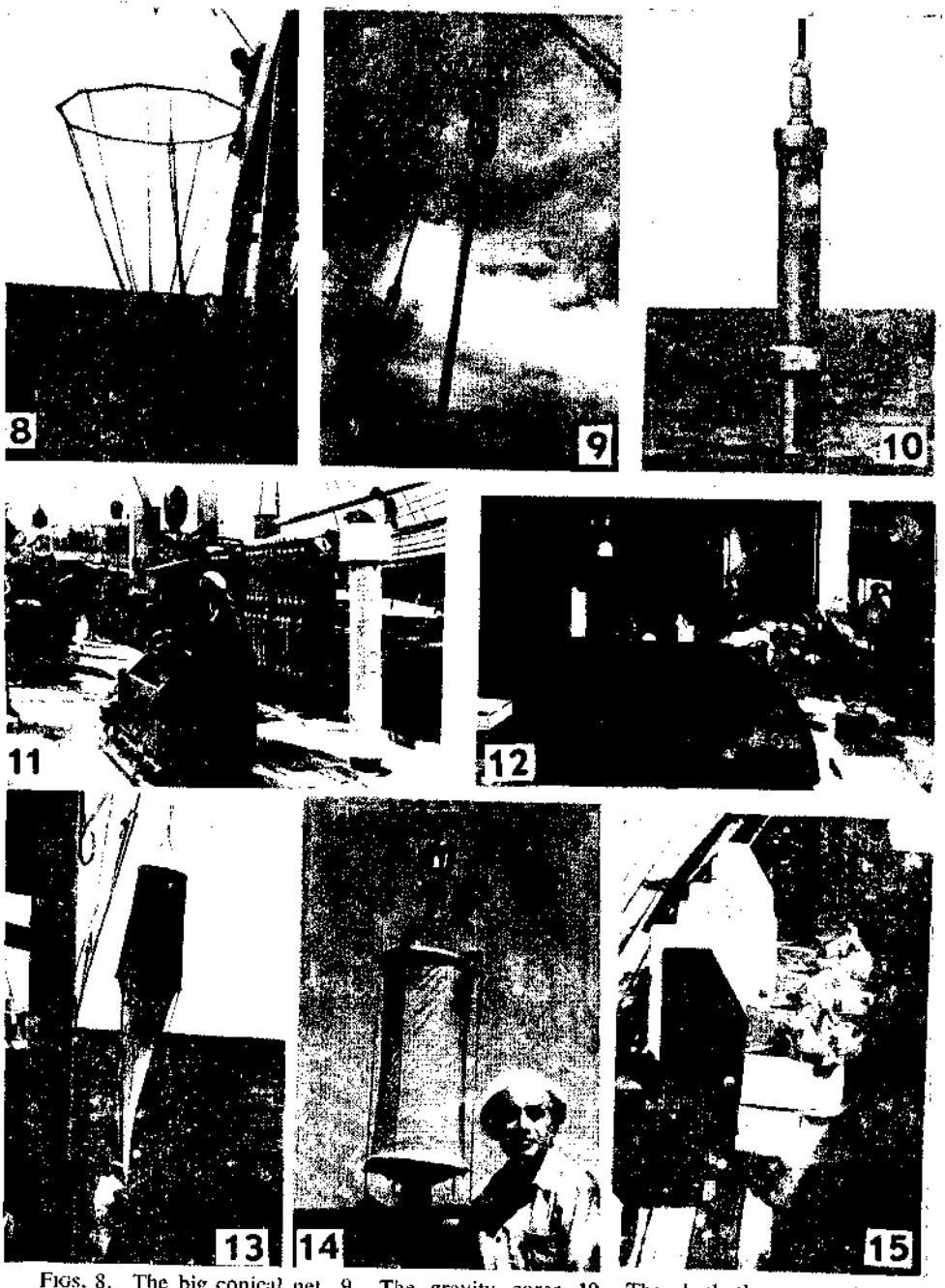
It was mentioned earlier that current measurements were made at every station but the duration of such measurement was relatively short, not exceeding 5 or 6 hours. Therefore at 6 stations continuous measurements were made for 24 hours and at one station for 12 hours. At these stations current meters were suspended at different depths up to 1,000 meters from an anchor buoy weighing about 2 tons and made out of a synthetic compound ' Penoplast '.

The meteorological division, with an up-to-date meteorological laboratory, was engaged in studying various problems in marine meteorology. Radio-sondes were used periodically to obtain temperature, pressure, humidity and wind velocity data from the upper air strata. Daily synoptic charts were also prepared and weather forecasts issued.

In the organization, co-ordination and execution there was the characteristic thoroughness and even the smallest details were given careful consideration. During expeditions of this magnitude one would expect accidents, disappointments and losses but such instances were indeed rare. Another noteworthy feature of the expedition was in the analyses and processing of data collected. It is often the experience that processing of the data and even some of the analyses will necessarily have to wait until the materials are brought back to the shore laboratories. This is because in most research vessels there will be only one or two small laboratories and provision



FIGS. 1. Soviet expedition ship *Vitiaz*, 2. The trawl winch, 3. The damping device or accumulator used with the trawl winch, 4. The deep sea camera, 5. Plastic dark- and clear-bottles used in ^{14}C experiments. The arrow shows the small pipette carrying ^{14}C, 6. The 'anchor buoy' 7. Submarine photometer.



FIGS. 8. The big conical net, 9. The gravity corer, 10. The bathythermosound, 11. Hydrographic winches and the rack with reversing water bottles, 12. The benthos laboratory, 13. The plankton net ready to go down, 14. Prof. Bogorov with the 'plankton catcher', 15. Alexeev current meters.

for the accommodation of the scientists is limited to a few. As work at sea proceeds round the clock it is difficult for these few to attend to the collection, analyses and processing of the materials collected. In *Vitiaz* most of the analyses and processing, particularly the chemical, physical and hydrological data were done on board, for she was a magnificent floating laboratory.

During the cruise from Cochin to Bombay the ship called at Male (Maldives), Tamatave and Nossi-Bé (Madagascar), Dzaoudzi (Comoro Islands), Zanzibar and Port Victoria in the Seychelles.

The results of this expedition will substantially add to our knowledge of this vast and little known area. The tropical and sub-tropical regions bordering the Indian Ocean have many of the world's densely populated countries. Population pressures on the existing food supplies result in the prevalence of protein deficiency diseases in these countries and the best way to combat these will be to expand their fisheries. India herself is vitally concerned with these problems and with her long coastline, a sea-faring tradition and rich fishery potentials, scientific knowledge of the seas around us will have direct and immediate bearing on our expanding marine fisheries. Many of us cherish the hope that before long our country too will be sending out expeditions, though not of the same magnitude as that of *Vitiaz*, to explore the waters around us and thus take her rightful place among the countries more advanced in marine biological and oceanographic research.

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