Effects of the Indian Ocean Expedition

Ernakulam, Kerala, India. The International Indian Ocean Expedition, organized in 1959, ends this year. Thirteen nations have participated in the expedition, among them India, the United States, the Soviet Union, the United Kingdom, Japan, Australia, France, the Federal Republic of Germany, and the Union of South Africa.

In setting up the program, many of the organizing scientists were deeply interested in stimulating basic studies of the ocean and atmosphere in countries surrounding the Indian Ocean in the hope of reducing the major shortages of food in those areas. They expected to gain more knowledge of the physical conditions that favor abundant sea life and to improve fishing methods. It was their hope that when the vessels of the participating nations withdrew at the end of the expedition the nascent marine research programs would be continued in India and other countries bordering on the Indian Ocean as a prelude to economic exploitation. This aspect of the program is, of course, of great interest to India.

Naturally, the expedition had purposes besides stimulation of the economies of countries around the Indian Ocean. These included (i) extension to the Indian Ocean of detailed concepts about the oceans, built up particularly in the Atlantic; (ii) extension of commercial fisheries, exploited mostly by Japan and the Soviet Union; and (iii) gathering of data relevant to operating or attacking missile-launching submarines.

Thus, in 1960, the needs of both the underdeveloped and the developed countries brought ships flocking to the Indian Ocean. Many of them engaged in studies of the distribution of zooplankton. To obtain measures of gross productivity of zooplankton the ships used a standard net to take samples over much of the ocean. They studied areas of upwelling, cold, nutrient-laden bottom water associated with persistent winds and currents off the coasts of western India, southeast Arabia, and Somalia. In some parts of the Arabian Sea concentrations of nutrients are as high as in any parts of the other oceans. Such areas of high biological productivity are favorable for fisheries, but they may also be associated with high fish mortality, for the nutrient-heavy water may be exceptionally cold, or depleted in oxygen.

All ships of the expedition are supposed to send samples of zooplankton to the Indian Ocean Biological Center (IOBC) at Ernakulam, which is staffed by Indians—three scientists and 18 technicians—and a Western curator paid by UNESCO. The samples are sorted into 65 broad categories, in preparation for more detailed study by specialists and for the making of species-distribution atlases of the Indian Ocean. The scientists and technicians at the center have sorted some 700 of the 1700 zooplankton samples they have received so far from ships of the expedition. They expect to receive about 600 more samples. (Very few have been received from vessels of the Soviet Union.) The sampling indicates that gaps in the abundance of zooplankton occur in regions southwest of Australia, south of Madagascar, between Mozambique and Madagascar, and west of the Seychelles, and in a region between 80° and 90°E and 15° and 25°S.

In other investigations American vessels found an equatorial undercurrent similar to, but weaker than, the undercurrents of the Atlantic and Pacific (*Science*, 25 January 1964). Explorations of ridges rising from the floor of the Indian Ocean, such as the Carlsberg in the Arabian Sea and the straight, 4800-kilometer ridge in the Bay of Bengal, have provided new data for speculation on continental drift.

Several Indian vessels have taken part in the expedition, most notably a 1500-ton frigate of the Indian Navy, the I.N.S. *Kistna*, and the 160-ton R.V. *Varuna*, built for the joint Indian-Norwegian project to develop prawn and other fisheries in south India.

Under the stimulus of the expedition the Indian government moved to create the zooplankton sorting center in Ernakulam. The idea for the center emerged in a conversation between N. K. Pannikar, secretary of India's national committee on oceanic research, and Roger Revelle, now head of Harvard's Center for Population Studies, at the 1959 International Oceanographic Congress. The first UNESCO curator of the center, Vagn K. Hansen, has returned to Denmark. His successor, Edward Brinton of the Scripps Institution of Oceanography, is expected to arrive shortly. The assistant curator is L. R. Kasturirangan, and the chief scientist is R. Raghu Prasad of the Central Marine Fisheries Research Institute.

Also under the stimulus of the Indian Ocean Expedition, the Indian government's Meteorological Department established, in 1962, an Institute of Tropical Meteorology in Poona, southeast of Bombay. The institute is headed by R. R. Pisharoty. The U.N. Special Fund gave over $800,000 to help establish the institute and the affiliated International Meteorological Center, housed temporarily in the meteorological observatory in Colaba, Bombay. The center will move to Poona when space is available in a building to be constructed for the parent institute.

The Meteorological Center, which has a staff of about 100, is now headed by C. R. V. Raman. C. S. Ramage, of the University of Hawaii, and other U.S. atmospheric scientists who helped set up the center have returned to the United States, but D. R. Jones, special representative of the World Meteorological Organization, and two other WMO experts are at Colaba. At the center, charts of wind direction and air pressure at many levels of the atmosphere are prepared daily, as a first step toward preparing atlases of important weather

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Institute of Tropical Meteorology at Poona, India. [Sidney O. Marcus, NODC]

patterns. Raman and D. Lal of the Tata Institute of Fundamental Research, Colaba, exchange information on circulation between the tropics and the mid-latitudes. The center has an automatic apparatus for receiving photographs direct from Tiros satellites. It also receives, daily, about 1100 surface reports, 450 upper-atmosphere reports from airplanes and balloons, and 300 reports from ships.

National Institute of Oceanography

Both the biological center at Ernakulam and the meteorological institute at Poona will become units of a National Institute of Oceanography, formation of which was approved by India's Council of Scientific and Industrial Research (CSIR) in 1964. The institute will be established in 1966 at a site yet to be chosen. The nucleus of the institute is the Directorate of Indian Ocean Studies in CSIR headquarters in New Delhi. The directorate is headed by Pannikar, who is also president of the Intergovernmental Oceanographic Commission, a body, associated with UNESCO, which coordinates international research efforts.

The new institute will not have to depend on the *Kistna* for oceanographic research. Money has been promised for construction of a 63-meter vessel which will cost something like $2 million. The vessel will not be built in an Indian yard, Pannikar says, because India lacks experience in building oceanographic vessels and because India's shipyards are booked solid with vessels of higher priority. Observers in India think the ship may be built in Japan.

Several sites are being considered for the new institute. One is Waltair on the Bay of Bengal, near the city of Vishakhapatnam. At the University of Andhra, in Waltair, the first Indian graduate program in physical oceanography was set up in 1952 under the supervision of Eugene Lafond. A student of internal waves, Lafond has worked for many years at the Naval Electronics Laboratory in San Diego. In 1963 he was scientific leader of the first cruise of the American research ship *Anton Bruun* in the Bay of Bengal. A number of his former pupils are now prominent in Indian oceanography.

Another possible site for the institute is the area of Ernakulam and Cochin, a busy port and industrial center. In addition to the marine biology sorting center, the area has a research unit of the Indian Navy, a unit of the Central Marine Fisheries Research Institute, the Central Marine Fisheries Technological Research Station (which works on boats and gear), the oceanography department of the University of Kerala, and two small units that will join the oceanographic institute. These two units are an Indian office for the International Biological Program planned for the late 1960's, and the Indian Ocean Physical Oceanography Center, headed by V. V. R. Varadachary, a former pupil of Lafond's and leader on cruises of the *Kistna*. The center was transferred from the supervision of the National Geophysical Research Institute in Hyderabad in 1964. Varadachary has been particularly interested in the monsoon-associated upwelling along both the eastern and western coasts of India. He is also studying echo-sounding data from 1964 cruises of the *Kistna* which indicate the presence of several canyons in the continental shelf off India's east coast, near Madras. The marine geologists of his ten-man group—R. R. Nair and A. V. S. Murty of the Central Marine Fisheries Research Institute—are working on studies of beach erosion at three sites in Kerala.

Not all the activities of the proposed oceanographic institute will be at one site. Presumably because of India's intense regional pressures, the institute will have strong units in several places. It will have eight divisions: physics, chemistry, biology, geology, coastal and nearshore studies, air-sea interactions, instrumentation, and data handling.

Symposium on Results of the Expedition

From 22 to 26 July a symposium was held, jointly sponsored by UNESCO and the World Meteorological Organization, on the meteorological results of the International Indian Ocean Expedition. Among the local organizers of the meeting were the Indian government's Meteorological Department and the Indian National Committee on Oceanic Research, two organizations whose research activity has expanded greatly as a result of the expedition.

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