U.S. PROGRAM IN BIOLOGY
INTERNATIONAL INDIAN OCEAN EXPEDITION

NEWS BULLETIN NO. 2
NARRATIVE REPORT. ANTON BRUUN CRUISE 1.

INTERNATIONAL INDIAN OCEAN EXPEDITION

WOODS HOLE OCEANOGRAPHIC INSTITUTION
JULY, 1963
I. Objectives and Procedures

Cruise I of RV ANTON BRUUN, the first scheduled cruise of the U. S. Program in Biology of the International Indian Ocean Expedition, was carried out in the Bay of Bengal during the period 12 March - 10 May, 1963. Chief Scientist was Dr. E. C. LaFond (U. S. Navy Electronics Laboratory). Chief Fisheries Biologist was Mr. Alonzo T. Pruter (U. S. Fish and Wildlife Service). A total of 20 Americans, 23 Indians, and two Thai scientists took part in various portions of the cruise. A list of the participants is appended.

Cruise I had two major scientific objectives: (1) study of the hydrography, chemistry, and plankton biology of the Bay of Bengal, particularly along its eastern boundaries in relation to possible upwelling areas produced by the Northeast monsoons, and (2) sampling of the benthic population on the Continental Shelf around the periphery of the Bay and, where possible, in deeper water to (a) assess the commercial fishery potential of the region, and (b) obtain biological and geological specimens for systematics and distributional studies. Work towards the second objective was curtailed midway through the cruise due to malfunction of the trawling winch.

The cruise track and tentative station positions are shown in Figure 1. The cruise itinerary and a summary of the scientific stations are shown in Tables 1 and 2. Standard stations included measurement of temperature, salinity, dissolved oxygen, phosphate, nitrite, nitrate, silicate, primary productivity, phytoplankton pigments and zooplankton tows. Methods used for physical, chemical, productivity, and pigment measurements are described in detail in a publication entitled "Instruction Manual for Routine Measurements for the U. S. Program in Biology, IIOE" prepared by David W. Menzel. This is available at the Woods Hole Oceanographic Institution.

Hydrographic casts were made with teflon-coated Nansen bottles to the bottom (in shallow water) or to 1000 m. A few deeper stations were made in the central portions of the Bay. Samples for primary productivity and phytoplankton pigments were obtained with plastic water samplers from the depths to which 100, 50, 25, 10, and 1% of the surface illumination penetrated.

Productivity measurements were made for 24 hours at natural, in situ, light intensities, using an on-deck incubator with neutral density screens to simulate the light at each depth sampled. Duplicate samples were exposed to fluorescent illumination at a constant intensity of 1000 foot candles for four hours.
Vertical net tows were made from 200 meters to the surface with an IIIOE standard net (one meter² mouth area, 0.33 mm. mesh opening). The displacement volume of each sample was measured. These samples have been deposited in the International Biological Center, Cochin, India.

Vertical plankton samples were also taken from 200 m to the surface with a 1/2 meter² mouth area, .064 mm. mesh-opening truncated net for microplankton samples. In addition, oblique plankton hauls were taken with a 1/2 m² area, 0.33 mesh opening net at all standard stations. The oblique hauls and the microplankton samples will be deposited at the U. S. National Museum Sorting Center, Washington, D.C.

Bathythermograph observations were made at each station and at intervals of one hour or less when running between stations. Bottom topography was recorded continuously with a precision echo sounder. Meteorological observations were made by Mr. C. Poornachandra Rao and reported by radio to the International Meteorological Center at Bombay.

Bottom fauna were sampled with a "Gulf of Mexico" shrimp trawl and with a biological dredge. Bottom sediment samples were taken with a mud snapper and/or a Phleger corer.

Table 1.

<table>
<thead>
<tr>
<th>Departed</th>
<th>Arrived</th>
</tr>
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<tbody>
<tr>
<td>Bombay, India - 12 March 1963</td>
<td>Phuket, Thailand - 22 March 1963</td>
</tr>
<tr>
<td>Phuket, Thailand - 23 March 1963</td>
<td>Chittagong, W. Pakistan - 3 April 1963</td>
</tr>
<tr>
<td>Chittagong, W. Pakistan - 4 April 1963</td>
<td>Visakhapatnam, India - 11 April 1963</td>
</tr>
<tr>
<td>Visakhapatnam, India - 14 April 1963</td>
<td>Visakhapatnam, India - 25 April 1963</td>
</tr>
<tr>
<td>Visakhapatnam, India - 28 April 1963</td>
<td>Madras, India - 3 May 1963</td>
</tr>
<tr>
<td>Madras, India - 4 May 1963</td>
<td>Bombay, India - 10 May 1963</td>
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</table>

Table 2.

<table>
<thead>
<tr>
<th>Cruise I Stations</th>
<th>Standard¹</th>
<th>Trawl</th>
<th>Dredge</th>
<th>Sediment²</th>
<th>Other³</th>
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<tr>
<td>Bombay - Phuket (Sta 13A-18B)</td>
<td>5</td>
<td>5</td>
<td>0</td>
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<tr>
<td>Phuket - Chittagong (Sta 19-43E)</td>
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<td>2</td>
<td>5</td>
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<td>10</td>
<td>4</td>
<td>12</td>
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<td>Visakhapatnam -Visakhapatnam (Sta 65-87)</td>
<td>23</td>
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<td>7</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Visakhapatnam - Madras (Sta 88-105)</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>2</td>
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</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>33</td>
<td>26</td>
<td>30</td>
<td>34</td>
</tr>
</tbody>
</table>

1. Includes hydrography, chemistry, productivity, plankton
2. Sampled with mud snapper or Phleger corer
3. Surface samples for chemistry productivity.
II. Pre-cruise Program

Prior to the cruise a program was conducted by Chief Scientist and Mrs. E. C. LaFond of visiting universities, institutions, and laboratories concerned with, or teaching marine science. At these activities the nature of the U. S. Program in Biology of the International Indian Ocean Expedition was explained, and leading Indian scientists were interviewed as possible candidates for the BRUIZ cruises. In addition, Indian oceanographers were oriented on new research being conducted throughout the world. Concurrently a U. S. liaison office in Bombay was established to function as an aid to U. S. scientists in India who might require supplies, and also to assist in solving other problems that arise. Lectures were given on oceanographic subjects at the following places:

Bombay Academy of Science, Bombay
Taraporevola Marine Biological Research Station, Bombay
Osmania University, Hyderabad
Andhra University, Waltair
Navy Physical Laboratory, Cochin
Oceanographic Research Wing of National Geophysical Research Institute, Cochin
Maharaja's College, Ernakulam
Kerala University, Trivandrum
Central Marine Fisheries Research Institute, Mandapam
Annamalai University, Chidabaram
Madras University, Madras
Maharaja Sayajirao University, Baroda
Gujarat University, Ahmedabad
Physical Research Laboratory of India, Ahmedabad
Delhi University, New Delhi

III. Preliminary Results

General

The amount of data collected in each type of investigation was enormous and detailed analysis will be required to draw conclusions from the interrelated and complex findings. However, some of the preliminary results were reported at the All-India Seminar on Marine Sciences, which was held at Andhra University, Waltair, India, on 26 - 27 April 1963. This symposium was sponsored jointly by Andhra University; the Indian National Committee on Oceanic Research; the U. S. Program in
Biology, International Indian Ocean Expedition; and the United States Information Service. Some of the tentative results are as follows:

**Meteorology**

The Bay of Bengal is dominated during half of the year by the southwest monsoon winds and during the other half by the northeast monsoon winds. The latter develop as the result of a high-pressure area over the cold Tibetan Plateau in south China.

The winter of 1962-63 was more severe than normal; the snow is believed to have piled up more on the high Tibetan Plateau, and persisted longer into the spring, than on previous years, for when the ANTON BRUUN was moving through the Andaman Sea in late March the winds were still from the northeast. However, as the cruise progressed, the winds slackened, and by the latter part of April and early May the southwest monsoon was well developed along the east coast of India.

**Physical Oceanography**

**Upwelling --**

As a result of the northeast winds the surface water in late March had been displaced offshore along the lee coasts of Thailand and Burma, and the subsurface water had upwelled. This was evident by a gradual tilting of the upper isotherms toward shore on the eastern side of the Andaman Sea. Here the deeper isotherms displaced downward, which implied an accumulation of intermediate-depth water near the coast. This is a characteristic upwelling pattern.

Northward along the Burma coast the isotherms were tilted even more shoreward and showed additional coastal upwelling. The strong tilting of the isotherms resulted from the effects of both the monsoon winds and the horizontal circulation. In late April the southwest winds had developed a strong upward displacement of isotherms off the east coast of India.

**Surface Currents --** (see Figure 2)

The direction of the horizontal currents in the Andaman Sea was northwestward through the Strait of Malacca and southwestward in the northern part of the Andaman Sea. Both currents turn to the west when they meet, and this results in a slow vertical motion in the eastern part of the Andaman Sea. These circulations also influence the vertical thermal structure.

Off the northern Burma coast in early May the flow was southerly down the coast. Since, the ship was later set northward, all along the east coast of India from the Hoogly Delta to Madras and the isotherms tilted upward, it is fairly certain that a clockwise surface circulation in the entire Bay of Bengal existed at that time.
Eddy --

Off the Andhra coast and the Hoogly River the isotherms in the thermocline were tilted upward toward shore, which implied upwelling and a northerly flow. However, the isotherms in the thermocline reached a maximum depth about 100 miles offshore. They then rose to a crest at about 200 miles off the coast. This structure appeared to form a thermal dome, which might mean that a large, clockwise eddy occurs in the region. This feature will require dynamic computations for confirmation.

Another explanation of the dome is that it may be the result of major internal waves, since large thermal oscillations were found in the southern part of the Bay of Bengal. The thermocline between Ceylon and the Nicobar Islands contained vertical displacements of as much as 50 meters and with wave lengths of about 250 miles.

Turbulence --

Around the Nicobar and Andaman Islands the thermal structure was variable and patchy, a condition that may be due to large-scale turbulence caused by islands.

In the central Andaman Sea several rip tides were observed. These appeared as long lines of rough turbulent water that passed the ship, at speeds of about one knot, when it was halted on stations. These phenomena are believed to be instrumental in mixing the water column and aiding the vertical displacement of nutrients.

Primary Production and Plankton

The primary organic production which closely followed the pattern of upwelling, was highest near the Thai and Burma coasts and around the Andaman Islands. The central part of the Bay of Bengal showed extremely low production. In the latter part of April, the southwest winds off the east coast of India started to blow and created a high primary-production zone near shore that corresponded with the recent upwelling. However, the principal area of primary production was on the far eastern side of the Bay of Bengal and Andaman Sea.

The secondary production in the sea closely followed the primary production, with high concentrations of zooplankton found near the Thai and Burmese coasts. In the later observational period on the other side of the Bay of Bengal, the high zone appeared to extend all the way around the head of the Bay and partly down the coast of India. The central Bay ranks very low in production of the larger planktonic organisms, however a strong echo was received from the deep scattering layer present throughout the Bay.
A "Gulf of Mexico" shrimp trawl was used to survey fish and shellfish resources from the R/V ANTON BRUUN. The trawl net is constructed of nylon webbing and is approximately 42 feet wide and 40 feet long. Horizontal spreading of the net is achieved by attaching an otter board to each wing. A bridle connects the otter boards to the main towing cable.

Trawling was hindered by mechanical problems on Cruise 1, chiefly difficulty in attaining an even lay of cable on the trawl winch. This situation became progressively worse until the winch was finally judged unsafe for further trawling on April 7.

Between March 20 and April 7, thirty-one trawl hauls were made as follows: one in 280 fathoms and one in 1000 fathoms of water between the Nicobar Islands and the coast of Thailand; three on the continental shelf off Thailand; twenty on the continental shelf, one in 200 fathoms and one in 1000 fathoms off Burma; and four near Port Blair in the Andaman Islands. Five of the hauls resulted in loss of or extensive damage to nets.

The continental shelf generally was favorable for trawling, although outcroppings of coral were encountered in several regions. The precipitous nature of the continental slope at depths from 100 fathoms to about 400 or 500 fathoms usually prevented trawling. The bottom generally consisted of mud and was fairly level at depths greater than 500 fathoms.

None of the hauls yielded fish or shrimp in "commercial quantities". Catches of fish ranged from 4 pounds to 321 pounds per hour of trawling, and shrimp catches ranged from zero to 56 pounds per hour of trawling. The overall average catch of fish and invertebrates amounted to less than 100 pounds per hour of trawling.

The shrimp—mainly Penaeidae and Caridea—generally were small, ranging from 100 to 300 heads-on count per pound. However, a few Penaeid shrimp weighing as much as one-half pound apiece were caught. Shrimp appeared to have a wide bathymetric range with as large catches being taken at depths from 150 to 200 fathoms as were taken in shallower water of less than 30 fathoms.

Although the fish catches were small, they consisted of a great number of species. Best catches were made at depths from about 8 to 30 fathoms. Most of the fish were preserved for shipment to the National Sorting Center. Fishes commonly caught included lizard fish (Synodontidae), goatfish (Mullidae), catfish (Tachysuridae), queenfish (Carangidae), flute mouths (Fistularidae),
slimys (Leiognathidae), threadfins (Polynemidae), silver biddies (Gerridae) and flatfish (Pleuronectidae, Bothidae, Cynoglossidae, Soleidae and Psittodidae). The largest fishes taken were a 225-pound shovel nose shark and a 200-pound ray.

Much of the bottom trawled appeared relatively barren of life. Many shells of mollusks and other invertebrates were brought up in the trawl; but almost all of them were empty. Very few sea stars were encountered and hand lining yielded no fish.

Bottom Topography

Bottom samples were acquired at most of the shallow stations. Although the primary purpose in collecting them was to obtain ostracods, there were usually enough samples to provide aliquot parts to the Geology Departments of the University of Southern California and Andhra University, Waltair, India. In addition, a water depth profile, made by means of a recording echo sounder, revealed for the first time the roughness of the sea floor in many newly explored areas. Of geological significance was a detailed profile, obtained across the Waltair coast, which showed a hard crown on the outer shelf. One speculation was that this is an old coral reef barrier, which would indicate warmer water in the past.

The most interesting discovery was the existence of sharp depressions—undoubtedly submarine canyons—in the continental slope. (Figure 3). One canyon was located off the Burma Coast at 19° 27' N and 92° 32' E. However, off the Andhra Coast several canyons were found. One was running directly west from Waltair and two others were just northerly along the continental slope. Another two were crossed close to their head just south of the canyon near Waltair, and the sounding disclosed relatively steep sides and a rounded bottom. It was proposed that this submarine canyon, which is near the University, be named Andhra Canyon, for it was at Andhra University that modern oceanography in India was initiated.

The next submarine canyon toward the north was V-shaped at the crossing, with a small accumulation of sediment that gives it a flat bottom 400 meters wide. The crossing was made where the canyon depth was 1400 meters, at an angle of only 5 degrees with the edge of the continental shelf, and its steepest slopes were about 1 to 5. This geological feature will probably be identified as Mahadevan Canyon, after Professor C. Mahadevan, the internationally acclaimed geologist of India, who was the father of marine geology and oceanography in India.
The last V-shaped canyon northward, 1190 meters deep at the crossing, will be called Krishna Canyon after Vice Chancellor Krishna, noted for providing facilities and inspiration to Indian marine science.

IV. Biological Collections

In addition to the plankton samples referred to above, fishes and invertebrates were collected at every opportunity for systematic studies. These included not only specimens obtained from the shrimp trawl and dredge hauls, but also organisms collected by night-lighting, dip-netting, shore collecting, etc. Collections made by individual participants were, by prearrangement, sent to their home institutions (i.e. the Philadelphia Academy of Sciences, the U. S. Fish and Wildlife Laboratory at Honolulu, the Virginia Institute of Marine Science, and the University of Kansas). The bulk of the collections have been sent to the U. S. National Museum Sorting Center, Washington, D.C. In addition to many smaller containers, these include 32 15-gallon drums, 10 cases of 1-gallon cans, and 25 cases of 1-quart jars. These collections will be sorted and distributed to specialists who have been designated to receive them by the U. S. Program in Biology Systematics Advisory Panel.

Station lists will be prepared giving a general description of each sample, time and location of its collection, and its disposition. Persons interested in receiving these lists, and those wishing to receive particular groups of organisms from the collections for study, should send their requests to J. H. Ryther, Scientific Director, U. S. Program in Biology, II0E, Woods Hole Oceanographic Institution, Woods Hole, Mass.

V. Final Cruise I Report

Station positions, corrected depths, temperatures, bathythermography observations, and all other data are currently being checked, processed, and tabulated by station. Charts and profiles showing the distribution of the more interesting variables will also be prepared. This information will be compiled in a final report which will be deposited with the National Oceanographic Data Center, Washington, D.C. and will be distributed to all interested persons.
Scientific Complement: Cruise I

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Junior Research Fellow  
Scientific Liaison Officer  
U. S. Program in Biology  
Reader in Marine Biology  
Junior Research Fellow  
Senior Research Fellow  
Lecturer  
Director of Films Division  
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P. K. Das
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R. Varadarajulu
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Thumnoon Sunpanish
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Mahn Bhovichitra
College of Fisheries
Kasetsart University
Bangkok, Thailand

Scientific Assistant
Junior Research Fellow
UNESCO Fellows
UNESCO Fellow
FIGURE 1. CRUISE TRACK OF CRUISE I SHOWING TENTATIVE STATION POSITIONS
FIGURE 2. SURFACE CURRENTS IN THE BAY OF BENGAL AT THE TIME OF CRUISE I (FROM U. S. HYDROGRAPHIC OFFICE PILOT CHARTS).
FIGURE 3. ECHOCGRAM SHOWING SUBMARINE CANYONS OFF THE EAST COAST OF INDIA BETWEEN APPROXIMATELY 17°54.0'N, 84°16.2'E and 17°44.0'N, 84°01.8'E. VERTICAL SCALE, 750-1500 METERS. HORIZONTAL SCALE, 15 MILES.
FIGURE 4. ABOVE: SIMULATED IN SITU PRODUCTIVITY INCUBATOR.
BELOW: PLASTIC WATER SAMPLE.
FIGURE 5. LEFT: MICROPLANKTON NET. RIGHT: IIOE STANDARD NET
FIGURE 6. GULF OF MEXICO SHRIMP TRAWL AND TRAWL COLLECTIONS.
UNITED STATES PROGRAM IN BIOLOGY
INTERNATIONAL INDIAN OCEAN EXPEDITION

The International Indian Ocean Expedition, in which more than 12 countries are participating, is a scientific endeavor sponsored and coordinated by UNESCO. U.S. participation in the Expedition is supported through the National Science Foundation, and includes a Program in Biology.

The major effort of the U.S. Program in Biology is based on a series of nine cruises of a biological oceanographic research vessel scheduled to take place during 1963 and 1964. In addition, support is also being provided for scientists to participate on an auxiliary vessel; at two existing shore laboratories; and as independent investigators in certain areas and island groups of the Indian Ocean. A tentative list of participants in all but the last category is appended.

1. The Biological Oceanographic Ship Cruises

The R/V ANTON BRUUN has been designated as the main biological research vessel. Responsibility for operation of the vessel has been assigned to Alpine Geophysical Associates, Inc. of Norwood, New Jersey. During its period of participation in the Expedition, the ANTON BRUUN will be based at Bombay. Also stationed at Bombay as Scientific Liaison Officer is Dr. T. S. Satyanarayana Rao, on leave from Andhra University in India.

On each of the nine cruises planned, stations will be occupied at intervals of 2 to 5° latitude on the meridional sections and more frequently on the coastal cruises. The basic program at each station will consist of the following:

a. Hydrographic cast to 1000 meters for temperature, salinity, dissolved oxygen, phosphate, nitrate, nitrite, silicate, ammonia.

b. Van Dorn bottle cast to depths of penetration of 100, 50, 25, 10 and 1% of incident light for pigment analysis and for 24-hour simulated in situ and 4-hour incubator C¹⁸ uptake experiments.

c. Submarine light penetration at all daylight stations.

d. Vertical plankton haul from 200 meters with standard IOE net (mesh aperture = 0.330 mm) for deposition in International Taxonomic Center at Cochin, India.

e. Vertical micro-plankton haul from 200 meters with No. 25 mesh net.

f. Oblique plankton tow with Be sampler (mesh aperture = 0.33 mm) from 2000 meters or greatest depth possible in shallow water.

g. Bathythermograph observation.

Additional work to be undertaken on each cruise will vary depending on each cruise. Intensive sampling will be done with different types of gear, as shown below in the cruise schedule established for the ANTON BRUUN.
<table>
<thead>
<tr>
<th>Cruise 1</th>
<th>Arrive</th>
<th>Sail</th>
<th>Destination</th>
<th>Fishing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar. 3</td>
<td>Mar. 8</td>
<td>Bombay</td>
<td>Gulf of Mexico</td>
<td>shrimp trawl, occasionally</td>
</tr>
<tr>
<td>Mar. 16</td>
<td>Mar. 17</td>
<td>Puket, Thailand</td>
<td>shrimp trawl, occasionally</td>
<td></td>
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<td>Mar. 28</td>
<td>Mar. 29</td>
<td>Rangoon</td>
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</tr>
<tr>
<td>Apr. 21</td>
<td>Apr. 22</td>
<td>Vizagapatam</td>
<td>shrimp trawl, occasionally</td>
<td></td>
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<tr>
<td>May 1</td>
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<tr>
<td>May 7</td>
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<td>Bombay</td>
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<td>May 22</td>
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<td>June 27</td>
<td>Jul. 2</td>
<td>Port Louis, Mau.</td>
<td>Isaacs-Kidd midwater trawl</td>
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<tr>
<td>Jul. 22</td>
<td>-</td>
<td>Bombay</td>
<td>Isaacs-Kidd midwater trawl</td>
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<th>Fishing Method</th>
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<td>Aug. 1</td>
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<td>Gulf of Mexico</td>
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<td>Aug. 21</td>
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<td>Sep. 16</td>
<td>-</td>
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<td>Nov. 5</td>
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<td>Karachi</td>
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<td>Dec. 1</td>
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<td>Menzies, trawl, Campbell grab, piston corer</td>
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<td>Japanese long-line fishing</td>
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<td>Gulf of Mexico</td>
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<td>Nov. 6</td>
<td>Nov. 17</td>
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<td>Gulf of Mexico</td>
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<td>Nov. 25</td>
<td>-</td>
<td>Bombay</td>
<td>Gulf of Mexico</td>
<td>shrimp trawl, occasionally</td>
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To permit the greatest continuity and degree of consistency in the results, a permanent scientific staff of eight will be on board the ANTÓN BRUUN and will have responsibility for making the hydrographic casts, bathythermograph observations, plankton tows, physical and chemical determinations (temperature, salinity, light penetration, dissolved oxygen, phosphate, nitrate, nitrite, silicate, ammonia), and productivity measurements. The permanent scientific staff, composed mainly of graduate students in biology or oceanography, was given a special three-month course in oceanographic methods and theory at the Bermuda Biological Station in the fall of 1962.

The U. S. Bureau of Commercial Fisheries is cooperating with the Program in Biology, and will participate in Cruises 1, 2, 4 and 5 of the ANTÓN BRUUN. The research program of the Bureau will include a program of longline fishing on Cruises 2 and 5 to sample the tuna, marlins, sharks and other apex predators. The Bureau is especially interested in the distribution and abundance of adult tunas in relation to the circulation during the two monsoon seasons; the relation of the apex predators to the food-chain, standing crops, and productivity; and the identification of subpopulations of tunas and other apex predators by means of serological techniques. Catches will be weighed and measured, recordings will be made of the sex and maturation of the gonads, collection of stomach contents, ovaries and blood samples will be obtained, and certain specimens will be retained for taxonomic work.

The Bureau will also conduct a program of bottom trawling on Cruises 1 and 4 to study the distribution and relative abundance of demersal species in relation to the topography and nature of the bottom with emphasis on species of potential commercial importance. In addition, Bureau scientists will be studying tuna larvae, juvenile tuna, and certain copepod species.

2. Auxiliary Ship Cruises

Due to the interest shown in carrying on physiological studies and making collections and observations in and around the island groups and in the shallow water areas of the Indian Ocean, arrangements have been made through Dr. Rolf Bolin of Stanford University to have TE VEGA operate in the Indian Ocean for approximately one year.

TE VEGA, a 135-ft. two masted schooner, will make three cruises scheduled tentatively as follows:

- **Cruise A. October - December, 1963.** Singapore-Colombo, Ceylon. Stops along island groups off the Malay Peninsula and/or those off Sumatra.

- **Cruise B. February - April, 1964** Colombo-Mauritius. Stops along the Maldives, Chagos Island.

- **Cruise C. June - September, 1964** Mauritius-Zanzibar. Stops along the Comoro Islands and the northwestern coast of Madagascar.
Since TE VEGA is primarily a teaching facility, only six participants in the U. S. Program in Biology can be accommodated at a time on each of the three cruises. The ship will be equipped with small boats, limited laboratory space, a darkroom, SCUBA, a winch for dredging and trawling at depths of 3000 fathoms, and general collecting gear.

3. Shore Laboratories

For those scientists interested in carrying on studies at shore laboratories in the Indian Ocean area, arrangements have been made to accommodate participants at the Centre d'Oceanographie at des Pêches at Nossi Be, Madagascar, and at the headquarters laboratory of the Central Marine Fisheries Research Institute at Mandapam Camp, India.

Dr. Arthur G. Humes, Professor of Biology at Boston University, has been designated as Chief Scientist and liaison officer for the U. S. participants at the Centre d'Oceanographie at des Pêches.

A vehicle, inflatable Zodiac boat, outboard motor, microscopes, and other items have been provided at each of the two shore laboratories to supplement the equipment and supplies that are being made available to participants in the U. S. Program.

4. Independent Studies

Several groups of independent investigators interested in carrying on intensive studies in certain areas of the Indian Ocean have been supported by the Program in Biology, and several additional groups are scheduled for support. These studies include:

a. Locality: Southern Red Sea, off island of Entedebir, in the Dahlac Archipelago off the Ethiopian coast.
   Time: March-April, 1962.
   Participants: Drs. Eugenie Clark, George Papenfuss, Thomas Goreau and Stephen Wainwright.
   Fields of Interest: Sharks, fishes, marine algae, corals, reef ecology.

b. Locality: Southwest Australia, Mauritius Madagascar.
   Time: August-September, 1962.
   Participants: Dr. Robert Scagel.
   Field of Interest: Marine Algae.

c. Locality: East African coast and Aden.
   Participants: Drs. Robert Scagel and George Papenfuss, joined in Kenya and Tanganyika by Dr. George Lawson.
   Field of Interest: Marine algae.
d. Locality: Cocos-Keeling.
   Participants: Miss Virginia Orr and Mrs. E. R. Ostheimer.
   Field of Interest: Mollusks.

e. Locality: East coast of India.
   Participant: Mr. C. M. Cutress.
   Field of Interest: Sea anemones.

f. Locality: West coast of India.
   Participant: Mr. K. M. Aziz.
   Field of Interest: Marine algae.

g. Locality: Seychelles.
   Participants: Drs. James Bohlke, John Randall, and three others.
   Field of Interest: Marine fishes.

h. Locality: Seychelles.
   Participants: Messrs. Richard W. Foster and Samuel Fuller.
   Field of Interest: Mollusks.

i. Locality: West coast of India.
   Participant: Mr. John Reintjes.
   Field of Interest: Clupeid fishes.

j. Locality: Comoro Islands.
   Participants: Mr. Richard W. Foster and Dr. Ruth Turner.
   Field of Interest: Mollusks.
### APPENDIX I

#### A. SCIENTIFIC PERSONNEL SCHEDULED TO WORK ABOARD R/V ANTON BRUUN.
*(All U.S. citizens except where noted)*

<table>
<thead>
<tr>
<th>CRUISE 1</th>
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<td>J. Hennessy</td>
<td>T. Chen (Nationalist China)</td>
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<td>G. L. Clarke</td>
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<td>C. P. Lee</td>
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<td>S. Yano</td>
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B. SCIENTIFIC PERSONNEL SCHEDULED TO WORK ABOARD R/V TE VEGA  
(All U.S. citizens except where noted.)

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C. SCIENTIFIC PERSONNEL SCHEDULED AT STATION OCEANOGRAPHIQUE, NOSSI BE, MADAGASCAR

| M. B. Allen                                   | J. S. Garth                                   | I. Rubinoff                                   |
| J. E. Bardach                                 | M. K. Hecht                                   | H. Sanders                                    |
| C. E. Cutress                                 | R. P. Higgins                                 | J. S. Thompson, Jr.                           |
| E. Y. Dawson                                  | C. Jagersten (Sweden)                         | M. Vannucci (Brazil)                          |
| G. M. Friedman                                | J. S. Karling                                 | L. P. Woods                                   |
|                                               | E. J. Kuenzler                                | W. Yaphe (Canada)                             |
|                                               | J. McLaughlin                                 | F. C. Ziesenhenne                             |
|                                               | R. Robertson (Gr. Britain)                    |                                              |

D. SCIENTIFIC PERSONNEL SCHEDULED AT THE CENTRAL MARINE FISHERIES RESEARCH INSTITUTE AT MANPADAM CAMP, INDIA

| M. B. Allen                                   | J. S. Garth                                   | I. Rubinoff                                   |
| J. E. Bardach                                 | M. K. Hecht                                   | H. Sanders                                    |
| C. E. Cutress                                 | R. P. Higgins                                 | J. S. Thompson, Jr.                           |
| E. Y. Dawson                                  | C. Jagersten (Sweden)                         | M. Vannucci (Brazil)                          |
| G. M. Friedman                                | J. S. Karling                                 | L. P. Woods                                   |
|                                               | E. J. Kuenzler                                | W. Yaphe (Canada)                             |
|                                               | J. McLaughlin                                 | F. C. Ziesenhenne                             |
|                                               | R. Robertson (Gr. Britain)                    |                                              |