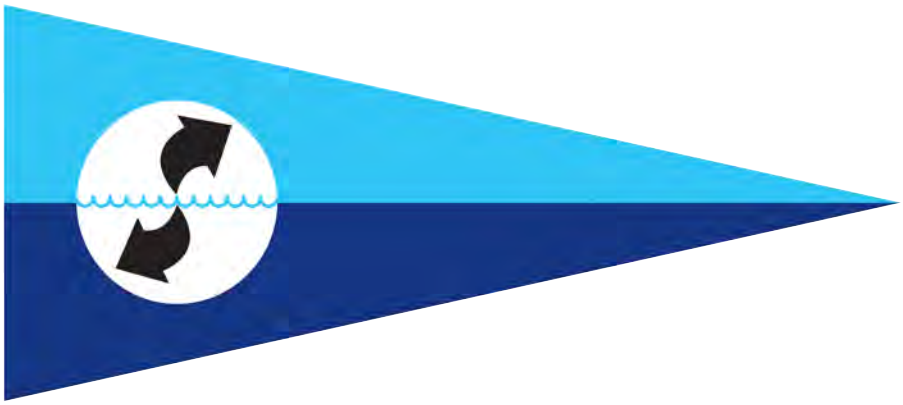
THE COLLECTED PAPERS OF ROBERT G. SNIDER IN RELATION TO THE FIRST YEARS OF THE INTERNATIONAL INDIAN OCEAN EXPEDITION



SCOR History Report #2

2020

Front Cover: IQOE Banner

From: IOC IIOE Information Paper No. 1. 1962. UNESCO/NS/IOC/INF-22,

Symbol and Pennant

"A pennant incorporating the symbol has also been proposed by SCOR for use by ships participating in the Expedition. These pennants are available from the following manufacturer:

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Robert G. Snider in 1963 (Source: *The Plano Star-Courier*)[1]

FOREWORD

Global oceanography was largely conducted, until the late 1950s, by scientists from single nations embarking on long expeditions to measure features of the ocean, the seafloor, and atmosphere, and to collect sea creatures. The most famous of these expeditions was the Challenger Expedition of 1872 to 1976, which was devoted primarily to systematic study of the ocean. Many other expeditions included "gentleman naturalists" who were generalists, collecting specimens and making measurements during voyages from naval ships of the British Navy and others. For example, Charles Darwin studied not only the animals of the Galapagos Islands on the voyage of the *HMS Beagle*, but also collected and studied whatever attracted his curiosity at the time (Darwin, 1845). A few decades earlier, Alexander von Humboldt collected specimens (plants, animals, minerals) and observations (oceanographic, meteorological, magnetic, geomorphic, and more) in northern South America and Mexico, which he used to begin to explain the connections between and natural and physical worlds to develop ecosystem ideas (Wulf, 2015).

This mode of ocean exploration, missions sponsored by single nations and sometimes conducted by only a few scientists, changed during the 1957-1958 International Geophysical Year (IGY). During the IGY, scientists from multiple nations worked cooperatively on a variety of Earth science topics, including ocean science. In the midst of planning for the IGY and as the product of other activities of the International Council of Scientific Unions (ICSU) that had been underway, ocean scientists helped form the ICSU Special Committee on Oceanic Research (SCOR), later renamed the Scientific Committee on Oceanic Research (Wolff, 2010). From SCOR's first meeting, the leading oceanographers from around the world began working to identify the priority ocean science topics that would require a large-scale, multi-national approach. An obvious place to start was the Indian Ocean, which was relatively unexplored at that time and featured the seasonally reversing monsoon system, which was suspected to affect ocean productivity. (Currie (1966) gives an interesting chart of previous work on the Indian

[1] Anonymous. 1963. Robert G. Snider Named Director Development Program Research Center. *The Plano Star-Courier*. 16 January 1963. p. 1.

Ocean.) SCOR scientists began planning the International Indian Ocean Expedition (IIOE) in 1957. Eventually, 40 research vessels from 23 nations became involved in the IIOE, which began in 1959 and lasted until 1965. An important aspect of the IIOE was that the planners included training and capacity building for scientists in the Indian Ocean region as an important aspect of the project. The National Institute of Oceanography (NIO) of India evolved from an IIOE center for sorting of marine organisms, which was located in Cochin, India. NIO celebrated its 50th anniversary at the end of 2015.

SCOR decided at its Annual Meeting in August-September 1959 to hire an IIOE Project Coordinator to handle the complicated logistical tasks of the enterprise. Robert G. Snider was hired for the job, based on his connections with the first SCOR President, Roger Revelle, and Snider's experience with coordination work. The U.S. National SCOR Committee paid Snider's salary through funding from the U.S. National Science Foundation. Snider served as the project coordinator from 1959 until the mid-1962. Behrman (1981) wrote an account of the IIOE and provides the following introduction to Snider:

> *To help win support for the Indian Ocean study from scientists and governments, SCOR appointed a co-ordinator. He was Robert G. Snider whom* [Roger] *Revelle had described as 'a born expediter'. During the Second World War, Snider had served as an officer in the United States Navy, co-ordinating tests of equipment used in anti-submarine warfare. He did not have a degree in oceanography, but the people with whom he dealt during the war had become leaders of the oceanographic community in the United States. After the war, Snider first worked for the Conservation Foundation in New York and then became president of International Population Research. He maintained his interest in the sea and served as chairman of a panel of ocean resources set up by the National Academy of Sciences' Committee on Oceanography. In August 1959, the Academy named him as co-ordinator for the United States effort in the Indian Ocean and he became international coordinator for SCOR at the end of that year, a job he was to do until the end of 1962. (Behrman 1981:16)*

Currie (1966) wrote about Snider:

> *…credit must go to R.G. Snider whose tireless efforts did much to arouse public enthusiasm and interest in the expedition. Participants were later to be grateful for many of the facilities which he arranged.*

Rao and Griffiths (1988) added

> *Shortly after the plan for the IIOE was unfolded in the prospectus issued by SCOR at its meeting in Helsinki in August 1960, Robert Snider left on a mission round the world to meet and persuade all countries interested in the expedition to contribute, plan and execute the programme. In this task he got full support from members of SCOR national*

committees in various countries. He particularly made it a point to meet 'political activators' and influential members of governments and local parliaments. He also carried with him colourful charts showing the proposed cruise tracks of the IIOE and, more importantly, an IIOE emblem that use of which on letterheads and packages would facilitate customs clearance of scientific equipment, exempting them from payment of duties, etc., for all countries participating in the International Indian Ocean Expedition. In India, he approached Homi Bhaba, the eminent nuclear scientist, who in turn obtained the support of Jawaharal Nehru, the then Prime Minister of India. The American participation in the IIOE had already been endorsed by President Eisenhower and later by President Kennedy.

Snider was appointed near the end of 1959 and opened the IIOE office in New York City on 1 December 1959. He hired Janet A. Smith as his secretary and the office never exceeded a staff of two. Snider worked quickly to lay the foundation for the IIOE, through memos that he issued and travel throughout the Indian Ocean region. The memos, tables, and charts included in this report were compiled and issued by Snider during his time as IIOE Project Coordinator. They were sent to the SCOR Secretariat by his widow upon Snider's death in the early 2000s.

Snider set the project in motion officially by the prospectus he issued on 21 January 1960 (pp. 1-7). This prospectus included the grid of stations proposed by Wüst (1959). This regular grid of stations was only partially sampled; the actually cruise tracks were much more complicated and designed to study processes of interest (see page 30). The prospectus made the case that all types of ocean scientists would need to be involved in order to make the IIOE a success. The prospectus also emphasized the practical benefits of the proposed research to society, perhaps more than was justified. The purpose of the prospectus was to "sell" the IIOE to governments and funding agencies in the nations that might be interested in the project. The prospectus estimated the IIOE would cost more than US$13 million for ship time and scientific personnel.

Walter M. Rudolph, Assistant to the Science Advisor of the U.S. Department of State, issued an "instruction memo" on 20 January 1960 to U.S. embassies in the Indian Ocean region to provide some background on the IIOE and describing how it was analogous to the International Geophysical Year, telling the embassies that Snider was requested to "call at the posts to discuss for their further background the International Indian Ocean Expedition and to describe more fully the purposes of his consultations abroad." The communication further stated that "Any courtesies, advice or assistance the posts may be in a position to extend to Mr. Snider will be appreciated." The communication also gave a detailed list of Snider's travel plans. Snider informed Ronald Fraser, the ICSU Executive Director, of his planned trip and suggested meeting with Fraser in The Hague in March 1960. Fraser responded positively on 2 February 1960, after Snider had left New York, stating "Meantime I have read the document accompanying your letter, and I can only say it is well suited to its purpose."

Snider travelled in the Indian Ocean region from 31 January to 25 March 1960. He stated the purpose of the trip in a letter to Detlev Bronk: He provided a 10-page list of individuals with

whom he met (see https://scor-int.org/wp-content/uploads/2020/04/Snider-List_of_Contacts_on_1960_Trip.pdf). Snider visited Japan (3-6 February), Singapore (7-8 February), Indonesia (9-10 February), Ceylon (12-16 February), India (16-22 February and 25 February to 2 March), Pakistan (22-24 February), USSR (2-6 March), West Germany (7-8 March), United Kingdom (8-16 March), The Netherlands (16-17 March), Switzerland (17 March), Portugal (17-19 March), and France (19-25 March). In Snider's list, he divided his contacts into "Policy Shapers", "Senior Scientific and Administrative Personnel", "Other Scientists", and "U.S. Citizens Briefed About Results of Discussions", and "Other Personal Contacts". The "Policy Shaper" tended to be the heads of science/fisheries/meteorology agencies and national academies/science societies and national SCOR representatives. For India, this group included the first Vice-President of India, Dr. Sarvepalli Radhakrishnan, later to become India's second President. "Senior Scientists…" were from the next level down in the agencies. "Other Scientists" were academic scientists. "U.S. Citizens… were typically staff from the U.S. embassy in the country visited, but also representatives of U.S.-based foundations such as the Ford and Rockefeller foundations. "Other Personal Contacts" were not always listed, but included reporters and port officials. Snider met with the President of ICSU while in the United Kingdom and the Secretary of ICSU while in the Netherlands. He met with Jacques Cousteau in France.

Following the issuance of the prospectus and presumably using it during his travels, Snider reported to SCOR in a 23 July 1960 memo (see p. 25) that

> *From January to March 1960 the Coordinator visited the fourteen nations to discuss the extent and nature of their participation in the Expedition as well as the possible assistance of various international organizations. Nations visited were Japan, Singapore, Indonesia, Ceylon, India, Pakistan, USSR, Federal Republic of Germany, Great Britain, Netherlands, Switzerland, Portugal, France and U.S.A. During this period individual discussions were held with almost 200 senior scientists, national policy shapers, administrators, international organizations officials, potential Fund sources and other scientists and officials.*
>
> *The immediate purpose was to stimulate national action in planning and organizing the various countries' efforts in the Expedition. Prior to 1 February virtually no nation visited had yet held a meeting of its National Committee to deal with the Expedition and in some countries no National Committees had been formed.*
>
> *In addition to national representatives the Coordinator discussed the Expedition with the President and the Administrative Secretary of ICSU, the Director General of WMO, representatives of UNESCO and FAO, the Director of the UN Special Fund, the Director of the Colombo Plan Bureau, national and regional representatives of U.S.I.C.A., and the administrators of the Tata Foundation, the Nuffield Foundation, the Wolfson Foundation, the Gulbenkian Foundation, Rockefeller Foundation, Ford Foundation, and others. The Coordinator also*

represented SCOR at the UNESCO Preparatory Meeting for the Intergovernmental Meeting on Oceanography in Paris.

According to Behrman (1981), Snider made five trips around the world during his three years as IIOE Coordinator, to promote the project. His status as an employee of the U.S. National Academy of Sciences probably helped him gain access to high levels of the scientific establishments in countries interested in participating in IIOE.

Snider met with Ronald Fraser (ICSU Administrative Secretary**)** and Günther Böhnecke (SCOR Secretary) on 16 March 1960 in The Hague to prepare for the upcoming meeting of the SCOR Executive Committee to be held in Paris, which would largely concern reports on the progress in plans for the IIOE. The Indian Ocean working groups (SCOR WGs 1 to 4) were combined in SCOR WG 5, along disciplinary lines: (a) oceanography—physical and chemical; (b) marine biology; (c) geology, geophysics and bathymetry; and (d) meteorology and climatology. For the latter group, SCOR and the World Meteorological Organization (WMO) agreed that the WMO committee on marine meteorology would assist in the development of the IIOE program. The meeting also included a discussion of cooperation with UNESCO in relation to the ships' tracks that would be set, involving negotiations by Snider with UNESCO representatives in Paris.

At a meeting in Hamburg between Snider and Böhnecke, an agenda was worked out for the SCOR Executive Committee meeting which took place in Paris on 21 and 25 March 1960, with Snider attending. The meeting mainly concerned the IIOE, including the following items (Wolff, 2010):

- a delay of start of the major work,
- national programs and the geographic areas of each,
- coordination of ship operations,
- total budget,
- equipment needs and uniform standards for equipment use and procedures,
- navigation aids,
- shore facilities,
- training of scientists from the Indian Ocean area and examination of their qualifications, and
- training of technicians.

Snider reported to the National Academy of Sciences Committee on Oceanography at their meeting on 22-23 April 1960. Snider had contact with Alan Waterman, the NSF Director and Detlev Bronk, the NAS President.

On 23 July 1960, Snider presented a report of his activities to the 1960 SCOR Annual Meeting in Helsinki, Finland. Among other information, Snider presented the map of the cruises already completed, as well as those planned through 1963 **(**see pp. 25-30**)**.

The Indian Ocean Working Group of SCOR (WG 5) met on 16-17 July 1960 in Copenhagen, Denmark and on 1 August 1960 in Helsinki, Finland, after SCOR meetings in these locations. George Deacon had been appointed as chair of WG 5 and his report of the meeting can be found on pages 8-24**.** Vladimir Kort was appointed as the group's Vice Chairman. According to Wolff (2010), the meeting was attended by a significant number of SCOR members beyond Deacon: Roger Revelle, Günther Böhnecke, Yasuo Miyake, N.K. Panikkar, Anton Bruun**,** Lev Zenkevitch, George Humphrey**,** Erik Steemann Nielsen, Ronald Currie, Columbus Iselin, and Håkon Mosby, in addition to Robert Snider, Fraser representing ICSU, some members of the Indian Ocean Working group, and representatives of various national and international institutions. WG 5 met in plenary session, and its working groups on Physical and Chemical Oceanography and Marine Meteorology, on Biological Oceanography, and on Marine Geology and Geophysics also met separately. The meeting included reports from the chairmen of these working groups and from national representative about their planned contributions to IIOE.

Coordination of national plans made it possible to match unused berths on ships with scientists from other countries ready to work on these ships. The importance of standardization and intercalibration of techniques, specifically in relation to oxygen, nutrients, and biological sampling, was discussed. The Subcommittee on Facilities for Ships made detailed recommendations about how local ports should accommodate ships taking part in the expedition, with the help of UNESCO. The Biological Working Group recommended that ^{14}C productivity measurements be made along the lines recommended by SCOR WG 3, modified as necessary by developments underway. They also recommended establishment of a sorting and taxonomy center in India as quickly as possible. The memberships of the working groups were as follows:

> **Working Group on Physical and Chemical Oceanography and Marine Meteorology:** George Deacon (Chairman), Günther Dietrich, Fritz Fuglister, Bostwick H. Ketchum, John Knauss, Paul Tchernia, and Michitaka Uda, S.V. Brujewicz, and John Swallow
>
> **Working Group on Geology and Geophysics and Bathymetry:** Robert L. Fisher and P.L. Bezrukov (co-chairmen), Bruce C. Heezen, Anthony Laughton, John Nafe, J.N. Nanda, and Eugen Seibold, A. Zhivago, and Hiroshi Niino
>
> **Biological Working Group:** Ronald I. Currie (Chairman), David H. Davies, George F. Humphrey, Johannes Krey, N.K. Panikkar, John Steele, B.G. Bogorov, Shigera Motoda, John Ryther.

On 13 November-16 December 1960, Snider traveled through the Middle East and the east coast of Africa to continue making contacts to stimulate regional interest in the IIOE. On 6 January 1961, he issued an update on the status of IIOE planning (see pp. 31-54). Included were separate reports on meteorology (pp. 44-49) and tide gauges (pp. 50-54). It appears that Snider may have delivered a paper at the Pan Indian Ocean Science Association meeting in November 1960 and was able to learn more about the current status of observations by participating in that meeting.

In 1961, John Knauss published a paper in *Science* (Knauss, 1961) and Robert Snider published a paper in *Discovery* (Snider, 1961) to publicize the expedition. Snider issued another update on planning for the expedition on 15 March 1961 (see pp. 55-56). He indicated that 10 reconnaissance cruises had already been completed by that time and that there was widespread interest and intentions to cooperate among nations in the Indian Ocean region as well as 7 major oceanographic nations from outside the region. Basic participation could be achieved even by countries not having oceanographic vessels, by maintaining tide gauges and meteorological stations, and by providing port facilities. Snider notes that he visited 40 different countries between 1 February 1960 and 1 March 1961.

On 31 March 1961, Snider issued a more-detailed report of his trip to the eastern part of the Indian Ocean region on 27 January to 3 March 1961 (see pp. 57-80**).** An important aspect of this trip was discussions in India on the establishment of an International Meteorological Center and the Indian Ocean Biological Centre. Again, Snider included specific reports on tide gauges (pp. 70-73**)** and meteorology (pp. 74-80). Much effort was devoted to developing and coordinating meteorological observations. Meetings were held in India on 18-20 July 1961 to focus on meteorology (pp. 81-132). This meeting was chaired by Snider and was for the purpose of receiving reports from countries in the region about their planned participation in the meteorological aspects of the expedition and to prepare a request to the UN Special Fund to support meteorological observations and the International Meteorology Center in Bombay. The meteorology component of the expedition was less developed than other aspects, but there were recommendations from the U.S. Committee for the IIOE that could provide some guidance.

Snider issued his final report of 1961 on 24 October (pp. 133-134). He reported that the initial development phase of the expedition was almost over and that the intensive field phase would begin around mid-1962. Snider mentions the importance of intercalibrations again and estimates the total cost of the expedition at around US$60 million, an increase from the earlier estimate of US$13 million.

On 4 April 1962, Snider issued lists of cruises expected through 1965 (p. 135), with a summary by nation (pp. 136-142), then sorted by area of the Indian Ocean (pp. 143-149**),** by discipline (pp. 150-176**),** and by month (pp. 177-233).

Snider issued his next update on the status of the expedition on 4 April 1962 (p. 135). Snider wrote

> *As of this date the organizing and preliminary planning phase of the Expedition appears to be drawing to an end. Emphasis hereafter will be primarily on operational and scientific coordination in timing, in disciplines and in areas, and on refinement and amplification of plans in the light of increasing knowledge obtained about the Indian Ocean.*

Snider gives some indication of his frustration with the slow pace of developments in some countries.

On 12 September 1962, Snider issued a one-page Summary of Southwest Indian Ocean Coordinating Meeting, Lourenço Marquès, Mozambique, 30 April to 2 May 1962 (p. 234).

The first meeting of IOC took place in Paris in October 1961. In the following year, IOC undertook the coordination of IIOE, thus leading to the end of Snider's role as SCOR's appointed coordinator. According to Urban (2016)

> *The SCOR Executive Committee decided at a meeting in April 1962 that the responsibility for coordinating that IIOE should be transferred to the Intergovernmental Oceanographic Commission (IOC). The date of transfer was originally 1 April 1963, but SCOR and IOC speeded up the transfer in 1962, with Snider reporting to the IOC Executive Secretary, Warren Wooster. IOC made the point that their mode of operation would be different from Snider's, shifting from a network of personal contacts to a series of regional meetings. Lloyd Berkner invited Snider to become the Vice President for Development of the Graduate Research Center of the Southwest in Dallas, Texas in late 1962. Snider's term at this institution was short-lived, as he was named executive director of the Commonwealth Industrial Research Corporation (in Pennsylvania) in October 1963 until July 1966. In October 1967, Snider was appointed deputy to the assistant commissioner for program plans and development of the Federal Water Pollution and Control Administration in Washington, D.C. Snider died in Tucson, Arizona in 1993.*

In 1967, Snider submitted a report entitled "Do Oceanographic Expeditions Pay Off?" to the National Council on Marine Resources and Engineering Development. Snider claimed that the IIOE and other projects in the Indian Ocean led to follow-on investments in fisheries development and increased fishing activities by Japan, Poland, and Russia. A large number of papers was published (see https://scor-int.org/project/iioe-1/ for access to the eight volumes of collected reprints).

The IIOE made several important advances in ocean sciences for the Indian Ocean region. Urban (2015) discussed IQOE achievements, which including the following:

- Intercalibrations and development of standard methods for ocean chemistry and biology (e.g., the Indian Ocean Standard Net)
- Establishment of 15 IIOE Reference Stations (Urban, 2020)
- Establishment of two centers in India for processing of samples and data from the ocean biology explorations and marine meteorology data: the Indian Ocean Biological Centre (Hansen, 1966) and the International Meteorological Center
- Development of methods to expedite shipments and clearances for equipment related to the experiment

The documents included in this report (and others) are available online at http://www.scor-int.org/IIOE_History.htm.

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May 2020
Grand Rapids, Michigan, USA

CONTENTS

CONSEIL INTERNATIONAL DES UNIONS SCIENTIFIQUES · INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
SPECIAL COMMITTEE ON OCEANIC RESEARCH
(SCOR)

INTERNATIONAL INDIAN OCEAN EXPEDITION

30 EAST 40TH STREET · NEW YORK 16, N. Y. · LEXINGTON 2-6533

COORDINATOR
ROBERT G. SNIDER

CABLES
SCORINDOC · NEWYORK

A PRELIMINARY PROSPECTUS

THE INDIAN OCEAN

Physical Characteristics - Although the Indian Ocean's 28,000,000 square miles cover over 14% of the earth's surface relatively little is known or understood about the region, which has an area five and a half times that of Antarctica and greater than that of Asia and Africa combined. The Ocean's behavior affects all of these continents yet only the most general features of its topography and circulation and the distribution of living organisms are known. For instance, more than three hundred times as many bathythermograph observations have been taken in the North Atlantic as in the Indian Ocean; almost half of the area has had no biological sampling and in most of the remainder observations range from 4 to 1 per 5° square.

The Indian Ocean has several unique characteristics. Nowhere else in the world is there a similar seasonal reversal of the prevailing wind. The wind system in that part of the Ocean lying above the equator is characterized by the two monsoons, one blowing from the Northeast for approximately six months and the other blowing from the Southwest for the rest of the year. This phenomenon has a vast but essentially still unknown effect upon the currents and organisms in the waters.

Another notable feature is the apparent productivity of this Ocean. In June 1957 a Russian ship not far from the main trade route between Colombo and the Gulf of Aden reported millions of tons of dead fish floating in an area some one thousand kilometers long and two hundred kilometers wide extending across the middle of the Ocean. Similar reports came simultaneously from British ships in the region. During the same year smaller fish kills were reported in nearby parts of the Arabian Sea. It is not known how the fish were killed, but the very size of this catastrophe gives some idea of the potential mid-ocean resources which are currently untapped. There is further fragmentary evidence of unusually high productivity.

The Indian Ocean is one of our last unexplored frontiers. Since 1873 less than two dozen vessels have carried out oceanographic investigations there. Modern techniques have only been used in quite limited areas. Limited coverage has left great gaps in both areas visited and in the nature, intensity and accuracy of observations. No systematic study has been attempted nor do the combined profiles of the observations reported give more than a preliminary picture of the Ocean's behavior and characteristics.

Socio-economic Characteristics - Many of the nations lying in the tropical and sub-tropical regions which surround the Indian Ocean are among the world's most densely populated countries, with continuing rapid growth. Over a quarter of the world's people live in these countries.

Population pressures on the existing food supplies result in prevalence of diseases attributed to protein starvation. Such protein deficiencies are common in India, Ceylon, Indonesia, Malaya and in parts of the east coast of Africa. Some of the nations bordering the Indian Ocean have a seafaring tradition and conduct extensive fisheries. To feed their crowded populations, they are interested in expanding these fisheries.

EXPEDITION DESIGN

Participation - Under the non-governmental sponsorship of the International Council of Scientific Unions (ICSU) and its Special Committee on Oceanic Research (SCOR) scientists in the various nations experienced in oceanographic research will staff vessels provided by marine laboratories of these several nations. Scientists from countries unable to provide vessels will be invited to work on the Expedition's ships. Every effort will be made to obtain active participation by each nation bordering the Indian Ocean. The degree and nature of participation will depend to some extent on the ability of each country to provide funds, facilities and personnel, and in part on general interest in advancement of the science of oceanography.

Up to 1 December 1959 the following fourteen nations had formed National Committees for SCOR: Australia, China (Taiwan), Denmark, France, Germany (Federal Republic), Great Britain, Indonesia, Israel, Japan, The Netherlands, Norway, Union of South Africa, United States of America, and Union of Soviet Socialist Republics. It is reasonable to assume that vessels will be available from at least Australia, France, Great Britain, India, Japan, Union of South Africa, U.S.A. and U.S.S.R.; it is hoped that Germany, The Netherlands and the Scandinavian countries and possibly others will also be able to provide some ship time.

Timing of the Expedition - The period of peak activity will occur in 1962 and 1963. Preliminary plans will be completed by August 1960 and the first cruises in the coordinated effort will occur in late 1960. The Expedition will continue into 1964 and data analysis will undoubtedly continue past that date. An atlas incorporating the full findings is contemplated.

Because of the present scarcity of information on the Indian Ocean, there will need to be continuous revision and reexamination of the plans as new data are acquired. Every effort will be made to complete preliminary processing and analysis of data within six to eight months in order to redirect subsequent cruises. This fact, together with the importance of obtaining a series of observations of the same area in different seasons, makes it desirable to spread the program over several years rather than to have a major simultaneous effort.

Procedure - A preliminary and tentative cruise pattern for the entire Indian Ocean (see Appendix A) has been agreed upon by members of SCOR and National Committees. In regions where seasonal differences due to monsoons are significant, ships will cruise twice along the same track. To complete the pattern will require about ten ship-years of operation over a total of 180,000 miles.

Uniform standards for observation techniques and instrumentation will be established. Exchanges of scientists between ships of participating nations will be arranged. Existing World Data Centers will be used as repositories and new biological centers for analysis and custody of biological specimens will be established in the Indian Ocean area.

Ships participating in the Expedition will devote at least half of their time to work according to the coordinated grid and half to independent investigations determined by the scientists involved. The intensity of studies in a given area will depend on the nature of the phenomena anticipated; thus many more observations may be expected in the boundary currents at the borders than in mid-ocean. Division of national responsibility for the various segments of the coordinated plan will be negotiated at meetings in 1960 and 1961. All nations which have agreed to participate have also agreed to adjust their plans to the common program.

PROBLEMS TO BE STUDIED

Physical Oceanography - Several fundamental oceanographic problems can be studied more efficiently in the Indian Ocean than elsewhere because of the reversal of the winds. Understanding the oceanic processes here will contribute to a knowledge of all oceans. The plan is to study basic questions such as: - How long does it take the winds to set up a current? How rapidly does this current deepen with time? What percentage of the energy required to maintain an ocean current comes from the winds and what part of it comes from the horizontal density gradients due to regional climatic differences? How does internal friction and how does friction with the bottom influence the velocity-depth distribution? What is cause and what is effect in the general circulation of the oceans?

The Indian Ocean is a vast environmental laboratory eminently suited for the investigation of these problems. It is a complete ocean system, yet small enough to be studied as a whole. While it is too large for a single nation's efforts it is ideal for an international cooperative endeavor. Extending from polar through tropical waters, and divided in its northern part into small oceans each subject to radical seasonal reversals of wind, it offers unparalleled opportunity for a wide variety of specialized investigations.

Chemical Oceanography - The Indian Ocean is unique among the world's seas in several ways. One of these, of course, is the extent of our scientific ignorance about it. From this point of view, the systematic collection of physical and chemical data during the survey will be very valuable, because for the first time it will be possible to describe the distribution of plant nutrients and dissolved organic compounds.

Perhaps a more significant singularity of the Indian Ocean is the fact that it is such a large basin closed off from exchange with other seas north of about 40° S. Into this vast gulf pour quantities of drainage water from the land carrying their burden of substances dissolved from the rocks and soil. Thus it is an ideal place to study the effect of runoff on the composition of sea water. For example, studies of elements such as copper and barium, with a relatively short residence time in the sea, should show concentrations markedly higher than in the Pacific or Atlantic.

In recent years the application of geochemical techniques to oceanic problems has added much to our understanding of residence times and of the rates of exchange between surface and deep waters. During the Expedition samples will be collected for carbon-14 dating, for analysis of carbon and oxygen isotopes, and for radium assay. This geochemical survey of an entire ocean will permit a much better evaluation of the circulation than has been possible where the sampling has been neither so systematic nor so extensive.

Meteorology - The meteorological objective is to obtain increased understanding of the energy exchange between sea and atmosphere, particularly near the air-sea boundary. To this end, basic research will be carried out on radiation input and on interaction of atmospheric pressure, winds, cloudiness, rainfall and evaporation with temperature, movement and roughness of the sea. A SCOR working group is drafting a list of desirable objectives in conjunction with various meteorological organizations.

Marine Biology - In addition to its effect on the circulation of near-surface waters, the monsoonal reversal of winds is expected to have important biological repercussions. Regions of upwelling and of high productivity should develop, decay, and shift from place to place, so that dramatic changes in the distribution and abundance of marine organisms can be anticipated. Nowhere else in the world ocean is it possible to study the interaction of atmosphere and biosphere on such a scale.

Standard biological collections and measurements made systematically over the whole area will define the biological "structure" of the ocean, the three-dimensional distribution of plants and animals. Integration of these observations will permit an assessment of the magnitude of the living resources. They also will provide the basic biological information -- the distribution of fish eggs and larvae, and of fish food, for example -- which are essential to the eventual understanding of fluctuations in the abundance and availability of commercial fish.

Since the War great advances have been made in the techniques for measuring primary production of organic matter. The widespread, systematic use of these methods by the ships of the Expedition will help us to assay, for the first time, the fertility of the Indian Ocean.

Marine Geology and Geophysics - Except for data collected during the IGY bottom topography and the crustal structure underlying the Indian Ocean are barely known. Old soundings delineate major structural components comparable to those of the Pacific and the Atlantic: trenches, undersea mountain ranges, a mid-ocean swell, and possibly fracture zones. The arrangement of these components and their relationship to the structures of the bordering continents are markedly different in the Pacific and Atlantic. Is the Indian Ocean a Pacific or an Atlantic type ocean? Precise modern soundings, in addition to clarifying this issue, will be of immediate use in providing a base map for all the other studies and data necessary for navigational charts, and it is even possible that they may uncover rich shallow-water fisheries at considerable distances from shore. Integrated geophysical studies - of the areal pattern of heat flowing from beneath the crust, the gravity field, the crustal thickness, and magnetic characteristics of oceanic and border areas - will certainly furnish basic information for the problems of ocean and continent development.

Intensive coring, dredging and bottom photography, will yield data on processes of sedimentation, productivity, climatic and magnetic changes during the last several millions of years, and the distribution of potential ores of manganese, nickel and cobalt in manganese nodules.

PRACTICAL IMPLICATIONS

The proposed research will provide fundamental and valuable scientific knowledge. Some findings will have direct and immediate bearing on economic development and human welfare. Location of shoals and regions of upwelling will identify likely fishing areas. Studies of distribution, nature and seasonal variation in nutrients and marine organisms will indicate what to fish for and when. Preliminary quantitative estimates of fish population, when supplemented by exploratory fishing will suggest the magnitude of the fishery resource.

The data obtained will provide an essential part of the information on which decisions can ultimately be reached on the nature of fishery operations, markets and methods of marketing, extent of investment, and related development problems. A new source of protein could mean food for hungry people. If it came from the ocean, land and other capital devoted to protein food raising could be shifted to other uses. Marine organisms could also provide fertilizer and animal feed in areas now lacking adequate supplies.

Meteorological information, related to oceanographic knowledge, will be obtained on a synoptic basis. This may lead to better long range weather forecasting. The ability to predict the onset of the monsoon and to estimate variations in the quantity of rainfall bears directly on flood control and on water regimen for agricultural use. The understanding of variations in location and intensity of ocean currents can lead to more economic routing of ships. Such knowledge applied in the North Atlantic has resulted in savings of as much as 10% in fuel consumption.

Charting and sampling the ocean floor through soundings, cores, geophysical measures, dredging and photography provide information useful for navigation and fisheries, and may reveal resources of economic value.

Finally, as never before, intensive training and experience in oceanographic research will be available to residents of a maritime area. Possibly twenty vessels, with facilities for about three hundred and fifty scientists will operate on the Expedition. Exchange of scientists between ships and partial cruises by individuals will increase the number of training billets available and vary their experience. Data processing centers and biological classification laboratories will serve as nuclei for post-Expedition scientific development around the Indian Ocean.

In other parts of the world, the focus over several years on the International Indian Ocean Expedition would serve as a device to attract students to the field of oceanography, helping to relieve a world shortage of marine scientists.

FINANCIAL REQUIREMENTS

Factors in Estimating Cost - Prior to detailed planning and scheduling, preliminary order of magnitude estimates of cost have been prepared using the most reliable projections and the most experienced professional judgment available.

Based on agreements made by SCOR representatives it may be assumed that marine scientists and oceanographic institutions throughout the world will commit time, vessels and efforts to the program. Also in accordance with SCOR agreements, it may be assumed that 50% of the time spent in the Indian Ocean will be devoted to the systematic study described above, the other half to special investigations individually chosen.

It is hoped that cost of ship transit to and from the site as well as the "uncoordinated" half of ship and scientist time there will be met by the participating institutions and countries as part of their existing program. Additional assumptions have been made regarding technical aspects as, for example, overall average speed of advance of ships along tracks in differing situations, time required by scientists for data analysis after completion of cruises, and cost of ship operation and of scientific staffs in different nations.

Using reasonable assumptions about the availability of ships and national cooperation (prior to firm national and institutional commitments) we have

estimated the following participation with corresponding costs. It should be emphasized that this is a very rough and preliminary estimate, and does not imply either a limitation or a demand on any country. It is given simply to illustrate the possible order of magnitude of the operation.

Nation	Number of Vessel Trips	Ship Years	Ship Operation Cost	Scientific Staff Cost	Coordinated International Indian Ocean Expedition Cost To Be Funded (Generally less than 50% of total cost)
Australia	*	1 1/3	$ 400,000	$ 360,000	$ 380,000
Denmark	1	2/3	150,000	280,000	200,000
France	1	2/3	200,000	200,000	180,000
Germany	1	2/3	250,000	280,000	250,000
Great Britain	2	1	300,000	400,000	300,000
India	*	1/2	100,000	180,000	140,000
Japan	4	2 2/3	600,000	1,000,000	800,000
Union of South Africa	*	1 1/3	250,000	360,000	305,000
U.S.A.	7	4 1/3	1,550,000	2,400,000	1,860,000
U.S.S.R.	3	2	1,500,000	2,640,000	1,960,000
TOTALS:		15+	$5,300,000	$8,100,000	$6,375,000

Additional - Special training and equipment - $200,000 to $300,000

* Frequent cruises as scheduled

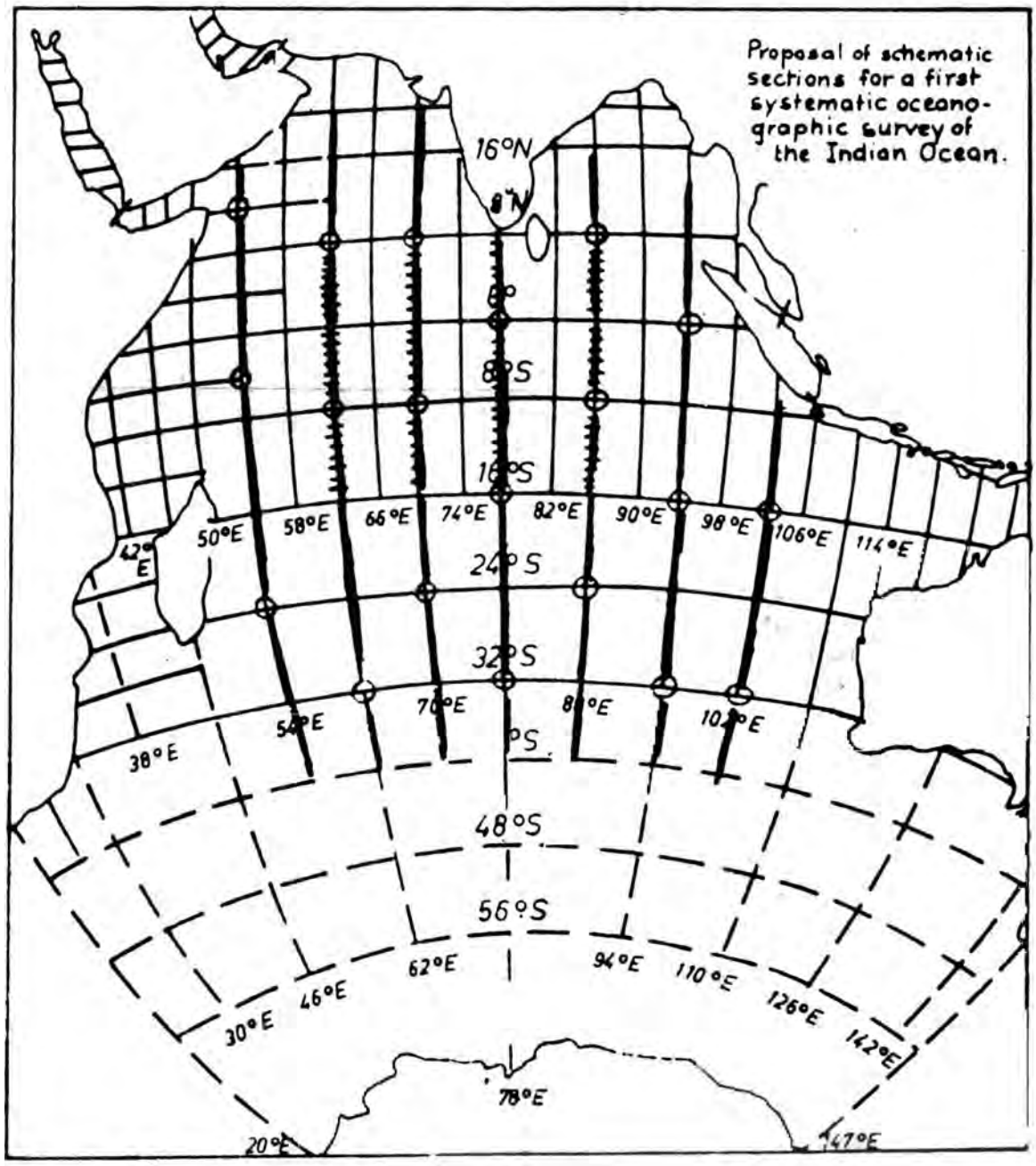
Of the total estimated cost - approximately thirteen and a half million dollars - about six and a half million dollars in new funds will be required to finance the Indian Ocean Expedition. This schedule would provide over 225,000 miles of coordinated research, allowing for development beyond the basic 180,000 miles as new problems for exploration arise.

Fund Sources - The $6,500,000 needed now will be solicited from governments, international agencies and private foundations. Here is an opportunity for support of basic research with a high potential for early practical application of findings. It is an opportunity for truly international scientific cooperation to benefit mankind. It is an opportunity for exploration of one of the last substantial unknown areas on this planet. It is hoped that the International Indian Ocean Expedition will attract development funds from individual governments, pre-investment and technical assistance funds from international agencies, training and equipment funds from private sources and basic scientific research funds from all sources.

NOTE: Detailed plans for research in the several scientific disciplines are being prepared by working groups. These will be discussed at the SCOR meetings in Copenhagen, July 9 and 20, 1960. Reports of the activity of SCOR and preliminary documents in some fields have been sent to National Committees for SCOR by its Secretary - Dr. Günther Böhnecke, Bernhard-Nocht-Strasse 78, Hamburg 4, Germany.

RGS/jas

21 January 1960


Proposal of schematic sections for a first systematic oceanographic survey of the Indian Ocean.
16°N
8°N
8°S
16°S
24°S
32°S
48°S
56°S
42°E
50°E
58°E
66°E
74°E
82°E
90°E
98°E
106°E
114°E
38°E
54°E
70°E
86°E
102°E
30°E
46°E
62°E
78°E
94°E
110°E
126°E
142°E
20°E
147°E
Repeated sections at SW-Monsoons and NE-Monsoons
Single sections
Systematic biological collections
Special equatorial biological studies
Complete study of water column

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

SPECIAL COMMITTEE ON OCEANIC RESEARCH

(SCOR)

Indian Ocean Working Group[1]

Chairman: Dr. G.E.R. Deacon

Report of Meeting at Copenhagen, July 16-17, 1960.

Helsinki - 1 August 1960

The group met from 0900 to 1100 on 16 July and from 0900 to 0930 and 1500 to 1800 on 17 July. The working-groups on Physical and Chemical Oceanography and on Marine Meteorology, Biological Oceanography, and Marine Geology and Geophysics, met from 1100 to 1800 on 16 July and 0930 to 1500 on 17 July. The following numbers refer to the Agenda circulated from the coordinator's office on 6 May 1960.

1. The chairmen of the three working-groups outlined their main conclusions and common issues were discussed. It was agreed that the chairmen and two or three members of each group should meet during the next few days to prepare statements as detailed as possible for further discussion at Helsinki.

2. National representatives gave brief accounts of the contributions their countries would try to make, and agreed to send details to the coordinator. It is evident that cooperation between countries will greatly increase the effectiveness of the Expedition. For example Australia has two Frigates available for a total of 2-1/2 Ship years and scientists for only half this time, whereas Germany, although not expecting to have a ship before late 1963, can provide five to ten scientists and nine technicians. Moreover, two ships are needed for some geophysical work and spare ship time can be used in this way. It was agreed that a new statement should be drawn up for national committees in such a way that it will appeal to working scientists and to emphasize these possibilities of cooperation. This statement should ask individual scientists to describe special problems they are interested in and, if possible prepared to contribute to.

3. After long discussion the committee agreed that the effort being made by U.S.A., USSR, Australia and other countries before the middle of 1962 would provide a reconnaissance of the main physical, biological, topographical and geological features. It was considered that the activity beginning in the middle of 1962 should take the greatest possible advantage of cooperation between ships that could work together to cover some of the important problems in as much detail as possible. For example, UK, US, and German ships might form a nucleus of work in the Arabian Sea, and Japan and Australia in the eastern part of the ocean.

Note: The list of the members of the Indian Ocean Working Group is given in Appendix A in the report of the coordinator.

It is hoped that others, particularly ships from the USSR, would join them as well as providing related information from other regions. Meetings of the scientists who will lead the work at sea in these cooperative programs should be held as soon as possible and supported in so far as necessary by SCOR.

4. It was agreed that a laboratory-meeting should be arranged at which all the chemists who would estimate oxygen and nutrient salts in the Indian Ocean should make comparative analyses and agree on common procedures. It was agreed that it might be advantageous to extend this laboratory-meeting idea to standardization of biological methods. It was considered desirable, that ships working in the same area should meet to check their methods and exchange samples.

5. It was generally recognized that no ocean-wide navigational aid was likely to be available in the Indian Ocean by 1962-63, though it might be possible for groups of ships doing intensive work in special coastal regions to arrange for local cover, for example by portable Decca systems. It was, nevertheless, agreed that the International Council of Scientific Unions be asked to use its influence to try to hasten development and installation in the Indian Ocean area of longer range navigational systems.

6. It was agreed that it would be an advantage to have measurements of seasonal and shorter period changes in mean sea level at as many points as possible, and that a reasoned appeal for operation of tide gauges during the entire period of the Expedition should be made to national committees, and other authorities in the neighbouring countries, after the matter has been discussed with the International Association of Physical Oceanography's Committee on Mean Sea Level. It was agreed that ships fitted with wave reading equipment should take representative samples of the wave conditions.

7. It was agreed that countries sending ships ought to be prepared to purchase equipment, if such equipment will make a considerable contribution to the joint programme, and if they can fit the observations into their own programme and purchase or make the equipment at reasonable cost. It was agreed that all echo-sounders ought to have precise control of transmission intervals and record speed. The accuracy should be about 1 in 5000. It was noted that UNESCO might be able to help in procuring equipment and that everyone would try to keep prices down.

8. The question of the biological centre was referred to the biology working-group for further consideration. It was also suggested that each working-group should give some idea of the sort of working facilities that even well-provided ships would be glad to use in shore laboratories of the neighbouring countries, and of the special things, rather outside the ordinary run of commerce, that the scientists might want to buy; some chemicals and preservatives might not be readily obtainable unless the small stocks usually held in seaports and neighbouring towns were increased a little.

It was agreed that each ship should let the coordinator know its radio call sign and times of radio operation so that a list could be prepared and the need and availability of shore or ship radio stations willing to pass messages

looked into. It was agreed that a small sub-committee of Dr. Bruun, Dr. Heezen, Professor Uda, Dr. Fisher and Dr. Humphrey should consider what special arrangements might be made about shore facilities and hospitality for the ships of the expedition.

9. It was considered that training of oceanographers and technicians from the bordering countries should start as soon as possible in the laboratories of the main contributors. It was noted that UNESCO had expressed its readiness to help by providing fellowships, and it was agreed that countries sending fellows should give some guarantee that they would be given employment and be ready to take part in the expedition, either in their own ships and laboratories or in the ships of other countries. It was agreed that SCOR and the national authorities receiving fellows should be asked to approve the appointments.

It was agreed that the aims and objects of the expedition should be given careful publicity through the publications of the International Council of Scientific Unions and through its component scientific bodies.

It was thought that the only practical way to run the expedition was for all contributors to bear their own costs, and for the sums obtained from international sources and scientific foundations to be used to help those who were making determined efforts and although providing basic facilities were short of some essential items.

12. The working-group considered that the main programme should be sufficiently clearly outlined after the Copenhagen and Helsinki meetings to make further general discussion unnecessary except at the annual meeting of SCOR. It was considered that all the funds available should be used to settle questions about the usefulness, accuracy, and intercalibration of methods, and spacing and timing of observations, to obtain the best possible cover in different seasons by ships working in the same areas. Much of the work could be done by correspondance, about which the coordinator should be kept informed. The rest might be done by laboratory-meetings between the individuals and groups most concerned. Such meetings might be financed by SCOR when arranged in consultation with the executive committee. It was agreed that the SCOR budget ought to have a reasonable allocation for this purpose, but that this budget item could be presented to the treasurer of ICSU only in very general terms, since it cannot be foreseen just where and when meetings will be necessary. It was felt that splitting up of meetings would release pressure on the countries that have not yet committed themselves and SCOR might have to urge them to make contributions. The actual times and plans of meetings would have to be a matter for the coordinator and for SCOR.

13. It was agreed that all ships taking part should write frequent cruise reports outlining where they had been and what observations they had made, and giving preliminary information about outstanding features. Ships would send these reports to their parent laboratories which would circulate them to all the national committees taking part in the work, and to a number of laboratories in each participating country, if the list is not too long. Some agreement would have to be reached about what is reasonable. It was agreed that the

Hydrographic data should be circulated in the same way, as soon as they had been checked and reproduced in mimeographed or printed form. Bathythermograph data would be sent to laboratories prepared to bear the cost of reproduction. It was agreed that there should eventually be a central authority ready to produce an atlas, and to issue collected reprints from scientific journals in which different scientists had presented conclusions based on the Indian Ocean observations.

APPENDIX I

REPORT OF THE SUB-COMMITTEE ON FACILITIES FOR SHIPS

The Sub-committee met on 18 July 1960 at the headquarters of the International Council for the Exploration of the Sea, and made the following suggestions for further examination and recommendation.

1. That since the expedition is co-sponsored by SCOR and UNESCO it would be appropriate that the ships carry some emblem, badge or pennant approved by UNESCO for the expedition, and papers establishing their part and purpose in this international enterprise.

2. The States give due recognition to the international nature of the work and give to the participating vessels the assistance and courtesies generally offered to visiting government vessels.

3. That the scientific personnel be regarded as officers of the vessels and that UNESCO might provide a document for each scientist and crew member to indicate that he is taking part in the International Indian Ocean Expedition.

4. That where possible, States provide the following facilities and concessions. Some of these are covered in item 2 and others are made reasonable by the fact that the countries sending ships are thereby already incurring large expenditure for the general good.

   (a) No canal and harbour dues for the research ships taking part. Port, docking facilities and pilotage at no cost or at the cheapest possible rates.
   (b) Tax-exempt fuel for ships engaged in the work of the expedition.
   (c) Special customs facilities for the entry and embarkation of scientific equipment and stores needed for the expedition. It is important that the packaging of delicate scientific equipment is not disturbed and that water samples are not opened.
   (d) Special customs facilities for trans-shipment from ships to home laboratories of scientific specimens collected by the expedition.
   (e) Simplication of procedure for gaining permission for ships to make scientific observations in coastal waters and to enter minor ports when necessary.
   (f) Special communication facilities where necessary, for example, in relaying messages.

(g) Information and as much help as possible in connection with storage and handling of the explosive charges needed for seismic studies.

5. That the National Oceanographic committees and the National Commissions for UNESCO do everything possible to promote cooperation between their scientific institutions and the scientists in visiting ships.

APPENDIX II

Report of working-group on physical and chemical oceanography and marine meteorology

The working-group met on 16 to 17 July in the Parliament Building in Copenhagen. Those present were Messrs. Böhnecke, Deacon, Dietrich, Fedorov, Fuglister, Hidaka, Iselin, Ketchum, Knauss, Laevastu, Tchernia and Uda.

The working-group felt that by 1962-63 there would be enough hydrographical and biological stations in the Indian Ocean to give a reasonably good overall network. Although the detailed study planned for 1962-63 ought to cover as much of the Ocean as possible in both summer and winter, the present estimate of ships and men likely to be available during 1962-63 suggests that they will be used most effectively by concentrating on special problems, in several major regions.

The characteristic of the Indian Ocean which distinguishes it most from other oceans and makes it a particularly useful region for physical studies, is the marked change in circulation with season caused by the change of winds with winter and summer monsoons. Most of the work in 1962-63 will be concentrated in studying these changes. The Arabian Sea will be fairly intensively covered by US and UK ships with enough lines of full hydrographic and biological stations during the NE and SW monsoons to give good maps, useful information about changes in slope of the density layers right down to the bottom, and enough data for geostrophic calculations and identification of the different water masses in winter and summer.

There will be another large area of intensive study northwest of Australia, extending at least as far as 90° east in which Japan and Australia will cooperate. It is hoped that the Japanese contribution will cover the period of the northern summer as well as the winter at home. SCAR will be asked to arrange as much oceanography as possible south of 40°S.

These surveys will include observations along lines of latitude and longitude arranged to give as nearly as possible synoptic cover. The spacing of stations with observations down to the bottom will not be more than a hundred miles, and the network will be strengthened by intermediate observations to lesser depths, by bathythermograph observations, and by use of such other salinity-temperature-depth recording equipment as is ready in time. The spacing of observations at the full stations will not be greater than the usual standard depth intervals. It is expected that ships taking part will use electric "salinometers" for "salinity" measurements.

In addition to these repeated lines there will be multiple ship studies of special problems in smaller regions. These might be joint physical and biological studies of a coastal area which at one time is dominated by upwelling water and at another by piling up of surface water by the wind. Another problem of interest to both physicists and biologists is that of the surface and sub-surface currents near the equator and their effects on the plankton and fish.

It is recognized that direct current measurements cannot be made on a routine basis, but all ships are asked to make measurements whenever they can. No recommendations were made except to emphasize the need for good reference points, such as anchored buoys, to see what the ships or floats are really doing.

The working-group recognized the need for work in the Red Sea and Persian Gulf in both winter and summer with special emphasis on the heat budget and water budget problems, and the supply of highly saline water to the northern part of the Indian Ocean. It was considered essential that there should be current measurements for at least two weeks in both winter and summer in the straits of Bab El Mandeb and Hormuz, and for a longer time, if possible. It was considered that the German anchored current meter is the most suitable for the purpose.

Among other areas not adequately provided for is the Bay of Bengal. The southern part of the ocean is partly covered by the Australian and South-African contributions, but it is hoped that some joint ship studies in physics and biology as well as geophysics can be arranged in the region of the Agulhas current and of the ocean between Madagascar and Mauritius.

METEOROLOGY

The working-group considered that the analyses of the oceanographic data would require daily weather maps as good as possible, and monthly climatic summaries for the actual working months and for as many 5° squares, or smaller areas, as possible. All the research ships should therefore take standard meteorological observations at the synoptic hours and send them at once to the authority that makes weather maps in their area. It was considered reasonable to urge meteorologists to join more actively in what should be the geophysical study of an ocean. The presence of the research ships and the great seasonal changes in water conditions will afford good opportunity for studying the energy exchange between atmosphere and ocean; the important observations will be temperature and humidity gradients, and wind profiles, and these have been made fairly successfully from floating buoys. Radiation measurements would be useful in connection with both physical and biological problems. Simple reports on times at which rain falls, and the location of rain by radar, would be possible. Radio sonde and radar wind observations would be valuable if the ships can carry enough special equipment.

CHEMISTRY

The chemical sub-group emphasized that chemical observations will be helpful in interpreting both physical and biological observations, and it recommended that all ships should carry out at least a minimum programme. To ensure comparable results from all observers it strongly recommends that all the analysts should participate in a working laboratory conference where each can conduct the various methods simultaneously and compare the results. This could also serve as a training course for those who need to learn the methods. SCOR should arrange a conference and provide funds.

The following is recommended as a minimum programme:

I. At all hydrographic stations and at each sampling depth
   - A. Oxygen
   - B_1. Inorganic phosphorus, or
   - B_2. Total phosphorus, or both.
   - C. Silicate (if possible).

Note: Inorganic and total phosphorus appears to be equal at depths below 1000 metres in the Atlantic Ocean, but this is not believed to be true in the Indian Ocean and it is hoped that both will be determined by some vessels.

At biological (Productivity) stations in upper water layers:
- A. Oxygen
- B. Inorganic phosphorus
- C. Total phosphorus
- D. Nitrate, if possible.

At occasional stations:
Requests have been received for water samples for shore laboratories interested in determinations of trace elements. Locations and depths desired and the volume, type of storage, etc. will be established by special request and agreement with each vessel when the cruise plans are known.

The analyses for oxygen, inorganic phosphorus, silicate and nitrate, must be completed in the ship soon after collection. If this is not possible samples for phosphate, silicate and nitrate may be frozen at -10°C in a plastic bottle and delivered to a shore laboratory. Frozen samples remain unchanged for two months, perhaps longer.

Samples for total phosphorus may be stored in glass bottles for periods of up to two years without change. The bottles to be used should, however, be tested to determine whether they leach phosphorus since some have been found to be unsatisfactory. Detailed descriptions of the methods will be provided on request to each scientist interested. The following methods are recommended:

1. Oxygen: Winkler-titration (cf. Barnes, 178-185)
2. Inorganic phosphorus: Molybedate method (cf. Harvey, 1948, Barnes 151-55)
3. Total phosphorus: Harvey method (cf. Harvey, 1948, Barnes 157-161, Ketchum et al., 1955) or perchloric acid digestion (cf. Hansen and Robinson, 1953)
4. Nitrate: Reduction, and analyses of nitrite (cf. Mullin and Riley, 1955, Barnes, 118-122).
5. Silicate: Molybdenum method (cf. Barnes 163-166)

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APPENDIX III

Report of Geology and Geophysics Working-Group

The geology-geophysics-bathymetry working-group for the Indian Ocean Expedition met on 16-17 July, and made the following recommendations:

1. Since it has been agreed that all ships participating in the Expedition will make certain basic observations regardless of their primary cruise aims, the working-group proposes that all vessels should record soundings continuously, employing echo-sounders with a precision time-base accurate to 1 part in 5000 or better. These soundings, together with navigational plots, should be distributed rapidly to other participants. They should also make routine 900 ft. bathythermograph observations at 2-hourly intervals, and more frequently when crossing convergences and major current boundaries. Also, standard meteorological observations and thermograph recordings of surface temperature.

2. Other operations which require little additional ship time should be encouraged. In the geological-geophysical category these include shallow sub-bottom reflection measurements, by sparker or sonoprobe, cores, bottom-photographs, dredging, magnetic measurements, and gravity observations from the larger and more stable vessels. These are not programmes like those in paragraph 1, to be expected of all ships.

3. Some or all the following types of observation should be carried out by ships making geological and geophysical expeditions. (See also Annex 1 for procedures, and report of second SCOR meeting in New York 1959, for summary of problems.)

(a) Precise bathymetric exploration, particularly of seamounts, ridges, trenches, and shelf and slope-topography.
(b) Continuously recorded magnetic intensity measurements.
(c) Continuously recorded gravimeter observations by suitable surface ships and pendulum gravity observations by sub-marines where ever available.
(d) Bottom photography, often in conjunction with rock-dredging to determine the abundance and distribution of manganese nodules on the deep-sea floor.
(e) Rock-dredgings as frequently as possible. Any biological specimens attached to the rocks collected should be preserved separately.
(f) Heat flow measurements in patterns appropriate to structure investigated.
(g) Collection of large water samples for radio-isotope dating and trace element analysis.
(h) Collection of gravity and piston cores with duplicate cores in areas of special interest. Piston cores with core barrels 30 feet or more in length are recommended.
(i) Seismic refraction measurements. Measurements by two ships making continuous profiles across transition zones and major structural features are desirable. Short profiles yielding information on shallow crustal layers may be carried out with small auxiliary shooting boats, or sono-buoy arrays. Since two rather large vessels are required to shoot the long seismic lines needed for measurements to the base of the crust (or the Mohorovicic discontinuity), the working-group recommends that special efforts be made for cooperative two-ship cruises, and that in addition funds be sought by the geophysical expedition to provide shooting ships, available at various times and places, for a total of about one ship year.

4. The working-group recommends that grants and fellowships be sought for travel and training of students, and for exchange of visiting scientists, both at sea and on shore. It suggests that the selection of recipients of such aid be made jointly by the laboratory where the students are to work, and by the agency providing the money.

5. To avoid duplication of effort, to ensure the widest possible coverage, and to ensure that all regions are adequately covered, means of rapid exchange of information about completed ships tracks, types and positions of operations completed, and programmes of proposed cruises is required. The working-group recommends that this information be distributed to all participants immediately on the completion of each cruise or of each part of a major cruise, either by a central office or by the laboratory actually responsible for the cruise.

6. Comments and suggestions on sounding techniques and procedures are appended in Annex 1.

The working-group consisted of Messrs. R.L. Fisher, B.C. Heezen, A.S. Laughton, J. Nafe, J.N. Nanda, and E. Seibold. Observers were Professor Hales, Commander Hunt and Dr. Neev, P.L. Bezrukov, A. Zhivago, and H. Niino were unable to attend.

APPENDIX IV

Report of the Biological Working-Group for the Indian Ocean Expedition

The working-group met on 16 and 17 July at the Parliament Building in Copenhagen and on 18 and 19 July at the Headquarters of the International Council for the Exploration of the Sea in Charlottenlund. Those present were: Miss Ray and Messrs. Austin, Bary, Bé, Bruun, Currie (Chairman), Davies, Fedorov, Fraser, Hall, Hansen, Humphrey, Ketchum, Krey, Laevastu, Pannikar, Snider, Steele, Steeman-Nielsen, Steinitz, Sugawara, Vetter, and Zenkevitch.

The primary biological aims of the expedition should be:

1. To study the three dimensional distribution of plants and animals.

2. To investigate the quantitative ecology of the plankton.

3. To collect as much information as possible within the scope of an oceanographical expedition about potential fisheries in the Indian Ocean.

As the expedition will be formed of a series of national contributions it is considered that while these nations work on problems of more specific interest to themselves they should also contribute to a general biological (reconnaissance) survey of the ocean. It is realised, however, that some of the ships taking part will neither be equipped nor staffed specifically for biological work and so it is proposed that the biological work requested from all ships should be kept to an absolute minimum. Such a programme must necessarily be confined to a study of the surface layers and to a limited section of the flora and fauna. To supplement this minimum programme, it is proposed that some of the larger ships with suitable biological staffs should make more detailed observations. If these are disposed along three meridional sections and repeated as much as possible in different seasons they should suffice to give a basic picture of the biological structure of the ocean. These two programmes together are considered to be the minimum amount of work which is essential, but for ships unable to participate to this extent in the biological programme a specially abbreviated alternative is proposed.

Besides the general biological survey the ships will have their own special tasks to perform in the area, and these should in most cases supplement the information obtained by the general biological survey. It is considered neither desirable nor necessary to make detailed proposals for work on these special tasks as the methods used will depend very largely on the problems being tackled. For information, however, a number of problems of particular interest in the Indian Ocean are noted in Annex 1 to the biological programme.

The basic biological programme to be undertaken by all ships taking part in the expedition.

Underway observations

1. Standard meteorological observations.
2. Continuous records of sea surface temperature.
3. Records of
   (a) Discoloured water and accumulations of plankton
   (b) Fish mortalities
   (c) Fish shoals observed on the surface and also on recording echo sounders
   (d) Depth and intensity of scattering layers shown on the recording echo sounders
   (e) Occurrence of flying fish, squid, turtles, sea snakes etc. and surface living animals such as Physalia, Velella, Janthina
   (f) Whales, dolphins, porpoises (sharks, squid, etc.)
   (g) Seals and Sirenia in coastal waters
   (h) The occurrence of insects, (especially of locust swarms)
   (i) Numbers and kinds of oceanic birds, to be recorded at three or four hour intervals
   (j) Floating material far from land such as land vegetation, drift wood cuttle bones, Spirula shells, pumice, etc. (samples should be collected)

Instructions for the above observations should be prepared and distributed to all ships.

The sub-committee recommends that it would be most desirable to have continuous records of the incident radiation on the sea surface and proposes that the meteorologists should be approached with a view of their cooperation in such a project.

Station observations

(to be made if possible at all hydrographic stations).

Daytime Stations

(preferably at 1200 local time and in any case between 1000 and 1400).

(a) Depth of sampling will be determined by measuring optical depths.
(b) Samples taken from 6 optical depths 100%, 75%, 50%, 25%, 10%, 1% to be measured for chlorophyll content and used for C_{14} determinations of photosynthesis using the simulated "in situ" technique.
(c) Nutrients to be measured as recommended by chemical working-group.

Night Stations

(2200 hrs. local time).

(a) Vertical net haul 200-0 metres. Displacement volume of catch to be measured on board with apparatus provided.
(b) Horizontal net haul near surface with a one-metre net towed for 30 mins, and if possible at the same time an oblique haul with similar net from 100-0 metres. Displacement volumes to be measured as in (a).
(c) Estimations of nutrients.

The extended biological programme to be undertaken by selected ships.

This work should, if possible be performed on three meridional sections in the Indian Ocean, along approximately 62°, 78° and 95° East extending from the continent southwards to the southern subtropical convergence. This programme will be as the basic programme but will include also:-

At night stations

Vertical net hauls in the depth intervals 1000-500m, 500-200 m, and 200-0 m.

At day stations

After the station a high speed sampler will be used to sample fish eggs and larvae.

Also at 500 mile intervals on these lines of stations tows with a mid-water trawl (such as the Isaacs-Kidd trawl) will be made between 1000 metres and the surface.

Ships which are neither equipped nor staffed sufficiently to undertake either of these biological programmes should be requested to do an absolute minimum of biological work which would include:

(a) The underway observations listed on p. 11.
(b) At night stations only, a single water sample taken with a Van Dorn sampler from one metre depth, filtered through a 0.5 u filter and preserved for chlorophyll analysis. Also a vertical net haul from 200 metres to the surface and a surface haul with a one-metre net after the station and towed for 30 mins.

Treatment of plankton catches.

All plankton should be preserved in 10% neutral formalin and it is proposed that the catches from oblique and horizontal tows should be divided by standard method, one half to be sent to a central handling station for plankton. This plankton station would primarily be a storage and sorting centre, but it is hoped that it might later be developed into a taxonomic centre in connection with the UNESCO training programme.

The committee felt that such a biological centre would most conveniently be stationed in India under the supervision of the Indian Government, but they stress the necessity for the appointment of a suitable director and staff to handle the collections. It is proposed that UNESCO should be requested to assist in the implementation of this as soon as possible.

Methods and equipment.

C_{14} method.	The recommendations proposed by SCOR working-group III at New York should be followed, but it is noted that these may need to be modified by developments resulting from work now in progress.
Chlorophyll.	The technique of Richards and Thompson should be followed but more precise details of the method will be submitted. Non-biological ships taking samples should preserve them by a prescribed method for later analysis in shore laboratories.
Zooplankton nets.	For vertical hauls a net of about 1/2 m^2 mouth area having nylon netting with a mesh size of 160-180 u should be used. The hauling speed should be 1 m/sec. and the net should be fitted with a flow-meter. For the horizontal and oblique hauls a net with 1 metre diameter mouth area and netting of 30 meshes per inch should be used, towed at a speed of 1-2 knots. This net should also be fitted with a flow-meter. Decisions on the type of sampler to be used for the high speed towing has been postponed to await the recommendations of the ICES herring committee (and other evaluation).
Biomass.	The displacement volume of catches from the vertical net hauls should be measured by a standard technique to be described in detail later.

Shore laboratory facilities.

Some facilities at selected shore stations will be necessary for the estimation of chlorophyll in samples taken by ships not specially equipped.

Supply of equipment.

At the selected shore laboratories spectrophotometers will have to be available, and also centrifuges.

Dr. Humphrey has suggested that if the Australian method is used for displacement volumes, then his laboratory would probably be able to supply the necessary apparatus.

The plankton nets recommended for the basic programme will have to be prepared for some of the participating ships.

Plastic 5 litre water sampling bottles of the Van Dorn type will be needed for nearly all of the ships.

Submarine and deck photometers may be necessary for some of the ships taking part in the extended biological programme.

Flow-meters will be needed by most ships.

Supplies of glass plankton storage jars of the "Kilner" jar type.

Filters, filtering apparatus and desiccators will be needed for the chlorophyll measurements. Gear which cannot at present be specified will be needed for the C_{14} measurements in selected ships.

If radiation measurements are done, recording thermopiles would be required.

The need for adequate supplies of spares of all this equipment is emphasized.

Observations by merchant ships.

It is suggested that the organisations sponsoring the merchant ships and fisheries surveying ships which send in visual or instrumental reports of, for example, discoloured water, whales, current rips etc. should be made aware of the expedition and requested to cooperate as fully as possible, as their observatories would be a valuable supplement to the work of the expedition.

ANNEX 1 to the Biological Programme

Special problems in the Indian Ocean.

The sub-committee is aware of the importance of many special problems in the Indian Ocean and believes that some of these can be the subject of special investigations. It is essential that the organisation of these special investigations be left to the specialists undertaking the work, and it is proposed that facilities should be available for specialists cooperating on such problems to meet together to plan their programmes. In much of this research close cooperation with the physical and chemical programmes will be essential and the work planned must depend on agreement between the biologists and the specialists in the other disciplines. Some possible subjects for special investigations are:

1. Upwelling and piling up of water along coasts.

It is hoped that when surveys of areas of upwelling and "anstau" are made attention will be paid to questions of the development and succession of phyto and zooplankton populations and of decomposition and nutrient regeneration in the coastal regions.

2. Equatorial divergence.

Since the problem will be studied intensively by the physical oceanographers, if possible the programme should be extended to include the effects on productivity.

3. Coral reefs.

It has been suggested that the productivity of coral reefs might be studied in the region of the Red Sea and it is possible that some countries in the area may be able to undertake this work. (For comparison similar studies should be made of central Indian Ocean reefs.)

4. Fish mortality.

The occurrence of extensive fish mortalities, particularly in the Arabian Sea has been noted. It should certainly be a task of the expedition to try to collect more information about the occurrence, extent and cause of such mortalities. The causative factors most worthy of consideration are sudden changes in water temperature, lack of dissolved oxygen in the water and the presence of blooms of certain micro-plankton organisms which are capable of releasing toxins into the water.

In the past these factors have been observed either together or separately in coincidence with mortalities, but the question of greatest importance is to determine the sequence of events as some of these manifestations may be resultant rather than causative.

5. Other special problems.

It is hoped that the study of the quantitative and qualitative distribution of the benthos (any rocks obtained in biological sampling should be retained for the geologists), and the biomass of the deep sea plankton will be included in a few national programmes. Other questions such as the particulate carbon/chlorophyll and the protein/chlorophyll ratio may be studied on some ships.

6. Regions of convergence.

Japanese experience has shown the importance of regions of convergence to oceanic fisheries and these features should receive special attention in exploratory work for potential fisheries.

Annex 1 to Report on Geology-Geophysics-Bathymetry

1. Base maps.

It is suggested that all soundings from the Indian Ocean available to date be collected and evaluated by one office, agency or laboratory, and copies of the evaluated data, preferably in the form of easily-reproduced plotting sheets, be made available to participants in the Indian Ocean Expedition. Countries taking part in the Expedition should now furnish all data from their files. Several hydrographic offices make such compilations, and a special effort should now be made to ensure that they get all soundings that have been made. Among agencies doing this work are the British Admiralty and the Scripps Institution. The sounding data should then be contoured by

experienced marine scientists, if special areas of interest are involved. The contoured base map should be reviewed by other scientists interested in the area.

A smaller scale version of the contoured data should be prepared and distributed for use in planning cruises. This chart, like the larger sheets a Mercator projection, should show the Indian Ocean and surrounding seas on the same scale as the General Bathymetric Chart of the Ocean (1:10.000.000 at the Equator).

An accompanying index chart to the same scale (1:10.000.000) should show sounding tracks and indicate areas of special interest or where data are most needed.

This compilation and collection of data should be started soon so that the soundings and resulting base charts will be available for planning all the work to be done after the middle of 1962.

2. Preservation of bathymetric materials and data.

All ships in the Expedition should be requested to prepare and preserve navigational plots of the ship's track. These plots or lists should include all fixes, times, course and speed changes and the like. The data should be in graphical or list form, preferably the former. The adjusted plot should be on a scale of 1:1 million or approximately 4 inches to a degree of longitude. Mercator plotting sheets of the scale agreed on should be made available for use at sea.

It is further suggested that navigational plots with soundings be prepared on the 1:1 million scale, in a form such that copies for general distribution can be made inexpensively. On these plots, soundings should be noted at intervals of not greater than 2 miles, and at all significant peaks, troughs and breaks-in-slope along the ship's track. Changes in the degree of roughness (average amplitude and length of bottom irregularities) should be noted. Soundings should be plotted as the nominal depth read from the sounder. On each plot the nominal sounding velocity must be specified. If corrected soundings are plotted, the method of correction must be indicated.

Echo-sounders should be operated continuously on a recording scale sufficiently expanded to allow soundings to be read to 2 m (1 fathom) at all depths. A minimum transmission length (ping-length) adequate to obtain a well-resolved record is required. Ordinarily, a 2-3 millisecond transmission is advisable to permit resolution of sub-bottom echoes. Records must be marked with date, local time, and depth scale at least hourly, and at each course and speed change. Echograms should be preserved either by the laboratory or agency taking them or by a designated office.

It is strongly recommended that echo-sounders with built-in time bases good to 1 part in 5000 or better be employed. Such instruments as the Precision Depth Recorder (made by Times Facsimile Company, Westrex Corporation, New York), the Precision Graphic Recorder (Alden Industries,

Massachusetts), the N.I.O. Precision Echo-sounder, and the special precision sounder made by ELAC (Kiel) are suitable. If other sounders are used, special effort to regulate, calibrate, and monitor the time base is required to obtain comparable soundings. All ships operating outside the continental shelves should be equipped with recording sounders capable of sounding the greatest ocean depths.

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

SPECIAL COMMITTEE ON OCEANIC RESEARCH

(SCOR)

Helsinki, 23 July 1960

Report of the Coordinator, International Indian Ocean Expedition

Organization

The Office of the Coordinator, with headquarters at 30 East 40th St., New York 16, N.Y., was established on 1 December 1959 with the financial support of the U.S. National Academy of Sciences. The Coordinator's first efforts were the initiation of correspondence with SCOR National Committee members and other scientists throughout the world in preparation for a trip to discuss Indian Ocean Expedition plans with them.

Contact with National Committees

From late January to late March 1960 the Coordinator visited fourteen nations to discuss the extent and nature of their participation in the Expedition as well as the possible assistance of various international organizations. Nations visited were Japan, Singapore, Indonesia, Ceylon, India, Pakistan, USSR, Federal Republic of Germany, Great Britain, Netherlands, Switzerland, Portugal, France and U.S.A. During this period individual discussions were held with almost 200 senior scientists, national policy shapers, administrators, international organizations officials, potential Fund sources and other scientists and officials.

The immediate purpose was to stimulate national action in planning and organizing the various countries' efforts in the Expedition. Prior to 1 February virtually no nation visited had yet held a meeting of its National Committee to deal with the Expedition and in some countries no National Committees had been formed.

In the discussions, the desirability of having national plans developed prior to 1 July 1960 was emphasized. The following items were suggested for consideration and inclusion in national reports:

1. Formation of National Committee (where necessary)

2. Statement (at least in principle) of national participation.

3. Detailed statement of extent and nature of participation (if possible).

    a. Development of national research program.
    b. Designation and description of participating ships and time schedules.
    c. Detailed equipment requirements list.

d. Tide gauge installation and operation (by Indian Ocean nations).
e. Nomination of qualified professional and technician trainees (by Indian Ocean nations).

4. Estimate of cost of national effort in Expedition.

5. Indication of extent of official hospitality, port facilities and waiver of formalities for Expedition vessels.

6. Extent of logistic assistance and laboratory facilities available (from Indian Ocean nations).

Discussions also dealt with participation of scientists in the Indian Ocean Working Group, navigational systems available, intercalibration of ships and procedures, publication plans, special financing methods, integration of meteorological research and service into the expedition program, and related items.

In addition to national representatives the Coordinator discussed the Expedition with the President and the Administrative Secretary of ICSU, the Director General of WMO, representatives of UNESCO and FAO, the Director of the UN Special Fund, the Director of the Colombo Plan Bureau, national and regional representatives of U.S.I.C.A., and the administrators of the Tata Foundation, the Nuffield Foundation, the Wolfson Foundation, the Gulbenkian Foundation, Rockefeller Foundation, Ford Foundation and others. The Coordinator also represented SCOR at the UNESCO Preparatory Meeting for the Intergovernmental Meeting on Oceanography in Paris.

Additional contact has been maintained with the National Committees of Australia, South Africa, Israel, China (Taiwan), Netherlands and Denmark.

As an immediate result of the trip it is possible to estimate the extent of training facilities available in various nations for post-doctoral or advanced post-masters degree candidates. Qualified advanced students from other countries could be trained for six months to one year, primarily on ship board, in the following quantities: Japan, one in each of seven fields of Oceanography at any one time, in English; United Kingdom, approximately nine at any one time; United States, at least fifty in various fields at any one time. In each instance tuition cost is borne by the training institution, but travel and subsistence must be provided. USSR can and has trained Indian Ocean nationals at sea.

Program Planning

Following the nomination by SCOR's Executive Committee of a reconstituted Indian Ocean Working Group to develop an overall scientific plan for the expedition, invitations were forwarded to nominees. Dr. G.E.R. Deacon of the U.K. agreed to serve as Chairman, Dr. V.G. Kort of USSR as Vice-Chairman; and the following individuals agreed to initiate sub-committee planning in their respective fields: Marine Geology, Geophysics and Bathymetry: Dr. R. L. Fisher of U.S.A. and Dr. P. L. Bezrukov of USSR - Co-chairmen; Marine Biology:

Mr. R. L. Currie of U.K. - Chairman; Physical and Chemical oceanography (and Meteorology): Dr. G.E.R. Deacon - Chairman. The full Working Group membership will be found in Appendix A of this report.

Each nation or institution likely to participate in the expedition with vessels was asked to submit replies to a questionnaire describing ships' characteristics, facilities, equipment, performance, and equipment needs. Full data on 22 vessels has been received and tabulated.

Extended discussions were held with U.S. Government agency representatives and staffs of oceanographic laboratories to assist in determining the extent, nature and timing of the U.S. effort in the expedition. After approval of participation was obtained from the Federal Council on Science and Technology with endorsement from President Eisenhower, the National Science Foundation and the Navy Department have agreed to provide Financial support for U.S. participation.

Reports from various nations indicate the following ship facilities will be available at a minimum:

Australia. Two vessels during period 1960-64 covering North, South and West (to 100° E) of Australia plus one cruise to Africa and return near 32°S.

British East African Territories. Possibly one vessel conducting research off east coast of Africa between Aden and Zanzibar beginning 1962.

Federal Republic of Germany. Possibly one vessel in 1963 or 1964 in northwest Indian Ocean.

France. One vessel during summer 1960 and 1961, 4°N to 32°S. Two cruises 1962-3 in western Indian Ocean, one in each monsoon.

Japan. Five vessels commencing 1962 making cruises on five tracks from the Bay of Bengal to 32°S during one monsoon. Possible cruises by other vessels during second monsoon.

Pakistan. Probably two vessels after 1961 operating north of 16°N in Arabian Sea and Bay of Bengal.

South Africa. Three vessels operating within 500 miles of South African Coast during period of Expedition.

U.S.S.R. Two extended cruises in northern and middle Indian Ocean by VITJAS in 1960-62. Three other vessels in northwest, central west and southwest Indian Ocean respectively in 1960-61.

United Kingdom. At least two cruises totaling approximately 7500 miles in each monsoon from 0° to 20°N in western Indian Ocean, 1962-3 by N.I.O. vessel. Two cruises 15°N to 10°S, East Africa to 75° East by U.K. Hydrographic Survey vessel, 1961-3.

U.S.A. Five cruises by three vessels totaling 34 months 1960-63. Western Indian Ocean, equatorial regions and primarily geological and geophysical cruises southern and western halves of Ocean. Possible additional cruise 1963-4.

The following countries plan to put scientific parties on board other nation's vessels: Denmark, Netherlands, Israel, Nationalist China. Israel has prepared a national program for scientific research.

Ceylon, India, Indonesia and possibly Portugal will participate. Their National Committees have not yet determined the extent of their effort.

Most vessels will have room for guest scientists. Such capacity varies from 2 to 16. In general, arrangements for carrying visiting scientists and exchanging scientific teams are worked out by individual laboratories or National Committees.

It is probable that additional cruises will be scheduled as the details of the scientific program and the research opportunities become more widely known.

In most instances nations have made specific cruise plans only through 1962. General coverage of the Indian Ocean above 32°N seems reasonably complete. Regions off the coasts of South Africa and Australia southward are covered and reconnaissance cruises in the mid ocean below 32°S will be made. Further coverage may be developed as the Expedition progresses. A schematic diagram of recent and impending cruise tracks is found in Appendix B.

Most nations will finance their own efforts. Those requiring assistance should turn initially to existing international fund sources of an inter-governmental or bi-lateral type for equipment procurement and other funds.

There has been insufficient time for many countries to provide a complete picture of the extent of their efforts. It is hoped that early action by National Committees may supply this necessary information. This is particularly important in the nomination of trainees because of the time required for arrangements.

Robert G. Snider
Coordinator

APPENDIX A

SCOR

INDIAN OCEAN WORKING GROUP

Dr. George E.R. Deacon (UK) - Chairman
Prof. V.G. Kort (USSR) - Vice Chairman
Mr. Robert G. Snider (USA) - ex-officio

Sub-Committee on Geology-Geophysics and Bathymetry

Dr. Robert L. Fisher (USA))Co-Chairmen
Dr. P.L. Bezrukov (USSR))Co-Chairmen
Dr. Bruce C. Heezen (USA)
Dr. A.S. Laughton (UK)
Dr. John Nafe (USA)
Dr. J.N. Nanda (India)
Dr. Hiroshi Niino (Japan)
Dr. Eugen Seibold (Germany)
Dr. A. Zhivago (USSR)

Sub-Committee on Marine Biology

Mr. Ronald I. Currie (UK) - chairman
Prof. B.G. Bogorov (USSR)
Dr. David H. Davies (South Africa)
Dr. George F. Humphrey (Australia)
Dr. Johannes Krey (Germany)
Dr. Shigeru Motoda (Japan)
Dr. N.K. Panikkar (India)
Dr. John Ryther (USA)
Dr. John Steele (UK)

Sub-Committee on Physical and Chemical Oceanography
(with liaison to Meteorology)

Dr. G.E.R. Deacon (UK) Chairman (pro tempore)
Dr. S.V. Brujewicz (USSR)
Dr. Günther Dietrich (Germany)
Mr. Fritz Fuglister (USA)
Dr. Bostwick H. Ketchum (USA)
Dr. John Knauss (USA)
Dr. John Swallow (UK)
Dr. Paul Tchernia (France)
Dr. Michitaka Uda (Japan)

APPENDIX B

INTERNATIONAL INDIAN OCEAN EXPEDITION

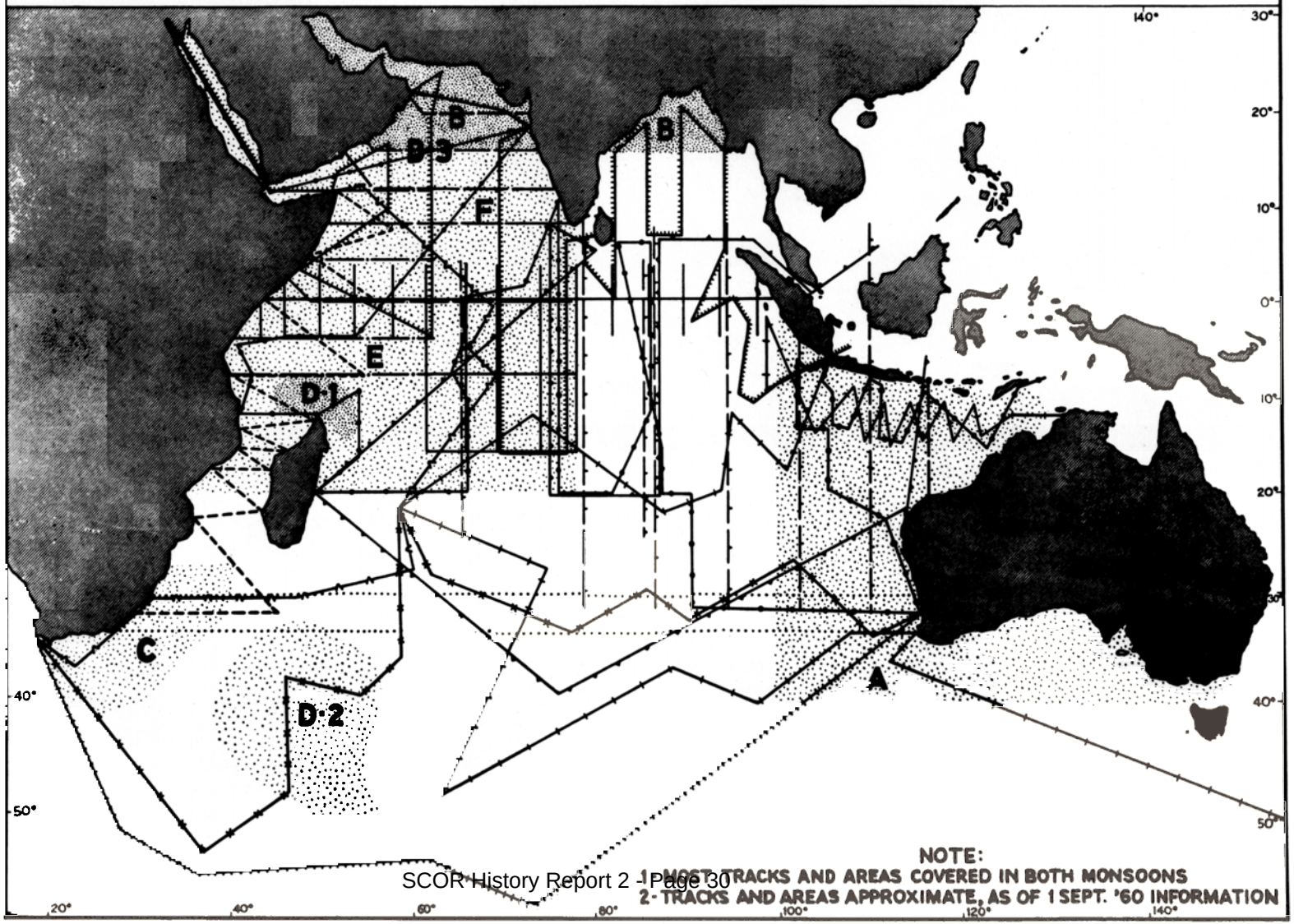
CRUISES COMPLETED AND PLANNED 1959-1963

TRACKS

AUSTRALIA - VIII-IX '62
FRANCE - VII-IX '60
JAPAN - '61-'63
USSR - X '59-IV '60
USSR - IX '60-III '61
USSR - VII '61-II '62
UK - N.I.O. '62-'63
UK - E.A.F.R.O. '62-'63
USA - LAMONT '59
USA - LAMONT '59-'60
USA - LAMONT '62
USA - SCRIPPS X-XI '60
USA - SCRIPPS VII '62-IV '63, VI '63-X '63

AREAS

A - AUSTRALIA
B - PAKISTAN
C - SOUTH AFRICA '62
D - USSR 1: VI '60, 2: I-III '61, 3: IX-XII '61
E - UK-HYDRO (15°N-10°S, E.AFRICA-75°E) X '61-IV '62, '62-'63
F - USA-W.H.O.I. (N.W. QUADRANT, INDIAN OCEAN) I-VI '62, VI-XII '63



NOTE:
1 - MOST TRACKS AND AREAS COVERED IN BOTH MONSOONS
2 - TRACKS AND AREAS APPROXIMATE, AS OF 1 SEPT. '60 INFORMATION

Conseil International Des Unions Scientifiques . International Council of Scientific Unions
Special Committee on Oceanic Research
(SCOR)

INTERNATIONAL INDIAN OCEAN EXPEDITION
30 East 40th Street . New York 16, N. Y. . LExington 2-6533

Coordinator
ROBERT G. SNIDER

Cables
SCORDINOC . NEWYORK

6 January 1961

CURRENT STATUS OF PLANNING FOR PARTICIPATION IN THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rough notes arising from R. G. Snider's Trip 13 November - 16 December 1960 to the Middle East and the East Coast of Africa and correspondence to 1 January 1961

UNITED KINGDOM

The United Kingdom has set up working groups in the following fields: Physical and chemical oceanography and meteorology; marine biology; and geology, geophysics, and bathymetry. In addition to cruises in both monsoons in the latter part of 1962 and first half of 1963 by the new R/V DISCOVERY across five E-W lines from the Arabian Peninsula and Northeast Africa to India and points South, the Admiralty hydrographic vessels will also run one cruise in early 1961 in HMS DARLYMPLE along the Arabian Peninsula Coast from the Red Sea to the Persian Gulf. HMS OWEN will run five lines in a period from October 1961 to the Spring of 1962 in a Northeasterly direction Southwesterly direction in the upper half of the Arabian Sea going as far South as Rodrigues and Mauritius. In addition, the East African Marine Fisheries Research Organization operating out of Zanzibar with probable support through the Royal Society, in addition to its usual support with the East African High Commission and CD&W funds, will operate from the East African Coast on a number of cruises well to the Eastward of Madagascar.

The Royal Society is also considering a cruise for botanical and geological observations in the islands of the upper Southern part of the Indian Ocean. Current plans call for oceanographic observations in conjunction with this cruise which may occur in 1962-1963. Islands to be visited are Amsterdam and St. Paul, Kerguelen, the Crozets, and Marion. Plans contemplate systematic ocenographic work not only along the ship's track but also in the general area while the land party is carrying on its investigation.

PAKISTAN

After extended planning and discussions, it appears that Pakistan will have 2 vessels, the PMS ZULFIQUAR and PMS MADADGAR which will operate in the Indian Ocean, roughly North of 16° North. ZULFIQUAR, the Pakistan hydrographic vessel, will be available for about two or three years operating for about 6 months in each year. MADADGAR, which is a fleet tug (Ex USS YUMA ATF 94) will be available for a distance out to 400-500 miles from the Coast since she must stand ready duty for rescue purposes. Pakistan will probably be able to equip these vessels with oceanographic gear but there may be problems in obtaining deep sea winches and precision depth recorders. This is being investigated. These ships can take one to two senior scientists and

several technicians. ZULFIQUAR goes into refitting in April 1961 and will start its cruising in January 1962.

Admiral Khan the Chief of Naval Staff has indicated that Naval berths at Karachi will be available at no charge to Expedition vessels, and that visiting ships will be given other assistance. Furthermore, representations are being made to the Government of Pakistan for ship reception facilities at Karachi and at East Pakistan ports. Pakistan's total effort in the Indian Ocean Expedition has been estimated at 59 lakhs of rupees (slightly over $1,000,000 U.S.).

INDIA

A meeting with a portion of the Indian National Committee in New Delhi on 23 November revealed that a 2,000 ton naval frigate would probably be made available by the Indian Navy for 4-6 months a year for a period of 2 years. A mine sweeper would also be available on the same basis. Two fisheries vessels about 150 tons and 95 ft. length would also participate, as would 2 small ships from Andrha University and University of Kerala.

In general India plans to work on or close to the continental shelf in both the Arabian Sea and the Bay of Bengal, but will also go as far as 5-7 degrees South of the Equator.

The National Committee under D. M. Wadia has set up 4 working groups to design an Indian national plan. These groups are:

1. Meteorology and physical Oceanography.
2. Marine Biology and Fisheries.
3. Marine geology and geophysics.
4. Chemical Oceanography and radioactivity.

These working groups are expected to report in January 1961. They will identify physical facilities and personnel available for the Expedition as well as deal with hospitality, available buildings, etc.

About 20 scientists will be working at sea and on the beach in connection with India's own effort. As in Pakistan and some other countries, concern was expressed about the cost and availability of some oceanographic equipment as well as precision depth recorders, and a question was raised about joint or cooperative purchasing by several nations in the Expedition. With regard to the Biological Research Center it was estimated that setting up new facilities including buildings would require about 6 months. Construction costs were estimated at $4.00 per sq. ft. for brick construction including fittings or about $3.00 per sq. ft. for the shell of a building. India is thinking in terms of a staff of about 35 people at a cost of about 5 lakhs of rupees per year (approximately $100,000).

EAST AFRICA

Discussions were held with Mr. E. B. David, C.B.E. Administrator of the East African High Commission in Nairobi and with other members of his staff including Lt. Col. S. P. Fearon Administrative Secretary of the East African Council for Agriculture, Animal Husbandry and Fisheries

Research, Major P. F. Smith of the Fisheries Research Organization, Mr. J. M. Fogarty of the Railways and Harbors Administration, Mr. B. W. Thompson, Acting Head of the Kenya Meteorological Service, and Mr. D. N. F. Hall, director of the African Marine Fisheries Research Organization at Zanzibar.

It was agreed that this group of individuals or agency representatives would serve as the equivalent of a National Committee for East Africa. All formal correspondence with regard to East Africa's participation would go through Col. Fearon. It was readily agreed that tide gauge information (under the auspices of the Railways and Harbors Administration of the High Commission) would be available to the Expedition. In addition, the Meteorological Service would be willing to participate actively (see separate notes on meteorological facilities).

The Marine Fisheries Research Organization at Zanzibar is getting a new seagoing crew for its research vessel MANIHINE, and they will start the cruise reports beginning 1 January, 1961. They will be prepared to send hydrographic data to data centers and with the new oceanographic equipment expected from the United Kingdom, they will be prepared to do a full oceanographic job in all fields. A main concern is the problem of handling Chlorophyl since they have no one to carry this out. They are also interested in getting special collections from various parts of the Indian Ocean of single species of marine animals.

Given political stability and some outside financial assistance, part of which is already indicated, East Africa is likely to play a strategic part in the Expedition, and there is every indication of a high degree of cooperation.

MALAGASY REPUBLIC (MADAGASCAR)

Because of the strategic location of Madagascar, I had extended discussions with a variety of scientists and government officials in an attempt to get formal participation by the Malagasy Republic in the Expedition. My initial contact was with Dr. Renaud Paulian, Director, Institute for Scientific Research for Madagascar, P. O. Box 434 Tananarive, Republique Malgache. I also talked with the following individuals: M. Louis A. Maugé, his associate; M. Follin, Cultural Attaché at the French Embassy; M. Norbert Zafimahova, Head of the Foreign Affairs Department in the Ministry of Foreign Affairs; Captain Lionnel, in charge of the Department of Lighthouses and Harbors in the Ministry of Public Works; M. M. J. Scheidecker, Head of the Meteorological Services; M. Despeaux, Adjunct Deputy Director of Customs; M. John Rakadomanana, in charge of Public Land Administration and a close friend of President Tsiranana, and with Vice President TSIEBO Calvin. I also talked with M. Rozier of the Coast Guard under the Ministre de Traveux Publique, and to M. Lacoste of the Postoffice and Communications Service; M. Michel Truffard, Assistant Manager of Stan-Vac Oil, and to U. S. Ambassador Frederick Bartlett and his Counselor, Mr. Jacobs.

My talk with M. Zafimahova dealt with the matter of hospitality for visiting vessels. He is responsible for relations with foreign

countries rather than with those in the French Metropolitan Community, and he was President of the last Parliament. He said that in principle hospitality as requested by SCOR Indian Ocean Group could be offered by the Republique Malgache, but that arrangements would have to be made by individual ships or countries. As a result primarily of my discussion with him, a formal letter was addressed to President Tsiranana inviting the Republique Malgache to be an active and formal participant in the Expedition. This letter was designed to start the internal action with the Customs Service, Ministry of Finance and the Ministry of External Affairs, among others, to consider the needs of visiting ships.

My talk with M. Despeaux revealed that harbor dues were under the Merchant Navy Bureau and were applied only at Tamatave and would probably be waived for Expedition vessels. Fuel tax would also be exempted, and other taxes would be subject to decision by the Minister of Finance. He said there would be no difficulty for vessels coming in with explosives at any port since they can be put in secure storage and then the ships could come alongside. He further said that Customs would give all possible help to vessels. He felt that the Republique Malgache would be able to give the participating vessels the same courtesies as those given to diplomats. It was suggested that whenever ships plan to arrive at ports in Madagascar, they should advise Dr. Paulian's organization (Institute for Scientific Research for Madagascar) well in advance, and this organization would make appropriate arrangements for their reception.

Much of my subsequent discussions dealt with tide gauge installations and meteorological facilities, both of which are noted in separate memoranda thereon. With regard to the Woods Hole proposal for measuring current in the Mozambique Channel by electrical potential differential, I found that there is no cross-channel cable. There is one cable running from Zanzibar to Durban. However, preliminary discussions were held to make tentative arrangements for installation of shore stations on the West Coast of Madagascar and in Mozambique, if these were desired. The narrowest crossing of the Mozambique Channel is from Mozambique Island to Cap St. André on the Western shoulder of Madagascar. However, there is no electricity at Cap St. André, and any shore installation there would require a portable generator. The nearest public power is at Majunga. The crossing from Mozambique to Cap St. André is slightly less than 230 miles. The principle for establishing a shore station for such measurement was discussed with Capt. Lionel, and he would be the individual responsible for making arrangements. In principle he saw no objections to this.

M. Maugé of the Institute listed the senior personnel and facilities of the research station at Nossy-Bé. M. Menache is the Director of the station and is a Physical Oceanographer. M. Fourmanoir is a specialist in the biology of fish. M. Crosmier is a specialist in the technology of fishes, and M. Frontier, in plankton. They have a crew for 2 ships and administrative personnel totalling 35 persons, including workers and labor. They have a library, good laboratory, (45 ft. by 24 ft.) and a 30 cubic meter aquarium with direct sea water.

M. Rozier of the Coast Guard indicated that some ships, particularly State vessels, are now relieved of pilotage fees but a formal arrangement must be worked out with the Ministry of Public Works. M. Rakadomamana agreed with statements of other individuals that in principle it would be perfectly feasible to get the use of land for shore stations such as current measuring stations, but he pointed out, as did others that final decision rested with the President, who is unquestionably the positive leader of the country.

Col. Gaetan, who is Military Attache at the French Embassy, said that the repair facilities at the major French Naval Base at Diego Suarez no doubt be later available to ships of the Expedition. Communications should be directed to the Naval Base maintained at Diego Suarez and preliminary negotiations would have to be worked out with the French Naval authorities in Paris, particularly in order to get priorities for emergency work. Any use of Diego Suarez radio communication facilities would have to be arranged in France.

Although the Island of Juan de Nova is under the control of the Ministre d'Outre-Mer in France, the economic activity is controlled from Mauritius. This island in the Mozambique Channel might serve as a shore base for a party investigating nearby problems. It has an airport with capacity of handling DC-3's and smaller aircraft and there are quarters for 10 persons on the island. There is an anchorage 1-1/2 miles north of the island, and there is radio communication to Tananarive. In Mauritius I saw Hector Pateroe of St. Pierre, Mauritius, (Tel. Moka 212) who is a Director of Rogers & Co. which controls the cocoanut plantations guano collection, and other activities on the island. He reported that Mr. Amedie Maingard controls the M/V Mauritius for Rogers & Co. M. Maingard represents CAL-TEX, AIRFRANCE and various shipping interests. Mr. Pateroe said that if any part of the Expedition was to use Juan de Nova they might write direct to him in detail to receive any assistance he could give. I talked also to M. La Coste of the Post-Telegraph Department about communications. There is a high frequency station at Tamatave which relays to Tananarive. On CW they work to Suez and on R/T for about 100 miles from Tamatave. They also work Kerguelen and Amsterdam.

M. Truffard, the assistant manager of Standard-Vacuum East Africa came to see me at my hotel about the possible fuel requirements of ships in the Expedition. He said that at the present time there is no bunkerage atTamatave but there may be in a couple of years. At the present time they can only supply fuel at the Naval installation at Diego Suarez. Two months notice is required to Stan-Vac to supply fuel there.

He also indicated that for refueling in the South Indian Ocean they could store ANY amount of oil in drums at Kerguelen. The supply vessel serving Kerguelen is under the control of the Mission Des Terres Australe which is part of the Ministre d' Outre-Mer in France. She goes annually to Kerguelen in September or October picking up oil in Tamatave. He also said that he did not know of the varieties of fuel available at Port Louis. He says that Durban has everything and there is a refinery there. Other major fueling points are Dar-es-Salaam, Mombassa, and Djibouti.

MAURITIUS

My visit to Mauritius was for the purpose of finding out what assistance the British Colonial Government could give to the Expedition. I have had discussions in London with Mr. C. E. Lambert of the Colonial Office who had informed the local government of my impending visit. As a consequence, the Colonial Secretary had arranged a number of conferences for me.

I saw the following people in Mauritius:

Mr. F. M. Lassemillante, (Acting Principal Assistant Secretary, Ministry of Agriculture and Natural Resources.)
Mr. Jean Baissac, (Fisheries Officer)
Mr. S. Staub, (Acting Deputy Director Agriculture.)
Mr. J. Vinson, (Director of the Institute of Mauritius.)
Dr. R. E. Vaughan, retired Director of the Institute.)
Hon. S. Boolell, (Minister of Agriculture.)
Mr. A. North Coombes, O.B.E., (Acting Director of Agriculture.)
Hon. A. L. Nairac, C.B.E., Q.C. (Minister of Industry, Commerce and External Communications)
Lt. Commdr. A. G. Booker (Harbor Master)
Mr. A. D. Swan (Director of Meteorological Services)
Mr. A. N. Bott (General Manager, Central Electricity Board)
Mr. G. Bunwaree (Principal Assistant, Ministry of Industry, Commerce and External Communications)
T. D. Vickers, Esq. C.M.G. (Colonial Secretary)
Sir Colville Montgomery Deverell K.C.M.G., C.V.O., O.B.E. (Governor of Mauritius)

The Colonial Office and the individuals I saw all made it clear that Mauritius would not be able to undertake any extra expenditures for the Expedition because of their very delicate financial condition. However, since Port Louis is an excellent port well into the Indian Ocean and the Mauritius Government controls islands to the East and North as far as approximately 1200 miles away, this is a strategic center.

In my discussion with various individuals I stressed the matter of assistance in tide gauge and meteorological installations (for details see separate memoranda on each of these), and on hospitality for visiting ships.

Mauritius is also interested in putting trainees on some passing ships for work particularly in Biological Oceanography and also in participation with shore parties on coral island investigations. They can arrange for return of personnel from East African ports. In regard to tide gauges, their assistance can be substantial. With regard to meteorological observations, most of the cost including that of operation might have to be assumed by other governments.

A special problem arises in connection with wave recording. They are interested in the possibility of electrical power generation either from waves or waves plus tidal impoundments. Mr. Bott indicated that some reef studies in connection with this had been carried out by Louisiana State University and that L.S.U. had offered some financial support to Mauritius for this. With regard to hospitality,

all of the points in the SCOR Indian Ocean Working Group memorandum were agreed upon in principle. Arrangements in detail are to be made according to Mr. Vickers, Colonial Secretary, through Mr. G. Bunwaree, Principal Assistant Secretary, Ministry of Industry, Commerce and External Communications. Mr. Bunwaree will be the individual who will be the coordinator, for the Colonial Secretary, of activities of the local committee which will probably be set up to enlist the participation of all agencies and individuals in Mauritius who might assist the Expedition.

UNION OF SOUTH AFRICA

On 8 December in Pretoria, I talked with Mr. C. G. Hide, Senior Liason Officer, Scientific Cooperation Division of the South African Council for Scientific and Industrial Research (CSIR). He brought in Mr. M. F. Baxter, the CSIR financial officer for preliminary discussion of the South African program. They pointed out that the presently planned South African effort exclusive of ship time, would run to about £ 100,000. The AFRICANA II is the best ship they have for research. She belongs to the Fisheries Administration and is used at the present time primarily for biology but she is fitted for deep sea oceanography and can probably handle geology also. AFRICANA II has no geographic limitations and is scheduled for a cruise out to 12-1500 miles to the East of South Africa and then Southwestward following or crossing the Agulhas current. She is scheduled for a 2 months cruise in 1961. In discussions later in Cape Town with Mr. DuPlessis, Director of Fisheries, I found she would probably be available in the same mid-year season in 1962 and 1963. The NATAL is a naval hydrographic vessel fitted for oceanographic and biological work but limited to about 500 miles off the coast and to points South of a line extending Eastward from the Northern border of the Union. JOHN D. GILCHRIST is a trawler attached to the University of Cape Town limited by its capabilities to about 200 miles from the shore. In addition, there is a new research vessel for use in the Antarctic which will be available in early 1962. This is an existing hull of about 3000 tons being strengthened and fitted for all types of meteorological and oceanographic research in addition to support of Antarctic parties in Queen Maud's Land. £ 32,000 extra is available for equipment and specific projects to be conducted by various universities and CSIR. This is above the ordinary outlays. On top of this the ships are provided by the Navy, the Ministry of Transport, and Fisheries Department.

South Africa is interested in carrying out sedimentary analysis and Carbon 14 measurements, but needs equipment for both of these. For Gravimetry they have budgeted £ 10,000 for equipment but they need additional £ 20,000 for stabilizing equipment. Discussions with Mr. M. P. Van Rooy, Director of the Weather Bureau, and his associates are outlined in a separate memorandum on meteorology.

I paid my respects to U. S. Ambassador Philip Crowe whom I had known for some time, and left a copy of the basic documentation on the Expedition with Mr. P. R. Cook, his Economic Counsellor, and Cdr. Oliver Norman, U.S.N., Assistant Naval Attaché.

I met Dr. S. M. Naudé, President of CSIR and Chairman of the South African Oceanographic and SCOR National Committee, and Dr. E. J. Marais, Director, National Physical Laboratory, one of whose institutes is the Oceanographic Unit. Mr. Anderson of this Unit has just moved his headquarters from Cape Town to Durban. I discussed the plans of other countries in the Expedition and pointed out that many were setting up special working groups to develop plans for each of 3 or 4 disciplines. I think South Africa has done considerable planning on this project and I believe they will follow the general pattern including the development of substantial meteorological programs. The National Physical Laboratory is interested in doing water dating and they want to develop C^{14} and Tritium programs. Faced with existing budgetary limitations, they are wondering whether to give up a gravimetry program in the place of the C^{14} program. The cost would be less, and one question in their minds is which would be considered the most important for the Expedition.

With regard to hospitality for ships, I saw Mr. Peter Philip, Head of the Political Division for Scientific International Relations in the Ministry of External Affairs. Since South Africa is not a member of UNESCO, he suggested that the correspondence for obtaining hospitality for visiting ships be undertaken by the President of SCOR rather than UNESCO, since South Africa has official connection with SCOR. Mr. Philip personally saw no problem in providing the facilities for ships which are desired. He feels that South Africa would approve the matter in principle, but would require notification for each arriving ship.

Mr. Hide agreed to serve as the Coordinator for all arrangements between the Expedition and South Africa. He said that if we desired to set up logistic centers at South African ports that these would be handled by CSIR, probably under the local administration at Cape Town of Professor John Day, and at Durban by Dr. David Davies. He also pointed out in connection with navigation that the Pretoria Observatory repeats the WWV time signal with the appropriate time correction for differences in location. They may be able to provide full Indian coverage for this.

In Durban I talked with Dr. David H. Davies, Director of the South African Association for Marine Biological Research at the University of Natal; Mr. Alan O. Simpson, President of the Association; Dr. George Campbell, Chairman of the Association's Board; Mr. F. Anderson and Mr. Christo Stavropoulos of the Oceanography Division of CSIR's National Physical Laboratory at Durban and some others. I visited the Centenary Aquarium which combines research and public display and saw the plans for the substantial extension of this institution primarily for research purposes. Since Dr. Davies is both a member of the South African National Committee and SCOR's Indian Ocean Working Group, I reviewed the progress and plans for the Expedition. My discussions with Mr. Anderson and Mr. Stavropoulos dealt largely with their plans for systems of automatic recording of oceanographic phenomena, South African salinometers developed by Anderson and their general plans for physical oceanographic work on AFRICANA II during her cruises as far East as Mauritius (58° E) and Southward to 38° S.

In Cape Town I talked with Dr. John H. Day, Professor of Oceanography at the University of Cape Town; CDR. J. K. Mallory, SAN, the Hydrographer of the South African Navy; Professor Trotti, Visiting Professor of Oceanography from the University of Genoa; Professor Orens, the new head of University's Department of Geochemistry; Mr. C. G. du Plessis, Director of Fisheries; Dr. B. Vandyk de Jager, Assistant Director of Fisheries; Mr. James Curran, U. S. Vice Consul in Cape Town, and a number of other individuals connected with the Expedition at the University, the headquarters of the Fisheries Department, Hydrographic Office and on board the AFRICANA II, the NATAL and the JOHN D. GILCHRIST. Day, Mallory, and du Plessis are members of the South African National Committee for SCOR.

Professor Day will be leaving South Africa on a year's leave of absence in early February to work in the U. K. During this time professor Eric Simpson of the Department of Geology at the University of Cape Town will take Professor Day's place as Chairman of the South African National Committee's Oceanography Steering Committee. Day described the organization of his department of oceanography in which he has formally established cooperation with a number of related disciplines by bringing in professors from other fields into the department on a part-time basis while maintaining a central oceanographic core. He went on to point out that the University of Cape Town is especially interested in the Agulhas current whereas the Fisheries Department has devoted most of its effort heretofore in the Benguela current of the West coast.

Day went on to describe the activities of some individuals and institutions in South Africa that I was unlikely to see. The Museum and Oceanarium at Port Elizabeth might operate a ship in the latter part of the Expedition working out to about 100 miles from the coast. Dr. G. R. Mc Lachlan is the Director of this museum. Professor A. L. Hales and Professor Sax of the Bernard Price Geophysical Institute, University of the Witswatersrand; Dr. Van Veeck of the Seismological Observatory under the Trignometrical Survey and Professor Simpson of the University of Cape Town are particularly interested in geophysical problems. Mr. Frank H. Talbot, Deputy Director of the South African Museum is a physical oceanographer and works closely with Day. Talbot is also interested in tuna.

Professor Orens is interested in establishing a service for the Expedition in his laboratory to analyse all cores taken in the Expedition. They are equipped to do spectographic analysis and full physical and chemical analysis of cores. They have the money to support one or possibly two scientists of their own and they would be prepared to analyse cores in terms of a large number of elements. They are interested in a large number of samples but they might need additional personnel. Professor Orens indicated that if there were 1,000 samples they would need additional equipment, manpower and space. He is preparing a proposal to be submitted to the South African National Committee for consideration. I raised the question of how this might fit in with the core analysis either proposed or under way by Lamont, the U. S. Geological Survey, Cambridge University and others.

Professor Day suggested that a regional meeting of representatives of National Committees from Mozambique, the Malagasy Republic, South Africa, Mauritius and East Africa be held somewhere in the region - preferably at Lourenco Marquês sometime after the South African National Committee meets on March 6 and 7, 1961. The purpose of such a meeting would be to compare and coordinate national plans for the East Coast of Africa and the Southwestern part of the Indian Ocean. He also urged that the Commission for Technical Cooperation South of the Sahara (CCTA) be kept advised of Expedition plans through M. E. Postel the Inter African Coordinator of CCTA. Day was also very interested in obtaining details of the Woods Hole Agulhas Current program. Day was also concerned about obtaining funds for transportation and subsistence for trainees from his or any country to undertake the special post-doctoral training proposed for the Expedition. He pointed out that a six months tour in the U. K. for instance, would probably run to some £ 750 and wondered if there were possible sources of such funds outside the Indian Ocean area.

I talked to him also about his oceanographic and marine biological bibliography. He has cards on 2,000 to 2,500 items but it deals only with the African part of the Indian Ocean and in general the references do not deal with anything North of 20° S. He is making this bibliography available to the Expedition and strip films of the cards should be forthcoming during January 1961. These will be incorporated into the Indian Ocean bibliography being prepared under the direction of Dr. John H. Ryther of the Woods Hole Oceanographic Institution who is Chairman of the U. S. Indian Ocean Panel's Working Group on Biological Oceanography. In addition to Day's material the bibliography will draw heavily on a FAO bibliography, material in the WHOI library and other sources.

Discussions with CDR. Mallory are outlined in a separate memorandum dealing with tide gauges (q.v.).

Mr. du Plessis said that not only would AFRICANA II be available for two months during the summer of '61 for its cruise well to the East and South of South Africa but that it would also probably be available in the same season for a similar length of time in this area in both 1962 and 1963. A decision on these future plans will probably be made by April or May 1961. He said that it is very difficult to change the season because AFRICANA II is supported in part through a contract with the Government of Southwest Africa which calls for work on the West coast of Africa during other seasons.

He also said that there were no present plans to carry out geological or geophysical investigations on AFRICANA II although they will possibly do some collection of benthic organisms and some dredging. They find it difficult to do a mid-water trawl from AFRICANA II particularly, I believe, because of her high freeboard. However, they expect to do a full biological and physical and chemical oceanographic program on AFRICANA II as well as some exploratory fishing. They could also do radio sonde observations and would be prepared to do so with the assistance of the South African Weather Bureau.

AFRICANA II is an excellent research vessel with capacious laboratory facilities, excellent quarters and ample deck room. She could possibly take one visiting scientist who would be required only to pay a small mess bill. Such arrangements, however, could not be worked out until cruises in 1962 and 1963. The Fisheries Department is interested in sending a small number of trainees at an advanced level but they find it difficult to move rapidly through their Civil Service regulations. The Fisheries Department Library and shore based laboratory facilities seem excellent. The library has 1,100 journals and receives 700 to 800 currently and there are some facilities for visiting scientists in the laboratories.

I also visited the NATAL, the South African Naval Hydrographic vessel and the JOHN D. GILCHRIST. NATAL is well fitted as a hydrographic vessel and also handles deep sea oceangraphic and geological and geophysical work. Her laboratory is less generous than on AFRICANA II but she seems to be a first class vessel. Radio sonde observations can be made from NATAL. The JOHN D. GILCHRIST is a converted trawler which at the moment is not fitted for deep sea work. She is 95 gross tons and 75 feet long. At the present time she is fitted with a 140 fathom echo sounder. Dr. Day is trying to get a precision depth recorder but would settle for any deep echo sounder such as might be available as surplus in the U.K. or the U.S. The present unit is a Marconi Graphite type 848, serial 663, 48 KC unit. One question raised was whether a different driver and receiver amplifier can be installed with the existing transducers in order to get greater range.

I also saw from a distance the PROTEA, about 1,000 gross tons and 200 feet long. She has been decommissioned and was up until 1956 a hydrographic vessel with a major conversion from the Flower Class Corvette. I asked CDR. Mallory to send me as much information as he could on her with the thought that if she were sufficiently longlegged and could attain a "quiet ship" condition she might be useful as a shooting ship for geophysical work. The details of her characteristics will be given limited circulation and if she appears at all satisfactory, an approach could be made to the South African Ministry of Defense to charter her and then man her with a small civilian crew.

In the course of my discussions in Cape Town it was suggested that perhaps during the meeting of various oceanographic vessels at the Tenth Pacific Science Congress in Honolulu a direct comparison be made between the salinometers from different sources and with titration on the same water samples. This occasion might also be an opportunity to make a direct comparison between other equipment and analytical processes.

MOZAMBIQUE My visit to Lourenco Marquès was cut short because of a plane delay in Mauritius. However, with the invaluable assistance of Professor José Pinto-Lopes, Director of the Instituto de Investigacao Cientifica de Mozambique, P. O. Box 1780, Lourenco Marquès, (telephone Boane 010) I was able to see virtually all the people I needed to during the twenty hours I was there. Notes on meteorology and on tide gauges are contained in separate memoranda (q.v.).

I talked with Con. Almirante Moreira Rato whom the Governor had designated as the individual to discuss the general plans of Mozambique for possible participation in the Expedition. He indicated that so far as ship operation was concerned, this would depend upon the Chief of the Hydrographic Brigade who is also Commanding Officer of the ALMIRANTE LACERDA and upon action by the Portuguese government.

With regard to hospitality and facilities for ships, he felt that all the arrangements requested by the SCOR Working Group could be taken care of and he agreed to take the initiative in making preliminary arrangements. In connection with the establishment of a possible current measurement station at Mozambique Island, he said that he felt this could probably be worked out satisfactorily.

The Director of the Meteorological Service of Mozambique is responsible for seismology and geomagnetism. He pointed out that Seismographic Observatory is being built about 90 kilometers Southwest of Lourenco Marquês and that this will be in operation by 1962. A Geomagnetic Laboratory has been started at a point 150 kilometers North of Lourenco Marquês and may be ready by 1962. During the IGY there was a seismograph and geomagnetic station in Lourenco Marquês. The Meteorological Service is also planning wave measurements and sea temperature measurements along the middle and northern coasts of Mozambique.

On the ALMIRANTE LACERDA I talked with LCDR. G. Lobo Fialho. He reported that the Captain (CDR. Barahona Fernandes) who was in Lisbon, had written him that Portugal is setting up a National Committee for the Indian Ocean and that the ship will get some new oceanographic equipment and will probably participate. The ship can now take soundings, bathythermograms and bottom samples for hydrographic purposes. Her cruising range is twelve days at economical speed (about 10 knots). They also take water samples, plankton samples, make the ordinary hydrological stations and take surface current measurements with RADIST on which they currently get a range up to 150 miles but might go to 180 miles. In plotting these current measurements they fare out the inconsistent observations. They currently have 7 officers - 6 hydrographers and 1 engineer - and they could possibly take one visiting scientist. Their echo sounder for which they claim 1% accuracy is an ELAC electro-accoustic sounder with "built-in" Voltage regulation. It has a depth range of 4,000 meters. As a reserve echo sounder they have an old Admiralty A/S 82. Both the ship and its boat have Hughes wet paper 180 meter sounders and there is also an Atlas Werke 800 meter sounder for the boat. At present the ship has a small winch forward with 2,500 fathoms of wire.

Dr. Pinto-Lopes' laboratory which was started only three years ago now has a substantial physical plant, seven scientists and a total staff of over forty. Its library is limited but growing. Scientific investigations are carried out in a variety of fields. Pinto-Lopes expressed considerable interest in the Expedition and will serve as the chief contact in Mozambique at the present time. His institute has recently taken over a marine biological library on a large island off Lourenco Marquês and there are plans to develop a substantial research program there.

It is not possible at this time to determine the extent to which Portugal (Mozambique) will actually participate in the Expedition. Indirect reports indicate a favorable prognosis however. Further contact will be developed with the appropriate authorities in Lisbon.

OTHER COUNTRIES

No substantial changes have been reported since the publication of the Coordinator's report of Helsinki, 23 July 1960 from Japan, Taiwan, Indonesia, Ceylon, U.S.S.R., Germany, Denmark, France and Israel.

Australia has announced plans for 1961 cruises by DIAMANTINA and is working on plans for later cruises.

The United Arab Republic has expressed an interest in participating and is reported to be considering refitting MAHABISS.

The United States has made substantial progress in developing a detailed national plan. During October and November 1960 thirty-one scientists, most of whom will be actually participants in the Expedition, have drawn up plans in each of five fields (geology, geophysics and bathymetry; physical and chemical oceanography; biological oceanography; marine meteorology; and data handling and analysis). These documents have been considered by the U. S. National Committee for SCOR and are now undergoing minor final modification. It is expected that they will be completed within the first two months of 1961 to be ready for final approval at the U. S. National Committee meeting in La Jolla on 4 and 5 March. These will be published and available for wide dissemination.

The United States ship participation at the present time appears to be as follows: ARGO and HORIZON from Scripps Institution of Oceanography to participate in '62 and '63; a new vessel and possibly VEMA from Lamont Geological Observatory for '62 and '63; a newly constructed vessel from Woods Hole Oceanographic Institution in the same period; the USS SERRANO and the USS REQUISITE of the U.S. Navy Hydrographic Office working respectively in the Malacca Straits and in the Persian Gulf and Arabian Sea areas in early 1961 at least; and a vessel from the National Aeronautics and Space Administration (NASA) working East and South of Mauritius from mid '61 through 1962 conducting meteorological and possibly some oceanographic work. There is also the possibility of the U. S. Coast and Geodetic Survey's research vessel PIONEER operating in the Bay of Bengal in 1963 and a serious attempt is being made to obtain a new vessel whose primary mission will be biological oceanography to carry out the program recently developed by U. S. biological oceanographers. In general, the tracks and areas indicated on the chart in the Coordinator's report for each U. S. institution still hold.

New York
6 January 1961

RGS:jas

Conseil International Des Unions Scientifiques - International Council of Scientific Unions
Special Committee on Oceanic Research
(SCOR)

INTERNATIONAL INDIAN OCEAN EXPEDITION
30 East 40th Street - New York 16, N. Y. - LExington 2-6533

Coordinator
ROBERT G. SNIDER

Cables
SCORINDOC - NEWYORK

6 January 1961

M E T E O R O L O G Y

Running Notes and Comments on Facilities and Personnel Arising from R. G. Snider's Trip 13 November to 16 December 1960 to The U.K., Pakistan, India and the East Coast of Africa Including Outlying Islands.

LONDON

The U.K. will be developing a meteorological program as part of their Indian Ocean Expedition plan. They have not as yet set up a separate Working Group but have combined this with Physical and Chemical Oceanography.

KARACHI (Pan Indian Ocean Science Association Meeting)

Professor J. Van Duijnen Montijn of De Bilt, Netherlands who is also Chairman of the Commission on Maritime Meteorology of WMO reported on the long-range program of the CMM to develop an international climatic atlas of the oceans. This is a thirty year program running from 1950 through 1979. For the Indian Ocean The Netherlands is to receive and process all data north of 50° S. Below 50° S South Africa is responsible. The Royal Netherlands Meteorological Institute is the agency involved. There is certainly a connection between the IIOE met. program and this work but since The Netherlands will not process any data until they have all reports from all areas including ship observations, it appears more likely that our data will be of use to them than their data will be of use to us. Two 1960 pamphlets published by the Royal Netherlands Meteorological Institute describe the program.

The Pakistan Meteorological Service (Director - Mr. S. D. Naqvi, Pakistan Meteorological Observatory) is very interested in participating in the Expedition. They will work in and around the Arabian Sea and the Bay of Bengal from 16° N northward which is the area for which they are responsible for weather reporting. Mr. Naqvi wants a permanent station set up on St. Martins Island south of Chittagong for meteorological observations, biological studies, etc.

DELHI

India has a Working Group on Meteorology and Physical Oceanography as well as three other Working Groups. They are to report to their National Committee in January. On a previous trip to New Delhi in February 1960, I had met Mr. Krishna Rao, Director of the Central Government Meteorological Service located at New Delhi. I believe that one of the seven members of the National Committee with whom I met in November was a representative of the Meteorological Service. I found out in Nairobi that the New Delhi meteorological radio transmission facilities will be able by July '61 to transmit facsimiles of weather charts. Nairobi (q.v.) will be able to do this by 1962. These two stations will be the only ones actually able to telefax forecasts and are, therefore, presumably the major meteorological centers for the Indian Ocean.

NAIROBI, Kenya

In a meeting at the East African Territories (q.v.) High Commission on 29 November I met among others, Mr. B. W. Thompson who is the Acting Director of the East African Meteorological Service (East African Meteorological Department, Private Bag, Nairobi, KENYA). Mr. Thompson gave me a descriptiton, based on his experience, of the meteorological observations conducted at various stations on the western side of the Indian Ocean.

At Lamu - 12 hours a day upper wind observations by pilot balloons.
At Mombasa - 24 hours a day upper winds by pilot balloons.
At Tanga - 12 hours a day, no upper atmosphere observations.
At Zanzibar - 12 hours a day, no upper atmosphere observations.
At Dar es Salaam - 24 hours a day upper air temperatures and pressures, radio sonde, weather radar, etc. - a first class station.
At Mtwara - 12 hours a day upper winds by pilot balloons.
At Mahé - in the Seychelles, 12 hours a day upper winds by pilot balloons.

In Somalia observations are rather haphazard. At Mogadishu 12 hours a day with a maximum of pilot balloons on an irregular basis.

On the Arabian coast including Aden, services come under the U.K. Air Ministry Meteorological Office. Aden is a first class station with complete facilities and there are three or four others including an R.A.F. station, I believe in Masirah in Oman.

In Mozambique Mr. Thompson reported observations rather thin although there was a first class station at Lourenco Marquès.

Arrangements are being made between Mr. D. N. F. Hall, Director of the East African Marine Research Organization and Mr. Thompson to have Thompson put two meteorologists on the R/V MANIHINE for several of her cruises during early 1961 to train the Fisheries Research Organization personnel in the use of newly installed radar and meteorological instruments.

Thompson also rated the station in Madagascar and those in islands under its jurisdiction as good and also the islands under Mauritius' jurisdiction.

Thompson pointed out that Nairobi could not add further facilities or staff without funds from outside East Africa since East African funds are very limited and the prospective change in governmental organization which will come after the election in January '61 makes everything rather uncertain. They would, however, be glad to handle and analyse meteorological data to their present capacity in their offices. It might be pointed out that they have billets for eight professional meteorologists but at the present time have only three on board because of the difficulty in recruitment during the period of uncertainty prior to the governmental change. As a consequence they are almost below the lower limit required to meet international standards as an international airport at Nairobi.

At the present time weather forecasts are broadcast. Nairobi is responsible for the region from 12° N to 15° S and to 60° E. By 1962 they will have facsimile broadcasting facilities installed with a high power station which will cover the whole western part of the Indian Ocean with telefax broadcasts. With the right frequency they would be able to reach the whole of the Indian Ocean. They will have two 10 KW transmitters and will be able to work CW or telefax or radio teletype. In this region east-west radio propagation is better than north-south. When New Delhi gets its facsimile in July '61 it will be the only other such station in the Indian Ocean area. Thompson indicated his willingness to use Nairobi after mid '62 as the weather central for all Indian Ocean weather if this could be worked out with WMO.

He also pointed out that the ship exchange of weather information is very poor now. This is due in part he believes, in some weakening of services in Ceylon particularly since Mrs. Bandanarieke's government has come into power. Nairobi gets a few ship reports. Pretoria gets some more and Mauritius does fairly well but the basic information is poor. As a general comment he pointed out that a period of maximum meteorological interest is in the non-monsoon months. He also wanted to obtain a list of the meteorological equipment which the various ships will carry and the observations they will make and was very interested in getting a copy of the U.S. Meteorological Working Group plan.

TANANARIVE, Malagasy Republic (Madagascar)

On 1 December I talked with Mr. M. J. Scheidecker, Director of the Meteorological Service of the Malagasy Republic and four or five of his professional associates. He said that Madagascar is responsible for an area from 10° N to 40° S or 50° S and from the African coast to 70° E. At present radio sonde observations are taken at Tananarive daily at 12:00 Noon GMT and the station is a class one station. By 1962 there will probably be radio sonde observations at Ile de Tromelin (also called Ile de Sable) which is east of Madagascar and north of Reunion. At the present time there is an 18 hour station there. Ile Europa with 18 hours coverage in the Mozambique Channel has a permanent meteorological station but there are no plans for radio sonde there. Tromelin is under the administrative control of Reunion but receives its logistic support from Tamatave, the major port on the east coast of Madagascar. Europa has two runways, one of 800 meters and one of 1200 meters which handle planes up to the size of a DC-3. There is also a permanent meteorological station on the Iles Glorieuses northwest of Diégo Suarez (this information not from Scheidecker). These islands are not part of the Comoros and are probably under the jurisdiction of Reunion.

There are 18 hour stations at Fort Dauphin (port on the southeast corner of Madagascar) and Diego Suarez (major French naval station and excellent harbor at the northern tip of Madagascar) and there will possibly be a station on Crozet in two years. There are no meteorological observations taken at Nosy Bé.

Mr. Scheidecker went on to make some general comments noting that at Mauritius the meteorological station takes only one radio sonde sounding a week. Kerguelen and Amsterdam meteorological stations are operated by the French government but they report their observations to Tananarive. In turn Tananarive in addition to giving territorial broadcasts repeats all the information coming to them to Pretoria who in turn relay it to Nairobi. Incidently, either at Tananarive or Nairobi I gathered that Pretoria was to have been a major regional weather forecasting center similar to Nairobi but that they have not been able to budget for increased transmission facilities. At Kerguelen there are radar wind observations and at Amsterdam radio sonde is used. They make daily reports and both are 18 hour stations. France is planning to obtain one of the Flower Class Frigates (this is the JASMIN based at Bordeaux) as a weather ship for Madagascar.

PORT LOUIS, Mauritius

I met Mr. A. D. Swan, Acting Director of Meteorological Services. There is a small metecrological station on Agalega which is north of Mauritius at about 10° S (Mauritius is about 20° S) and also at Diego Garcia which is in the Chagcs Islands some 1200 miles to the NE of Mauritius at approximately 7° S and 73° E. These remote islands under the administrative control of Mauritius are at the present time serviced by the coconut oil companies who maintain coconut plantations. There was unconfirmed rumor that the companies were going to close down operations because they were not profitable. If this happens there is the possibility that the meteorological stations will have to be closed down because personnel could not be serviced unless new arrangements were made. Rodrigues has a permanent installation (about 200 miles east of Mauritius).

Mr. Swan stated that they actually take two radio sonde observations a week and take radar wind observations five times a week. In order to take daily soundings at Mauritius and at all their dependencies, they would require an additional £3,500 per year plus cost of additional staff. The cost of increasing their pilot balloon program to achieve a satisfactory minimum standard would cost about £1,000 per year. The Acting Director of Meteorological Services was reluctant to expand the staff through procurement and training unless such expansion was part of a permanent program.

PRETORIA, South Africa

I talked with Mr. M. P. Van Rooy, Director of the Weather Bureau and with several of his assistants including Mr. Engelbrecht and Dr. Hofmeyer who is in charge of the design of instruments. They make radar wind and radio sonde observations at Durban, Port Elizabeth, Cape Town and Marion Island.

They will also be in charge of the new South African research vessel now being strengthened for work in the Antarctic. This vessel will be converted as a first class research vessel which will also provide logistic support for the South African Antarctic program in Queen Maud Land. Except during the time of supply and relief of Antarctic parties she will be available for both meteorological and oceanographic work and she will take these observations enroute to and from the Antarctic.

The South African meteorologists expressed considerable interest in the Expedition's meteorological program and indicated they would cooperate fully with the South African ships and also with other countries. They were particularly interested in reducing lead time in equipment procurement and especially in getting new and advanced sensing equipment on short notice. The Pretoria Observatory repeats with the necessary time corrections due to its different location, and WWV time signal. They may be able to provide full Indian Ocean coverage on this. Later discussions in Cape Town revealed that radio sonde observations could be conducted from the Fisheries Research Vessel AFRICANA II and the Naval Frigate NATAL.

LOURENCO MARQUES, Mozambique

The new Director of the Meteorological Service (name not obtained) reported that radio sonde observations are taken at Lourenco Marqués and that the budget has just been approved for a radar wind installation which will be in operation in 1962. They take one sounding aday at Lourenco Marqués. Radio sonde observations were started at Lumbo which is in northern Mozambique near the Mozambique Island on the day I was in Lourenco Marqués which was December 9th. They also take one sounding a day. Other meteorological stations operate as described in Volume IV (?) of the WMO Directory.

GENERAL

Each of the countries, territories and colonies which I visited welcomed the opportunity of participating in the meteorological and other phases of the Expedition. In many of them, however, it will be necessary to "beef up" the local programs in order to achieve the type of frequent observations to the upper atmosphere which are desired by the Expedition. This will mean budgeting by someone for even such types of expendables as radio sonde (see for example the one or two radio sonde measurements per week by Mauritius due to budgetary limitations). This money will have to come from outside many of these territories. The reaction of the Acting Director of Meteorology in Mauritius about an expanded program without long-range prospects of continuity is significant.

All representatives of meteorological services were most interested in the imaginative breadth of concept of the proposed meteorological program as evinced by the 27 October 1960 memorandum of the Chairman of the U.S. Meteorology Working Group which was the latest document available during my visits.

There is every reason to believe that each territory, country and colony will mount a meteorological program as part of its "national" program and that each geographic area will have the equivalent of a National Committee to direct its activities in the Expedition.

The office of the Coordinator of the International Indian Ocean Expedition has a file of the names and posts of individuals responsible for setting up local arrangements for the meteorological and other aspects of the Expedition. In communicating with any of these agencies it would be most helpful if information copies of letters or other transmission of documents is made available to the office of the Coordinator.

New York
6 January 1961

RGS: Jas

Conseil International Des Unions Scientifiques - International Council of Scientific Unions
Special Committee on Oceanic Research
(SOOR)

INTERNATIONAL INDIAN OCEAN EXPEDITION
30 East 40th Street - New York 16, N. Y. - LExington 2-6533

Coordinator
ROBERT G. SNIDER

Cables
SCORINDOC - NEW YORK

6 January 1961

T I D E G A U G E S

Running Notes and Comments on Facilities and Personnel Arising from R. G. Snider's Trip 13 November to 16 December 1960 to The U.K., Pakistan, India and the East Coast of Africa Including Outlying Islands.

LONDON

Having made available Mr. L. P. Disney's memorandum on a tide gauge network for the Expedition to the British Admiralty's Hydrographic Office during a visit to the U.K. in October, I had an opportunity to discuss certain aspects of the tide gauge program with Commander D. L. Gordon, R.N. the tide gauge expert in Admiralty Hydro and with Commander F. W. Hunt, M.B.E., R.N. who has been active in the U.K. programming of Admiralty's Hydrographic vessels' participation in the Expedition.

From information at hand CDR. Gordon indicated that there had been an IGY tide gauge at Old Grand Port, Mauritius. The question was raised as to whether this would be in operation. Gordon had also written to the Chief Ports Manager in Mombasa, Kenya who is responsible for all harbors in Kenya and Tanganyika about tide gauge installations. In Nairobi (q.v.) I found this was a Mr. Earley who is Port Director for Kenya and Tanganyika and reports to the Railways and Harbors Administration of the East African High Commission. He was represented in the meeting in Nairobi by Mr. J. M. Fogarty. Mr. Earley was described by Miss Torrance, Economic Advisor in the Office of the U. S. Consul General in Nairobi as being very able and cooperative. Mr. Earley's address is - Mercantile House, Mombasa, Kenya.

Gordon's purpose in writing was to ask for a tide gauge in Mombasa, Dar es Salaam and in Mikindani or Lindi since Dr. G. E. R. Deacon had wanted a SW-NE line of tide gauges from Mikindani to the Seychelles to Addu Atoll in the Maldives. An alternative line would be Mombasa (Kenya), Mogadishu (Somali) and Masirah (Oman). U. K. Hydro does not want to get involved in tide gauges in Socotra because of staff shortages.

In Madagascar Gordon wanted one in the southeast and something between the southeast corner of Madagascar and Tamatave, and any others possible in addition to the continuation of IGY installations.

In Mauritius (q.v.) and dependencies, U.K. Hydro would like to set up a tide gauge on either Rodriques or Diego Garcia. According to their ship scheduling it would be easier to do this on Rodriques and my subsequent talks in Mauritius indicated that there would be more likelihood of permanent support of various observational programs on Rodriques. The question was raised about who would read tide gauges on any of these islands and what the weather conditions would be. It was also suggested that if U.K. Hydro made the installation on Rodriques that some vessel passing Diego Garcia early in the Expedition might make the tide gauge installation there.

CDR. Gordon also proposed a year's observation of tidal changes at Port Victoria on Mahè in the Seychelles and at least a month's observation at Farquhar Islands in the South Seychelles at about 10° S and NNE of Diego Suarez, Madagascar. He also expressed interest in an installation at Agalega which is a Mauritius Dependency. Subsequent conversations in Mauritius (q.v.) suggested the chances of making such an installation and who might be contacted to maintain the equipment and collect the information. It was suggested that ships visiting the area early in the Expedition assist in selecting tide gauge sites on islands and also in the installation of such gauges.

Comments on the U.K. National Program (q.v.) will describe the schedule of Admiralty Hydro's two vessels HMS DALRYMPLE and HMS OWEN both of which will operate in the Indian Ocean in '61 and which may also in '62 mount a very substantial program for the Expedition.

KARACHI

A paper delivered during the Pan Indian Ocean Science Association meeting Nov. '60 suggested that bench marks in East Pakistan and possibly in other parts of the Indian Ocean might not be standardized and as a consequence might result in misleading mean sea level and tidal extremes information..

The Survey of Pakistan establishes, maintains and observes tide gauges of which there are several in both the Arabian Sea and the Bay of Bengal. They in cooperation with the Pakistan Navy will set up, maintain and observe tide gauges as required by the Expedition's program. Details in regard to their locations will be forthcoming but there is one to the west of Karachi and one in Karachi. In East Pakistan there is one in Chittagong and at least one to the west of Chittagong.

Commander S. R. Islam, P.N., Hydrographer of the Pakistan Navy and Convenor of the Pakistan National Committee (Napier Barracks, Naval Headquarters, Karachi, Pakistan) agreed to comment on the proposed tide gauge network for the Expedition as it applied to Pakistan. His comments are expected within the next few weeks.

DELHI

Only general comments were made about the proposed tide gauge network at the meeting of the Indian National Committee which I attended on 23 November. However, a copy of Mr. Disney's memorandum including the proposed network had been forwarded to Mr. Chugh of the Survey of India and he is responsible for tidal measurements. It is expected that he will respond in the near future.

NAIROBI, Kenya

A meeting on 29 November was chaired by Lt. Col. S. P. Fearon, Administrative Secretary of the East African Council for Agriculture, Animal Husbandry and Fisheries Research acting for Mr. E. B. David, Administrator of the East African High Commission whom I had seen on 25 November. Mr. J. M. Fogarty of Railways and Harbors Administration of the East African High Commission speaking for Mr. Earley, Port Director for Kenya and Tanganyika said permanent tide gauges were maintained by his agency at Mtwara, at Dar es Salaam and at Mombasa.

For making arrangements for tidal observations in the Seychelles (and this would probably include Farquhar since this is under the Seychelles' government), communications should be addressed to the Port Officer, Mahé, Seychelles Islands, Indian Ocean. Contacts, by name, of plantation managers and retired individuals living in the Seychelles who might be responsible for the tidal observations should be obtained from the Colonial Secretary, Mahé. Mr. Fogarty expressed a desire to know in what form to send tide gauge information from the installation. I agreed to call this to the attention of Dr. Rossiter of the Permanent Mean Sea Level Commission at The Observatory, Birkenhead, England. My impression was that there would be full cooperation from the East African territories in the tide gauge program.

TANANARIVE, Malagasy Republic (Madagascar)

I talked to Captain Lionnel in charge of the Department of Lighthouses and Harbors in the Ministry of Public Works. He stated that there was one tide gauge operating continuously at Tamatave, the major port on the east coast of Madagascar and there is one installed at Fort Dauphin on the SE corner of Madagascar which was currently inoperative due to a failure of a drum gear which is on order. Both of these are 24 hour systems.

He indicated that on Ile Juan de Nova which is under the administration of the Outre-Mer Department of France and is in the Mozambique Channel WSW of Cape St. Andre, it might be possible to install a tide gauge if desirable although the existing pier is out of water at low tide. The island is a copra and guano source with a colony of about one hundred people. Two ships a month visit the island which from an economic point of view, is controlled by the Rogers & Company in Port Louis, Mauritius of which Mr. Hector Paturoe is the manager. Within this organization M. Amedia Maingard controls the M/V MAURITIUS which services Juan de Nova and M. Maingard represents Cal Tex, Air France and various shipping interests at Port Louis. M. Giraud is a director of the company and has an office in Tananrive. There are three Mauritians on Juan de Nova who could manage a tide gauge.

Tromelin (see meteorology notes) has no tide gauge. Mayotte in the SE part of the Comoros Islands is under French jurisdiction but is serviced by a beacon and buoy tender from Diego Suarez. A tide gauge could be installed there. French Navy would handle this and arrangements would have to be made through Paris.

Bassas-da-India, a coral atoll 60 miles NW of Ile Europa, could possibly serve as observation center and an observation buoy could be installed in the atoll. The reef is about 3 meters high.

At Tuléar on the SW coast of Madagascar there is a tide gauge now installed in good condition which can be considered as part of the reporting system for Madagascar. The existing tide gauge installations of Madagascar are as follows:

Brille electric clock installed Diego Suarez, Majunga and Tuléar. 24 hour Richard mechanisms at Tamatave and Fort Dauphin. The installation at Majunga is not operating well at the present time and has a 4 meter scale and needs a 5 meter scale because of the tidal range. On the east coast of Madagascar the range between high and low water is about half a meter and on the SW the tidal range is about 3 1/2 meters.

Additional note on Ile Juan de Nova - there is an airport with a capacity to handle planes up to and including a DC-3 (Dakota). There are also quarters for ten persons on the island and there is a good anchorage 1 1/2 miles north of the island and a radio transmitter. Arrangements could be made for handling a small scientific party if desired. Mr. Hector P. Paturau (Consul de France) address is - St. Pierre, Mauritius, telephone - Moka 212, cables - HECPA.

PORT LOUIS, Mauritius

Tide gauges come under the direction of the Harbour Master (LCDR. A. G. Booker) in the Ministry of Industry and Commerce and External Communications. Mr. G. Bunwaree, Principal Assistant Secretary of the Ministry of Industry and Commerce and External Communications is the individual agreed upon by me and the Colonial Secretary - the Honorable T. D. Vickers, C.M.G. as the single official contact for arrangements about the Expedition.

LCDR, Booker reported that the tide gauge which was set up at Grand Port was damaged during the cyclone in March 1960 and that it is now being stored by the Harbor and Quay Department. It could be set up again if required. The tide gauge at Diego Garcia which was used during the IGY is reported by him to be still operating. Booker said he had been asked to keep it in operation by the Lamont Geological Observatory of Columbia University which had supplied the equipment.

On Agalega a tide gauge could be installed either near the meteorological station at one end of the island or near the oil company at the other end of the island. There is no sheltered water at Agalega but there is a fair anchorage. As indicated in the notes on meteorology, there is at least a possibility that the coconut plantations on both Agalega and Diego Garcia may be closed down. This will seriously effect the logistics of each of these islands since it is the oil companies' ship which supports the existing meteorological stations and the existing or possible tide gauge operations. The two companies are Diego, Ltd. and Agalega, Ltd. with headquarters in Port Louis. M. Joseph Lamusse is the Director of both companies CAPT. Raoul Lanier is at present the manager at Diego Garcia and M. Philippe Talbot is the manager at Agalega. Another island under the control of Diego Ltd. is Peros Banhos where there is a coconut plantation and the manager of which is M. Robert Talbot. Peros Banhos is 120 miles north of Diego Garcia and the harbor or anchorage can handle any draft ship. A third island under Diego, Ltd. is Salomons also in the Chagos Islands where there is only 2 1/2 fathams of water. M. Serge Guillemin is the plantation manager.

Rodriques has a permanent population and a tide gauge could be set up there. The Harbors Department did the installation of a tide gauge during the IGY and they could undertake the installation of one if the equipment was available for the Indian Ocean Expedition. Personnel could be found through CDR. Booker to operate the tide gauge. Booker might also make an installation at Farquhar which although it is in the Seychelles gets some of its logistic support from Mauritius.

LOURENCO MARQUES, Mozambique

Tide gauge installation, maintenance and operation in Mozambique is under the direct control of the Hydrograph Brigade of Mozambique. The Chief of this organization - Missao Hildrografica de Mocambique - is COM. Barahona Fernandes who is also the commanding Officer of the Portuguese Hydrographic vessel "ALMIRANTE LACERDA". This unit reports directly on technical matters to Lisbon and is under the general military control of the Naval Commandant of Mozambique who is also Chief of the Departmento de Servicos Marinha - Con Admiral Moriera Rato.

The Hydrographic vessel has taken about a dozen 29 day tide gauge stations at various places along the Mozambique coast and there are four stations where there is a year or more of tidal observations with permanent equipment. These latter are at Lourenco Marques. Beira, Mozambique Island and at one other point between these. I received every possible informal indication that these permanent stations would participate in the tide gauge network and there seems to be a high likelihood that Portugal will be participating in the Expedition (see note in memo on National Participation).

CAPE TOWN, Union of South Africa

A discussion with CDR. J. N. Mallory, S.A.N. the Hydrographer of South Africa revealed that the tide gauge at Port Elizabeth has been in continuous operation since 1954. The tide gauge at East London has been in continuous operation since 1936. The gauge at Durban since 1948. They will analyse the records from these gauges for mean sea level computation from January '62 for at least a full year. There are no suitable sites for other tide gauge stations between Durban and Port Elizabeth. However, tide gauges at Mossel Bay and Kuysma will also be in operation during '62 and the records will be analysed.

SOMALIA

Although I made no direct contact with Somalia, I did talk briefly in Cape Town with Professor Trotti of the University of Genoa who is Visiting Professor at the University of Cape Town. He indicated that Somalia has a very shallow water coastline and few if any harbors. He said that ships had to lie out between one and three miles and he doubted whether there would be many suitable places for tide gauge installations. In Nairobi I had found that the Head of the U. S. Operations Mission (USOM) to the Republic of Somalia is Mr. Will Muller and that there is a Fisheries Advisor attached to this Mission and located at Mogadishu whose name is William Napier.

New York
6 January 1961

RGS:jas

CONSEIL INTERNATIONAL DES UNIONS SCIENTIFIQUES - INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
SPECIAL COMMITTEE ON OCEANIC RESEARCH
(SCOR)

INTERNATIONAL INDIAN OCEAN EXPEDITION
30 EAST 40TH STREET - NEW YORK 16, N. Y. - LEXINGTON 2-6533

COORDINATOR
ROBERT G. SNIDER

CABLES
SCORINDOC - NEWYORK

PLANNING PROGRESS

for the

INDIAN OCEAN EXPEDITION

The International Indian Ocean Expedition, sponsored by the International Council of Scientific Unions' Special Committee on Oceanic Research and by UNESCO, is taking definite shape. With investigations scheduled throughout the period 1960-1964, ten reconnaissance cruises have already been completed. Virtually every nation and colony around and in the Indian Ocean has indicated, at least unofficially, that it will participate. Seven additional countries outside of the Indian Ocean area will make substantial studies with their own ships and scientists, and other countries will provide scientific parties.

Levels of participation fall into three categories. Nations providing ships and scientific parties include Australia (at least 2 ships), East Africa (1), France (2), Germany (1), India (5), Indonesia (1), Japan (at least 5), Pakistan (3), Portugal (1), South Africa (4), U.S.S.R. (at least 4), the U.K. (at least 4), and the U.S. (at least 10). These are the major participants.

In the second category are those countries and colonies bordering on the Indian Ocean which will participate through making observations on tidal changes and upper atmosphere meteorological phenomena. Two networks of shore bases around and in the Ocean are being developed for this purpose. The Indian Ocean nations will also offer special hospitality and facilities for visiting ships of the Expedition. Countries undertaking these responsibilities only will probably be Burma, Ceylon, Malagasy Republic, Malaya, Mauritius and dependencies, Mozambique (through Portugal), and Thailand. In addition, through British Colonial or Commonwealth connections some observations will be carried out in Oman, the Laccadive, Maldive, and Seychelle Islands, through French contacts at Amsterdam and Kergulen Islands, and in the Andaman Islands through India.

Nations providing scientific parties without ships include Denmark, Israel, Nationalist China and possibly Canada. Some of the smaller nations around the Indian Ocean will participate in training and research on other nations' vessels. The United Arab Republic also has expressed interest in participation. Thus, as of early 1961, approximately twenty five countries with over forty four vessels appear to be participants in this international venture. More than sixty individual cruises will probably be carried out.

Most nations have established National Committees of scientists and government administrators who will design their research programs and will obtain funds, scientific staff, equipment and facilities to carry out the research. At meetings of SCOR's Indian Ocean Working Group in Scandinavia in the summer of 1960, international agreement was reached on a basic minimum program in each of the disciplines involved. Subsequently most nations have expanded and detailed their own plans.

Reasonably complete coverage of the entire Indian Ocean to at least 40° S can be expected and efforts are being made by SCOR and through collaboration with ICSU's Special Committee on Antarctic Research (SCAR) to investigate as far south as 56° S. Close cooperation is being maintained with the World Meteorological Organization, the Food and Agriculture Organization of the United Nations and the International Association of Meteorologists and Atmospheric Physicists.

The scientific effort is designed to obtain a better understanding of the entire "heat engine" which is the Indian Ocean and its atmosphere together with its boundaries. Thus, studies will be conducted in the fields of marine geology, geophysics and bathymetry; physical and chemical oceanography; biological oceanography; and meteorology from the air-sea interface to the upper atmosphere. Several hundred scientists in these disciplines throughout the world are already engaged in planning for future cruises and in analysis of past investigations. In the United States, for example, 31 scientists in five Working Groups have drawn up a substantial national plan in consultation with many more specialists in various marine research laboratories. Over one hundred American biologists have thus far expressed an interest in some type of participation.

With the exception of some of the countries bordering on the Indian Ocean, there will be relatively little ship activity during 1961. However, by mid 1962 full scale operations by virtually every participant will be under way. These will continue through 1964. During the 13 months from 1 February 1960 to 1 March 1961 the Coordinator made 58 visits to 40 countries, 27 of which are directly involved in the Expedition. Active interest by scientists and governments is developing rapidly and full detailed plans for each nation's program should be available by the summer of 1961.

The Expedition's findings will be presented in atlas form together with collected volumes of individual scientific papers. Further important outcomes are the development of a body of trained scientists and technicians within the Indian Ocean area to continue oceanographic research; the development of existing and new institutions in this region, including a biological classification center and reference collection; and presumably the beginning of a better understanding about some of the natural factors which affect the existence of that quarter of the world's population living in the countries bordering on the Indian Ocean.

RGS/jas
15 March 1961

CONSEIL INTERNATIONAL DES UNIONS SCIENTIFIQUES · INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
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PART I

GENERAL COMMENTS ON CURRENT STATUS

Notes on Programs and Facilities Discussed During R. G. Snider's Trip 27 January to 3 March 1961 to the Eastern Half of the Indian Ocean.

AUSTRALIA

Australia is mounting a substantial effort on GASCOYNE and DIAMANTINA. These vessels are navy training frigates which are made available to C.S.I.R.O. Oceanographic Laboratory at Cronulla for a maximum of thirty-four weeks a year. Cruises last ordinarily for six weeks. Because of their training responsibilities, it is unlikely that either ship will be available for a substantial tour as a weather vessel. Both the Navy and the oceanographic laboratory say that each other's activities do not interfere at all in their work.

Up to now the emphasis in Australian research has been on physical and chemical oceanography and on biological oceanography. Australia will explore the possibility of developing a geological program on these two ships which are fitted to carry such a program out and also a meteorological program. There is a possibility that some one or two of the Navy's survey vessels might be able to do some geology and geophysics. Dr. George F. Humphrey as Chairman of their National Committee, will explore the possibility of obtaining a suitable meteorological plane specially equipped for work in the Expedition.

Mr. Peter Ward, Scientific Advisor to the Royal Australian Navy, reported that a VLF station was to be set up in Australia in 1964. This could contribute to the OMEGA Navigational System. Mr. Ward also pointed out that there is a large supply of explosives in one and one-quarter pound units which are surplus to the Australian Navy. These can be built up in different combinations to almost any size of explosives and in addition there are a number of three hundred pound depth charges. All of these are available at Fremantle and after negotiation with the Royal Australian Navy it is quite likely that these could be obtained by any vessel for use in geophysical work in the Indian Ocean at no cost.

Australia plans to supplement the Japanese work on five North-South lines in the eastern part of the Indian Ocean. Japan (q.v.) will work in the northern winter on these lines and Australia will work in the northern summer. Australia may expand its National Committee and it plans to develop a formal national program for the Expedition. They will provide observations to fit into the proposed tide gauge and meteorological networks (q.v.)

INDONESIA

Indonesia has verbal approval for its participation in the Expedition and expects formal Cabinet approval in the near future. When this occurs a new National Committee will be set up under the general direction of the Indonesian Science Council (MIPI).

They are obtaining a new oceanographic research vessel being built in Japan with Japanese war reparations at a cost equivalent to about $1,500,000 US. This is a 650 ton 12 knot vessel with a number of laboratory spaces and space for almost twenty scientists and a similar number of technicians in addition to officers and crew. She will be fully equipped for geological, meteorological, physical and chemical oceanographic, and biological work. One Navy Hydrographic survey vessel may also be available. The vessel is to be delivered about April 1962.

Indonesia has thirty scientists and technicians, some of whom are candidates for training under war reparations in Japan, who will be at least part of the scientific party on the new vessel. There will be billets for visiting scientists and the ship will have substantial (25 to 30 day) range. She will be operated either by the Indonesian Navy or the Indonesian Sea Communications Ministry.

Indonesia will also fit into both the meteorological and tide gauge networks (q.v.). They are also willing to offer the hospitality requested by the SCOR Indian Ocean Working Group, providing adequate advance notice is given by letter request to the Ministry of External Affairs with copies to the Navy Department and the Indonesian Science Council (Madjelis Ilmu Pengetahuan Indonesia, Djakarta) which will coordinate Expedition activities locally. Indonesia will develop in the near future a complete national plan for its Expedition activity.

MALAYA

The Malayan government expects to act on its participation in the Expedition before the end of March. It appears

highly likely that Malaya will fit into the tide gauge and meteorological networks (q.v.), will offer the type of hospitality desired, and may organize some oceanographic and biological work in the Straits of Malacca. They are interested in sending technician trainees on other vessels coming into Singapore or Penang. There appears to be a high degree of interest in the Fisheries Department, the Meteorological Department, the Navy and the University of Malaya at Kuala Lumpur. The Ministry of External Affairs has been most cooperative. These agencies and institutions would form the basis of a National Committee, since there is no Academy of Science, with Fisheries of which Dr. SOONG Min Kong is the Director, as the Executive Agency.

In addition to tide gauge and meteorological facilities (q.v.), Malaya has two 150 foot naval vessels (unequipped) which might do limited oceanographic work and one Fisheries research vessel which has done surface salinities and plankton sampling. Several smaller naval craft have done water sampling. Malaya's interest would probably be limited to the Straits of Malacca.

CEYLON

During the twelve months following my initial discussions in Ceylon, no decision had been reached on formal participation. In company with Professor C. C. de Silva, President of the Ceylon Association for the Advancement of Science and two leading members of the CAAS, I talked with The Honorable C. P. De Silva, Minister of Agriculture, Fisheries, Power and Irrigation and members of his staff. It had been agreed earlier that this Ministry would serve as the Executive Agency for any participation Ceylon might undertake.

I outlined different levels of participation. The basic one involved providing tidal and meteorological reports and offering hospitality to visiting Expedition vessels. A second level of designing a national research program to deal with problems of Ceylon's interest was suggested. The Honorable Mr. De Silva expressed considerable interest and indicated that if no additional expenditure was required on Ceylon's part, that basic participation would probably be possible.

Subsequent correspondence with Mr. D. T. E. A. de Fonseka, Director of Fisheries and the Executive Agent for his Ministry, confirms the present unavailability of any additional funds for any expenditure. He has pointed out, however, that some tidal and meteorological information (q.v.) can be made available from other departments through his Agency. In addition, Fisheries Department maintains substantial interest in the Expedition and within budgetary limitations may be able to carry out some biological and oceanographic research on its two 45 foot

experimental fishing vessels. They have a maximum range of 100 miles but concentrate on the Continental Shelf extending from 15 to 30 miles from the coast.

Interest was also expressed in having some well qualified Ceylonese junior scientists trained if no added expenditure was involved. Mr. de Fonseka offered to adjust their biological investigations where possible to obtain information desired by other nations about Ceylon's nearby waters.

INDIA - Cochin

Cochin and its sister port Ernakulam appear to be eminently suited for the Biological Classification Center for the Expedition. Less than 150 miles from the southern tip of India, Cochin is more centrally located in the Indian Ocean than any other port where there is substantial biological and other oceanographic activity.

Kerala State University has almost completed the construction of a new oceanographic laboratory (approx. 5,000 sq. ft.) having nine small laboratories and a similar number of specialized large laboratories. The nearby Maharaja's College offers an opportunity for expansion of laboratory facilities and a possible source of biological technicians. The Marine Fisheries Laboratory (a sub-station of Central Marine Fisheries) already carries out physical, chemical and biological oceanographic studies between the southwest Indian coast and the Laccadives and Minicoy with a staff of about twenty using the M/S KALAVA, a converted trawler. This vessel has a hydrographic winch with wire to work to 3,500 meters, seven water sampling bottles, deep and shallow bathythermographs and two 400 fathom echo sounders. This facility is under the immediate direction of Mr. R. Jayaraman.

The Kerala State University Research Department, housed in temporary quarters on the Naval Station on Willingdon Island, is under the local direction of Dr. C. V. Kurien. They expect a new building to be completed within three to six months. They offer training for the M.Sc. in marine biology and oceanography in a two year course. Their research staff currently consists of three Ph.D.'s and seven M.Sc.'s plus one Ph.D. University Grants Scholar and four Ph.D. candidates. There are about twenty students.

Their twin diesel M/S CONCH, a 50 foot vessel operates generally within the 100 fathom curve out to 45-50 miles from the beach making physical and chemical oceanography casts, marine biological samplings and trawling for prawns.

The Naval Physical Laboratory is located on the Naval Station under the direction of Mr. V. Narayan Rao. They carry out geophysical, acoustic and other naval studies.

The port itself is excellent. There is a 400 foot wide, 31 feet deep channel with a draft limit of 26 feet. On the commercial side, there is alongside berthing for seven vessels at a 2,000 foot pier with four additional berths under construction, plus eleven moorings. In addition, there is possible nested berthing for four vessels at the Naval Station except during the months of February, March, August and September.

The port has 20 to 30 shipping agents and is a substantial freight handling center without a paralyzing amount of traffic. Warehousing facilities are excellent and transportation facilities for personnel, equipment and specimens are excellent since there is a main railhead within yards of the piers. An air field, at present handling at least DC-3's, is located within two miles of the dock area and the new oceanography laboratory and offers services daily to all major centers in India. The advantage of close personal contact with the Customs administration in a small port is considerable in order to obtain careful treatment of specimens, samples and materials, and equipment in transit.

There is ample power and ample space for expansion of buildings. Currently water is rationed. An eight inch line is to be replaced within the next three years by a thirty-six inch line although the commercial sector of the port may be serviced by a new large line during 1961. At present 80 to 100 tons of water are supplied daily to vessels. Fuel oil of any kind is available.

The twin cities of Cochin and Ernakulam each with a population of approximately 100,000 offer limited recreational facilities. Housing of personnel at the center might offer some problems. It was reported that housing for technicians would probably cost about 50 rupees (approximately $10 US) per month for a bedroom, sitting room and attached kitchen and bath but that facilities would be very scarce unless new flats were built or housing requisitioned by the government as has been done in Bombay, Madras and Calcutta. Such an arrangement is administered by a Central Government Estate Manager in the major cities and by a State Government Accommodations Controller in the smaller cities. Larger quarters for more senior scientists consisting of two bedrooms, living room, kitchen, bath, storage room and garage would run from 115 to 200 rupees per month. It was also suggested that the Government Guest House on Bolghatty Island might be available for short-time quarters for visiting scientists. This building, the former headquarters of Governors and British Residents is a five minute boat ride from the new laboratory and also from the Naval Station. It has five family apartments or quarters for 15 to 20 people and adjoins a small golf course.

The main hotel on Willingdon Island has inexpensive and very comfortable quarters consisting of about 40 rooms. Alcoholic beverages are readily available in Kerala State, an unusual phenomenon in India.

INDIA - Bombay

During an interval between planes, I visited the Colaba Observatory of the Central Government Meteorological Service, in order to obtain an on-the-ground impression of the possible facilities for an International Meteorological Center. I talked with Mr. V. Srinivasan, Assistant Meteorologist. Conclusions are reported in Part III - Meteorology (q.v.).

INDIA - New Delhi

At an informal meeting of the Indian National Committee, I discussed the establishment of a biological center and a meteorology center for the Expedition. In this and subsequent discussions, it became apparent that India would welcome external recommendations about the location of a biological center. Since the concensus of several persons (Dr. David D. Keck of the U.S. National Science Foundation, Dr. Eugene C. La Fond of the U.S. Naval Electronics Laboratory and Dr. Karl Banse currently at the University of Washington, Seattle) who have either surveyed a number of institutions and locations or have spent several years in India, points to Cochin as the first choice, this has been called to the attention of the Indian National Committee. My own observations indicate that Cochin has many important advantages and few significant disadvantages.

One proposal currently being discussed in India is that the necessary space for the Biological Center would be provided by Kerala State University in its new oceanographic laboratory or through the support of the Central Government. A similar situation apparently would obtain if expansion were required to Maharaja's College. It is also being proposed that some Central Indian Government agency would provide and pay for the basic staff. Further, this plan calls for payment by the various universities and the Zoological Survey of India of the salaries of some specialists who would be at the Center on a permanent basis. It is also being proposed that necessary additional equipment to meet the needs of the Expedition (i.e., microscopes, centrifuges, special air-conditioned laboratories, added library facilities, etc.) would be provided by agencies outside India such as national governments, UNESCO and private sources.

An Indian Government decision on these proposals is expected during the spring of 1961. These proposals are based on the assumption that technicians and scientists attached to the Biological Center from outside of India on either a semi-permanent or short-time basis, would be supported entirely by their institutions or governments.

India currently plans to carry out research on one Naval frigate, one 200 ton Fisheries research vessel and three small research vessels. Working Groups in each discipline have been established and preliminary reports had been received from all but one group. The complete plan is expected during the spring of 1961.

India plans to work in the area from Bombay to the west of the Laccadives and Maldives, to the south of Ceylon, to as far east as the Andamans and up to Calcutta. Their major effort, however, will be on the Continental Shelf and to about fifty miles beyond. They will cooperate in the tide gauge and meteorological networks (q.v.). A decision will be reached in the near future on what elements of an international meteorological program India will be willing to assume.

India is planning to nominate trainees for specialized six months' to a year's work at U.S. and U.K. centers. Ten candidates are under consideration from Andhra University, the Indian Navy, and other institutions. Hospitality for visiting ships, in accordance with the SCOR recommendations, is being explored by a Working Group in contact with the Ministry of External Affairs.

India's national plan for the Expedition will include a detailed description and budget for equipment requirements. It was estimated that 10-15 lakhs of rupees ($200-300,000 US) of foreign currency would be required. Considerable discussion was devoted to the long lead time required between the time plans were drawn up and the time operations began. It was agreed that planning should be completed and procurement and training initiated as soon as possible. I discussed training of Indian nationals with Dr. Rudolph Fritsch, UNESCO representative in India and with Dr. Olive Reddick of the U. S. Educational Foundation in India. UNESCO fellowships are handled by the Paris headquarters on the basis of local recommendations. A similar procedure with final decisions in Washington is followed by the U. S. agency. Both systems require very substantial lead time and the number of fellowships are limited. Travel funds through the U. S. Educational Foundation, at least, are available. Discussions with Indian National Committee members revealed that a UNESCO assisted oceanographic training center at Andhra University in Waltair would be welcomed.

PAKISTAN

The Pakistan National Committee has received verbal assurance from the Minister of Agriculture and Fisheries that Pakistan will participate and will provide major financial support for its effort. This Ministry will serve as the Executive Agent for the various governmental and private efforts. Formal written approval of the national plan is expected from the Cabinet in the immediate future. Pakistan's cooperation in the tide gauge and meteorological networks (q.v.) is assured.

Two Pakistan naval vessels have been committed for work from 16°N northward in the Arabian Sea and the Bay of Bengal. Equipment is being obtained to fit these out for full oceanographic and meteorological research. A Fisheries research vessel may also be available for investigations along the Continental Shelf. It is probable that Pakistan will be able to finance the bulk of its equipment needs from its own Treasury and will require only a small amount of assistance from other sources. Such aid, however, will be critical.

Detailed plans for their program have been worked out and final Working Group reports are expected to be available for the Committee's next meeting in May. The groups actively involved in the program are Navy, Meteorology, Fisheries, C.S.I.R.O., Geological Survey, Atomic Energy Commission and the universities, which are developing a diploma program in oceanography at the graduate level under the stimulus of the National Committee on Geology and Geophysics.

Pakistan is particularly interested in having some of its facilities used for a technician training center for the Expedition. A new Fisheries Laboratory at Karachi harbor has just been completed with funds from the U.S. International Cooperation Administration. There are twenty-five large laboratory and office spaces in the plant with opportunity for further expansion. In addition to biological, biochemical and apparatus rooms, there are twenty-one bedrooms in the residential part of the establishment and two dormitories of approximately 800 square feet each. The Council of Scientific and Industrial Research Organization, the Meteorological Department, Fisheries Department and the Navy Hydrographic Department have also expressed interest in providing staff to conduct training at this laboratory for junior scientific personnel from the Indian Ocean area. Pakistan would welcome discussions with UNESCO about such a training center if UNESCO plans to support any such centers in the Indian Ocean area. In addition, the Pakistan Meteorology Department has expressed an interest in having the International Meteorological Center established at Karachi.

Members of the National Committee also propose that one oceanographer with broad experience could give major assistance to Pakistan and other nations developing new ship-board programs. He could spend up to a year in the area working with newly fitted out research vessels and their scientific staff during shakedown periods. During this same time he might be able to get substantial assistance in carrying out a research program of his own.

BURMA

Although Burma has not yet made a decision on participation in the Expedition, I was able to talk to senior representatives of most of the agencies which might be involved. Emphasis was placed on initial small scale participation in the tide gauge and meteorological networks (q.v.) and in offering hospitality and taking advantage of training facilities. There was interest expressed by several agencies in developing a small national program for the Expedition with particular reference to the Continental Shelf and nearby waters.

Commodore Than Pe, Vice Chief of Staff, Defense Staff indicated that participation would be welcomed by the Navy but that final decision would rest with the Ministry of External Affairs. He pointed out that there was an existing Maritime Development Coordinating Committee with representatives of the Port Administration, Navy, Merchant Marine, Meteorology and Irrigation Departments, Chaired by the Secretary of the Transportation Department. To serve as a national oceanographic research committee, it would be necessary to co-opt representatives from the Foreign Office, the University, the Fisheries Department and the Burma Science Association, Dr. Po E, Director of the Meteorological Service expressed considerable interest as did the Navy Hydrographer. LCDR Khin Maung Maung Myint, II and Dr. Daw Thin Kyi, the Head of the Geography Department at the University of Rangoon.

I talked with the Honorable James Barrington, Permanent Secretary of the Ministry of External Affairs about having Burma take formal action to participate. On the basis of a formal letter subsequently forwarded to him, Burma should make its decision during the early spring of 1961.

THAILAND

Although Thailand has established a National Committee for SCOR, it has not as yet had an opportunity to develop a program for its participation in the Expedition. This is in part because most of its oceanographic interest and activity has been toward the east in the Gulf of Thailand. However, at least

minimum participation is likely in the tide gauge and meteorological networks (q.v.) and the growing fishing industry on Thailand's Bay of Bengal coast gives further impetus to national interest in the Expedition. The recent completion of the NAGA Expedition has directed the attention of many of Thailand's leaders to oceanographic research. The Chairman of their National Committee, ADM Luang CHAMNARN Adhyubha has urged cooperation in planning the Expedition. It is reported that the National Commission for UNESCO and the National Research Council will recommend participation to the Cabinet and the Royal Thai Navy Hydrographic Service will be the cooperating agency.

NATIONALIST CHINA

Taiwan is one of the three countries outside of the Indian Ocean area which have expressed an interest in participating in the Expedition, although they have no research vessel available to work in that area. Chinese scientists and government are extremely interested in developing oceanographic science in their country.

I met with the Chinese National Committee on Oceanic Research, Chaired by Dr. Veichow C. JUAN of the National Taiwan University and talked with a number of other scientists and government officials. These discussions dealt not only with the procedure whereby Chinese scientists might cruise on other nations' vessels but also with the possibility of training junior scientists and technicians for initial work on vessels operating in the Indian Ocean.

I was also fortunate in being able to talk with ADM LI Yu-Shih, Commander-in-Chief of the Chinese Navy. Dr. Hu Shih, President of Academia Sinica and Dr. CHIEN Shih-liang, President of the National Taiwan University and a number of their associates about the possibilities of developing oceanic research in Taiwan. Opportunities for extra-national financial support were explored. It seems probable that there will be close collaboration between the Navy and scientists within and outside the University in the immediate future to develop seagoing science in various fields of oceanography. The National Committee has set up five Working Groups to develop considerable interest among scientists in a variety of fields.

JAPAN

Japan has developed a preliminary plan for their participation in the Expedition. The budgeted cost amounts to the equivalent of $900,000 US. Their Fiscal Year begins in April and budget requests must be made by August. At the present time

five research vessels with over sixty scientists are scheduled to make one cruise each of about a month's duration in the eastern Indian Ocean during the period December '62 to March '63. These vessels will carry out a broad program of research in a variety of disciplines.

At a meeting of the Japanese National Committee on Oceanic Research it was agreed that Japan would set up special Working Groups to outline their program in detail. The Committee, under the Chairmanship of Dr. Yoshio FUJIOKA, also undertook to try to obtain addition support from Government to carry out further cruises in the eastern part of the Indian Ocean during the period December '63 to March '64. Presently scheduled areas of operation are outlined in Part III - Meteorology (q.v.). An agreement has been worked out with Australia whereby Australia will cover these tracks during the opposite monsoon which occurs in the northern summer when Japanese research vessels operate nearer to home.

The establishment of Working Groups made up of scientists who will actually go on the Expedition will enable scientists from other nations to work directly with their opposite numbers in developing plans. Added effort by Japan will help to increase the coverage of the eastern part of the Indian Ocean.

Discussions with Dr. Kiyoo WADACHI, Director of the Meteorological Agency and also President of the Japan Science Council, and Dr. K. TERADA, in charge maritime meteorology, dealt with the possibility of substantial Japanese support of the Expedition's meteorological program. They agreed to explore the possibilities of obtaining equipment and also providing partial support of weather ship operations. This will have to be followed up by SCOR.

A procedure was worked out for initiating specialized training for scientists from other countries. Formal requests from these countries for six months to one year training, for post-doctoral and some other advanced scientists, must be made by the government involved to the Japanese Ministry of Foreign Affairs. Copies of such communications should go to the President of the Science Council of Japan (Dr. Kiyoo WADACHI, Ueno Park, Tokyo) and to the Secretary of the Japanese National Committee on Oceanic Research (Dr. Michitaka UDA at the Science Council of Japan, Ueno Park, Tokyo).

UNITED STATES

Discussions at the Scripps Institution of Oceanography at La Jolla, California indicated considerable activity at the working level in planning for the Expedition. A request was made that arrangements should be worked out with appropriate

authorities for explosives storage depots at Fremantle, Singapore, Aden and Cape Town. It was also suggested that the Indian Navy or possibly other navies from the Indian Ocean area, might provide "shooting ships" for geophysical exploration. In the light of ARGO's recent MONSOON cruise, it was suggested that all ships in the Expedition work out, maintain and publish a communications watch schedule.

Discussions at Woods Hole Oceanographic Institution revealed that planning for the U. S. biological program is developing rapidly under the direction of Dr. John H. Ryther. Several vessels are being considered to serve as the U. S. biological vessel and a large number of biologists have expressed interest in actually participating in the program on ships. Plans for the SCOR Working Group meeting on chemical oceanographic and biological oceanographic methods are progressing well. Both meetings will be held at about the same time as the Tenth Pacific Science Congress in Honolulu in late August and early September 1961.

The U. S. National Committee for SCOR has approved the U. S. national plan which involves an expenditure estimated at over $12,000,000. Detailed plans for programs in physical and chemical oceanography; geology, geophysics and bathymetry; biological oceanography; meteorology; and data handling and analysis have been drawn up. A limited number of copies of the U.S. plan will be distributed immediately and further copies will probably be available at a later date.

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OTHER COUNTRIES

FRANCE

The COMMANDANT ROBERT GIRAUD will carry out a physical and biological oceanographic cruise in the northwest Indian Ocean from Diego Suarez to Bombay, the Persian Gulf, the Gulf of Aden and along the coast of Somalia. This cruise will extend from 3 April to 4 June 1961 and 86 oceanographic stations will be made.

GERMANY

With the prospect of a new research vessel in 1963, the German National Committee is developing plans for direct participation in the Expedition.

MAURITIUS

The government of Mauritius has given formal approval in detail to the SCOR request for hospitality and facilitation of visits for Expedition vessels.

PORTUGAL

Portugal has formally decided to participate in the Expedition and has set up a National Committee under the chairmanship of CAPT Jose Pereira Parreira, PN, Director of the new Instituto Hidrografico in Lisbon under the Ministry of Marine. Additional equipment is being installed on the Naval Hydrographic vessel ALMIRANTE LACERDA based at Lourenco Marques. It is anticipated that tide gauge and meteorological observations in Mozambique will help to complete the two networks.

UNION OF SOUTH AFRICA

South Africa is considering nomination of scientific trainees for work in the preparation of the Expedition. They not only expressed interest in placing scientists on vessels of other nations but also offer some space on their own vessels for the accommodation of visiting scientists.

UNION OF SOVIET SOCIALIST REPUBLICS

The R/V ACAD ALEXANDER KOVALEVSKY will operate in the Red Sea and the northwest part of the Indian Ocean making a comparative study of the "quantitative development of life" in this area.

Copies of the list of approximately 140 persons with whom the Expedition has been discussed on this trip are available upon request. Similar lists for two previous extended trips are also available. These, however, do not replace the list of Working Groups and participating scientists which will be forthcoming in the next six months or so from various nations. Participating nations are urged to make available to the Coordinator's office at the earliest possible date - it is hoped by mid-summer 1961 - full details of their national plans, cruise schedules and tracks.

RGS/jas
31 March 1961

CONSEIL INTERNATIONAL DES UNIONS SCIENTIFIQUES · INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
SPECIAL COMMITTEE ON OCEANIC RESEARCH
(SCOR)

INTERNATIONAL INDIAN OCEAN EXPEDITION
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COORDINATOR
ROBERT G. SNIDER

CABLES
SCORINDOC - NEWYORK

PART II

T I D E G A U G E S

Notes on Facilities Discussed During R. G. Snider's Trip 27 January to 3 March 1961 to the Eastern Half of the Indian Ocean.

AUSTRALIA

Discussions with Dr. George F. Humphrey as Chairman of the Australian National Committee on Oceanic Research at Cronulla indicated that Australia would adopt the proposals made for tide gauge operations made for the Permanent Service for Mean Sea Level by Disney and modified by Chugh and Rossiter. This would call for continuation of the IGY gauges at Port Darwin, Port Hedland, Fremantle, Albany and Port Adelaide.

INDONESIA

An agreement was reached by MIPI, the Hydrographer at the Navy Department and the Ministry of Sea Communications on the installation and operation of one permanent tide gauge at Tjilatjap (Chilachap) and five sixty-day stations along the West and South coasts of Sumatra, Java and Bali at Salang (Tjalang) Bay, Padang, Benkulen (Benkoelen), Pelabuhan Ratu (Gontong Bay) and Benua (Bonos) in Bali. This is in accordance with the Disney proposal for the Permanent Service for Mean Sea Level as modified by Chugh and Rossiter. All three government agencies are involved in some aspect of the installation and operation. The Navy Hydrographer, Major Wardiman, and RADM. Martadinata, Chief of Naval Staff agreed that the Navy would take primary responsibility.

I had no opportunity to discuss a recent proposal for close observations of tidal change within a degree of the equator. Padang would fall within this category as would several small islands and even smaller ports. This matter can be explored further through the Madjelis Ilmu Pengetahuan Indonesia (MIPI) in Djakarta.

MALAYA

Establishment and maintenance of tide gauges at appropriate places was discussed as one part of small-scale participation in the Expedition. No one present at the meeting in Kuala Lumpur was personally familiar with the actual tide gauge installations. There was a firm belief (confirmed by communication from Mr. Chugh of the Survey of India) that there is a permanent installation at Penang and another at Singapore. There may be tide gauges at Port Swettenham and Port Dickson.

When Malaya reaches a final decision on participation in the Expedition, it is likely that the Harbours and Railways Agency, responsible for tide gauges, will participate in the national committee and that Malayan tidal information will be available.

CEYLON

Due to current fiscal difficulties it is unlikely that Ceylon will be able to expand its tidal observations at present beyond the existing gauge in Colombo harbor maintained by the Master of the Harbour. I pointed out that additional tide gauges at Galle and Trinchomalee would be helpful.

PAKISTAN

In accordance with previous discussions, the Survey of Pakistan will provide installation and operation of four tide gauges during the Expedition, probably two each in West and East Pakistan.

INDIA

India has agreed to cooperate in continuing eight stations which operated during the IGY at Kandla, Veraval, Bombay, Mangalore, Cochin, Madras, Vizagapatnam, Sauger and they propose to establish a station at Minicoy Island. Mr. R. S. Chugh, Deputy Superintending Surveyor of the Geodetic and Research Branch of the Survey of India has been active in advising on the locations of Indian Ocean tide gauge installations for the Expedition.

BURMA

Discussions with the Hydrographer of the Burmese Navy, the Nautical Surveyor of the Mercantile Department and the Port Surveyor of Burma revealed that there is a permanent tide gauge established at Elephant Point at the mouth of the Irrawaddi about 30 miles below Rangoon. This is under the operational control of U Ba Ngwe, the Port Surveyor.

If Burma makes a formal decision to participate, as seems most likely, information from this gauge will be available to fit into the network. The Burmese Hydrographic Office is interested in determining the cost of a twenty four component tide predictor and hopes to obtain one.

THAILAND

Conversations with Captain AMPORN Penyapol of the Royal Thai Navy Hydrographic Office and with VADM, Desakorn Vicharn, Director and RADM, MAHAGHITA Sanith, Deputy Director of the Hydrographic Department revealed that there is a seven day automatic tide gauge at Phuket on Selang Island off the West coast of Thailand. This gauge has been in operation for at least eight or nine years and they can calculate for any hourly or other heights.

If Thailand participates formally in the Expedition, as seems probable, this gauge would help to complete the network of the Eastern side of the Bay of Bengal.

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MAURITIUS

Lamont Geological Observatory, which owns the IGY tide gauge originally installed at Grand Port, is exploring with the Harbour Master of Mauritius the matter of its re-installation.

GENERAL

A document prepared recently by the Physical Oceanography Working Group of the U. S. National Committee emphasizes the desirability of establishing tidal stations within one hundred miles of the equator. Such installations would be limited to a small section of the Southern Somalia coast which has been reported as having great lengths of extreme shallow water, a small part of the Southern end of the Maldives including Addu Atoll and a small part of the Western coast of Sumatra and some of its off-shore islands. Various participating nations are asked to give thought to planning such installations.

RGS/jas
31 March 1961

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PART III

M E T E O R O L O G Y

Notes on Facilities Discussed During R. G. Snider's Trip 27 January to 3 March 1961 to the Eastern Half of the Indian Ocean.

AUSTRALIA

Discussions at Sydney and Canberra revealed that although there was meteorological representation on the Australian National Committee, no substantial meteorological research program had been drawn up as yet. However, Dr. George F. Humphrey, Chairman of the Committee and RADM. Beecher, Deputy Chief of Naval Staff undertook to stimulate the development of such a program from different angles.

It had been hoped that GASCOYNE and DIAMANTINA might carry out some of the weather ship functions proposed in the U. S. Meteorology Working Group program but their joint naval training and oceanographic responsibilities are such that they could not operate on a weather ship schedule. However, in their scheduled cruises these vessels will certainly make surface meteorological observations and possibly will undertake a radiosonde program. It is also probable that radiosonde and rawinsonde observations will be made on land based stations as part of the meteorological network. The possibility of equipping an Australian aircraft with the necessary sensing devices and other meteorological equipment to conduct investigations in the eastern part of the Indian Ocean is being explored. Australia will also consider the possibility of partial support of weather ships and meteorological instrumentation.

INDONESIA

The Indonesian Meteorological Service has expressed a willingness to participate in the Expedition network. Mr. Soekanto and Mr. Fatah of the Meteorological Institute, Djakarta said that their shore observations might have to be increased appreciably

to meet the Expedition's needs. They require specific plans in order to determine what added equipment would be necessary. Possible fund sources were discussed.

Ship-borne observations will unquestionably be undertaken on their new Marine Research Vessel, the JALANIDHI, being built in Japan for April '62 delivery (see Part I). The vessel as designed has meteorological observation, operations and analysis rooms and a main deck balloon filling station.

Since Indonesia feels helium will be difficult to obtain, the question was raised about ship board experience in other countries with generation of hydrogen. They feel that a deck load of 100 hydrogen bottles would be space consuming and that a hydrogen generator, if there has been substantial experience and satisfaction with safety procedures, would be preferable. Since this issue may affect the final revision of their ship plans, any experience or comments made to the Office of the Coordinator prior to the summer of 1961 would be appreciated. The question was also raised about the calibration of pyrheliometers.

A detailed Indonesian meteorological program will be forthcoming.

MALAYA

Although Malaya has not reached a final decision on its participation, there is a high probability that it will be able t cooperate in the meteorological network. At a meeting in Kuala Lumpur their Meteorological Department was represented by Mr. Ho Tong Yuen and encouraging correspondence has been exchanged with Mr. K. Rajendram, Director of the Malayan Meteorological Service in Singapore.

Radiosonde observations are taken at Singapore every six to twelve hours and also at the Royal Air Force base at Butterworth in northern Malaya near Penang. Increased observations would require additional staff and equipment. The University of Malaya at Kuala Lumpur is interested in increasing its meteorological training. Mr. W. L. Dale of its Department of Geography is the individual particularly involved.

CEYLON

Due to fiscal retrenchment, Ceylon at this time is unable to increase its existing activities without outside help. However, within existing limitations, Ceylon can be expected to participate in the network.

Mr. D. J. Jayasinghe and Mr. L. A. D. I. Ekanayake, Director and Deputy Director of the Ceylon Meteorological Office reported that radiosonde observations are made at Colombo airport at 1200 G.M.T. on alternate days but that radio wind observations are made daily at that time. There are also four pilot balloon stations in the island which make surface observations in addition. Mr. U. Rath of the International Civil Aviation Organization Regional Office at Bangkok was present during these discussions. He pointed out that the Expedition's requirements for the basic observations in the shore stations network were identical with the WMO and ICAO needs and that any increase in frequency of observations would have three uses.

INDIA

During a visit to Cochin in Kerala State in southwest India for other purposes, I made a casual investigation of the feasibility of locating an Expedition meteorological center there. Although space might be available the radio communication facilities here would be less satisfactory than Bombay. Furthermore, the air field now serves only planes up to approximately a DC-3 (Dakota) size although it might be able to handle a DC-4. Existing meteorological facilities are limited.

A brief visit in Bombay to the Colaba Observatory of the Indian Meteorological Department and subsequent discussions in New Delhi with Mr. Krishna Rao, Director of the Indian Meteorological Service and Mr. C. Ramaswamy of the Meteorological Department and Dr. K. R. Ramanathan a member of the Indian National Committee and an eminent research meteorologist, revealed that India would welcome the establishment of an international meteorological center for the Expedition at Bombay which would be their first choice although New Delhi could handle this. The Colaba Observatory is housed in a reinforced concrete two story building about ten minutes by taxi from the center of Bombay close to the Tata Institute of Fundamental Research.

One quarter or one half of the floor (three to six comfortable sized offices) would be made available immediately if desired. Any requirement over 10,000 square feet would unquestionably require new facilities. There is also another building on the Colaba Station which is a geomagnetic research headquarters. The main geomagnetic station is fifty miles to the south. Furthermore, the main Indian meteorological research center is at Poona about eighty miles to the southeast of Bombay.

Bombay is responsible for forecasts in the area bounded by 5 $^{\circ}$ N, 20° N and 60° W and both meteorological and naval radio facilities at Bombay are excellent. Bombay is also a major transportation center with an international airport capable of handling and servicing any type of plane. Bombay Port can handle

any Expedition vessels which might need to be in close contact with the meteorological center. Dr. Krishna Rao indicated that India would probably be able to provide the physical accommodations for the center. Housing for staff could certainly be found in the metropolitan area.

India now makes radiosonde and rawin observations at 0000 and 1200 G.M.T. at Veraval, Bombay, Trivandrum, Madras, Vizagapatnam and Calcutta, and Port Blair in the Andamans. Furthermore, pilot balloon observations are made at Minicoy Island, Cochin, Mangalore and Vengurla at 0000, 1200 and 1800 G.M.T. and at Bombay and Trivandrum at 0600 and 1800 G.M.T. I did not get information on the east coast minor stations.

New Delhi now has radio teletype direct connections with Moscow and Tokyo, fitting into the Northern Hemisphere Meteorological Collection and Exchange Center network which includes Moscow, Frankfort, New York and Tokyo. New Delhi will have a Northern Hemisphere Analysis Center in April 1961 and by July 1961 will have facsimile broadcasting facilities. It will be necessary to tell the Indian Government and the Indian Meteorological Service what facilities are required for the International Center.

India had not thought of making upper air observations until the U.S. Meteorology Working Group draft report came to their attention. They are now considering carrying out upper air observations on the frigate which will be made available to the National Committee by the Indian Navy. They have had no ship-board experience with hydrogen, however, and will welcome any suggestions or guidance.

During the early spring of 1961 India expects to indicate what part of an international meteorological program they might undertake basing their comments on the U. S. preliminary draft. Indian representatives felt that it was rather unlikely that they would be able to assume any financing of weather ships or Mamos buoy operations unless strong representations by outside groups were made to the Central Government Ministries involved.

PAKISTAN

The Meteorological Service will cooperate fully in the Expedition's meteorological network. Their meteorological observations will include those at shore stations and on their ships operating in the Arabian Sea and the Bay of Bengal north of 16° N and in passage between West Pakistan and East Pakistan. Most equipment requirements have been noted and budgets have been drawn up indicating total financial requirements for presentation to Government. The Pakistan National Data Center for analysis of their Expedition data will be established under the Meteorological Service with assistance of their C.S.I.R.O.

The Pakistan National Committee will hold a meeting in May 1961 at which they plan to decide on what elements of the international meteorological program they can undertake. They are interested in having the International Meteorological Center for the Expedition established in Karachi. The Director of the Meteorological Service, Mr. S. D. Naqvi wants at least one weather ship in the Arabian Sea. This is also urged by the Acting Director of the Meteorological Service in East Africa (q.v.).

Mr. Naqvi has also proposed that specific intensive observations of meteorological phenomena be carried out on specified "Days" as in the IGY, based on sun spot activities or meteor showers. He also called attention to the difficulties in providing meteorological forecasts based on enciphered data for which receiving stations had no code. He cited Indonesia as one country practicing this procedure.

Major funds have been voted by East Pakistan for research on tropical cyclones and their prediction. Dr. Gordon E. Dunn, Director of the National Hurricane Research Center at Miami, Florida, U.S.A. (U.S. Weather Bureau) has been working with Mr. Naqvi on this East Pakistan research program. Mr. HAMEEDUDIN Ahmed, Joint Secretary of the Ministry of Defense, to whom the Meteorological Service reports, suggested that some of the funds for such research in the Bay of Bengal might be directed to fundamental research for the Expedition's meteorological program, since the cooperative international venture could contribute to the understanding of tropical cyclone prediction for East Pakistan.

BURMA

Although Burma has not made a final decision on participation in the Expedition, it is probable that its meteorological observations will fit into the Indian Ocean Expedition network. Dr. Po E, Director of the Burmese Meteorological Department and Chairman of the Burmese IGY Committee, stated that they make radiosonde observations at Rangoon every alternate day at 000 G.M.T. and they hope to do this daily. They plan to make similar observations at Meiktila, about ninety miles southwest of Mandalay within six months. They make no radar wind observations but they are considering installing one station in 1962. There is one pilot balloon station on the Coco Islands north of the Andamans and several pilot balloon stations along the east side of the Bay of Bengal. They have no plans for radiosonde or rawin at any of these.

When Burma makes a formal decision to participate, its National Committee will probably be built around its Maritime Coordination Committee in which meteorology is represented. Dr. Po E suggested that a special prefix should be established for meteorological reports from Expedition vessels and others contributing to the meteorological program for the Expedition.

THAILAND

VADM. BUNNAG Charoon, R.T.N., Director of the Thai Meteorological Service indicated that there are three major meteorological stations making radiosonde observations once daily at 0000 G.M.T. These are at Bangkok, at Songkla in south Thailand at about 5° N and at Chingmi in the north at about 19° N. They also have a pilot balloon station at Phuket making regular observations at 0000 G.M.T. and some observations at 0600, 1200, 1800 G.M.T. This station was established in 1940.

Admiral Bunnag said that they had tried several radiosonde observations a day during the IGY but found it too costly. Costs at that time were about 1,000 Bhat (Ticals) or approximately $50 US per upper air sounding for gas and transmitter.

A communication dated 21 March 1961 indicates the high probability that Thailand will participate at least on a small scale which will include the meteorological network.

NATIONALIST CHINA

Discussions with the National Committee at Taipei, Taiwan revealed that they would like to send trainees to the International Meteorological Data Center when established.

JAPAN

Japan plans cruises from 8° N to 32° S along 78° E, 86° E and 94° E, and from approximately 8° S to 32° S along 102° E, 106° E and 110° E, and from 8° S to 24° S along 114° E. All of these cruises will involve "regular meteorological observations" and "study of the mechanism of boundary layer phenomena". These cruises will be carried out between December '62 and March '63. An effort is being made to organize similar cruises in this general area, without duplication in the same period 1963-64. One Meteorological Agency vessel will conduct observations along the 86° E meridian.

Discussions with Dr. Kiyoo Wadachi, Director of the Japanese Meteorological Office, Dr. K. Terada of their Division of Maritime Meteorology and Dr. S. Syono of the University of Tokyo revealed a substantial interest in the international meteorological program. They indicated, however, that a formal request from SCOR would be required to obtain Japanese decision on a contribution to the support of weather ships or Indian Ocean Expedition meteorological research and also for participation in the supply of meteorological

equipment for use at various shore and ship-borne meteorological stations in the Indian Ocean. A decision on these procedures for specific requests to various nations for extra-national activities should be reached by SCOR in the very near future.

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GENERAL COMMENTS AND NOTES FROM OTHER NATIONS

EAST AFRICA

The Acting Director of the Meteorological Service of East Africa, Mr. B. W. Thompson, has submitted specific comments on the U.S. Working Group proposal for a meteorological program.

UNITED STATES OF AMERICA

Conversations in Bangkok with Colonel Jones, USAF, Commanding Officer of the Third Meteorological Wing based at Honolulu and Major Terry, USAF based at Clark A.F.B. in the Phillipines suggested a possible substantial interest in tropical meteorology by the United States Air Force. Further follow-up of this interest should be made. Conversations at Scripps Institution of Oceanography at La Jolla with Dr. Tj. H. Van Andal revealed that Portuguese Timor has forty surface meteorological stations and that Dr. Marciano Viegas Baptista is Chief of the Meteorology Department there. He felt that Portugal might be able to contribute meteorological observations for the eastern end of the Indian Ocean.

WORLD METEOROLOGICAL ORGANIZATION

WMO, implementing Recommendation 30 (CMM-III), has invited appropriate action on the part of member countries on various elements of participation in the Expedition. Replies are reported from twenty five members including twelve members bordering on the Indian Ocean.

INTERNATIONAL ASSOCIATION OF METEOROLOGISTS AND ATMOSPHERIC PHYSICISTS

IAMAP is organizing an ad hoc committee to advise SCOR on a meteorological research program for the Expedition. Ten countries have been asked to participate. The U. S. Meteorological Working Group program may serve as a point of departure for this body.

Meteorological Planning Meeting of the International Indian Ocean Expedition held at 'Resham Bhavan' at 9 a.m. on 18 July, '61 (Plenary Session I)

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Present

Mr. Robert G. Snider	Spl.Com. on Oceanic Research	) Chairman
Mr. D. J. Jayasinghe	Ceylon	
Mr. B. W. Thompson	East Africa	
Dr. K. R. Ramanathan Mr. P. R. Krishna Rao Mr. C. Ramaswamy Dr. R. Ananthakrishnan Dr. L. S. Mathur Mr. K. N. Rao Dr. P. R. Pisharoty	India	
Dr. Soeoto Mangoensoemarto Dr. Soekanto	Indonesia	
Dr. Hidetaka Futi	Japan	
Mr. Ramanisarivo	Malagasy Rep.	
Mr. K. Rajendram	Malaya	
Mr. A. F. Sundberg	Mauritius	
Mr. S. N. Naqvi	Pakistan	
Cdr. Kajit Buajitti	Thailand	
Mr. A. N. Shahbaz	UN Special Representative	
Prof. Colin S. Ramage	United States of America	
Mr. K. Parthasarathy	WMO Representative	

The delegate from the U.K. was expected to arrive the following day. Participation by South Africa and Portugese East Africa was uncertain, while Burma and Australia had intimated that they would not be represented.

Mr. Robert G. Snider, Chairman of the meeting said that there were two issues that had to be considered by the representatives present. Firstly, it was necessary to know the extent of participation by the various countries in the meteorological programme for the expedition and secondly to formulate a regional

request for a grant from the UN Special Fund, to meet the cost of certain elements of the programme. He said that the Executive Agency for handling this request was the WMO. In view of the fact that the Governing Body of the UN Special Fund was to meet shortly, it was important that a formal request to the fund should be submitted by the 5th of September, at the latest. He mentioned that no national commitments to the programme were expected of delegates at this stage.

Prof. Ramage gave a brief outline of the meteorological programme and problems to be studied during the Expedition. Although an international committee of SCOR had been formed for other disciplines, such as Oceanography and Geology, none had yet been set up for Meteorology. If the funds were approved, then the UN and WMO would become the administering body for the programme, while the Sub-Committee would be the day-to-day controlling agency for the proposed IMC.

The Chairman next explained how the Met. programme came to be written by the US Working Group on Meteorology.

Mr. Parthasarathy gave the views of the WMO. He said that a request to the UN Special Fund should have a bearing on the economic development of the countries concerned such as the training of technicians. Pure research as envisaged in the Programme would not be supported by the UN Special Fund. He also mentioned that another criteria for support is that the Government's contribution should be of the same order as the grant. There is no limit for the number of countries required to sponsor the programme in order to obtain funds.

In the discussions that followed, Dr. Ramanathan emphasized that the problem under study in the Indian Ocean was not a matter of merely local interest, since it formed part of the study of the general circulation.

Mr. Thompson said that there may be some difficulty for delegates in inducing their respective Governments to support the programme; it may be a quicker method if one Government makes a request by itself. The Chairman then inquired of the representative from India if his country was prepared to seek support for this project on its own.

Dr. Ramanathan replied that the National Committee for the IIOE fully supports the project and that the support of the Government was also expected. Dr. Krishna Rao then mentioned the proposed establishment of an Institute of Tropical Meteorology in Poona for which a grant from the UN Special Fund is being contemplated. This Institute would co-operate in all respects with the IMC and take over its functions when the IMC ceases to operate after 1964. If the two projects could be related, it would partly meet the criteria laid down by the UN Special Fund.

Prof. Ramage said that the economic aspects of the programme to the various countries would be difficult to assess, but some mention should be made in the request of the devastating nature of cyclones and the importance of forecasting of the onset of the monsoon, in order to stress the importance of the project. He then spoke on the design and distribution of the network of stations proposed for the Expedition and desired that each country amplify how it would fit into the plan.

The Chairman called upon a representative from each country to indicate the present meteorological activity in his country and the future programme that would contribute to the plans of the expedition. The existing programme and the future plans envisaged by the different countries are given separately as an annex to this report.

The Sub-Committees were then formed - one to review the existing draft request to the UN Special Fund under the chairmanship of Dr. Ramanathan. The Second Committee under the chairmanship of Mr. Thompson was to draw up a detailed meteorological plan, including costs, for the expedition.

There were discussions on the location of the IMC. Dr. Ramanathan said that every facility would be offered for establishing the IMC at Colaba (Bombay), including training facilities at Santacruz. The facilities offered at Colaba could be inspected by the Committee.

Mr. Naqvi mentioned the existence of a Weather Centre and Institute of Tropical Meteorology at Karachi. He doubted whether the effort of the IMC Bombay would not in some respects duplicate the work already being carried out at Karachi.

The meeting then agreed that the IMC could be located at Bombay, provided the facilities available are suitable.

The meeting then divided to work into two sub-committees.

Meteorological Planning Meeting of the International Indian Ocean Expedition held at 'Reshan Bhavan' at 3.45 p.m. on 19th July, 1961. (Plenary Session II)

Present

Mr. D. J. Jayasinghe	Ceylon
Mr. B. W. Thompson	East Africa
Dr. E. R. Ramanathan Mr. F. R. Krishna Rao Mr. C. Ramaswamy Dr. R. Ananthakrishnan Dr. L. S. Mathur Mr. K. N. Rao Dr. P. R. Pisharoty	India
Dr. Soeroto Mangoensoemarto Dr. Soekanto	Indonesia
Dr. Hidetaka Futi	Japan
Mr. Ramanisarivo	The Malagasy Rep.
Mr. K. Rajendram	Malaya
Mr. A. F. Sundberg	Mauritius
Mr. S. N. Naqvi	Pakistan
Cdr. Kajit Baujitti	Thailand
Prof. Colin S. Ramage	United States of America
Dr. A. G. Forsdyke	U.K.
Mr. A. N. Shahbaz	UN Special Representative
Mr. K. Parthasarathy	WMO Representative

The meeting commenced at 3.45 p.m. under the chairmanship of Mr. Thompson, in place of Mr. Snider who was not able to be present. Dr. Forsdyke was asked by the Chairman to indicate the extent of the U.K. participation in the Expedition programme. He replied that the estimated cost of the U.K.'s effort would be £ 30,000 and the assistance could best be provided in the form of equipment, staff and money for the programme that was proposed by East Africa and Mauritius. The mechanism through which assistance would be given to Mauritius and East Africa will have to be discussed with the Colonial Offices in U.K. A brief account of his report is given in the attached sheet.

The meeting then separated into the two sub-committees to carry on with their works.

UNITED KINGDOM

Existing Programme and Plan for IIOE

Existing Programme

R/S/W stations are maintained at Aden, Bahrain, Gan. Surface observing stations are maintained at the following stations in S. Arabia and Persian Gulf Area:

Sharjah, Masirah, Salalah, Riyan, Mukeires, Beiban, Dhala.

Future Plans

1. Subject to financial approval, the U.K. would support R.S.W. observations in Seychelles and increased R.S.W. observations at Nairobi, Dar-Es-Salaam and Mauritius as well as increased surface and PB observations along the East African Coast. This support would consist mainly in the provision or loan of equipment and possibly staff.

2. The U.K. regards it of the utmost importance that ordinary Ships' observations shall be made as frequently and densely as possible and that they should be of a high standard. The accurate observation of air-sea temperature difference is regarded as especially important in the study of the interaction between atmosphere and ocean. In the absence of a satisfactory method of measuring rainfall at sea, it is important that the time and intensity of rainfall shall be carefully recorded especially over the open ocean areas.

Meteorological Planning Meeting of the International Indian Ocean Expedition held at 'Resham Bhavan' at 3.30 p.m. on 20th July, 1961. (Plenary Session III)

Present

Mr. Robert G. Snider	Spl. Com. on Oceanic Research - Chairman
Mr. D. J. Jayasinghe	Ceylon
Mr. B. W. Thompson	East Africa
Dr. K. R. Ramanathan Mr. P. R. Krishna Rao Mr. C. Ramaswamy Dr. R. Ananthakrishnan Dr. L. S. Mathur Mr. K. N. Rao Dr. P. R. Pisharoty	India
Dr. Soeroto Mangoensoemarto Dr. Soekanto	Indonesia
Dr. Hidetaka Futi	Japan
Mr. Ramanisarivo	The Malagasy Rep.
Mr. K. Rajendram	Malaya
Mr. A. F. Sundberg	Mauritius
Mr. S. N. Naqvi	Pakistan
Cdr. Kajit Baujitti	Thailand
Prof. Colin S. Ramage	United States of America
Dr. A. G. Forsdyke	U.K.
Mr. K. Parthasarathy	WMO Representative
Mr. A. N. Shahbaz	U.N. Special representative.

The Chairmen of the two sub-committees (Dr. K. R. Ramanathan and Mr. Thompson) reported to the meeting the deliberations of their respective committees. The Sub-Committee reports were presented in the form of resolutions and recommendations. There was some discussion on a point raised by Mr. S. N. Naqvi regarding the provision

of funds for the increased observational network not already covered by the national planning of the individual participating countries and also communication facilities between countries. Mr. C. S. Ramage said that in such cases, the US may fill in the gap in observational network.

Then the meeting was adjourned for the resolutions committee to reconsider the resolutions in the light of the points raised in the meeting.

The meeting re-assembled at 1700 hrs. The Secretary presented the minutes of the meeting on 18-7-1961 which were unanimously approved.

The Chairman of the resolutions committee, Mr. C. S. Ramage, presented the revised version of the resolutions and recommendations including a new one on rainfall at sea. All these were unanimously adopted.

The Chairman of the meeting then moved a recommendation from the Chair on the establishment and functions of an I.I.O.E. sub-committee. Mr. K. Parthasarathy (WMO) pointed out that the selection of personnel as recommended in the recommendation was slightly different from the normal recruitment procedure of WMO. The meeting after some discussion accepted the recommendation noting the spirit behind it.

Finally, the Chairman expressed his appreciation of the hospitality and assistance from the India Met. Department and the Government of India which made this meeting a success. In reply, Mr. P. R. Krishna Rao spoke a few words and hoped that when the I.M.C. is established at Bombay, the Meteorologists from the different countries would again come to India and co-operate with the India Meteorological Department and the I.M.C.

Mr. Robert Snider (Chairman) announced a token contribution of Rs. 220 from the visiting meteorologists for the Poona Flood Relief Fund organised by the Times of India, Bombay.

Finally with a vote of thanks by Dr. K. R. Ramanathan to the Chairman, appreciating the excellent way in which Mr. Snider conducted the meetings, the Conference came to a close at 1730 hrs IST.

METEOROLOGICAL PLANNING MEETING

INTERNATIONAL INDIAN OCEAN EXPEDITION

The Sub-Committee appointed "to review the existing Draft Request for U.N.Special Fund" was composed of the following.

1.	Dr. K.R. Ramanathan,	India (Chairman)
2.	Mr. K.Parthasarathy,	WMO Special Fund
3.	Mr. A.N.Shabaz,	UN Special Fund
4.	Mr. C.S. Ramage,	U.S.A.
5.	Mr. Soeroto,	Indonesia
6.	Mr. S.N.Naqui,	Pakistan
7.	Mr. A.F. Sundberg,	Mauritius
8.	Mr. Ramanisarivo,	Malagasay Republic

After considerable discussion, it was decided that India should sponsor a request for financial assistance from the U.N. Special Fund for the establishment of an I.M.C. at Bombay, and that other interested Governments be requested to advise the U.N.Special Fund of their support of the I.M.C. This was submitted in the form of a resolution which was adopted by the COMMITTEE (cf Resolution 1).

A "Memorandum of a request to the U.N.Special Fund for assistance towards the Meteorological Research Programme for the Indian Ocean area" was also prepared by the Sub-Committee. It was agreed that the working out of the details of the Memorandum should be left to the Government of India who are to sponsor the request.

A summary of the Memorandum is enclosed.

/S/ K.R.RAMANATHAN

Chairman.

SUMMARY OF MEMORANDUM OF REQUEST TO THE U.N. SPECIAL FUND FOR ASSISTANCE TOWARDS THE METEOROLOGICAL RESEARCH PROGRAMME FOR THE INDIAN OCEAN AREA.

1. PURPOSE

1.1 The purpose of the project is to collect extensive meteorological data including those of a type hitherto unavailable over the Indian Ocean area and adjoining lands. With the help of these data, the large-scale atmospheric circulation and weather processes over this region will be studied in relation to the general circulation of the whole world. These studies are expected to yield improved weather forecasting methods and techniques.

2. BACKGROUND

2.1 Inadequate knowledge of the large-scale influences on weather have always hampered weather forecasting in the countries in this area. Limited observations and limited international exchange of observations make difficult even short range forecasting in the countries surrounding this large body of water which covers one seventh of the earth's surface. The need for the development of improved forecasting techniques and for the training of meteorological personnel of the countries concerned in the application of the best methods of analysis and forecasting has been keenly felt. This need has become even greater and more urgent in recent years in view of the large-scale development plans of many of the countries in the field of agriculture, exploitation of water resources, flood control programmes and programmes for ameliorating the consequences of weather calamities such as tropical cyclones, torrential rains, etc.

2.2 The economy of many of the Indian Ocean countries such as India, Pakistan, Burma, Malagasay, East Africa, etc. is mainly agricultural. As agriculture is affected directly by the variations of the summer monsoon which brings the bulk of the rain to these countries, planned programmes for the improvement of agriculture require accurate advance information of the onset of the rains, its variations from day-to-day, the occurrence of spells of heavy rain and breaks in the rains in the middle of the growing season. The present knowledge of the character of the circulation over the oceans in the monsoon area is to inadequate to allow development of forecasting methods which can be used by the meteorological services of the countries for providing the different types of forecasts and warnings needed for agricultural development.

2.3 Many of the countries in this area suffer from periodical visitations of severe tropical storms which cause considerable damage to property and food crops, dislocation of transport and communication and untold human suffering including loss of human lives. Every such severe cyclone causes a set-back in the economic development of the country. There is a very great need, therefore, for developing forecasting methods to provide adequate and timely warnings for tropical cyclones. These cyclones originate and develop over the ocean areas and move over to land where they cause disaster. In order to develop appropriate forecasting techniques, it is necessary to collect more data from the ocean areas and study them with the help of classical as well as modern methods involving the use of electronic computors if we are to develop appropriate forecasting techniques. Considering the vast expanse of the Indian Ocean, the inherent difficulties of making observations over a large ocean area and the limited resources, both financial and of trained man-power of the countries concerned, it is much beyond the resources and capacity of any single country to plan and carry out a programme of observations and investigations described above without assistance on a large scale from international organizations as well as from developed countries which have the resources and the technical know-how.

2.4 The International Indian Ocean Expedition which is being organized by the Special Committee for Oceanic Research in which a number of countries in the Indian Ocean Area and other countries such as the U.S.A., U.K., U.S.S.R., Japan are participating has now afforded the opportunity of carrying out an extensive and co-ordinated meteorological programme for the Indian Ocean Area as a whole. As a number of ships of different countries will be operating in the Indian Ocean area for oceanographic observations, these can be used for making specialized meteorological observations which would otherwise be impossible. The participating nations and the International Association of Meteorology and Atmospheric Physics have established working groups to design meteorological programmes to be integrated with the oceanographic Expeditions. An essentially international programme for Meteorology was drawn up by the U.S. Working Group for Meteorology after a meeting in October last. This as well as the programmes and suggestions from other countries were discussed at a meeting of the Meteorological Representatives of the Expedition countries held in Bombay from 18th - 20th July, 1961 and a co-ordinated meteorological programme was drawn up. Essentially the programme consists of :-

2.4.1 Increased efforts by the countries concerned to collect better and more extensive meteorological data for the ocean areas as well as adjoining land areas by establishing more land observatories, specially equipped ships for observations over the sea, use of improved instruments and methods and techniques of observation.

2.4.2 The establishment of an International Meteorological Centre in the Indian Ocean, to make immediate and practical use of the vast amount of data flowing from the Expedition ships, island and shore stations for issue of appropriate forecasts for expedition operations, to analyze and process them, to conduct research on them and to evolve forecasting techniques, and to train selected meteorological personnel of the countries of the region in these techniques.

2.5 The observational programme will be carried out with the resources of the countries in the Indian Ocean area, supplemented by assistance in the form of observational equipment etc., by interested Scientific Organizations in the developed countries.

2.6 The assistance of the Special Fund is required for the establishment of an International Meteorological Centre.

3. PROJECT

3.1 Description

3.1.1 The I.M.C. to be set up with the assistance of the Special Fund will have the following functions :-

3.1.1.1 Provide special training for expedition meteorological observers and technicians and maintain strict quality control over the observations during the expedition period.

3.1.1.2 Forecast weather and sea conditions for all expedition ships for these operations.

3.1.1.3 Be a base for the Expedition's meteorological research; collect and process with electronic computer (wherever necessary) all meteorological observations made in the Indian Ocean region from July '62 through June '64.

3.1.1.4 Train students in modern operational and research techniques in Meteorology.

3.1.1.5 Maintain effective liaison with representatives of the other disciplines in the International Indian Ocean Expedition and with the various meteorological agencies.

3.1.2 These will be expanded in the final request to be submitted by the Indian Government.

3.2 Duration of the Project

3.2.1 The International Meteorological Centre will be established in the Spring of 1962, begin full operation on 1 July 1962, cease full operation on 30 June 1964 and after completing data processing, finally close down in December 1964.

3.3 Location of the Project

3.3.1 It is understood that the Government of India and Pakistan have plans of establishing Institutes of Tropical Meteorology at Poona and Karachi and are deeply interested in the development of programmes akin to those envisaged in the I.M.C.

3.3.2 The Indian National Committee for Oceanographic Research have welcomed the idea of co-operative international study and research in Meteorology and have suggested that the proposed centre might be established at Bombay. In the Regional Meteorological Office, Bombay, there already exist good facilities for forecasting, communication and office accommodation. In view of these and many other facilities which exist in Bombay, the meeting of the Meteorological Representatives held at Bombay accepted the suggestion to locate the International Meteorological Centre at the Meteorological Office, Colaba, Bombay.

3.4 Requirements of the I.M.C.

3.4.1 Staff

(a)	Director	1
(b)	Division Chiefs	3
(c)	Senior Technicians	5
(d)	Research Meteorologist cum Forecasters	10
(Total (a) to (d) International staff 19)		
(e)	Administrative Staff	6
(f)	Scientific and Technical Assistants	35
(g)	Messenger staff	10
(Total number of Local staff (e) to (g) 51)		
	Total (a) to (g)	70

3.4.2 Accommodation:

To accommodate the staff, communication equipment, the laboratories, the dark room, the seminar room, the computer and the card storage room etc., a floor area of 7000 sq. ft. is required. The India Meteorological Department proposes to make available the required space

(a) by rearranging and economising existing accommodation in the Colaba Observatory and the Regional Met. Centre (both located in the same compound),

(b) by putting up prefabricated temporary structures on the roof of the Regional Centre building

and (c) by transferring some of the space needed by the I.M.C. for training and material storage purposes to Santracruz and Poona Met. Offices respectively.

Furniture: Approximate cost 22,000 U.S. dollars.

Modifications of the existing accommodation like Air conditioning of some of the rooms including the Electronic Computer room, etc.

Approximate cost: 35,000 U.S. dollars.

3.4.3 Equipment:

(a) Electronic computer, auxiliary equipment and maintenance.
Approximate cost: 262,000 U.S. dollars.

(b) Communication, office and other equipment.
Approximate cost: 1,371,250 U.S. dollars.

(c) Stationery, punch card and Photo supplies.
Approximate cost: 15,000 U.S. dollars.

3.4.4 Fellowships: 12

Approximate cost: 90,000 U.S. dollars.

3.5 Financing

3.5.1

	Amounts in U.S. Dollars		
	Equivalent Local contribution	Special Fund contribution	Total
Staff (cf. 3.4.1)	160,000	460,000	620,000
Travel cost including shipping		98,000	98,000
Accommodation (c.f. 3.4.2)	45,000		45,000
Furniture (c.f. 3.4.2)	22,000		22,000
Modifications like Air Conditioning etc. (c.f. 3.4.2)	5,000	30,000	35,000
Equipment (c.f. 3.4.3 (a & (b)		1,633,000	1,633,000
Supplies (c.f. 3.4.3(c))	3,000	12,000	15,000
Fellowships (c.f. 3.4.4)	Nil	90,000	90,000
Total	235,000	2,323,000	2,558,000
Leave sickness and other contingencies 20%	47,000	464,600	511,600
Grand Total	282,000	2,787,600	3,069,600

3.5.2 The contribution India is likely to make for the establishment of the I.M.C. at Bombay is indicated above. The remainder has to be met either from the Special Fund or contributed by other agencies. If this aid is not forthcoming, India will have to reconsider the set up for the proposed I.M.C. at Bombay.

4. CONCLUSION

The Government of India requests the Special Fund to support the Meteorological Research Programme as described in the preceding paragraphs and to sanction for this purpose the assistance in the form of experts and equipment, details of which have been given in para 3.5.1 above. The total cost of the assistance required from the Special Fund is 2,787,600 U.S. dollars.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

List of Resolutions and Recommendations

Resolution 1: Locating International Meteorological Centre at Bombay.

Resolution 2: Expression of Thanks.

Recommendation 1: Establishment of an IIOE Meteorological Sub-Committee.

Recommendation 2: Telecommunications.

Recommendation 3: General circulation: Surface and Rawinsonde network.

Recommendation 4: Aircraft Reconnaissance flights.

Recommendation 5: General circulation : Cloud Photography.

Recommendation 6: General circulation: Pilot Balloon ascents.

Recommendation 7: General circulation: Satellite Data.

Recommendation 8: General circulation: All-sky cameras.

Recommendation 9: General circulation: Storm Detecting radar.

Recommendation 10: General circulation: Ozone.

Recommendation 11: General circulation: Miscellaneous.

Recommendation 12: General circulation: Miscellaneous.

Recommendation 13: General circulation: Miscellaneous.

Recommendation 14: Speedy installation of equipment.

Recommendation 15: Rainfall at sea.

Recommendation 16: Climatology: Evaporation.

Recommendation 17: Climatology: Radiation.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Res. 1: Locating International Meteorological Centre at Bombay.

THE COMMITTEE

RECOGNIZING the need for the establishment of an International Meteorological Centre

i) for the servicing and testing of the instruments for the Expedition

ii) for collecting, processing and an analyzing the meteorological data

iii) for the issue of meteorological forecasts and warnings required for the operation of oceanographic ships of the expedition

and iv) for continuing research on the data that will be gathered;

NOTING the offer of the Indian National Committee for Oceanic Research to provide utility and communication facilities for locating such a centre at the Meteorological Office, Colaba, Bombay

DECIDES a) to request the Government of India to agree to locate the International Meteorological Centre at Bombay for the duration of the International Indian Ocean Expedition and to make a request to the UN Special Fund for financial assistance for the establishment of such a centre at Bombay,

and b) to request other interested Governments to advise the U.N. Special Fund of their support of the IMC.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Res. 2. Expression of Thanks

The Planning Committee resolves to express its appreciation to the Indian Meteorological Service and the Indian Government for their hospitality and excellent arrangements in connection with the meeting.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 1: Establishment of an IIOE Meteorological Sub-Committee.

THE COMMITTEE

NOTING the opinion of the President of SCOR and

RECOGNISING the need for close co-ordination of all International Indian Ocean Expedition meteorological activities.

RECOMMENDS the establishment of an IIOE Meteorological Sub-Committee to advise the Scientific Director for Meteorology of the IIOE and to select the international staff for the International Meteorological Centre; the Sub-Committee to be composed of a group of not more than five research meteorologists of whom at least two should be from Indian Ocean countries and the Sub-Committee to be selected by SCOR.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 2: TELECOMMUNICATIONS

THE COMMITTEE

CONSIDERING the question of the telecommunications necessary to achieve speedy reception of normal and special Indian Ocean meteorological data at the I.M.C. and

NOTING the existing telecommunications facilities

RECOMMENDS (1) that no change takes place in the methods of transmission of weather reports from merchant and naval ships to shore stations during the period of the Expedition, but all services should endeavor to arrange with their local communications authorities to improve or expedite the collection and onward transmission of reports where necessary.

(2) That oceanographic and weather ships of the Expedition report their observations direct to the IMC by special arrangements to be made by the Indian Telecommunications authorities.

(3) That special telecommunications links be established between Bombay and certain other major centres as set out below* to enable faster traffic handling to be achieved without interference with normal operational meteorological telecommunications requirements.

*A. Point-to-point RTT duplex links

1. Bombay-Karachi	) 24 hours
2. Bombay-Colombo	) operation
3. Bombay-Nairobi	) Usage limited
4. Bombay-Bangkok	) initially to 4
5. Bombay-Cairo	) to 6 hours per day.

*B. Circuits inward to Bombay only

1. Canberra (RTT)
2. Peking (W/T)
3. Djakarta (RTT)

(4) That arrangements be made for the reception at IMC of facsimile broadcasts of Tokyo, southern hemisphere stations and weather satellite data. Tokyo is requested to explore the possibility of sending machine analyses to the IMC.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 3: GENERAL CIRCULATION - SURFACE AND RAWINSONDE NETWORK.

THE COMMITTEE

REALISING the importance of a description and improved understanding of the general circulation of the atmosphere to the economy and safety of human life in the region of the Indian Ocean, and

NOTING the present distribution of operational meteorological stations in countries bordering the Indian Ocean and at islands within the Ocean, and the extensions to this network proposed by these countries

RECOMMENDS (1) that the network of stations making surface synoptic observations and reporting in international meteorological circuits be increased by:

(a) the addition of the following observing stations:

Crozet Island, Heard Island and Peuros Banhos Island and MAMOS buoys in the Arabian Sea and the Bay of Bengal

(b) the extension of the programme of/ships and land stations to/ all full 6 hourly synoptic observations.

(2) that the network of stations making rawinsonde observations twice daily (at 0000 and 1200 Z) and reporting in international meteorological circuits be increased by:

(a) the establishment of new stations at:

Christmas Island, Crozet Island, Diego Garcia, Heard Island, Mahe, Minicoy, Mogadiscio and Salalah.

(b) the provision of radar and wind equipment to convert the present radiosonde to full rawinsonde at the following stations:

Addis Ababa, Djakarta, Lahore, Mandalay, Mossuril, Rangoon and Visakhapatnam.

(c) the provision of radiosonde to convert the present radar wind to full rawinsonde at the following stations:

Butterworth, Chanthaburi, Comoro Island, Diego Suarez, Fort Dauphin and Kuala Lumpur.

(d) that weather ships able to operate rawinsonde be established on the equator in longitudes 83° E. and 94° E.

(e) that oceanographic vessels be equipped for rawinsonde observations

(f) that all rawinsonde observations be made at 0000 and 1200 GMT.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 4: AIRCRAFT RECONNAISSANCE FLIGHTS

THE COMMITTEE

NOTING the great importance in meteorological research of aircraft reconnaissance flights and their particular value to the programme of the Expedition

RECOMMENDS that all countries operating meteorological reconnaissance or research aircraft undertake such flights in the Indian Ocean during the period of the Expedition as frequently as possible and in co-ordination with the Expedition programme.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 5: GENERAL CIRCULATION: CLOUD PHOTOGRAPHY

THE COMMITTEE

NOTING the ease with which time lapse cameras for cloud photography can be fitted to aircraft and

CONSIDERING the value of these observations

RECOMMENDS that special arrangements be made to fit these cameras to civil and military aircraft flying on routes crossing the Indian Ocean and that the exposed films be forwarded to the IMC by the met. service of the destination aerodrome.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPOSITION

Rec. 6: GENERAL CIRCULATION: PILOT BALLOON ASCENTS.

THE COMMITTEE

NOTING the extension of the rawinsonde network which it is hoped will be achieved during the course of the Indian Ocean Expedition nevertheless

EMPHASISES the continuing importance of pilot balloon observations throughout many parts of the area and

RECOMMENDS that all countries making pilot balloon observations seek by all means to extend their network and achieve higher flights by the use of bigger balloons with a high rate of ascent.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 7: GENERAL CIRCULATION: SATELLITE DATA

THE COMMITTEE

NOTING the great importance and value of satellite data and that U.S. satellites will be in orbit during the period of the Expedition

RECORDS its appreciation of the effort the U.S. is making in this new sphere and

RECOMMENDS that the IMC ensures that the photographic results of satellites in orbits over the Indian Ocean be made regularly and rapidly available to services in the region.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 8: GENERAL CIRCULATION: ALL-SKY CAMERAS.

THE COMMITTEE

NOTING the importance of a network of cameras photographing over a 180° field for sky recording at surface stations

RECOMMENDS that the network suggested below be set up for operation during the Expedition.

Singapore, two ocean weather ships on equator, Gan, Seychelles, Nairobi, Srinagar, Bombay, Ahmedabad, Minicoy, Diego Garcia, weather ship NASA, Kerguelen Island.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 9: GENERAL CIRCULATION: STORM DETECTING RADAR.

THE COMMITTEE

NOTING the existence of storm detecting radars at the following stations:-

Bangkok, Kota-Bahru, Butterworth, Singapore, Gauhati, Madras, Nagpur, New Delhi, Bombay, Karachi, Calcutta, Dacca, Entebbe, Nairobi, Dar-es-Salaam

RECOMMENDS that photographs of the radar screens be taken and made available to the IMC on request.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 10: GENERAL CIRCULATION - OZONE

THE COMMITTEE

CONSIDERING the importance of a knowledge of the distribution of Ozone in studies of the atmosphere and

NOTING that measurements of ozone are made at New Delhi, Srinagar, Ahmedabad, Kodaikanal, Hyderabad and Quetta

RECOMMENDS that ozone sounding stations supplemented by spectrophotometer observations should be undertaken at the following additional stations

Pretoria, Salisbury, Tananarive, Mauritius, Nairobi, Bahrein, Kerguelen, NASA (Weather ship) Djakarta, Chieng Mai, Cuttack or Calcutta

REQUESTS that the IMC conduct comparison trials of the various instruments used during the period of the Expedition.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 11: GENERAL CIRCULATION - MISCELLANEOUS

THE COMMITTEE

NOTING the importance of meteorological surface and upper air stations at Mogadiscio and Salalah for describing the behaviour of the recurring monsoon and

NOTING also that unusual difficulties may be encountered in establishing these stations

RECOMMENDS that special arrangements be made if necessary.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 12: GENERAL CIRCULATION - MISCELLANEOUS

THE COMMITTEE

NOTING that during the International Indian Ocean Expedition, some upper air soundings chiefly at sea will be made only once daily

RECOMMENDS that the time for these soundings be fixed at 0000 GMT.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 13: GENERAL CIRCULATION: MISCELLANEOUS

THE COMMITTEE

RECOMMENDS that copies of any special meteorological observations made during the period of the Expedition should be lodged with the I.M.C.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 14: SPEEDY INSTALLATION OF EQUIPMENT

THE COMMITTEE

NOTING

i) that the maximum effort of the Expedition will begin in the spring of 1962

(ii) that long delays in the order, delivery and installation of technical equipment have occurred in the past

RECOMMENDS that all concerned act speedily to procure and instal items of equipment required for the expedition programme.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 15: RAINFALL AT SEA

THE COMMITTEE

NOTING	the absence of a satisfactory method of measuring rainfall at sea
CONSIDERING	the need for knowledge of rainfall amounts and times of occurrence
RECOMMENDS	that every effort should be made to observe and record the times of occurrence, nature and intensity of precipitation especially over the open ocean.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 16: CLIMATOLOGY: EVAPORATION

THE COMMITTEE

CONSIDERING the need for observations of evaporation from water surfaces, particularly from islands and coastal stations in the Indian Ocean

RECOMMENDS that all States establish Class A or similar evaporation pans at the most suitable location within their territory to achieve a satisfactory network.

METEOROLOGICAL PLANNING COMMITTEE OF SCOR FOR

THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Rec. 17: CLIMATOLOGY: RADIATION

THE COMMITTEE

APPRECIATING the importance of as dense a network as possible of integrating radiation recorders for the measurement of total and diffuse radiation and

NOTING the present network of radiation recorders as shown in the attached List A

RECOMMENDS that additional integrating radiation recorders be established at the surface stations indicated in List B and that all weather and oceanographic ships should be so equipped wherever possible and

REQUESTS the IMC to undertake comparisons of the various types of instruments used by each Meteorological Service in the Indian Ocean.

LIST A

(a Stations already recording total and diffuse sky radiation.

1. Delhi
2. Jodphur
3. Nagpur
4. Calcutta
5. Madras
6. Kodaikanal
7. Bangalore
8. Poona
9. Karachi
10. Quetta
11. Multan
12. Peshawar
13. Chittagong
14. Dacca
15. Tananarive
16. Entebbe
17. Nairobi
18. Dar-es-Salaam
19. Several stations in South Africa

(b) Stations recording total radiation only.

1. Chiengmai
2. Udorn rajadhani
3. Bangkok
4. Songkhla
5. Singapore
6. Mauritius

LIST B

Stations recommended to complete the Indian Ocean network

1. Bahrein
2. Salalah
3. Aden
4. Magadiscio
5. Seychelles
6. Diego Garcia
7. Gan
8. Minicoy
9. Crozet
10. Kerguelen
11. Lourenco Marquez
12. Mossuril
13. Cocos Island
14. Bali ~~Ben Pasar~~
15. Djakarta
16. Palembang
17. Port Blair
18. Veraval
19. Bombay
20. Mangalore
21. Visakapatnam
22. Jiwani
23. Nokkundi
24. Rangpur
25. Colombo

TABLE I

METEOROLOGY PROGRAMME - INTERNATIONAL INDIAN OCEAN EXPEDITION

Large Scale Atmospheric Circulation and Related Studies

Activity	Current Effort	Additional Effort to which States committed	*Further Effort requested by Bombay SCOR Met. meeting to meet Total Additional Requirements
General Circulation (Surface & Upper Air Stations) (Recommendation 3)	$ 6,988,000 **	$ 2,329,000	$ 2,790,000
Radiation (Recommendation 17)	177,000		205,000
Ozone (Recommendation 10)	72,000		116,000
Storm Warning Radar (Recommendation 9)	1,350,000	270,000	
Sky Recording (Recommendation 8)			13,000
GRAND TOTAL FOR TWO YEARS OPERATIONS:	$ 8,587,000	$ 2,599,000	$ 3,124,000

NOTE These figures do not include cost of weather ships, oceanographic ships or the observations (surface and upper air) which they will do. Nor do they include the cost of the MAMOS buoys or their servicing.

* Further effort not likely to be forthcoming from states themselves.

** Recurrent cost alone estimated. Owing to the different circumstances in the various states, the capital investment in coastal and island upper air and surface meteorolical stations in the Indian Ocean could not be estimated with any degree of certainty; however, it is unlikely to be less than US $3,000,000 and may well be twice this figure

S U M M A R Y (All figures in US dollars) INDIAN OCEAN GENERAL CIRCULATION EFFORT - RECOMMENDATION 3 Meteorological Station Network shown on Chart) T A B L E II

COUNTRY	Estimated cost of present annual recurrent effort		Estimated cost of additional stations already recommended to or approved by Governments which will contribute to the Expedition				Estimated cost of additional effort recommended by sub-committee in Rec. 3 *	
	Upper Air	Surface	Upper Air		Surface		Capital	Ann.Recurrent
			Capital	Ann.Recurrent	Capital	Ann. Recurrant		
1	2	3	4	5	6	7	8	9
British East Africa	45,000	26,000		35,000		5,000		
Malagasy Republic	42,000			16,000				
Mauritius	8,000	24,000		22,000				
South Africa	414,000	72,000						
Portugal (Mozambique)	138,000	48,000						
Somalia		15,000						
Arabian Penin. & Gan	140,000	30,000						
Pakistan	248,000		463,000	325,000	51,000	7,000		
India	880,000	200,000		150,000	37,000	56,000		
Ceylon	18,000	30,000						
Thailand	70,000	75,000						
Malaya & Singapore	30,000	60,000	55,000	25,000	10,000	10,000		
Indonesia	90,000	95,000	70,000	160,000				
France	69,000	42,000						
Australia	345,000	240,000						
CAPITAL TOTAL			588,000		98,000		298,000	
ANN.RECURRENT TOTAL:	2,537,000	957,000		733,000		78,000		1,246,000
Japan (1 yr ship obs.)				21,000				
2-YR EXPEDITION COST:	5,074,000	1,914,000	588,000	1,487,000	98,000	156,000	298,000	2,492,000
GRAND TOTALS	6,988,000		2,329,000				2,790,000	

* Not itemized by countries because of incomplete representation at Bombay meeting.

S U M M A R Y

T A B L E III

INDIAN OCEAN RADIATION STATION EFFORT Recommendation 17.

(All figures in US Dollars)

	Current Effort		Further effort requested by SCOR Bombay Meeting (Recommendation I7)	
	Capital	Annual Recurrent	Capital	Annual Recurrent
Measurement of Total Radiation only	18,000	6,000		
Measurement of Diffuse Radiation only			18,000	6,000
Measurements of Total and Diffuse Radiation	105,000	21,000	125,000	25,000
TOTAL:	123,000	27,000	143,000	31,000
GRAND TOTAL FOR TWO YEARS OPERATIONS:	177,000		205,000	

S U M M A R Y

T A B L E IV

INDIAN OCEAN OZONE STATION EFFORT - Recommendation 10

(All figures in US Dollars)

	Current Effort		Recommended Network	
	Capital	Annual Recurrent	Capital	Annual Recurrent
	36,000	18,000	66,000	25,000
GRAND TOTAL FOR TWO YEARS OPERATIONS:	72,000		116,000	

PROPOSED TELECOMMUNICATION CHANNELS

Rec. 2

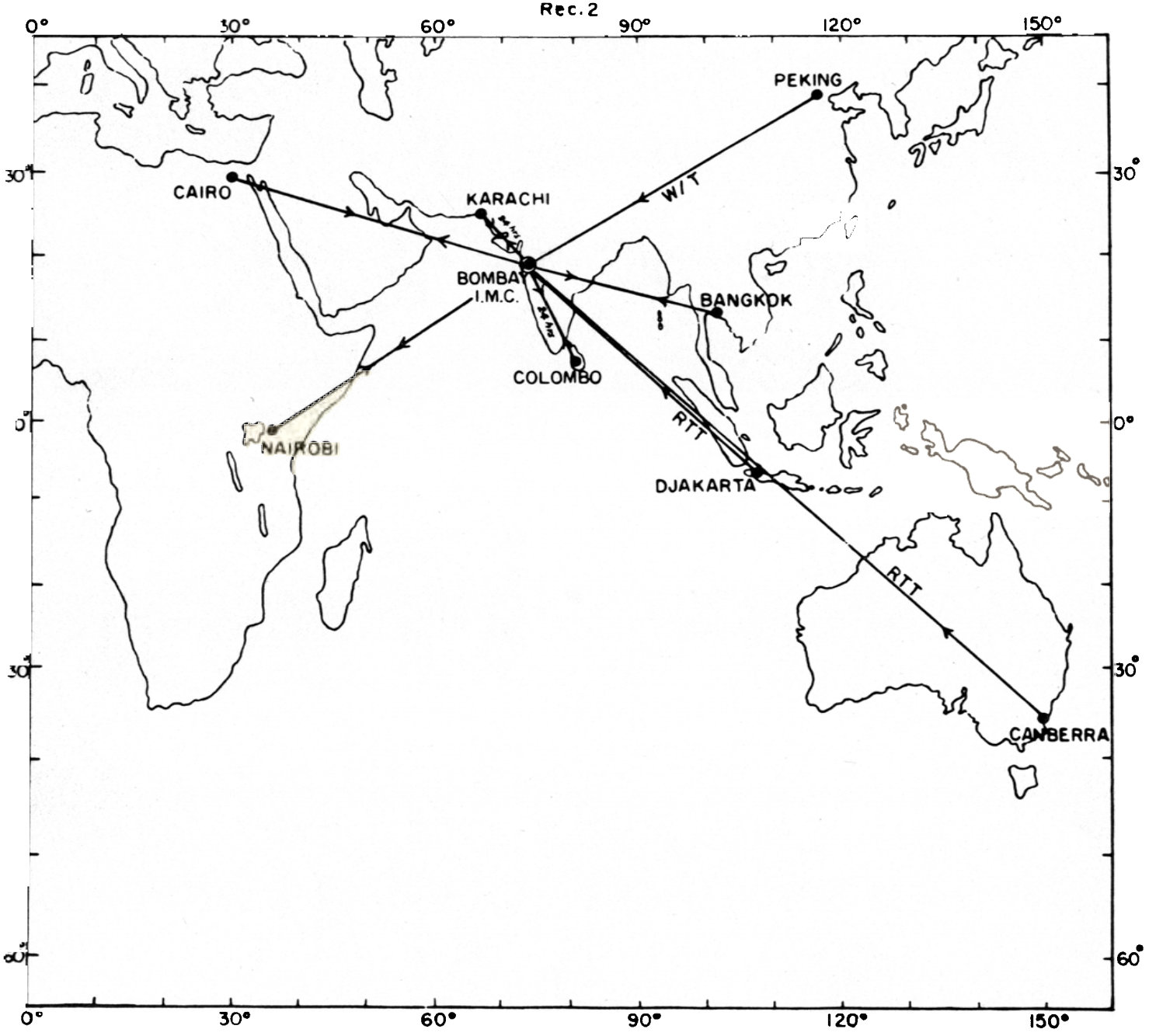


FIG. 1

ADDITIONAL SURFACE SYNOPTIC STATIONS

Rec.3 (1a)

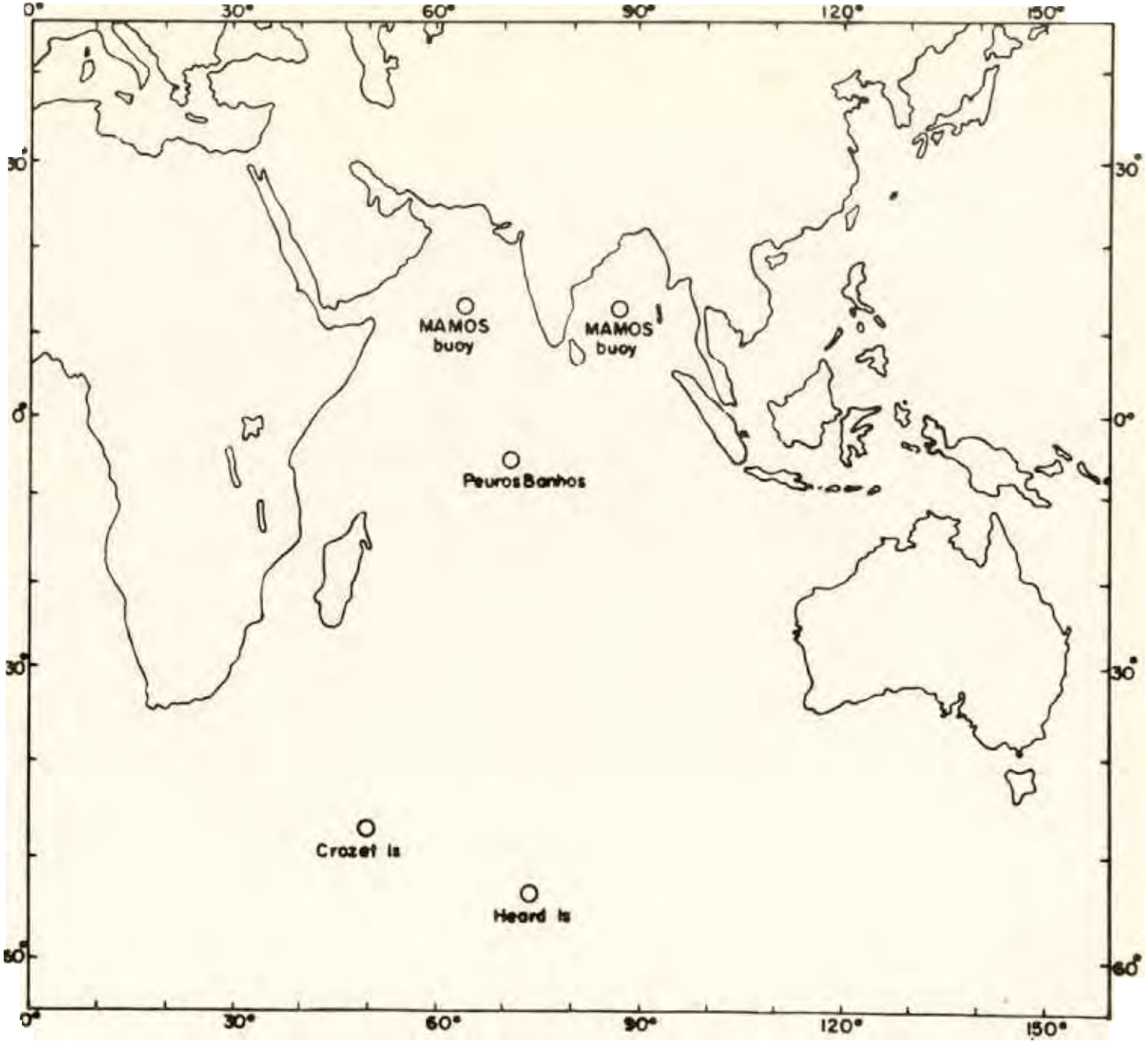
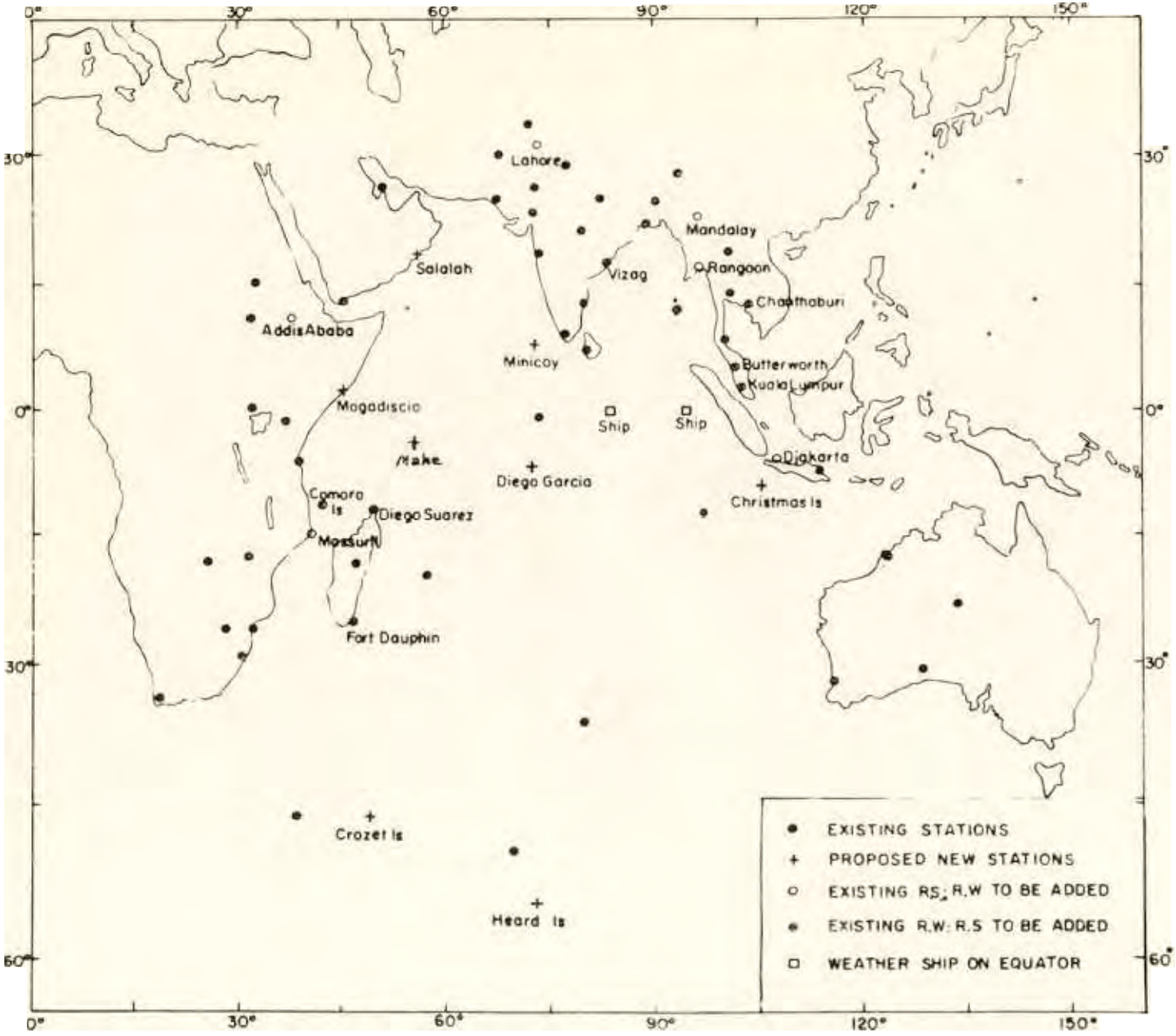


FIG.2

RAWINSONDE STATIONS

Rec.3 (2a,b,c,d)



ALL-SKY CAMERA AND STORM-DETECTING RADAR STATIONS

Rec. 8, 9

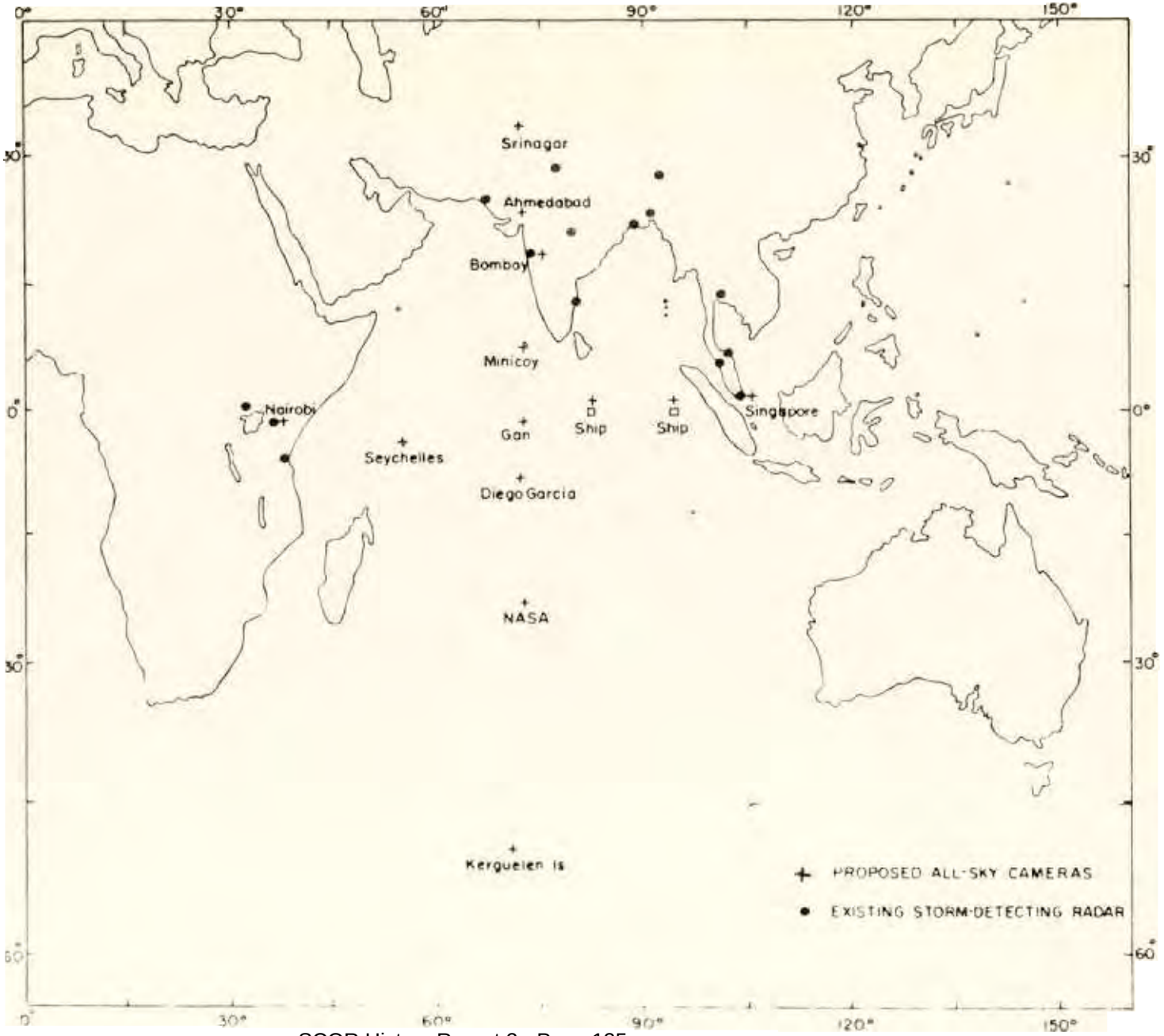


FIG 4

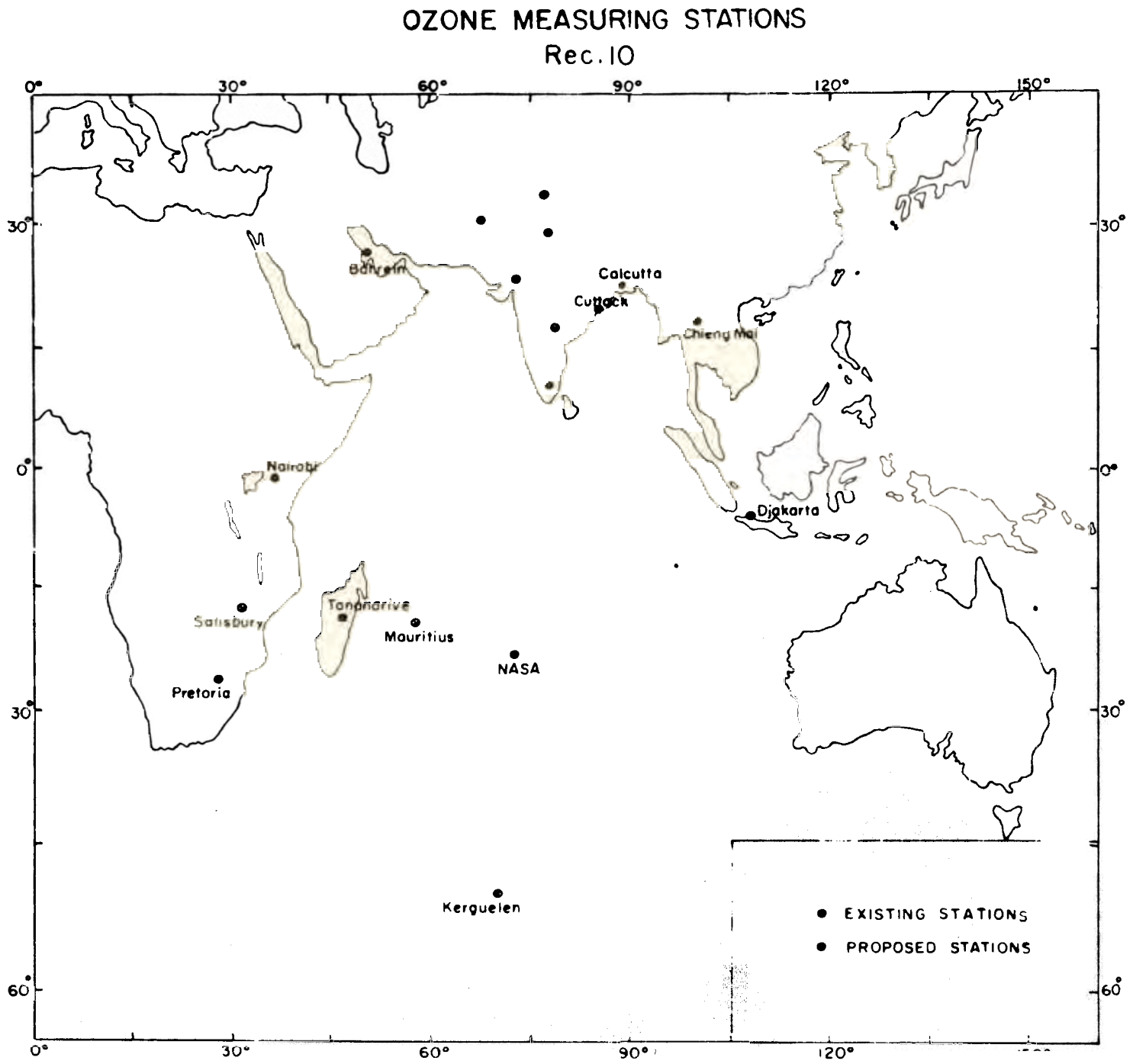

OZONE MEASURING STATIONS
Rec. 10
0°
30°
60°
90°
120°
150°
Bahrein
Calcutta
Cuttack
Chiang Mai
Nairobi
Djakarta
Salisbury
Tananarive
Mauritius
NASA
Pretoria
Kerguelen
EXISTING STATIONS
PROPOSED STATIONS

FIG. 5

RADIATION MEASURING STATIONS
Rec.17

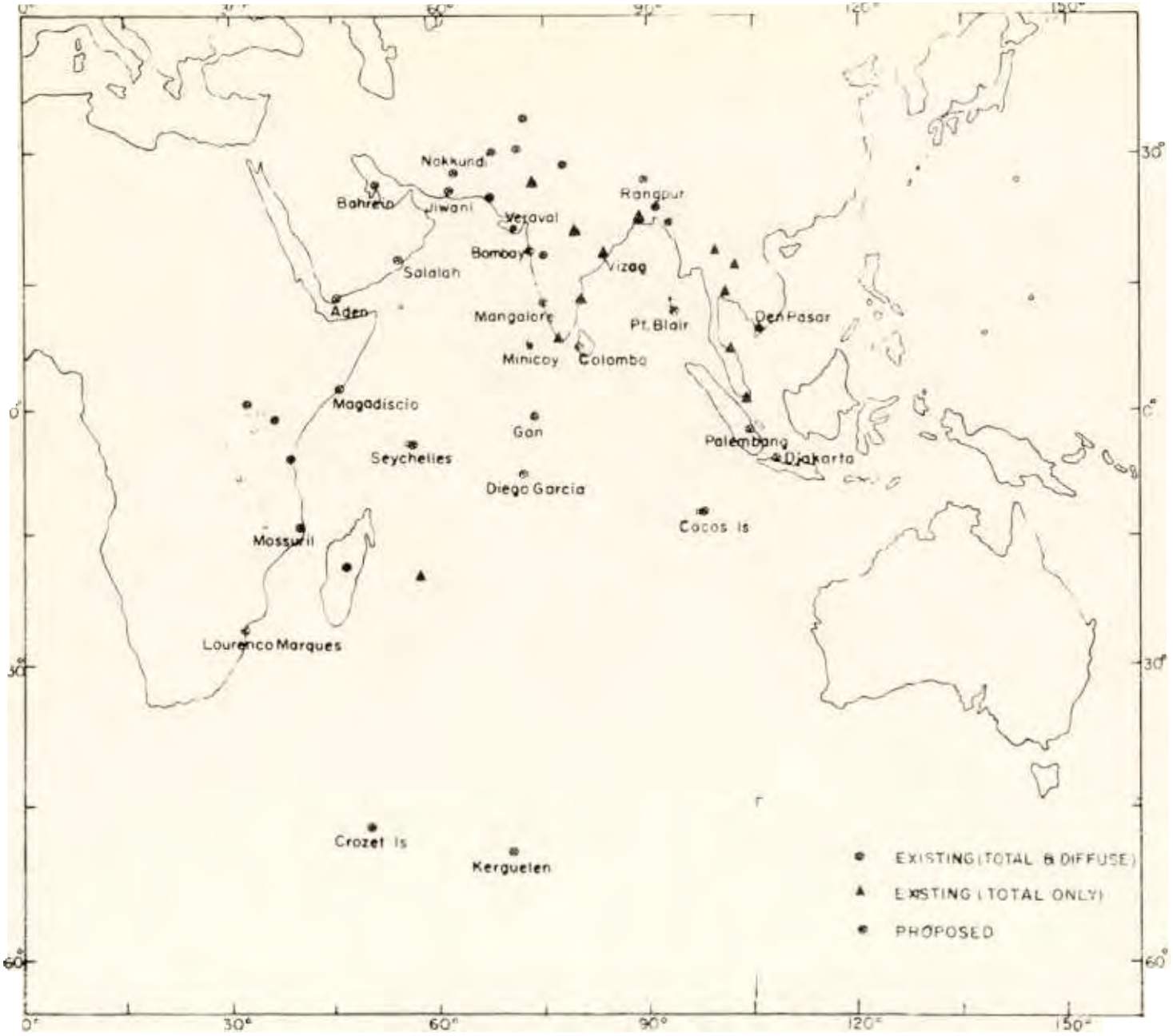


FIG.6

GENERAL SUMMARY OF THE MET. TELECOMMUNICATIONS REQUIREMENTS OF THE IMC BOMBAY. (SUBJECT TO SOME REVISION)

The Committee carefully examined the telecommunication requirements of the proposed IMC and came to the following conclusions.

A. Point-to-point RTT links. - RTT links on a 24 hour basis would be required between Bombay and Karachi and between Bombay and Colombo Similar RTT links but on a restricted basis would also be necessary between Bombay and Cairo, between Bombay and Bangkok and between Bombay and Nairobi for the reception of data for the four principal synoptic hours 00, 06, 12 and 18 GMT from the countries around the Indian Ocean. It was understood from the representative of the India Meteorological Department that it would not be feasible to diplex or multiplex the existing AFTN channels within the available time. Hence the provision of additional RTT links through Overseas Communication Service of the Indian Government as proposed above would be the only practical solution to the problem.

B. RTT broadcast receptions

Additional RTT equipment would be needed at the Bombay OCS and for the reception of RTT broadcasts from Canberra and Djakarta.

C. W/T Receptions

The reception of Chinese W/T broadcasts at New Delhi should be improved by the strengthening of the reception methods and machinery at New Delhi.

D. Data received at Delhi on the Delhi-Moscow and Delhi-Tokyo NHEC links.

As the Delhi-Tokyo RTT link passed through Bombay and as all the NHEC data received from Moscow are being transmitted to Tokyo through Bombay, it should be possible to make available to IMC Bombay all the data received from Moscow and Tokyo under the NHEC system, by providing the facility of a drop-copy at the IMC Bombay. The Committee would strongly recommend that this facility be provided at Bombay.

E. Facsimile Reception

The additional equipment proposed in the draft IMC plan for Facsimile receptions at the IMC end would ensure the required facsimile reception from Tokyo and Southern Hemisphere and of Weather Satellite data.

The Committee would recommend that Japan may explore the feasibility of Tokyo relaying the Washington Analysis on the NHE Channels to New Delhi.

F. Collection of ship's reports

The Committee came to the conclusion that the additional telecommunication links between IMC Bombay and the other countries proposed above should remedy to a great extent the existing deficiencies in the reception of ships' data from the Indian Ocean. The Committee also felt that any change in the existing procedure in regard to the addressing of messages by Merchant Shipping would require the prior concurrence of CMM which would be difficult to obtain in time. The Committee therefore recommends that no change may be made in regard to the addressing of messages at present.

G. Weather Bulletins in Oceanographic vessels in the Indian Ocean during the Expedition period.

It was understood from the representative of the India Met. Department that it would not be possible to utilize the AIR transmitters for the dissemination of Weather Bulletins to the Oceanographic vessels as the AIR aerials were oriented east to west. Further, the AIR transmitter could be used only if voice-transmissions were contemplated.

It was understood from the Indian representative that the transmissions from the coastal Radio station at Bombay for ships were made on medium as well as short-wave and that they could be picked up by ships plying in the Indian Ocean to the south of the equator. The Committee, therefore, came to the conclusion that the best possible arrangement under the existing circumstances would be for the Weather ships located near the equator to pick up these bulletins and retransmit them to the oceanographic vessels to the south of the equator.

Details of the additional telecommunication facilities required, together with the capital cost of the equipment and the recurring cost for the provision of the facilities, are given in the Appendix.

Requirement for Meteorological Telecommunication for IMC

(A) Point-to-Point RTT communication links:

1) Bombay - Karachi) 24 hr. RTT link error-corrected and
2) " - Colombo) half-speed i.e. 30 w.p.m. is planned.
3) " - Cairo (restricted hrs.) Limited hour use
4) " - Bangkok " ") (4 hrs. synoptic)
5) " - Nairobi " ")

Initial capitsl cost	(IMC) Indian effort US $	Distant effort US $
Equipment schedule attached $90,000 per circuit x 5)	450,000	450,000
Recurring cost per year	138,600	138,600
1) Karachi ... 28,800		
2) Colombo ... 28,800		
3) Cairo ... 27,000		
4) Bangkok ... 27,000		
5) Nairobi ... 27,000		
	138,600	

(b) For RTT Reception Circuits:

1) Canberra
2) Djakarts

Initial capital cost: Equipment schedule includes provision for this. $20,000 per new circuit; Total 3 circuits	40,000	Existing installation
Recurring cost per year $6,000 per circuit for 2 circuits - $12,000 per year. (This is only an approximate estimate).	12,000	-

(C) For W/T Reception Circuit:

Peking W/T for 12 hrs. a day		
Capital	20,000	-
Recurring	12,000	-

		(IMC) Indian effort UN $	Distant effort
(D)	RTT link New Delhi-Bombay-Tokyo: facility to have drop-copy of the circuit traffic at Bombay IMC - Capital cost	2,200	-
	Recurring cost per year	2,500	-
(E)	FAX Reception from Satellite		
	(a) Aerial	18,500	
	(b) Equipment (taken from draft Ramage plan, page 11)	16,800	
(F)	Indian Met. Dept. Teleprinter equipment for internal links (Ramage plan, page 11) - Capital cost	50,400	-
	(Bombay-Calcutta) Capital	7,500	-
	(Bombay-New Delhi) costs		
	(Bombay- Madras)	10,800	-
	Recurring cost per year	25,000	-

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Equipment schedule for circuits (A) to (D)

	Capital cost	Recurring cost per yr.
	$	$
Indian Stations		
items (A,B,C and D)	512,200	165,100
items (E & F)	104,000	25,000
	616,200	190,100
Distant stations	450,000	138,600
Total	1,066,200	328,700

Equipment schedule for Met. circuits for the Indian Ocean Expedition 62 - 64

- - - - - - - - - - -

S. No.	Description	Qty.	Indian*
1.	HF (4-27.5 Mcs) Radio Telegraph transmitter of about 10 kw output power and complete with crystal OBC and F_1 drive units suitable for 400 V, 3 ph 50 cps. AC mains	10	(5)
2.	Duel diversity RF (4-27.5 Mcs) telegraph receivers, suitable for on - off, FSK, reception (A_1 F_1) must include AFC circuits; The equipment to be suitable for 230 V AC 50 cps. mains operation (Marconi HR 11, STC Rx5C type)	13	(8)
3.	Automatic error detecting/correcting multiplex equipment (TOR/ARQ) suitable for 4/2 channel operation equipped with sub-divider on one channel and leased and public traffic line connecting units. Fully Electronic transistorized equipment is required for operation from 230 V AC 50 Cps mains (Siemens or Hasler make preference)	10	(5)
4.	Receive only page printer Ollivetti type "t2-SR" with perforating attachment type Olivetts T2-PF or Siemens type T 100 with perforating attachment	40	(25)
5.	Printing Reperforator for sending and receiving with key board Ollivetti type No.T2-PN fitted with end of line Indicator T2-ST or Siemens type 68 F.	26	(16)
6.	Page Printer with key board Ollivetti type T2-SN with perforating attachment T2-PF or Siemens type T100 with perforating attachment	16	(10)
7.	Automatic transmitter pulsed type Siemens No. TZ 61b TZ 519	20	(10)
8.	6-channel FMVFT equipment for operating speed of 240 bands per channel (230 AC mains supply)		
	Sending terminals	2	(2)
	Receiving terminals	2	(2)

* Note:- Figures in brackets indicate Indian's requirements included in the total figures under the column "QTY".

CONSEIL INTERNATIONAL DES UNIONS SCIENTIFIQUES - INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
SPECIAL COMMITTEE ON OCEANIC RESEARCH
(SCOR)

INTERNATIONAL INDIAN OCEAN EXPEDITION
30 EAST 40TH STREET · NEW YORK 16, N. Y. · LEXINGTON 2-6533

COORDINATOR
ROBERT G. SNIDER

CABLES
SCORINDOC - NEWYORK

COORDINATOR'S REPORT
24 October 1961

The period of promotion, preliminary organization and development of the Expedition is drawing to a close. Intensive investigation will begin about mid-1962. Planned programs for the forthcoming fiscal period are, in most instances, financed. Future plans must be drawn on the assumption of continued financing. Working groups of participating scientists and ship operators must now coordinate individual and national efforts to achieve optimum coverage of the Indian Ocean with the available facilities.

Participation - The following countries have formed national committees and have indicated that they will participate in the Expedition: Australia, Ceylon, China (Nationalist), Denmark, France, Germany (Federal Republic), India, Indonesia, Israel, Japan, Pakistan, Portugal, South Africa, Thailand, Union of Socialist Soviet Republics, United Kingdom, United States of America. Of these, all except Ceylon, China, Denmark and Thailand will operate at least one vessel in the Expedition. Scientists from non-ship operating nations will ride various vessels, and there will be a general practice of carrying non-nationals on all vessels where facilities permit.

All countries, except Ceylon, Denmark, Indonesia, Thailand and U.S.S.R. have indicated that working groups composed of prospectively participating scientists have been established to draw up detailed national plans in one or more of the Expedition's disciplines of biological oceanography, geology and geophysics, meteorology and physical and chemical oceanography. In most instances, however, names of these scientists have not been made available to the office of the Coordinator.

The Malagasy Republic is in the process of forming a National Committee. Ad-hoc committees have been formed in East Africa and in Mauritius and are currently functioning. Burma and Malaya have been approached and participation is under consideration. Egypt has expressed an interest in participation but no action has been reported. Ethiopia and South Vietnam have offered special port facilities. Saudi Arabia, Somalia and the Trucial States as well as Iran and Iraq have not been approached.

Geological programs will be included in over two-thirds of the cruises, geophysical programs in less than half of the cruises, according to present information. Inquiries have been initiated on explosives storage and supply. Proposals have been made to conduct core analysis and samples of all cores at a single center.

Physical and chemical oceanographic observations will emphasize the study of current systems and the seasonal monsoon effect as well as providing a description of the general characteristics of the Indian Ocean. Some increase in intensity of coverage in the Bay of Bengal and the Central Southern Indian Ocean is required for adequate understanding. An effort should be made to obtain full seasonal as well as geographic coverage, through some revision of ship schedules.

Current Developments - During the period since the last meeting of SCOR, the Coordinator has visited each participating nation with the exception of Israel and USSR from one to five times. Consultations with scientists and government officials have been held to facilitate organization and planning of the Expedition.

Three meetings, one on standardization, two on intercalibration, held with financial assistance from UNESCO, have amply demonstrated the importance of further effort along these lines to achieve inter-comparability of results in each discipline.

Each prospective participating nation has been requested to provide hospitality and facilities in accordance with the recommendation of SCOR's Indian Ocean Working Group embodied in the proceedings of the last SCOR meeting. A letter from the Secretary-General of UNESCO to member nations and personal discussions by the Coordinator in nations and other governmental units bordering the Indian Ocean have elicited descriptions of facilities for Expedition ships from Ethiopia, Indonesia, Iraq, Japan, Malagasy Republic, Mauritius, Singapore, South Africa and South Vietnam. The matter is under consideration in other nations.

Although it is not possible to arrive at a precise figure for the total probable outlay by all nations for the entire period of the Expedition's probable life - 1959 to 1965 - it seems reasonable to estimate that the cost will be in the order of $60,000,000. This does not include the construction cost of at least six new oceanographic research vessels which are scheduled to be built and to participate in the program.

Robert G. Snider

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B R I E F S U M M A R Y

STATUS OF PARTICIPATION IN IIOE AS OF 4 APRIL 1962

As of this date the organizing and preliminary planning phase of the Expedition appears to be drawing to an end. Emphasis hereafter will be primarily on operational and scientific coordination in timing, in disciplines and in areas, and on refinement and amplification of plans in the light of increasing knowledge obtained about the Indian Ocean.

Thirteen ship-operating countries and seven non-ship-operating countries or governmental units are participating. 39 vessels are now scheduled to carry out work in the Expedition, and at least seven more vessels are likely to participate. Their cruises vary from a few months in length to several of well over a year and one of two years. Funding for next twelve months is generally adequate.

During the two years beginning June 1962, an average of at least seven ships will be operating at any one time in the Expedition, although in any given month this may vary from three to twelve or more vessels. Most scheduled effort now is in the months of December, January, February and March. Least ship activity occurs in April and May, in October and November. However, many cruises are scheduled to cover the same area in each monsoon.

Some areas are attracting appreciably more ships than others. Eighteen ships are scheduled to operate in the Arabian Sea, whereas only eight operate in the Bay of Bengal. Many fewer ship months are involved in the latter. Between 10° N and 10° S, fourteen ships operate in the western half and fourteen operate east of 78° E. Fifteen operate in the South West Indian Ocean and thirteen in the South East. There is much less intensive coverage in the region below 32° S than above, and very little below 40° S. However, twelve reconnaissance cruises to date by various nations have revealed problems attracting further investigation in most regions. On the basis of these, and the cruises now scheduled in the next two years, it is reasonable to expect an increasing activity running into 1965. Few nations have detailed plans now beyond early 1964.

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A slippage of approximately six months has occurred in a number of programs. This does not constitute a serious problem at this stage of the Expedition. At a later stage it might. Although full-scale financing for the immediate budget years has encountered some resistance no major reductions are in sight. Planning for subsequent years is developing in greater detail together with the identification and commitment of individual scientists. A number of new vessels will become available during the next several years and they are being scheduled for maiden cruises in the Expedition. Interest and backing for the Expedition seems to be developing at a satisfactory rate. UNESCO is supporting training and special scientific meetings, and assisting in support, with India, of an Expedition taxonomic center at Cochin.

The stage has now been reached when each nation must begin to interrelate its plans with those of others. Firm international commitments properly drawn up at a series of regional meetings as well as through correspondence, will be required to achieve maximum coordination of the Expedition in disciplines, areas and times.

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THE SITUATION IN THE NATIONS

UNITED STATES of AMERICA

ARGO enters the Indian Ocean again in June '62 for 12 months operations. Works Central and Southern regions in both East and West, alternating between Physics and Chemistry, and Geology and Geophysics, with full minimum program in all disciplines. HORIZON joins as shooting ship doing some Physics and Chemistry in September to end of year. BAIRD follows in '64 doing Geology and Geophysics in Southern half.

VEMA, having completed two reconnaissance cruises in the Indian Ocean, enters again in June '62 for 2 months in Western half. In early '62, she and CONRAD operate in similar area for 3 months. Primary emphasis Geology and Geophysics, although full minimum program contemplated all disciplines.

WILLIAMSBURG, concentrating primarily on Biology, operated by Woods Hole for the U.S. Biological Program, operates for 2 years ('63 and '64) on nine cruises, concentrating on the Western half of the ocean and the Bay of Bengal. Physics and Chemistry will also be major programs, together with Meteorology. A chartered auxiliary vessel will do Biology and Geology during most of this period in island groups of all areas except South East Indian Ocean.

ATLANTIS II, emphasizing Physics and Chemistry will operate in opposite monsoons in '63 and '65 in the Western half. CHAIN, emphasizing Geology and Geophysics, operates in the same area September to March in '63-'64 and '64-'65. Both vessels do minimum in other disciplines including Meteorology.

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Two weather ships, not yet funded, are planned for Equator below Bay of Bengal for '63 and '64. U.S. effort in meteorological program will be major, at IMC Bombay in conjunction with India and, it is hoped, UN Special Fund, in supplementing and coordinating analysis of tropical circulation and air-sea interface problems, on U.S. and other ships, and in conjunction with existing and amplified meteorological networks. A NOMAD automatic boat-type weather station for Bay of Bengal installation is scheduled for July '62 delivery there.

USS REQUISITE (Hydro) has made two cruises in upper Arabian Sea. USS SERRANO (Hydro) two in Bay of Bengal. She will return in 1962 to work in the Andamann Sea, along the Burmese Coast and on two sections across the Bay of Bengal to Vizapatnam and to Ceylon.

Assistance in filling some gaps in tide gauge network contemplated. U.S. Coast and Geodetic Survey (one vessel) plans to participate. Funding for '62-'63 looks reasonably satisfactory.

UNITED KINGDOM

HMS DALRYMPLE in Oct.'61 to Feb.'62 did magnetic surveys in the Red Sea and along the Arabian coast and sediments in the Persian Gulf. Probably similar program 1962-3.

HMS OWEN operating from last October to next May has done precise bathymetry, magnetism and gravity in area from Karachi to Gan to Mauritius to the Kenya coast and the Gulf of Aden including the Seychelles and three northeast-southwest sections across this area. '62-3 off Kenya coast with possibly two deep water oceanographic cruises. '63-4 and '64-5 in west Indian Ocean. No plans formulated.

RRS DISCOVERY February '63 to April '64 in northwest and western Indian Ocean to 78°E and southwest to 30°S. A full program in all disciplines with concentration on biology, physics and chemistry in two seasons along the Arabian coast and current in two seasons along the equator and geophysics in Arabian Sea.

UK is planning adequate to substantial effort in tide gauge and meteorological programs. Planning is substantial, full advance funding has not finally been decided. Level of cooperation is very high.

MANIHINE program (Zanzibar) is doubtful because of withdrawal of local support.

FRANCE

Three cruises completed by CMDT. ROBERT GIRAUD emphasizing physical oceanography in northwest Indian Ocean. Five vessels - CALYPSO, CMDT. ROBERT GIRAUD, a 22 m. biological vessel based at Tulear (Madagascar), a new 70 m. oceanographic vessel, and a 35 m. new vessel destined for New Caledonia and operating enroute will work

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between December '62 and probably into 1964 from 30°S northward in the western part of the Indian Ocean, in the Arabian Sea, Persian Gulf, Gulf of Aden and Red Sea primarily doing physical oceanographic sampling and measurement and direct current measurements. Biology will be concentrated at Tulear and Nosy-Bé in the Mozambique Channel. Tide gauges will be maintained at Kerguelen and Amsterdam. No serious financial problems reported. Cooperation good.

PORTUGAL

One survey vessel ALMIRANTE LACERDA being converted and equipped for oceanographic work operating out of Lourenco Marques in Mozambique Channel and southward. Participation planned in meteorological and tide gauge networks. Overall participation presumably planned for life of Expedition into 1965. Financial problems unknown.

GERMAN FEDERAL REPUBLIC

A new research vessel will be laid down in 1962 and will operate in either '63 or '64 in the Arabian Sea and adjoining gulfs, etc. Largely in the boundary current regions in two monsoon seasons conducting research in all disciplines. No details of program or personnel currently available. Financing seems satisfactory and cooperation good.

UNION OF SOVIET SOCIALIST REPUBLICS

VITJAZ has completed two extensive cruises each of about 250 stations in both the Arabian Sea and the Bay of Bengal and south to about 20°S. Third cruise scheduled to depart from Djakarta in April or May '62 for about eight months operating in the east, central and southeast Indian Ocean with some evident emphasis on equatorial current studies and benthic studies although a full program in all disciplines is promised, without details. Financing problems, if any, unknown. Cooperation seems good since data from 250 stations of VITJAZ' Indian Ocean cruise is now held by NODC. No information on subsequent cruises or on cruises by other Russian vessels although they are in Indian Ocean.

JAPAN

Failure to obtain budgetary support for a five vessel expedition which would have been on station for 30 days each on meridional lines between 78°E and 114°E from 8°N in the Bay of Bengal to 32°S between December '62 and March '63 has resulted in the withdrawal of that program with its reasonably full disciplinary coverage. At the time of my visit to Tokyo in late February a limited program of two or possibly three vessels operating for the same length of time on station doing physics, chemistry and biology in an area which may extend only to 15° or 20°S and may go further north into the Bay of Bengal was re-instated. Geology and geophysics, much needed new equipment, and possibly meteorology were eliminated but cost of ship time to and from the Indian Ocean was assumed by non-Indian Ocean Expedition accounts. On 29 March announcement was made that UMITAKA MARU and KOYO MARU would participate in 1962-63.

Three Ministers of Government with whom I talked indicated that for 1963-4 and possibly '64-5 a full program comparable to Japan's original plan would be supported.

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Japan's effort in the Expedition probably least of any major oceanographic nation inspite of fact one fourth Japan's tuna catch comes from there. Every effort both internal and international required to stimulate Japan to mount program compatible with her abilities, economic interests and international responsibilities.

SOUTH AFRICA
Several cruises by NATAL (SAN) one by AFRICAN II (Fisheries Agency) in June-July '61 and trips by R/V JOHN D. GILCHRIST. AFRICANA II east to longitude of Mauritius, NATAL to 5-600 miles from east and south coast of South Africa. 1962 to early '63 eight two or three week cruises in varying disciplines plus basic general program by NATAL. Similar range and length of program emphasizing biology in June-July '62 by AFRICANA II. Coastal work by GILCHRIST. Every evidence South Africa will continue to develop its physical, chemical biological and geophysical programs in Agulhas and Mozambique Current areas during life of Expedition into 1965. No serious financial problems evident although lack of funds for specific units of shipboard equipment (stable platform for gravimeter) and added laboratory funds (total analysis of all IIOE cores) limit expansion in these areas. Growing interest and high cooperation.

MOZAMBIQUE (see PORTUGAL)

MALAGASY REPUBLIC (MADAGASCAR)
Program closely allied with France providing bases for most French ship operation. Local participation in meteorological and tide gauge networks and hospitality, and local biological effort.

MAURITIUS
Local committee for liaison together with hospitality-courtesy. Also participation in meteorological network at Mauritius and Diego Garcia with U.S. assistance, tide gauge installation and operation, and assistance at small islands north and northeast of Mauritius.

BRITISH EAST AFRICA (TANGANYIKA, KENYA, ZANZIBAR)
With rapid political evolution current status of participation unclear. Zanzibar Marine Laboratory reported losing its local funding (70%) and research vessel MANIHINE. Meteorological participation particularly at Nairobi seems assured. Possibilities of Tanganyika active participation to be explored. Tide gauge program assumed satisfactory pending further investigation. Major participation in programs within region's capacities probably dependent on UK effort. Cooperation has been very good.

SEYCHELLES
UK installing radiosonde-rawind on Mahé. Accessibility difficult Hospitality reported unparalleled.

SOMALIA
No direct contact although facilities for non-local tide gauge installation and upper atmosphere sounding and wind finding reported likely.

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ARABIAN PENINSULA
Only contacts through British (Colonial Office, Commonwealth Relations Office, and RAF). Most sites and facilities for radiosonde-rawind, radiation, and tide gauge measurements can be worked out with cooperation of British.

RED SEA and PERSIAN GULF
No formal negotiations with countries bordering these waters although Ethiopia has offered hospitality-courtesy. Israel is conducting a shallow water biological and geological study in the lower Red Sea and many nations are operating in transit through the Red Sea and into the Persian Gulf.

PAKISTAN
At least two vessels operating in both the Arabian Sea and Bay of Bengal above 15°N from 1962 through '64. Currently one survey vessel converted for deep sea research now in upper Bay of Bengal. Small craft probably to work on continental shelf. Total program afloat and onshore covers all disciplines with modest effort but substantial for Pakistan. Meteorological and tide gauge programs fit networks. Some financial problems in equipping second major vessel and obtaining top level government backing for program. National Committee most energetic and very high cooperation.

INDIA
Five vessels committed to program including INS KISTNA, Frigate currently being converted to full time oceanographic work and deep sea research across Arabian Sea and Bay of Bengal, plus 70' new Fisheries Research vessel with range to 200 miles from coast (approx.), plus three vessels for continental shelf operations around India.

KISTNA to work as far as 12°S in northwest end of Indian Ocean to Africa and Arabian Peninsula, through Laccadives and Maldives and to Andamans and Nicobars plus linked sections to 2-300 miles from India's coasts plus sections across Arabian Sea and Bay of Bengal. Programs planned in all disciplines.

India's submission of satisfactory formal request to the U.N. Special Fund for assistance on the International Meteorological Center at Bombay moving at less than desired rate. India committed in principal to such submission. The Special Fund and WMO await proper request to expedite matters.

Physical arrangements at Cochin together with staffing plans for plankton taxonomic center moving at less than desired rate. Information on developments last several weeks lacking. Situation probably reasonably satisfactory but requires constant follow-up and negotiation.

Mainland and island links in meteorological network all satisfactory as well as tide gauge plans including Laccadives installation at Androth.

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Negotiation in India for special treatment of semi-permanent U.S. personnel at meteorological and biological centers developing parallel to similar negotiation from U.S. side.

CEYLON
Limited formal participation through Ceylon National Committee has been assured by governmental endorsement. Such participation will probably take place through meteorological observation, some tide gauge observation and some hospitality. Limited local waters observations from small Fisheries Research vessels may occur.

MALDIVE ISLANDS
Preliminary contracts have been made through British channels to explore possibilities of temporary island stations and some logistic support. The results of these investigations will be reported later.

BURMA
There are good contacts with leading figures in both the past and present Cabinets. Local ad-hoc committee has been formed at government request to seek government sponsorship for participation. Burma's limited offering will include meteorological observation, some tide gauge observation and possibly ship courtesy. Some small effort in biology and hydrography, which might take place with Thailand and Malaya, can be developed. Burma's status in the Expedition should be clarified within the next few months.

THAILAND
Increased planning and government support of the Thailand effort has resulted in commitment of one 90 ton vessel to research off the west coast of Thailand and a plan for utilizing a new 350 ton vessel (if some additional equipment can be obtained) for similar work well toward the Andamans and Nicobars. If arrangements can be made with Burma and Malaya this vessel would also work on physical and chemical problems and with assistance, on biology and geology-geophysics problems, along the western coast of all three countries in the boundary current areas of the eastern part of the Bay of Bengal, helping to fill a major gap in geographic and seasonal coverage.

Thailand's meteorological participation will be substantial and they have available for partial support of the IMC at Bombay over $50,000.

MALAYA
A responsible Executive Department is taking aggressive initiative in organizing a local committee to sponsor a Malayan program for the Expedition, Malaya has just formally announced participation in the Expedition. Biological, geological and hydrographic interest is substantial and Malaya is in a financial position to make considerable contribution on its own, or in conjunction with Thailand. Participation in meteorological and tide gauge networks is assured.

SINGAPORE
Although Singapore does not have a direct interest in the Indian Ocean it has already offered hospitality-courtesy to Expedition ships and will participate in the meteorological network.

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INDONESIA
There have been no recent developments reported from Indonesia except reconstitution of its National Committee. A 650 ton research vessel is being constructed in Japan for mid-62 delivery but local personnel to man the 30 odd scientific billets are not evident. If appropriate manning by key individuals from some other nations were possible, together with an expression of willingness from the Indonesian government, it could combine training and research effort in the southeast Asian area which is badly needed. Earlier reports have indicated Indonesia's willingness to install and operate meteorological and tide gauge stations.

AUSTRALIA
Australia's more or less regular Indian Ocean operations with DIAMANTINA and prospective occasional operations in the Indian Ocean with GASCOYNE apparently go forward in an area extending to about 80°E, 40°S and northward toward the Bay of Bengal.

To date Australia has announced no program in geology or geophysics but is reported to be planning a shipboard meteorological program in addition to contributing observations from existing shore and island meteorological stations.

Emphasis has been placed on biological, physical and chemical oceanography and bathymetry. Australia had planned to cover in the northern summer the same tracks as the Japanese covered in the northern winter. No knowledge of the affect of the changed Japanese program on Australian plans is at present available.

Australia may be able to install and operate tide gauges at Christmas and Cocos Keeling.

An intercalibration session at or near Fremantle on VITJAZ and an Australian vessel is planned for late June or early July. Indirect reports indicate that certain aspects of biological and chemical oceanography will be emphasized. Other participants are invited.

NATIONALIST CHINA
No recent reports or plans for participation are available. It is unlikely that a Chinese ship will participate but some scientists are reported to wish to avail themselves of training or to carry out their own research on other peoples' vessels.

ISRAEL
In addition to its current Red Sea investigations referred to above, Israel plans studies in the Gulf of Elath, in other parts of the Red Sea and hopes to send scientists on other nations' vessels.

DENMARK, NETHERLANDS, UNITED ARAB REPUBLIC, ITALY and ARGENTINA
These countries are reported to be sending one or more scientists either for special formal research or for training on ships of other nations. Trainees are also reported from Hong Kong.

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SUMMARY OF SHIP PROGRAMS - APPENDIX A - BY AREAS

REGION I - (Arabian Sea to 10° N)

(France)

FNS COMMANDANT ROBERT GIRAUD - 1963 - Physical and Chemical Oceanography
CALYPSO - 1962-63 - Physical and Chemical Oceanography

(Germany)

VESSEL - 1963-64 or 1964-65 - Biology, Physical Oceanography, Geology and Geophysics.

(India)

INS KISTNA - 1962, 1963 - Biology, Physical Oceanography, Geology and Geophysics, Meteorology.
R/V VARUNA - 1962, 1963 - Biological Oceanography, Physical Oceanography, Chemistry, Geology and Geophysics, Meteorology.
R/V CONCH - 1962, 1963 - Biological Oceanography.

(Pakistan

PNS ZULFIQUAR - 1962, 1963, 1964 - Physical and Chemical Oceanography, Biology, Geology and Geophysics, Meteorology.

(U.S.S.R.)

VITJAZ - 1962 - Physics, Geology and Geophysics, Biology

(United Kingdom)

HMS DALRYMPLE - 1961-62, 1962-63 - Geology and Geophysics (magnetic surveys and sediment studies)
HMS OWEN - 1961-62, 1962-63 - Geophysics, (bathymetry, magnetism, gravity), Meteorology (synoptic observations).
RRS DISCOVERY III - 1963-64 - Biology, Chemistry, Physics, Geophysics, Meteorology.

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REGION I - (Arabian Sea to 10° N

(United States

R/V VEMA - 1962, 1963 - Geology and Geophysics, Physics and Chemistry, Biology.
R/V CONRAD - 1963 - Cruise not detailed.
WILLIAMSBURG - (based at Bombay, India) - 1963, 1964 - Biological cruises. Meteorology (synoptic observations and radiosonde)
AUXILIARY VESSEL - (based at Bombay, India) - 1963 - Biology, Geology.
ATLANTIS II - 1963 & 1965 - Physics and Chemistry, Geology and Geophysics, Meteorology.
CHAIN - 1963-64, 1964-65 - Geology and Geophysics, Physics and Chemistry.
HORIZON - 1962 - Geology and Geophysics.

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REGION II - (Bay of Bengal to 10° N)

(India)

INS KISTNA - 1962, 1963 - Biology, Physical Oceanography, Geology and Geophysics, Meteorology.
M.F.V. BANGADA - 1962, 1963 - Biological Oceanography.
NOT YET DESIGNATED - 1962, 1963 - (Naval coastal minesweeper ?) Biological Oceanography.

(Pakistan)

PNS ZULFIQUAR - 1962, 1963, 1964 - Physical and Chemical Oceanography, Biology, Geology and Geophysics, Meteorology.

(Thailand)

OCEANOGRAPHIC VESSEL NO. 2 - 1962-63 - Physical and Chemical Oceanography, Biological Oceanography, Geology Meteorology.

(U.S.S.R.)

VITJAZ - 1962 - Physics, Geology and Geophysics, Biology.

(United States)

WILLIAMSBURG - (based at Bombay, India) - 1963 - Biological cruises. Meteorology (synoptic observations and radiosonde).

AUXILIARY VESSEL - (based at Bombay, India - 1963 - Biology, Geology.

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REGION III-Central Western Indian Ocean (10° N to 10° S-Africa to 78° E

(France)

FNS COMMANDANT ROBERT GIRAUD - 1962 or 1963 - Physical and Chemical Oceanography.

(India)

INS KISTNA - 1962, 1963 - Biology, Physical Oceanography, Geology and Geophysics, Meteorology.
R/V CONCH - 1962, 1963 - Biological Oceanography.

(U.S.S.R.

VITJAZ - 1962 - Physics, Geology and Geophysics, Biology.

(United Kingdom)

HMS OWEN - 1961-62, 1962-63 - Geophysics (bathymetry, magnetism, gravity), Meteorology (synoptic observations).
RRS DISCOVERY III - 1963-64 - Physics, Chemistry, Biology, Geophysics, Meteorology.

(United States)

R/V VEMA - 1962, 1963 - Geophysics and Geology, Physics and Chemistry, Biology.
R/V CONRAD - 1963 - Cruise plans not detailed.
WILLIAMSBURG - (based at Bombay, India) - 1963, 1964 - Biological cruises. Meteorology (synoptic observations and radiosonde).
AUXILIARY VESSEL - (based at Bombay, India) - 1963, 1964 - Biology, Geology.
ATLANTIS II - 1963 & 1965 - Physics and Chemistry, Geology and Geophysics, Meteorology.
CHAIN - 1963-64, 1964-65 - Geology and Geophysics, Physics and Chemistry.
ARGO - 1962-63 - Physical Oceanography, Chemistry, Biology, Geology and Geophysics, Meteorology.
HORIZON - 1962 - Geology and Geophysics, Physical and Chemical Oceanography.

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REGION IV- Central Eastern Indian Ocean (10° N to 10° S, 78° E to Java)

(Australia)

HMAS DIAMANTINA - 1962, 1963, 1964 - Biology, Chemistry, Physics, Meteorology (including radiosonde and radiation), possibly Geology and Geophysics.
HMAS GASCOYNE - 1962, 1963 - Biology, Chemistry, Physics, Meteorology and possibly Geology and Geophysics.

(India

INS KISTNA - 1962, 1963 - Biology, Physical Oceanography, Geology and Geophysics, Meteorology.

(Japan)

UMITAKA MARU - 1962-63, 1963-64 - Biology, Chemistry, Physics, Meteorology. 1963-64 - Geology and Geophysics added.
RYOFU MARU - 1963-64 - Physics and Chemistry, Geology and Geophysics, Meteorology.
KOYO MARU - 1962-63, 1963-64 - Biology, Geology, Meteorology.
TAKUYO MARU - 1963-64 - Physics and Chemistry, Geology and Geophysics, Meteorology.
KAGOSHIMA MARU - ~~1962-63~~, 1963-64 - Biology, Physics and Chemistry, Geology and Geophysics, Meteorology.

(Thailand

OCEANOGRAPHIC VESSEL NO. 2 - 1962-63 - Physical and Chemical Oceanography, Biological Oceanography, Geology, Meteorology.

(U.S.S.R.)

VITJAZ - 1962 - Physics, Geology and Geophysics, Biology.

(United States)

WILLIAMSBURG - (based at Bombay, India) - 1963 - Biological cruises. Meteorology (synoptic observations and radiosonde).
AUXILIARY VESSEL - (based at Bombay, India) - 1963 - Biology, Geology.
WEATHER SHIPS - 1963, 1964 - Meteorology. Also Biology, Chemistry and Physics.
ARGO - 1962-63 - Physical Oceanography, Chemistry, Biology, Geology and Geophysics, Meteorology.

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REGION V - South Western Indian Ocean (Africa to 78° E south of 10° S)

(France)

FNS COMMANDANT ROBERT GIRAUD - 1962 or 1963 - Physical and Chemical Oceanography.
BIOLOGICAL VESSEL - (based in Madagascar) - 1962 - Biological Oceanography.

(Portugal

PNS ALMIRANTE LACERDA - 1962, 1963 - Physical and Chemical Oceanography, Biology, Geology and Geophysics, Meteorology.

(South Africa)

NATAL - 1962, 1963 - Biology, Geology, Geophysics, Physics.
AFRICANA II - 1961, 1962 - Physics, Chemistry, Biology.

(United Kingdom)

HMS OWEN - 1961-62, 1962-63 - Geophysics (bathymetry, magnetism, gravity), Meteorology (synoptic observations).

(United States

R/V Vema - 1962, 1963 - Geophysics and Geology, Physics and Chemistry, Biology.
R/V CONRAD - 1963 - Cruise plans not detailed.
WILLIAMSBURG - (based at Bombay, India) - 1963, 1964 - Biological cruises. Meteorology (synoptic observations and radiosonde).
AUXILIARY VESSEL - (based at Bombay, India) - 1963, 1964 - Biology, Geology.
ATLANTIS II - 1963, 1965 - Physics and Chemistry, Geology and Geophysics, Meteorology.
CHAIN - 1963-64, 1964-65 - Geology and Geophysics, Physics and Chemistry.
ARGO - 1962-63 - Physical Oceanography, Chemistry, Biology, Geology and Geophysics, Meteorology.
HORIZON - 1962 - Geology and Geophysics, Physical and Chemical Oceanography.
SPENCER F. BAIRD - 1964 - Geology and Geophysics, Chemistry.

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REGION VI - South Eastern Indian Ocean (78° E to Java south 10° S)

(Australia)

HMAS DIAMANTINA - 1962, 1963, 1964 - Biology, Chemistry and Physics, Meteorology (including radiosonde and radiation) possibly Geology and Geophysics.
HMAS GASCOYNE - 1962, 1963 - Biology, Chemistry, Physics, Meteorology, and possibly Geology and Geophysics.

(Japan)

UMITAKA MARU - 1962-63, 1963-64 - Biology, Chemistry, Physics, Meteorology. 1963-64 - Geology and Geophysics.
RYOFU MARU - 1963-64 - Physics and Chemistry, Geology and Geophysics, Meteorology.
KOYO MARU - 1962-63, 1963-64 - Biology, Geology, Meteorology.
TAKUYO MARU - 1963-64 - Physics and Chemistry, Geology and Geophysics, Meteorology.
KAGOSHIMA MARU - ~~1962-63~~, 1963-64 - Biology, Physics and Chemistry, Geology and Geophysics, Meteorology.

(U.S.S.R.)

VITJAZ - 1962 - Physics, Geology and Geophysics, Biology.

(United States)

R/V CONRAD - 1963 - Cruise plans not detailed.
WILLIAMSBURG - (based at Bombay, India) - 1963 - Biological CRUISES. Meteorology (synoptic observations and radiosonde).
ARGO - 1962-63 - Physical Oceanography, Chemistry, Biology, Geology and Geophysics, Meteorology.
HORIZON - 1962 - Geology and Geophysics, Physical and Chemical Oceanography.
SPENCER F. BAIRD - 1964 - Geology and Geophysics, Chemistry.

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CONSEIL INTERNATIONAL DES UNIONS SCIENTIFIQUES · INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
SPECIAL COMMITTEE ON OCEANIC RESEARCH
(SCOR)

INTERNATIONAL INDIAN OCEAN EXPEDITION
30 EAST 40TH STREET NEW YORK 16, N. Y. · LEXINGTON 2-6533

COORDINATOR
ROBERT G. SNIDER

CABLES
SCORINDOC · NEWYORK

SUMMARY OF SHIP'S PROGRAMS - APPENDIX B - BY DISCIPLINES

PHYSICAL & CHEMICAL OCEANOGRAPHY

RRS DISCOVERY III

1963 June-July
South Arabian Coast
Chemistry - (NIO) General survey plus detailed upwelling region investigation. Estimation of nutrient composition of sea water and organisms, and exchanges with bottom sediments. Measurement of ultraviolet adsorption in sea water and distillates, particularly in plankton blooms.
Physics - (NIO) Direct current measurement with current waters B/T and towed electrodes; possibly with neutrally buoyant floats.

1963 August to October
Hydrography and Biology - (NIO) 2 stations daily-current to 200 meters; chemical, physical and biological (algal production) sampling to 500 meters at noon; chemical, physical sampling to bottom; biological sampling (Zooplankton esp.) to 1,500 m. at 2200. Various trawls and net hauls to bottom periodically.

1963 November
Equatorial region, African coast to 78°E
Current measurements
Physics - (NIO) Special current measurements using direct reading meters and neutrally buoyant floats at points along equator and on at least 3 meridional sections.
Chemistry - (NIO) Physical and chemical sampling to 600 m. at 30 mile intervals on meridional sections.

1964 March - Equatorial region - African coast to 78°E. - Current measurements
Physics - (NIO) Special current measurements using direct reading meters and neutrally buoyant floats at points along equator and on at least 3 meridional sections.
Chemistry - (NIO) Physical and chemical sampling to 600 m. at 30 mile intervals on meridional sections.

R/V VEMA

1962 June-July - SW Indian Ocean Madagascar Basin Mozambique Channel, Madagascar Seychelles, Mauritius area: Northern Indian Ocean ridge; Gulf of Aden.

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R/V VEMA (continued)

Physics & Chemistry - Water sampling at various depths for physical and chemical characteristics, C_{14} and tritium sampling, B/T and sound velocity measurements.

1963 - 17 March - 15 June - Aden to Capetown - Southern Indian Ocean; South Africa, Kerguelen Disciplines not specified - probably similar to 1962.

NATAL

1962 April - Cruise 1 - Agulhas current to 500 miles off South African Coast. 37 stations on 4 sections in 3 weeks - Durban to Simonstown
Physics - Hydrology of Agulhas Current - Hydrographic casts to bottom, B/T, G.E.K. (C.S.I.R.)
May - Cruise 2 - Across South East African Continental shelf 2 Sections to South Easterly direction of Cape Agulhas to 500 miles - 3 weeks.
Physics - G.E.K. observations (C.S.I.R.)
June - Cruise 3 - S.E. from Mazeppa Bay to 35°S, 37°E, thence westward to Cape Agulhas - 2-1/2 weeks.
Physics - As in Cruise 2.
July - Cruise 4 - Agulhas Current - Same as Cruise 1.
Physics - As in Cruise 1.
Aug. - Cruise 5 - 2-1/2 weeks, E of Natal and S of Madagascar to 600 miles from African coast.
Physics - (CSIR and Weather Bureau) 48 hour station at 32°S, 44°E to study energy exchange between ocean and atmosphere; temperature and current measurement vs. depth and internal waves to 300 m. G.E.K.
Oct. - Cruise 6 - Agulhas Current - Same as Cruise 1.
Physics - As in Cruise 1.

1963 January - Cruise 7 - Agulhas Current - same as Cruise 1.
Physics - As in Cruise 1.
February - Cruise 8 - E. of Natal and S. of Madagascar to 600 miles. Same as Cruise 5.
Physics - As in Cruise 5.

AFRICANA II

1961 June, July - Agulhas Current to 1,500 miles off African coast. 2 sections from Laurenco Marques and to Durban extending to 38°S, 58°E - 42 stations.
Physics - Temperatures and sallinities at all stations.
Chemistry - Analysis of oxygen, inorganic phosphate and broad trace element composition -- all stations.

VITJAZ

1962 April-October - Eastern, Equatorial and Central Indian Ocean. Enter at Djakarta, depart at Suez.
Physics - Investigation of surface and subsurface circulation and make up of Indian Ocean water mass during northern summer months.

GERMAN

NEW VESSEL

1963-4 or 1964-5 - Mid November to Mid February in Arabian Sea.
Physical Oceanography - Primary emphasis on this discipline with 417 stations in 10,200 track miles.

HMAS DIAMANTINA - General area of operations between 0° and 45° S, 85° E and 140° E.
1961 - 26 July to 26 August
1962 - August-September
1963 - February-March, June, July-August, December
1964 - February-March, May, July-August, December
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.

HMAS GASCOYNE - General area of operations between 0° and 45° S, 85° E and 140° E.
1962 - August-September
1963 - February-March
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.

UMITAKA MARU

1962-3 - 1963-4 December-March - 8°N to 32°S along 78°E - 30 days.
Chemistry - Dissolved oxygen and nutrient salt analysis, trade elements, etc.
Physics - General oceanographic observations to bottom at least every 150 miles, B/T's, Shallow stations at intermediate points, Ekmann current meter observations in equatorial region.

RYOFU MARU

1963-64 - December-March - 8°N to 32°S along 86°E - 30 days.
Physics and Chemistry - General oceanographic observation; Current measurement; Special chemical elements.

KAGOSHIMA MARU

1963-64 - December-March - 8°S to 32°S along 106°E, 8°S to 22°S
Physics and Chemistry - General oceanographic observation; current measurement; special chemical elements.

TAKUYO MARU

1963-64 - Dec.-March - 8°S to 32° along 102°E, 8°S to 32°S along 110°E - 20 days.
Physics and chemistry - General oceanographic observation; current measurement; special chemical elements.

FNS COMMANDANT ROBERT GIRAUD

1962 or 1963 - July to September - Cape Guardafui to 30°S linked sections from coast to 5-600 miles out.
Physical and Chemical Oceanography - Hydrographic stations, temperature, salinity, oxygen and direct current measurements Bab el Mandeb and Ormuz Straits. Similar to 1960 cruise completed same area same season.

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FNS COMMANDANT ROBERT GIRAUD (Continued)

1963 - January to March ? - Eastern Arabian Sea
Physical and Chemical Oceanography - Hydrographic stations and direct current measurements in Bab el Mandeb and Ormuz Straits assisting CALYPSO. Same area as April-June 1961 GIRAUD cruise.

CALYPSO

1962-1963 - December 1962 to March 1963 - Red Sea, Gulf of Aden, Arabian Sea, Persian Gulf.
Physical and Chemical Oceanography - Hydrographic stations and direct current measurement in Bab el Mandeb and Ormuz Straits. Five traverses of Red Sea, three in Gulf of Aden. Joint operation in Arabian Sea and Persian Gulf with GIRAUD, covering same area as her April-June 1961 cruise.

INS KISTNA - (Indian Navy Frigate converted for oceanography)

1962 and 1963 - At least 6 months sea time each year in N.W. Indian Ocean and in Bay of Bengal. Primarily deep-sea cruising in both S.W. and N.E. monsoons in both areas.
Arabian Sea - Bombay to Karachi to mouth of Persian Gulf to Bombay. E-W sections on 19°N and 17°N and on 12°N and 9°N to 52°E. Westerly section from Cochin to 5°N, 62°E - South to 10°S to 66°E, North to 0°, to 1°N, 70°E, South to 10°S, to 74°E, North to 0° thence to Cochin.
Bay of Bengal - 7 coastal sections Madras to Burma, up to 200 miles from coast. Section on 92°E - 20°N to 12°N and west to India. Three transverse sections to Andamans, Nicobars and Sumatra between 10°N and 5°N linked with meridional sections on 89°, 87°, 84°, 82°, 79°E between 8°N and 5°N. 5 Sections NNE-SSW and NNW-SSE between 9°N and 0° starting at 77°E and going to 95°E.
Physical Oceanography - Hydrographic stations to 2000 m. Surface and subsurface current measurement. Transparency and sound propagation studies.
Chemistry - Standard analysis for PO_4, NO_3, SiO_4, pH, O_2 and CO_2; plus large-volume sampling for radioactive isotope analysis.

R/V VARUNA (75' new fisheries research vessel)

1962 and 1963 - At least 6 months each year - both monsoons. Approximately to 1000 fathom curve on west coast of India.
Physical Oceanography - Hydrographic stations and current measurements to vessel's capacity.

PNS ALMIRANTE LACERDA

1962 - Southwest monsoon period. Mozambique Channel. 8 sections between Mozambique and 43°E.
Physical and Chemical Oceanography (NOTE: No detailed program or schedule available)
1963 - Same as 1962

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OCEANOGRAPHIC VESSEL NO. 2 - (90 tons) (Thailand)

1962 and 1963 - December 1962 and January 1963 - Continental Shelf off west Thailand coast. Twelve E-W sections 20 miles apart with 49 stations at 20 mile intervals. 8 anchored coastal current stations.
Physical and Chemical Oceanography - Hydrographic casts at all stations. Current measurement.

PNS ZULFIQUAR - (2,000 tons)

1962 - (months not determined) - Bay of Bengal - North of 19° N, and Arabian Sea - East of 64° E and North of 18° N. Eleven stations in Bay of Bengal, fourteen in Arabian Sea.
Physical and Chemical Oceanography - Hydrographic casts analysed for temperatures, salinities, oxygen, nitrate, silicate, inorganic and total phosphate. Current and transparency measurements.

1963 - (months not determined) - Bay of Bengal - 16° N to 21° N and 91° E to Burmese coast - 9 stations. Arabian Sea - Gulf of Oman to 66° E and 22° N to 25° N - 14 stations.
Physical and Chemical Oceanography

1964 - (months not determined) - Bay of Bengal - 16°N to 18°N and 84° E to 91° E - 11 stations. Arabian Sea - 18° N to 22° N and 58° E to 64° E - 14 stations.
Physical and Chemical Oceanography

ARGO (Scripps Institution of Oceanography)

1962 - 27 June to 24 July - Equatorial section from 96°E to 46°E. (Knauss)
Physical Oceanography - Hydrographic stations every 110 miles, alternately to bottom and 1,000 m. Two day current measuring stations at approximately 90°E, 80°E, 72°E and 55°E. Measurements relative to anchored buoys with propellor type current meters for shallower, faster currents; with Swallow Floats for currents less than 15 cm/sec.
Chemistry - At least minimum recommended program at all stations.
27 July to 25 August - Meridional sections probably on 55°E and 72°E, at least one of which will extend from 5°N to 5°S. (Knauss)
Physical Oceanography - 5 to 10 stations on each section, at one-half degree intervals within 3° of the equator, at 1° intervals beyond for current measurements relative to anchored buoys. Several hydrographic casts to bottom, remainder to 1000 m.
Chemistry - At least minimum recommended program at all stations.
28 August to 27 September - Meridional sections at approximately 80°E and 90°E, at least one of which will extend from 5°N to 5°S. (Knauss)
Physical Oceanography - 5 to 10 stations on each section, at one-half degree intervals within 3° of the equator, at 1° intervals beyond for current measurements relative to anchored buoys. Several hydrographic casts to bottom, remainder to 1000 m.
Chemistry - At least minimum recommended program at all stations.

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ARGO (Scripps Institution of Oceanography) (continued)

1 October to 26 October - Cochin to Mauritius via Laccadives-Maldives-Chagos.
28 October to 29 November - Mauritius to Fremantle via Kerguelen, Amsterdam.
2 December to 23 December - Fremantle to Darwin via Wharton Basin. (Shor and Raitt)
Physics and Chemistry - Hydrographic casts, atmospheric water vapor collection and dissolved gas extraction from large volume water samples. Detailed studies of deuterium and oxygen 18 in deep and surface water, marine water vapor and rain; of dissolved bicarbonate concentration and carbon 13 content; of concentrations and isotopic ratios in dissolved gases; of rare gases such as xenon and helium occurrence.

1963 - 15 February to 15 May - Equatorial region from 96°E to 46°E, between 5°N and 5°S, generally going from east to west. (Knauss)
Physical Oceanography - Hydrographic stations and current measurement as in July-September 1962 program, but in opposite monsoon. Detailed plans not completed.
Chemistry - As in July-September 1962 program.
15 May to 1 June - Zanzibar to Antarctic Convergence to Cape Town. (Kneeling)
Chemical Oceanography - Investigation in high latitude of air-sea carbon dioxide exchange. Hydrographic stations.

HORIZON (Scripps)

1962 - 10 October to 22 December - Mid ocean and Amsterdam ridges, Wharton Basin.
Physical and Chemical Oceanography - Water sampling.

SPENCER F. BAIRD (Scripps)

1964 - 15 January to 15 July (March, April, May in Indian Ocean 15°S to 40°S between Australia and Mauritius. (Riedel)
Chemistry - Atmospheric and sea surface carbon dioxide measurements.

ATLANTIS II (WHOI)

1963 - June through December - Latitudinal sections across Arabian Sea and N.W. Indian Ocean to 80°E, coordinated with scheduled observations of other nations. Also Agulhas current system from Mozambique Channel to Republic of South Africa or investigations in Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile average interval along approximately 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes particularly related to productivity; direct current and electrical potential measurements.

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ATLANTIS II (WHOI) (continued)

1965 - February through July - Similar program to 1963 in opposite monsoon (N.W. quadrant Indian Ocean), latitudinal tracks plus either Agulhas current or Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile intervals along 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes, currents, etc.

CHAIN (WHOI)

1963-64 - September to March - N.W. Indian Ocean to 25°S, 80°E including Arabian Sea.
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of accoustic properties of Indian Ocean.

1964-65 - September to March
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of accoustic properties of Indian Ocean.

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SUMMARY OF SHIP'S PROGRAMS - APPENDIX B - BY DISCIPLINES

BIOLOGICAL OCEANOGRAPHY

RRS DISCOVERY III

1963 - March-May - Seychelles Ridge, Somali Basin, Carlsberg Ridge, Arabian Basin
Biology - observation of surface phenomena
June-July - South Arabian Coast
Water movements, nutrient cycle, organic production, succession of plant and animal populations.
Biology - (NIO) Intensive water sampling and sampling with vertical nets on continental shelf at 20-30 miles intervals, 40-50 miles in deep water plus bottom samples and periodic net tows. Detailed investigation of one upwelling center. Qualitative and quantitative plankton studies.
August-October - 4 transverse sections across Arabian Sea.
Hydrography and Biology - (NIO) 2 stations daily-current to 200 meters; chemical, physical and biological (algal production) sampling to 500 meters at noon; chemical, physical sampling to bottom, biological sampling (Zooplankton cap.) to 1,500 m. at 2200. Various trawls and net hauls to bottom periodically.
November - Equatorial region - African coast to 78°E.
Biology - (NIO) Water sampling for chlorophyl measurement and chemical analysis; vertical net hauls to 500 m. at 30 mile intervals. Towed horizontal and oblique nets.

1964 - January-February - 4 transverse sections across Arabian Sea.
Hydrography and Biology - (NIO) 2 stations daily-current to 200 meters; chemical, physical and biological (algal production) sampling to 500 meters at noon; chemical, physical sampling to bottom, biological sampling (Zooplankton esp.) to 1,500 m. at 2200. Various trawls and net hauls to bottom periodically.
March - Equatorial region - African coast to 78°E. Current measurements.
Biology - (NIO) Water sampling for chlorophyl measurement and chemical analysis; vertical net hauls to 500 m. at 30 mile intervals. Towed horizontal and oblique nets.

R/V VEMA

1962 - June, July - SW Indian Ocean, Madagascar Basin, Mozambique Channel, Madagascar Seychelles, Mauritius Area; Northern Indian Ocean ridge; Gulf of Aden.
Biology - Plankton sampling at various depths, microbiological sampling, ocean bottom trawls.

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R/V VEMA (continued)

1963 - 17 March to 15 June - Aden to Capetown - Southern Indian Ocean - South Africa, Kerguelin - Disciplines not specified - probably similar to 1962.

WILLIAMSBURG

Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C-14 technique), phytoplankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises.

1963 - Feb. - April - Cruise I - Bay of Bengal, Andaman Sea, and Nicobar Islands. 15 sections around the Bay of Bengal from Ceylon to Nicobars out to 250 miles from coast and section from Rangoon to Ceylon. Dredging and bottom trawling on continental shelf additional.

1963 - May - July - Cruise 2 - Cochin to 20°N, 70°E to 40°S to 80°E to Colombo and Cochin. Midwater and/or surface collecting additional.

1963 - Aug.- Sept. - Cruise 3 - Cochin to Karachi to 20°N, 60°E to 40°S to 50°E to Tamatave. Midwater and/or surface collecting additional.

1963 - Oct. - Nov. - Cruise 4 - Tamatave to Reunion to 40°S, 55°E to 75°E to Cochin. Diversions to Chagos, Maldives and Laccadives. Midwater and/or surface collecting additional.

1964 - Jan. - March - Cruise 5 - Arabian Sea and Gulf of Aden. 19 sections around the coast of the Arabian Sea from Cochin to Cape Guardafui out to 250 miles from the coast and a transverse section from Africa to India on 10°N. Dredging and bottom trawling on continental shelf additional.

1964 - April - May - Cruise 6 - Cochin to 20°N, 65°E to 40°S to 30°E to Durban. Midwater and/or surface collecting additional.

1964 - June - July - Cruise 7 - (Agulhas Current) Durban to Port Elizabeth to 40°S, 25°E; 5 sections within 500 miles of coast to Lourenco Marques to S. end of Madagascar to 40°S, 45°E to 30°E to Durban. Dredging and bottom trawling on continental shelf additional.

1964 - Aug.-Sept. - Cruise 8 - (Mozambique and Somali Currents) 10 sections from Durban to 5°N, 50°E across Mozambique Channel and to 500 miles from African coast to Zanzibar and along Kenya and Somalia coasts, thence S. on 50°E to Diego Suarez and Nosy Be.
Dredging and bottom trawling on continental shelf additional.

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WILLIAMSBURG (continued)

1964 - Oct.-Nov. - Cruise 9 Nosy Be to Reunion, N. on 55°E to 10°N via Seychelles diversion, to Laccadives, Maldives and Chagos for investigations, to Cochin. Dredging and bottom trawling on continental shelf and island groups additional.

AUXILIARY VESSEL - (Charter by WHOI) Based at Bombay

Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, dividing equipment and dredging and experimental trawling to 100 fathoms.

1963 - March - May - Cruise A. Singapore, Nicobar Islands - Andaman Islands - Cochin.

1963 - June - Sept. - Cruise B. Cochin - Laccadive Islands - Maldive Islands - Cochin.

1963 - October - December - Cruise C - Cochin - Chagos Archipelago - Mauritius.

1964 - January - February - Cruise D - Mauritius - Seychelles - Madagascar.

1964 - March-June - Madagascar - Comoros Islands - Zanzibar

NATAL

1962 - April - Cruise 1 - Agulhas Current to 500 miles off South African coast. 37 stations on 4 sections in 3 weeks. Durban to Simonstown.
Biology - Plankton and productivity of Agulhas current; Botany-Taxonomy of Diatoms and Peridinians. Plankton hauls to 100 m. on all stations; intensive hauls to 400 m. on 12 stations.
July - Cruise 4 - Agulhas Current - Same as Cruise 1.
Biology - as in Cruise 1.
August - Cruise 5 - 2-1/2 weeks E. of Natal and S. of Madagascar to 600 miles from African coast.
Biology - (S. African Museum) Distribution of subsurface pelagic fishes - Tunny experimental fishing; Plankton and productivity investigation of Agulhas Current - regular net hauls to 100 m. periodic to 400 m. 2 sections to 600 miles.
October - Cruise 6 - Agulhas Current to 500 miles off South African coast. 37 stations on 4 sections in 3 weeks. Durban to Simonstown.
Biology - As in Cruise 1.

1963 - January - Cruise 7 - Agulhas Current to 500 miles off South African coast. 37 stations on 4 sections in 3 weeks. Durban to Simonstown.
Biology - As in Cruise 1.
February - Cruise 8 - E. of Natal and S. of Madagascar to 600 miles.
Biology - As in Cruise 5.

AFRICANA II

1961 - June, July - Agulhas Current to 1,500 miless off African Coast. 2 Sections from Lourenco Marques and to Durban extending to 38°S, 58°E. 42 Stations.

1962 - June, July - Port Elizabeth to Prince Edward Is. to Crozet Is. to East London.
Biology - Primary productivity by C^{14} technique - Plankton hauls for qualitative and quantitative analysis at all stations. Surface trawling, hand and long-lining, midwater trawling and blanket netting in passage.

VITJAZ

1962 - April-October - Eastern, Equatorial and Central Indian Ocean. Enter at Djakarta, depart at Suez.
Biology - Investigation of biological structure of Indian Ocean from point of view of exploitation for commercial fishing. Collection of material for investigation of zonal difference in appearances of various creatures in Indian Ocean.

NEW GERMAN VESSEL

1963-4 or 1964-5 - October - April - 187 day cruise to Gulf of Aden, Arabian Sea, Persian Gulf.

1963 or 1964 - Mid-October to Mid-November - Straits of Babel Mandeb and Gulf of Aden.
Biology - Intensive investigation with primary emphasis on biology - 30 days 3000 track miles.

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.

1961 - 26 July to 26 August
1962 - August-September
1963 - February-March, June, July-August, December
1964 - February-March, May, July-August, December
Biology - Primary production, zooplankton, phytoplankton.

HMAS GASCOYNE - General area of operations between 0° and 45° S, 85° E and 140° E.

1962 - August-September
1963 - February-March
Biology - Primary production, zooplankton, phytoplankton.

UMITAKA MARU

1962-63 - 1963-64 - December-March - 8°N to 32°S along 78°E - 30 days.
Biology - Investigation of animals and plants, collection of bottom specimens, plankton hauls and trawls down to 1,000 m. at stated periods, water samples for productivity analysis.

KOYO MARU

1962-63 - 1963-64 - December-March - 8°N to 32°S along 94°E - 30 days.
Biology - Investigation of animals and plants and special chemical elements.

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KAGOSHIMA MARU

1963-64 - December-March - 8°S to 32°S along 106°E, 8°S to 22°S along 118°E (?) - 30 days.
Biology - Investigation of animals and plants.

BIOLOGICAL VESSEL - (22 m.) (FRANCE)

1962 - Throughout year ? - Mozambique Channel based at Tulear, Malagasy Republic.
Biological Oceanography - Program under Prof. Peres will conform with internationally agreed "Program for Biology"

INS KISTNA - (Indian Navy Frigate converted for oceanography)

1962 and 1963 - At least 6 months sea time each year in N.W. Indian Ocean and in Bay of Bengal. Primarily deep-sea cruising in both S.W. and N.E. monsoons in both areas.
Arabian Sea - Bombay to Karachi to mouth of Persian Gulf to Bombay. E-W sections on 19°N and 17°N and on 12°N and 9°N to 52°E. Westerly sections from Cochin to 5°N, 62°E - South to 10°S to 66°E, North to 0° to 1°N, 70°E, South to 10°S, to 74°E, North to 0° thence to Cochin.
Bay of Bengal - 7 coastal sections Madras to Burma, up to 200 miles from coast. Section on 92°E - 20°N to 12°N and west to India. Three transverse sections to Andamans, Nicobars and Sumatra between 10°N and 5°N linked with meridional sections on 89°, 87°, 84°, 82°, 79°E between 8°N and 5°N. 5 Sections NNE-SSW and NNW-SSE between 9°N and 0° starting at 77° and going to 95°E.
Biology - Qualitative, quantitative and systematic studies of phyto and zooplankton and benthos. Primary productivity (C_{14} method) and abundance of plants and animals in relation to chemical and physical features. Related features such as dissolved oxygen, water movements and oceanic circulation, and distribution of organisms. Experimental fishing.

R/V VARUNA (75' new fisheries research vessel)

1962 and 1963 - At least 6 months each year - both monsoons. Approximately to 1000 fathom curve on west coast of India.
Biological Oceanography - Phytoplankton, zooplankton and benthic studies; primary productivity; experimental fishing and applied fisheries research on continental shelf and adjoining areas.

R/V CONCH (50' vessel) - Kerala University

1962 and 1963 - At least 6 months each year - both monsoons. Continental shelf to 45-50 miles from coast on west coast of India from Cochin.
Biological Oceanography - Phytoplankton, zooplankton and benthic studies; primary productivity; experimental fishing and applied fisheries research on continental shelf and adjoining areas.

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M.F.V. BANGADA - (Ministry of Food and Agriculture fishing vessel)

1962 and 1963 - At least six months each year - both monsoons. Continental shelf and adjoining areas in Bay of Bengal. Biological Oceanography - Phytoplankton, zooplankton and benthic studies; primary productivity; experimental fishing and applied fisheries research on continental shelf and adjoining areas.

(NOT YET DESIGNATED) -(Indian Naval coastal minesweeper?)

1962 and 1963 - Available for short periods for coastal work in Bay of Bengal.
Biological Oceanography - Phytoplankton, zooplankton and benthic studies; primary producitivty; experimental fishing and applied fisheries research on continental shelf and adjoining areas.

PNS ALMIRANTE LACERDA

1962 - Southwest monsoon period. Mozambique Channel. 8 sections between Mozambique and 43° E.
Biology
(NOTE: No detailed program or schedule available)
1963 - Same as 1962

OCEANOGRAPHIC VESSEL NO. 2 (Thailand) - (90 tons)

1962 and 1963 - December 1962 and January 1963 - Continental Shelf off west Thailand coast. Twelve E-W sections 20 miles apart with 49 stations at 20 mile intervals. 8 anchored coastal current stations.
Biological Oceanography - One meter net plankton tows, dip net biological collections at some stations and on coast.

PNS ZULFIQUAR - (2,000 tons)

1962 - (months not determined) - Bay of Bengal - North of 19° N, and Arabian Sea - East of 64°E and North of 18°N. Eleven stations in Bay of Bengal, fourteen in Arabian Sea.
1963 - (months not determined) - Bay of Bengal - 16°N to 21°N and 91°E to Burmese coast - 9 stations. Arabian Sea - Gulf of Oman to 66°E and 22°N to 25°N - 14 stations.
1964 - (months not determined) - Bay of Bengal - 16°N to 18°N and 84°E to 91°E - 11 stations. Arabian Sea - 18°N to 22°N and 58°E to 64°E - 14 stations.
Biology - Primary production, plankton sampling, chlorophyl observation, sea weed samples.

ARGO (Scripps)

1962 - 27 June to 24 July - Equatorial section from 90°E to 46°E.
27 July to 25 August - Meridional sections probably on 55°E and 72°E, at least one of which will extend from 5°N to 5°S.

ARGO (Scripps) (continued)

1962 28 August to 27 September - Meridional sections at approximately 80°E and 90°E, at least one of which will extend from 5°N to 5°S. (Knauss)
Biology - At least minimum recommended program at all stations.
1 October to 26 October - Cochin to Mauritius via Laccadives-Maldives-Chagos.
28 October to 29 November - Mauritius to Fremantle via Kerguelen, Amsterdam.
2 December to 23 December - Fremantle to Darwin via Wharton Basin. (Shor and Raitt)
Biology - Occasional special micro and macroplankton hauls and mid water trawls.

1963 - 15 February to 15 May - Equatorial region from 96°E to 46°E, between 5°N and 5°S, generally going from east to west. (Knauss)
Biology - As in July-September 1962 program.

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CONSEIL INTERNATIONAL DES UNIONS SCIENTIFIQUES - INTERNATIONAL COUNCIL OF SCIENTIFIC UNION
SPECIAL COMMITTEE ON OCEANIC RESEARCH
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INTERNATIONAL INDIAN OCEAN EXPEDITION
30 EAST 40TH STREET - NEW YORK 16, N. Y. - LEXINGTON 2-6533

COORDINATOR
ROBERT G. SNIDER

CABLES
SCORINDOC - NEWYORK

SUMMARY OF SHIP'S PROGRAMS - APPENDIX B - BY DISCIPLINES

GEOLOGY and GEOPHYSICS

RRS DISCOVERY III

1963 - March-May - Seychelles Ridge, Somali Basin, Carlsberg Ridge, Arabian Basin.
Geophysics - Bathymetry, magnetic, gravity and seismic surveys, bottom photography and sampling.
June, July - South Arabian coast.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.
August-October - 4 transverse sections across Arabian Sea.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.
November - Equatorial region - African coast to 78°E.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.

1964 - January-February - 4 transverse sections across Arabian Sea.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.
March - Equatorial region - African coast to 78°E.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.
April - Colombo to Suez
Geophysics on passage.

HMS OWEN (Cambridge

1961-2 - October-May - Red Sea, Arabian Sea and West Central Indian Ocean - Africa to India to Gan to Mauritius.
Bathymetry, Magnetism, Gravity, Meteorology
(Synoptic observation)

1962-3 - October-April - Probably N.W. Indian Ocean. New plans being developed for virtually full time deep water oceanographic cruise.

1963-4 - 1964-5 - in West Indian Ocean - No plans formulated.

HMS DARLYMPLE (Imperial College)

1961 - October - Red Sea & Arabian Coast to Persian Gulf
Magnetic Surveys

1961-2 - November-February - Persian Gulf (lower)
Sediment Studies

1962-3 - Probably similar - Geology & Geophysics

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R/V VEMA

1962 - June, July - SW Indian Ocean, Madagascar Basin, Mozambique Channel, Madagascar Seychelles, Mauritius area; Northern Indian Ocean ridge; Gulf of Aden.
Geophysics & Geology - PDR bathymetry, magnetic and gravity measurements continuously. Seismic reflection profiles, bottom thermal and acoustic probes, bottom sampling, coring and photography, island rock collections.

1963 - 17 March to 15 June - Aden to Capetown - Southern Indian Ocean, South Africa, Kerguelen.
Disciplines not specified - probably similar to 1962.

AUXILIARY VESSEL - (Charter by WHOI) Based at Bombay
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

1963 - March-May-Cruise A. Singapore, Nicobar Islands - Andaman Islands - Cochin.

1963 - June - Sept. - Cruise B. Cochin - Laccadive Islands - Maldive Islands - Cochin.

1963 - October - December - Cruise C - Cochin - Chagos Archipelago - Mauritius.

1964 - January - February - Cruise D - Mauritius - Seychelles - Madagascar.

1964 - March-June - Madagascar - Comoros Islands - Zanzibar

NATAL

1962 - May - Cruise 2 - across South East African continental shelf. Two sections to South Easterly direction of Cape Agulhas to 500 miles. 3 weeks.
Geology - (University of Capetown - Department of Oceanography) Geological and chemical analysis of bottom sediments on continental shelf and deep sea sediments. Precision echo sounder profile.
Geophysics - (Bernard Price Geophysical Institute) - Seismic, gravity and magnetic observations.
June - Cruise 3 - S.E. from Mazeppa Bay to 35°S, 37°E, thence westward to Cape Agulhas - 2-1/2 weeks.
Geology, Geophysics, as in Cruise 2.
August - 2-1/2 weeks E. of Natal and S. of Madagascar to 600 miles from African coast.
Geophysics - (Bernard Price Institute) Gravimetric measurement underway.

1963 - February - Cruise 8 - E. of Natal and S. of Madagascar to 600 miles (same as Cruise 5).
Geophysics - as in Cruise 5.

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HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.

1961 - 26 July to 26 August

1962 - August - September

1963 - February-March, June, July-August, December

1964 - February-March, May, July-August, December

Geology and Geophysics - Bathymetry.

HMAS GASCOYNE - General area of operations between 0° and 45°S, 85°E and 140°E.

1962 - August-September

1963 - February-March

Geology and Geophysics - Bathymetry

VITJAZ

1962 - April-October - Eastern, Equatorial and Central Indian Ocean. Enter at Djakarta, depart at Suez.

Geology and Geoophysics - Investigation of geological bottom formations and the earth under the Indian Ocean.

GERMAN

NEW VESSEL

1964 or 1965 - Mid February to Mid March in Persian Gulf

Geology and Geophysics - Primary emphais during this period.

UMITAKA MARU
1963-4 - December-March - 8°N to 32°S along 78°E - 30 days.
Geology & Geophysics - POR Bathymetry, gravity and magnetism; bottom specimens.

RYOFU MARU
1963-4 - December-March - 8°N to 32°S along 86°E - 30 days.
Geology and Geophysics - Subterranean heat; Collection of bottom of specimens; Precision Sounding.

KOYO MARU
1962-3 - 1963-4 - Dec.-March - 8°N to 32°S along 94°E - 30 days.
Geophysics - Precision Echo Sounding.
Geology - Collection of bottom specimens.

TAKUYO MARU
1963-4 - December-March - 8°S to 32°S along 102°E 8°S to 32°S along 110°E - 20 days.
Geology and Geophysics - Precision echo sounding, collection of bottom specimens; Terrestrial magnetism.

KAGOSHIMA MARU
1963-64 - December-March - 8°S to 32°S along 106°E, 8°S to 22°S along 118°E (?) - 30 days.
Geology and Geophysics - Precision Sounding; Collection of bottom specimens.

INS KISTNA - (Indian Navy Frigate converted for oceanography)
1962 and 1963 - At least 6 months sea time each year in N.W.Indian Ocean and in Bay of Bengal. Primarily deep-sea cruising in both S.W. and N.E. monsoons in both areas.
Arabian Sea - Bombay to Karachi to mouth of Persian Gulf to Bombay. E-W sections on 19°N and 17°N and on 12°N and 9°N to 52°E. Westerly section from Cochin to 5°N, 62°E - South to 10°S to 66°E, North to 0°, to 1°N, 70°E, South to 10°S, to 74°E, North to 0° thence to Cochin.
Bay of Bengal - 7 coastal sections Madras to Burma, up to 200 miles from coast. Section on 92°E - 20°N to 12°N and west to India. Three transverse sections to Andamans, Nicobars and Sumatra between 10°N and 5°N linked with meridional sections on 89°, 87°, 84°, 82°, 79°E between 8°N and 5°N. 5 Sections NNE-SSW and NNW-SSE between 9°N and 0° starting at 77°E and going to 95°E.
Geology and Geophysics - Continuous bathymetry, sediment coring, gravity and magnetic studies, heat flow and seismic refraction in significant areas.

R/V VARUNA (75' new fisheries research vessel)
1962 and 1963 - At least 6 months each year - both monsoons. Approximately to 1000 fathom curve on west coast of India.
Geology and Geophysics - Bottom samples.

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PNS ALMIRANTE LACERDA

1962 - Southwest monsoon period. Mozambique Channel. 8 sections between Mozambique and 43°E.
Geology and Geophysics
(NOTE: No detailed program or schedule available)

1963 - Same as 1962

OCEANOGRAPHIC VESSEL NO. 2 - (90 tons) (THAILAND)

1962 and 1963 - December 1962 and January 1963 - Continental Shelf off west Thailand coast. Twelve E-W sections 20 miles apart with 49 stations at 20 mile intervals. 8 anchored coastal current stations.
Geology - Bottom sediment samples.

PNS ZULFIQUAR - (2,000 tons)

1962 - (months not determined) - Bay of Bengal - North of 19°N, and Arabian Sea - East of 64°E and North of 18°N. Eleven stations in Bay of Bengal, fourteen in Arabian Sea.
Geology and Geophysics - Bathymetry, coring, dredging.

1963 - (months not determined) - Bay of Bengal - 16°N to 21°N and 91°E to Burmese coast - 9 stations. Arabian Sea - Gulf of Oman to 66°E and 22°N to 25°N - 14 stations.
Geology

1964 - (months not determined) - Bay of Bengal - 16°N to 18° N and 84°E to 91°E - 11 stations. Arabian Sea - 18°N to 22°N and 58°E to 64°E - 14 stations.
Geology

ARGO (Scripps)

1962 - 27 June to 24 July - Equatorial section from 90°E to 46°E.
27 July to 25 August - Meridional sections probably on 55°E and 72°E, at least one of which will extend from 5°N to 5°S.
28 August to 27 September - Meridional sections at approximately 80°E and 90°E, at least one of which will extend from 5°N to 5°S. (Knauss)
Geology and Geophysics - Continuous precise bathymetry, gravity and magnetometry underway.
1 October to 26 October - Cochin to Mauritius via Laccadives-Maldives-Chagos.
28 October to 29 November - Mauritius to Fremantle via Kerguelen, Amsterdam.
2 December to 23 December - Fremantle to Darwin via Wharton Basin. (Shor and Raitt)
Geology and Geophysics - 50 long seismic refraction profiles with measurements to the mantle, in the basins, along the midocean rise and on the ridges enroute. Magnetometry and gravitmetry underway. Paleomagnetic studies. Special heat flow studies on and near mid ocean rise, also in basins. Reconnaissance coring, especially in mid latitudes in Wharton and northeast Reunion Basins.

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ARGO (Scripps) (continued)

1962-63 - 27 December to 12 February - Darwin to Vizagapatnam via Djakarta. (Fisher)
Geology and Geophysics - Underway geophysical investigation of the Indonesian Trench and environs. Detailed magnetic and gravity studies to investigate trench-island area and ridge relationship. Precision bathymetry.

1963 - 15 February to 15 May - Equatorial region from 96°E to 46°E, between 5°N and 5°S, generally going from east to west. (Knauss)
15 May to 1 June - Zanzibar to Antarctic Convergence to Cape Town. (Kneeling)
Geology and Geophysics - Precision bathymetry, gravity and magnetic observations underway.

HORIZON (Scripps)

1962 - 9 September to 27 September - Red Sea and Arabian Sea
Geology and Geophysics - Bathymetry and bottom sampling.
10 October to 22 December - Mid ocean and Amsterdam ridges, Wharton Basin.
Geology and Geophysics - Acts as shooting ship for ARGO's seismic refraction studies. Bottom sampling.

SPENCER F. BAIRD (Scripps)

1964 - 15 January to 15 July (March, April, May in Indian Ocean) 15°S to 40°S between Australia and Mauritius. (Riedel)
Geology and Geophysics - Detailed stratigraphic and geochemical sampling in critical areas found in earlier reconnaissance cruises. Continuous precise bathymetric and magnetic studies underway. Oriented coring for paleomagnetic studies. Heat flow measurements, bottom sampling, bottom photography and sediment coring for paleoceanographic studies.

ATLANTIS II (WHOI)

1963 - June through December - Latitudinal sections across Arabian Sea and N.W. Indian Ocean to 80°E, coordinated with scheduled observations of other nations. Also Agulhas current system from Mozambique Channel to Republic of South Africa or investigations in Reunion Basin.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.

1965 - February through July - Similar program to 1963 in opposite monsoon (N.W. quadrant Indian Ocean) latitudinal track plus either Agulhas current or Reunion Basin.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.

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CHAIN (WHOI)

1963-64 - September to March - N.W. Indian Ocean to 25°S, 80°E including Arabian Sea.

Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.

Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.

1964-65 - September to March

Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.

Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.

AIRPLANES AND SHORE PARTIES (WHOI)

1963-5 - Coastlines of Indian Ocean - Selected areas.

Geology - Coastal geology studies of phenomena associated with extremely rapid energy changes at and near the beach.

Overall reconnaissance by airplane photo time lapse technique, in conjunction with WHOI airborne meteorological program. Field examination at selected sites of the effects of sea on selected coastal features and effect of sea state during seasonal monsoons on beach profiles and materials.

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COORDINATOR
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SUMMARY OF SHIP'S PROGRAMS - APPENDIX B - BY DISCIPLINES

METEOROLOGY

RRS DISCOVERY III

1963 - March-May - Seychelles Ridge, Somali Basin, Carlsberg Ridge, Arabian Basin.
Meteorology - Synoptic observation and radio sonde.

1963 - June, July - South Arabian Coast
Meteorology - Synoptic observation and radio sonde.

1963 - August-October - 4 transverse sections across Arabian Sea.
Meteorology - Synoptic observations and radio sonde.

1963 - November - Equatorial region - African coast to 78°E.
Meteorology - Synoptic observations and radio sonde.

1964 - January-February - 4 transverse sections across Arabian Sea.
Meteorology - Synoptic observations and radio sonde.

1964 - March - Equatorial region - African coast to 78°E.
Meteorology - Synoptic observations and radio sonde.

1964 - April - Colombo to Suez.

WILLIAMSBURG

Meteorology - Synoptic observations and radio sonde.

1963 - Feb.-April - Cruise 1 - Bay of Bengal, Andaman Sea, and Nicobar Islands.

1963 - May-July - Cruise 2 - Cochin to 20°N, 70°E to 40°S to 80°E to Colombo and Cochin.

1963 - Aug.-Sept. - Cruise 3- Cochin to Karachi to 20°N, 60°E to 40°S to 50°E to Tamatone.

1963 - Oct.-Nov. - Cruise 4 - Tamatone to Reunion to 40°S, 55°E to 75°E to Cochin. Diversions to Chagos, Maldines and Laccodines.

1964 - Jan.-March - Cruise 5 - Arabian Sea and Gulf of Aden. 19 sections around the coast of the Arabian Sea from Cochin to Cape Guardafui out to 250 miles from the coast and a transverse section from Africa to India on 10°N.

1964 - April-May - Cruise 6 - Cochin to 20°N, 65°E to 40°S to 30°E to Durban.

1964 - June-July - Cruise 7 - (Agulhas Current) Durban to Port Elizabeth to 40°S, 25°E; 5 sections within 500 miles of coast to Lourenco Marques to S. end of Madagascar to 40°S, 45°E to 30°E to Durban.

1964 - Aug.-Sept. - Cruise 8 - (Mozambique and Somali Currents) 10 sections from Durban to 5°N, 50°E across Mozambique Channel and to 500 miles from African coast to Zanzibar and along Kenya and Somalia coasts, thence S. on 50°E to Diego Suarez and Nosy-Be.

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WILLIAMSBURG (continued)
1964 - Oct.-Nov. - Cruise 9 - Nosy-Bè to Reunion, N. on 55°E to 10°N. via Seychelles diversion to Laccadines, Maldines and Chagos for investigations, to Cochin.

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
1962 - August-September
1963 - February-March, June, July-August, December
1964 - February-March, May, July-August, December
Meteorology - Radio sonde and radiation balance.

HMAS GASCOYNE - General area of operations between 0° and 45°S, 85°E and 140°E.
1962 - August-September
1963 - February - March
Meteorology - Radio sonde and radiation balance.

UMITAKA MARU
1962-63 - 1963-64 - December-March - 8°N to 32°S along 78°E - 30 days.
Meteorology - Synoptic observation and airsea interface studies.

RYOFU MARU
1963-64 - December-March - 8°N to 32°S along 86°E - 30 days.
Meteorological observation

KOYO MARU
1962-63 - 1963-64 - December-March - 8°N to 32°S along 94°E 30 days.
Meteorological observations

TAKUYO MARU
1963-64 - Dec.-March - 8°S to 32°S along 102°E. 8°S to 32°S along 110°E. 20 days.
Meteorological observations

KAGOSHIMA MARU
1963-64 - Dec.-March - 8°S to 32°S along 106°E, 8°S to 22°S along 118°E (?) - 30 days
Meteorological observations

INS KISTNA - (Indian Navy Frigate converted for oceanography)
1962 and 1963 - At least 6 months sea time each year in N.W.Indian Ocean and in Bay of Bengal. Primarily deep-sea cruising in both S.W. and N.E. monsoons in both areas.
Arabian Sea - Bombay to Karachi to mouth of Persian Gulf to Bombay. E-W sections on 19°N and 17°N and on 12°N and 9°N to 52°E. Westerly section from Cochin to 5°N, 62°E - South to 10°S to 66°E, North to 0°, to 1°N, 70°E, South to 10°S, to 74°E, North to 0° thence to Cochin.

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INS KISTNA (continued)
Bay of Bengal - 7 coastal sections Madras to Burma, up to 200 miles from coast. Section on 92°E - 20°N to 12°N and west to India. Three transverse sections to Andamans, Nicobars and Sumatra between 10°N and 5°N linked with meridional sections on 89°, 87°, 84°, 82°, 79°E between 8°N and 5°N. 5 Sections NNE-SSW and NNW-SSE between 9°N and 0° starting at 77°E and going to 95°E.
Meteorology - Surface observations plus upper atmosphere if equipment available.

R/V VARUNA (75' new fisheries research vessel)
1962 and 1963 - At least 6 months each year - both monsoons. Approximately to 1000 fathom curve on west coast of India.
Meteorology - Surface observations.

PNS ALMIRANTE LACERDA
1962 - Southwest monsoon period. Mozambique Channel. 8 sections between Mozambique and 43°E.
Meteorology
(NOTE: No detailed program or schedule available)
1963 - Same as 1962.

OCEANOGRAPHIC VESSEL NO. 2 (Thailand) - (90 tons)
1962 and 1963 - December 1962 and January 1963 - Continental Shelf off west Thailand coast. Twelve E-W sections 20 miles apart with 49 stations at 20 mile intervals. 8 anchored coastal current stations.
Meteorology - Special surface observations at stations and at synoptic hours.

PNS ZULFIQUAR - (2,000 tons)
1962 - (months not determined) - Bay of Bengal - North of 19°N, and Arabian Sea - East of 64°E and North of 18°N. Eleven stations in Bay of Bengal, fourteen in Arabian Sea.
Meteorology - surface observations and radiation.
1963 - (months not determined) - Bay of Bengal 16°N to 21°N and 91°E to Burmese coast - 9 stations. Arabian Sea - Gulf of Oman to 66°E and 22°N to 25°N - 14 stations.
Meteorology - Surface observations and radiation.
1964 - (months not determined) - Bay of Bengal 16°N to 18°N and 84°E to 91°E - 11 stations. Arabian Sea - 18°N to 22°N and 58°E to 64°E - 14 stations.
Meteorology - Surface observations and radiation.

ARGO (Scripps)
1962 - 27 June to 24 July - Equatorial section from 90°E to 46°E.
27 July to 25 August - Meridional sections probably on 55°E and 72°E, at least one of which will extend from 5°N to 5°S.
28 August to 27 September - Meridional sections at approximately 80°E and 90°E, at least one of which will extend from 5°N to 5°S. (Knauss)
Meteorology - Extent of observations determined by availability of equipment.

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ARGO (Scripps) (continued)

1962 - 1 October to 26 October - Cochin to Mauritius via Laccadives-Maldives-Chagos.
28 October to 29 November - Mauritius to Fremantle via Kerguelen, Amsterdam.
2 December to 23 December - Fremantle to Darwin via Wharton Basin. (Shor and Raitt)
Meteorology - Extent of observations determined by availability of equipment.

1963 - 15 February to 15 May - Equatorial region from 96°E to 46°E, between 5°N and 5°S, generally going from east to west. (Knauss)
Meteorology - As in July-September 1962 program.

ATLANTIS II (WHOI)

1963 - June through December - Latitudinal sections across Arabian Sea and N.W. Indian Ocean to 80°E, coordinated with scheduled observations of other nations. Also Agulhas current system from Mozambique Channel to Republic of South Africa or investigations in Reunion Basin.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

1965 - February through July - Similar program to 1963 in opposite monsoon (N.W. quadrant Indian Ocean) latitudinal tracks plus either Agulhas current or Reunion Basin.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

U.S. WEATHER SHIPS

Time series at single location on one weather ship below Bay of Bengal on equator of basic biological, chemical and physical oceanographic observations.
Meteorology

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CABLES
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SUMMARY OF SHIP'S PROGRAMS - APPENDIX B - BY DISCIPLINES

ADDITIONAL SHIPS - No Disciplines Indicated

NEW VESSEL FOR NOUMEA (France) - (35 m.)

Vessel under construction proposed to make Indian Ocean cruise, date, place and program unknown, enroute to Noumea.

NEW CONSTRUCTION (France) - (70 m.)

New research ship may possibly operate in Expedition. No further information.

NEW VESSEL (Thailand) - (350 tons)

This vessel may be available - if adequately equipped by early 1963 for cooperative work with adjoining countries along entire East coast of Bay of Bengal.

JALANIDHI - (650 ton Indonesian research vessel under construction)

This vessel is being constructed for use in the Indian Ocean Expedition. Completion reported August 1962. No schedule or program plans available for Indonesian shipboard operations.

HMS OWEN

1962-63)
1963-64) In Western Indian Ocean - No plans formulated
1964-65)

PNS MADADGAR - (1,000 tons)

Reported to participate in 1962 and 1963.

FISHERIES RESEARCH VESSEL - (90 tons)

Two reported under procurement - one for West Pakistan, one for East Pakistan - coastal observations.

1Apr62

U.S. COAST & GEODETIC SURVEY (one Class I ship - 2-3,000 tons)

1963 or 1964 - In part of Indian Ocean which has been given inadequate attention. The USC&GS plans to participate in latter phases of Expedition and its program is flexible.

USS REQUISITE (Hydrographic Office)

This vessel has done some work in the Arabian Sea and Persian Gulf. It is reported to be participating further but no plans or schedules are available.

USS SERRANO (Hydrographic Office)

This vessel has done some work in the Straits of Mallacca and the Andaman Sea. It is reported to be participating further but no plans or schedules are available.

R/V VEMA

1963 - 17 March to 15 June - Aden to Cape Town. Southern Indian Ocean, South Africa, Kerguelen.

Disciplines not specified - probably similar to 1962.

R/V CONRAD

1963 - 17 March to 15 June - Aden to Cape Town. Southern Indian Ocean, South Africa, Kerguelen, West Australia.

Cruise plans not detailed.

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SUMMARY OF SHIP'S PROGRAMS - APPENDIX C - BY MONTH

1961

June '61

AFRICANA II - Agulhas Current to 1,500 miles off African coast, 2 sections from Lourenco Marques and to Durban extending to 38°S, 58°E, 42 stations.
Physics - Temperatures and salinities at all stations.
Chemistry - Analysis of oxygen, inorganic phosphate and broad trace element composition - all stations.
Biology - Primary production by C^{14} technique - Plankton hauls for qualitative and quantitative analysis at all stations. Surface trolling, hand and long-lining, midwater trawling and blanket netting in passage.

July

AFRICANA II - Agulhas Current to 1,500 miles off African coast, 2 sections from Lourenco Marques and to Durban extending to 38°S, 58°E, 42 stations.
Physics - Temperatures and salinities at all stations.
Chemistry - Analysis of oxygen, inorganic phosphate and broad trace element composition - all stations.
Biology - Primary production by C^{14} technique - Plankton hauls for qualitative and quantitative analysis at all stations. Surface trolling, hand and long-lining, midwater trawling and blanket netting in passage.

October

HMS DALRYMPLE - Red Sea & Arabian Coast to Persian Gulf
Magnetic Surveys

HMS OWEN - Red Sea, Arabian Sea and West Central Indian Ocean
Africa to Gan to Mauritius
Bathymetry, Magnetism, Gravity, Meteorology
(Synoptic observation)

1Apr62

November '61

HMS DALRYMPLE - Persian Gulf (lower)

Sediment Studies

HMS OWEN - Red Sea, Arabian Sea and West Central Indian Ocean - Africa to Gan to Mauritius
Bathymetry, Magnetism, Gravity, Meteorology
(Synoptic observation)

December

HMS DALRYMPLE - Persian Gulf (lower)
Sediment Studies

HMS OWEN - Red Sea, Arabian Sea and West Central Indian Ocean
Africa to Gan to Mauritius
Bathymetry, Magnetism, Gravity, Meteorology
(Synoptic observation)

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COORDINATOR
ROBERT G. SNIDER

CABLES
SCORINDOC - NEWYORK

SUMMARY OF SHIP'S PROGRAMS - APPENDIX C - BY MONTH

1962

January '62

HMS DALRYMPLE - Persian Gulf (lower)
Sediment Studies

HMS OWEN - Red Sea, Arabian Sea and West Central Indian Ocean - Africa to Gan to Mauritius
Bathymetry, Magnetism, Gravity, Meteorology
(Synoptic observation)

February

HMS DALRYMPLE - Persian Gulf - (lower)
Sediment Studies

HMS OWEN - Red Sea, Arabian Sea and West Central Indian Ocean - Africa to Gan to Mauritius.
Bathymetry, Magnetism, Gravity, Meteorology
(Synoptic observation)

March

HMS OWEN - Red Sea, Arabian Sea and West Central Indian Ocean - Africa to Gan to Mauritius
Bathymetry, Magnetism, Gravity, Meteorology
(Synoptic observation)

April

HMS OWEN - Red Sea, Arabian Sea and West Central Indian Ocean - Africa to Gan to Mauritius.
Bathymetry, Magnetism, Gravity, Meteorology
(Synoptic Observation)

NATAL - Cruise 1 - Agulhas Current to 500 miles off South African coast. 37 stations on four sections in 3 weeks - Durban to Simonstown.
Physics - Hydrology of Agulhas Current - Hydrographic casts to bottom, B/T GEK.
Biology - Plankton and productivity of Agulhas Current; Botany-Taxonomy of Diatoms and Peridinians. Plankton hauls to 100 m. on all stations; intensive hauls to 400 m. on 12 stations.

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April '62 contd

VITJAZ - Eastern, Equatorial and Central Indian Ocean. Enter at Djakarta, depart at Suez.
Physics - Investigation of surface and subsurface circulation and make up of Indian Ocean water mass during northern summer months.
Geology and Geophysics - Investigation of geological bottom formations and the earth under the Indian Ocean.
Biology - Investigation of biological structure of Indian Ocean from point of view of exploitation for commercial fishing. Collection of material for investigation of zonal difference in appearances of various creatures in Indian Ocean.

May

HMS OWEN - Red Sea, Arabian Sea and West Central Indian Ocean Africa to Gan to Mauritius.
Bathymetry, Magnetism, Gravity, Meteorology (Synoptic observation)

NATAL - Cruise 2 - across South East African continental shelf. Two sections to South Easterly direction of Cape Agulhas to 500 miles - 3 weeks.
Geology - Geological and chemical analysis of bottom sediments on continental shelf and deep sea sediments. Precision echo sounder profiles.
Geophysics - Seismic, gravity and magnetic observations.
Physics - GEK observations.

VITJAZ - Eastern, Equatorial and Central Indian Ocean. Enter at Djakarta, depart at Suez.
Physics - Investigation of surface and subsurface circulation and make up of Indian Ocean water mass during northern summer months.
Geology and Geophysics - Investigation of geological bottom formations and the earth under the Indian Ocean.
Biology - Investigation of biological structure of Indian Ocean from point of view of exploitation for commercial fishing. Collection of material for investigation of zonal difference in appearances of various creatures in Indian Ocean.

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June '62

R/V VEMA - SW Indian Ocean, Madagascar Basin, Mozambique Channel, Madagascar Seychelles, Mauritius area; northern Indian Ocean ridge; Gulf of Aden.
Geology & Geophysics - PDR bathymetry, magnetic and gravity measurements continuously. Seismic reflection profiles, bottom thermal and acoustic probes; bottom sampling, coring and photography, island rock collections.
Physics & Chemistry - Water sampling at various depths for physical and chemical characteristics, C_{14} and tritium sampling, B/T and sound velocity measurements.
Biology - Plankton sampling at various depths, microbiological sampling, ocean bottom trawls.

NATAL - Cruise 3 - S.E. from Mazeppa Bay to 35°S, 37°E, thence westward to Cape Agulhas - 2-1/2 weeks.
Geology, Geophysics, Physics - as in Cruise 2.

AFRICANA II - Port Elizabeth to Prince Edward Is. to Crozet Is. to East London. Similar to cruise in 1961.
Physics - Temperatures and salinities at all stations.
Chemistry - Analysis of oxygen, inorganic phosphate and broad trace element composition -- all stations.
Biology - Primary productivity by C_{14} technique - Plankton hauls for qualitative and quantitative analysis at all stations. Surface trolling, hand and long-lining, midwater trawling and blanket netting in passage.

VITJAZ - Eastern, Equatorial and Central Indian Ocean. Enter at Djakarta, depart at Suez.
Physics - Investigation of surface and subsurface circulation and make up of Indian Ocean water mass during northern summer months.
Geology and Geophysics - Investigation of geological bottom formations and the earth under the Indian Ocean.
Biology - Investigation of biological structure of Indian Ocean from point of view of exploitation for commercial fishing. Collection of material for investigation of zonal difference in appearances of various creatures in Indian Ocean.

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June '62 contd

ARGO - Equatorial section from 96°E to 46°E.
Physical Oceanography - Hydrographic stations every 110 miles, alternately to bottom and 1,000 m. Two day current measuring stations at approximately 90°E, 80°E, 72°E and 55°E. Measurements relative to anchored buoys with propellor type current meters for shallower, faster currents; with Swallow floats for currents less than 15 cm/sec.
Chemistry - At least minimum recommended program at all stations.
Biology - At least minimum recommended program at all stations.
Geology and Geophysics - Continuous precise bathymetry, gravity and magnetometry underway.
Meteorology - Extent of observations determined by availability of equipment.

July

R/V VEMA - SW Indian Ocean, Madagascar Basin, Mozambique Channel, Madagascar Seychelles, Mauritius area; northern Indian Ocean ridge; Gulf of Aden.
Geology & Geophysics - PDR bathymetry, magnetic and gravity measurements continuously. Seismic reflection profiles, bottom thermal and acoustic probes; bottom sampling, coring and photography, island rock collections.
Physics & Chemistry - Water sampling at various depths for physical and chemical characteristics, C_{14} and tritium sampling, B/T and sound velocity measurements.
Biology - Plankton sampling at various depths, microbiological sampling, ocean bottom trawls.

NATAL - Cruise 4 - Agulhas Current to 500 miles off South African coast. 37 stations on four sections in 3 weeks - Durban to Simonstown.
Physics - Hydrology of Agulhas Current - Hydrographic casts to bottom, B/T, GEK.
Biology - Plankton and productivity of Agulhas Current; Botany-Taxonomy of Diatoms and Peridinians. Plankton hauls to 100 m. on all stations; intensive hauls to 400 m. on 12 stations.

AFRICANA II - Port Elizabeth to Prince Edward Is. to Crozet Is. to East London. Similar to cruise in 1961.
Physics - Temperatures and salinities at all stations.
Chemistry - Analysis of oxygen, inorganic phosphate and broad trace element composition -- all stations.
Biology - Primary productivity by C_{14} technique - Plankton hauls for qualitative and quantitative analysis at all stations. Surface trolling, bard and long-living, midwater trawling and blanket netting in passage.

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July '62 contd

VITJAZ - Eastern, Equatorial and Central Indian Ocean. Enter at Djakarta, depart at Suez.
Physics - Investigation of surface and subsurface circulation and make up of Indian Ocean water mass during northern summer months.
Geology and Geophysics - Investigation of geological bottom formations and the earth under the Indian Ocean.
Biology - Investigation of biological structure of Indian Ocean from point of view of exploitation for commercial fishing. Collection of material for investigation of zonal difference in appearances of various creatures in Indian Ocean.

ARGO - Equatorial section from 96°E to 46°E.
Physical Oceanography - Hydrographic stations every 110 miles, alternately to bottom and 1,000 m. Two day current measuring stations at approximately 90° E, 80°E, 72°E, and 55°E. Measurements relative to anchored buoys with propellor type current meters for shallower, faster currents; with Swallow floats for currents less than 15 cm/sec.
Chemistry - At least minimum recommended program at all stations.
Biology - At least minimum recommended program at all stations.
Geology and Geophysics - Continuous precise bathymetry, gravity and magnetometry underway.
Meteorology - Extent of observations determined by availability of equipment.

ARGO - Meridional sections probably on 55°E and 72°E, at least one of which will extend from 5°N to 5°S.
Physical Oceanography - 5 to 10 stations on each section, at one-half degree intervals within 3° of the equator, at 1° intervals beyond for current measurements relative to anchored buoys. Several hydrographic casts to bottom, remainder to 1000 m.
Chemistry - At least minimum recommended program at all stations.
Biology - At least minimum recommended program at all stations.
Geology and Geophysics - Continuous precise bathymetry, gravity and magnetometry underway.
Meteorology - Extent of observations determined by availability of equipment.

FNS COMMANDANT ROBERT GIRAUD - Cape Guardafui to 30°S linked sections from coast to 5-600 miles out. (Alternatively in 1963)
Physical and Chemical Oceanography - Hydrographic stations, temperature, salinity, oxygen and direct current measurements Bab el Mandeb and Ormuz Straits. Similar to 1960 cruise completed same area same season.

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August '62

NATAL - Cruise 5 - 2 1/2 weeks. E. of Natal and S. of Madagascar to 600 miles from African coast.
Biology - Distribution of subsurface pelagic fishes - Tunny experimental fishing; Plankton and productivity investigation of Agulhas Current - regular net hauls to 100 m. periodic to 400 m. 2 sections to 600 miles.
Physics - 48 hour station at 32°S, 44°E to study energy exchange between ocean and atmosphere; temperature and current measurement vs. depth and internal waves to 300 m., G.E.K.
Geophysics - Gravimetric measurement underway.

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phytoplankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

VITJAZ - Eastern, Equatorial and Central Indian Ocean. Enter at Djakarta, depart at Suez.
Physics - Investigation of surface and subsurface circulation and make up of Indian Ocean water mass during northern summer months.
Geology and Geophysics - Investigation of geological bottom formations and the earth under the Indian Ocean.
Biology - Investigation of biological structure of Indian Ocean from point of view of exploitation for commercial fishing. Collection of material for investigation of zonal difference in appearance of various creatures in Indian Ocean.

HMAS GASCOYNE - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phytoplankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

ARGO - Meridional sections probably on 55°E and 72°E, at least one of which will extend from 5°N to 5°S.
Physical Oceanography - 5 to 10 stations on each section, at one-half degree intervals within 3° of the equator, at 1° intervals beyond for current measurements relative to anchored buoys. Several hydrographic casts to bottom, remainder to 1000 m.

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August '62

ARGO - contd

Chemistry - At least minimum recommended program at all stations.
Biology - At least minimum recommended program at all stations.
Geology and Geophysics - Continuous precise bathymetry, gravity and magnetometry underway.
Meteorology - Extent of observations determined by availability of equipment.

ARGO - Meridional sections at approximately 80°E and 90°E, at least one of which will extend from 5°N to 5°S.
NOTE: Location of Meridional cross sections can be adjusted to coordinate operations with other nations' vessels which may be working extended longitudinal runs.
Physical Oceanography - 5 to 10 stations on each section, at one-half degree intervals within 3° of the equator, at 1° intervals beyond for current measurements relative to anchored buoys. Several hydrographic casts to bottom, remainder to 1000 m.
Chemistry - At least minimum recommended program at all stations.
Biology - At least minimum recommended program at all stations.
Meteorology - Extent of observations determined by availability of equipment.

FNS COMMANDANT ROBERT GIRAUD - Cape Guardafui to 30°S linked sections from coast to 5-600 miles out. (Alternatively in 1963)
Physical and Chemical Oceanography - Hydrographic stations, temperature, salinity, oxygen and direct current measurements Bab el Mandeb and Ormuz Straits. Similar to 1960 cruise completed same area same season.

September '62

HMAS GASCOYNE - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phytoplankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

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September '62 contd

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phytoplankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

VITJAZ - Eastern, Equatorial and Central Indian Ocean. Enter at Djakarta, depart at Suez.
Physics - Investigation of surface and subsurface circulation and make up of Indian Ocean water mass during northern summer months.
Geology and Geophysics - Investigation of geological bottom formations and the earth under the Indian Ocean.
Biology - Investigation of biological structure of Indian Ocean from point of view of exploitation for commercial fishing. Collection of material for investigation of zonal difference in appearances of various creatures in Indian Ocean.

ARGO - Meridional sections at approximately 80°E and 90°E, at least one of which will extend from 5°N to 5°S.
NOTE: Location of Meridional cross sections can be adjusted to coordinate operations with other nations' vessels which may be working extended longitudinal runs.
Physical Oceanography - 5 to 10 stations on each section, at one-half degree intervals within 3° of the equator, at 1° intervals beyond for current measurements relative to anchored buoys. Several hydrographic casts to bottom, remainder to 1000 m.
Chemistry - At least minimum recommended program at all stations.
Biology - At least minimum recommended program at all stations.
Meteorology - Extent of observations determined by availability of equipment.

HORIZON - Red Sea and Arabian Sea
Geology and Geophysics - Bathymetry and bottom sampling.

FNS COMMANDANT ROBERT GIRAUD - Cape Guardafui to 30°S linked sections from coast to 5-600 miles out. (Alternatively in 1963)
Physical and Chemical Oceanography - Hydrographic stations, temperature, salinity, oxygen and direct current measurements Bab el Mandeb and Ormuz Straits. Similar to 1960 cruise completed same area same season.

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October '62

NATAL - Cruise 6 - Agulhas Current to 500 miles off South African coast. 37 stations on four sections in 3 weeks. Durban to Simonstown.
Physics - Hydrology of Agulhas Current - Hydrographic casts to bottom, B/T, GEK.
Biology - Plankton and productivity of Agulhas Current; Botany-Taxonomy of Diatoms and Peridinians. Plankton hauls to 100 m. on all stations; intensive hauls to 400 m. on 12 stations.

HMS OWEN - Probably N.W. Indian Ocean. New plans being developed for virtually full-time deep water oceanographic cruise.

VITJAZ - Eastern, Equatorial and Central Indian Ocean. Enter at Djakarta, depart at Suez.
Physics - Investigation of surface and subsurface circulation and make up of Indian Ocean water mass during northern summer months.
Geology and Geophysics - Investigation of geological bottom formations and the earth under the Indian Ocean.
Biology - Investigation of biological structure of Indian Ocean from point of view of exploitation for commercial fishing. Collection of material for investigation of zonal difference in appearances of various creatures in Indian Ocean.

ARGO - 1 to 26 October - Cochin to Mauritius via Laccadives-Maldives-Chagos 28 October to 29 November - Mauritius to Fremantle via Kerguelen, Amsterdam.
Geology and Geophysics -50 long seismic refraction profiles with measurements to the mantle, in the basins, along the midocean rise and on the ridges enroute. Magnetometry and gravitmetry underway. Paleomagnetic studies. Special heat flow studies on and near mid ocean rise, also in basins. Reconnaissance coring, especially in mid latitudes in Wharton and northeast Reunion Basins.
Physics and Chemistry - Hydrographic casts, atmospheric water vapor collection and dissolved gas extraction from large volume water samples. Detailed studies of deuterium and oxygen 18 in deep and surface water, marine water vapor and rain; of dissolved bicarbonate concentration and carbon 13 content; of concentrations and isotopic ratios in dissolved gases; of rare gases such as xenon and helium occurrence.
Biology - Occasional special micro and microplankton hauls and mid water trawls.
Meteorology - Extent of observations determined by availability of equipment.

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October '62 contd

HORIZON - Mid ocean and Amsterdam ridges, Wharton Basin.
Geology and Geophysics - Acts as shooting ship for ARGO's seismic refraction studies. Bottom sampling.
Physical and Chemical Oceanography - Water sampling.

November '62

HORIZON - Mid ocean and Amsterdam ridges, Wharton Basin.
Geology and Geophysics - Acts as shooting ship for ARGO's seismic refraction studies. Bottom sampling.
Physical and Chemical Oceanography - Water sampling.

HMS OWEN - Probably N.W. Indian Ocean. New plans being developed for virtually full-time deep water oceanographic cruise.

ARGO - 28 October to 29 November - Mauritius to Fremantle via Kerguelen, Amsterdam.
Geology and Geophysics - 50 long seismic refraction profiles with measurements to the mantle, in the basins, along the midocean rise and on the ridges enroute. Magnetometry and gravitmetry underway. Paleomagnetic studies. Special heat flow studies on and near mid ocean rise, also in basins. Reconnaissance coring, especially in mid latitudes in Wharton and northeast Reunion Basins.
Physics and Chemistry - Hydrographic casts, atmospheric water vapor collection and dissolved gas extraction from large volume water samples. Detailed studies of deuterium and oxygen 18 in deep and surface water, marine water vapor and rain; of dissolved bicarbonate concentration and carbon 13 content; of concentrations and isotopic ratios in dissolved gases; of rare gases such as xenon and helium occurrence.
Biology - Occasional special micro and macroplankton hauls and mid water trawls.
Meteorology - Extent of observations determined by availability of equipment.

December '62

UMITAKA MARU - 8°N to 32°S along 78°E - 30 days between Dec. and March.
Biology - Investigation of animals and planets, collection of bottom specimens, plankton hauls and trawls down to 1,000 m. at stated periods, water samples for productivity analysis.
Chemistry - Dissolved oxygen and nutrient salt analysis, trace elements, etc.

December '62

UMITAKA MARU - contd
Physics - General oceanographic observations to bottom at least every 150 miles, B/T's, Shallow stations at intermediate points, Ekmann current meter observations in equatorial region.
Meteorology - Synoptic observation and airsea interface studies.

KOYO MARU - 8°N to 32°S along 94°E - 30 days between Dec. and March.
Biology - Investigation of animals and plants and special chemical elements.
Geophysics - Precision Echo sounding.
Geology - Collection of bottom specimens.
Meteorological observation.

HMS OWEN - Probably N.W. Indian Ocean. New plans being developed for virtually full-time deep water oceanographic cruise.

OCEANOGRAPHIC VESSEL NO. 2 (Thailand) - (90tons) - Continental Shelf off west Thailand coast. Twelve E-W sections 20 miles apart with 49 stations at 20 mile intervals. 8 anchored coastal current stations.
Physical and Chemical Oceanography - Hydrographic casts at all stations. Current Measurement.
Biological Oceanography - One meter net plankton tows, dip net biological collections at some stations and on coast.
Geology - Bottom sediment samples.
Meteorology - Special surface observations at stations and at synoptic hours.

CALYPSO - Red Sea, Gulf of Aden, Arabian Sea, Persian Gulf.
Physical and Chemical Oceanography - Hydrographic stations and direct current measurement in Bab el Mandeb and Ormuz Straits. Five traverse of Red Sea, three of Gulf of Aden. Joint operation in Arabian Sea and Persian Gulf with GIRAUD, covering same area as her April-June 1961 cruise.

ARGO - 2 December to 23 December - Fremantle to Darwin via Wharton Basin.
Geology and Geophysics - 50 long seismic refraction profiles with measurements to the mantle, in the basins, along the midocean rise and on the ridges enroute. Magnetometry and gravitmetry underway. Paleomagnetic studies. Special heat flow studies on and near mid ocean rise, also in basins. Reconnaissance, coring, especially in mid latitudes in Wharton and northeast Reunion Basins.

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December '62

ARGO - contd

Physics and Chemistry - Hydrographic casts, atmospheric water vapor collection and dissolved gas extraction from large volume water samples. Detailed studies of deuterium and oxygen 18 in deep and surface water, marine water vapor and rain; of dissolved bicarbonate concentration and carbon 13 content; of concentrations and isotopic ratios in dissolved gases; of rare gases such as xenon and helium occurrence.
Biology - Occasional special micro and macroplankton hauls and mid water trawls.
Meteorology - Extent of observations determined by availability of equipment.

ARGO - Darwin to Vizagapathnam via Djakarta.
Geology and Geophysics - Underway geophysical investigation of the Indonesian Trench and environs. Detailed magnetic and gravity studies to investigate trench-island area and ridge relationship. Precision bathymetry.

HORIZON - Mid ocean and Amsterdam ridges, Wharton Basin.
Geology and Geophysics - Acts as shooting ship for ARGO's seismic refraction studies. Bottom sampling.
Physical and Chemical Oceanography - Water sampling.

1Apr62

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INTERNATIONAL INDIAN OCEAN EXPEDITION
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COORDINATOR
ROBERT G. SNIDER

CABLES
SCORINDOC · NEWYORK

SUMMARY OF SHIP'S PROGRAMS - APPENDIX C - BY MONTH

1963

January '63

UMITAKA MARU - 8°N to 32°S along 78°E - 30 days between December and March.
Biology - Investigation of animals and planets, collection of bottom specimens, plankton hauls and trawls down to 1,000 m. at stated periods, water samples for productivity analysis.
Chemistry - Dissolved oxygen and nutrient salt analysis, trace elements, etc.
Physics - General oceanographic observations to bottom at least every 150 miles, B/T's Shallow stations at intermediate points, Ekmann current meter observations in equatorial region.
Meteorology - Synoptic observation and airsea interface studies.

KOYO MARU - 8°N to 32°S along 94°E - 30 days between December and March.
Biology - Investigation of animals and plants and special chemical elements.
Geophysics - Precision Echo sounding.
Geology - Collection of bottom specimens.
Meteorological observation.

HMS OWEN - Probably N.W. Indian Ocean. New plans being developed for virtually full-time deep water oceanographic cruise.

NATAL - Cruise 7 - Agulhas Current to 500 miles off South African coast. 37 stations on four sections in 3 weeks. Durban to Simonstown.
Physics - Hydrology of Agulhas Current - Hydrographic casts to bottom, B/T, GEK.
Biology - Plankton and productivity of Agulhas Current; Botany-Taxonomy of Diatoms and Peridinians. Plankton hauls to 100 m. on all stations; intensive hauls to 400 m. on 12 stations.

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January '63 contd

FNS COMMANDANT ROBERT GIRAUD - Eastern Arabian Sea
Physical and Chemical Oceanography - Hydrographic stations and direct current measurements in Bab el Mandeb, and Ormuz Straits assisting CALYPSO. Same area as April-June 1961 GIRAUD cruise.

OCEANOGRAPHIC VESSEL NO. 2 (Thailand) - (90 tons) - Continental Shelf off west Thailand coast. Twelve E-W sections 20 miles apart with 49 stations at 20 mile intervals. 8 anchored coastal current stations.
Physical and Chemical Oceanography - Hydrographic casts at all stations. Current Measurement.
Biological Oceanography - One meter net plankton tows, dip net biological collections at some stations and on coast.
Geology - Bottom sediment samples.
Meteorology - Special surface observations at stations and at synoptic hours.

CALYPSO - Red Sea, Gulf of Aden, Arabian Sea, Persian Gulf.
Physical and Chemical Oceanography - Hydrographic stations and direct current measurement in Bab el Mandeb and Ormuz Straits. Five traverses of Red Sea, three of Gulf of Aden. Joint operation in Arabian Sea and Persian Gulf with GIRAUD, covering same area as her April-June 1961 cruise.

ARGO - Darwin to Vizagapatnam via Djakarta.
Geology and Geophysics - Underway geophysical investigation of the Indonesian Trench and environs. Detailed magnetic and gravity studies to investigate trench-island area and ridge relationship. Precision bathymetry.

February '63

UMITAKA MARU - 8°N to 32°S along 78°E - 30 days between December and March.
Biology - Investigation of animals and planets, collection of bottom specimens, plankton hauls and trawls down to 1,000 m. at stated periods, water samples for productivity analysis.
Chemistry - Dissolved oxygen and nutrient salt analysis, trace elements, etc.
Physics - General oceanographic observations to bottom at least every 150 miles, B/T's, Shallow stations at intermediate points, Ekmann current meter observations in equatorial region.
Meteorology - Synoptic observation and airsea interface studies.

1Apr62

February '63 contd

KOYO MARU - 8°N to 32°S along 94°E - 30 days between December and March.
Biology - Investigation of animals and plants and special chemical elements.
Geophysics - Precision Echo sounding.
Geology - Collection of bottom specimens.
Meteorological observation.

HMS OWEN - Probably N.W. Indian Ocean. New plans being developed for virtually full-time deep water oceanographic cruise.

WILLIAMSBURG - Cruise 1 - Bay of Bengal, Andaman Sea, and Nicobar Islands, 15 sections around the Bay of Bengal from Ceylon to Nicobars out to 250 miles from coast and sections from Rangoon to Ceylon. Dredging and bottom trawling on continental shelf additional.
Biology - Basic program for all cruises. Complete Hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises.
Meteorology - Synoptic observations and radiosonde.

NATAL - Cruise 8 - E. of Natal and S. of Madagascar to 600 miles from African coast.
Biology - Distribution of subsurface pelagic fishes - Tunny experimental fishing; Plankton and productivity investigation of Agulhas Current - regular net hauls to 100 m. periodic to 400 m. 2 sections to 600 miles.
Physics - 48 hour station at 32°S, 44°E to study energy exchange between ocean and atmosphere; temperature and current measurement vs. depth and internal waves to 300 m., G.E.K.
Geophysics - Gravimetric measurement underway.

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phyto-plankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

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February '63 contd

FNS COMMANDANT ROBERT GIRAUD - Eastern Arabian Sea.
Physical and Chemical Oceanography - Hydrographic stations and direct current measurements in Bab el Mandeb and Ormuz Straits assisting CALYPSO. Same area as April-June 1961 GIRAUD cruise.

CALYPSO - Red Sea, Gulf of Aden, Arabian Sea, Persian Gulf.
Physical and Chemical Oceanography - Hydrographic stations and direct current measurement in Bab el Mandeb and Ormuz Straits. Five traverses of Red Sea, three of Gulf of Aden. Joint operation in Arabian Sea and Persian Gulf with GIRAUD, covering same area as her April-June 1961 cruise.

ARGO - Darwin to Vizagapatnam via Djakarta.
Geology and Geophysica - Underway geophysical investigation of the Indonesian Trench and environs. Detailed magnetic and gravity studies to investigate trench-island area and ridge relationship. Precision bathymetry.

ARGO - Equatorial region from 96°E to 46°E, between 5°N and 5°S, generally going from east to west.
Physical Oceanography - Hydrographic stations and current measurement as in July-September 1962 program, but in opposite monsoon. Detailed plans not completed.
Chemistry - As in July-September 1962 program.
Biology - As in July-September 1962 program.
Geology and Geophysics - As in July-September 1962 program.
Meteorology - as in July-September 1962 program.

HMAS GASCOYNE - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phytoplankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

March '63

UMITAKA MARU - 8°N to 32°S along 78°E - 30 days between December and March.
Biology - Investigation of animals and planets, collection of bottom specimens, plankton hauls and trawls down to 1,000 m. at stated periods, water samples for productivity analysis.
Chemistry - Dissolved oxygen and nutrient salt analysis, trace elements, etc.
Physics - General oceanographic observations to bottom at least every 150 miles, B/T's Shallow stations at intermediate points, Ekmann current meter observations in equatorial region.
Meteorology - Synoptic observation and airsea interface studies.

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March '63 contd

KOYO MARU — 80°N to 32°S along 94°E - 30 days between December and March.
Biology - Investigation of animals and plants and special chemical elements.
Geophysics - Precision Echo sounding.
Geology - Collection of bottom specimens.
Meteorological observation.

HMS OWEN - Probably N.W. Indian Ocean. New plans being developed for virtually full-time deep water oceanographic cruise.

RRS DISCOVERY III - Seychelles Ridge, Somali Basin, Carlsberg Ridge, Arabian Basin.
Geophysics - Bathymetry, magnetic, gravity and seismic surveys, bottom photography and sampling.
Meteorology - Synoptic observation and radiosonde.
Biology - observation of surface phenomena.

WILLIAMSBURG - Cruise 1 - Bay of Bengal, Andaman Sea, and Nicobar Islands, 15 sections around the Bay of Bengal from Ceylon to Nicobars out to 250 miles from coast and sections from Rangoon to Ceylon. Dredging and bottom trawling on continental shelf additional.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Station every 120 miles on meridional sections, more frequently on coastal cruises.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL - (Based at Bombay) Cruise A - Singapore, Nicobar Islands, Andaman Islands - Cochin.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phyto-plankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

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March '63

FNS COMMANDANT ROBERT GIRAUD - Eastern Arabian Sea
Physical and Chemical Oceanography - Hydrographic stations and direct current measurements in Bab el Mandeb and Ormuz Straits assisting CALYPSO. Same area as April-June 1961 GIRAUD cruise.

CALYPSO - Red Sea, Gulf of Aden, Arabian Sea, Persian Gulf.
Physical and Chemical Oceanography - Hydrographic stations and direct current measurement in Bab el Mandeb and Ormuz Straits. Five traverses of Red Sea, three of Gulf of Aden. Joint operation in Arabian Sea and Persian Gulf with GIRAUD, covering same area as her April-June 1961 cruise.

ARGO - Equatorial region from 96°E to 46°E, between 5°N and 5°S, generally going from east to west.
Physical Oceanography - Hydrographic stations and current measurement as in July-September 1962 program, but in opposite monsoon. Detailed plans not completed.
Chemistry - As in July-September 1962 program.
Biology - As in July-September 1962 program.
Geology and Geophysics - As in July-September 1962 program.
Meteorology - As in July-September 1962 program.

HMAS GASCOYNE - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phytoplankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

April '63

AUXILIARY VESSEL (Based at Bombay) Cruise A - Singapore, Nicobar Islands, Andaman Islands - Cochin.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

HMS OWEN - Probably N.W. Indian Ocean. New plans being developed for virtually full-time deep water oceanographic cruise.

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April '63 - contd

RRS DISCOVERY III - Seychelles.Ridge, Somali Basin, Carlsberg Ridge, Arabian Basin.
Geophysics - Bathymetry, magnetic, gravity and seismic surveys, bottom photography and sampling.
Meteorology - Synoptic observation and radiosonde.
Biology - observation of surface phenomena.

WILLIAMSBURG - VESSEL (Based at Cochin) - Cruise 1 - Bay of Bengal, Andaman Sea, and Nicobar Islands, 15 sections around the Bay of Bengal from Ceylon to Nicobars out to 250 miles from coast and sections from Rangoon to Ceylon. Dredging and bottom trawling on continental shelf additional.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Station every 120 miles on meridional sections, more frequently on coastal cruises.
Meteorology - Synoptic observations and radiosonde.

ARGO - Equatorial region from 96°E to 46°E, between 5°N and 5°S, generally going from east to west.
Physical Oceanography - Hydrographic stations and current measurement as in July-September 1962 program, but in opposite monsoon. Detailed plans not completed.
Chemistry - As in July-September 1962 program.
Biology - As in July-September 1962 program.
Geology and Geophysics - As in July-September 1962 program.
Meteorology - As in July-September 1962 program.

May '63

AUXILIARY VESSEL (Based at Bombay) Cruise A - Singapore, Nicobar Islands, Andaman Islands - Cochin.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

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May '63 - contd

RRS DISCOVERY III — Seychelles Ridge, Somali Basin, Carlsberg Ridge, Arabian Basin.
Geophysics - Bathymetry, magnetic, gravity and seismic surveys, bottom photography and sampling.
Meteorology - Synoptic observation and radiosonde.
Biology - observation of surface phenomena.

WILLIAMSBURG - (Based at Bombay) - Cruise 2 - Cochin to 20°N, 70°E to 40°S to 80°E to Colombo and Cochin.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Midwater and/or surface collecting additional.
Meteorology - Synoptic observations and radiosonde.

ARGO - Equatorial region from 96°E to 46°E, between 5°N and 5°S, generally going from east to west.
Physical Oceanography - Hydrographic stations and current measurement as in July-September 1962 program, but in opposite monsoon. Detailed plans not completed.
Chemistry - As in July-September 1962 program.
Biology - As in July-September 1962 program.
Geology and Geophysics - As in July-September 1962 program.
Meteorology - As in July-September 1962 program.

ARGO - Zanzibar to Antarctic Convergence to Cape Town.
Chemical Oceanography - Investigation in high latitude of carbon dioxide exchange. Hydrographic stations.
Geology and Geophysics - Precision bathymetry, gravity and magnetic observations underway.

June '63

RRS DISCOVERY III - South Arabian coast.
Water movements, nutrient cycle, organic production, succession of plant and animal populations.
Biology - Intensive water sampling and sampling with vertical nets on continental shelf at 2030 mile intervals, 40-50 miles in deep water plus bottom samples and periodic net tows. Detailed investigations of one upwelling center. Qualitative and quantitative plankton studies.

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June '63

RRS DISCOVERY III - Contd
Chemistry - General survey plus detailed upwelling region investigation. Estimation of nutrient composition of sea water and organisms, and exchanges with bottom sediments. Measurement of ultraviolet adsorption in sea water and distillates, particularly in plankton blooms.
Physics - Direct current measurement with current waters, C/T and towed electrodes; possibly with neutrally buoyant floats.
Geophysics - PRD bathymetry, magnetic and gravity measurements continuously.
Meteorology - Synoptic observations and radiosonde.

WILLIAMSBURG - (Based at Bombay) - Cruise 2 - Cochin to 20°N, 70°E to 40°S to 80°E to Colombo and Cochin.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C^{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Midwater and/or surface collecting additional.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL (Based at Bombay) Cruise B - Cochin, Laccadive Islands Maldive Islands - Cochin.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phytoplankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

ARGO - Zanzibar to Antarctic Convergence to Cape Town.
Chemical Oceanography - Investigation in high latitude of carbon dioxide exchange. Hydrographic stations.
Geology and Geophysics - Precision bathymetry, gravity and magnetic observations underway.

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June '63 - contd

ATLANTIS II - Latitudinal sections across Arabian Sea and N.W. Indian Ocean to 80°E, coordinated with scheduled observations of other nations. Also Agulhas current system fromMozambique Channel to Republic of South Africa or investigations in Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile average intervals along approximately 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes particularly related to productivity; direct current and electrical potential measurements.
Geology and Geophysics - Precision echo sounding continuously continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

July '63

RRS DISCOVERY III - South Arabian coast
Water movements, nutrient cycle, organic production, succession of plant and animal populations.
Biology - Intensive water sampling and sampling with vertical nets on continental shelf at 2030 mile intervals, 40-50 miles in deep water plus bottom samples and periodic net tows. Detailed invesigation of one upwelling center. Qualititative and quantitative plankton studies.
Chemistry - General survey plus detailed upwelling region investigation. Estimation of nutrient composition of sea water and organisms, and exchanges with bottom sediments. Measurement of ultraviolet adsorption in sea water and distillates, particularly in plankton blooms.
Physics - Direct current measurement with current waters, B/T and towed electrodes; possibly with neutrally bucyant floats.
Geophysics - PRD bathymetry, magnetic and gravity measurements continuously.
Meteorology - Synoptic observations and radiosonde.

WILLIAMSBURG - (Based at Bombay) - Cruise 2 - Cochin to 20°N, 70°E to 40°S to 80°E to Colombo and Cochin.

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July '63 - contd

WILLIAMSBURG - contd
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Midwater and/or surface collecting additional.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL - (Based at Bombay) Cruise B - Cochin, Laccadive Islands Maldive Islands - Cochin.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phyto-plankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

FNS COMMANDANT ROBERT GIRAUD - Cape Guardafui to 30°S linked sections from coast to 5-600 miles out. (alternatively 1962)
Physical and Chemical Oceanography - Hydrographic stations, temperature, salinity, oxygen and direct current measurements Bab el Mandeb and Ormuz Straits. Similar to 1960 cruise completed same area same season.

ATLANTIS II - Latitudinal sections across Arabian Sea and N.W. Indian Ocean to 80°E, coordinated with scheduled observations of other nations. Also Agulhas current system from Mozambique Channel to Republic of South Africa or investigations in Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile average intervals along approximately 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes particularly related to productivity; direct current and electrical potential measurements.

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July '63 contd

ATLANTIS II - contd

Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology- Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

August '63

RRS DISCOVERY III - 4 transverse sections across Arabian Sea

Hydrography and Biology - 2 stations daily-current to 200 meters; chemical, physical and biological (algal production) sampling to 500 meters at noon; chemical, physical sampling to bottom, biological sampling (zooplankton especially) to 1,500 m. at 2200. Various trawls and net hauls to bottom periodically.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.
Meteorology - Synoptic observations and radiosonde.

WILLIAMSBURG - (Based at Bombay) - Cruise 3 - Cochin to Karachi to 20°N, 60°E to 40°S to 50°E to Tamatave.

Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zoo-plankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Midwater and/or surface collecting additional.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL - (Based at Bombay) Cruise B - Cochin, Laccadive Islands Maldive Islands - Cochin.

Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

HMAS DIAMANTINA - General area of operations between 0°and 45°S, 85°E and 140°E.

Biology - Primary production, zooplankton, phytoplankton.

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August '63 contd

HMAS DIAMANTINA - contd
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

FNS COMMANDANT ROBERT GIRAUD - Cape Guardafui to 30°S linked sections from coast to 5-600 miles out. (alternatively 1962)
Physical and Chemical Oceanography - Hydrographic stations, temperature, salinity, oxygen and direct current measurements Bab el Mandeb and Ormuz Straits. Similar to 1960 cruise completed same area same season.

ATLANTIS II - Latitudinal sections across Arabian Sea and N.W. Indian Ocean to 80°E, coordinated with scheduled observations of other nations. Also Agulhas current system from Mozambique Channel to Republic of South Africa or investigations in Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile average intervals along approximately 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes particularly related to productivity; direct current and electrical potential measurements.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

September '63

RRS DISCOVERY III - 4 transverse sections across Arabian Sea
Hydrography and Biology - 2 stations daily-current to 200 meters; chemical, physical and biological (algal production) sampling to 500 meters at noon; chemical, physical sampling to bottom, biological sampling (zooplankton especially) to 1,500 m. at 2200. Various trawls and net hauls to bottom periodically.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.
Meteorology - Synoptic observations and radiosonde.

WILLIAMSBURG - (Based at Bombay) - Cruise 3 - Cochin to Karachi to 20°N, 60°E to 40°S to 50°E to Tamatave.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production

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September '63 contd

WILLIAMSBURG - contd
Biology - contd
(C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Station every 120 miles on meridional sections, more frequently on coastal cruises. Midwater and/or surface collecting additional.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL - (Based at Bombay) Cruise B - Cochin, Laccadive Islands Maldive Islands - Cochin.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

FNS COMMANDANT ROBERT GIRAUD - Cape Guardafui to 30°S linked sections from coast to 5-600 miles out. (alternatively 1962)
Physical and Chemical Oceanography - Hydrographic stations, temperature, salinity, oxygen and direct current measurements Bab el Mandeb and Ormuz Straits. Similar to 1960 cruise completed same area same season.

ATLANTIS II - Latitudinal sections across Arabian Sea and N.W. Indian Ocean to 80°E, coordinated with scheduled observations of other nations. Also Agulhas current system from Mozambique Channel to Republic of South Africa or investigationsin Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile average intervals along approximately 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes particularly related to productivity; direct current and electrical potential measurements.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

CHAIN - N.W. Indian Ocean to 25°S, 80°E including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.

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September '63 - contd

CHAIN - contd

Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

October '63

RRS DISCOVERY III - 4 transverse sections across Arabian Sea
Hydrography and Biology - 2 stations daily-current to 200 meters; chemical, physical and biological (algal production) sampling to 500 meters at noon; Chemical, physical sampling to bottom, biological sampling (zooplankton especially) to 1,500 m. at 2200 Various trawls and net hauls to bottom periodically.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.
Meteorology - Synoptic observations and radiosonde.

WILLIAMSBURG - (Based at Bombay) - Cruise 4 - Tamatave to Reunion to 40°S, 55°E to 75°E to Cochin. Diversions to Chagos, Maldives and Laccadives.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurment of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C^{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Midwater and/or surface collecting additional.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL -(Based at Bombay) Cruise C - Cochin, Chagos Archipelago, Mauritius.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

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October '63 -(contd)

ATLANTIS II - Latitudinal sections across Arabian Sea and N.W. Indian Ocean to 80°E, coordinated with scheduled observations of other nations. Also Agulhas current system from Mozambique Channel to Republic of South Africa or investigations in Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile average intervals along approximately 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes particularly related to productivity; direct current and electrical potential measurements.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

CHAIN - N.W. Indian Ocean to 25°S, 80°E including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.
Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

NEW VESSEL (Germany) - 187 day cruise to Gulk of Aden, Arabian Sea, Persian Gulf. (alternatively 1964)
Mid October to Mid November - Straits of Bab el Mandeb and Gulf of Aden.
Biology - Intensive investigation with primary emphasis on biology - 30 days 3,000 track miles.

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November '63

RRS DISCOVERY III - Equatorial region - African coast to 78°E.
Current measurements.
Physics - Special current measurements using direct reading meters and neutrally buoyant floats at points along equator and on at least 3 meridional sections.
Chemistry - Physical and chemical sampling to 600 m. at 30 mile intervals on meridional sections.
Biology - Water sampling for chlorophyl measurement and chemical analysis; vertical net hauls to 500 m. at 30 mile intervals. Towed horizontal and oblique nets.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.
Meteorology - synoptic observations and radiosonde.

WILLIAMSBURG - (Based at Bombay) - Cruise 4 - Tamatave to Reunion to 40°S, 55°E to 75°E to Cochin. Diversions to Chagos, Maldives and Laccadives.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Midwater and/or surface collecting additional.
Meteorology - Synoptic ohservations and radiosonde.

AUXILIARY VESSEL - (Based at Bombay) Cruise C - Cochin, Chagos Archipelago, Mauritius.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 mo. studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

ATLANTIS II - Latitudinal sections across Arabian Sea and N.W. Indian Ocean to 80°E, coordinated with scheduled observations of other nations. Also Agulhas current system from Mozambique Channel to Republic of South Africa or investigations in Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile average intervals along approximately 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes particularly related to productivity; direct current and electrical potential measurements.

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November '63 - contd

ATLANTIS II - contd

Geology and Geophysics- Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

CHAIN - N.W. Indian Ocean to 25°S, 80°E including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.
Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

NEW VESSEL (Germany) - 187 day cruise to Gulf of Aden, Arabian Sea, Persian Gulf. (alternatively 1964)
Mid October to Mid November - Straits of Bab el Mandeb and Gulf of Aden.
Biology - Intensive investigation with primary emphasis on biology - 30 days 3,000 track miles
Mid November to Mid February in Arabian Sea.
Physical Oceanography - Primary emphasis on this discipline with 417 stations in 10,200 track miles.

December '63

NEW VESSEL (Germany) - 187 day cruise to Gulf of Aden, Arabian Sea, Persian Gulf. (alternatively 1964).
Mid November to Mid February in Arabian Sea.
Physical Oceanography - Primary emphasis on this discipline with 417 stations in 10,200 track miles.

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December '63 contd

HMAS DIAMANTINA - General area of operations between 0° and 45° S, 85°E and 140°E.
Biology - Primary production, zooplankton, phytoplankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

AUXILIARY VESSEL - (Based at Bombay) Cruise C - Cochin, Chagos Archipelago, Mauritius.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

ATLANTIS II - Latitudinal sections across Arabian Sea and N.W. Indian Ocean to 80°E, coordinated with scheduled observations of other nations. Also Agulhas current system from Mozambique Channel to Republic of South Africa or investigations in Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile average intervals along approximately 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes particularly related to productivity; direct current and electrical potential measurements.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

CHAIN - N.W. Indian Ocean to 25°S, 30°E including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.
Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.

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December '63 contd

CHAIN - contd

Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

UMITAKA MARU - 8°N to 32°S along 78°E - 30 days between December and March.
Biology - Investigation of animals and planets, collection of bottom specimens, plankton hauls and trawls down to 1,000 m. at stated periods, water samples for productivity analysis.
Chemistry - Dissolved oxygen and nutrient salt analysis, trace elements, etc.
Geology and Geophysics - PDR bathymetry, gravity and magnetism; bottom specimens.
Physics - General oceanographic observations to bottom at least every 150 miles, B/T's, shallow stations at intermediate points, Ekmann current meter observations in equatorial region.
Meteorology - Synoptic observation and airsea interface studies.

RYOFU MARU - 8°N to 32°S along 86°E - 30 days between December and March.
Physics and Chemistry - General oceanographic observation; current measurement; special chemical elements.
Geology and Geophysics - Subterannean heat, collection of bottom specimens; Precision sounding.
Meteorological observation.

KOYO MARU - 8 °N to 32°S along 94°E - 30 days between December and March.
Biology - Investigation of animals and plants and special chemical elements.
Geophysics - Precision Echo sounding.
Geology - Collection of bottom specimens.
Meteorological - observation.

TAKUYO MARU - 8°S to 32°S along 102°E, 8°S to 32°S along 110°E - 20 days., between December and March.
Physics and Chemistry - General oceanographic observation; current measurement; special chemical elements.
Geology and Geophysics - Precision echo sounding, collection of bottom specimens; Terrestrial magnetism.
Meteorological observations.

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December '63 - contd

KAGOSHIMA MARU - 8°S to 32°S along 106°E, 8°S to 22°S along 118°E
30 days - between December and March.
Biology - Investigation of animals and plants.
Physics and Chemistry - General oceanographic observation.
Geology and Geophysics - Precision sounding; collection of bottom specimens.
Meteorological observations.

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COORDINATOR
ROBERT G. SNIDER

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SUMMARY OF SHIP'S PROGRAMS - APPENDIX C - BY MONTH

1964

January '64

RRS DISCOVERY III - 4 transverse sections across Arabian Sea
Hydrography and Biology - 2 stations daily-current to 200 meters; chemical, physical and biological (algal production) sampling to 500 meters at noon; chemical, physical sampling to bottom, biological sampling (zooplankton especially) to 15,000 m. at 2200. Various trawls and net hauls to bottom periodically.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.
Meteorology - Synoptic observations and radiosonde.

WILLIAMSBURG (Based at Bombay) Cruise 5 - Arabian Sea and Gulf of Aden. 19 sections around the coast of the Arabian Sea from Cochin to Cape Guardafui out to 250 miles from the coast and a transverse section from Africa to India on 10°N.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Dredging and bottom trawling on continental shelf additional.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL (Based at Bombay) Cruise D - Mauritius, Seychelles, Madagascar.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

NEW VESSEL (Germany) - 187 day cruise to Gulf of Aden, Arabian Sea, Persian Gulf. (alternatively 1965)
Mid November to Mid February in Arabian Sea.
Physical Oceanography - Primary emphasis on this discipline with 417 stations in 10,200 track miles.

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January '64 (continued)

CHAIN - N.W. Indian Ocean to 25°S, 80°E including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems. Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

UMITAKA MARU- 8°N to 32°S along 78°E - 30 days between December and March.
Biology - Investigation of animals and planets, collection of bottom specimens, plankton hauls and trawls down to 1,000 m. at stated periods, water samples for productivity analysis.
Chemistry - Dissolved oxygen and nutrient salt analysis, trace elements, etc.
Geology and Geophysics - PDR bathymetry, gravity and magnetism; bottom specimens.
Physics - General oceanographic observations to bottom at least every 150 miles, B/T's, Shallow stations at intermediate points, Ekmann current meter observations in equatorial region.
Meteorology - Synoptic observation and airsea interface studies.

RYOFU MARU - 8°N to 32°S along 86°E - 30 days between December and March.
Physics and Chemistry - General oceanographic observation; current measurement; special chemical elements.
Geology and Geophysics - Subterranean heat; collection of bottom specimens; Precision sounding.
Meteorological observation.

KOYO MARU - 8°N to 32°S along 94°E - 30 days between December and March.
Biology - Investigation of animals and plants and special chemical elements.
Geophysics - Precision Echo sounding.
Geology - Collection of bottom specimens.
Meteorological observation.

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January '64 (continued)

TAKUYO MARU - 8°S to 32°S along 102°E, 8°S to 32°S along 110°E - 20 days between December and March.
Physics and Chemistry - General oceanographic observation; current measurement; special chemical elements.
Geology and Geophysics - Precision echo sounding, collection of bottom specimens; Terrestrial magnetism.
Meteorological observations

KAGOSHIMA MARU - 8°S to 32°S along 106°E, 8°S to 22°S along 118°E - 30 days between December and March.
Biology - Investigation of animals and plants.
Physics and Chemistry - General oceanographic observation.
Geology and Geophysics - Precision sounding; collection of bottom specimens.
Meteorological observations.

February '64

RRS DISCOVERY III - 4 transverse sections across Arabian Sea.
Hydrography and Biology - 2 stations daily-current to 200 meters; chemical, physical and biological (algal production) sampling to 500 meters at noon; chemical, physical sampling to bottom, biological sampling (zooplankton especially) to 15,000 m. at 2200. Various trawls and net hauls to bottom periodically.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.
Meteorology - Synoptic observations and radiosonde.

WILLIAMSBURG (Based at Bombay) Cruise 5 - Arabian Sea and Gulf of Aden. 19 sections around the coast of the Arabian Sea from Cochin to Cape Guardafui out to 250 miles from the coast and a transverse section from Africa to India on 10°N.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Dredging and bottom trawling on continental shelf additional.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL (Based at Bombay) Cruise D - Mauritius, Seychelles, Madagascar.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

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February '64 (continued)

HMAS DIAMANTINA - General area of operations between 0° and $45^{\circ}S$, $85^{\circ}E$ and $140^{\circ}E$.
Biology - Primary production, zooplankton, phytoplankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

CHAIN - N.W. Indian Ocean to $25^{\circ}S$, $80^{\circ}E$ including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems. Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

NEW VESSEL (Germany) - 187 day cruise to Gulf of Aden, Arabian Sea, Persian Gulf. (alternatively 1965)
- Mid November to Mid February in Arabian Sea.
Physical Oceanography - Primary emphasis on this discipline with 417 stations in 10,200 track miles.
- Mid February to Mid March in Persian Gulf.
Geology and Geophysics - Primary emphasis during this period.

KAGOSHIMA MARU - $8^{\circ}S$ to $32^{\circ}S$ along $106^{\circ}E$, $8^{\circ}S$ to $22^{\circ}S$ along $118^{\circ}E$ - 30 days between December and March.
Biology - Investigation of animals and plants.
Physics and Chemistry - General oceanographic observation.
Geology and Geophysics - Precision sounding; collection of bottom specimens.
Meteorological observations.

UMITAKA MARU- $8^{\circ}N$ to $32^{\circ}S$ along $78^{\circ}E$ - 30 days between December and March.
Biology - Investigation of animals and planets, collection of bottom specimens, plankton hauls and trawls down to 1,000 m. at stated periods, water samples for productivity analysis.

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February '64 (continued)

UMITAKA MARU (cont'd) — Chemistry - Dissolved oxygen and nutrient salt analysis, trace elements, etc.
Geology and Geophysics - PDR bathymetry, gravity and magnetism; bottom specimens.
Physics - General oceanographic observations to bottom at least every 150 miles, B/T's, Shallow stations at intermediate points, Ekmann current meter observations in equatorial region.
Meteorology - Synoptic observation and airsea interface studies.

RYOFU MARU - 8°N to 32°S along 86°E - 30 days between December and March.
Physics and Chemistry - General oceanographic observation; current measurement; special chemical elements.
Geology and Geophysics - Subterranean heat; collection of bottom specimens; Precision sounding.
Meteorological observation.

KOYO MARU - 8°N to 32°S along 94°E - 30 days between December and March.
Biology - Investigation of animals and plants and special chemical elements.
Geophysics - Precision Echo sounding.
Geology - Collection of bottom specimens.
Meteorological observation.

TAKUYO MARU - 8°S to 32°S along 102°E, 8°S to 32°S along 110°E - 20 days between December and March.
Physics and Chemistry - General oceanographic observation; current measurement; special chemical elements.
Geology and Geophysics=Precision echo sounding, collection of bottom specimens; Terrestrial magnetism.
Meteorological observations.

March '64

RRS DISCOVERY III - Equatorial region - African coast to 78°E. Current measurements.
Physics - Special current measurements using direct reading meters and neutrally buoyant floats at points along equator and on at least 3 meridional sections.
Chemistry - Physical and chemical sampling to 600 m. at 30 mile intervals on meridional sections.
Biology - Water sampling for chlorophyl measurement and chemical analysis; vertical net hauls to 500 m. at 30 mile intervals. Towed horizontal and oblique nets.
Geophysics - PDR bathymetry, magnetic and gravity measurements continuously.
Meteorology - synoptic observations and radiosonde.

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March '64 (continued)

WILLIAMSBURG (Based at Bombay) Cruise 5 - Arabian Sea and Gulf of Aden. 19 sections around the coast of the Arabian Sea from Cochin to Cape Guardafui out to 250 miles from the coast and a transverse section from Africa to India on 10°N.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Dredging and bottom trawling on continental shelf additional.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL (Based at Bombay) Cruise E - Madagascar, Comoros Islands, Zanzibar.
Biology and Geology - Collection and observations in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

SPENCER F. BAIRD - in Indian Ocean 15°S to 40°S between Australia and Mauritius.
Geology and Geophysics - Detailed stratigraphic and geochemical sampling in critical areas found in earlier reconnaissance cruises. Continuous precise bathymetric and magnetic studies underway. Oriented coring for paleomagnetic studies. Heat flow measurements, bottom sampling, bottom photography and sediment coring for paleoceanographic studies.
Chemistry - Atmospheric and sea surface carbon dioxide measurements.

CHAIN - N.W. Indian Ocean to 25°S, 80°E including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.
Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.
Physics and Chemistry-Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

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March '64 (continued)

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phytoplancton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

NEW VESSEL (Germany) - 187 day cruise to Gulf of Aden, Arabian Sea, Persian Gulf. (alternatively 1965)
- Mid February to Mid March in Persian Gulf.
Geology and Geophysics - Primary emphasis during this period.

KAGOSHIMA MARU - 8°S to 32°S along 106°E, 8°S to 22°S along 118°E - 30 days between December and March.
Biology - Investigation of animals and plants.
Physics and Chemistry - General oceanographic observation.
Geology and Geophysics - Precision sounding; collection of bottom specimens.
Meteorological observations.

UMITAKA MARU - 8°N to 32°S along 78°E - 30 days between December and March.
Biology - Investigation of animals and planets, collection of bottom specimens, plankton hauls and trawls down to 1,000 m. at stated periods, water samples for productivity analysis.
Chemistry - Dissolved oxygen and nutrient salt analysis, trace elements, etc.
Geology and Geophysics - PDR bathymetry, gravity and magnetism; bottom specimens.
Physics - General oceanographic observations to bottom at least every 150 miles, B/T's, Shallow stations at intermediate points, Ekmann current meter observations in equatorial region.
Meteorology - Synoptic observations and airsea interface studies.

RYOFU MARU - 8°N to 32°S along 86°E - 30 days between December and March.
Physics and Chemistry - General oceanographic observation; current measurement; special chemical elements.
Geology and Geophysics - Subterranean heat; collection of bottom specimens; Precision sounding.
Meteorological observation.

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March '64 - contd

KOYO MARU - 8°N to 32°S along 94°E - 30 days, between December and March.
Biology - Investigation of animals and plants and special chemical elements.
Geophysics - Precision Echo sounding.
Geology - Collection of bottom specimens.
Meteorological observation.

TAKUYO MARU - 8°S to 32°S along 102°E, 8°S to 32°S along 110°E - 20 days, between December and March.
Physics and Chemistry - General oceanographic observation; current measurement; special chemical elements.
Geology and Geophysics - Precision echo sounding, collection of bottom specimens; Terrestrial magnetism.
Meteorological observations.

April '64

RRS DISCOVERY III - Colombo to Suez
Geophysics on passage.

WILLIAMSBURG - (Based at Bombay - Cruise 6 - Cochin to 20°N, 65°E to 40°S to 30°E to Durban.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Mid-water and/or surface collecting additional.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL - (Based at Bombay) Cruise E - Madagascar, Comoros Islands, Zanzibar.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

SPENCER F. BAIRD - In Indian Ocean 15°S to 40°S between Australia and Mauritius.
Geology and Geophysics - Detailed stratigraphic and geochemical sampling in critical areas found in earlier reconnaissance cruises. Continuous precise bathymetric and magnetic studies underway. Oriented coring for paleomagnetic studies. Heat flow measurements, bottom sampling, bottom photography and sediment coring for paleoceanographic studies.
Chemistry - Atmospheric and sea surface carbon dioxide measurements.

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May '64

WILLIAMSBURG - (Based at Bombay) Cruise 6 - Cochin to 20°N, 65°E to 40°S to 30°E to Durban.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Station every 120 miles on meridional sections, more frequently on coastal cruises. Mid-water and/or surface collecting additional.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL - (Based at Bombay) Cruise E - Madagascar, Comoros Islands, Zanzibar.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

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Chemistry - Atmospheric and sea surface carbon dioxide measurements.

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phyto-plankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

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June '64

WILLIAMSBURG - (Based at Bombay) Cruise 7 - (Agulhas Current) Durban to Port Elizabeth to 40°S, 25°E; 5 sections within 500 miles of coast to Lourenco Marques to S. end of Madagascar to 40°S, 45°E to 30°E to Durban.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Dredging and bottom trawling on continental shelf additional.
Meteorology - Synoptic observations and radiosonde.

AUXILIARY VESSEL - (Based at Bombay) Cruise E - Madagascar, Comoros Islands, Zanzibar.
Biology and Geology - Collection and observation in and around island groups and shallow water areas. Shore parties landed on atolls for intensive 2-3 month studies. Extensive investigations of each region by Auxiliary Vessel. Small boats, dark rooms, some laboratory space, diving equipment and dredging and experimental trawling to 100 fathoms.

July '64

WILLIAMSBURG - (Based at Bombay) - Cruise 7 - (Agulhas Current) Durban to Port Elizabeth to 40°S, 25°E, 5 sections within 500 miles of coast to Lourence Marques to S. end of Madagascar to 40°S, 45°E to 30°E to Durban.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Dredging and bottom trawling on continental shelf additional.
Meteorology - Synoptic observations and radiosonde.

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phyto-plankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, General physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

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August '64

WILLIAMSBURG - (Based at Bombay) Cruise 8 - (Mozambique and Somali Currents). 10 sections from Durban to 5°N, 50°E across Mozambique Channel and to 500 miles from African coast to Zanzibar and along Kenya and Somalia coasts, thence South on 50°E to Diego Suarez and Nosy Be.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Dredging and bottom trawling on continental shelf additional.
Meteorology - Synoptic observations and radiosonde.

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phyto-plankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

September '64

WILLIAMSBURG - (Based at Bombay) Cruise 8 - (Mozambique and Somali Currents). 10 Sections from Durban to 5°N, 50°E across Mozambique Channel and to 500 miles from African coast to Zanzibar and along Kenya and Somalia coasts, thence South on 50°E to Diego Suarez and Nosy Be.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on Meridional sections, more frequently on coastal cruises. Dredging and bottom trawling on continental shelf additional.
Meteorology - Synoptic observations and radiosonde.

CHAIN - N.W. Indian Ocean to 25°S, 80°E including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.

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September '64 contd

CHAIN - contd

Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

October '64

WILLIAMSBURG - (Based at Bombay) Cruise 9 - Nosy Be to Reunion, N. on 55°E to 10°N via Seychelles diversion, to Laccadives, Maldives and Chagos for investigations, to Cochin.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production C14 technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Dredging and bottom trawling on continental shelf and island groups additional.
Meteorology - Synoptic observations and radiosonde.

CHAIN - N.W. Indian Ocean to 25°S, 80°E including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems. Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

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October '64 contd

NEW VESSEL (Germany) - 187 day cruise to Gulf of Aden, Arabian Sea, Persian Gulf. (alternatively 1963)
Mid October to Mid November - Straits of Bab el Mandeb and Gulf of Aden.
Biology - Intensive investigation with primary emphasis on biology - 30 days 3,000 track miles.

November '64

WILLIAMSBURG - (Based at Bombay) Cruise 9 - Nosy Be to Reunion, N on 55°E to 10°N via Seychelles diversion, to Laccadives, Maldives and Chagos for investigations, to Cochin.
Biology - Basic program for all cruises. Complete hydrographic stations to bottom for measurement of physical and chemical oceanographic parameters, measurement of light penetration, primary production (C_{14} technique), phyto-plankton pigments, zooplankton sampling from selected depth intervals and midwater trawl hauls. Stations every 120 miles on meridional sections, more frequently on coastal cruises. Dredging and bottom trawling on continental shelf and island groups additional.
Meteorology - Synoptic observations and radiosonde.

CHAIN - N.W. Indian Ocean to 25°S, 80°E (including Arabian Sea.)
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.
Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

NEW VESSEL (Germany) - 187 day cruise to Gulf of Aden, Arabian Sea, Persian Gulf. (Alternatively 1963).
Mid October to Mid November - Straits of Bab el Mandeb and Gulf of Aden.
Biology - Intensive investigation with primary emphasis on biology - 30 days 3,000 track miles.
Mid November to Mid February in Arabian Sea.
Physical Oceanography - Primary emphasis on this discipline with 417 stations in 10,200 track miles.

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December '64

HMAS DIAMANTINA - General area of operations between 0° and 45°S, 85°E and 140°E.
Biology - Primary production, zooplankton, phytoplankton.
Physics and Chemistry - Hydrology, water masses, circulation, light transmission, general physical oceanography, pigments, nutrient chemistry.
Meteorology - Radiosonde and radiation balance.
Geology and Geophysics - Bathymetry.

CHAIN - N.W. Indian Ocean to 25°S, 80°E including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.
Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis.
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COORDINATOR
ROBERT G. SNIDER

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SUMMARY OF SHIP'S PROGRAMS - APPENDIX C - BY MONTH

1965

January '65

NEW VESSEL (Germany) - 187 day cruise to Gulf of Aden, Arabian Sea, Persian Gulf. (alternatively 1964)
Mid November to Mid February in Arabian Sea.
Physical Oceanography - Primary emphasis on this discipline with 417 stations in 10,200 track miles.

CHAIN - N.W. Indian Ocean to 25°S, 80°E including Arabian Sea.
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Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

February '65

ATLANTIS II - Similar program to 1963 in opposite monsoon (N.W. quadrant Indian Ocean), latitudinal tracks plus either Agulhas current or Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile intervals along 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes, currents, etc.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

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February '65 contd

CHAIN - N.W. Indian Ocean to 25°S,80°E including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.
Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.
Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyze horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

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Mid November to Mid February in Arabian Sea.
Physical Oceanography - Primary emphasis on this discipline with 417 stations in 10,200 track miles.
Mid February to Mid March in Persian Gulf.
Geology and Geophysics - Primary emphasis during this period.

March '65

ATLANTIS II - Similar program to 1963 in opposite monsoon (N.W. quadrant Indian Ocean), latitudinal tracks plus either Agulhas current or Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile intervals along 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes, currents, etc.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

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March '65 - contd

CHAIN - N.W. - Indian Ocean to 25°S, 80°E including Arabian Sea.
Geology and Geophysics - Investigation of structural relationship of Madagascar to Africa, substructure of Seychelles and relationship if any with Madagascar, structure of neighboring basins and ridge systems.
Techniques of investigation will include seismic refraction and reflection, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic and gravity measurements and precise bathymetry.

Physics and Chemistry - Standard physical and chemical observations on a supplementary basis. Surface water temperature to 600 feet measured by towed thermistor chain and digital computer to measure and analyse horizontal and vertical temperature variations to study stability of surface water, internal waves and near surface sound transmission paths. Evaluation of acoustic properties of Indian Ocean.

NEW VESSEL (Germany) - 187 day cruise to Gulf of Aden, Arabian Sea, Persian Gulf. (alternatively 1964)
Mid February to Mid March in Persian Gulf.
Geology and Geophysics - Primary emphasis during this period.

April '65

ATLANTIS II - Similar Program to 1963 in opposite monsoon (N.W. quadrant Indian Ocean), latitudinal tracks plus either Agulhas current or Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile intervals along 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes, currents, etc.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

1Apr62

May '65

ATLANTIS II - Similar program to 1963 in opposite monsoon (N.W. quadrant Indian Ocean), latitudinal tracks plus either Agulhas current or Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile intervals along 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes, currents, etc.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shiboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

June '65

ATLANTIS II - Similar program to 1963 in opposite monsoon (N.W. quadrant Indian Ocean), latitudinal tracks plus either Agulhas current or Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile intervals along 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes, currents, etc.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

July '65

ATLANTIS II - Similar program to 1963 in opposite monsoon (N.W. quadrant Indian Ocean), latitudinal tracks plus either Agulhas current or Reunion Basin.
Physics and Chemistry - Approximately 400 deep hydrographic stations at 40 mile intervals along 17,500 miles of track. Special emphasis wind and thermal driven oceanic circulation, upwelling and chemical changes, currents, etc.
Geology and Geophysics - Precision echo sounding continuously, continuous seismic profiling, magnetics and gravity when feasible. Also special studies.
Meteorology - Full shipboard meteorological observations including radiosonde and radar wind coordinated with WHOI airborne meteorological investigations.

CONSEIL INTERNATIONAL DES UNIONS SCIENTIFIQUES · INTERNATIONAL COUNCIL OF SCIENTIFIC UNION
SPECIAL COMMITTEE ON OCEANIC RESEARCH
(SCOR)

INTERNATIONAL INDIAN OCEAN EXPEDITION
30 EAST 40TH STREET · NEW YORK 16, N. Y. · LEXINGTON 2-6533

COORDINATOR
ROBERT G. SNIDER

CABLES
SCORINDOC · NEWYORK

SUMMARY OF SHIP'S PROGRAMS - APPENDIX C - BY MONTH

ADDITIONAL SHIPS - NO SPECIFIC MONTHS INDICATED

PNS ALMIRANTE LACERDA
1962 and 1963 - Southwest monsoon period. Mozambique Channel. 8 sections between Mozambique and 43°E.
Physical and Chemical Oceanography.
Biology
Geology and Geophysics
Meteorology
(NOTE: No detailed program or schedule available)

NEW VESSEL FOR NOUMEA (France) -(35 m.)
Vessel under construction proposed to make Indian Ocean cruise, date, place and program unknown, enroute to Noumea.

NEW CONSTRUCTION (France) -(70 m.)
New research ship may possibly operate in Expedition. No further information.

NEW VESSEL (Thailand) - (350 tons)
This vessel may be available - if adequately equipped by early 1963 for cooperative work with adjoining countries along entire East coast of Bay of Bengal.

JALANIDHI - (650 ton Indonesian research vessel under construction)
This vessel is being constructed for use in the Indian Ocean Expedition. Completion reported August 1962. No schedule or program plans available for Indonesian shipboard operations.

HMS OWEN
1962-63)
1963-64) In Western Indian Ocean - No plans formulated.
1964-65)

INS KISTNA - (Indian Navy Frigate converted for oceanography)
1962 and 1963 - At least 6 months sea time each year in N.W. Indian Ocean and in Bay of Bengal. Primarily deep-sea cruising in both S.W. and N.E. Monsoons in both areas.
Arabian Sea - Bombay to Karachi to mouth of Persian Gulf to Bombay, E.W sections on 19°N and 17°N and on 12°N and 9°N to 52° E. Westerly section from Cochin to 5°N, 62°E - South to 10°S, to 66°E, North to 0°, to 1°N, 70°E, South to 10°S, to 74°E, North to 0° thence to Cochin.

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INS KISTNA - contd

Bay of Bengal - 7 coastal sections Madras to Burma, up to 200 miles from coast. Section on 92°E - 20°N to 12 °N and west to India. Three transverse sections to Andamans, Nicobars and Sumatra between 10°N and 5°N linked with meridional sections on 89°, 87°, 84°, 82°, 79°E between 8°N and 5°N. 5 sections NNE-SSW and NNW-SSE between 9°N and 0° starting at 77°E and going to 95°E.

Biology - Qualitative, quantitative and systematic studies of phyto and zooplankton and benthos. Primary productivity (C_{14} method) and abundance of plants and animals in relation to chemical and physical features. Related features such as dissolved oxygen, water movements and oceanic circulation, and distribution of organisms. Experimental fishing.

Physical Oceanography - Hydrographic stations to 2000 m. Surface and subsurface current measurement. Transparency and sound propagation studies. Chemistry - Standard analysis for PO_4, NO_3, SiO_4, pH, O_2 and CO_2; plus large volume sampling for radioactive isotype analysis.

Geology and Geophysics - Continuous bathymetry, sediment coring, gravity and magnetic studies, heat flow and seismic refraction in significant areas.

Meteorology - Surface observations plus upper atmosphere if equipment is available.

R/V VARUNA - (75' new fisheries research vessel)

1962 and 1963 - At least 6 months each year - both monsoons. Approximately to 1000 fathom curve on west coast of India.

Biological Oceanography - Phytoplankton, zooplankton and benthic studies; primary productivity; experimental fishing and applied fisheries research on continental shelf and adjoining areas.

Physical Oceanography - Hydrographic stations and current measurements to vessel's capacity.

Chemistry - Standard analysis of water samples.

Geology and Geophysics - Bottom samples.

Meteorology - Surface observations.

R/V CONCH (50' vessel) - Kerala University

1962 and 1963 - At least 6 months each year - both monsoons. Continental shelf to 45-50 miles from coast on west coast of India from Cochin.

Biological Oceanography - Phytoplankton, zooplankton and benthic studies; primary productivity; experimental fishing and applied fisheries research on continental shelf and adjoining areas.

M.F.V. BANGADA - (Ministry of Food and Agriculture fishing vessel)

1962 and 1963 - At least six months each year - both monsoons. Continental shelf and adjoining areas in Bay of Bengal.

Biological Oceanography - Phytoplankton, zooplankton and benthic studies; primary productivity; experimental fishing and applied fisheries research on continental shelf and adjoining areas.

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NOT YET DESIGNATED - (Naval coastal minesweeper ?)
1962 and 1963 - Available for short periods for coastal work in Bay of Bengal.
Biological Oceanography - Phytoplankton, zooplankton and benthic studies; primary productivity; experimental fishing and applied fisheries research on continental shelf and adjoining areas.

PNS ZULFIQUAR - (2,000 tons)
1962 - (months not determined) - Bay of Bengal - North of 19°N, and Arabian Sea - East of 64°N and North of 18°N. Eleven stations in Bay of Bengal, fourteen in Arabian Sea.
Pnysical and Chemical Oceanography - Hydrographic casts analysed for temperature, salinities, oxygen, nitrate, silicate, inorganic and total phosphate. Current and transparency measurements.
Biology - Primary production, plankton sampling, chlorophyl observation, sea weed samples.
Geology and Geophysics - Bathymetry, coring, dredging.
Meteorology - Surface observations and radiation.
1963 - (months not determined) - Bay of Bengal - 16°N to 21°N and 91°E to Burmese coast - 9 stations. Arabian Sea - Gulf of Oman to 66°E and 22°N to 25°N - 14 stations.
Physical and Chemical Oceanography
Biology
Geology
Meteorology
1964 - (months not determined) - Bay of Bengal - 16°N to 18°N and 84°E to 91°E - 11 stations. Arabian Sea - 18°N to22°N and 58°E to 64°E - 14 stations.
Physical and Chemical Oceanography
Biology
Geology
Meteorology

PNS MADADGAR - (1,000 tons)
Reported to participate in 1962 and 1963

FISHERIES RESEARCH VESSEL - (90 tons)
Two reported under procurement - one for West Pakistan, one for East Pakistan - coastal observations.

U.S. COAST & GEODETIC SURVEY (one Class I ship - 2-3,000 tons)
1963 or 1964 - In part of Indian Ocean which has been given inadequate attention. The USC&GS plans to participate in latter phases of Expedition and its program is flexible.

USS REQUISITE (Hydrographic Office)
This vessel has done some work in the Arabian Sea and Persian Gulf, It is reported to be participating further but no plans or schedules are available.

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USS SERRANO (Hydrographic Office)

This vessel has done some work in the Straits of Mallacca and the Andaman Sea. It is reported to be participating further but no plans or schedules are available.

U.S. WEATHER SHIPS

Time series at single location on one weather ship below Bay of Bengal on equator of basic biological chemical and physical oceanographic observations.

Meteorology

AIRPLANES & SHORE PARTIES (WHOI)

1963-5 - Coastlines of Indian Ocean - Selected areas.

Geology - Coastal geology studies of phenomena associated with extremely rapid energy changes at and near the beach. Overall reconnaissance by airplane photo time lapse technique, in conjunction with WHOI airbornemeteorological program. Field examination at selected sites of the effects of sea on selected coastal features and effect of sea state during seasonal monsoons on beach profiles and materials.

HMS DALRYMPLE

1962-63 Red Sea and Arabian coast to Persian Gulf.

Geology and Geophysics - Probably similar

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SUMMARY OF SOUTHWEST INDIAN OCEAN COORDINATING MEETING, LOURENÇO MARQUÈS, MOZAMBIQUE 30 APRIL to 2 MAY 1962

A meeting with eighteen participants representing British East Africa, France, Malagasy Republic, Portugal (Mozambique), Republic of South Africa and the United States met for three days, largely in working groups dealing with specific disciplines. A one hundred sixty-six page report, about one half of which represents the deliberations of the working groups and the balance copies of various information documents presented to the meeting, was prepared by the local Portuguese committee and distributed to addressees on the SCOR primary mailing list and to the participants. Most of the institutions planning to operate in this area were represented.

After a detailed comparison of national and institutional programs in the various disciplines, it was the consensus that coverage of the area was adequate with the exception of the region East and Southeast of Madagascar. Specific reference stations were recommended. Need for rapid exchange of data, for standardization of various techniques and the coordination of various programs was emphasized. Specific recommendations were made for a variety of issues in each of the several disciplines.

It was agreed that for successful coordination a responsible representative for each major discipline at each participating institution should be present at such meetings. Participating countries and institutions agreed to continue through direct contact their coordination and exchange of plans, personnel and data.

RGS/jas
12 September 1962