intergovernmental oceanographic commission

information paper 9

UNESCO/NS/10C/INF-63

FOREWORD

The International Indian Ocean Expedition has just been given an example to follow. The first two volumes of data reports of the IOC Co-operative Expedition EQUALANT I were recently published by the National Oceanographic Data Centre and tabled at the third session of the Intergovernmental Oceanographic Commission. Such quick action, which all marine scientists of the world will wholeheartedly welcome, became possible only as a result of thoroughly organized data exchange between the participants of the Expedition.

Every scientist participating in the IIOE will recognize that the publishing of a complete set of cruise and data reports for the whole International Indian Ocean Expedition would greatly enhance its scientific significance. Although the proper procedure for publishing IIOE reports has not yet been agreed upon internationally, timely transmission of cruise reports and data by all participating countries to WDC-A and WDC-B will undoubtedly facilitate finding such a procedure. For all the references regarding the exchange of oceanographic data resulting from the IIOE one should look into the Report of the Co-ordinating Group (document IOC/III-6) and Resolution III-11 of the last IOC session.

unesco

Unesco Office of Oceanography
Paris, September 1964

WS/0964-86-NS

IIOE INFORMATION PAPER
No. 9

1.1 Third Session of IOC

The Intergovernmental Oceanographic Commission held its Third Session from 10 to 19 June 1964, at Unesco Headquarters in Paris. Representatives from 35 Member States and 6 non-Member States and international organizations participated. Among various items discussed at the session, two items were of particular interest to the Expedition. These were Item 4, International Oceanographic Programmes (a) International Indian Ocean Expedition and Item 5, Exchange of Data and Information.

1.2 Discussion on Item 4(a) The International Indian Ocean Expedition

The Summary Report of the Meeting of the International Co-ordinating Group for the International Indian Ocean Expedition, which had been held from 23 to 27 January 1964 was introduced, as document UNESCO/IOC/III-6*, by the Chairman of the Co-ordinating Group, Dr. K. N. Fedorov, who also drew the attention of the Commission to the IIOE Information Papers Nos. 6 and 7, issued by the Secretariat (documents UNESCO/NS/IOC/INF-49 and INF-56). The Commission established an ad-hoc Co-ordinating Group composed of representatives of all the countries (among those present at the session) and international organizations interested in the IIOE. It was also agreed that the IOC Secretary would be chairman of this Working Group as, in his capacity as the International Co-ordinator of IIOE, he had also chaired the meeting of the Co-ordinating Group. The terms of reference for this ad-hoc Working Group were:

1. to consider the problems of data exchange
2. to consider the problems of publishing atlases
3. to consider the possible solution regarding the existence of a co-ordinating group after 31 December 1965
4. to report their findings to the Commission.

The Chairman further introduced the Report submitted by Dr. D. N. F. Hall, Subject Leader for the Fisheries Aspects of the IIOE (document UNESCO/IOC/INF-53 and reproduced as Annex II of this issue). It was decided that an ad-hoc Working Group of experts would review this report and inform the Commission on its findings. The Commission asked Dr. M. Ruivo of FAO to be chairman of this Group.

The Commission, after receiving the reports of the ad-hoc Groups, adopted two resolutions relating to the IIOE, these appear in Annex I of this issue.

1.3 Ad-hoc Working Group on General Problems of the IIOE Co-ordination

This ad-hoc group met on 16 June under the Chairmanship of Dr. Y. Takenouti, Assistant Secretary of the Commission. Representatives from Australia, France, Germany, India, Italy, Japan, U.K., U.S.A. and U.S.S.R. participated. FAO,

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*The contents of this document were published in IIOE Inf. Pap. No.6. The full text can be obtained from this Office on request.

ICSU, SCOR, and SCAR were also represented at the meeting.

(1) Dr. M. Ruivo, chairman of the ad-hoc Group on Fisheries Aspects of IIOE, informed participants that his group attached particular importance to the exchange of provisional data as soon as possible after the completion of cruises. If such an exchange was organized, special charts showing distribution of various parameters would be prepared by the Fisheries Subject Leader and distributed among the IIOE participants. A distinction was made between such charts prepared for immediate use and atlases which would be prepared to summarize results of the whole expedition.

(2) In connection with the problems of atlases a summary of the report to SCOR by the Working Group on Atlases (see 2.1 of this issue) was brought to the attention of the Working Group. It was recognized, however, that in the absence of experts thoroughly familiar with the preparation of atlases, discussion on this point could not be other than very general. It was understood that the period during which the data would be compiled into the atlases, would extend long beyond the official period of the Expedition and would differ according to the disciplines involved. For the preparation of atlases in meteorology and bathymetry, certain arrangements have already been made by the International Meteorological Centre in Bombay and the British Admiralty respectively and continuation of this work should be encouraged. On the other hand, before beginning preparation of the atlases, there must be agreement on more details such as, for example, size, projection, scale, etc. The Working Group felt that it would be most appropriate to invite SCOR to advise the Commission further on these scientific details so that the next Co-ordination Group Meeting might arrange to start work on the preparation of atlases. It was also noted that financial assistance from Unesco for the publication of the atlases would be necessary.

The Working Group agreed to suggest that the Commission approve the Report of the International Co-ordination Group Meeting for IIOE.

(3) The necessity of having another International Co-ordination Group Meeting was discussed, and it was agreed that, since ship operations for the Expedition would be terminated by the end of 1965, there would be no real need to continue co-ordination of ship operations. However, co-ordination of data exchange and of the preparation of atlases would become increasingly important. The major items to be included in the Provisional Agenda of the next meeting were formulated as follows:

1. Review of work to date, including reports of SCOR experts.
2. Problems of the exchange of IIOE data.
3. Work accomplished by the Fisheries Subject Leader, The International Co-ordinator for Meteorology and the Curator of the IOBC.
4. Future oceanographic work in the Indian Ocean.
5. Processing, analysis and publication of results.
6. Other problems.

The importance of circulating to national co-ordinators and SCOR experts relevant documentation on the Agenda items well in advance of the meeting was stressed by the Group.

It was also suggested that for the next meeting of the IIOE Co-ordination Group, not only national co-ordinators be invited but also representatives from interested international organizations and scientists actively participating in the study of the Indian Ocean.

The Working Group considered that various symposia on the results of IIOE, to be organized in 1964 and 1965 would provide good opportunity for informal discussion of certain problems of co-ordination. Important items, however, should be left to a formal meeting of the Co-ordination Group, this to be organized some time subsequent to the completion of the principal IIOE cruises and before the next session of IOC. This puts the most probable date for such a meeting around the autumn of 1965.

1.4 Ad-hoc Working Group on the Fisheries Aspects of the IIOE

(1) The Working Group met from 09.00 - 12.30 hours on 13 and 16 June 1964 under the chairmanship of Dr. M. Ruivo (FAO). Representatives of Australia, France, India, Italy, Japan, USA, USSR and other IOC Member States interested in the Expedition, together with representatives of FAO, UNESCO, IOC, PSA, IPFC and SCOR participated. The Subject Leader for the Fisheries Aspects of the Expedition, Dr. D. N. F. Hall, and the Curator of the IOBC, Dr. V. Hansen, were also present.

(2) The SLF introduced the subject by reviewing his report (UNESCO/IOC/INF-53). The Working Group congratulated the SLF on the excellent work done, and accepted the report as a basis for discussion on the following lines:

(a) A review of recent information
(b) The exchange of fisheries data
(c) The follow-up of the IIOE fisheries aspects
(d) The machinery to accomplish (c)

(3) A review of recent information.

The Working Group noted and made recommendations and suggestions on the following:

(a) The Nankai Regional Fisheries Research Laboratory and the Honolulu Biological Laboratory of the U.S. Bureau of Commercial Fisheries have entered into a joint plan of action to work up the catch/effort data on oceanic fishing.

(b) FAO is endeavouring to get catch/effort data relating to all fisheries in the Indian Ocean area, according to the recommendation of the 1st session of the ACMRR, with particular emphasis on long range fleet operations. Further, a system to report on catch and effort data of tuna, on a world-wide basis, is being established.

(c) The present situation respecting the SCOR Working Group on the preparation of Atlases reveals that information is coming forward too slowly. From the point of Fisheries Atlases, data on physical, chemical and biological parameters in the upper 500m. are the most relevant.

(d) Data being obtained by the two USSR vessels Orlik and Vorobiev, engaged in fishery studies in the Red Sea and the Indian Ocean,

will be made available, and information enabling track charts of the vessels to be published in the series of IIOE Information Papers, will be provided.

(e) The Curator of the IOBC stressed the need to receive samples of plankton collected by the IOSN, and the USSR was requested to speed the submission of samples. The USSR delegate agreed to this and will bring the request to the attention of the institutions concerned. In relation to the IOBC studies of tuna larvae and to contribute to the preparation of the distributional charts referred to in the SLF report, para IV.A.4, the Working Group recommended that the possibility should be explored of the secondment to IOBC for about one year of a scientist from the Nankai Laboratory or from the Inter-American Tropical Tuna Commission.

(f) The mechanism whereby surface water temperature observations made by Japanese commercial fishing vessels might reach the Colaba Observatory, is not operating as it should. The Working Group emphasised the value of this information for fisheries research and operations, and requested the IIOE meeting of National Co-ordinators to stimulate the submission of such observations.

(g) The attention of the Working Group was called to some of the recommendations of the recent meeting of the FAO Expert Panel for the Facilitation of Tuna Research (Rome, 8-12 June 1964), particularly to those concerning the collection of larvae, dissemination of catch and effort statistics, oceanography and tuna ecology. The Working Group suggested that this should be kept in mind by the SLF in developing his work.

(4) The Exchange of Fisheries Data.

(4.1) After noting the difficulties experienced by the SCOR experts in obtaining information on biological studies made by various laboratories, and that the problem of obtaining fisheries data will be even more complex, it was agreed that this process would be improved by the existence of a specialized data centre. The Working Group noted that the SLF's suggestion in paragraph IV.A.9 and IV.B. of his report, concerning the possible utilization of the EAMFRO Laboratory for the possible storage and processing of IIOE fisheries data, should be considered withdrawn, and other possibilities were discussed. Consideration was given to the possible extension for this purpose of the terms of reference of the IOBC, originally established for the analysis of the IOSN samples, but this was regarded as inadvisable.

Also considered was the Indian National Oceanographic Data Centre, recently set up by the Indian Government. It was considered, however, that it would be more beneficial if use could be made of the FAO specialized centre for fishery data, recommended at the 2nd session of ACMRR. FAO has stated that it is prepared to establish such a centre, initially for the purpose of storing the fisheries data from the IIOE, and has asked for guidance on the duties which the centre might be expected to perform.

The Working Group commends FAO for having agreed to initiate this valuable project, and recommends that the data centre should

(i) store the fisheries data (that is all the data of a fisheries-useful nature which is not stored by WDCs, such as data from biological sampling of fish catches, and those noted in para. IV.A.2. of the SLF Report)
(ii) organize, keep up-to-date, and distribute a catalogue of the data which has been deposited
(iii) furnish data under request and at cost.

(4.2) It was further recommended that the joint Working Group established by ACMRR and SCOR to study the general problem of biological data exchange (Chairman, Dr. G. Hempel) should be requested to advise FAO and IOC on the precise nature of the observations which should be considered "fisheries data" for the purpose of the operation of the data centre, and to formulate a guide to a standard procedure for the submission of data. It was suggested that FAO should take advantage of the experience of the WDCs in the storage and handling of data.

(4.3) The Working Group recommends that FAO and the SLF should take active steps to stimulate the submission of data and recommends to IOC that Governments, National and Regional Bodies concerned be urged to assist FAO in the development of the Fisheries Data Centre.

(5) Follow-up of the IIOE Fisheries Aspects.

(5.1) The dissemination of IIOE data and its presentation for fisheries research and development purposes were discussed at great length. Distinction was made between atlases as the final form of presenting the results of the Expedition, and charts summarising information for immediate use and which can be of great benefit to the development of fisheries in the Indian Ocean area. All aspects relating to the atlases should be developed as a responsibility of the International Co-ordination Group, which should, however, keep in mind the requirements of fisheries research. The Working Group strongly supported the recommendations contained in the SLF Report, para. IV.A.1 and IV.A.7 that the fisheries data should be presented in chart-form and that maximum benefit from the Expedition, from the fisheries point of view, requires that an evaluation of the gross results in the form of supplementary notes to the charts, be made at the earliest possible date.

(5.2) The Working Group considered that the national reports describing IIOE cruises would have increased value if they included reference to all fishery research operations and preliminary summaries of fisheries research results. The Working Group recommended that these reports, together with plans for future operations, should be submitted regularly to

the SLF, who should arrange for essential information to be distributed to all interested participants through the IIOE Information Papers or other speedy system.

(5.3) The Working Group recommended that full advantage should be taken of the IPFC Sessions for discussion of the Fisheries Aspects of the IIOE, and suggested that the SLF Report and the report of this Working Group be submitted for consideration at the next Session. The Working Group noted the invitation transmitted by the FAO representative that IOC observers will be welcomed at the next IPFC meeting.

(5.4) The possible impact of the IIOE as a whole, and particularly of the fishery research carried out during the Expedition, on the development of fishing activities in the area, was discussed. The Working Group noted that Special Fund Projects for fisheries development in the countries around the Indian Ocean are under consideration and recommended that during the planning of these projects, proper study should be made of the data collected during the IIOE. The Working Group recognized that the development of fisheries in the area, at an international level, is the primary concern of FAO.

(6) The machinery to accomplish the follow-up of the IIOE fisheries aspects.

(6.1) The Working Group devoted some attention to the machinery for dealing with the follow-up of the IIOE Fishery Aspects. It was the general opinion that, for this Expedition in its present stage of development, the SLF system was the most appropriate and its continuation was recommended. The Working Group, having in mind the recommendations made in the follow-up (Items 5.1 and 5.2) expressed the opinion that the SLF should work in close co-operation with FAO and relevant institutions of participant countries in the implementation of the recommendation respecting the establishment and working of the fisheries data centre of the IIOE, and that one of his main duties should be the preparation of the charts mentioned in 5.1.

(6.2) The Working Group noted that the SLF would be leaving Zanzibar permanently in December 1964, and expressed concern that he might leave the project at so critical a period. Considering the long association of Dr. Hall with the area, it was the general opinion that means should be explored to retain his services.

The Working Group recommended to IOC that UNESCO and FAO should seek means for the continuation of the work of the Fisheries Subject Leader by providing financial support either themselves or through other agencies likely to be interested in this project.

1.5 Discussion on Item 5. Exchange of Data and Information.

This includes four sub-items, which are:

(a) Report of the Working Group on Data Exchange, from 27 to 30 January 1964.
(b) Discussion on general principles of Data Exchange.
(c) Declared national programmes.
(d) International Marine Science and other publications.

Among these sub-items, the first two are of particular interest to the IIOE.

After the introduction of this agenda by the Secretary, the Chairman suggested that an ad-hoc Working Group be formed to consider the Report of the Working Group and inform the Commission of its findings.

The USSR delegate introduced the proposal of the Soviet delegation suggesting additional amendments to the Draft Provisional Guide for Oceanographic Data Exchange. He called attention to the need for a more concrete definition of the function of World Data Centres to establish relationships between these centres on the basis of equality of rights and mutual assistance.

Dr. J. B. Tait, Chairman of the IOC Working Group on Data Exchange, agreed to become chairman of the ad-hoc Working Group which would consider the Report mentioned under (a) and suggested that the same Group should also consider points (b), (c) and (d) of this agenda item.

The Chairman further asked for the views of the Commission on whether oceanographic data exchange through Data Centres should remain under the auspices of an ICSU body, namely CIG, to which the USSR delegate replied that there was no alternative at the moment.

Prof. V. G. Kort, representative of the CIG, made in this connection the following statement:

"In preparing its "Guide of International Data Exchange through the World Data Centres" the CIG was guided by the advice of various non-governmental scientific organizations responsible for various geophysical disciplines. Until now SCOR was considered by CIG as the organization responsible for Chapter X "Oceanography" of this Guide. CIG, however, recognizes that the role of national programmes in oceanography has considerably increased and that, in connection with developing international co-operation in marine science, national and governmental bodies would like to play a greater role in the exchange of oceanographic data. Therefore CIG is ready to co-operate with the Intergovernmental Oceanographic Commission on the problem of oceanographic data exchange and agrees with the desire of the IOC to bear the responsibility for maintaining on the proper scientific level the part of the Guide relating to oceanographic data exchange. In agreeing to this, the CIG takes into account the fact that the IOC has such authoritative scientific consultants as SCOR and ACMRR."

The ad-hoc Working Group met on 16 and 17 June, 1964, and reported its findings in the form of a draft resolution and suggestions for amendments of

the Provisional Guide for Exchange of Oceanographic Data. The Commission adopted the Resolution III-11, "Exchange of Oceanographic Data", approving the new text of the Provisional Guide for Exchange of Oceanographic Data. The Resolution is reproduced in Annex I of this issue.

As it appears in the Resolution, the Secretary was instructed to prepare and distribute widely, upon acceptance by CIG, a Manual on International Oceanographic Data Exchange, which includes the Provisional Guide for Exchange of Data, the introduction and general sections of the CIG Guide to International Data Exchange and other documents.

National Co-ordinators for IIOE will receive the Manual mentioned above in due course. They are requested, however, until further notice, to continue with the current system of IIOE Data Exchange, which has been already announced in the IIOE Inf. Pap. No.2 (p.3 and Annex C).

2. Recent activities of SCOR

The Executive Committee met in Paris from 8 to 9 June 1964, and among the various items discussed at the above meeting, the following were of particular interest to the IIOE.

2.1 Report to SCOR by the Working Group on Atlases

The Working Group, Chairman Mr. J. L. Reid, Jr., of SIO, has submitted the Report and this was communicated to the IOC, as mentioned in the preceding section. The Secretary was instructed to make available this report to National Co-ordinators, since it was considered to contain basic guiding principles for the preparation of atlases resulting from the Expedition. Following is the summary of the report prepared by Dr. W. S. Wooster. The full text of the Report is to be circulated to National Co-ordinators, and those who are interested in the preparation of atlases can obtain it from the Office of Oceanography, Unesco, on request.

Summary of report to SCOR by the Working Group on Atlases.

Oceanographic atlases of large areas, such as the Indian Ocean, may show unexpected features or new and different aspects of old ones. They may also bring together in maps or vertical sections, physical, chemical, biological or geological features which have not previously been related. Even when data are not sufficiently abundant or of the highest possible quality, much can be learned from their assembly in atlas form.

Decisions on the practical scientific requirements and principles of preparation of oceanographic maps must be left to the scientists concerned with their preparation. Where maps are prepared by several people, an editor and review board can ensure the application of uniform methods and standards.

The following types of atlases may be possible from IIOE data:

1. Meteorological Atlases: These can be of two types, upper air and surface, with data for the period 1963-64 averaged by calendar month

and five degree square. The upper air atlas might contain 156 charts of monthly mean resultant winds and steadiness, pressure heights, temperatures and dew points for levels of 850, 700, 500, 300, 200 and 100 mb., plus monthly mean atmospheric cross sections on selected meridians (N-S and E-W wind components, pressure heights, potential temperatures, dew points).

The surface atlas might contain 144 charts, including monthly mean resultant winds and steadiness, pressure, air and sea temperatures, cloudiness, rain frequency, incoming radiation and heat exchange.

2. Physical and Chemical Properties: A deep water atlas (below 500 - 1000 m) could include all data, regardless of season, with maps and sections of temperature, salinity, density, oxygen and other chemical properties, plus geopotential anomaly at intermediate depths. An atlas of the upper layers could be on a seasonal basis where data are sufficiently abundant (as in the Arabian Sea), and would include maps and sections of the same properties given above. Perhaps 112 pages of maps and sections would be needed for the deep water atlas, 100 pages for the atlas of the upper layers.

3. Biological Atlases: These could include maps of the following parameters, where possible by seasons: zooplankton volume, chlorophyll, C^{14} assimilation, shoals of scombriform (tuna) fishes, whales, and birds. Biological data will be worked up slowly, and data for preparation of zoogeographic atlases will not be available for at least five years. This work will require the advance preparation of bibliographies for the principal groups. Biologists should work closely with physical-chemical oceanographers and meteorologists in the preparation of atlases.

4. Geological and Geophysical Atlases: These may include maps of bathymetry, geomorphology, tectonics, bottom sediments, components such as $CaCO_3$. It is too early to make suggestions on geophysical maps.

The cost of preparing material for atlases is difficult to estimate and should be borne by the institutions concerned. Estimates of printing and binding can be based on similar existing atlases (NORPAC and the Woods Hole IGY Atlas) which could be printed in the U.S. or Japan for about $11,000 to $15,000 for 1000 copies.

3. Exchange of Data and Information.

3.1 Data Received by WDC-A by 10 June, 1964.

A table indicating data resulting from IIOE and received by WDC-A as of 10 June, 1964, has been received from the Centre and is reproduced as Annex III of this issue. For the explanation of the table, symbols, etc., readers are requested to refer to "6-monthly Catalogue of Data" which is published by the WDC-A.

We are also informed that "provisional data" of the physical and chemical station data of the following IIOE cruises have been received by WDC-A.

Australia	DIAMANTINA	Cruise	Dm 3/61
		"	Dm 1/62
		"	Dm 2/62
		"	Dm 4/62
	GASCOYNE	"	G 4/62

3.2 National Newsletter.

Germany

The Office of Oceanography, Unesco, received the booklet entitled "Internationale Indische Ozean Expedition, Forschungsschiff 'Meteor'" published by Deutsche Forschungsgemeinschaft. The contents are similar to those of Annex I of Information Paper No. 8.

India

The International Indian Ocean Expedition, Newsletter of India, No.4 and No.1 of Vol.II, have been received by this Office. They contain articles on the Indian programmes of the Expedition which are reproduced below.

From the Indian Newsletter No.4:

Indian Programme:

During the quarter, January to March, 1964 there were no cruises of INS KISTNA. As the ship had suffered some slight damage during her NOMAD operation in September 1963, she was taken to docks for repairs. The repairs have not yet been completed and it is expected that the ship will be ready towards the end of April 1964 to commence her 1964 cruises.

The R. V. VARUNA completed the post monsoon programmes by the end of 1963. Most of the time she was busily engaged in intensive fishery research programmes and could spare little time for cruises connected with IIOE. The sections comprising about 20 stations were, however, completed as part of the IIOE programme in the post monsoon period.

In order to review the progress made in the 1962-63 cruises with special reference to the problems and difficulties that have arisen in the cruises of INS KISTNA, a meeting of the Cruise Leaders and the Naval Officers was convened by the Director of the Indian Programme at Bombay in the middle of March 1964. The purpose of the meeting was also to discuss the 1964 cruising programme and finalise the details. Among the points discussed, the most important were, the ratio of cruise time to shore time so that the maximum endurance of the ship could be taken advantage of, the additional facilities by way of fitting up of new items of equipment and working facilities in the ship's laboratory etc. It was decided that in the early 1964 cruises, the effort will be concentrated in the Bay of Bengal and accordingly a cruise programme is being drawn up with extensive coverage of the east coast of India and the northern Bay of Bengal.

From the Indian Newsletter, Vol.II, No.1

Indian Programme

INS KISTNA

The INS KISTNA left Bombay on 20th May 1964 to undertake monsoon cruises of the year 1964. From May 22 to June 1, she has carried out seismic exploration studies in the Arabian Sea. Shri T. C. S. Rao of the Directorate of Scientific Research (Navy) was in charge of these studies. Scientists from the Indian Naval Physical Laboratory, Cochin, Central Water and Power Research Station, Poona, Atomic Minerals Division, Delhi and Indian Ocean Physical Oceanography Centre, Ernakulam collaborated in these studies. On the completion of these studies the ship proceeded to Madras and started a series of cruises in the Bay of Bengal. In the first three cruises, detailed studies on the continental shelf along the east coast of India will be undertaken. It is also proposed to make detailed sections along the 'Swatch of No Ground' - the Ganges submarine canyon - during the 3rd and the 4th cruises (Cruises XVII and XVIII) in the current series. The fourth cruise will be in the mid Bay of Bengal, where one or two meridional sections will be worked.

With the fitting up of the medium duty winch, it is now proposed to undertake bottom sampling with the aid of gravity corers and snappers, along the continental shelf. The dredge and trawl will also be used.

The following is the proposed programme of monsoon cruise of INS KISTNA for 1964:

Arrival	Place	Departure	Remarks
-	Bombay	20.5.64	
22.5.64	Cochin	1.6.64	for Seismic experiments.
4.6.64	Madras	8.6.64	Commence Cruise XV
20.6.64	Madras	23.6.64	Commence Cruise XVI
4.7.64	Visakhapatnam	13.7.64	Commence Cruise XVII
22.7.64	Calcutta	29.7.64	Commence Cruise XVIII
3.8.64	*Penang	7.8.64	Operational visit.
7.8.64	Langkawi	12.8.64	-
17.8.64	Madras		

*Provisional

The chart showing tracks of monsoon cruises is appended. (See Annex V)

The undermentioned are the nominees for cruises XV and XVI

Cruise Leader	
1. Dr. V. V. R. Varadachari	Physical Oceanography
Indian National Committee on Oceanic Research	
2. Shri A. B. Wagh	Biology - Plankton.
3. Shri V. N. Sankaranarayanan	Salinometry, Phosphates and Silicates sampling
4. Shri N. Jaganmohan Rao	Physical Oceanography
5. Shri L. V. Gangadhara Rao	-do-

Directorate of Scientific Research (Navy)	
6. Shri P. S. Srivastava	Waves and Swell
7. Shri J. N. Garg	Chemistry - Oxygen
Zoological Survey of India	
8. Shri K. V. Rama Rao	Biology
9. Shri Prem Kumar	-do-
Kerala University	
10. Shri A. N. P. Ummer Kutty	Biology
India Meteorological Department	
11. Shri P. L. Raman	Meteorology
12. Shri V. Natarajan	-do-
13. Shri A. L. Jog	-do-
Indian Ocean Physical Oceanography Centre (IOE)	
14. Dr. M. G. A. P. Setty	Geology

*There has been changes in the Personnel since issuing this list.

3.3 Cruise Reports

(1) Australia

H.M.A.S. DIAMANTINA

Summaries of the H.M.A.S. DIAMANTINA Cruises Dm 1/64 and 2/64 have been received from the Australian National Co-ordinator. Following is an extract of these summaries and station maps appear in Annex IV; for details of the programmes, please refer to IIOE Information Paper No.8, 1.3 Cruise Plans.

Cruise Dm 1/64. 28 January - 18 February, 1964.

Scientific Personnel

R. G. Chittleborough (Cruise Leader)
J. Prothero
L. Thomas
J. Betjeman, University of W.A.

Itinerary

28/1/64	0800	Depart Fremantle
6/2/64	0630	Arrive Fremantle
15/2/64	1330	Depart Fremantle
18/2/64	0930	Arrive Fremantle

Programme

Stations

61 stations Dml/1/64 - Dml/61/64

subsurface hyrology	at	47 stations
sediment sampling		31 stations
bottom photography		8 stations
bottom trawling		10 stations
midwater trawling		10 stations
Indian Ocean Standard net haul		7 stations

Cruise Dm 2/64. 24 March - 21 April, 1964

Scientific Personnel

D. Rochford (Cruise Leader)
F. Davies
N. Dyson
J. Prothero

Itinerary

24/3/64	0900	Depart Fremantle
6/4/64	0900	Arrive Penang
9/4/64	1400	Depart Penang
21/4/64	0800	Arrive Fremantle

Programme

Stations

42 stations	Dm2/62/64 - Dm2/103/64	
	bathythermograms at	42 stations
	subsurface hydrology	42 stations

H.M.A.S. GASCOYNE

Summaries of the H.M.A.S. GASCOYNE Cruises, G 2/64 and G 3/64 have been received from the Australian National Co-ordinator. The following is an extract from these summaries; station maps appear in Annex IV; for details of the programmes, please refer to the IIOE Information Paper No.8, 1.3 Cruise Plans.

Cruise G 2/64. 21-26 February, 1964.

Scientific Personnel

D. Vaux (Cruise Leader)
R. Bradley
L. Olsen

Itinerary

21/2/64	1600	Depart Adelaide
26/2/64	1000	Arrived Port Lincoln

Programme

Stations

35 stations	G2/81/64 - G2/115/64
	Subsurface hydrology at 35 stations.

Cruise G 3/64. 5 - 25 March, 1964.

Scientific Personnel

B. Hamon (Cruise Leader)
R. Bradley (9/3/64 - 25/3/64)
F. de Castillejo
K. Fleming

Itinerary

5/3/64	0930	Departed Adelaide
9/3/64	0830	Arrived Hobart
11/3/64	0830	Departed Hobart
14/3/64	0800	Arrived Sydney
18/3/64	1530	Departed Sydney
25/3/64	1500	Arrived Sydney

Programme

Stations

45 stations G3/116/64 - G3 160/64

bathythermograms	at	34 stations
surface sampling		18 stations
subsurface hydrology		26 stations
GEK zero check		34 stations

(2) Portugal

N.H. ALMIRANTE LACERDA

Summary of Cruise AL 1/64, from April 11 to May 21, has been received from the Portuguese National Co-ordinator. The following is an extract of this summary and a station map appears in Annex IV.

Scientific personnel:

Comdr. (EH) A. SOUSA LEITÃO (cruise leader)
Lieut. comdr. COSTA SALEMA
" BRANDÃO PEREIRA
" A. JOSÉ ROGADO
" J. PONCES ÁLVARES
Lieut. N/R M. MONTEIRO FIADEIRO
Dr. A. JORGE de FREITAS

Itinerary

11/4/64	0335	Departed Lourenço Marques
20/4/64	1425	Arrived Beira
24/4/64	1300	Departed Beira
2/5/64	0707	Arrived Nacala
6/5/64	1323	Departed Nacala

8/5/64	2146	Arrived Mocímboa da Praia
10/5/64	0715	Departed Mocímboa da Praia
14/5/64	1832	Arrived Beira
18/5/64	1837	Departed Beira
21/5/64	1600	End of oceanographic cruise
28/5/64	0235	Arrived Lourenço Marques

Station notes

BT - Bathythermogrammes

Analysis made on board:

Salinity (inductive salinometer)
Oxygen
Inorganic phosphate

Analysis on laboratory at Lourenço Marques:

Total phosphorous
Silicate
Nitrite
Nitrate

Echo sounding continuously

Zooplankton

Indian Ocean Standard net haul from 200 m.

Programme

Stations

Surface sampling	45 stations
Bathythermograms	122 stations
Subsurface sampling	45 stations
Plankton net hauls	39 stations
Tides and surface currents	4 stations

3.4 Cruise Plan

Australia

H.M.A.S. DIAMANTINA

The following is an extract of the cruise plan of the H.M.A.S. DIAMANTINA Cruise 3/64, which has been received from the Australian National Co-ordinator; a track chart appears in Annex V.

Cruise Dm 3/64. 4 May - 15 June, 1964 (42 days)

Area. As shown on accompanying chart.

From Fremantle to SCOR-UNESCO Reference Station 1, to upwelling region south of Java, to SCOR-UNESCO Reference Station 2; and Singapore.

Singapore to Bangkok
Bangkok to Singapore
Singapore to SCOR-UNESCO Reference Station 2, to upwelling region south of Java, to SCOR-UNESCO Reference Station 1, and Fremantle.

Objectives.

To study the development of upwelling south of Java (hydrology, primary production, pigments and zooplankton).

To measure non-particulate organic matter formed during photosynthesis.

To measure productivity in rich, dilute, tropical waters with a high silt load using scintillation counting. To investigate long and short wave radiation.

Stations.

At Reference and Position Stations shown on chart.

Position Stations in the upwelling region will be subject to the results achieved. Broadly, there will be three stations per day (0600, 1200 and 1800 hours S.M.T.) with the ship remaining overnight on the evening station for a repetition of the observations the following morning.

Work at Stations.

Reference Stations: (1 : 32°S., 111°50'E in 500 m
2 : 9°S., 105°E)

Hydrological sampling to the bottom for temperature, salinity, oxygen, nitrate, inorganic phosphate and total phosphorous.

Sampling to 150 m for primary production and pigments.

Zooplankton sampling to 200 m by Indian Ocean standard net.

Wind speed, air temperature and sea and sky state observations.

Position Stations: (Indian Ocean)

Hydrological sampling to 500 m for temperature; salinity, oxygen, nitrate, inorganic phosphate and total phosphorous.

Sampling to 150 m for primary production and pigments.

Sampling to 150 m for phytoplankton counting and identification.

Zooplankton sampling to 200 m by Indian Ocean standard net.

Wind speed, air temperature and sea and sky state observations.

Position Stations: (Gulf of Thailand)

Hydrological sampling to the bottom for temperature, salinity, oxygen, nitrate, inorganic phosphate and total phosphorus.

Sampling to 150 m for primary production and pigments.

Sampling to 150 m for primary production by scintillation counting.

Wind speed, air temperature, sea and sky state observations.

Personnel:

H. Jitts (Cruise Leader)
J. Klye
C. Middleton
B. Scott
J. Stevenson (C.S.I.R.O., Division of Meteorological Physics)
D. Subba Rao
Thai Scientist (Singapore-Bangkok-Singapore)

Probable Itinerary:

Depart Fremantle	May 4
Arrive Singapore	" 18
Depart Singapore	" 21
Arrive Bangkok	" 24
Depart Bangkok	" 26
Arrive Singapore	" 29
Depart Singapore	June 1
Arrive Fremantle	" 15

Sampling and Observations:

Hydrology:

(A) Nansen bottle sampling to the bottom.

1. South of 20°S : 0, 25, 50, 75, 100, 150, 200, 300, 500, 700, 900, 1100, 1300, and 1500 m and then at 500 m intervals to the bottom.

2. North of 20°S : As for 1 with additional samples at 125, 250 and 400 m.

Samples for salinity, oxygen, nitrate and inorganic phosphate at all depths.

Samples for total phosphorous at 0, 50, 100, 200, 300, 500, 700, 900, 1100, 1300, and 1500 m and then at 500 m intervals to the bottom.

(B) Nansen bottle sampling to 500 m.

0, 25, 50, 75, 100, 125, 150, 200, 250, 300, 400 and 500 m.

Samples for salinity, oxygen, nitrate and inorganic phosphate at all depths.

Samples for total phosphorous at 0, 50, 100, 200, 300 and 500 m.

Physics:

Bathythermograph cast to 274 m.
Echo sounding continuously.
Meteorological reports on station.

Phytoplankton:

At stations in the upwelling region 5 litre samples at 0, 25, 50, 75, 100 and 150 m for counting and identification of species.

Zooplankton:

Indian Ocean Standard net haul from 200 m.

Primary Production:

Twin 6 litre samples at 0, 25, 50, 75, 100 and 150 m for incubation at 1100 foot candles in fluorescent light bath. Additional samples at Position Stations for measurements with simulated in situ incubator. Additional samples at Position Stations for measurements of dissolved organic matter produced during photosynthesis; with solid phosphor scintillation counter.

Biochemistry:

5 litre samples at 0, 25, 50, 75, 100 and 150 m for pigment determination.

Laboratory Work:

Shipboard

Hydrology: Salinity, oxygen, inorganic phosphate and total phosphorous determinations.

Phytoplankton: Centrifugation and settling; microscopic examination of samples.

Zooplankton: Concentration and storage of samples.

Primary Production: Incubation in simulated in situ and fluorescent baths; filtration Geiger and scintillation counting of samples.

Biochemistry: Filtration and drying of samples over silica gel. Storage of filters over silica gel in the refrigerator.

Cronulla

Hydrology: Determination of nitrate by strychnidine method.

Biochemistry: Spectrophotometric measurement.

Cochin (I.O.B.C.)

Zooplankton: Taxonomic studies.

3.5 Correction for "LIST OF IIOE CRUISES" IIOE Inf. Pap. No.8, Annex II

Country	Ship	for	read	in column
PORTUGAL	Lacerda	IV-V/64	11/IV-28/V/64	Period

4. Meteorology Programme.

News from the Scientific Director's Office, IIOE Meteorology Programme No.11, June 1964, has been received. The following is an extract of this newsletter.

The NOMAD automatic weather buoy has been anchored in the Bay of Bengal and is now transmitting weather reports at 6-hourly intervals. At the International Meteorological Centre back plotting staff has been augmented. The computer is now being operated on a two-shift basis. A limited number of monthly mean resultant wind charts of the Indian Ocean region have been distributed.

NOMAD

At dawn on 24 April the SAGARDEEP, a new lighthouse tender of the Indian Department of Lighthouses and Lightships hove to at 12°37'N, 86°3'E, in a dead calm sea with the U.S. Navy's NOMAD aboard. Launching began at 0730, the anchor was dropped at 1020 and what might have been a ticklish operation was carried out with smooth dispatch. NOMAD is now broadcasting regularly every six hours coded synoptic observations of wind, air temperature sea temperature and pressure. Located near the centre of a region seldom traversed by ships but frequently the site of tropical cyclone development, NOMAD should provide invaluable information not otherwise obtainable.

INTERNATIONAL METEOROLOGICAL CENTRE

Staff

Six more observers have joined the US group in Bombay. They will be primarily engaged in back plotting the master charts, using mailed manuscript data. The surprising quantity of these data has necessitated the increase.

IMC has given a limited distribution to its second pre-published report, "Analyses of monthly mean resultant winds for standard pressure levels over the Indian Ocean and adjoining continental areas" by C. R. V. Raman and C. M. Dixit. Part I of the report describes the charts and calls attention to significant distributions. Part II consists of 60 charts showing the mean monthly resultant winds for all available stations between 20°E and 155°E and 45°N and 50°S, analyzed by streamlines for the levels 850 mb, 700 mb, 500 mb, 300 mb, and 200 mb. The charts usefully contribute to the present analysis programme at IMC. Shortly after the end of IIOE additional data collected during the expedition will be meshed with those already available to produce a definitive set of mean charts which will be given wide distribution.

Since the last News all computer data processing programmes have been checked out with sample punch card sets of data. The computer can now check radiosonde, rawin, surface ship and surface island station observations. A two-shift schedule began on 1 June. For about two to three hours on each shift the computer will be

used to process all types of data punched on cards. The remainder of the time it will be used to check out programmes and to make research computations. By the end of June it is estimated that 280,000 cards will have been punched at IIC.

A paper by Miller and Suryanarayana on Sea-Air Heat Exchange was presented by the latter at a meeting in Calcutta.

5. The Indian Ocean Biological Centre

5.1 Dr. Vagn Hansen, Curator of IOBC, has reported on the samples received by the Centre in May, 1964. These are:

Date of receipt	Ship	Cruise No.	Total No. of samples	Station Nos.
1	ANTON BRUUN	V	45	282-245
9	DISCOVERY		34	5006 and 5124-5371
26	OSHORO MARU	4	13	OS 1-13
29	PIONEER	Opr.442 Leg. V	19	2-23
Total number of samples			111	

Dr. Hansen also reported that six stations have been operated by IOBC for productivity study, 2 off Cochin and 4 in the backwaters.

5.2 Scientists to visit IOBC, Ernakulam

By agreement between Unesco, the Israeli National Committee on Oceanic Research and the Indian National Committee on Oceanic Research, arrangements have been made for Dr. Kimor (Sea Fisheries Research Station, Haifa) and Miss Lerner (Department of Zoology, Hebrew University, Jerusalem) to study at the Indian Ocean Biological Centre, Ernakulam. These scientists are expected to examine some of the material collected with the Indian Ocean Standard Net as well as to make field studies in the vicinity of Cochin. It is anticipated that other countries will soon participate in this study plan.

6. Tide Gauges in the Indian Ocean.

At the Third Session of IOC, the Permanent Service for Mean Sea Level distributed a document entitled "A Global Network of Tide Gauge Stations". This was in the form of charts and an index and represented their understanding of the position on 19th February, 1964. The index for the Indian Ocean is reproduced below and the chart can be obtained from this Office on request.

> Each station marked on the chart has a country/station code number. Stations indicated as awaiting a gauge installation may now be in operation; some of the proposed installations may equally as well have been cancelled. Some installations are of a temporary character. The INDEX is in a geographical order proceeding along coastlines; the combination of individual country and station code numbers enables the

identification of gauge sites shown on the charts. The entry "most recent data received" refers to the situation on 19th February, 1964; the absence of data for two or more years may indicate the station is no longer operational, though the more usual explanation is that the task of reducing the data to mean values is not or cannot be given a sufficiently high priority by the station authority.

Installations have been omitted, from both charts and index, in those cases where it has been felt that the sites were so far up an estuary that the sea level recordings would not be representative of conditions at the open coast.

INDEX OF TIDE GAUGE STATIONS IN THE INDIAN OCEAN

Country		Port	Recent data received	Remarks
430	SOUTH AFRICA	1 Walvis Bay	1962	
		11 Luderitz	1962	
		21 Port Nolloth	1962	
		31 Stompneus Bay	1962	Discontinued, to be resited at Gordons Bay
		36 Saldanha Bay		
		41 Robben Island	1959	Gauge removed to Knysna
		51 Table Bay Harbour	1962	
		53 Alfred Basin		
		55 Hout Bay Harbour		
		61 Simons Bay	1962	
		71 Hermanus	1962	
		81 Mossel Bay	1962	
		86 Knysna	1962	
		88 Port Elizabeth	1960	
		90 East London		
		91 Durban		
432	MOZAMBIQUE	1 Lourenço Marques		
		11 Beira		Destroyed, to be re-installed.
		21 Mozambique Island		
439	COMORO ISLANDS	1 Comoro Island		To be installed
440	MADAGASCAR	1 Nosy-Bé	1960	
442	SEYCHELLES	1 Mahe Island (Port Victoria)	1962	
450	MAURITIUS	1 Grand Port		Installation damaged by hurricane in 1960, to be re-installed in 1964
453	CHAGOS ARCHIPELAGO	1 Diego Garcia	1962	
454	MALDIVE ISLANDS	1 Addu Atoll	1962	

Country	Port	Recent data received	Remarks
455 LACCADIVE ISLANDS	11 Minicoy Island		Installed late 1963
460 TANGANYIKA	1 Mtwara	1962	
	11 Dar-es-Salaam	1962	
	21 Tanga		Installed July 1962
470 KENYA	11 Mombasa (Kilindini)		Installed 1961
475 SOMALIA	1 Guiba (River Entrance)		Installation abandoned?
	11 Mogadiscio		To be installed
477 BRITISH SOMALILAND	21 Zeila		Installation abandoned?
485 ADEN PROTECTORATE	1 Aden	1963	
	11 Mukalla		Installation abandoned?
487 MUSCAT AND OMAN	1 Salala		Installation abandoned?
	11 Masirah	1962	
490 PAKISTAN (West)	1 Gwadar		To be installed
	21 Karachi	1962	
500 INDIA	1 Mundra	1959	Discontinued
	11 Kandla	1961	
	21 Veraval	1961	
	31 Bhaunagar	1961	
	41 Bombay (Apollo Bandar)	1961	
	61 Ratnagiri	1958	
	71 Mangalore	1961	
	81 Cochin	1961	
	91 Madras	1961	
	101 Visakhapatnam	1961	
	111 Saugor	1961	
	131 Diamond Harbour	1961	
	141 Calcutta (Garden Reach)	1961	
510 PAKISTAN (East)	11 Chittagong (Sadarghat)	1961	
	21 Chittagong (Patenga Point)	1960	
	23 Chittagong (T.M. Compound)	1962	
	25 Chittagong (Juldia)	1962	
	31 St.Martins Island		To be installed
520 CEYLON	1 Colombo	1957	
	11 Galle		To be installed
	21 Trincomalee		To be installed
	31 Jaffna		To be installed

Country	Port	Recent data received	Remarks
540 ANDAMAN ISLANDS	1 Port Blair	1961	
560 INDONESIA	12 Tjalang		To be installed
	22 Padang		To be installed
	41 Benkoelen		To be installed
	52 Genteng		To be installed
	121 Tjilatjap		To be installed
	142 Benoa		To be installed
562 COCOS ISLANDS	1 Cocos Island	1962	
563 CHRISTMAS ISLANDS	1 Christmas Island	1962	
600 THAILAND	1 Ko Ta-Phao Noi (Phuket)	1961	
	21 Phrachuap Kirikhan	1961	
	31 Bangkok Bar	1961	
	41 Fort Phra Chula Chomklao	1960	
	61 Ko Sichang	1961	
605 MALAYA	41 Singapore	1961	
680 AUSTRALIA	4 Wyndham		
	11 Darwin	1962	
	18 Karumba	1960	
	181 Williamstown (Melbourne)	1962	
	193 Burnie, Tasmania		
	195 Devonport, Tasmania		
	201 Hobart, Tasmania	1962	
	225 Geelong		
	226 Point Lonsdale		
	241 Port Macdonnell	1962	
	306 Port Adelaide (Outer Harbour)		
	381 Wallaroo		
	391 Port Pirie		
	431 Port Lincoln		
	441 Thevenard	1960	
	451 Albany	1962	
	461 Bunbury	1962	
	471 Fremantle	1962	
	474 Geraldtown		
	481 Port Hedland	1962	
A ANTARCTIC	1 Bahia Esperanza	1959	
	3 Argentine Islands	1961	

Country	Port	Recent data received	Remarks
A ANTARCTIC (Contd)	7 South Georgia		Proposed
	8 Gough Island		Proposed
	9 Tristan de Cunha		Proposed
	10 Falkland Islands		Proposed
	11 Chatham Islands		Proposed
	12 Antipodes Island or Bounty Island		Proposed
	13 Campbell Island		Proposed
	14 Macquarie Island		Proposed
	15 New Amsterdam		Proposed
	16 Iles de Kerguelen		Proposed
	17 Iles Crozet		Proposed
	18 Marion Island		Proposed

7. Miscellaneous

7.1 A memorandum from Dr. R. Serène, Unesco Regional Marine Animals Taxonomy Expert in Southeast Asia has been received by the Office, referring to his conversation with Dr. Ronwall, Director of The Zoological Survey of India, Calcutta. The following is an extract from this memorandum:

> It is not the main aim of the IIOE to provide a survey of the marine fauna of the Indian Ocean. However (excluding the planktonic organisms, which are actually so intensely studied) some participating countries to IIOE have included in their programmes some biological (animal) collections, resulting from fishing operations: nets, long lines, trawl, dredge, shore stations, etc....
>
> It seems that during 1963 and more during 1964 this faunal aspect has and will occur more often. An indication of this is the organisation by the Smithsonian Institution of a sorting centre in U.S.N.M. Washington, which is to a great extent actually devoted to sorting Indian Ocean Material. In many ways certain other countries will profit from the facilities offered by their own Indian Ocean cruises to increase their collections and knowledge of Indian marine fauna. The IIOE will create in any case a new focus of interest in this fauna. This very wide field cannot be co-ordinated at the international level, being sometimes difficult to co-ordinate at the national level. The collecting and distributing of reprints on IIOE results (now underway) is probably the only but possible step to attain co-operation in place of co-ordination.
>
> But in the field of taxonomy some actions seem to have an essential and basic value.
>
> The marine fauna of India had been usually studied in the past by the Zoological Survey of India and the type specimens deposited and curated in its collections at Calcutta. At the present stage of our taxonomic knowledge of the Indian Ocean fauna, it is still essential to use the type system.

The utilisation by the Smithsonian Sorting Centre of identification sheets established by references to the literature only, is an indication that the classic type system is still considered necessary.

The catalogue of the types of Indian Ocean species deposited in the Calcutta collections is today already prepared as a part of the key catalogue of types of the "Humid Tropic" project. The National Indian Committee for the IIOE could perhaps request the Zoological Survey of India to urge the publication of those marine fauna species types in connection with IIOE needs and provide the Zoological Survey with necessary assistance. This publication would be a very valuable contribution given by India to all the world scientists interested. This catalogue would be only a list. But considering the actual state of the literature referring to those species (published 1890-1920), it would be better to complement in some cases this catalogue with a photographic catalogue of the types. This more ambitious project would be more expensive.

The case of Brachyura only has been examined in detail as an example.

a) There are, in the Calcutta collection, about 300 species types; few museums in the world have actually so large a collection. The total of the Brachyura species for the world does not reach 1500.

b) The catalogue is already established.

c) The photographs could be taken by the staff, with some training, in a period of 3 months.

d) The organization of the plates for printing and the printing in a period of 4 or 5 months; I could spend myself some weeks (4 or 5) in assisting the staff in organising the photographic and plate printing work.

e) The publication expenses will be approximately US $2,000 for 500 copies, referring to the figures received in Calcutta. The presentation should be in the form (size) of "Memoirs of the Indian Museum." 50 photograph plates with 6 species types by plate (total 300 types).

f) Dr. Panikkar, I seem to remember, offered during the IOBC meeting to provide for covering some of the expenses on printing matter about Indian Ocean material.

The National Indian Committee for IIOE could perhaps ask UNESCO to assist this work of the Zoological Survey of India as a joint project, requesting financial help of, for example, US $1,000 from UNESCO.

7.2 Recent Publications in respect of the IIOE.

(1) The International Geophysics Bulletin, No.83, May 1964 (Transaction of the American Geophysical Union, Vol.45, No.2) contains an article "Progress of the International Indian Ocean Expedition". This is a summary of progress to date, achieved by the participating countries of the Expedition, and is prepared by Dr. I. E. Wallen, Assistant Director for Oceanography, Museum of Natural History, Smithsonian Institution.

(2) "Meteorology in the International Indian Ocean Expedition" with the sub-title "Ships and Planes are Exploring the Largest Single Wind System on Earth", written by Prof. Colin S. Ramage, Scientific Director for IIOE Meteorological Programme, has appeared in "Explorers Journal" Vol.42, No.2, July 1964. This article deals with the meteorology programme of IIOE, the work of the International Meteorological Centre in Bombay, work of four airplanes of the U.S. Weather Bureau's Research Flight Facilities over the Indian Ocean and meteorological information obtained by TIROS weather satellites.

7.3 Information on unusual phenomena in the Bay of Bengal

This Office has received a copy of a letter from Mr. John F. Cronin, U.S. Air Force Cambridge Research Laboratories, addressed to Mr. J. A. Tubb, Regional Fisheries Officer for Asia and the Far East of FAO. An extract of the letter is reproduced below:

> "We are investigating an unusual series of photographs taken by a TIROS meteorological satellite over the Bay of Bengal on 24 June 1962. If there exists oceanographic data, observations, etc., indicating unusual seas, turbid waters, upwelling, fish kill, change in color, etc. in the Bay of Bengal between 23 June and 30 June, could a copy of such information be loaned or sent to me."

Any pertinent information, sent to Mr. Cronin direct, will be highly appreciated. His address is as follows:

Mr. John F. Cronin,
Geotechnics Branch,
Terrestrial Sciences Laboratory,
Air Force Cambridge Research Laboratories,
Office of Aerospace Research,
Bedford, Massachusetts 01731,
U.S.A.

ANNEX I

Resolutions relating to the Expedition adopted by the Intergovernmental Oceanographic Commission at its Third Session.

RESOLUTION III-2
INTERNATIONAL INDIAN OCEAN EXPEDITION

The Intergovernmental Oceanographic Commission

Approves the Report of the Meeting of the International Co-ordination Group for the International Indian Ocean Expedition as a basis for the future guidelines for co-ordination of the Expedition,

Authorizes the Secretary to take immediate action as recommended in this Report,

Takes note with appreciation of the preliminary report of the SCOR Working Group on Atlases,

Authorizes the Secretary to make available this report to National Co-ordinators,

Invites SCOR to provide further advice as would be needed in the course of preparation of atlases incorporating the results of the Expedition,

Resolves

1. That the next meeting of this Co-ordination Group be convened before the next session of IOC,

2. That an invitation to this meeting be extended to National Co-ordinators, to representatives from interested international organizations and to scientists actively participating in the scientific work of the Expedition, and

3. That this group be charged with the task of working out and reporting to the Commission on the future work in the Indian Ocean after the termination of the present field work of the Expedition. It will study particularly the problems relating to the exchange of data, the publication of atlases and results of observations for the Indian Ocean and other problems concerning the Co-ordination of the Expedition.

RESOLUTION III-3
FISHERIES ASPECTS OF THE IIOE

The Intergovernmental Oceanographic Commission

Having considered the recommendations contained in the Report by the Subject Leader for the Fisheries Aspects of the International Indian Ocean Expedition (SLF), the conclusions of the ad hoc working group on the subject and the value of the Indian Ocean Biological Centre regarding the studies of tuna larvae,

Suggests that the Secretariat of FAO explore the possibility of arranging the secondment to the IOBC for about one year of a specialist in tuna larvae from the Nankai Regional Fisheries Research Laboratory or from the Inter-American Tropical Tuna Commission,

Recognizing that the collection of fisheries data would be improved by the existence of a specialized data centre, and that the proper storage and retrieval of fisheries data will become increasingly important to international and regional co-operative research,

Being informed that FAO is prepared to establish in accordance with the Second Session of ACMRR Recommendations a fishery data centre, initially for the purposes of storing IIOE fisheries data,

Commends FAO for having agreed to initiate this valuable project, and

Recommends that the FAO data centre should : (i) store fisheries data, (ii) organise, keep up-to-date and distribute a catalogue of deposited data, (iii) furnish data under request and at cost, and

Urges Governments, National and Regional Bodies, to assist FAO in the development of the Fisheries Data Centre.

Noting further the conclusions of the ad hoc Working Group on the follow-up of the fisheries aspects of the IIOE and the possible impact of the IIOE as a whole, and particularly of the fisheries research carried out during the Expedition on the development of fisheries in the area,

Adopts the recommendation of the ad hoc Working Group on the dissemination of fisheries data of immediate use in chart form and its early evaluation, and also

Adopts the recommendations of the ad hoc Working Group on the submission of national reports and the speedy dissemination of the fisheries information they contain.

Noting the usefulness of the IPFC Sessions as a forum for the discussion of fisheries matters,

Recommends that full advantage be taken of the next session of IPFC (Kuala Lumpur, October 1964) for the discussion of the SLF Report and the Report of the ad hoc Working Group, and

Noting the invitation transmitted by the FAO representative that observers will be welcomed,

Requests the Bureau of IOC to nominate observers to that meeting.

Appreciating that, for the Expedition in its present stage of development, the SLF system is an appropriate method for dealing with the follow-up of the fisheries aspects of the IIOE, and

Appreciating the desirability that the SLF should work in close co-operation with FAO and regional and national institutions concerned in the operation of the centre for the fisheries data of the IIOE and that one of his main duries should be the preparation of the fisheries charts,

Requests Unesco and FAO to seek means for the continuation of the work of the SLF by providing financial support either themselves or through other agencies likely to be interested in this project.

RESOLUTION III-11
EXCHANGE OF OCEANOGRAPHIC DATA

The Intergovernmental Oceanographic Commission

Desiring to foster the full and expeditious exchange of oceanographic data,

Recognizing that this desire is closely related to the intention of IOC Members to co-operate in joint scientific study of the oceans,

Recognizing further that this intention expresses itself either in participation of IOC Members in international co-operative expeditions or in declaring publicly their own national oceanographic programmes with a view to exchanging data resulting therefrom,

Recognizing the special interest of Members in the organization and operation of World Data Centres and specialized and regional centres for the collection and exchange of oceanographic data, in accordance with the principles of equality of rights and mutual assistance,

Resolves (1) to approve the new text of the Provisional Guide for Exchange of Oceanographic Data as prepared by the IOC Working Group in co-operation with SCOR;

(2) to submit it for inclusion into the General CIG Guide to International Data Exchange through the World Data Centres; and

(3) to keep it under constant review by the Commission's working group in co-operation and consultation with SCOR and ACMRR.

Recommends that all scientific data originating from "declared national oceanographic programmes" and "international co-operative oceanographic expeditions" (as defined in the above Provisional Guide), comprising results of observations and measurements by ships and recording stations outside territorial waters, as well as sea level observations, be exchanged by the methods and under the definitions and specifications prescribed in the above Provisional Guide for Exchange of Oceanographic Data, commencing with 1 January 1960.

Recommends that in view of the great scientific value of long time series records, mean sea level observations should be reported back to the time of establishment of the gauge wherever practicable.

Resolves that upon acceptance by CIG, the principal documents regulating the exchange of oceanographic data between Members will be the present resolution, the Provisional Guide for Exchange of Oceanographic Data approved herein, the introduction and general sections of the CIG Guide to International Data Exchange, and associated recommendations of the Commission's Working Group on Oceanographic Data Exchange,

Instructs the Secretary to prepare and distribute widely a Manual on International Oceanographic Data Exchange which will include the documents mentioned in the preceding paragraph, lists of national and specialized oceanographic data centres together with their addresses, methods of operation and services and facilities available, and such other information as will be useful in facilitating the full and expeditious exchange of oceanographic data,

Recommends that the Commission, through its Secretary, communicate the present resolution and associated documents to the CIG, at the same time indicating its desire to be represented on that body.

ANNEX II

Report by the Subject Leader for the Fishery Aspects of the Expedition

PART I - Introduction

Following preliminary discussions in Paris during February 1963, of which an account has been circulated, arrangements were made for the SLF to make an extensive tour of the countries surrounding the Indian Ocean. The objects of the tour were to determine precisely what are the existing fisheries of the Indian Ocean and the degree of importance each country places on them, the potentialities, the means of developing the potentialities, and such other information which will enable the greatest benefit to be secured from the Expedition to the fisheries of the area. Apart from ten days spent in Zanzibar, the tour occupied four months, from 23 July to 15 November, during which period the SLF visited South Africa, Mozambique, East Africa, Somalia, Aden, West Pakistan, India, Ceylon, East Pakistan, Burma, Thailand, Malaya, Singapore, Indonesia, Australia, Japan, Hong Kong, Mauritius and Madagascar.

It is obvious that no single tour of this nature can uncover every feature of the various problems involved, but a great quantity of essential information and revealing impressions was obtained. That it was possible to do so much in such a short time is due entirely to the help which was received everywhere. The information is summarized briefly in Part II, and is the basis for the recommendations in Part IV.

PART II - Situation Report.

It is a not uncommon assumption that the existence of a potential marine fishery implies that there is anxiety for its development; and that a deficiency of proteins in the diet, or the ready availability of cheap fish, implies a population eager to eat marine fish. These assumptions are understandable, but untrue.

The exploitation of marine resources usually requires capital investment on a scale much greater than that required to develop freshwater resources. It is to be expected, therefore, that a country might be reluctant to make an investment in a marine fishery when the same investment in a freshwater fishery might yield a greater return. Countries around the Indian Ocean having extensive freshwater fisheries are East Pakistan, Burma and Tanganyika. In Tanganyika, where the rainfall is generally low, inland centres of population tend to live close to areas of freshwater: dried marine fish from the coast has little chance of competing with fresh fish straight from a river or a lake.

Feeding is largely a question of habit, and, by habit, the population of some countries around the Indian Ocean are not extensive fish eaters. This applies particularly to Australia and to the African continent: in some parts of the African continent where protein deficiency occurs, even so marine fish are still actively avoided.

Features such as these influence considerably the degree of importance with which governments regard the development of marine resources.

South Africa

Latitude 20°E, the accepted western limit of the southern Indian Ocean, crosses the western end of the Agulhas Bank. The major fisheries of South Africa are all to the west of this line, and, apart from the fishery for the pilchard, Sardinops ocellata, are demersal in nature.

To the east of latitude 20°E, the commercial fisheries are also largely demersal. Of these, the Agulhas Bank trawl fishery is the most important, but although the Bank is 120 miles wide, almost all the effort is confined to within 40 miles of the coast. Elsewhere, handlining and small boat trawling are important whilst off Natal the lobster Palinurus gilchristi forms a useful catch. (The only South African crustacean of real economic importance is of course the Cape Crayfish, Jasus lalandii, which occurs only irregularly east of 20°E.)

South Africa's biggest fishing company has co-operated in an 18-month investigation of the tuna (deep longline) potential, and currently has one vessel operating deep longline gear as a commercial exercise.

Off the coast of Natal the continental shelf is much narrower than off the south coast, and interest in pelagic fish is greater. Shoals of Sardinops migrate northwards from Cape Province, accompanied by a variety of predators: trolling, and particularly shore seines, make a valuable catch. However, in view of the dominance of the demersal fisheries and the reasonable belief that the present catch from the Agulhas Bank is below the highest sustainable, the current development is entirely in the demersal fisheries. Possible lines of future development are: (1) anchovies and sardines, (2) surface shoaling tunas, (3) oceanic tunas, (4) sharks, (5) midwater and bottom prawns. With the exception of (3), fisheries developing along any of these lines would be within 40 miles of the coast.

South Africa, with its well developed research centres, is well able to handle data in any form. It is considered that IIOE data can be of little assistance to the existing fisheries, but it may be of great use in long term planning.

Mozambique.

The continental shelf is extensive only in the bight north and south of Beira. At present, fishing throughout Mozambique is not extensive due largely to the lack of expertise. The most important fisheries are all for demersal species: the most important single fishery is trawling for the rock-lobster Palinurus gilchristi in depths down to 80 fm., a fishery which extends from north of Lourenço Marques to Durban. Handline fishing is undertaken by Portuguese who operate along all the coast north of Lourenço Marques: old trawlers which stay at sea for 3-5 days are used. This technique is used also by Africans who undertake daily trips in small sailing craft, and on rafts made from the midrib of palm fronds. Prawn (Penaeidae) and the crab Scylla serrata are locally important.

Current development is aimed at increasing the catches of crustaceans, and, in addition to one certain new cannery, four more are under consideration, exclusively for prawns (Penaeidae) crabs and lobsters.

Mozambique has one marine research station, sited on Inhaca Island, but it has no permanent staff dealing with fisheries research.

It is unlikely that the IIOE can assist materially the existing fisheries, but the data can be an essential element in future planning, particularly if recommendations on likely lines of development are included.

East Africa (Tanganyika, Kenya, Zanzibar).

The continental shelf is very narrow, mostly less than five miles wide, and in parts less than two miles wide: there is an almost continuous fringing coral reef. Traditional fishing techniques predominate along the entire East African coast. Handline fishing from sail driven craft, a high proportion of which are outrigger dug-out canoes, the trapping of migratory species of Scomberomorus by means of fishing stakes and fixed nets, and the use of a variety of pots are important techniques.

It is generally appreciated that the demersal marine potential is slight, and recently (1961), stimulated by EAMFRO, purse seining brightly illuminated areas at night for sardines was introduced, while even more recently purse seine operations against surface shoaling tunas were started. These operations were by a company sponsored by the Zanzibar Government, and, as a result of the revolution, are now suspended.

Despite this setback, it is likely that the most important immediate developments will be purse seining activities, by one or other of the mainland countries if not by Zanzibar. Deep longline operations for tuna and marlin are also a likely line of development, particularly off Kenya.

The Rufiji Delta is the most northerly large area along the east coast of Africa for commercially important prawns (Penaeidae), and Tanganyika is anxious to develop prawn trawling.

Each of the East African Territories has a department dealing with fisheries, and Zanzibar is the site of the inter-Territorial Fisheries Research Station (EAMFRO). Data from the IIOE is regarded as an essential element in the development of the vitally important pelagic fisheries, but the lack of essential shore facilities will be a factor limiting development for some time.

Somalia.

The continental shelf is extremely narrow, largely less than five miles wide, and the entire coast is extremely exposed particularly during the southerly monsoon. During the southerly monsoon the northerly flowing coastal current becomes the swiftest known oceanic current in the world. Subsistence (handline/castnet) fishing is very limited, by far the most important of the Somalia fisheries being that for tuna in the Gulf of Aden. In the past six years a modified form of Japanese deep longline, drum mounted and fished from 28' powered craft, has been introduced. The craft fish exclusively for two

canneries (Abo and Candala) which operate for only about seven months of the year (mid October-May).

A remarkably high catch-rate has been recorded, up to 97 fish per 100 hooks, almost all yellowfin tuna in the weight-range 5-18 kg.

Current development is concentrated on the small boat deep longline technique, but the difficulty of disposing of the catch is a serious problem, and greatly limits the area in which fishing can be conducted.

Somalia has no immediate means of utilizing scientific data, but information which bears directly on fish concentrations and migrations would be useful, particularly any confirmation of the belief that high catch rates can be obtained along the exposed eastern coast.

Aden (Aden State, the Federation and Eastern Aden Protectorate).

West of Aden city the continental shelf is relatively extensive, 20 miles wide, but to the east it becomes very narrow. The important local fisheries are all for pelagic fish, of which there seem to be enormous numbers: handlining for rock cods and snapper has a potential, but it is only undertaken if there is a shortage of other fish. Fresh bait trolling, handlining and a crude live bait technique are used to catch yellowfin tuna between October and March. Encircling nets and set nets are the main techniques for catching longtail tuna and skipjack: the fishery extends throughout the year, with the best catches in the period November-January. The best tuna areas are east of Aden, along the coast of the Federation. By far the greatest catches of Scomberomorus spp. (Kingfish), largely commerson, are taken during July-August by means of encircling nets operated from powered sambuks. The most important kingfish area is over the broader continental shelf to the west of Aden.

Although beach seining and the use of cast nets are the only techniques employed, and operations are limited to water less than two fathoms, so great are the numbers of sardines that they form an important part of the total catch, particularly of the Eastern Aden Protectorate.

Of less importance are fisheries for demersal species, for rock lobsters and Penaeidae, and for turtles.

Exploratory deep longline operations in the Gulf of Aden have shown a very high catch rate, largely of yellowfin tuna, and while recent development has consisted largely of improvements to the local craft and gear, currently there is a strong move to attract outside capital for investment in modern gear and shore facilities in order that the full potential of the undoubtedly abundant pelagic species can be realized.

Aden has a fishery department which is well able to utilize fisheries-useful data.

West Pakistan.

West of Karachi, that is along most of the coast of West Pakistan, the continental shelf is some 25 miles wide, but to the east, across the Indus Delta,

it is much broader, about 60 miles wide. Owing to the rough seas induced by the southerly monsoon, fishing is restricted to creeks and backwaters from May to August: the open-sea fishing season is of eight months duration, from September to April.

Gill net fisheries for pelagic and semi-pelagic species are the most important, but over the broader continental shelf trawling for prawns (Penaeidae) is important, while Sciaenidae (Croakers) are also trawled to some extent. Sciaenidae move from west to east near to the coast during the periods February-April and September-November. Frequently they are found in surface shoals, when a form of ring net, made by fastening gill nets together, is used with effect. During the period February-April, shoals of Polynemidae (Threadfins) travel from the south towards the Indus Delta, and are caught by gill nets over the broad continental shelf. Mackerels, which include species of Scomberomorus and Cybium, together with bonito, are gilled almost throughout the fishing season, but a peak in the catches occurs during the period November-March which is the time of the sardine/anchovy gill net fishery.

Current development is the expansion of the existing fisheries rather than the introduction of new ones. The indigenous sailing craft, up to 70 ft. in length, have been found well suited to inboard engines, and the new fish harbour could scarcely accommodate much larger craft.

Fisheries research in West Pakistan, and the ability to utilize IIOE data effectively, is likely to be hampered severely by the shortage of trained personnel and equipment.

India.

The west coast fisheries account for about 75-80% of the total Indian marine catch, and are confined largely to within 10 miles of the shore. The broad continental shelf off the Indus Delta is even broader to the south (100 miles), due to the configuration of the coastline of the State of Bombay, thence gradually tapering to about 20 miles wide in the far south. The east coast has a uniformly relatively narrow continental shelf (20 miles). The west coastal waters are invariably muddy: coral is absent, and almost all the sea bed is trawlable, but to the south there is a greater concentration on pelagic species.

The most important single fishery is for the Indian mackerel, Rastrelliger kanagurta, and takes place between August and April from a little south of Bombay to Quilon in Kerala State. The most important fishing methods are beach-seines, boat seines and gill nets. Shoals appear spasmodically at other places along the coast, and although some occur along the east coast, 98% of the catch is from the west.

The total catches of Clupeidae exceed those of the Indian mackerel. Of the clupeids, Sardinella longiceps (the oil sardine) is the most important, but the abundance fluctuates enormously from year to year. The sardine season is August to April: the bulk of the commercial catches are juveniles. Nets commonly used in the fishery are boat-seines, drift nets and cast nets.

The fishery third in importance is for prawns (Penaeidae), over 90% of the landings occuring in the Bombay/Kerala areas. Offshore trawling from small powered craft takes place from June to October, but from October to April very large catches of one species (Metapenaeus dobsoni) are taken by Chinese dip nets in Kerala backwaters.

In 1953 there was established in Bombay an offshore fisheries research unit, aimed at exploring the potential of the broad continental shelf off north west India. Some 6-7 trawlers have been operating steadily over the past six years and off southern Maharashtra (Bombay State) some 15-20 trawlers are now operating in selected areas.

Current developments in India are to more and more small craft, but extending the present cruising range, and to increasing the effectiveness and intensity of well tried techniques. For example it has not been shown that purse seining can catch mackerel better than the very big (5,000 ft.) beach seines (Rampani), which are used in an active manner to take sighted shoals and which may catch over 2,000,000 fish in one operation: when the fish are present they are close inshore; when they are absent they appear to be absent altogether.

Although India's marine fisheries are run by the various states, fisheries research is national in character; and while the location of the Central Marine Fisheries Research Station at Mandapam Camp leaves much to be desired, extensive research staff is well able to utilize IIOE data in any form.

Ceylon.

Apart from the Palk Strait and a small area off the north east coast, Ceylon is surrounded by a narrow continental shelf (2-20 miles). The island is affected by both monsoons, but there is a movement of fishermen to the lee-side of the island with each change of monsoon.

Ceylon's fisheries are undeveloped, beach seining being the most important technique followed by gill netting. Other techniques in regular use are trolling, handlining, bottom and tuna longlining, and trawling. The beach seine is used as an active instrument against sighted shoals, of which sardines and mackerel are the most important, but in some areas it may be set completely blind.

A variety of gill nets is used extensively from an unusual form of shaped raft, usually some 15-18 ft. in length. Although these rafts are powered by outboard engines, of about 5 h.p., lack of space limits severely the amount of netting which can be carried: no ice can be carried, and the fishermen are continuously drenched by the sea. Fishing is carried out at night and early morning (2 a.m. - 7 a.m.), not further offshore than 10 miles.

Trolling is done from outrigger canoes, the main species being Scomberomorus spp., Acanthocybium spp. and skipjack. Handlining, bottom longlines and trawling produce the general tropical demersal fauna of lutianids, lethrinids and epinephelids. There is a small market for prawns (Penaeidae), but much of the prawn catch is used for bait, the release of live material being an integral part of the Ceylon handlining.

The Wadge Bank, off southern India, has been trawled commercially by craft operating from Colombo for many years. At present two Government-owned trawlers are in action, fishing exclusively to supply the Mutwal Fisheries Factory.

It is believed that one deep longline vessel operates from Colombo.

During recent development, some 1,200 small (26 ft.) decked craft, suitable for a variety of fishing techniques, have been introduced. It was proposed that they should operate up to 30 miles offshore, and it was anticipated that each would produce 3,000 cwt. of fish each year. They have not reached this target, some returning only 200 cwt. a year. Current development plans are aimed at rectifying this situation, which has arisen due to the accumulation of many small causes, and to replacing by modern stern trawlers the vessels which are now fishing the Wadge Bank.

So far as fisheries research is concerned, the administrative machine in Ceylon employs non-scientific personnel in posts which would normally be regarded as of an essentially scientific character: the undoubtedly competent scientists appear to be unable to voice their opinions to effect, and the system may reduce considerably the benefit which Ceylon might expect from IIOE data.

East Pakistan.

The continental shelf is broad (80-100 miles) along the entire coastline, and frequently very shallow. Owing to the effect of both monsoons the fishing season is short, lasting from November to March.

It is reported that some 30,000 metric tons of fish and 5,000 tons of prawns are caught during this season, mostly by set nets and traps. Gear and craft are obsolete and while the potential of the Bay of Bengal is virtually untapped, freshwater fisheries so predominate in this land which, at the end of the southerly monsoon is two-thirds below water, that little attention is paid to the marine fisheries and their potential.

A group of three FAO experts is trying to stimulate the marine fisheries, and the biologist of this group appears to be the only scientist currently in East Pakistan who would be able to appreciate IIOE data in any form.

Burma.

The continental shelf off Burma is fairly broad, ranging in width between 40 and 100 miles. That portion of the coast adjacent to the Bay of Bengal, that is north of Cape Negrais, is rough during the southerly monsoon, the effect of which limits considerably the fishing activity along all the coast.

Burmese fisheries are undeveloped: the total annual marine catch is probably less than 20,000 tons, only half the freshwater catch.

In the extreme north of Burma, and again in the delta of the Irrawaddy, estuarine fisheries predominate, traps, filter nets and surface gill nets being used for the capture of creatures such as sergestids, mysids, prawns (Penaeidae),

clupeids and leiognathids. Between these two areas some small boat activity takes place, surface gill nets being used for the capture mainly of Cybium spp., pomfrets, Chirocentrus dorab and Hilsa ilisha. A similar but more productive fishery, including also filter nets and large traps, occurs along the east shore of the Gulf of Martaban. The most productive area of the coast is the Mergui Archipelago where there is a wide range of fishing activity.

There is little mechanised fishing: it takes two forms: (a) small (5-10 ton) inboard engined craft operate from the area immediately east of Cape Negrais and from the east coast of the Gulf of Martaban, both lots of craft concentrating particularly on gill netting in the area of 15°N 95°E., (b) a group of three trawlers operate all year round, Sciaonidae (Jewfish) forming about a quarter of the catch: during the northerly monsoon they obtain good catches from the same area as the small gill net boats, but during the southerly monsoon, operations are restricted to the coastline north of the Mergui Archipelago.

The Directorate of Fisheries, as an independent unit, was established very recently (1961). Programmes in hand are mostly those designed to provide the basic information, about Burmese fisheries and the natural resources, on which future development plans can be built. Current development is aimed largely at mechanizing indigenous craft and the introduction of techniques, such as trolling, which can be carried out from small powered craft. IIOE fisheries data is unlikely to be of immediate use in Burma, but will assist in planning.

Thailand.

Thailand has two distinct marine fishing areas: (a) the Gulf of Thailand which is a small part of the vast Sunda Shelf, (b) the Andaman Sea coast, along which the continental shelf is relatively narrow. Of these areas, by far the most important is the Gulf of Thailand where 750 trawlers operate. The Gulf produces some 235,000 of the total of 240,000 tons of annual marine landings. The disparity between the coasts is likely to be intensified in the immediate future rather than reduced, since the important centres of population lie adjacent to the Gulf; and not unnaturally, most of the research activity will be devoted to the Gulf. However, some preliminary studies of the adjacent Indian Ocean are in hand, and IIOE data would be useful.

Malaya and Singapore.

As with Thailand, Malaya too has two distinct local fishing areas: (a) to the east, on the great Sunda Shelf, and (b) to the west, in the Strait of Malacca. The northerly monsoon affects considerably the fishing activity along the east coast, which coast produces about one-quarter of the total Malayan catch.

Despite the extensive continental shelf around the peninsula, the most important fishery is for Rastrelliger kanagurta, almost all of which are taken by boat seines operated on dark nights. The main fishing area is about midway along the west coast of Malaya, but purse seining for Rastrelliger and clupeid species is important also off the east coast.

Fishing stakes are a feature of Malayan fisheries, and prawns (Penaeidae) are an important catch, along with which are taken a wide range of small fish.

An important new development in Malayan fisheries is deep longlining. About 20 vessels are currently on charter to a firm in Penang, ten of which are engaged in fishing the Indian Ocean. Smaller craft (100 tons) work the eastern part of the ocean, while larger craft operate in the western part from south of Madagascar to East Africa.

Further development of this oceanic fishing will certainly take place; and Malaya is better able to take immediate advantage of oceanic fisheries-useful data than most of the countries around the Indian Ocean. It may be supposed that trawling will replace the fixed machines, which catch enormous numbers of very juvenile fish, but at present the stakes appear to present a more attractive investment: there is considerable antagonism between prospective trawler-men and stake owners. Despite trials, no way has been found superior to the well established night time operations, using unpowered craft, for catching Rastrelliger.

The important Singapore fisheries are bottom longlining in the South China Sea, a technique which produces a catch of higher quality than trawling, and fixed machines. It is possible that fishing in the Indian Ocean will take place from Singapore in the future.

Malaya and Singapore have the scientists to utilize the aspects of the IIOE data which will benefit the countries.

Indonesia.

The fisheries of Indonesia are somewhat complex due to the vast extent of, and variation within the archipelago, but they are mostly concentrated in coastal waters, and most of the craft and gear are still rather primitive. The most common coastal fishery, dominating the west coast of Sumatra and areas along the south coast of Java, is beach seining. The catches are not specific, but consist of a variety of coastal species.

Encircling gill nets and seines are used particularly on the east coast of Sumatra in the Malacca Strait, and at places along the west coast for species of Rastrelliger.

A sardine fishery, employing bright lights and dip nets, is conducted mainly along the western side of Bali Strait. The fishing season is the northerly monsoon, with a peak in December/January dominated by Sardinella longiceps.

A common fishing method employed throughout the west coast of Sumatra, the south coast of Java, and the Lesser Sunda Islands is trolling from sailing craft. The catches consist of a selection of tunas and tunny-like fish, Euthynnus alleteratus, Auxis thazard and dolphin (Coryphaena) being probably most common. In some places, such as Bali, this fishery is so well established that 200 craft may operate from a small fishing village and produce a catch capable of supporting a small cannery. Experimental fishing from motorized vessels, which should be capable of exploiting the more productive offshore waters, is now underway.

Exploratory deep longline fishing has been undertaken in the Indian Ocean, and at present several Japanese built deep longliners are operating from Djakarta. The catches are very largely (c. 70%) yellowfin tuna, followed by big-eyed tuna and albacore.

The most important invertebrate fishing is for prawns (Penaeidae). The biggest prawn fishery is situated midway along the east coast of Sumatra, the gear being stakes and filters. Recent surveys have shown the existence of prawn areas, possibly seasonal along west Sumatra and south Java.

Current development is aimed at modernizing the craft and gear engaged in the local fisheries on the one hand, and introducing new techniques, particularly in respect of the oceanic tunas, on the other.

Indonesia has two marine research organizations, one well equipped, dealing with oceanic problems, one well staffed, dealing with fisheries.

Australia.

Although parts of the west coast have a fairly narrow continental shelf, less than 30 miles wide, the north and north west coast and much of the south coast has an extensive shelf.

The most important fishery in Australia, by weight and value, is that for the western crayfish, Panulirus cygnus. Most of the 750 craft engaged in the fishery are small, less than 40 ft. in length, although a few go up to 80 ft. Although many sorts of craft are employed, each is well suited to the particular area in which it operates. The fishing effort in Western Australia appears already to be too high, the returns of some of the craft being scarcely economic, but it is known that there are northern stocks of crayfish which might be exploited at some time in the future. The most important fishery for a single teleost species is the active beach seining for the Australian salmon, Arripis trutta, particularly important off western Australia. The same technique is used also in the capture of the second most important species, Mugil cephalus, which, together with other mullets, constitutes the largest Australian teleost fishery: this fishery is, however, largely outside the Indian Ocean.

Next in importance is the tuna fishery in which poling is the technique most used. In this fishery, the southern bluefin tuna, Thunnus thynnus maccoyii, consitutes by far the largest percentage, the species being particularly important off South Australia.

Shark, barracouts (Leionura atun), flatheads and snapper (Chrysophrys auratus) are other important species which are caught by a variety of techniques including bottom and midwater longlining, trolling, trawling, handlining, Danish seining and traps; but of these species the shark and flatheads are largely confined to the eastern states of New South Wales and Victoria.

Australian fisheries are not very extensive, a feature which is undoubtedly associated with, but not the result of, the low population density in Australia

and the ready availability of other forms of protein. The most likely lines of immediate development appear to be in the Northern Territories, where scarcely any fisheries exist although it is believed that prawns (Penaeidae) and many economically important teleosts are abundant, and in southern Australia where the Great Australian Bight already has the largest demersal fishery. Stocks of southern bluefin tuna, unexploited by Australia, are known to exist off Western Australia, but whether they can be fished economically from Australia is another matter.

Mauritius.

Apart from a small area to the north of the island, Mauritius has a very narrow continental shelf (1-5 miles wide). Cyclones are a menace to small boat operations, but fortunately those passing close to the island are not very frequent.

Every type of fishing device which may be used is laid down by law, and every net has to be licensed: it seems certain that the maximum catch is being returned from the local waters, and that under present conditions no gain can be obtained from an increased effort. In each of the past four years, 2,400 fishermen have caught less than 1,500 tons of fish and invertebrates, species of Siganidae, octopus and Lethrinidae being the most important. This is only half the island's requirements.

The development of the fisheries is considered to be of very great importance. The source of an increased catch must be the open ocean, but whether the development should take the form of wide ranging craft capable of exploiting the albacore south of Mauritius and the yellowfin tuna off East Africa, or whether it should be concentrated on small boat operations is undecided. IIOE data can be of the greatest use in the development.

Madagascar.

Off the east coast the continental shelf is very narrow (10 miles), and rough seas limit the fishing activity, but off the west coast the shelf is relatively extensive (30 miles).

No catch statistics are maintained: the fishery is very undeveloped and fish are landed all around the coasts from an unkown number of pirogues. Catches are taken largely by handlines, set nets and traps: Scomberomorus commerson is taken by trolling off the southwest coast.

Several lines of development are under consideration. Exploratory deep longline fishing has shown the presence, within 30 miles of the west coast, of yellowfin tuna, albacore, and various billfish, and it is thought that operations off the north west coast would be particularly effective, while off the north west and north east coasts, purse seining for small surface shoaling tunas and for sardines may prove worthwhile.

The trolling for Spanish mackerel, noted above, is the first Malgashe fishery to show signs of organization, and it is expected to develop, There is considered to be a potential fishery for prawns (Penaeidae) particularly

along the north west coast, while a fishery for rock-lobsters (Panulirus and Palinurus spp.) off the south coast may give a steady, if unspectacular, yield.

Japan.

The Japanese fishing activity of greatest importance in the IIOE context is of course the deep longline fishing in the Indian Ocean. Japanese activity in the Arabian Sea and in the Bay of Bengal has been slight so far, but Japanese tuna boats may be encountered almost anywhere else in the Indian Ocean. The catch-data which it has been possible to amass from these vessels has led to the belief that all aspects of oceanic fishing are so well known in Japan that little can be done to further the study. This is not true. The fundamental importance of fish to the Japanese nation made it necessary to institute unique training facilities, with the result that more people were well informed about fish and fishing than anywhere else in the world. The phenomenal spread of Japanese fishing was due largely to industrial enterprise coupled with the ready availability of well informed personnel; but the fishery scientisits in Japan were faced, and still are faced, with precisely the same fundamental problems of biology and population dynamics as scientists in any other country.

Briefly, fisheries research in Japan today is at three distinct levels. At the Prefectural level there are about 45 laboratories, almost all of which are engaged in marine studies. About 20 of these have tuna boats for research: the rest have smaller craft for the study of other species. Also at the Prefectural level are the fisheries high schools, about 36 of which have tuna boats. At the Regional (Governmental) level, only the Nankai laboratory is engaged full time in tuna research: six others are engaged in various marine fisheries studies, one in freshwater, and one in pearl research. Together these laboratories have some 8-10 research vessels, two of which are for tuna research. At the University level, there are two fishery universities and 12 other universities have fishery departments: both the former and four of the latter operate fair-sized tuna boats.

It is well appreciated in Japan that IIOE data coupled with the catch-data which only Japan can supply may go far to solve some of the outstanding problems, and there is keenness to co-operate in such an exercise.

PART III - Expectations from the Expedition.

A. General.

1. The predominant wish of the countries around the Indian Ocean is that the IIOE shall provide a background of hydrobiological information against which national fisheries development and research programmes can be organized; and provide it as quickly as possible. It is considered by several countries that the degree of precision is of less immediate importance than the overall impression which can be obtained from the correlated data: accuracy can be increased as more data becomes available. Of the various types of information, temperature, salinity, plankton volumes, the concentration of fish and decapod larvae, carbon-14 estimations, and the concentration of available nutrients are considered to be the most important; that is, those types of information which will indicate likely productive areas.

2. Most countries regard oceanic fishing as a possible line of development, and all information which will indicate the concentration and distribution of large pelagic species is regarded as of equal importance to A.1 above.

3. A wish was expressed by some countries that positive recommendations be given to them on the most likely way in which their fisheries could be developed.

B. Specific.

The following specific requests, other than any mentioned above, were received.

South Africa. All possible data on Clupeidae and midwater crustacean Decapoda in the south western Indian Ocean, particularly in close proximity to the coast, and any data on demersal populations on the continental shelf. Also any data relating to whales and whaling.

Mozambique. Advice (see A.3). Bottom profiles particularly of the Mozambique Channel.

East Africa & Somalia. All possible data on the timing, intensity and geographic extent of the upwelling which occurs off the Somalia/Arabia coastlines.

Aden. As for East Africa and Somalia, plus any data on turtles.

West Pakistan. Any data relating to catches of fish, pelagic and demersal, off the Pakistan coast.

India. All possible data on the upwelling believed to occur in the area of the Gulf of Cambay. Any information which will elucidate the erratic behaviour of Sardinella longiceps, and to a lesser extent Rastrelliger kanagurta.

Ceylon. All possible data on Rastrelliger kanagurta and Chanos chanos.

Malaya & Singapore. All possible data on Rastrelliger kanagurta and all data from the Malacca Strait and South China Sea.

Madagascar. All possible information on crustacean Decapoda off the eastern and southern coasts, and Clupeidae off the northern coast.

Hong Kong. Hong Kong was omitted from Part II as the Colony in no sense fishes the Indian Ocean, but it is included here because, although vessels may not take observations in the South China Sea, any vessels that do so are asked to contact the Director, Hong Kong Fisheries Research Station.

Japan. All possible data on the killer whale, Orca orca, which is now causing increasing losses of catch, not so much by predation of hooked tuna as by frightening all tuna from the locality. All possible information on the survival rate of tuna larvae, and on tuna spawning areas. All information which will help to define the factors limiting the distribution of the tuna species.

PART IV - Recommendations.

A. Dissemination of Data - General.

1. The quickest, easiest, cheapest and most readily assimilable form of presenting oceanographic data is by chart, and to accommodate those countries which seek speedy dissemination of data it is recommended that inexpensive contour charts be prepared, initially of the following types of collocated information (assuming direct comparability of observations):

(a) Surface temperature.
(b) Surface salinity.
(c) Surface concentration of nitrates.
(d) Surface concentration of phosphates.
(e) Results of carbon-14 estimations.
(f) Zooplankton concentration (weight or volume), from IIOE standard hauls.
(g) Main thermocline depth (at a selected time of day).

These seven types of information could be presented on four charts (a & b, c & d, c & f, g).

The spacing in time of the charts should be initially for the four seasons, namely:

(i) Northerly monsoon (Dec. Jan. Feb.)
(ii) North to South change (Mar. Apr. May)
(iii) Southerly monsoon (June July Aug.)
(iv) South to North change (Sept. Oct. Nov.)

A monthly spacing may be possible when all results are available.

The size of the charts suggested is foolscap (13" x 8"), and the process photo-lithography.

2. Charts similar to those above should be prepared wherever possible summarizing the following types of information:

(a) Sightings of surface shoals of fish.
(b) Sightings of flocks of sea birds.
(c) Echo-sounding records of shoals.
(d) Deep longline catches of large pelagic species.
(Tokai University prepare charts reporting average fishing conditions every ten days, and would be most willing to co-operate in this.)
(e) Midwater trawling results (Isaac Kidd).

3. To accommodate those countries having important demersal fisheries, similar charts are required summarizing information over the extensive areas of the continental shelf. The following additional information is required:

(a) An accurate chart of the depth and type of sea-bed.

(b) Bottom temperature.
(c) Whether or not a main thermocline occurs above the sea-bed.
(d) Analyses of the demersal invertebrate fauna.
(e) Analyses of the demersal vertebrate fauna.
(f) Echo-traces of demersal fish.

4. As results of the analyses of IIOE standard net hauls become available from Cochin the following data of particular importance should be presented on similar charts:

(a) Total fish egg concentration.
(b) Total fish larvae concentration.
(c) Clupeid larvae concentration.
(d) Tuna larvae concentration.
(e) Billfish larvae concentration.
(f) Crustacean deapod larvae concentration.

It is noted that the Nankai Tuna Research Laboratory is now able to identify the larvae of all the Indian Ocean tunas and marlins, and, with the assistance of that Institute, it may be possible for (d) & (c) above to be subdivided.

5. Additional charts may be required for special features; for example, Japan is willing to co-operate in the recovery of tuna tagged by EAMFRO and charts summarizing releases and recoveries may be required eventually.

6. Supplementary noted will be required for some charts; for example, those charts which record observations of midwater fish shoal echoes should be supported by records of the transmission frequency.

7. Maximum benefit from the Expedition requires that an appreciation of the gross results be made at the earliest possible date: it is a particularly important consideration that this appreciation will be of greatest benefit to the least well developed countries. The appreciation can be presented largely in chart form, with supplementary notes, and can be revised as necessary along with the other charts.

8. When all the material from the Expedition has been worked up and this proposed system of inexpensive charts ceases to have any usefulness, all the data should be presented in atlas form (SCOR already has the production of such an atlas under consideration). This atlas should include in addition to the information noted above:

(a) Records of fish mortalities.
(b) Concentrations of phytoplankton and zooplankton at the surface of the sea.
(c) Current measurements.
(d) Records of the sonic scattering layer.
(e) Meteorological data, particularly solar radiation.
(f) A bathymetric chart.
(g) State of the sea.

9. It has been pointed out to me that intergovernmental agencies should not do research, but should provide the data and advice which will enable countries to do research. A decision is required therefore on whether the compilation of the charts and their interpretation, suggested in points 1-7 above, should be regarded as a function of the SLF. I think it should be, and that the charts should be prepared in Zanzibar. EAMFRO has a Rotaprint machine (Model R75) capable of reproducing charts, and, although the Organization does not have the equipment to produce the plates, previously this was arranged fairly easily with the Zanzibar Government Printer. However, to ensure the satisfactory supply of plates for this exercise, it may be necessary to equip the Organization with the necessary plate-producing equipment. Additional staff that would be required would be one graduate and one cartographer to handle incoming data and to draw the originals, together with one assistant who could also be trained in the production of plates and the operation of the Rotaprint machine.

10. In whatever institute the charts are prepared, it is essential that the institute be supplied with full particulars of all observations made during the Expedition which may be considered to be of a fishery-useful nature. These were listed and classified in the preliminary report to the IOC by the SLF.

B. Dissemination of Data - Specific.

Recommendations at A 1-10 call for the establishment of a clearing house for IIOE fisheries-useful data, which, it is suggested, might be EAMFRO. Wherever the clearing house is established, answers to specific requests can be supplied either by direct extraction from incoming data (e.g. by Thermofax), or, should this source be inadequate, by the SLF referring the request direct to the institute(s) which might be able to supply the answer.

C. General Considerations.

1. It is foreseen that the period of usefulness of the SLF may cease by the end of 1966, and inconsequence the following general arrangements are recommended:

(a) That the SLF be supplied with a detailed account of all completed IIOE cruises and all cruises planned, so that an assessment can be made of the adequacy of the coverage and the need for more effort.

(b) That early steps be taken to implement the production of the charts referred to in A.

(c) That the fullest use be made of the forthcoming meeting of the IPFC (Kuala Lumpur, October 1964) for the discussion by scientists from the Indian Ocean countries of the fishery aspects of the IIOE.

(d) That there be facility to arrange other meetings of fisheries scientists during 1965/66 should these be desirable.

(c) That, with the anticipated reduction in usefulness of the SLF during late 1966, the meeting of the IPFC at about that time should be used to assess the benefits of the IIOE, and to re-appraise national fisheries development and research programmes.

2. Although it is considered that the IIOE should provide a load in the development of the Indian Ocean fisheries, it is considered that the preparation of specific recommendations is outside the terms of reference of the SLF, and that such requests should be referred by the SLF to FAO.

Zanzibar.
25 March, 1964.

(Sgd) D. N. F. Hall,
Subject Leader
Fisheries Aspects,
IIOE

SHIP PROGRAMS

ANNEX III

Country Institution Catalogue Number Ship	Period	Region	Type of Observation: Serial and Computed Data: No. of Stas.	Serial and Computed Data: Data	Serial and Computed Data: Sample Depths	BTs	Currents	Bottom Topography	Bottom Sediments	Biological	Meteorological	Surface	Remarks
1	2	3	4a	4b	4c	5	6	7	8	9	10	11	12
102. AUSTRALIA													
102.1 Commonwealth Scientific and Industrial Research Organization													
102.1 G-1 DIAMANTINA (Cruises Dm 1/59-Dm 2/59) (IIOE)	16-18. VII., 11. X.-19.XI. 1959	NE Indian Ocean	53	T, S, O_2, σ_t, P_{inorg}	3000-5000 Max.-5800	*		D		Plankton--51 Pigments--47 Productivity-49	Wd, Ta, Tw, Bar, Cld, Vis	T, S, Waves	Data in pub. rep.: "Oceanographical Cruise Report No. 1, Oceanographical Observations in the Indian Ocean in 1959, H.M.A.S. DIAMANTINA Cruises Dm 1/59 and Dm 2/59" (Div. Fish. & Oceanogr., CSIRO, Austr., 1962)
102.1 G-2 DIAMANTINA (Cruise Dm 1/60) (IIOE)	2.II.-23. III.1960	NE Indian Ocean	56	T, S, σ_t, O_2, P	Max.-610	*		D		Productivity-28 Pigments--27 Plankton--56	Wd, Ta, Tw, Cld, Bar, Vis	T, S, Waves	Data in pub. rep.: "Oceanographical Cruise Report No. 2, Oceanographical Observations in the Indian Ocean in 1960, H.M.A.S. DIAMANTINA Cruise Dm 1/60" (CSIRO, Austr., 1962)
102.1 G-3 DIAMANTINA (Cruise Dm 3/60) (IIOE)	16.X.-12. XI.1960	NE Indian Ocean	20	T, S, σ_t, O_2, P, N	Max.-5590	*		D			Wd, Ta, Tw, Cld, Bar, Vis	T, S, Waves	Data in pub. rep.: "Oceanographical Cruise Report No. 4, Oceanographical Observations in the Indian Ocean in 1960, H.M.A.S. DIAMANTINA Cruise Dm 3/60" (CSIRO, Austr., 1962)
102.1 G-4 DIAMANTINA (Cruise Dm 2/60) (IIOE)	11.VII.-26.IX.1960	NE Indian Ocean, Arafura Sea, Timor Sea, Savu Sea, Banda Sea, Flores Sea, Bali Sea	86	T, S, O_2, P, P_{inorg}, σ_t	4000 Max.-5521	B* -158		D		Plankton--104 Productivity-152 Pigments--117	Ta, Tw, Wd, Cld, Vis, Bar	T, S, Waves	Data in pub. rep.: "Oceanographical Cruise Report No. 3" (CSIRO, Austr., 1963)
102.1 G-5 DIAMANTINA (Cruise Dm 1/61) (IIOE)	14.II.-10. III.1961	NE & SE Indian Ocean, Great Australian Bight	16	T, S, O_2, P, P_{inorg}, N, σ_t	3300-4800 Max.-4958	B* -43		D		Productivity-16 Pigments--16 Plankton--14	Ta, Tw, Wd, Cld, Vis, Bar	T, S, Waves	Data in pub. rep.: "Oceanographical Cruise Report No. 7" (CSIRO, Austr., 1963)

Country Institution Catalogue Number Ship	Period	Region	Type of Observation										Remarks
			Serial and Computed Data			BTs	Currents	Bottom Topography	Bottom Sediments	Biological	Meteorological	Surface	
			No. of Stas.	Data	Sample Depths								
1	2	3	4a	4b	4c	5	6	7	8	9	10	11	12
102.1 G-6 DIAMANTINA (Cruise Dm 2/61) (IIOE)	1.V.-12.VI.1961	NE Indian Ocean, Timor, Bali, Java & South China Seas	41	T, S, σ_t, O_2, P_{inorg}, P_{total}, Ni	30-80, to 4500 Max.-4522	B*		D		Primary Prod.-40 Pigments--40 Plankton--40	Ta, Tw, Wd, Cld, Vis, Bar	T, S, Waves	Data in pub. rep.: "Oceanographical Cruise Report No. 9" (CSIRO, Austr., 1963)
102.1 G-7 DIAMANTINA (Cruise Dm 3/61) (IIOE)	24.VII.-26.VIII.1961	NE Indian Ocean, Timor Sea								Plankton--11 Pigments--37			Australian Oceanographic Data Centre (AODC) O.C.R. 11 Provisional data
102.1 G-8 DIAMANTINA (Cruise Dm 1/62) (IIOE)	13.II.-8.III.1962	NE Indian Ocean, Timor, Banda & Flores Seas								Pigments--32			AODC O.C.R. 14 Provisional data
102.1 G-9 DIAMANTINA (Cruise Dm 2/62) (IIOE)	17.VII.-22.VIII.1962	NE Indian Ocean								Pigments--30			AODC O.C.R. 15 Provisional data
102.1 G-10 DIAMANTINA (Cruise Dm 3/62) (IIOE)	25.IX.-5.X.1962	NE & SE Indian Ocean								Pigments--18			AODC O.C.R. Provisional data
102.1 I-7 GASCOYNE (Cruise G 4/62) (IIOE)	19.VIII.-16.IX.1962	NE Indian Ocean								Pigments--36			AODC O.C.R. Provisional data
113. FRANCE													
113.3 Office de la Recherche Scientifique et Technique Outre-Mer													
113.3 C-2 COMMANDANT ROBERT GIRAUD	3.VII.-19.XII.1962	NW Indian Ocean, Gulf of Aden, Mozambique Channel	111*			B-113*	Surface GEK--61*					T*	Track chart and chart of surface temperature isotherms & current observations given in pub. rep.: "Cahiers Océanographiques" XV Année No. 5, 1963

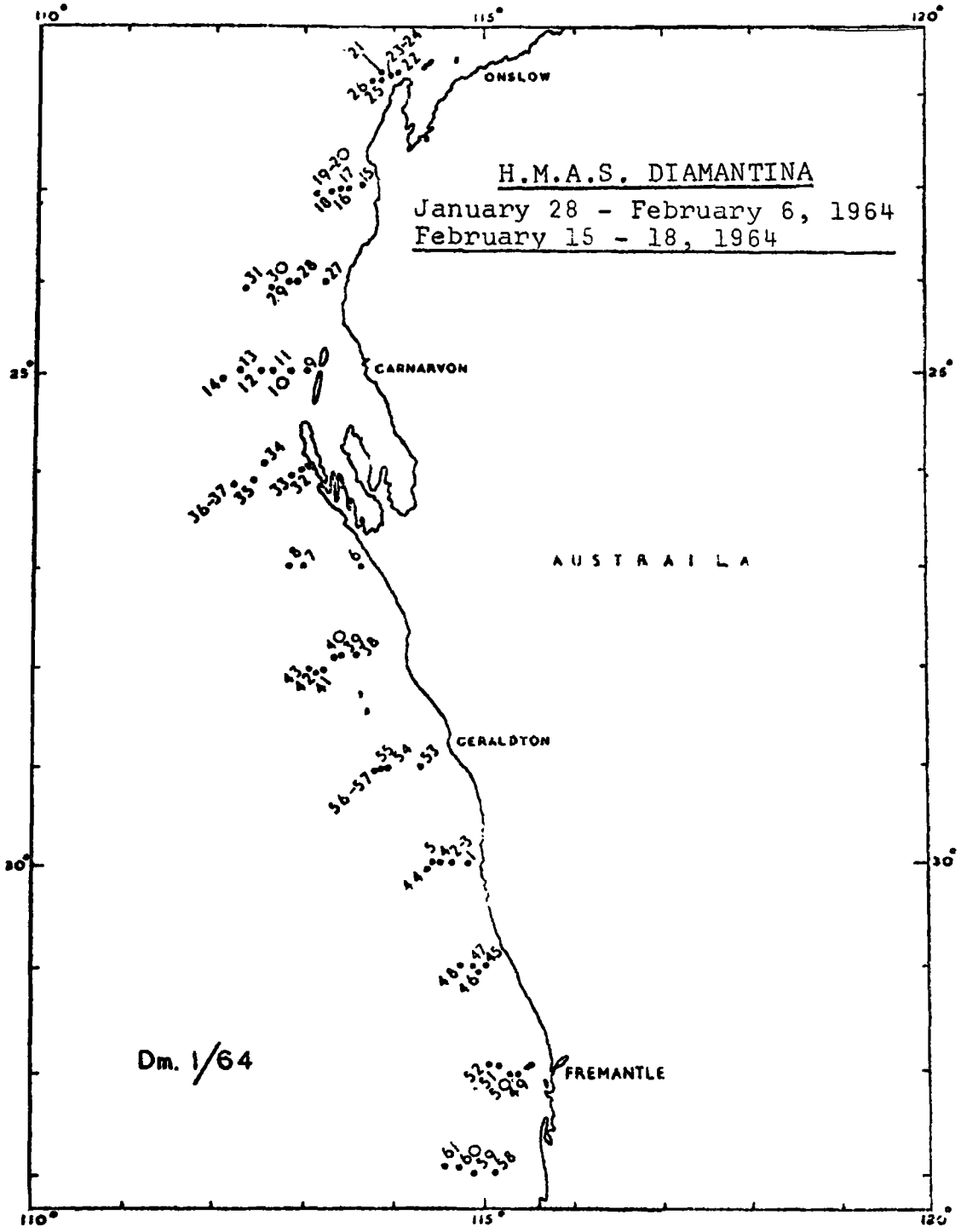
Country Institution Catalogue Number Ship	Period	Region	Type of Observation: Serial and Computed Data: No. of Stas.	Serial and Computed Data: Data	Serial and Computed Data: Sample Depths	BTs	Currents	Bottom Topography	Bottom Sediments	Biological	Meteorological	Surface	Remarks
1	2	3	4a	4b	4c	5	6	7	8	9	10	11	12
120. INDONESIA													
120.1 Lembaga Penelitian Laut													
120.1 B-1 R. I. JALANIDHI (Cruise 1) (IIOE)	6-9.VI. 1963	Java Sea, NE Indian Ocean	7	T, S, O_2, PO_4-P	1000- 6000 Max.- 6000			D					NODC 42 JL
120.1 B-2 R. I. JALANIDHI (Cruise 2) (IIOE)	18-21.VI. 1963	NE Indian Ocean	7	T, S, O_2	to 3500 Max.- 3500			D					NODC 42 JL
120.1 B-3 R. I. JALANIDHI (Cruise 3) (IIOE)	11.-24. VIII.1963	NE Indian Ocean	20	T, S, O_2	to 3900 Max.- 4395			D					NODC 42 JL
120.1 B-4 R. I. JALANIDHI (Cruise 4) (IIOE)	26-29.IX. 1963	NE Indian Ocean	9	T, S, O_2	1400- 4400 Max.- 4486			D					NODC 42 JL
136. REPUBLIC OF SOUTH AFRICA													
136.1 Division of Sea Fisheries, Oceanographic Research Institute, Durban													
136.1 A-2 AFRICANA II (IIOE)	19.VI.-12. VII.1962	NW & SW Indian Ocean	23	T, S, σ_t, δ, ΔD, Vs, O_2, Q	0-3700 Max.- 3862			D			Wd, W, Bar, Ta, Tw	Waves	NODC 91041
136.1 A-3 AFRICANA II (Cruise 251) (IIOE)	14.VI.-15. VII.1961	NW Indian Ocean	28	T, S, O_2, PO_4-P	400- 3900 Max.- 3932			D			Wd, Bar, Ta, Tw, W	Waves	NODC 91050 AF

Country Institution Catalogue Number Ship	Period	Region	Type of Observation: Serial and Computed Data: No. of Stas.	Serial and Computed Data: Data	Serial and Computed Data: Sample Depths	BTs	Currents	Bottom Topography	Bottom Sediments	Biological	Meteorological	Surface	Remarks
1	2	3	4a	4b	4c	5	6	7	8	9	10	11	12
136.1 A-4 AFRICANA II (Cruise 273) (IIOE)	3-16.IV. 1963	NW & SW Indian Ocean	13	T, S, O_2	to 3800 Max.- 3890			D			Wd, Bar, Ta, Tw, W, Cld, Vis	T, S, Waves, Col, Transp	NODC 91049 AF
136.1 A-5 AFRICANA II (Cruise 285) (IIOE)	11-29.III. 1964	SE Atlantic & SW Indian Oceans	21	T, S, O_2, PO_4-P	3600- 3800 Max.- 3890			D			Wd, Bar, Ta, Tw, W, Cld, Vis	pH, Transp, Waves	NODC 91936 AF
136.3 University of Cape Town													
136.3 A-4 NATAL (IIOE)	6.IV.-22. X.1962	SE Atlantic, NW and SW Indian Ocean	109	T, S, σ_t, δ, ΔD, Vs, O_2, Q	0-200, 2300- 3800 Max.- 4700			D			Wd, W, Bar, Ta, Tw, Cld, Vis	Waves	NODC 91040
136.3 A-5 NATAL (IIOE)	11.I.-27. I.1963	NW Indian Ocean	37	T, S, O_2, σ_t, δ, ΔD, Vs, Q	0-4000 Max.- 5000		Surface	D			Wd, W, Bar, Ta, Tw, Cld, Vis	Waves, Col, Transp	NODC 91044
136.3 A-6 NATAL (IIOE)	22-24.VII. 1963	NW Indian Ocean	7	T, S, σ_t, ΔD, Vs, O_2, PO_4-P	75-100 Max.- 150			D					NODC 91174 NA
137. UNION OF SOVIET SOCIALIST REPUBLICS													
137.1 Academy of Sciences of the USSR; Arctic & Antarctic Research Institute, Head Board of the North Sea Route, and Institute of Oceanology													
137.1 B-6 (continued on next page)													

Country Institution Catalogue Number Ship	Period	Region	Type of Observation										Remarks
			Serial and Computed Data			BTs	Currents	Bottom Topography	Bottom Sediments	Biological	Meteorological	Surface	
			No. of Stas.	Data	Sample Depths								
1	2	3	4a	4b	4c	5	6	7	8	9	10	11	12
137.1 B-6 VITYAZ (Cruise 31) (IIOE)	18.X.1959- 19.IV.1960	NW & NE Indian Ocean, Gulf of Aden, Mozambique Channel; Red, Arabian, Laccadive, Savu, Banda, Molukka & Philippine Seas	208	T, Cl, S, σ_t, pH, Alk, P, Si, NO_2-N, CO_2, O_2	2000- 3500 Max.- 6813	T-193		D, P†	Surface- -119 Core- -97	Plankton- -203		Waves Instr.- -10, Col, Transp	†Bathymetric data in pub. rep: "Data of Oceanological Investigations R/V VITYAZ Cruise 31, Bottom Topography" (Inst. of Oceanol. Moscow 1962) with text and 318 profiles
138. UNITED KINGDOM 138.2 Hydrographic Department, Admiralty													
138.2 A-4 OWEN (IIOE)	9.XI.1961- 10.V.1962	Gulf of Aden, Arabian Sea, NW Indian Ocean					Surface- 2 charts	P			Wd, W, Vis	T, S, σ_t	Current, Meteorological and Surface data in pub. rep.: "Surface Temperature and Salinity Observations H.M.S. OWEN 1961-1962" (Admiralty Marine Science Publication No. 5, H.D. 540, Hydrographic Department, Admiralty 1963) Bathymetric, Magnetic and Gravity data in pub. reps.: "Bathymetric Magnetic and Gravity Investigations H.M.S. OWEN 1961-1962, Intergovernmental Oceanographic Commission, International Indian Ocean Expedition" (Admiralty Marine Science Publication No. 4, Part 1 - Text; Part 2 - Profiles, H.D. 539, Hydrographic Department, Admiralty, 1963)

Country Institution Catalogue Number Ship	Period	Region	Type of Observation: Serial and Computed Data: No. of Stas.	Serial and Computed Data: Data	Serial and Computed Data: Sample Depths	BTs	Currents	Bottom Topography	Bottom Sediments	Biological	Meteorological	Surface	Remarks
1	2	3	4a	4b	4c	5	6	7	8	9	10	11	12
139. UNITED STATES OF AMERICA													
139.3 U. S. Naval Oceanographic Office													
139.3 B-8 EASTWIND (IIOE)	31.III.-25.IV.1961	Arabian Sea, NE & NW Indian Ocean	31	T, S, σ_t, δ, ΔD, Vs, O_2	800-1000, 2800-2900 Max.-2940			D			Wd, Bar, Ta, Tw, Cld, Vis	Waves, Transp	Data in pub. rep.: "Oceanographic Stations Taken in the Indian Ocean by USCGC EASTWIND (WAGB-279) in 1961" (US Naval Oceanogr. Office Tech. Rep. TR-141, July 1963) NODC 31599
139.3 C-1 REQUISITE (IIOE)	16.II.-5.III.1960	Gulf of Iran	55	T, S, σ_t, δ, ΔD, Vs, Q	Max.-63			D			Wd, W, Bar, Ta, Cld, Vis	Waves	NODC 31658
139.3 C-2 REQUISITE (IIOE)	4.I.-31.III.1961	Arabian Sea, Gulf of Oman, Gulf of Iran	206	T, S, σ_t, δ, ΔD, Vs, Q	0-400 Max.-3500			D			Wd, W, Ta, Bar, Cld, Vis	Waves	NODC 31865
139.3 D-1 SERRANO (IIOE)	13.III.-11.IV.1961	Gulf of Thailand, Malacca Strait, Singapore Strait, Burma Sea	101	T, S, σ_t, δ, ΔD, Vs	30-60 Max.-1250	B-609		D			Bar, Ta, Tw, Hum, W, Cld, Vis	Waves, Transp	NODC 31639
139.8 Scripps Institution of Oceanography													
139.8 B-7 HORIZON (Zephyrus Exped.) (IIOE)	12.VII.-26.IX.1962	NW & NE Atlantic, Alboran, Arabian, Red, Tyrrhenian Seas, Gulfs of Aden & Suez, Mediterranean Sea -Eastern & Western Basins	30	T, S, O_2, σ_t, δ_t, σ_θ sp, ΔD	75-5200 Max.-5287	B*		D			W, Wd		NODC 31183

Country Institution Catalogue Number Ship	Period	Region	Type of Observation: Serial and Computed Data: No. of Stas.	Data	Sample Depths	BTs	Currents	Bottom Topography	Bottom Sediments	Biological	Meteorological	Surface	Remarks
1	2	3	4a	4b	4c	5	6	7	8	9	10	11	12
139.8 I-1 ARGO (Monsoon Exped.) (IIOE)	24.IX.1960-13.IV.1961	NE, NW & SW Pacific, Banda Sea, NE, NW, SW & SE Indian Ocean	37	T, S, O_2, σ_t, δ_t, $\sigma_{\theta sp}$, ΔD	900-5200 Max.-5304	B*		D			Wd, W		NODC 31181
139.8 I-3 ARGO (Lusiad II Exped.) (IIOE)	1.VII.-21.IX.1962	NE & NW Indian Ocean	97	T, S, O_2, PO_4, SiO_3, NO_3, σ_t, δ_t, $\sigma_{\theta sp}$, ΔD	1000-1200, 3200-5000 Max.-5018			D			Wd, W		NODC 31184
139.8 I-4 ARGO (Lusiad III Exped.) (IIOE)	6.X.-20.XII.1962	Arabian Sea, NW, SW & NE Indian Ocean	30	T, S, O_2, σ_t, δ_t, $\sigma_{\theta sp}$, ΔD	2000-3900 Max.-5153			D			Wd, W		NODC 31184
139.8 I-5 ARGO (Lusiad V Exped.) (IIOE)	17.II.-10.V.1963	NE & NW Indian Ocean, Laccadive Sea	105	T, S, O_2, PO_4, NO_2, σ_t, δ_t, $\sigma_{\theta sp}$, ΔD	1000-1200 Max.-1233			D			W, Wd		NODC 31184
139.8 I-6 ARGO (Lusiad VI Exped.) (IIOE)	19-25.V.1963	NW Indian Ocean, Mozambique Channel	3	T, S, O_2, σ_t, δ_t, $\sigma_{\theta sp}$, ΔD	1400-3800 Max.-3829			D			W, Wd		NODC 31184
139.9 Lamont Geological Observatory of Columbia University													
139.9 A-6 VEMA (Cruise 16) (IIOE)	29.XII.1959-16.II.1960	NE & NW Indian Ocean	30	T, S, δ, σ_t, ΔD, Vs, O_2	1300-4700 Max.-6630			D					NODC 31834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115°
120°
25°
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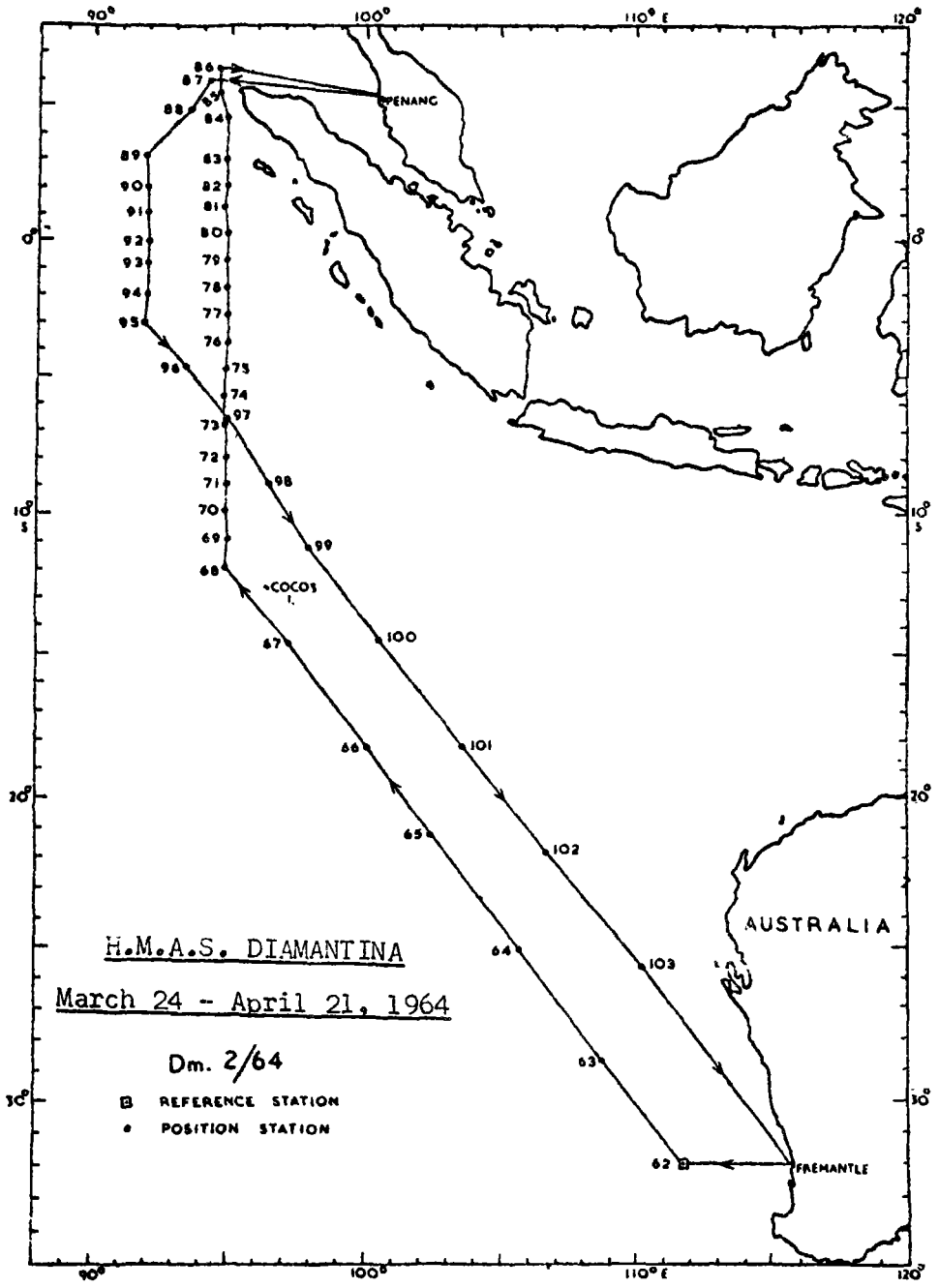
ONSLOW
CARNARVON
GERALDTON
FREMANTLE
AUSTRALIA
H.M.A.S. DIAMANTINA
January 28 - February 6, 1964
February 15 - 18, 1964
Dm. 1/64

STATION MAP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100°
110° E
120°
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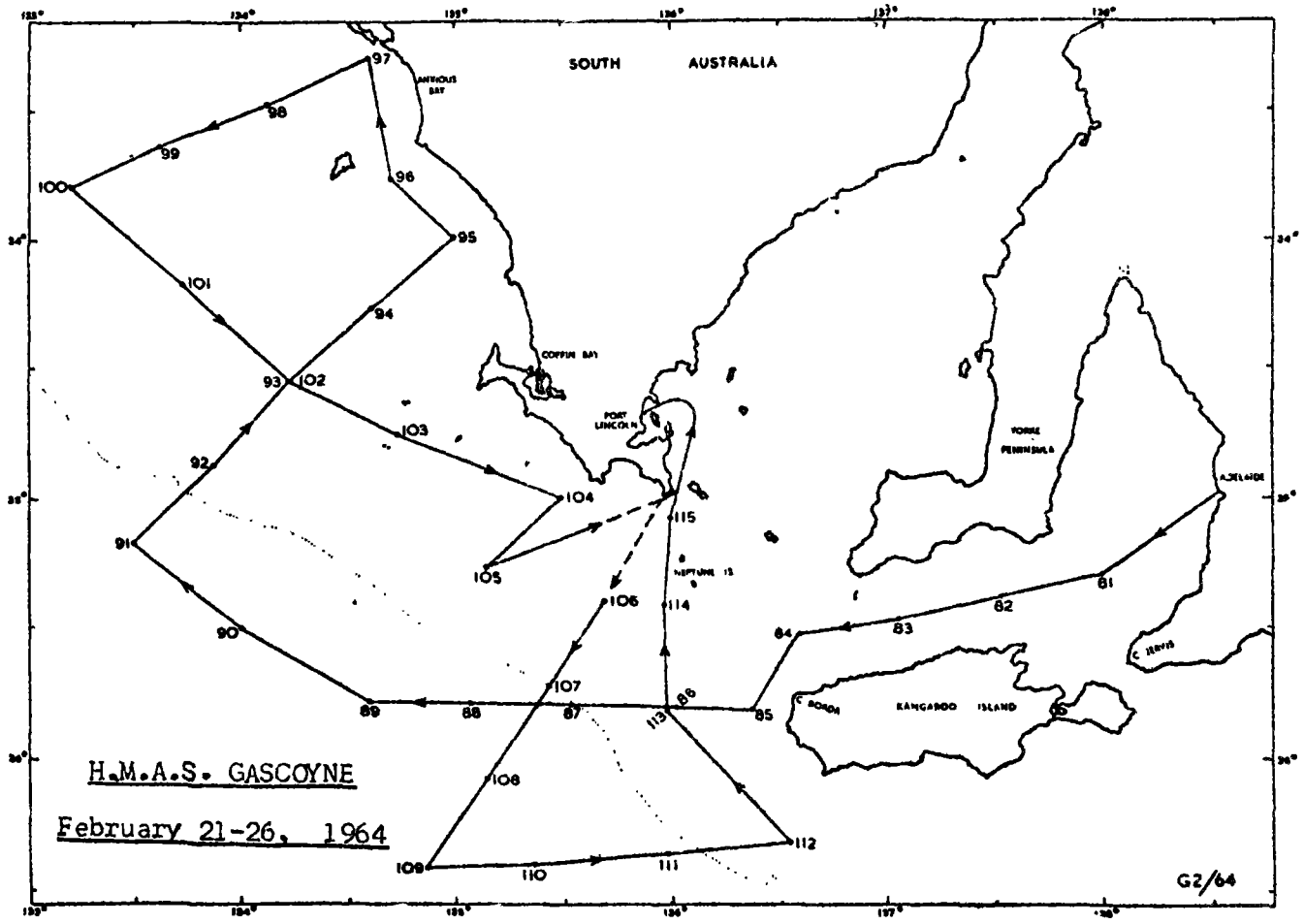
10° S
20°
30°
PENANG
COCOS I.
AUSTRALIA
FREMANTLE
H.M.A.S. DIAMANTINA
March 24 - April 21, 1964
Dm. 2/64
REFERENCE STATION
POSITION STATION


SOUTH AUSTRALIA
ANTHONY BAY
COFFIN BAY
PORT LINCOLN
NEPTUNE IS
YORKE PENINSULA
ADELAIDE
C. BORDA
KANGAROO ISLAND
C. JERVIS
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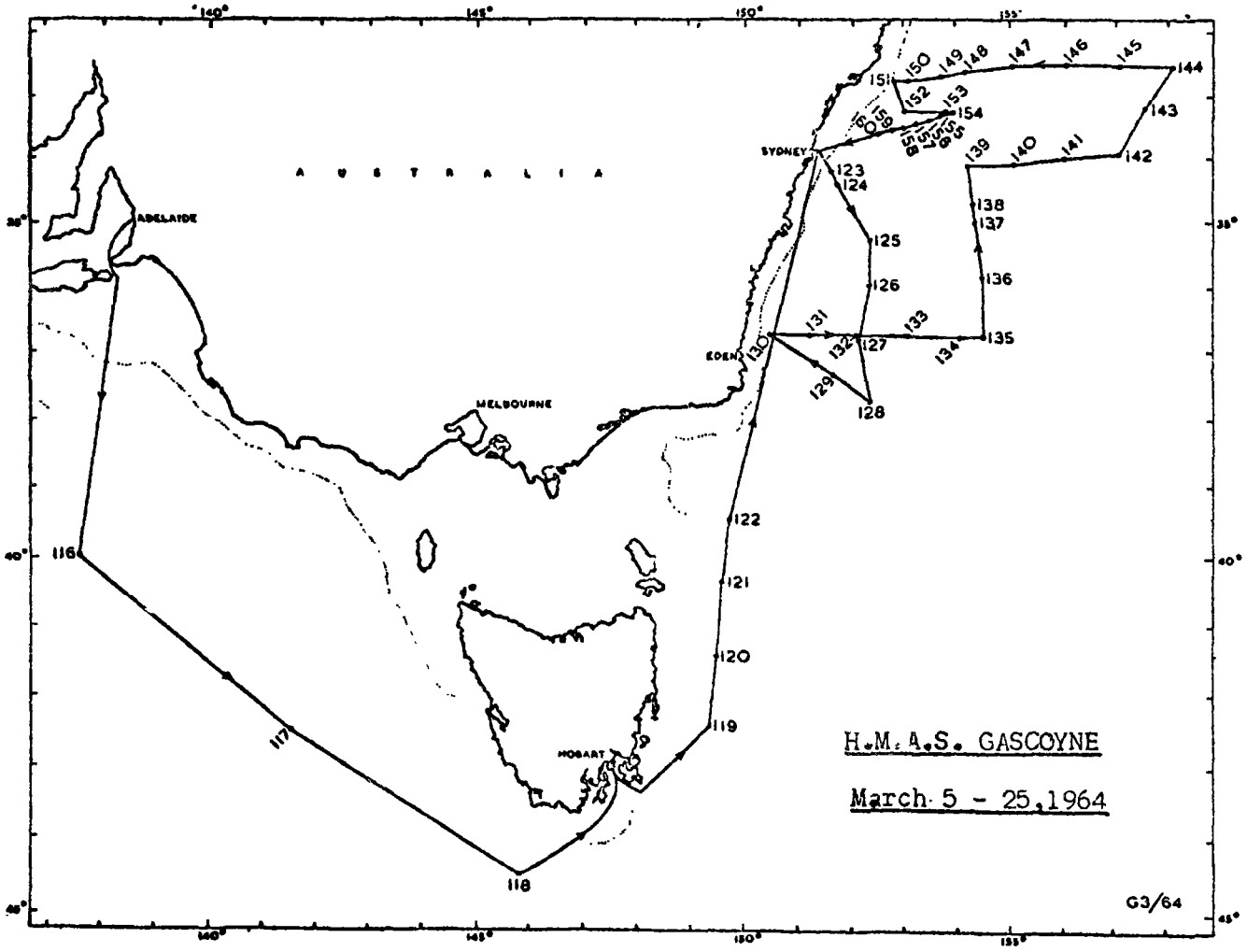
H.M.A.S. GASCOYNE
February 21-26, 1964
G2/64


A U S T R A L I A
ADELAIDE
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HOBART
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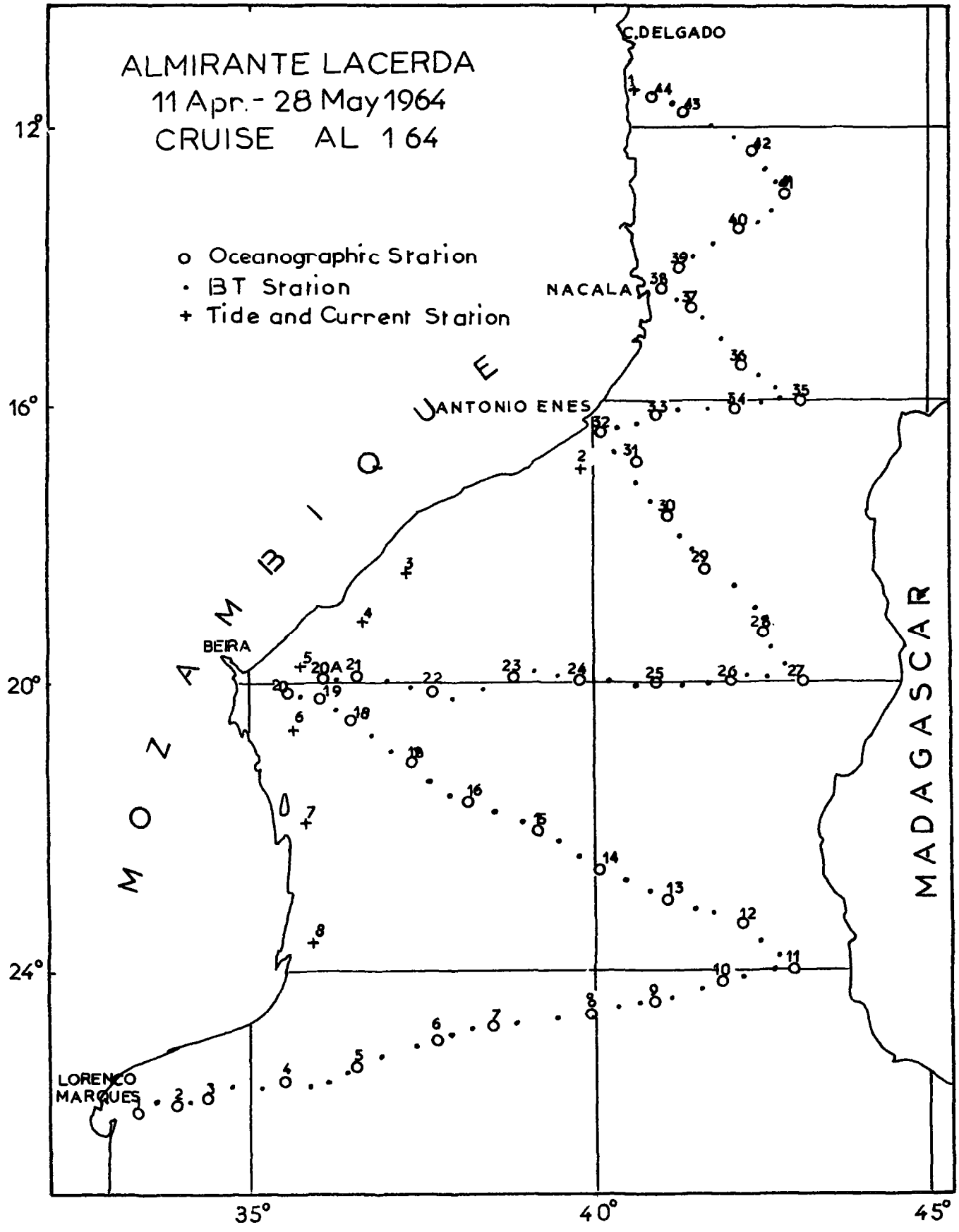
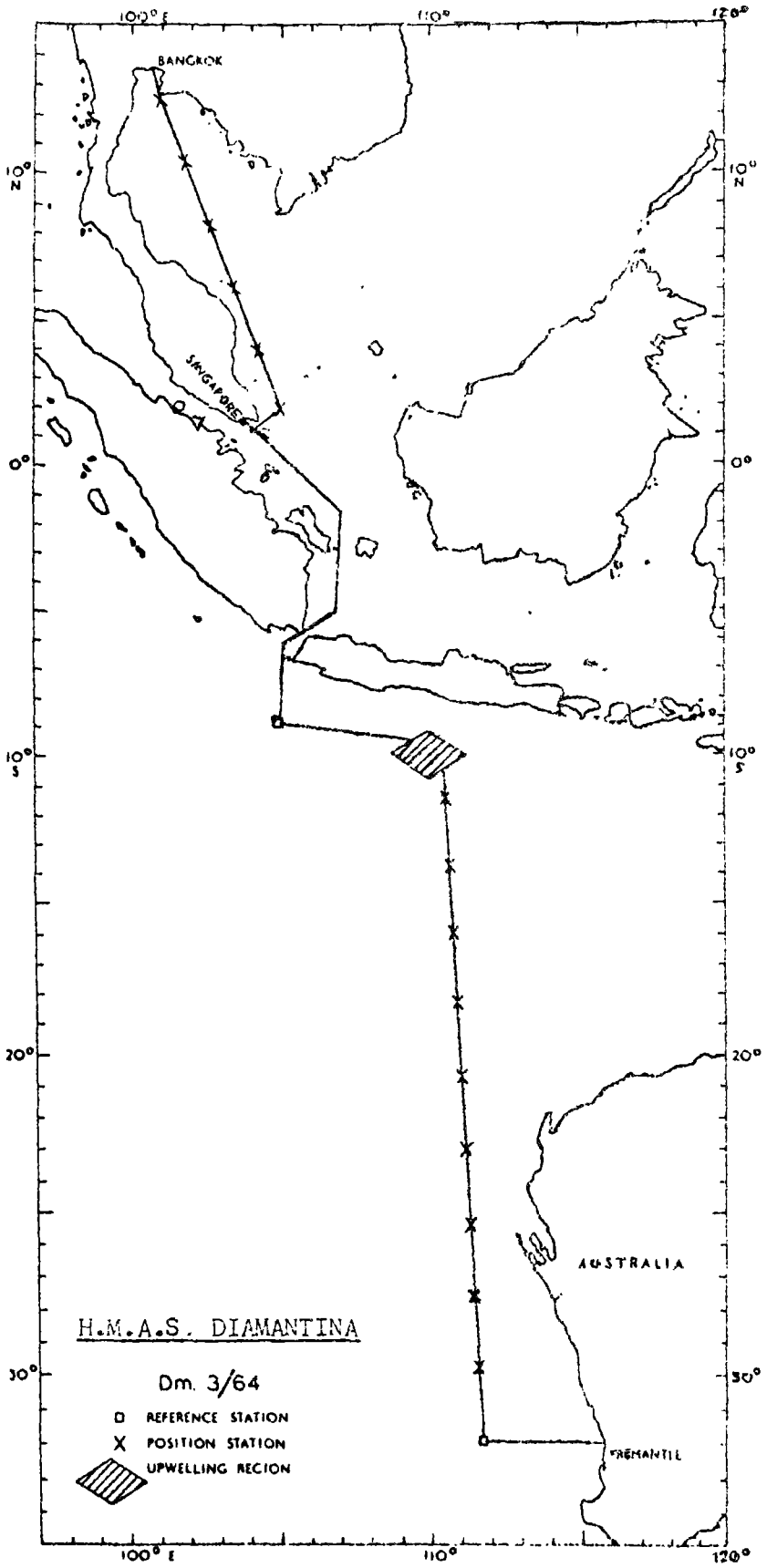
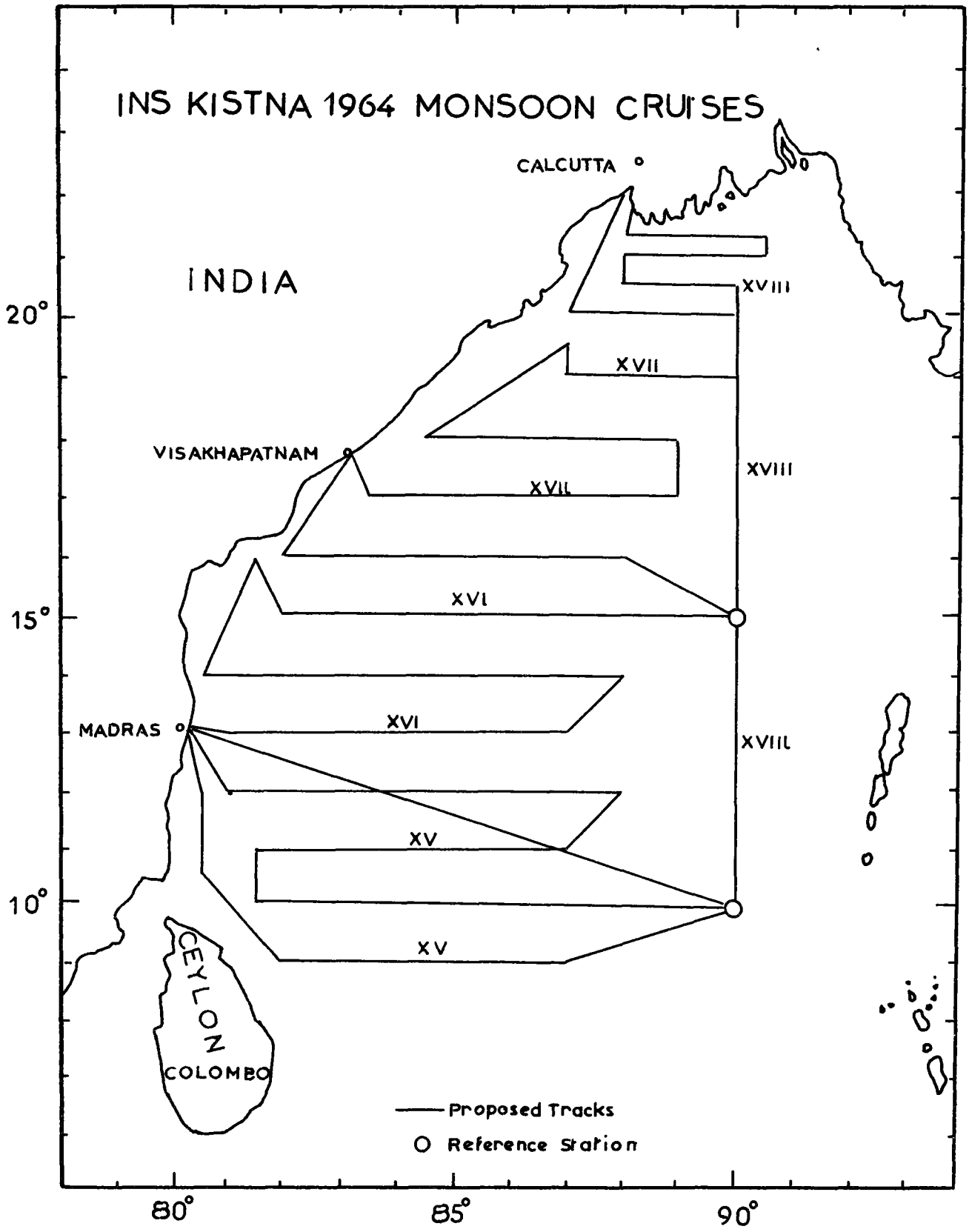
H.M.A.S. GASCOYNE
March 5 - 25, 1964
G3/64


ALMIRANTE LACERDA
11 Apr. - 28 May 1964
CRUISE AL 164
o Oceanographic Station
· BT Station
+ Tide and Current Station
C.DELGADO
NACALA
ANTONIO ENES
BEIRA
LORENCO MARQUES
MOZAMBIQUE
MADAGASCAR
12°
16°
20°
24°
35°
40°
45°



Scheduled IIOE Track


INS KISTNA 1964 MONSOON CRUISES
CALCUTTA
INDIA
XVIII
XVII
VISAKHAPATNAM
XVIII
XVII
XVI
MADRAS
XVI
XVIII
XV
XV
CEYLON
COLOMBO
Proposed Tracks
Reference Station
20°
15°
10°
80°
85°
90°