intergovernmental oceanographic commission

information paper 3

UNESCO/NS/10C/INF - 43

FOREWORD

Since distribution of IIOE Information Paper No. 2 and its supplement, important meetings have been held of the Scientific Committee on Oceanic Research and the Bureau of the Intergovernmental Oceanographic Commission. At both of these meetings the progress of the Expedition and its co-ordination were discussed. Brief summaries of the actions of SCOR and the Bureau are contained in the present paper. One of the most important decisions was to hold an IIOE co-ordination meeting in Paris on 22-24 January 1964.

With field work in the Indian Ocean reaching its peak, problems connected with the exchange of data and information, the compilation and analysis of observations, and the preparation of atlases are becoming increasingly important. In many ways these activities offer the greatest opportunities for international co-operation, without which the full scientific value of the Expedition cannot be readily achieved. It is to be hoped that SCOR and its working groups, and IOC and its associated activities will provide effective mechanisms for facilitating this essential joint action.

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Unesco Office of Oceanography
Paris, June 1963

IIOE INFORMATION PAPER
No. 3

1. Recent actions of SCOR

During the Sixth SCOR Meeting, from 3 to 9 April 1963 in Halifax, discussions of IIOE led to the following actions:

1.1 Reports were presented by Mr. Paul Tchernia and Professor J. Krey, disciplinary experts for plankton and descriptive oceanography, respectively. Mr. Tchernia's report, reproduced as Annex I, finishes with several recommendations which were approved by SCOR. A portion of Professor Krey's report, including a record of discussions he held with Soviet biologists, is reproduced as Annex II.

1.2 It was reported that the geologists and geophysicists with whom Dr. Humphrey had corresponded felt that there was no need for a disciplinary expert in these fields. In discussing this question, SCOR noted the existence of various problems concerned with the preparation of Indian Ocean bathymetric charts, and suggested that an expert be found to study these problems and suggest appropriate action.

1.3 The Indian National Committee plans to establish an advisory committee for the Indian Ocean Biological Center; Dr. Panikkar was requested to act for SCOR on this committee.

1.4 A Working Group on Atlases, with particular reference to IIOE, has been established under the chairmanship of Mr. Joseph L. Reid, Jr. Other members include Professor P.L. Bezrukov, Professor S. Motoda, Professor Colin Ramage and Dr. Vagn Hansen (ex officio, as Curator of IOBC).

2. Recent activities of IOC

The Bureau and Consultative Committee of IOC met in Moscow from 6 to 8 May 1963. A summary of discussions concerning IIOE follows:

"Coordination of the International Indian Ocean Expedition

In accordance with Resolution 3, many of the countries participating in the Expedition have appointed national coordinators. Experts in several fields of physical and biological oceanography have been appointed by SCOR to review the status of work in these fields, and preliminary reports have been presented to SCOR. Although no expert has yet been appointed in the fields of geology and geophysics, there appear to be several problems concerning the preparation of bathymetric charts which would merit review by a specialist. A subject leader for the fisheries aspects of the Expedition has been appointed.

The Bureau considered that one of the principal requirements for coordination was to facilitate the exchange of information between participants. This exchange could be effected in part by the Secretariat, and participating countries were urged to supply such information for distribution. It was agreed that a meeting of the national coordinators and appointed experts should be held in order to improve inter-communication. The exchange of data is an important element of this problem, and the Bureau decided to hold the coordinating meeting at about the same time as the meeting of the working group on data exchange, before the next session of the Commission and preferably in late January, 1964.

A proposal of the USSR, concerning geological and geophysical studies along one or two meridional sections in the Indian Ocean, was referred to national coordinators for their review and subsequent discussions at the coordinating meeting. (see Annex III)

In connection with the Unesco plan to issue collected reprints of the Expedition, the representative of the United Kingdom suggested that these should be accompanied by lists of available translations of the papers into other languages."

Arrangements have been made to hold the IIOE Coordination Meeting on 22 to 24 January 1964. Invitations will be sent in the near future to countries participating in the Expedition and to the experts concerned with various special fields of investigation.

3. Exchange of information

3.1 Newsletters on national IIOE programs are being published by some national committees. The following have been received by this office:

"IIOE Newsletter of Japan" published by the IIOE Data Center of Japan, Marine Division, Japan Meteorological Agency, Tokyo (No.3 dated March 1963).

"United Kingdom IIOE Programmes. Newsletter" published by the Royal Society (No.1 and 2, May 1963). Since distribution of this newsletter is limited to UK laboratories, it is reproduced here for wider distribution (Annex IV).

3.2 Cruise reports have been received from the South African National Coordinator for the following cruises:

NATAL Cruise N/N	5 to 22 November 1962
NATAL Cruise 7	7 to 29 January 1963

The main aim of Cruise N/N was to acquire soundings from a region not covered by previous surveys, and to investigate seamounts in the region. Observations included gravity cores, grabs, midwater trawls, meteorology and gravimetry. The region was southeast of Cape Town, south to 40°S and east to 35°E.

Cruise 7 worked 4 profiles from Durban to Cape Town and extending offshore 380 to 480 miles. The scientific program consisted principally of descriptive oceanography and plankton studies.

3.3 Cruise plans have been received from the Australian National Coordinator for the following cruises:

GASCOYNE 1/63	17 January to 17 February 1963
DIAMANTINA 1/63	28 March to 28 April 1963

On both operations, observations are to be made along the meridian 110°E, from 32°S to 10°S. The objectives are:

> To determine zooplankton biomass, primary production, pigments, particulate carbon, and micronekton abundance along the 110°E meridian.
>
> To examine the environmental factors likely to influence these biological properties, and the inter-relations of these properties with particular reference to the dynamics of production.

3.4 We have been informed that United Kingdom will establish a radio sonde station in the Seychelles for the IIOE. Huts and equipment have been despatched and it is expected that the station will make at least one ascent per day from August 1963 to December 1964. Data obtained from these soundings will be transmitted to Aden and incorporated in synoptic meteorological broadcasts from there.

3.5 It has been reported by the Portuguese Hydrographic Institute that the tide gauge in operation at Beira, Mozambique (19°49'S, 34°50'E) was destroyed by a storm. It is hoped that a new gauge will be in operation by the end of 1963.

4. Meteorological Observations

The International Scientific Coordinator for Meteorology has pointed out that some research vessels operating in the Indian Ocean have not been transmitting surface weather observations as recommended in Resolution 4 of the second Session of IOC. The pertinent section of the Resolution follows:

> Recommends that operators of all participating oceanographic vessels should ask the meteorological services of their respective countries to designate these vessels "selected ships" and, in accordance with standard WMO practice, to provide them with instructions for the making and rapid transmission by radio, of surface weather observations, and that observations should be made at or near 00, 06, 12 and 18 hours GMT encoded, and sent as soon as possible to the most convenient ship-shore radio station for inclusion in meteorological broadcasts, and that the same routine should be followed for shipboard upper air observations;

The important work of the International Metoeorlogical Center can only be accomplished successfully if the Center has prompt access to all surface weather observations in the Indian Ocean. Therefore, participants in the Expedition are urged to instruct their ships to cooperate in this program, whether their principal mission be hydrography, geology-geophysics, biology or some other type of marine investigation.

5. National IIOE Coordinators *

East Africa	Mr. D.N.F. Hall	East African Marine Fisheries Research Organization P.O. Box No. 668 Zanzibar
(Note that Mr. Hall was incorrectly shown in IIOE Information Paper No.2 as coordinator for Zanzibar alone)		
Portugal	Mr. Manuel Antunes da Mota	National Committee for Oceanographic Research Instituto Hidrografico Rua do Arsenal, Porta H 1° Lisboa 2
USSR	Prof. P.L. Bezrukov	Institute of Oceanology Academy of Sciences of the USSR 8 Bakhrushina Moscow G-127
	Dr. V.M. Naumov (deputy)	All Union Research Institute of Fisheries and Oceanography (VNIRO) 17, Krasnoselskaya Street Moscow B-140

* Changes to list given in Annex B of IIOE Information Paper No.2

6. National Participants

6.1 Participation of Malaya

Notification of the participation of Malaya in the Expedition has been received in a letter of 4 March from the Permanent Secretary for External Affairs. An extract from the letter follows:

"At a meeting of the Working Committee of the NSCOR various proposals by members regarding the scope of desirable Malayan requirements under IIOE were considered. These are summarised below:

ATMOSPHERE
Meteorology

As many sea station reports as possible from 1° to 8° North latitude; preferably including wind speeds and directions at 0, 1500, 3000 and 6000 feet.

HYDROSPHERE

Oceanography

Observations desirable from straight E-W-E runs at intervals of 1° latitude from 1° to 8° North at different hours of the day and different months of the year - recordings to include;

currents - speed and direction
water - temperature and salinity at 10 fathom intervals depth
echo depth soundings
core-samples - minimum interval density $\frac{1}{2}^{\circ}$ (30 miles) and depth 5 metres where practicable

Biological Studies

Any stop at least 1 hour plus 3-hour night stop for collection under lights (maximum one per night)

- one person to be stationed on board
- in addition beach work on Phuket & Nicobar Islands as can be fitted conveniently with other projects

Fisheries

Productivity and continuous plankton sampling - both moving and stationary (1 hour) at intervals of 20 to 30 miles, night and day.

LITHOSPHERE

Geophysical work

Indication of major tectonic structures may be revealed by a suitable network of gravimetric, seismic, magnetometric, and echo sounding measurements - proposed network totals 2600 sea miles and would need to be traversed only once if suitable ship-based equipment is available on one of the specially fitted IIOE ships.

Marine Geology

Bottom sampling would be desirable at intervals not greater than 10 miles on the same traverse network as proposed for the geophysical measurements and would involve stops, some of which might be long over the deeper portions of the sea-bed.

The various proposals could be conveniently classified into main groups as follows:

(a) single traverses with highly specialized equipment;

(i) continuous without stops;
(ii) intermittent with stops;

(b) repeated traverses with more simple equipment;

(i) continuous without stops;
(ii) intermittent with stops;

Proposals under (a) would involve the utilization of specially fitted ships of the IIOE for a relatively short period; proposals under (b) would involve the repeated use of smaller vessels, some of which possibly could be made available periodically by the Naval Branch of the Federation of Malaya."

6.2 Participation of Ceylon

The following information on participation of Ceylon in the Expedition has been received in a letter of 8 April from the Permanent Secretary, Ministry of External Affairs:

"With reference to your letter No. NS/9/89/88 dated 16th November 1962 I have the honour to inform you that the Government of Ceylon has taken the following steps in connection with the above Expedition.

A Ceylon Committee for the International Indian Ocean Expedition was formed, consisting of The General Secretary of the Ceylon Association for the advancement of Science, University of Ceylon, Colombo, as Convenor and General Secretary, and representatives of the University of Ceylon, the Port Commissioner, the Director of Fisheries and the Director of Meteorology.

Three meetings of the Committee have been held and the Committee has decided that it would participate in three main directions, viz.

i. The reporting of Meteorological observations;

ii. The reporting of Tide Gauge observations; and

iii. The obtaining of harbour facilities for IIOE ships.

The meteorological observations consist of radiosonde data, radar observations and surface observations from pilot balloon stations.

Tidal gauge observations are to be supplied by the Colombo Harbour authorities. The Committee intends negotiating for the establishment of tidal gauges in Galle, Jaffna and Trincolalee. The records are to be sent to the Permanent Service for Mean Sea Level, The Observatory, Birkenhead, England.

Harbour facilities. The following facilities have been arranged:

i. Exemption from harbour fees; port, docking facilities and pilotage at no cost or at the cheapest possible rates.

ii. Tax exempt fuel.

iii. Special customs facilities for the entry and embarkation of scientific equipment and stores needed for the Expedition (it being important that the packaging of delicate scientific equipment be not disturbed and that water samples are not opened).

iv. Special customs facilities for transhipment, from ship to home or other laboratories, of scientific specimens collected by the Expedition.

v. Simplification of procedure for obtaining permission for ships to make scientific observations in coastal waters and to enter minor ports when necessary.

Other activities :-

i. Ship observations. It was felt necessary to expand the programme for receiving ship observations in Colombo and the Royal Ceylon Navy is willing to transmit these observations to the Colaba Observatory, Bombay.

ii. The Royal Ceylon Navy might be in a position to collect data of interest to the IIOE in the course of their routine cruises.

iii. The Fisheries Department had asked for advice regarding the manner in which it could participate, and it was suggested that the Department could make regular observations on surface and deep temperatures in coastal waters, and that advice on biological work could be obtained from a Fisheries Biological Research Station which was soon to be established in Cochin. It is therefore possible that the Fisheries Department may contribute to the work of IIOE, and the Department reported that it was planning to make observations on salinity and temperature in a few selected areas in coastal waters."

7. Submarine Volcanism

Dr. Miljenko Buljan, Director of the Institute of Oceanography and Fisheries in Split (Yugoslavia) and member of the FAO Advisory Committee on Marine Resources Research, has suggested that participants in the Expedition should look for evidence of submarine volcanism in the Indian Ocean. The influence of submarine volcanic activity on the chemistry, physics and biology of the ocean has been investigated by Dr. Buljan during the past ten years. He has shown that such activity may not only increase the temperature of near-bottom waters, but may also have an important effect on the productivity of overlying waters through the addition of nutrient salts.

The following phenomena may be indicators of submarine volcanism:

1. Increase in the ratio of borate or fluoride to chlorinity, or an increase in the specific alkalinity.

2. Occurrence of unusually high concentrations of silicate, phosphate, nitrite or iron in deep waters.

3. Low concentrations of dissolved oxygen and the presence of hydrogen sulfide in regions where this is not usually the case.

4. Unusual temperature increase in near-bottom waters.

5. Isolated open-ocean patches of discolored water.

6. Mass mortality of fish in the open ocean.

7. Direct observations of submarine volcanic activity, discharge or perlite or pumice, and the presence of submarine volcanic cones.

Information on any of these phenomena could be sent to this Office, or directly to Dr. Buljan.

8. RRS DISCOVERY - Radio Communications and Schedule

The following information on radio communications with RRS DISCOVERY (call letters GLNE) has been furnished by Mr. Ronald Currie:

Medium Frequency: 500, 512, 480, 454, 410 Kc/s

Intermediate Frequency (radio telephone): 2182 (distress); 2009, 2016, 2527 (ship-shore); 2241, 2301, 2431 (ship-ship); 2381 (calling); 2252, 2738 Kc/s.

High Frequency (w/telegraphy): 4183.5 (C), 4203, 4228; 6275.75 (C), 6305.25, 6342; 8367 (C), 8407, 8456; 12550.5 (C), 12610.5, 12684; 16734 (C), 16814, 16912; 22252.5 (C), 22350, 22287.5 Kc/s - frequencies marked (C) are for calling, others for working.

High Frequency (radio telephone):

4072.4	8204.4	12340.5	16470.5	22010.5 Kc/s
4123.6	8255.6	12389.5	16519.5	22059.5
4091.6	8223.6	12361.5	16491.5	22031.5
4104.4	8261.9	12382.5	16526.5	22066.5
4129.9		12368.5	16512.5	22045.5

The following watch keeping is planned:

Zone B (30°E to 80°E)			Zone C (80°E to 160°E)		
0400	0600	GMT	0000	0200	GMT
0800	1000		0400	0600	
1200	1400		0800	1000	
1600	1800		1200	1400	

The following revised schedule for RRS DISCOVERY has been received:

R.R.S. "DISCOVERY"

Alteration to the proposed programme for the I.O.E.

Season	Date	Port of call	Cruise programme	Duration of cruise
	May 12			
	19			
	26	Leave Plymouth 31 May	Passage out	19 days
	June 2			
	9			
	16	Aden, 19-22 June		
	23			
South West Monsoon	30			
	July 7			31 days
	14		Survey of upwelling on South Arabian coast	
	21	Karachi, 23-26 July		
	28			
	Aug 4			25 days
	18	Aden, 20-23 August		
	25			
	Sept. 1		Carlsberg Ridge	19 days
	8	Mombasa, 11-14 Sept.		
	15			
	22		Single ship seismics	18 days
	29			
		Seychelles, 2-5 Oct.		
	Oct. 6		Carlsberg Ridge	
	13	R/v HMS "Owen" 17 Oct.	Two ship seismics	16 days
	20	Mombasa, 21-24 Oct.		
	27			
	Nov. 3		Two ship seismics	22 days
	10			

Season	Date		Port of call	Cruise programme	Duration of cruise
	Nov.	17	Aden, 15-18 November		
		24			
	Dec.	1			22 days
		8			
		15	Plymouth, 10 December		
		22			
		29		Refit and Christmas leave	
	Jan.	5	Leave Plymouth 10 Jan.	Passage out	
		12			
North East Monsoon		19			19 days
		26	Aden, 29 January to 1 February	SURVEY I	
	Feb.	2			
		9			
		16		20°, 16° and 120°N sections	30 days
		23			
	Mar.	1	Cochin, 3-6 March		
		8			
		15		8°N and 55°E sections	22 days
		22	Seychelles, 28-31 Mar.		
		29			
	Apr.	5		60°, 68° and 80°E sections	30 days
		12			
		19			
		26	Colombo, 30 April to 2 May		
	May	3			
		10		Equatorial current	25 days
		17			
		24	Seychelles, 27-29 May		
		31		Equatorial current	13 days
	June	7			
		14	Mombasa, 11-13 June		
		21		SURVEY II	
		28			
	July	5		Equatorial sections	30 days
		12	Cochin, 13-15 July		
South West Monsoon		19			
		26			
	Aug.	3		8° and 12°N sections	30 days
		10	Bombay, 14-16 August		
		17		16°N section	13 days
		24			
		31	Aden, 29 Aug. to 1 Sept.		
	Sept.	7		Passage home	19 days
		14	Plymouth 20 Sept.		
		21			
		28			

27 May 1963

R.R.S. "DISCOVERY"

Staff for upwelling cruise, 31st May - 20th August

	Join Plymouth	Join Aden	Join Karachi
Biology	Mr. R.I. Currie (in charge)		
Physics	Dr. J.C. Swallow		
Bacteriology	Miss B. Kirtley		
Chemistry	-	Mr. F.A.J. Armstrong	
Biology	Mr. P.M. David		
Physics	Mr. M.J. Tucker		
Hydrographic	Cdr. R.A.G. Nesbitt		
Chemistry	Mr. P.G. Brewer		
Chemistry	Mr. G. Topping		
Biology	Mr. P. Herring		
Biology	Mr. M.V. Angel		
Physics	Mr. N.D. Smith		
Biology	Mr. A. de C. Baker		
Biology	Mr. A.D. Mackintyre		Mr. B. Irwin
Biology	-	Mr. D.H. Cushing	-
Biology	Mr. R. Bailey		
Biology	Dr. A. Prakash		
Resident Assistant	Mr. T. Vertue		

ANNEX I

ON THE COORDINATION OF PHYSICAL OCEANOGRAPHY OPERATIONS IN THE INDIAN OCEAN EXPEDITION

by

Paul Tchernia

The idea of an international campaign of coordinated synoptic observations covering the whole of the Indian Ocean was first discussed by the CSAGI Working Group on Oceanography at a meeting held in January 1957 at Göteborg. This idea, taken over by SCOR from its very founding (in July, 1957), took shape in 1959 in the form of an international year of oceanographic observations to be carried out on a very large scale with facilities supplied jointly by the nations or scientific bodies taking part.

In effect, problems peculiar to the Indian Ocean implied the very close coordination of oceanographic and meteorological observations, repetition of these observations during all four seasons of the year, their concentration into a region north of 20°S, and the making of these observations on a tight grid because of the scarcity of previous observations and the strong horizontal gradients of certain essential characteristics encountered in certain regions.

According to the principle of action used in the International Geophysical Year, a principle that has proved so fruitful for all disciplines involving planet-wide mobile phenomena (meteorology, magnetism, seismology, etc.), these observations should be performed simultaneously in a network with identical instruments and methods, concentrating on the study of non-permanent phenomena, whose variations both in time and space would be investigated, as well as their essential relationships with phenomena covered by other disciplines.

In 1959 Professor G. Wüst proposed a division of work based on such a systematic grid, but his plan was considered too strict by some and was not adopted. In place of a precise and limited operation, strictly coordinated in space and time and grouping problems of the ocean and the atmosphere in its objectives - an operation which, because of the peculiarities of the Indian Ocean, could have been a model in the history of oceanography - each national working group or institution was allowed to draw up its own plans in terms of its own facilities and its own interests. Only a very general line of action was retained from Wüst's plan.

Soon S.C.O.R. was confronted with a very large number of plans for participation, involving both permanent and non-permanent phenomena, and so little coordinated in space and above all in time that the "International Oceanographical Year of the Indian Ocean" was transformed into an "International Indian Ocean Expedition" which would last from 1961 to 1965. The peak period, originally planned for 1961-62, was gradually postponed to 1963-64.

As this period drew near, the need arose for the principal scientific authorities responsible for future undertakings to meet and to compare their projects so that, as far as possible, duplication or gaps might be avoided; so that precise requests

for exchanges or cooperation among ships working at the same time in neighbouring regions could be presented to the responsible authorities; and finally, so that the technical recommendations made by SCOR during the Copenhagen meeting of July, 1960, could be recalled and if necessary strengthened or clarified.

Instead of holding this meeting for the Indian Ocean as a whole, it was first decided to hold four distinct meetings corresponding to the regions - northwest, southwest, northeast and southeast - of this Ocean. In fact only two of these meetings were held - for the southwest Indian Ocean at Lourenco-Marques from 30 April to 2 May 1962, and for the north-west Indian Ocean at the National Institute of Oceanography, Wormley, from 9 to 11 July 1962.

During the Second Session of Unesco's Intergovernmental Oceanographic Commission (Paris, 20 to 28 September 1962) a special meeting was held by S.C.O.R. on the coordination of the Indian Ocean campaigns, where the rather disappointing results of the first two meetings were reported. In fact, it was shown that after two or three years of reflexion, discussion, and preparation, it was difficult to make any significant changes in plans of cruises which would shortly take place in regions rather remote from the research centers who would send their ships and personnel. The preparation of these campaigns has required considerable effort on the part of the responsible authorities to obtain the money, personnel and equipment needed to carry them out. The campaign plans were conceived in such a way as to meet the desires of the maximum possible number of specialists in the various branches of oceanography represented in the institution or country responsible for the campaign, but without reference to a precise general plan adopted internationally.

The fact that the International Indian Ocean Year 1961-62 has become the International Indian Ocean Expedition 1961-65 indicates very clearly the swelling development of this enterprise, but also the deviation from the original plan which was to carry out a coordinated operation, a multiple ship survey on a large scale devoted to this Ocean's non-permanent characteristics during one year. This operation implied not only the mobilization of facilities and personnel to the maximum possible extent but also the turning over of these facilities to a single command responsible for the planning and execution of the operation.

Such operations have been carried out, but on a smaller scale of time and space and by grouping the facilities of teams whose previous scientific orientation and personal relations simplified this cooperation :

Operation Cabot (1950) : Two nations supplied six ships for three weeks.
Operation Overflow (May - June 1960).
Operation Gibraltar Sill (May-June 1961) : Five nations supplied six ships for four weeks.
etc.....

Operations of this kind are certainly more difficult to carry out when they imply using for months at a time the facilities of fifteen or twenty nations whose stages of development in oceanographic research vary widely.

What was possible to achieve through goodwill has been done, largely thanks to the efforts of the Working Groups of S.C.O.R. and the extremely useful personal initiatives of Mr. Snider in his approaches to various governments. Certain problems were indicated, interest was awakened, a large number of nations agreed to join the undertaking with their own facilities and ideas, the active participation of meteorologists and WMO was obtained, contacts were made, meetings among certain responsible authorities were organized, problems were solved concerning customs, movements of ships in territorial waters, and radiocommunication; meanwhile, the scientific planning remained very loose.

We are facing a period of increased activity which will result in augmenting the sum of our knowledge of the hydrographic structure and the movement of water masses in the Indian Ocean, but we will not achieve the full efficiency that could have been provided by a multiple ship survey devoted for one year to that region of the Indian Ocean influenced by the alternating system of monsoons. When the plan took shape in 1959-60 it may have been that oceanographic opinion was not sufficiently alert to the general implications of circulation problems peculiar to the Indian Ocean, nor to the possible effectiveness of international cooperation in making possible an operation of this type on the scale of an ocean, even the smallest one.

It is also worth noting that among the various branches of geophysics, physical oceanography was the one which resisted the coordinated work of the International Geophysical Years for the longest time. We had to wait for the third International Geophysical Year (1957-58) to see physical oceanography officially listed - and very tardily - on the program, and it cannot be said that what was done in physical oceanography during the last International Geophysical Year was particularly inspired by the essential principle of action of the International Geophysical Years.

Yet, even though the physical oceanography of the International Indian Ocean Expedition does not appear to us to be sufficiently coordinated, it represents notable progress over that of the recent IGY in that :

1. For the first time true cooperation on an international scale has been established between oceanographers and meteorologists;

2. Many series of observations will be repeated at least during the two principal seasons of the monsoon;

3. We are at last trying to organise the standardization and intercalibration of instruments, methods and techniques among the various teams responsible for observations;

4. The IOC, a permanent intergovernmental body created in 1961 and linked to the highest of international bodies, the UN, now helps us very effectively in solving a large part of the practical problems that can be raised by this coordination.

Conditions for the conception and execution of a strictly coordinated operation appear in 1963 to be much more favorable than those prevailing in 1959-60. Nothing can be accomplished without time, adherences to the general plan were made known only slowly and gradually. It must be admitted that at first men's minds were rather unprepared for this undertaking and some were even reluctant.

At the stage reached on 1 April 1963, our thinking might be set down as follows :

... to allow the presently planned hydrographic operations to take place according to the plans of their organizers, intervening only when advice is asked;

... to try to keep, with the very efficient help of NODC Washington, an inventory in the form of seasonal charts of the hydrographic operations carried out in the Indian Ocean;

... to close this inventory in October 1964, and with the help of those of our colleagues who will then be truly interested in the study of the formation and circulation of the characteristic water masses in the Indian Ocean, draw up a succinct balance sheet of what will have been done;

... to define then, as precisely as possible, the principal problems raised by the hydrographic structure and dynamics of the Indian Ocean;

... to propose coordinated operations to be carried out according to a well-determined plan to gather data believed necessary to solve these problems;

... to propose these operations, to take a census of teams volunteering to carry them out, and then, in full agreement with responsible authorities, to organize and carry out as much as possible, including, if necessary, a multiple ship survey with all the requirements of subordination that this implies.

ANNEX II

ON THE COORDINATION OF PLANKTON RESEARCH IN THE INDIAN OCEAN EXPEDITION

In accordance with Resolution 3 of the Second Session of the IOC, Professor J. Krey was appointed by SCOR to review the work accomplished and make specific recommendations on the subject of plankton research during the International Indian Ocean Expedition. Professor Krey's report has been received by the President of SCOR and by the Secretariat of IOC. Two sections of this report are reproduced here as being of immediate interest to scientists participating in the IIOE.

Section 1

Advice and recommendations contained in the minutes of a meeting devoted to a discussion of the International Programme in Marine Biology, Indian Ocean, held in Moscow, 18-22 March, 1963

Minutes prepared by Professor J. Krey and Professor L.A. Zenkevich. Other participants in the meeting - Professor B.G. Bogorov, Professor T.S. Rass, Dr. M.E. Vinogradov. The meeting was held at the request of Dr. G.F. Humphrey, President of SCOR.

The results of research work that had been carried out to date were discussed and a number of recommendations were put forward for consideration by scientists, national coordinators, SCOR and IOC. The recommendations, which are shown below, are open to comment by all persons receiving this document. Comments should be sent to the Office of Oceanography, Unesco, Paris.

a) Attention of the IOE members is drawn to the inadequate and incomplete research coverage of the southern part of the Indian Ocean and its south-western area and also of the Arabian Sea and the Bay of Bengal, and, especially, the areas of oxygen deficiency and H_2S appearance.

b) For establishing a more complete picture of marine biology of the Indian Ocean it was felt desirable to develop a network of shore and island stations for biological observations along with expeditionary studies carried out aboard research vessels. It was emphasized that stations away from the mainland and situated on islands should be used for the collection of biological materials. It was recommended that the following shore stations should be utilized for collection purposes:

Cronulla, Australia, C.S.I.R.O., Division of Fisheries and Oceanography.
Madagascar, Nosy-Bé, Station Océanographique.
Cape Town, Division of Fisheries
Bombay, Dept. of Zoology, Institute of Sciences
Mandapam, India, Central Marine Fisheries Research Station
Seychelles Isl., station should be established anew
Kerguelen Island, French Research Station

c) The participants of the meeting expressed an immediate desire to see the collected materials in printed form in the shortest possible time (express information); the latter should be produced in the form of brief accounts with a cartographic picture of distribution, whereas detailed treatment of the freshly collected materials should be postponed to a later period. It was felt appropriate that a reference list on a given narrow problem should be attached to the express information account. Also, a list of specialists dealing with the processing of particular material should be provided. This could be done as a loose-leaf collection.

d) There was expressed an unanimous opinion that "weather ships" should also be used for carrying out biological observations.

e) The participants of the meeting expressed the desire that SCOR should submit all the above-mentioned problems to IOC so that the latter, as an intergovernmental body, could bring them to the attention of respective governments.

f) Additional proposal to point (b): The organization of shore stations for biological work will permit year-round (seasonal) and also multiannual observations.

g) Having attached special attention to plankton studies the members of the meeting noted the desirability of establishing diurnal and multiurnal observations (stations) for the investigation of the vertical migration of plankton.

h) The meeting also stressed the major significance of investigations devoted to the horizontal and vertical distribution of early fish stages - eggs and larvae. The investigations were considered to be of important biological significance and most helpful for the estimation of the numeral characteristics and the spawning places of fishes.

Section 2

Answers to a questionnaire on plankton work sent by Professor J. Krey to participants in the IIOE

France

1) a. Institute: Station Marine d'Endoume, rue de la Batterie des Lions Marseille (7e), France, and Station Marine de Tulear, B.P. 141, Tulear (Madagascar).

b. Leading scientist: Professor J.M. Peres, Directeur de la Station Marine d'Endoume.

c. Collaborating scientists: Professor L. Deveze
Dr. Minas
Dr. Pizarro
Dr. M. Travers
Dr. A. Travers
Dr. A. Bourdillon
Mr. Aboussouan
Mr. Leveau
Mr. Bonin

2) a. Vessel: "Actaea" (12 m long)

b. Area of investigation: 50 miles off Tulear

c. Time of work at sea: 15 July - 10 August, 1962
14 August - 21 September, 1962
1 April - 15 May, 1963

3) a. Planktological problems being followed during the cruise: primary production, phytoplankton, zooplankton.

b. Methods applied for:

i. sampling: big bottles and filtration - C^{14} method of Steemann Nielsen - plankton nets, standard Mediterranean and Currie IIOE net.

ii. preservation: millipore filter dried in refrigerator for chlorophyll determination, formalin and lugol for net samples.

iii. analysis: analyses made in the "Station Marine d'Endoume".

c. Depths or levels of work: 0 - 20 m, 0.5 (2) - 5 - 10 - 20 (30) - 40 - 60 - 80 m, 0 - 200 m if possible.

d. Time of sampling: Cruise 14 Aug. - 21 Sept. 7 - 14 h. local time

e. Quantity of samples: Cruise 14 Aug. - 21 Sept., 29 stations

4) a. How are the results worked out?

b. When will it be finished? Probably at the end of 1963

c. Where and when will it be published? At the end of 1963 in a special number of "Recueil des Travaux de la Station Marine d'Endoume.

d. Completely or summarized? Completely.

5) Which environmental work has been done? Temperature, salinity, O_2, transparency.

6) Questionnaire filled in by Professor J.M. Peres.

Republic of South Africa

I

1) a. Institute: Oceanographic Research Institute, P.O. Box 736, Durban.

b. Leading scientists: Professor David H. Davies (primary production)

c. Collaborating scientists: Miss B. Mitchell-Innes, M.Sc. (dino-flagellata)

2) a. Vessel: R.S. "Lady Theresa"

b. Area of investigation: fixed stations off Durban

c. Time of work at sea: one cruise per year on R.S. "Africana II", Division of Sea Fisheries (Cape Town) 6 weeks - 2 months - primary production.

3) Planktological problems being followed during the cruises: primary production.

4) Where and when will the results be published? The long cruises primary production results will appear in the publications of the Director of Sea Fisheries, Cape Town.

5) Which environmental work has been done? Temperatures and salinities.

6) Questionnaire filled in by Professor D.H. Davies.

7) Additional information: Little plankton work is being carried out in this Institute. The supporting studies on plankton for the primary production work are being carried out by the Division of Sea Fisheries and the Department of Oceanography of the University of Cape Town. Both these organisations have extensive programmes on plankton. We are attempting to carry out specialised taxonomic work on the Flagellates but have met with difficulties in relation to staff in this connection.

II

1) a. Institute: Division of Sea Fisheries, Beach Road, Sea Point, Cape Town.

b. Leading scientists: Drs. A. De Decker, F. Mombeck

c. Collaborating scientists: Miss E. Nel, Mr. R.I. Dick.

2) a. Vessel: Africana II, Gross tonnage = 882;

b. Area of investigation: Southwestern Indian Ocean.

c. Time of work at sea: June-July 1961, June-July 1962, April 1963.

3) a. Planktological problems being followed during the cruise: Horizontal and vertical distribution. Standing crop. Taxonomy. Primary production (C^{14}).

b. i. Sampling: N50V-, N70V (closing)-, N100H-, N100B- and N200B-nets (Discovery type).
Currie net (1963 only)
Nansen-Petterson bottles (for phytoplankton counts)

Continuous plankton sampling from surface while steaming.

Probing for deep zooplankton by small net attached to hydrological wire.

ii. Preservation: Neutral formalin.

iii. Analysis: Settled volumes. Counting. Full taxonomy of such groups for which a specialist is available.

iv. Calibration or standardization: Flow-meters (with N100H and Currie nets only).

c. Depths or levels of work: N50V; 100-0m. Nansen-Petterson : 0, 10, 20*, 30, 50, 75, 100, 150‡(*in 1961 only

(‡ in 1962 only).

Currie net: 200-0 m.

N100H : surface. N100B : 250-0 in 1961
150-0 in 1962

N200B : various depths depending on time available, mostly 1000-0 m.

N70V : 50-0, 100-50, 250-100, 500-250, 750-500, 1000-750, 1500-1000.

Depth controlled by wire length.

d. Time of sampling: No rigid time schedule could be followed, but most of the sampling was done in daylight hours, except 18 N70V-nets (100-0) taken for a check on diurnal migration and most of the continuous surface sampling which was done while the ship was underway between stations.

e. Quantity of samples:

N50V	NP	N70V	N100H	N100B	N200	Deep probes	Contin. surf.s.	C^{14}	Year
17	210	211	29	28	24	61	28	16	1961
13	124	161	15	16	9	51	124	16	1962

4) a. How are the results worked out? Only the 1961 material has been worked on so far:

Phytoplankton: taxonomy and distribution finished, (MS in preparation).

Copepoda: N70V-samples) well advanced for taxonomy
N100H + B " and ecology.
N200- ---- identification completed.

(MMSS in preparation)

Surface collection (continuous) partly finished.

Hyperiid Amphipods: N100 (H+B) and N200 finished.

Pelagic Polychaeta: " " " " "

b. When will it be finished? ?

c. Where and when will it be published? Mostly by the Government Printer, Pretoria.

One paper has already been printed:

A. DE DECKER : Zur Oekologie und Verbreitung der Copepoden aus dem Meeresplankton Suedafrikas.
1962 Biologisch Jaarboek Dodonaea, Gent.XXX - pp.86-122.

d. Completely or summarized: Depending on size and nature of data obtained.

5) a. Which environmental work has been done? Temperature, salinity. Oxygen, phosphates. Full meteorological observations every two hours.

b. When will this material be available? At the Division of Sea Fisheries, Sea Point.

6) Additional information: Nil

7) The Director of Sea Fisheries, Sea Point, Cape Town.

England

1) a. Institute: National Institute of Oceanography, Wormley, Godalming, Surrey.

b. Leading scientist: R.I. Currie - in charge of programme.

c. Collaborating scientists: P.M. David, P. Foxton, M.R. Clarke, A. de C. Baker, Miss B. Kirtley

Also assistants from N.I.O. students and visiting workers including D.H. Cushing, A.D. Mackintyre.

2) a. Vessel: R.R.S. "Discovery"

b. Area of investigation: Arabian Sea

c. Time of work at sea: May-August 1963; Jan. - Sept. 1964.

3) a. Planktological problems being followed during the cruises:

1. Study of phytoplankton and zooplankton in relation to chemistry and physics of the upwelling region off Arabia

2. Midwater trawling in Arabian and Red Sea

3. Study of sea birds and their relation with surface biocoenoses

4. Distribution of cephalopods

5. Study of sonic scattering layers in relation to vertical migration and many more specialised problems

6. Collection of standard net hauls and other distributional material for IOE biological centre, Cochin

7. Study of distribution of fish from acoustic records and midwater trawling. Fish eggs and larvae by Gulf III

b. Methods applied for

I. sampling: 1. Bacteria - special sampler
2. Phytoplankton 7.5 litre all plastic water bottle
3. Zooplankton - I.O. Standard Net haul
- Gulf III sampler 60 mesh and 1 mm mesh
- Vertical net 70 cm diam.
- I.O. Standard net as towed net for horizontal and oblique hauls
- Isaacs-Kidd Midwater Trawl 10 foot model with 6 mm Knot to Knot mesh and the closing bucket Foxton described at Copenhagen.

4. Nekton - British Columbian Midwater Trawl - about 18 metres side, square mouth.
   - hand net and hand lining.
5. Acoustic methods - Narrow beam high frequency E/S operating at 36 and 54 Kc/sec.
   - Precision depth recorder, wide beam operating at 16 Kc/sec.
6. Also various experimental nets.

II. Preservation: 1. For general plankton 10% neutral formalin (neutralised with hexamine 1 kg to 10l strong formalin)
2. Deep freezing for certain specimens.

III. Analysis: Chlorophyll estimations by Richards & Thompson method
Zooplankton displacement volume, chemical analyses and systematic analysis.

IV. Calibration or standardization: Chlorophylls will be expressed as optical densities at 750, 665, 645, 630, 510, 480, 435 and 410 m (Unicam Sq 500 spectrophotometer) Thermopiles calibrated against National Standard at Kew Observatory.
Photometers calibrated in reference to thermopile.
Chemical techniques in charge of Mr. F.A.J. Armstrong, Plymouth.
Flowmeters - laboratory calibrated with field checks once monthly.
Depth gauges - pressure tank calibrations.
Reference stations will be occupied where possible.

c. Depths: Phytoplankton, 6 depths in euphotic zone.
Zooplankton vertical hauls to 1500 m in divided hauls 50-0, 100-50, 200-100, 500-200, 1000-500, 1500-1000 and occasionally to 5000 m in 1000 m intervals.

Isaacs-Kidd trawls to 1000 metres at selected stations.
Divided in 200 metre layers.

Larger midwater trawls in upper 300 metres.

d. Time: Stations twice daily 1200 hrs and 2200 hrs local time.

4) a. How are the results worked out? Mostly on board ship excepting that zooplankton will only be sorted to group level on board.

b. When will it be finished? Impossible to say.

c. Where will it be published? Generally in marine journals and more specialised publications.

d. Completely or summarized? Reviews will also be published.

5) a. Which environmental work has been done? Complete coverage of usual chemical and physical observations t^{o} C, S^{o}/oo, O_2, H_2S, inorg P, total P, NO_3, NO_2, Si.

Direct current measurements both by meter and neutrally buoyant floats.

b. Where will this material be available? At the NIO, although standard data will be submitted to Data Centres.

USSR

1) a. Institute: Institute of Oceanology of the Academy of Sciences of the USSR, Bakhrushina 8, Moscow 127.

b. Leading scientists: Prof. B.G. Bogorov, Drs. L.A. Ponomareva, N.M. Voronina, O.I Koblentz-Mishke, M.E. Vinogradov.

c. Collaborating scientists: A.G. Naumov, I.N. Sukhanova, V.V. Zernova.

2) a. Vessel: R/V "Vityaz"

b. Area of investigation: Northern part of the Ocean, north of 30°S

c. Time of work at sea: Cruise 31. November 1959 - April 1960
" 33. October 1960 - March 1961
" 35. July 1962 - November 1962

3) a. Planktological problems being followed during the cruises: Quantitative and qualitative distribution of phyto- and zoo-plankton, primary production, distribution of some common species and its connection with different water masses, currents and so on, different trophical levels in plankton, connection between phyto- and zoo-plankton; distribution of the deep-sea plankton; bioluminescence; deep-scattering layers; taxonomy of some groups (Diatomea, Peridinea, planktonic Foraminifera, Radiolaria, Salpa Copepoda, Ostracoda, Amphipoda, Mysidae, Euphausiidae, Decapoda) and some other problems.

b. Methods applied for
I. sampling: for zooplankton:
Closing Juday net with mouth area of 0.5 m^2 and filter - cone from bolting silk or nylon n 38 (38 meshes in 1 linear cm). For standard sampling - 0-25, 25-50, 50-100, 100-200, and 200-500 m. It is used for each station.
Closing Bogorov-Rass net with mouth area of 1.0 m^2 and filter-cone from silk n 15 (15 meshes in 1 linear cm). It is used for deep-sea stations. Standard layers 0-50, 50-100, 100-200, 200-500, 500-1000, 1000-2000 (or 1000-1500, 1500-2000), 2000-4000 (or 2000-3000 and 3000-4000 or 3000-bottom).
Conical net with mouth area of 2.0 m^2 with 5 mm meshes. 0-1000 m. Used for each station.

Big conical net with mouth area of 25 m^2. It is used for selected stations from 4000 or 5000 m to the surface.
Perlon ring-trawl with mouth area of 2.0 m Ø and 2 mm meshes. It is used for horizontal sampling on different levels from 500 to 6000 m.
Isaaks-Kidd midwater trawl
Special pleustonic trawl for collecting plankton in the upper 0-30 cm layer.
IOE standard net - used only during the last cruise.
1 litre Nansen water bottle. Standard levels - 0.5, 10, 25, 35, 50, 75, 100, 150, 200 m and depth of the thermocline. It is used for each station.
5-10 litre water bottle.
200 litre water bottle (it is used very seldom).

II. Preservation: in 4% formol and selected samples - in alcohol.

III. Analysis: different methods (for example - determination of the displacement volume, determination of the counted of some species and so on).

IV. Calibration or standardization: Depths of work controlled by wire angle and special hydrostatic or acoustic depth recorder.

c. Quantity of samples: for example:
Cruise November 1959 - April 1960: about 200 planktological stations and 2500 samples collected by one litre Nansen water bottle, three ten-litre water bottles, 200 litre water bottle, Juday net, Bogorov-Rass net, ring-trawl, conical net, Isaaks-Kidd trawl, pleustonic trawl, and other nets.
Cruise October 1960 - March 1961: about 2000 samples.
Cruise July 1962 - November 1962: 100 stations and more than 1500 samples, among them IOSN for the International Center in Cochin in the layer of 0-200 m - 48 samples.

4) How are the results worked out, when will it be finished, and where and when will it be published ? The following publications of the Indian Ocean's plankton have been issued:

M.E. Vinogradov and N.M. Voronina, 1962: Some data of the distribution of zooplankton in the northern Indian Ocean. Tr.Inst. Ocean. v 58, p. 80-113.

I.N. Sikhanova, 1962: On the specific composition and distribution of the phytoplankton in the northern Indian Ocean. Tr.Inst.Ocean. v 58, p. 27-39.

M.E. Vinogradov, N.M. Voronina and I.N. Sukhanova, 1961: The horizontal distribution of the tropical plankton and its relation to some peculiarities of the structure of water in the open sea areas. Okeanologia, v.I, No.2, p. 283-293.

M.E. Vinogradov, 1962: The quantitative distribution of the deep-sea plankton in the northern part of the Indian Ocean. Okeanologia, v.2, No.4, p. 577-592.

M.E. Vinogradov and N.M. Voronina, 1961: The distribution of zooplankton in the Arabian Sea and its connection with the oxygen minimum layer. Okeanologia, v. I, No.4.

N.M. Voronina, 1962: Distribution of macroplankton in the northern Indian Ocean. Okeanologia, v.2, No.1, p. 119-125.

N.M. Voronina, 1962: On the surface plankton of the Indian Ocean. Tr.Inst. Ocean., v. 58, p.67-79.

B.G. Bogorov and M.E. Vinogradov, 1961: Certain esculiaritipe of the plankton biomass distribution in the surface waters of the Indian Ocean in winter 1959-1960. Oceanological research, No.4, p.66-71.

V.V. Zernova, 1962: Quantitative distribution of the phytoplankton in the northern Indian Ocean. Tr.Inst. Oceanol. v. 58, p.45-53.

L.A. Ponomareva and A.G. Naumov, 1962: The distribution of plankton biomass in the Arabian Sea and Bengal Bay. Dokl. Akad. Nauk, v. 142, No.2.

M.E. Vinogradov and N.M. Voronina, 1962: The distribution of different groups of plankton in accordance with their trophic level in the Indian equatorial currents area. Rapp. et Proc.-Verb., v.153, No.33, p.200-204.

5) Questionnaire filled in by: Dr. M.E. Vinogradov

The work was carried out in contact with meteorologists, hydrologists and chemists.

Australia

1) a. Institute: CSIRO. Division of Fisheries and Oceanography, Cronulla, Sydney Australia.

b. Leading scientist: D.J. Tranter

c. Collaborating scientist: A.C. Heron

2) a. Vessels: H.M.A.S. "Diamantina", H.M.A.S. "Gascoyne"

b. Area of investigation: Eastern Indian Ocean, particularly 110°E. longitude.

c. Time of work at sea: 1960-1963 including 6 cruises along 110°E., August 1962/63.

3) a. Planktological problems being followed during the cruises:

1. Seasonal and geographic distribution of zooplankton along 110°E.
2. Temperature-salinity distribution of common species
3. Plankton production

b. Methods applied for

1. Sampling: Clarke-Bumpus-sampler (aperture 0.26 mm) zooplankton weighed in raw state
2. Analysis: C^{14}

c. Depths or levels of work: 200 m - 0 m; 0, 50, 100, 200 m

d. Time of sampling: 0800-1230; 2030-0030

e. Quantity of samples: 1000 samples collected to date; 150/cruise currently

4) a. How are the results worked out? Standard taxonomic procedure.

b. When will it be finished? 1965.

c. Where will it be published? Probably Austr. J. Mar. Freshw. Res.

d. Completely or summarized? Completely.

5) a. Which environmental work has been done? Temperature, salinity, oxygen, nitrate, inorganic phosphate, total phosphate, particulate carbon, pigments, CO_2 uptake.

Occasionally, light meter readings, photometry, detailed meteorological observations.

b. Where will this material be available? Cruise reports (C.S.I.R.O.)

6) Additional information: The main contribution by this laboratory towards an understanding of the zooplankton of the Indian Ocean will be a seasonal study of the population along meridian 110°E. Observations are being made every two months at fixed stations and fixed times. Environmental information is fairly complete. Vertical (or oblique) hauls from 200 m, horizontal hauls at 0, 50, 100 and 200 m. Stations 1 1/2° apart from 32°S to 10°S. Two cruises completed, third in progress.

7) Questionnaire filled in by: D.J. Tranter.

Publications:

Tranter, D.J. (1962): Zooplankton abundance in Australasian waters. Aust. J. Mar. Freshw. Res., 13: 106-142.

Tranter, D.J. and Newell, B.S. (in press): Enrichment experiments in the Indian Ocean. Deep-Sea Research.

Tranter, D.J. (in press): A comparison of biomass determinations by Indian Ocean Standard Net, Juday Net and Clarke-Bumpus sampler. Nature.

U.S.A.

1) a. Institute: National Science Foundation

b. Leading scientist: see attached list

c. Collaborating scientists: see attached list

2) a. Vessel and G.R.T.: R/V "Anton Bruun", 1600

b. Area of investigation: Bay of Bengal + Western Indian Ocean

c. Time of work at sea: 2 years, exped. starts in February 1963.

3) a. Plantological problems being followed during the cruises:

primary production
zooplankton-geography
vertical distribution and others
IIO net hauls

b. Methods applied for

I. sampling: IIOE Vert. tow, oblique tows to 2000 m.

II. preservation: formalin

c. Depths or levels of work: 7 depth intervals to 2000 m.

d. Time of sampling: When on station

e. Quantity of samples: ca. 2000 samples

4) a. How are the results worked out? by individuals, sorted at Cochin and Smithsonian Inst., Washington, D.C.

b. When will it be finished? ?

c. Where will it be published? Exped. Series published by Smithsonian Inst.

d. Completely or summarized? Both.

5) a. Which environmental work has been done?

in physical oceanography: hydro station to 1000 m. for T + S
in chemical oceanography: above depth - PO_4, O_2, NO_2, NO_3, NH_3, SiO_3

b. Where will this material be available? Above Exped. Reports, data at National Data Center, Washington, D.C.

6) Questionnaire filled in by : John H. Ryther, Woods Hole Oceanographic Institution.

7) Additional information: In addition to IIOE net (purchased from Plymouth, England) will use pressure-operated opening and closing 3/4 m^2 (.33 mm mesh) nets designed by Dr. Allan Bé, Lamont Geological Observatory, Palisades, N.Y. These will operate at following depth intervals: 0-25 m, 25-100 m, 0-100 m, 100-250 m, 250-500 m, 500 - 1000 m, 1000 - 2000 m. Will also use fine mesh net for vert. or horizontal phytoplankton tows. Also incubator and simulated in situ productivity measurements, chlorophyll measurements at 100%, 50%, 25%, 10% and 1% incident light levels. Also, at selected stations, midwater trawling at 0-1000 and 1000-2000 m with opening-closing IK. midwater trawl. IIOE net hauls to Cochin, India, all other samples to Smithsonian Inst.

Planktonologists participating in the U.S. Biological Program

Backus, Richard H. *
Bé, Allan W.H.
Benson, Richard H.
Bieri, Robert
Brinton, Edward
Cohen, Daniel M. *
Della Croce, Norberto
Ebeling, Alfred W. *
Frontier, Serge
Gibbs, Robert H. Jr. *
Grice, George D.
Jones, E.C.
Kornicker, Louis S.
Maddocks, Rosalie Frances
McDowell, Samson, Jr.
McGowan, John A.
Mead, Giles *
Menzies, Robert J.
Norris, Richard E.
Pe, Ni Ta
Pierce, E. Lowe
Rao, T.S.S.
Steele, Donald H.
Thompson, Jesse C. Jr.
Townsley, Sidney J.
Vannucci, Marta

* Ichthyologists who will work with mid water trawl collections. Others working in phytoplankton or invertebrate zooplankton groups.

ANNEX III

INTERNATIONAL PROGRAMME FOR GEOLOGICAL-GEOPHYSICAL STUDY OF THE OCEANS

Presented by Professor V.G. Kort
U.S.S.R.

The object of the programme is study of the age, origin, geological history and structure of the oceans as well as the working out of the united absolute scale of the Quarternary period for the whole of the earth.

This object is achieved by accomplishing geological-geophysical operations along the system of trans-oceanic meridional sections, by deep well drilling the loose sediments of the ocean bottom down to the basalt layer and by carrying out research operations at the base geological-geophysical test sites.

The meridional sections are performed approximately along the median lines of the main ocean basins at the greatest distance away from the continents and islands as well as from the mid-oceanic ridges.

The meridional sections cross the main climatic and structural zones of the oceans. Four oceanic sections altogether are planned to be performed during the first stage of the operations : two sections in the Pacific Ocean and one section in each of the Atlantic and Indian Oceans.

Deep drilling of the loose sediments is also carried out along the meridional oceanic sections within the zones convenient from the point of view of their hydro-meteorological conditions.

Oceanic geological-geophysical test sites are located on the meridional sections or close to them on the main oceanic structures (ocean bed, submarine elevations, etc.,). The tentative number of the test sites on each of the meridional sections is 3, 12 test sites in all.

Programme for research operations on the meridional sections includes: grab sampling in the upper layer of the bottom sediments, taking of long cores of a great diameter, study of suspension from the surface to the bottom. Geothermic gradient determination, sampling for paleomagnetic investigations, measurements by the seismic reflection method. Bottom photography and underwater filming. Stations begin with anchoring a buoy aiming to locate the soundings, to measure currents and to determine the primary product.

Standard hydrological and hydrochemical investigations. Before the observations begin a detailed sounding is conducted at a site of 20 x 20 miles in size for defining the most representative place for the ship's station. The total duration of the station is about 2 days. The stations are performed at about 100-120 miles intervals.

Deep well drilling operations are carried out after geological-geophysical conditions on the meridional sections are found out.

The oceanic well drilling at present cannot be done everywhere because of weather conditions, calm zones are the most favourable ones. The drilling is accomplished through the whole depth of the loose bottom sediments with sampling in the upper layer of the bedrock.

Distances between wells are determined experimentally taking account of possible coordinating the stratigraphic horizons in the loose ocean sediments.

While drilling in the Atlantic Ocean it is desirable to coordinate the location of wells with the Project "Loco" (USA) investigations.

Base geological-geophysical test sites are intended for study of the principal structure areas of the ocean bottom in its key regions.

The tentative area of the test sites is from 100 x 100 x 200 x 200 miles.

Programme of research at the test sites consists of:

1. Echo-sounding with precision recording on the grid of tacks at intervals of about 10 miles; stratigraphic recording in the upper part of bottom sediments, magnetometric determinations, gravimetry. At some places the grid of tacks thickens.

2. Research at stations. A net of the stations is located along the tacks 20 miles apart thickening in separate areas.

Observations at the stations are conducted according to the programme analogous to that of the meridional section stations except for the buoys' anchoring.

3. Work * at bottom autonomic geological-geophysical stations placed in the corners of the test site and in its centre (five stations for a site).

The complex of operations of each geological-geophysical station should include seismic and gravity measurements, heat flux determination, the velocity of diffusion through bottom using labelled atoms, fixing of the processes going on the bottom surface with the help of slow speed filming; velocity and direction determination of currents in the bottom layer, fluctuations of bottom temperature, bottom hydrochemical sampling. At the same time the automatic geological-geophysical station should be an anchor load for the buoy automatic hydrological station. The total duration of work at the base geological-geophysical sites is about 2 months.

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* The above-mentioned work is included into the programme after working out and industrial manufacturing bottom geological-geophysical stations.

THE ROYAL SOCIETY

UNITED KINGDOM IIOE PROGRAMMES NEWSLETTER NO.1, MAY 1963

HMS OWEN - Work completed, November 1961 to December 1962.

At the present time HMS Owen is in the middle of her second geophysical reconnaissance cruise in the Arabian Sea. The ship is equipped with a precision echo sounder, a nuclear precision magnetometer and an Askania sea gravimeter. Continuous measurements of depth, magnetic field strength, and gravity, were made along all tracks during both cruises, with the following exceptions: magnetic field was not measured on the track through the Maldives from latitude 3°N southwards to Addu Atoll, nor on the north-westerly track into Karachi; gravity was not measured on the track from Karachi to Aden, nor on the track from Lamu (north of Mombasa) to the Seychelles which passes through (1°S, 50°E); neither gravity nor magnetics were measured on the track from the Seychelles to Mombasa passing through (6°S, 48°E). Measurements were virtually continuous on all other tracks. Connexions to land gravity survey networks were made at all ports. Geophysical observations made in addition to these routine measurements of depth, magnetic field and gravity are mentioned in the summary of cruises which follows:

(a) OWEN - first cruise 1961-62

(Throughout this cruise samples of surface water were collected every four hours for the Fisheries Research Laboratory at Lowestoft).

Aden (8.11.61) - Lamu (16.11.61 - 11.12.61) - Seychelles (15.12.61) - 19.12.61) - Mombasa (23.12.61 - 8.1.62) - Aldabra Atoll - Agalega Atoll - Bombay (25.1.62).

Scientific Personnel	D.H. Matthews, Ph.D., Dept. Geodesy and Geophysics, Cambridge.
	B.D. Loncarevic, Ph.D., " " " " "
	J.A. Grant " " " " "

In addition to the measurements made on passage specimens of granite for $K^{40}:A^{40}$ dating were collected in the Seychelles, and a land gravity survey was made on Aldabra Atoll using a Worden Master gravimeter.

Bombay (29.1.62) - Addu Atoll (5.2.62 - 13.2.62) - Mauritius (19.2.62 - 22.2.62) - Tromelin Is. - Agalega - Aldabra - Seychelles - (3.3.62 - 11.3.62) - Mombasa (15.3.62).

Scientific Personnel	T.F. Gaskell, Ph.D, British Petroleum Ltd.
	B.D. Loncarevic. Ph.D, Dept. Geodesy & Geophysics, Cambridge.
	J. Beaumont, M.A. " " " "
	J.A. Grant " " " "

Orientated specimens of basalt and dolerite for palaemagnetic work were collected at Mauritius and from dykes in the Seychelles. A basalt beach boulder was collected on Tromelin Is. Bottom samples were taken with a small grab in the lagoon of Addu Atoll and on the Seychelles Bank for Professor J.H. Taylor, London University. Land gravity surveys were made at Addu Atoll and on Mahé Is. (Seychelles). Six days were spent on a broad survey of the northern part of the Seychelles Bank.

Mombasa (12.4.62) - Seychelles (16.4.62 - 17.4.62) - Karachi (26.4.62 - 28.4.62) - Aden (4.5.62).

Scientific Personnel					
	B.C. Browne, M.A.,	Dept.	Geodesy &	Geophysics,	Cambridge.
	L.H. Flavill	"	"	"	"
	J.A. Grant	"	"	"	"

Short cores were taken at (14°39'S, 63°49'E) and at (02°55'N, 56°35'E).

(b) OWEN - second cruise 1962-63

Aden (1.11.62) - Bombay (27.11.62-30.11.62) - Seychelles (6.12.62-10.12.62) - Mombasa (18.12.62).

Scientific Personnel					
	D.H. Matthews, Ph.D.,	Dept.	Geodesy &	Geophysics,	Cambridge
	C.S. Mason, M.A.	"	"	"	"
	A.K. Wheatley	"	"	"	"

The usual measurements of depth, magnetic field strength and gravity, were made on passage and in the course of two detailed surveys on the Carlsberg Ridge. Buoys containing recording magnetometers were anchored in both survey areas and at (8°N 57°E) in order to observe the diurnal variation of magnetic field whilst the ship was working near the buoy. Similar recording magnetometers were operated at the R.A.F. School, Khormaksar (Aden) and at the Seychelles College, Port Victoria by Lt.Cdr. Clay, R.N. (ret'd) and by Rev. Brother Mark respectively. The two detailed surveys on the Carlsberg Ridge and the tracks near (8°N 57°E) and between the Seychelles and Lamu (Kenya), were intended as reconnaissance of areas designated for bottom sampling and seismic refraction studies during the cruise of RRS Discovery, August - November 1963.

Plans for the second half of this cruise (Mombasa (c. 6.4.63) - Karachi (c.28.4.63) - Aden (c. 16.5.63)) include a survey of the northern end of the Carlsberg Ridge between (8°N 59°E), Socotra and the entrance to the Gulf of Aden.

Data Reduction

Depths corrected from Matthews' Tables have been plotted at ten minute intervals along the ship's tracks on British Admiralty One Million Series Oceanic Plotting Sheets. Copies may be obtained on application to the Hydrographer of the Navy, Admiralty, Whitehall, London, S.W.1.

Geophysical results are being worked up in Cambridge. Reduction of seagravimeter and towed magnetometer records taken on the Owen 1961-62 cruise is complete. A map, based upon observations obtained from HMS Owen, HMS Dalrymple and U.S. Project Magnet, showing the regional magnetic field in the Arabian Sea has been prepared and privately circulated. Further copies are available. A cruise report for the voyage of HMS Owen 1961-62 is being prepared at the Admiralty Hydrographic Department for publication in August 1963. The volume will contain a summary of instrumental details and profiles of total field magnetic anomaly, free-air gravity anomaly, and bathymetry, plotted with a horizontal scale of 1:100,000. Reduction of Owen 1962-63 data is not complete.

Dr. A.S. Laughton, National Institute of Oceanography, Wormley, Surrey, has drawn tentative bathymetric contour charts on the basis of sounding information collected by the Admiralty Hydrographic Department on One Million Series Plotting Sheets. The contoured sheets cover most of the area between Agalega Atoll, the Murray Ridge and the coast of Africa. The sheets have been circulated privately.

Papers are in press discussing the northern end of the Carlsberg Ridge and the Amirantes Trench. A 16 mm coloured ciné film has been made to illustrate the cruise of HMS Owen 1961-62.

Publications

Miller, J.A. and Mudie, J.B. 1961. Potassium - Argon Age Determinations on Granite from the island of Mahé in the Seychelles Archipelago. Nature 192, 1174-75.

Loncarevic, B.D. and Matthews, D.H. 1962. Geophysical Reconnaissance of the Arabian Sea. New Scientist 14 513-515.

Unpublished Report

Loncarevic, B.D. 1963. Gravity measurements Indian Ocean 1961-62

23 pp. text and gravity base station location diagrams. Ca 300 pp. calculated gravity observations.

(A copy of this unpublished gravity report of HMS Owen 1961-62 cruise is available on loan from the Royal Society. The corrected gravity values of this cruise will be published shortly in the form of profiles by the Hydrographic Department of the Admiralty together with bathymetric and magnetic profiles.)

HMS DALRYMPLE - 1962-63 cruise

P. Barker and F. Dewes of the Applied Geophysics Department, Imperial College, accompanied HMS Dalrymple on her voyage to and from the Persian Gulf and during her stay there, the total period extending from September 1962 to March 1963.

A proton magnetometer was towed for over 10,000 miles, all but 800 of which were in the Indian Ocean. The instrument worked well throughout the investigation, the records obtained being almost continuous. The magnetometer work was carried out during the passage across the Indian Ocean and a detailed study was made of the John Murray Ridge. A series of lines with a spacing of approximately 10 miles, representing over 4,000 miles in all, was steamed across this feature. The results of this survey will, it is hoped, provide valuable data on the composition and origin of this Ridge. Conclusions must await the reduction and interpretation of the results. All that it is possible to say at present is that only rarely are there anomalies large enough to be even suggestive of oceanic basalt. The ridge does not seem to be of the straightforward mid-oceanic type. Records will be combined with those obtained in 1961/62 by HMS Dalrymple and other ships. Reduction of the data will be carried out on the University of London 'Mercury' computer.

Another party of Geophysicists from Imperial College comprising D. Taylor Smith, D. Jenkinson, P.A. Mark and F. Dewes continued the 'sparker' (continuous stratigraphic profile) traverses commenced in the Southern Gulf during the 1961/62 cruise. However, due to boat engine trouble and adverse weather conditions only a comparatively small number of traverses were run.

A party of Sedimentologists (G. Evans, D.J. Shearman, C.G.St.G. Kendall, D.J.J. Kinsman and Sir P. Skipwith) from Imperial College carried out a sedimentological and submarine geological survey of the Trucial Coast in the S.W. Gulf, from September 1962 to May 1963. This work was a continuation of that commenced the previous season.

The coastal belt consists of a complex of small dune-capped islands, lagoons, tidal deltas, reefs, mangrove swamps and alga flats. A large variety of carbonate sediments is forming here, including reef limestones, oolites, skeletal calcarenites, pelletoid calcarenites and calcilulites. The coastal complex is bounded to landward by wide saline flats - Sabka - which are the site of extensive evaporite deposition. An interesting suite of evaporite minerals forms in this environment, including halite, gypsum, anhydrite, dolomite and celestite. These minerals are partly formed by the evaporation of waters drawn up through the sediments of these flats from the lagoons to seaward, and probably partly by the replacement of earlier carbonate sediment by these solutions.

During HMS Dalrymple's survey work in the Persian Gulf a series of twenty bottom sampling stations were occupied. Cores and grab samples were taken at each station. These bottom sediment samples, together with those collected by HMS Dalrymple during her 1961/62 cruise provide a fairly good cover of the southern part and of the western part of the northern Persian Gulf. The samples and their macrofauna and microfauna are currently under investigation.

Publications

Resulting from the 1961/62 cruise. R. Curtis, G. Evans, D.J.J. Kinsman, D.J. Shearman, Association of Dolomite and Anhydrite in the Recent Sediments of the Persian Gulf. Nature, Vol. 197, No. 4868, pp. 679-680 Feb. 16, 1963.

May 1963.

THE ROYAL SOCIETY

UNITED KINGDOM IIOE PROGRAMMES NEWSLETTER NO.2 MAY 1963

RRS DISCOVERY - See pp.9 - 10 for revised programme for IIOE.

First cruise: May-August 1962 - South Arabian Coast upwelling.

For details of scientific programmes see booklet entitled British National Committee for Oceanic Research, United Kingdom Scientific Programme during the International Indian Ocean Expedition 1961-64 published by the Royal Society in September 1962.

Second cruise: August to December 1962
Geophysical cruise

During the last three months of 1963 RRS Discovery will be working in the Arabian Sea on geological and geophysical programmes arranged jointly by the National Institute of Oceanography and the Department of Geodesy and Geophysics, Cambridge. The work will include some two-ship seismic exploration in company with HMS Owen between the Kenya coast and the Seychelles bank. The provisional programme is as follows:-

August 23: sail from Aden to the northern area of the Carlsberg Ridge where dredging, photography and heat flow measurements will be carried out. Similar measurements will then be made in the area which has been surveyed to the south west in the foothills of the ridge and thence a track will be laid to Mombasa with regular heat flow measurements and a diversion for a magnetic survey of the Seychelles northern boundary fault. The ship will reach Mombasa on September 11th.

RRS Discovery will leave Mombasa to load explosives on September 14th and will undertake short single ship seismic operations between the Kenya coast and the Seychelles and long single ship seismic lines in a flat area of the Indian Ocean to the north east of the Seychelles. Heat flow measurements will be made on

passage and in the areas of the seismic investigations. The ship will reach the Seychelles on October 2nd.

It is proposed that RRS Discovery will leave Port Victoria on October 5th and will collect bottom samples and dredge hauls from the Seychelles bank and from its slopes. RRS Discovery will rendezvous with HMS Owen on October 17th near 7°N 47°E for two-ship seismic work on the way into Mombasa, where she will arrive on October 21st.

The ship will sail on October 24th for further two-ship seismic work in the same area and thence will steam for Aden via the Carlsberg Ridge. The ship is expected to reach Aden on November 15th and on November 18th will sail for U.K.

Three days have been allowed for heat flow measurements across the Red Sea on the return voyage.

Throughout the cruise opportunities will be taken for extending the magnetic and topographic surveys of the Arabian Sea, for bottom photography, coring and experiments with a sea-bottom seismograph. The gravity meter at present in the Indian Ocean will by then be in use in the Atlantic.

The Senior Scientist from August until the ship returns in December will be Dr. M.N. Hill. It is expected that the scientists aboard concerned with the geological and geophysical work will number about 15. Amongst these will be Dr. A.S. Laughton and Mr. J. Jopling from N.I.O. and Mr. J.C. Cleverly, Mr. D. Davies, Mr. T.J.G. Francis, Dr. D.H. Matthews, Mr. J.M. Shorthouse and Mr. J.E. Sclater from the Department of Geodesy and Geophysics.

HMS OWEN

HMS Owen wi-l rendezvous with RRS Discovery on October 17th for two-ship seismic work between the position 7°N 47°E and Mombasa. The ship will be at Mombasa. The ship will be at Mombasa from October 21st to 24th, where all remaining depth charges will be loaded and used with RRS Discovery as the receiving ship between Mombasa and the Seychelles bank. It is hoped that in all five long seismic profiles can be obtained in the area. HMS Owen will return to Mombasa on about November 5th, when her part of the geological and geophysical programme of IIOE will be complete.

Tide Gauges

The automatic tide gauges installed by HMS Owen during her 1961/62 cruise at Gan and Seychelles will continue to be operated until the end of 1964.

The gauge installed by HMS Dalrymple in October 1961 has become inoperative due to movements of sand banks.

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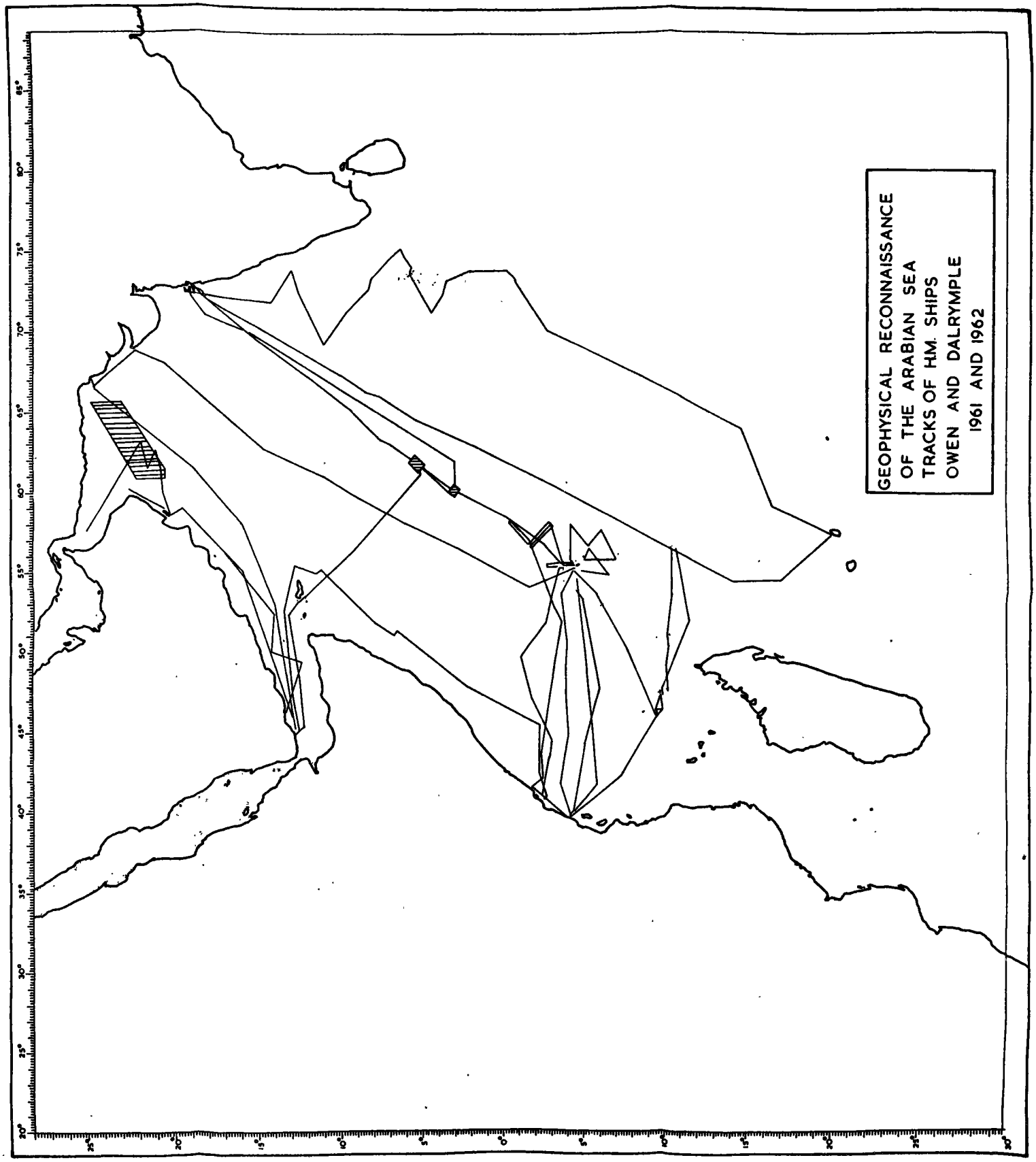
28 May 1963


GEOPHYSICAL RECONNAISSANCE
OF THE ARABIAN SEA
TRACKS OF H.M. SHIPS
OWEN AND DALRYMPLE
1961 AND 1962