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Unesco reports in marine science 31

MABAHISS/John Murray 50th anniversary: Marine science of the North West Indian Ocean and adjacent waters

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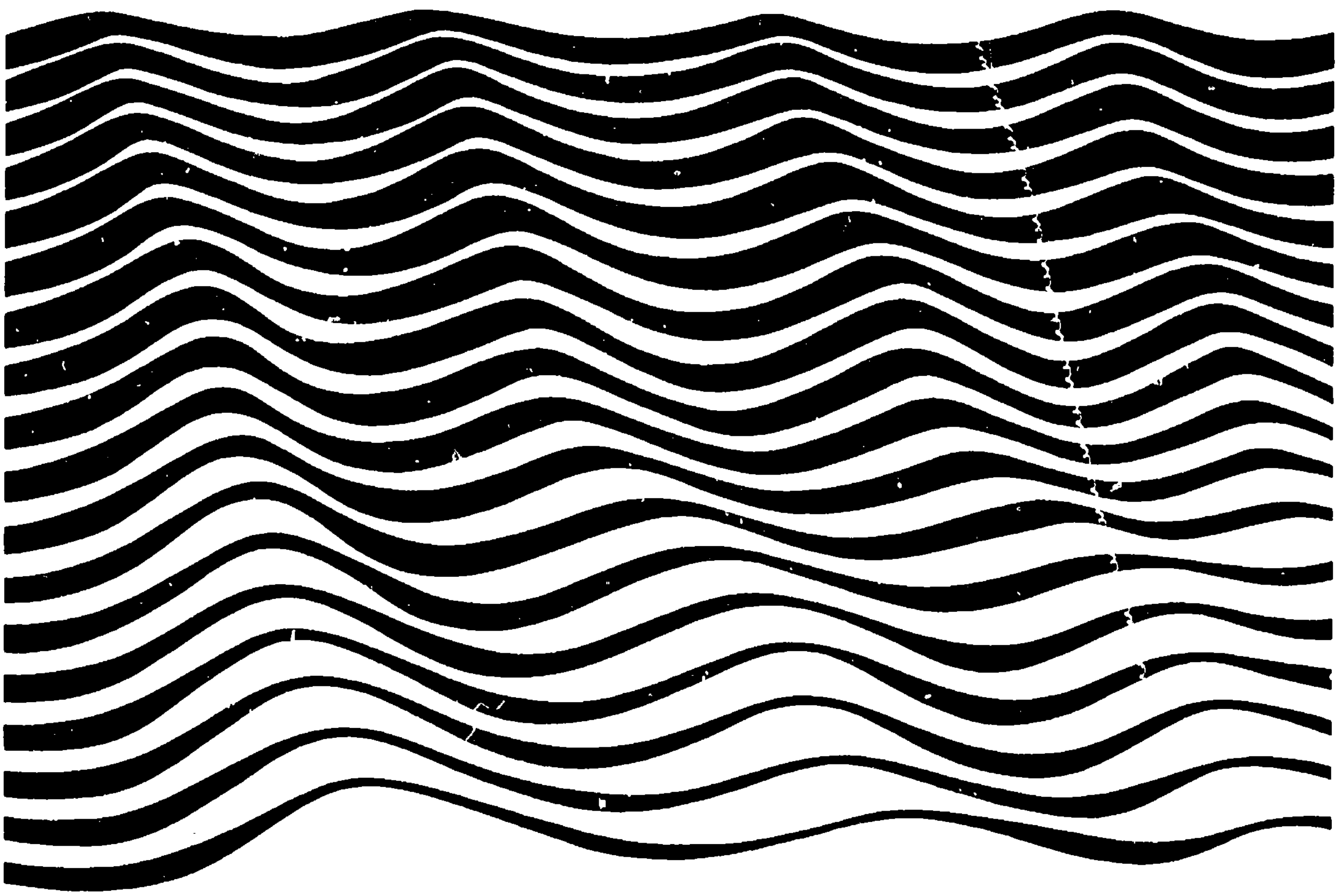
Report of a symposium on the occasion of the 50th anniversary of the MABAHISS/ John Murray Expedition (1933/34)
University of Alexandria, Egypt
3 to 7 September 1983



Unesco, 1985

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12	Geología y geoquímica del margen continental del Atlántico Sudoccidental, Informe final del Taller de Trabajo organizado por la Unesco en Montevideo, Uruguay, 2-4 de diciembre de 1980 Spanish only	1981
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16	Marine and coastal processes in the Pacific: ecological aspects of coastal zone management Report of a Unesco seminar held at Motupore Island Research Centre, University of Papua New Guinea, 14-17 July 1980 English only	1981
17	The coastal ecosystems of West Africa, coastal lagoons, estuaries and mangroves A workshop report, Dakar, 11-15 June 1979 Available in English and French	1981
18	Coral reef management in Asia and the Pacific: some research and training priorities Report of a Unesco workshop held in Manila, Philippines 21-22 May 1981 English only	1982
19	Mareas rojas en el Plancton del Pacífico Oriental Informe del Segundo Taller del Programa de Plancton del Pacífico Oriental, Instituto del Mar, Callao, Perú 19-20 de noviembre de 1981 Spanish only	1982
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21	Comparing coral reef survey methods A regional Unesco/UNEP workshop, Phuket Marine Biological Centre, Thailand, December 1982 English only	1983
22	Guidelines for marine biological reference collections Prepared in response to a recommendation by a meeting of experts from the Mediterranean Arab countries Available in English, French and Arabic	1983
23	Coral reefs, seagrass beds and mangroves: their interaction in the coastal zones of the Caribbean Report of a workshop held at West Indies Laboratory, St. Croix, U.S. Virgin Islands, May, 1982 English only	1983
24	Coastal ecosystems of Latin America and the Caribbean The objectives, priorities and activities of Unesco's COMAR project for the Latin America and Caribbean region Caracas, Venezuela, 15-19 November 1982 Available in English and Spanish	1983
25	Ocean engineering teaching at the university level Recommended guidelines from the Unesco/IOC/ECOR workshop on advanced university curricula in ocean engineering and related fields, Paris, October 1982 Available in English, French, Spanish, Russian, Arabic and Chinese	1983
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31	MABAHISS/John Murray 50th anniversary: Marine science of the North West Indian Ocean and adjacent waters Report of a symposium on the occasion of the 50th anniversary of the MABAHISS/ John Murray Expedition (1933/34), University of Alexandria, Egypt, 3 to 7 September 1983 English only	1985

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PREFACE

Unesco Reports in Marine Science are issued by the Unesco Division of Marine Sciences. The series includes papers designed to serve specific program needs and to report on project developments. Collaborative activities of the Division and the Intergovernmental Oceanographic Commission, particularly in the field of training and education, are also represented in the series.

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ABSTRACT

An International symposium was convened by Alexandria University, 3-7 September 1983, to celebrate the 50th Anniversary of the John Murray Expedition to the Indian Ocean on board the Egyptian Research Vessel MABAHISS (1933-1934). The symposium was co-sponsored by UNESCO and its IOC with several Egyptian, British and International Organizations. The present report describes this activity, and provides abstracts and syntheses of the papers presented to the symposium in the various marine scientific disciplines covering the areas of the Indian Ocean, the Red Sea and the adjacent gulfs and seas. Within the framework of the symposium, round-table discussions were organized by the IOC to identify gaps in marine scientific knowledge in these areas and to recommend future cooperative research to fill these gaps. The discussions led to a series of recommendations which identified research needs in interdisciplinary areas as well as in the major disciplinary fields within marine science. Details of these recommendations are given in this report.

RESUME

L'Université d'Alexandrie a organisé, du 3 au 7 septembre 1983, un colloque international pour célébrer le cinquantième anniversaire de l'expédition que John Murray a effectuée dans l'océan Indien à bord du navire de recherche égyptien, le MABAHISS (1933-1934). Ce colloque était placé sous les auspices conjointes de l'Unesco et de la COI, et de plusieurs organisations égyptiennes, britanniques et internationales. Le présent rapport rend compte de cette activité ; il contient des résumés et des synthèses des communications présentées au colloque dans diverses branches des sciences de la mer intéressant l'océan Indien, la mer Rouge et les mers et golfes adjacents. Dans le cadre de ce colloque, des tables rondes ont été organisées par la COI, pour identifier les lacunes que comportent les connaissances en sciences de la mer concernant cette région et recommander la réalisation de recherches en commun afin de les combler. Les discussions ont donné lieu à une série de recommandations répertoriant les besoins en matière de recherche, aussi bien à l'échelon interdisciplinaire que dans chaque grande discipline des sciences de la mer. On trouvera un aperçu de ces recommandations dans le présent rapport.

RESUMEN

Del 3 al 7 de septiembre de 1983, se celebró en la Universidad de Alejandría un simposio internacional para conmemorar el quincuagésimo aniversario de la expedición de John Murray al Océano Indico, a bordo del buque egipcio de investigaciones MABAHISS (1933-1934). El simposio fue patrocinado por la Unesco y la COI, conjuntamente con organizaciones egipcias, británicas e internacionales. En el presente informe se describe esa actividad y se ofrecen resúmenes y síntesis de los estudios presentados sobre las diferentes disciplinas de las ciencias del mar, estudios que versan sobre el Océano Indico, el Mar Rojo y los golfos y mares contiguos. Durante el simposio, la COI organizó mesas redondas con el fin de determinar las lagunas que existían en los conocimientos científicos marinos de esas zonas y recomendar futuras investigaciones conjuntas para remediarlas. Las discusiones se plasmaron en una serie de recomendaciones que precisaban las necesidades de investigación en los campos interdisciplinarios, así como en las principales esferas de las ciencias del mar. En el presente informe figuran detalles de dichas recomendaciones.

РЕЗЮМЕ

С 3 по 7 сентября 1983 г. Александрийским университетом был проведен Международный симпозиум по случаю празднования 50-й годовщины экспедиции Джона Муррея в Индийском океане на борту египетского исследовательского судна МАБАХИСС /1933-1934 годы/. Этот симпозиум был организован ЮНЕСКО и МОК совместно с некоторыми организациями Египта, Великобритании и международными организациями. В настоящем докладе описывается это мероприятие и приводятся выдержки и резюме докладов, представленных на этом симпозиуме по различным научным морским дисциплинам и охватывающим области Тихого океана, Красного моря и прилегающих заливов и морей. В рамках этого симпозиума МОК организовала дискуссии за круглым столом с целью определения пробелов в научных морских знаниях в этих районах и рекомендации будущих совместных исследований для заполнения этих пробелов. В результате состоявшихся обсуждений был подготовлен ряд рекомендаций, определяющих потребности в исследованиях в междисциплинарных областях, а также по основным направлениям морской науки. Подробно эти рекомендации приводятся в настоящем докладе.

ملخص

دعت جامعة الاسكندرية الى عقد ندوة دولية من ٣ الى ٧ سبتمبر/أيلول ١٩٨٣ للاحتفال بمرور ٥٠ عاما على بعثة جون موراى الى المحيط الهندى على متن سفينة البحوث المصرية "مباحث" (١٩٣٣ – ١٩٣٤)، وقد شارك فى رعاية الندوة اليونسكو ولجنتها الدولية الحكومية لعلوم المحيطات مع عدة منظمات مصرية وبريطانية ودولية . ويرد فى هذا التقرير وصف لهذا النشاط وملخصات وخلاصات جامعة للبحوث التى قدمت للندوة فى مختلف فروع علوم البحار وشملت مناطق المحيط الهندى والبحر الأحمر وما يتاخمهما من خلجان وبحار، ونظمت كوى فى اطار الندوة مناقشات فى شكل موائد مستديرة بهدف تحديد الثغرات القائمة فى معارف علوم البحار فى هذه المناطق ومن أجل التوصية باجراء بحوث تعاونية فى المستقبل لسد هذه الثغرات . وقد أفضت المناقشات الى مجموعة من التوصيات تحدد الحاجات فى ميدان البحوث الجامعة بين التخصصات وفى المجالات الرئيسية فى علوم البحار، ويرد فى هذا التقرير تفصيل تلك التوصيات .

摘　　要

亚历山大大学于1983年9月3日至7日召开了一次国际讨论会，庆祝约翰·默里乘埃及考察船马巴希斯号考察印度洋（1933—1934年）50周年。讨论会是由教科文组织及其国际海洋学委员会联合几个埃及，英国和国际组织发起的。本报告介绍了这项活动，并提供了提交讨论会的，有关各海洋科学学科的论文摘要和概述，涉及的海域有印度洋，红海及毗邻的海湾和海域。国际海洋学委员会，在讨论会的范围内，组织了园桌讨论会，以确定海洋科学知识在这些领域方面的空白，并为填补这些空白提供了有关今后合作研究的建议。讨论会归纳出一系列建议，确定了各学科间领域和海洋科学内各主要学科领域的必要研究项目。这些建议的详细内容载于本报告。

FOREWORD

The MABAHISS/John Murray International Symposium on Marine Science of the North West Indian Ocean and Adjacent Waters was convened to mark the 50th Anniversary of the John Murray Expedition to the Indian Ocean 1933/1934 on board the Egyptian Research Vessel 'MABAHISS. The Academy of Scientific Research and Technology of Egypt, UNESCO and the IOC co-sponsored the meeting which was also supported by the Royal Society and the Natural Environment Research Council (NERC) of the U.K. as well as the USA Office of Naval Research in London. The meeting was attended by one hundred and two participants (see Annex 1) from Canada, Egypt, France, Federal Republic of Germany, Greece, India, Iraq, Kuwait, Monaco, Norway, Pakistan, Qatar, Saudi Arabia, Sudan, Turkey[1], United Kingdom and United States and by representatives of UNESCO, IOC, FAO and the Saudi-Sudanese Red Sea Joint Commission.

The Symposium was organized into eight sessions dealing with historical and scientific aspects relevant to the region and the MABAHISS/John Murray Expedition. These sessions were followed by a Round-Table Discussion organized by the IOC with a central objective of identifying gaps in marine scientific knowledge of the region and suggesting co-operative research projects which could benefit from international co-operation. The participants of the working groups of the Round-Table discussions (Annex II) were provided with a working document (IOC/INF 539) containing a synopsis of replies to a questionnaire sent earlier to the invited speakers and to some potential participants.

The report includes a synthesis of the scientific presentations made by the invited speakers. It also includes a list of the scientific poster papers presented in the meeting and the abstracts of the invited papers. The full texts of these papers are found in Deep-Sea Research (Pergamon Press) as Volume 31, Nos. 6-8, pages 571-1036, a special issue entitled "Marine Science of the North West Indian Ocean and Adjacent Waters - Proceedings of the MABAHISS/John Murray International Symposium (Egypt, 3-7 September 1983)", edited by Martin V.Angel and dedicated to the memory of Francis A. Richards.

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[1]The Turkish participants to the Symposium arrived at Alexandria on board the Turkish Research Vessel "K. PIRI REIS", which paid a courtesy visit to Alexandria at the time of the symposium.

A preliminary report on the Symposium, based on the main programme of the meeting, was prepared by Professor S.K.El-Wakeel and Dr M.V.Angel, (the co-ordinators of the symposium) and issued by the University of Alexandria.

Unesco wishes to take this opportunity to thank all the co-sponsors for their active role in supporting the meeting. Recognition is due to the efforts of the late Professor F.A.Richards, who at the time was chief scientist of the US Office of Naval Research (ONR) in London and editor of Deep-Sea Research. Professor Richards was instrumental in arranging both ONR support and the publication in Deep-Sea Research of the scientific papers presented at the Symposium.

Special thanks are due to Professor Dr. Peter Lockwood (U.K.), who acted as the Symposium Rapporteur, and to Dr Martin V. Angel for his assistance in editing and revising the report.

CONTENTS

1. BACKGROUND AND OBJECTIVES

As a result of an initiative from the University of Alexandria in 1980 the 21st General Conference of UNESCO resolved to contribute to the commemoration of the cruise of the MABAHISS by supporting "activities associated with the fiftieth anniversary of the John Murray Expedition in the Indian Ocean which was undertaken on the Egyptian Research Vessel MABAHISS in 1933-1934" (21 C.5, Objective 7.4, para 2674).

With this in view, an Egyptian Preparatory Committee was established (Annex III) with Prof. M. El-Hadary, President of Alexandria University as its head. On 10 March 1982, a letter inviting comments on the Egyptian proposals for the commemoration was sent to a number of British scientists and institutions by Prof. El-Hadary. The British National Committee on Oceanic Research and the Advisory Committee on International Oceanographic Affairs of the UK's Natural Environment Research Council expressed interest. As a result, an informal meeting took place during the Joint Oceanographic Assembly (Halifax, N.S., Canada (August 1982). Attending the meeting were 15 interested scientists from Canada, Egypt, UK, USA, SCOR (Scientific Committee on Oceanic Research) and UNESCO (Annex IV). It was generally agreed that the initial activity would be a seminar/symposium, followed by a series of co-operative cruises. It was also proposed that IOC should be invited to co-sponsor the symposium. The proposal was adopted in Resolution XII-19 at the 12th Session of the IOC Assembly, where it was further resolved to use the outcome of the symposium "as a basis for the planning of future marine scientific activities of IOC in the above-mentioned region".

A meeting was held in the Royal Society, London, November 1982 to discuss plans for the celebration to take place in Alexandria in September 1983. In attendance were several Egyptian and British scientists and a Unesco representative (Annex V). It was agreed the main objective of the commemoration should be the stimulation of co-operative oceanographic research in the North-western Indian Ocean and adjacent waters. At the international symposium to be held from 3-7 September, historical aspects would be reviewed. However, the main emphasis would be on summarizing the present status of knowledge of the region, identifying future research needs, and on initiating collaborative investigations.

1.1 Publication of the Narrative of the John Murray/MABAHISS Expedition

As a result of the interest aroused by the plans to commemorate the 50th Anniversary of this event, attention was drawn to the existence of a narrative written by the late R.B.Seymour-Sewell, the scientific leader of the Expedition. This narrative, which Sewell unsuccessfully tried to publish during his lifetime, had been found among the holdings of the British Museum (Natural History)as three typescript versions in varying stages of completion.

To mark the anniversary of the Expedition, UNESCO decided to publish a volume (in English and Arabic versions) of which the bulk will consist of the unpublished narrative. Dr A.L.Rice of the Institute of Oceanographic Sciences, Wormley, UK, was selected by UNESCO as editor for this volume.

The book will be illustrated by a series of contemporary photographs, mostly made available by H.C.Gilson, one of the British scientists on the MABAHISS in 1933, and will include a variety of background information, much of it previously unpublished.

With regard to the Expedition, another publication of note is a book whose title translates as "Modern Sindbad" written by Dr Hussein Faouzi, the medical officer and one of the two Egyptian scientists on board MABAHISS during the expedition. This literary work, published originally in Egypt in Arabic in 1938, draws upon the author's impressions and observations experienced during the voyage of MABAHISS in the Indian Ocean. Dr Faouzi's book has been selected by UNESCO, as a programme activity of the Organisation's Sector of Culture, to be published in French in the series "Collection UNESCO d'Oeuvres Représentatives".

1.2 The Symposium

1.2.1 Welcoming addresses

On September 3rd 1983, fifty years to the day after the sailing of the MABAHISS the anniversary symposium was inaugurated by the President of Alexandria University, Professor Dr Mahmoud El-Hadary. He welcomed the participants and introduced the following distinguished speakers. Opening addresses were then given by:-

- Governor of Alexandria, Mr Mahamed Fawzi Mo'az
- Prof. Abdel-Salam M.Shalaby, Dean of the Faculty of Sciences of Alexandria University
- Prof. Dr Abul Fetouh A.Latif, Vice-President of the Egyptian Academy of Scientific Research and Technology, Representative of the Academy's President
- Dr Martin V.Angel, Representative of the U.K.
- Dr Dale C.Krause, Director of the UNESCO Division of Marine Sciences, Representative of the Director General of UNESCO
- Dr Selim A.Morcos, on behalf of the Chairman and the Secretary of IOC

In addition to the welcome extended to the participants and the attention drawn to the increasing importance of marine sciences, the recurring themes in the addresses were the important role achieved by the MABAHISS Expedition in both scientific and symbolic roles and the influence which it had had on the subsequent development of Egyptian marine science. The expedition was notable for being the first wide-ranging study of the Indian Ocean, an area largely neglected by the CHALLENGER and incompletely covered by the INVESTIGATOR.

Apart from the significance of the scientific findings, the expedition set the scene for the subsequent development of marine science in Egypt and the neighbouring states. For example, further Egyptian expeditions to the Red Sea were organized in 1934-35 whilst later in 1948 the two veteran members of the scientific staff on the 1933 cruise, Professor Hussain Faouzi and the late Professor A.F.Mohamad, were able to found the Department of Oceanography of Alexandria University. This Department has been actively engaged in Red Sea and Mediterranean studies, and has, in its turn, contributed to the establishment and expansion of several departments of marine science elsewhere in the Arab and African countries.

It was stressed that not only did the MABAHISS Expedition contribute much in scientific discoveries and as a stimulus to marine science in the region, but it also had significance in terms of the active co-operation between nations in the study of the sea. This was not the first time scientists of different nationalities had collaborated at sea, but, because all the equipment remained on board at the end of the expedition, it was one of the first occasions on which both technical expertise and equipment for marine research was transferred by one nation to another on any substantial scale.

The opportunity provided by the University of Alexandria for scientists from outside the region to participate in a conference marking the 50th Anniversary of this significant cruise was welcomed and messages of good wishes for the meeting were received from the Director-General of UNESCO, the Chairman and the Secretary of IOC, the President of the Royal Society of the U.K. and the Chairman of the Natural Environment Research Council of the U.K. The moral and material support contributed by many national and international organizations (Egyptian Academy of Scientific Research and Technology, the Ministry of Higher Education and Scientific Research of Egypt and the Egyptian National Commission for UNESCO, the Royal Society, the Natural Environment Research Council of the U.K., the British Council, the U.S. Office of Naval Research in London, UNESCO, IOC, the Saudi-Sudanese Red Sea Commission, Marine Science Centre in Basrah, Iraq, the Kuwait Institute for Scientific Research, the University of Qatar) were noted with appreciation, and the hope expressed that just as the MABAHISS cruise could be seen as the precursor of the International Indian Ocean Expeditions of 1959-65 so too might the present meeting lead to future co-operative research in the Indian Ocean and associated waters.

Details of the opening addresses are given in Annexes VI-IX, and of the closing remarks and votes of thanks in Annex X.

2. THE OPENING SESSION

In his opening address to the Symposium, Professor M. Al-Hadary, President of the University of Alexandria, stressed the fact that the MABAHISS Expedition is considered to be the first positive work in the history of oceanography of the Indian Ocean. He informed the participants that in view of the historical value of the Research Vessel MABAHISS, the University of Alexandria has requested the transfer of its ownership to the University, and that steps have been taken towards the conversion of this historical vessel into an oceanographic museum, as an annex to the new building of the Oceanography Department of Alexandria University. In this context the President of Alexandria University called for international co-operation and support in the forthcoming phase of the project to help in the restoration process of MABAHISS. Before closing his speech, Professor El-Hadary expressed the hope that the symposium would succeed in producing an international co-operative programme of oceanographic research in the area concerned. (The full text of Professor Al-Hadary's speech is given in Annex VI).

The Governor of Alexandria, H.E.M.Fawzi Mo'az, expressed a keen interest in the Symposium and the pride of the Governorate in hosting the meeting in the Research Centre of Alexandria University which is considered to be one of the major centres for scientific research in the country. He highlighted the importance of the MABAHISS Expedition, and the scientific and cultural contributions of the two Egyptian scientists of the Expedition. In his speech, the Governor of Alexandria emphasized the problem of marine pollution in general and in particular for its potential to affect the beaches of Alexandria. He urged the participants to direct their thoughts and attention to such practical matters.

Professor Dr Abdel-Salam M.Shalaby, Dean of the Faculty of Science of Alexandria University honoured the two Egyptian pioneers in Oceanography who were members of the MABAHISS-John Murray Expedition in 1933, as being the founders of the Department of Oceanography at the Faculty of Science of Alexandria University. The Department which they founded can be compared to a tree which has grown to cast its shadow of influence throughout the region. Scholars and graduates of this Department have assisted in the creation of oceanographic institutes and departments in many Arab countries.

Professor Abul Fetouh A. Latif, Vice-President of the Academy of Scientific Research and Technology of Egypt, addressing the Symposium on behalf of the Academy President, drew attention to the fact that the request made by the British Government to the Egyptian Government to allow the use of the Egyptian Research Vessel MABAHISS in the John Murray Expedition to the Red Sea and the Indian Ocean, was indicative of the high level which Egypt had already reached (more than 50 years ago) in the field of oceanography. The scientific results of this Expedition are of great scientific value and remain important sources of oceanographic knowledge of the Red Sea and the Indian Ocean. Professor Latif mentioned that Egypt has been a leading country in the field of oceanography in the Middle East and Africa since the establishment of its Hydrobiological Institute in Alexandria in 1918. He outlined the Academy's present policy in promoting many research projects in the various fields of marine sciences.

The U.K. representative, Dr Martin Angel, Head of Biology Department, Institute of Oceanographic Sciences, U.K., recalled that fifty years ago a small band of hardy scientists and supporting crew of the MABAHISS set forth to study an almost unknown ocean. It was a symbolic occasion, one of the earliest instances of the scientists of two nations co-operating together at sea. Increasingly since then oceanography has become an international topic of interest as awareness has increased of the limitations of natural resources of Earth and of the interaction of systems in the sea, on land and in the air. Man's impact on the seas has increased, particularly as recent events have shown in the Gulf through pollution. Despoilation in one area inevitably produces knock-on effects elsewhere but it requires far more information than is yet available before prediction of the short and longer term effects of anthropogenic abuse of the system can achieve greater precision. Hopefully this symposium will provide both one further step in progress towards a rational utilisation of marine systems and the stimulus to excite young scientists of the region to press such studies forward. Before closing, Dr Angel conveyed the best wishes of Sir Anthony Huxley, President of the Royal Society and of Sir Herman Bondi, Chairman of the Natural Environment Research Council of the U.K. for the success of the meeting (see Annex VII for the full text of Dr Angel's speech).

Dr Dale C. Krause, Director of UNESCO Division of Marine Sciences, speaking on behalf of the Director General of UNESCO, noted that the John Murray Expedition on board MABAHISS was a landmark in the growth of international co-operation in marine science. The Expedition was a joint effort of the scientific communities of Egypt and the United Kingdom. The Expedition's reports remain one of the main sources of information on many aspects of the Northern India Ocean. The MABAHISS Expedition turned out to be one of the most successful early experiments in science and technology transfer. It led to the founding of the Oceanography Department in Alexandria University, which in turn has played a strong role in strengthening marine science in the region. It is because of this history, as well as the opportunities that would arise from the Symposium deliberations, that UNESCO supported the scientific activities associated with the celebration of the 50th Anniversary of the John Murray Expedition. When the decision of the Egyptian Authorities to preserve MABAHISS and transfer it to a Museum came to the attention of the Director General of UNESCO, Mr Amadou Mahtar M'Bow, he promptly decided to make a further contribution through UNESCO for this purpose, hoping that this contribution would raise interest in and strengthen the efforts of the restoration of MABAHISS for future generations as a museum and an instrument for public guidance, as well as a tourist attraction. (The full text of Dr Krause's speech is given in Annex VIII).

Dr Selim A. Morcos, addressing the meeting on behalf of the chairman and the Secretary of the Intergovernmental Oceanographic Commission (IOC), stated that the John Murray Expedition to the Red Sea, the North West Indian Ocean and the Adjacent Gulfs on board the Egyptian Research Vessel MABAHISS in 1933-1934, was, from all points of view, a good example of international co-operation in the study and exploration of the ocean. The Expedition was an early precursor of the International Indian Ocean Expedition initiated by the Scientific Committee on Oceanic Research (SCOR) and later co-ordinated by the IOC. Thus, when the IOC Assembly, at its 12th Session, accepted the invitation to co-sponsor the present symposium, one of its main objectives was to make good use of the symposium's outcome as a basis for the planning of its future co-operative marine science activities in this region, within the relevant research programmes of the IOC's regional subsidiary bodies such as CINCWIO and in the future IOCINDIO. For this purpose, the Round Table Discussion was planned for this symposium. Dr Morcos expressed the hope that, in the light of the scientific presentations during the symposium and the equally important informal discussions among the participants, a few well-identified and most promising research problems would be formulated as concrete, practical recommendations to be brought to the attention of the 17th Session of the IOC Executive council and of the IOC's regional subsidiary bodies and to be considered for eventual implementation. (The full text of Dr Morcos's speech is given in Annex IX).

3. THE HISTORICAL SESSION

3.1 Reminiscences by: Professor Dr.Hussain Faouzi, Expedition Biologist and Doctor

Belying the passage of time since his participation in the MABAHISS/John Murray Expedition, Professor Faouzi presented a vigorous and stimulating account of his recollections of the cruise, of his audience with the King to report the outcome of the expedition and of the role of the MABAHISS' home port Alexandria as a contributor to Mediterranean culture and commerce.

When Director of Fisheries Research, he had first heard of the MABAHISS Expedition from Professor Bangham, who was seeking a second assistant to accompany the chemist Abdel Fattah Mohamed, from his own department. Dr Faouzi had immediately seized the opportunity to join the scientific staff on board. During the cruise he had admired the calm demeanour of the scientific leader Lt-Col. Seymour Sewell and shared the feeling of both friendship and respect towards him which was general.

They had experienced the worst conditions the Red Sea could offer in terms of heat and humidity and there were difficulties and losses of equipment in the first trials. Despite the conditions however the sailors and scientific staff never complained, and his first report home to the Director General of Coastguards and Fisheries indicated the commitment of all concerned to their duty.

Turning to consider the re-awakening of marine science interests in Egypt early in this century, mention was made *inter alia* of the community of interest in the field of scientific research shared by the then Crown Prince of Egypt and the Prince of Monaco, Albert I. Of particular importance too had been the outward looking nature of Alexandria, a city imbued with the culture and ambience of the Mediterranean region,and hence providing a favourable environment in which the fledgling interests in marine science could thrive and grow.

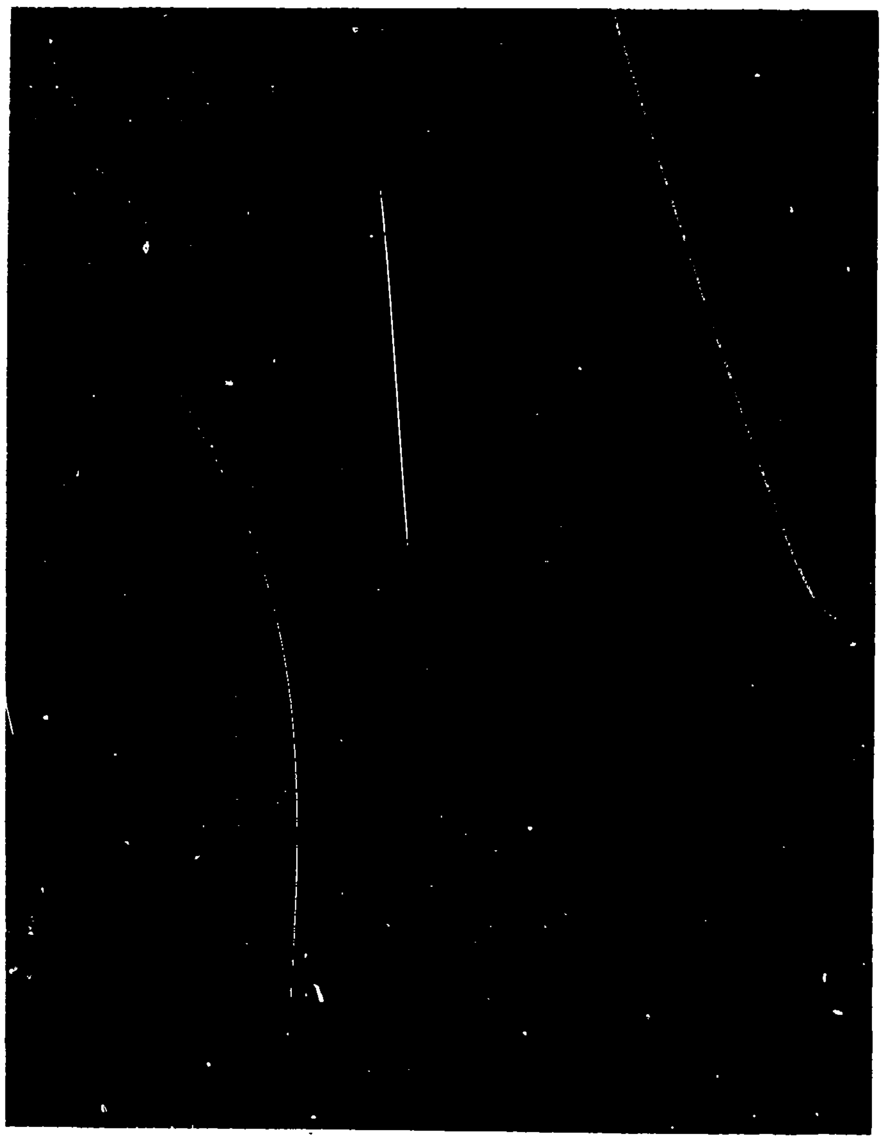


FIG.1. The R/V (MABAHISS) after her launch in 1930
(photo courtesy of Swan Hunter Shipbuilders Ltd)

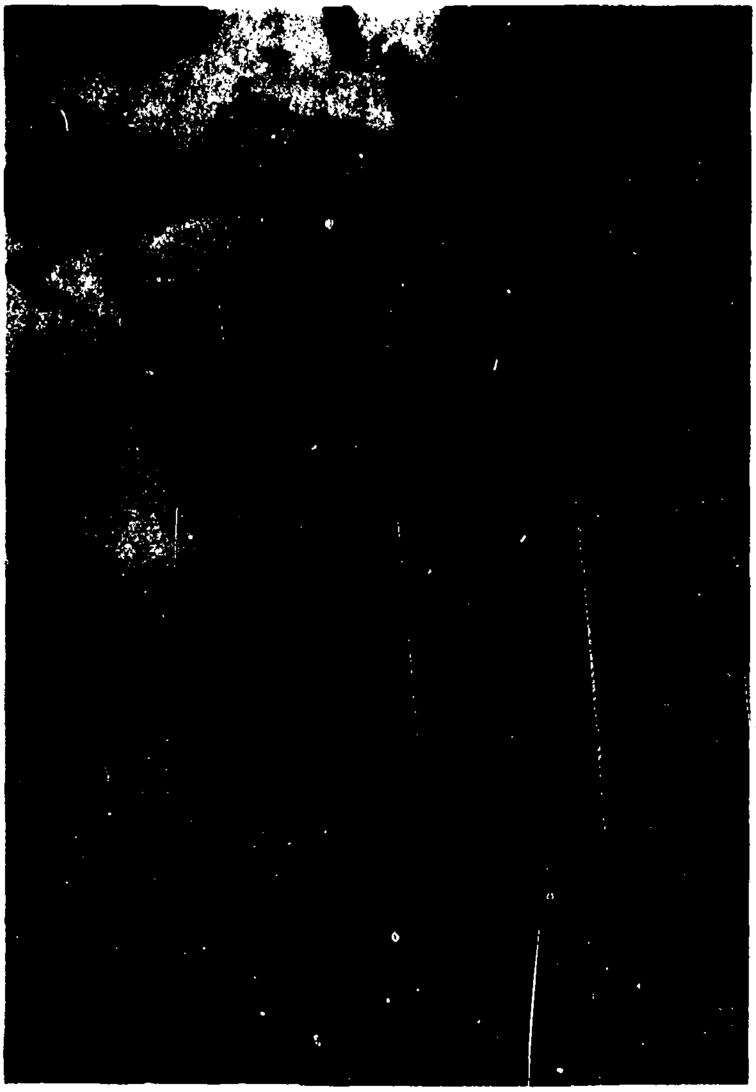
3.2 Historical perspectives.

3.2.1. The background to the MABAHISS/John Murray Expedition (1933/34)
Based on the papers by Dr A.L Rice, Dr Selim Morcos, Professor Aleem and Professor W. Wooster (and edited extracts from Seymour Sewell's narrative).

The northern Indian Ocean was not studied by the CHALLENGER expedition during its four and a half year periegesis of the world's oceans in the 1870's and, indeed, apart from some cruises by RIMS INVESTIGATOR from 1880, onward cruises by the Austrian NOVARA in the 1850's and the German VALDIVIA in the nineties the area remained largely unresearched in the 19th Century. Even in the first three decades of this century there was only a passing interest in the region. True the DANA had discovered the Carlsberg Ridge during her circumnavigation of 1928-30 and visits by the GAUSS 1901-03, PLANET 1906-07 and the SNELLIUS in the late 20's, together with information from vessels in passage, had produced an awareness of the general patterns of circulation and some knowledge of the water exchange between the Red Sea and the Gulf of Aden. Nevertheless overall knowledge tended then, as indeed today, to lag behind that available for other seas.

Sir John Murray, one of the original participants in the CHALLENGER cruise, had felt that the area merited attention and on his death in 1914 left shares in the Christmas Island Phosphate Company, the interest on which was to be applied "to scientific research or investigation or exploration which are likely to lead to an increase of natural knowledge and especially in the science of oceanography". By 1931 a considerable sum had accumulated and Murray's elder son enlisted the assistance of Professor Stanley Gardiner, Dr W.T.Colman and Dr E.J.Allen to determine the most appropriate means of meeting his father's wishes. After consultations it was concluded that an expedition should be mounted to investigate the Western India Ocean under the leadership of Lt. Col. R.G. Seymour Sewell. Seymour Sewell himself already had some experience of the region having served as naturalist on board the INVESTIGATOR.

A number of vessels were considered, the DANA, WILLIAM SCORESBY and GEORGE BLIGH but eventually the MABAHISS (a Mersey trawler built by Swan Hunter on the Tyne partly for fishery research and partly for custom work) (Fig.1) was selected when it was offered on loan by the Egyptian



John Murray - Mabahiss Expedition (1933-34) scientific staff

Back row, left to right: Abdel Fattah Mohamed (Chemist); Lt. Cmdr. W. I. Farquharson R. N. (Surveyor and Navigator); H. C. Gilson (Chemist); and T. T. Macan (Zoologist)

Front row, left to right: E. F. Thompson (Chief Chemist); R. B. Seymour Sewell (Leader and Zoologist); Hussein Faouzi (Zoologist and Ship's Doctor).

FIG.2 Scientific Staff of the John Murray/MABAHISS Expedition (1933-1934).

Government following representations made by Stanley Gardiner. K.N. MacKenzie was appointed captain and the Mabahiss entered the dockyard in Alexandria to be fitted out in July 1933. The staff H. Faouzi, A.F.Mohamed, E.F.Thompson, W.J.Griggs (Engineer), H.C. Gilson, T.T.Macan, R. Lloyd Jones (Wireless operator) and Seymour Sewell joined the vessel during the summer and she sailed on 3rd September with an Egyptian crew, two Egyptian officers and flying the Egyptian flag and the British Ensign together. (Fig.2)

It was planned that the expedition should, if possible, carry out a series of cruises, each lasting for approximately 20 days, in the following areas (see Fig.3 for ship's track).

(a) the south end of the Red Sea and the head of the Gulf of Aden;

(b) the Gulf of Aden and the channel between Cape Guardafui and Socotra;

(c) the southern coast of Arabia and across to Karachi;

(d) the Gulf of Oman and down to Bombay;

(e) across the Arabian Sea from Bombay to Mombasa;

(f) the African coast in the region of Mombasa and Zanzibar;

(g) across the Arabian Sea from Zanzibar to Kardiva Channel in the Maldives, calling at the Seychelles;

(h) from Colombo through the Maldive Archipelago and back to Cochin in India;

(i) from Cochin across the Arabian Sea to Aden;

(j) the Gulf of Aden, repeating previous observations;

(k) the south end of the Red Sea, repeating previous observations, and back to Alexandria.

During the course of these various cruises, routine observations were to be carried out at intervals of every four hours, namely at 4, 8 and 12 morning and evening, on

(i) the temperature of the surface water;

(ii) the salinity of the surface water;

(iii) the temperature of the air, as shown by both the wet and dry bulb thermometers;

(iv) the direction and force of the wind, and

(v) the height of the barometer.

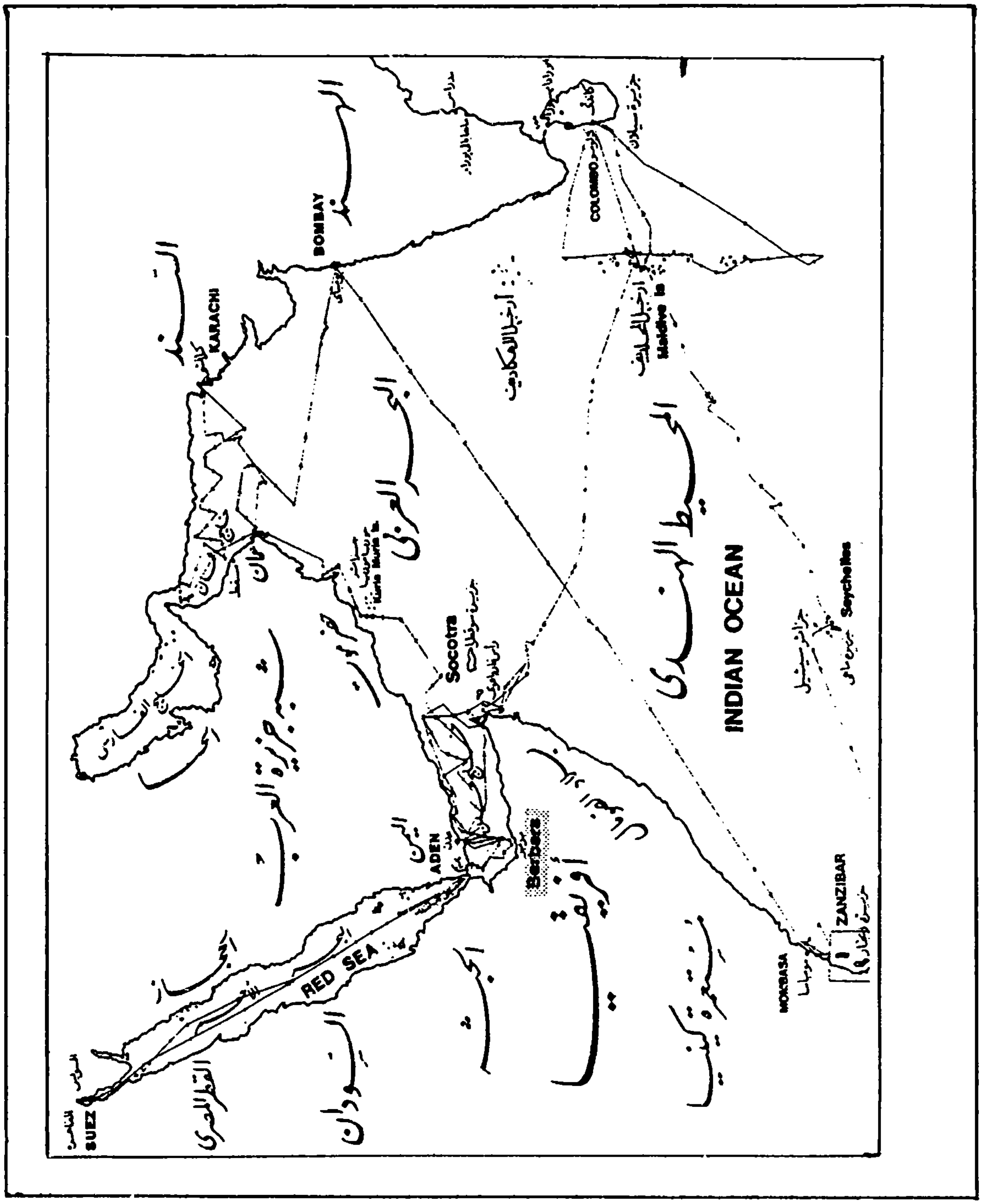


FIG. 3 Ship's track of R/V 'MABAHISS' for the John Murray Expedition (1933-1934), a contemporary map by H. Facuzi (1939).

During each cruise stations were to be made at intervals, the distance between them depending largely on circumstances, but falling as far as possible in definite lines to enable sections to be drawn. It was hoped that it would be possible to carry out some 10-12 such stations in each of the main voyages so that the distance between each would be in the neighbourhood of a day's steaming, or some 200 miles. At each station a complete examination was to be made of the sea water at the following depths:

Surface	150 metres	1500 metres
10 metres	200 "	2000 "
20 "	300 "	2500 "
30 "	400 "	3000 "
40 "	600 "	etc.
50 "	800 "	
60 "	1000 "	
80 "		
100 "		

and was to include the temperature, salinity, pH concentration (acidity or alkalinity), phosphate, nitrate, nitrite and silicate content, amount of dissolved oxygen and any other estimations as might be thought desirable. In certain areas, such as the Gulf of Aden, it was hoped to get stations at closer intervals so as to be able to trace the movements of deep water masses in more detail, while during the two visits it was expected that it should be possible to detect seasonal changes in the general conditions. Also on each of the main cruises it was hoped that it should be possible to carry out, on at least two occasions, 24-hour observations on the conditions present in the upper few hundred metres in order to detect the changes that occur in:

(1) the level at which the floating plant-population (phyto-plankton) is concentrated;

(2) the total quantity of this phyto-plankton;

(3) the level at which certain ingredients of the zoo-plankton are to be found by day and by night.

Certain areas of the continental slopes were selected for specially intensive study, namely:-

(1) the southern end of the Red Sea;

(2) the Gulf of Aden;

(3) the south and south-east coast of Arabia;

(4) the Gulf of Oman and the entrance to the Arabian Gulf;

(5) the east coast of Africa in the vicinity of Zanzibar, and

(6) the western slopes of the Maldive Archipelago.

The actual selection of the areas had to be left to circumstance, since much depended on the character of the sea-floor as revealed by the echo-sounding apparatus, the first necessity being a gradual slope so that the contour lines should lie as far apart as possible. In these areas a special study was to be made of the zonal distribution of the fauna according to depth between the levels of 50 and 1000 fathoms; the general routine was as follows:-

(a) the depth of water ascertained by the echo-sounding apparatus;

(b) a sample of the bottom to be obtained, this also serving as a check on the depth as given by the echo;

(c) a collection of the bottom fauna by means of a grab,dredge or trawl, the actual selection of the apparatus used being dependent on the character of the sea floor.

A comprehensive programme indeed.

Altogether the MABAHISS sailed some 22000 miles during the expedition and (how different from today's research vessels) received a warm welcome wherever she anchored, even if no prior permission had been sought. Despite the cramped working conditions, lack of air conditioning and frustrations arising from loss of gear the dedication of all concerned enabled much to be achieved . Eventually 11 volumes of reports were produced, primarily relating to the biota but also providing valuable information on pH and other chemical aspects. The mass of sediment obtained is still being worked up today and the use of the echo-sounder, then a recent innovation, provided much valuable material on water depth. Seymour Sewell had good reason to be happy with his team and the results achieved and it is perhaps fitting to complete this brief account with the words with which he ends his own report of the epic journey:

> "In conclusion I am very glad to be able to take this opportunity of expressing my thanks and my great appreciation of the splendid manner in which all those who were associated with me in the expedition carried out their duties,. Many of my scientific colleagues had had no experience of work of this kind or the nature of life on board a small ship on the

high seas; but in spite of all discomforts, and only those who have suffered from sea-sickness can realize what these discomforts were like, they carried out their work in a manner that was beyond all praise. Of the ship's staff I cannot speak too highly; they one and all did their utmost to ensure the success of the expedition and to help us in every possible way. To many of our Egyptian colleagues such a voyage was something entirely foreign to their ordinary experience; it took them to strange lands and unknown waters and entailed what to them was before unknown, a prolonged absence from home and their fellow countrymen; but in spite of all hardships they were invariably cheerful and hard-working and I know that I am speaking for us all when I say that we, as a result of the experience, have formed a very high opinion of the personnel of the Egyptian Coast Guard Service."

(Largely from the 'Narrative of John Murray Expedition 1933/34', by the late R.B.Seymour Sewell, edited by A.L. Rice and soon to be published by Unesco.)

3.2.2 The Egyptian Red Sea Expedition (1934/1935)

Taking up the story of the MABAHISS history Dr Selim Morcos described how six months after its return from the Indian Ocean the vessel was the base for the Egyptian Red Sea Expedition and became the first research ship to visit the Gulf of Aqaba since the Austrian POLA Expedition (1895/96). The work of Dr Mohamed on the salinity of the surface water of the Red Sea then has formed a useful basis for the studies of later workers. Other noteworthy findings included the observation that surface temperatures are higher on the Arabian than on the Egyptian side of the Red Sea and that the Gulf of Aqaba is better oxygenated than the Red Sea. The MABAHISS was able to provide a more synoptic view of the features of water properties in the Red Sea than had previously been obtained since, by contrast with most vessels which had just made observations during passage from Suez to Bab el Mandab, transverse passes were made across the water body.

The 47 oceanographic stations of the 1933 MABAHISS cruise revealed major phenomena for the first time, including the adiabatic increase of temperature in the gulf of Aqaba, the intermediate layer of minimum oxygen and the intermediate maximum of phosphate in the Red Sea. The exchange of water between the Red Sea and Gulf of Aqaba in the Strait of Tiran, the water circulation and the formation of deep and bottom water in winter in the Northern Red Sea were described for the first time.

Echo-location was an important element in the Red Sea survey and the Expedition found the Mabahiss Deeps.

3.2.3 The International Indian Ocean Expedition (1959-1965)

Thirty five years after the first MABAHISS cruise the Indian Ocean was again singled out as being relatively unstudied in a modern context and was selected as the focal area for the multinational programme that became the International Indian Ocean Expedition.

The concept was initiated by S.C.O.R whose members wished to have a better knowledge of the variability of the monsoons, the effects of seasonal change in the windstress and the high productivity in the northern Arabian Sea. The ultimate scale of operations, involving forty vessels from 23 countries and, spanning the period from 1959 65, far exceeded any previous study. The overall estimated cost of some $60 million dollars makes a salutary contrast with the £20 thousand pounds expended on the MABAHISS cruise. As Professor Wooster noted 'the I.I.O.E. was probably the largest unco-ordinated expedition in history and in part its success was due to this.'

The I.I.O.E provided a useful focus for the developing countries and it was appropriate that after S.C.O.R.'s initiative the exercise received input from I.O.C., UNESCO, WHO and FAO, and soon after its establishment the IOC took over the task of co-ordination, from SCOR.

Most of the effort was applied to the northern Indian Ocean and many lessons were learnt - particularly in relation to the need for intercalibration of instruments and methods and the difficulty of sampling and indeed of navigating precisely, in the Somali current. It is perhaps invidious to single out items of particular value which resulted from the effort but apart from the mass of fundamental data that was obtained significant results related (1) to the meteorological studies taken up by the W.M.O. in view of their importance in weather predictions in the region, (2) the subsequent maintained interest of the F.A.O. in the fishery potential of the area, (3) the establishment of the plankton sorting centre at Cochin, and of Oceanographic studies in Thailand, (4) the publication of an oceanographic atlas for the Indian Ocean and (5) last but not least, the discovery of the hot metaliferous brines in the Red Sea. As mentioned by Professors Aleem and Morcos, many students from the countries of the region also benefited from opportunities offered for experience in new oceanographic techniques. Valuable findings indeed, not just for those whose interests relate to scientific fundamentals but also for the more pragmatic needs of economic potential in the developing countries of the region. A full narrative of the events leading up to the I.I.O.E. and highlights of the cruises edited by Daniel Behrman is published by the UNESCO press under the title "Assault on the Largest Unknown: The International Indian Ocean Expedition 1959-65 (available in English, French, Russian and Spanish versions).

Comparing the MABAHISS/John Murray Expedition and the I.I.O.E., Professors Aleem and Morcos mentioned that although 25 years apart, each exercise represented a significant event in the development of marine sciences in the region, and each was a natural product of the state of art and the international climate at these two points in history.

3.2.4 The development of Egyptian Marine Science.

The further development of marine science in Egypt was reviewed by Professor S.K. El Wakeel. Egyptian interest in the marine science can be traced back to the 18th and 19th Century, when occasional marine investigations such as the survey of water levels in the Mediterranean and Red Seas were undertaken, but it was only in the present century that systematic and wide ranging studies have commenced. The first unit devoted to marine research was the Hydrobiological Institute founded at Shatby, Alexandria in 1924. Later, in 1931, this was replaced by the Alexandria Institute of Hydrobiology and Fisheries at Kayet Bay under the aegis of the Fisheries Directorate. In the same year Cairo University established a marine biological station at Al-Ghardaqua.

Basic and applied research on marine flora and fauna was undertaken by both the aforementioned laboratories but hostilities in the early 1940's precluded further expansion. After the war however the need for further graduates with specialisms in marine science was recognised and in 1948 Professor Hussain Faouzi and Professor Abdel Fattah Mohamed, the two MABAHISS veterans, founded the Department of Oceanography.

In 1960 the Alexandria Institute of Hydrobiology and Fisheries and the Marine Biological Station at Al Ghardiqua were merged, under the auspices of the Academy of Scientific Research and Technology, to form what is now the Institute of Oceanography and Fisheries. The Institute undertakes basic and applied research in relation to fishery development, improving fishing gear, and conservation and, in addition, provides technical advice in relation to the formulation of legislation.

The academic aspects of marine science devolve upon the Department of Oceanography, Alexandria University, the only Egyptian institute producing graduate oceanographers. Over the years the alumni have included some 250 B.Sc's, 150 Diploma students, 75 M.Sc's and 15 Ph.D's.

Research activities span a wide field in chemistry, hydrology & productivity - particularly in respect of the Nile delta and coastal lagoons - and there are also ecological and taxonomic studies relating to the Mediterranean, Red Sea, Suez Canal and harbours. Pollution is a major study in the Alexandria region. Future programmes are planned with regard to modelling Mediterranean littoral ecosystems.

An outline of recent studies and work in progress was given varying from the study of tides in the Suez Canal to the effects of the Aswan Dam on productivity of coastal Mediterranean waters and from seasonal variations of the hydrographic conditions to the monitoring of oil pollution in the Red Sea.

4. THE SCIENTIFIC SESSIONS

SYNTHESIS OF THE SCIENTIFIC PRESENTATIONS

The thirty-two scientific papers presented at the meeting together with the poster displays, provided evidence of the extent of advances in oceanography in the region since the International Indian Ocean Expedition. Highlights of the contributions are described below.

4.1 The Indian Ocean

4.1.1 Introduction.

Perhaps nowhere else in the world is there such a combination of features to interest not only exponents of all the major disciplines, but also those concerned with practical exploitation. *Inter alia* there are the interrelation between wind stress and the movement of water masses for the physicist; the effects of seasonal reversal and variability for the modeller; the largest known seasonal region of upwelling in the world with its implications for the biology and chemistry of the region; the extensive oxygen depletion in the Arabian Sea , again with chemical and biological connotations and a configuration of the ocean basin, appreciation of the significance of which led ultimately to the acceptance of the concept of sea-floor spreading and polar reversals. Coupled with the features attractive to the pure scientist are those with commercial implications, the effect of upwelling and increased productivity on fisheries, the unexploited stock of mesopelagic fish and the possible interactions between such fish and oxygen depleted waters, the mineral potential of continental margins and the special problems associated with the exploitation of resources in relation to the maintenance of ecological integrity.

The principal features which dominate the hydrography of the Indian Ocean are the inputs of (1) highly saline water from the Red Sea and the Gulf, (2) fresh water from the rivers of the Indian sub-continent, (3) antarctic bottom water and above all others, (4) the effects of the marked seasonal reversal of wind stress associated with the north-east and south-west monsoons.

Surface current patterns in February indicate a fairly typical oceanic pattern with north and south equatorial currents moving westerly, an equatorial counter current in an easterly direction and in the

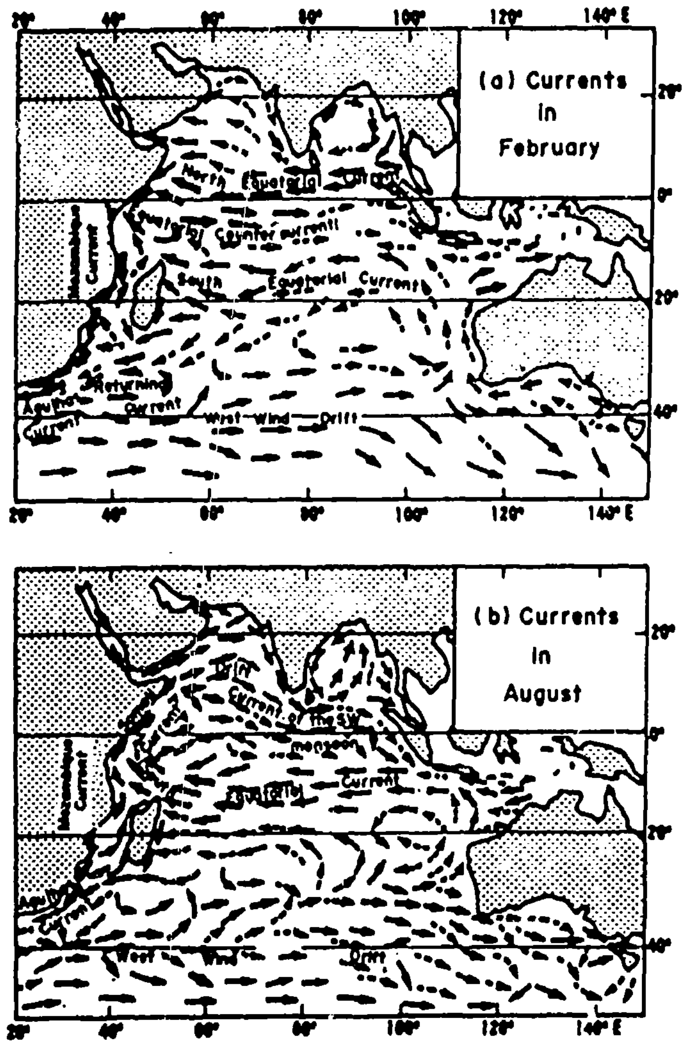


FIG.4 Surface currents in the Indian Ocean (a) in February (b) in August. (From Tchernia, P. Descriptive Regional Oceanography, Pergamon Press, Oxford, 1978).

southern ocean an easterly movement. Within the north-west Indian Ocean, there is a general westerly drift towards Cabo Guadafui but with southerly drifts along the coasts of Somalia and the Indian sub-continent (Fig.4a).

The pattern is quite different in August, when, under the influence of the severe wind stress of the south-west monsoon, the Somali current changes direction, the north equatorial current is effectively reversed as the south-west current and the equatorial current flow is westerly (Fig.4b).

Centres of upwelling with associated regions of high productivity appear off the Somali coast in summer, whilst mid-water regions with severely depleted oxygen levels and showing evidence of denitrification occur in the Arabian Sea and extend some way down the Indian sub-continent.

4.1.2 Geomorphology and history of the ocean basin. (Fig.5)

4.1.2.1 Geomorphology

The Indian Ocean with a surface area of a little under 50 million km^2, though smaller than the other great oceans (Atlantic, Pacific and Antarctic), is comparable in depth (3,800m).

Prominent in the submarine morphology are a number of ridges separating the various basins. Principal amongst the former is the Carlsberg Ridge which, at its northern end, connects both with the East Africa Rift and the Red Sea systems. Within the Indian Ocean, it runs generally in a south easterly direction to a little south of the Equator and then moves southerly to some 25°S where it conjoins with the south west and south east ridges which in turn are continuations of the great submarine ridges of the other oceans. Further significant features of the bottom topography are the Ninety East Ridge running for some 2,500km north/south at that longitude and the north/south *soi disant* central ridge. The island groups of the Lacadives, Maldives and Chagos, represent the tips of the higher peaks of the latter. To the west of the Carlsberg Ridge and between it and Madagascar lies another ridge with which are associated the Amirantes and the Seychelles at one end, and Mauritius and Reunion at the other, with the Nazareth Banks and Mascarene Plateau between. A lesser feature, though one important in the context of the

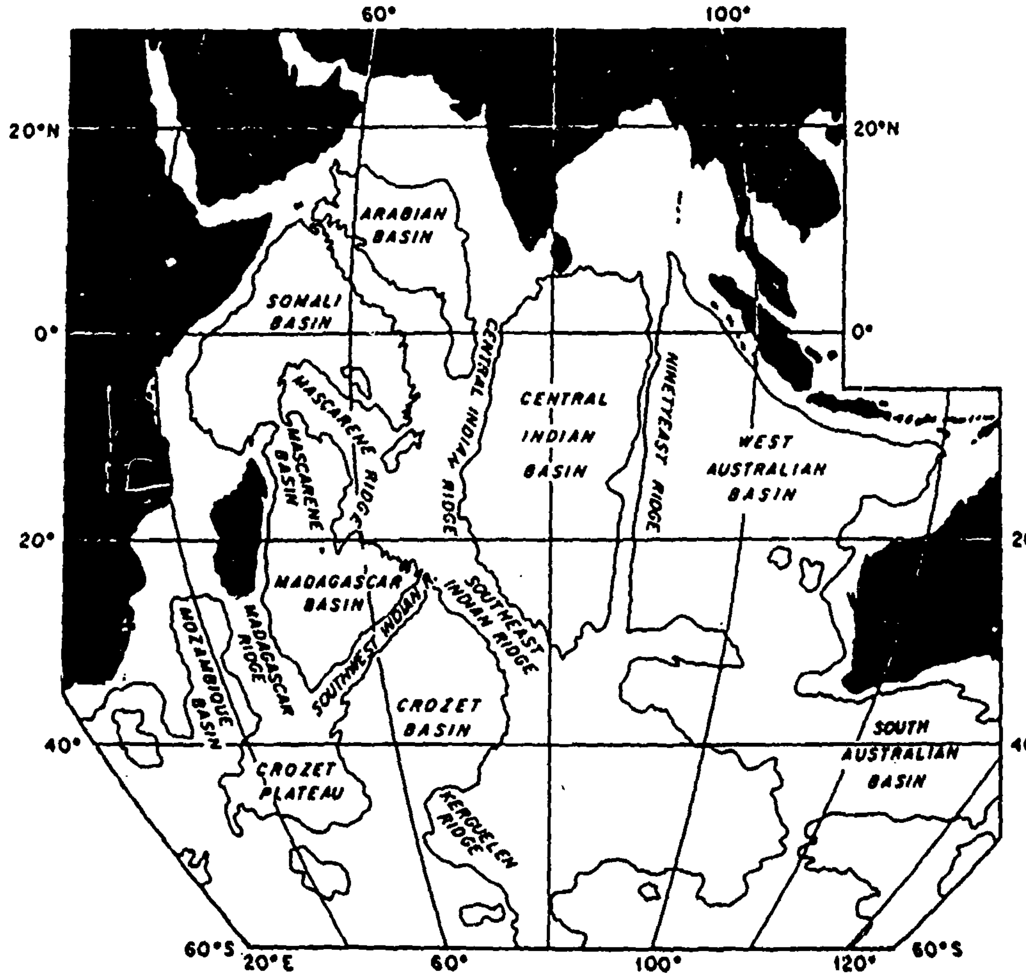


FIG.5 The major ridges and basins of the Indian Ocean in relation to the 4km isobath. From B.A.Warren (1978) Deep-Sea Research 25, p.316. After Wyrtki (1971).

present meeting, is the Murray Ridge forming the south eastern boundary of the Gulf of Oman, first located by the MABAHISS. The principal basins separated by these features are:- the Arabia Basin to the north and east of Carlsberg Ridge; the Somali Basin to the west of the northern part of the Ridge; the Nazareth trench between the Carlsberg Ridge and the Seychelles/Mauritius Ridge, with the Mascarene Basin to the east between the latter ridge and Madagascar. The deepest part of the Indian Ocean is in the Jarva trench south and east of the Ninety East Ridge, at some 7,500m.

4.1.2.2 Geological history

Outlining the history of the ocean, Professor F. Vine summarised the concepts associated with sea floor spreading and continental drift. Although the basic suggestion that the continents may have separated is not of recent origin, the understanding of the implication of magnetic anomalies, observed during the International Indian Ocean Expedition, played an important part in the development of current ideas in relation to the mechanisms involved in the process.

Study of the history of the basin is complicated by the presence within the system of a number of micro-continents (Madagascar, Ninety East Ridge, Lacadive-Chagos Plateau and Seychelles-Mascarene Plateau), regions which are aseismic, in addition to the spreading ridges and trailing continental margins. Nevertheless, the study of the mesozoic magnetic anomalies in the Mascarene, Mozambique and Western Somali Basins, together with the discovery of fracture zones *inter alia* in the Carlsberg and South Western Ridges, have made possible reasonable interpretation of the history of the Indian Ocean since the break-up of Gondwana land, some 160m years ago.

Five separate phases in the growth of the Indian Ocean have been recognised, though only four of these are indicated in the north western region currently under discussion. The first period, in the late Jurassic and early Cretaceous, involved in the separation of Gondwana into a western component (Africa and South America) and Eastern Gondwana (Madagascar, India, Antarctica and Australia). Evidence for this period of development is found in the anomalies of the Western Somali and Mozambique Basins. In the Aptian period of the lower Cretaceous, spreading occurred south of India resulting further in the separation of India and Madagascar from Australia and Antarctic. In the Santonian period of the Cretaceous, a new spreading zone was initiated which led to the separation of India and Madagascar and the formation of the Mascarene Basin. Spreading ceased in this Basin in the Danian era, but new activity began north east of the Seychelles, separating the Seychelles Bank from India and initiating the spreading from the Carlsberg Ridge which is continuing to the present time. Extension of this spreading activity into the region of the Gulf of Aden and Red Sea occurred in the late Tertiary period.

At the northern end of the Indian Ocean, the Oceanic part of the Arabian plate is being subducted beneath the continental Eurasian plate and, in the process, the thick layer of overlying superficial sediment is scraped off to accumulate in the Makran prism of Pakistan and Iran. The processes involved in consolidation of these sediment layers can result in the trapping of pockets of gas and consequently, the processes involved are of more than purely academic interest. Dr S. White used marine geophysical data as a basis for discussing the structure and tectonics of the three different margins of the Gulf of Oman, the compressed region offshore at Makran, the passive continental margin of Oman to the south west and, to the south east, the inter-oceanic region of the Murray Ridge.

The extension of the activity zone of the Carlsberg Ridge passes up the Red Sea, Gulf of Aqaba, Dead Sea and north to Lake Tiberias. Considering the formation of the Red Sea, Dr R.W.Girdler suggested there has been an anticlockwise rotation of Arabia with respect to Nubia as the Arabian and African plates have moved apart. The Gulf of Aden was probably initiated in the late Eocene, the origin of the northern Red Sea was somewhat later and seems to have involved three phases: (1) an oligocene Gulf of Suez stage, (2) the first stage of development of the Gulf of Aqaba/Dead Sea axis in the lower Miocene and (3) further development of this system in the Pliocene/Pleistocene which are still continuing. Current estimates of the extent of the movements associated with these last two processes are 62km and 45km respectively, and the sum of these two values rather neatly fits the present mismatch of 107km observed between the western mountain scarps of Sinai and Arabia. Moving back Arabia the necessary 107km would produce co-linearity of these scarps; compelling evidence for the suggestion that the separation is due to the relative movement of plate components.

4.1.3. Physical Oceanography

4.1.3.1. An overview

In presenting an overview of the physical oceanography of the region, Dr J. Swallow discussed the importance of the wind field in the near surface circulation and the relation of the lateral displacement to the upwelling zones, drawing attention to the various factors of importance in the initiation of the upwelling process off Somalia and the Arabian Peninsula.

At low latitudes off Somalia upwelling during the south west monsoon is related to the turning offshore of the boundary current which has reached that latitude partly as an overshoot from south of the equator. By contrast the upwelling occurring at 7-10°N is due initially to offshore Ekman transport in response to local southerly winds and is then modified subsequently after the onset of the main monsoon by a strong clockwise eddy propagating shorewards from the region of maximum clockwise windstress curl. Finally, in the zone off the Southern Arabian coast the boundary current is weak and there is a broad zone of upwelling. In this area there is coastal upwelling due to Ekman transport of surface water offshore, in response to winds parallel to the coast. In addition there is a region, some 400km wide, in which open sea upwelling occurs in response to positive windstress curl. The upwelling in this region is estimated to reach 8 million m^3 sec^{-1} over a surface area 1000 km by 400km. The ultimate fate of the upwelled water is still in some doubt and the biologists were urged to address themselves to the question as to whether the use of indicator species might assist in resolving this problem.

There is uncertainty at present as to the means by which the cooled upwelled water is replaced. Sinking of surface water during the winter in the Arabian sea is insignificant and consequently some of the replacement must occur at intermediate depth, perhaps in the upper few hundred metres below the Somali current.

In the Arabian Sea oxygen levels decline below the surface and the lowest values are usually at about 600-800 m below the surface in the N.E. part of the region though concentrations of less than 0.2 mlℓ^{-1} can, on occasions, be found at all depths from 200-1000m.

The origin and maintenance of these low oxygen concentrations must depend on the balance between the consumption of O_2 during oxidation of organic material and renewal by advection and mixing. The near surface waters are re-oxygenated by advection and mixing but downward mixing is limited by the strong tropical thermocline. Poor circulation alone does not however appear to be a satisfactory explanation of the maintained low O_2 levels in sub-surface water since it seems likely that substantial volumes of sub-surface water must enter the Arabian Sea to account for the dilution of the water entering from the Gulf of Aden and Arabian Gulf. A possible solution would be if aged water with an already reduced O_2 content was entering the region. Water from the Banda sea has a relatively low O_2 level (2-2.5ml ℓ^{-1}) and might be a significant contributor to the lower levels but there is a need also to investigate the depth paths and oxygen consumption in the other two water masses crossing the equator into the Arabian Sea at intermediate depth.

Reviewing the question of the reversing current patterns associated with the north-eastern and south-western monsoon, Dr. M. Fieux provided some elegant reconstructions of the May to August surface current patterns of the Western Indian Ocean based on the 1979 observations. Attention was drawn however to the great variability of Indian Ocean currents and the need therefore for determination of interannual variation of the system to be modelled adequately.Taking up this point, Madame Delecluse outlined the previous theoretical models for the Somali current system; Lighthill's concept of remote forcing by equatorial westerlies; Cox's consideration of local versus remote forcing and Anderson and Moore's suggestion that the southern part of the current is an inertial boundary current forced by the southern hemisphere coastline. A numerical model based on windstress seems to replicate the observed effects in at least the southern part of the current.

Another model based on 60 years of ship observations of wind speed gives a good fit to surface current patterns in the Arabian Basin. Discussing this Dr. Mark Luther predicted that still better fits may be anticipated when real time synoptic values for wind speed and direction are available.

Luther's existing computer model displays the following features. With the onset of the south-west monsoon, a northward flow develops across the Equator near the African coast and turns offshore a few degrees north. The remnant of the previous summer's anticyclonic gyre in the north-western part of the Indian Ocean basin still persists at the onset of the monsoon and a two gyre current pattern develops consistent with field observations over this period (May-June). As the south-west monsoon intensifies, the southern gyre moves northwards until it begins to interact with the northern gyre though both current streams maintain their integrity until the summer winds moderate. Then the gyres coalesce. Southward flow across the Equator commences about a month before the onset of the north-east monsoon and the northern gyre largely dissipates as the northerly winds develop. With increasing intensity of the winter monsoon, the southward flowing boundary current extends further south and gives rise to eddies and meanders as it separates from the coastal region. This winter Somali current itself dissipates as the winter winds moderate and a northward flow across the Equator begins as the winds reverse at the start of a new annual cycle. The northward flow in its turn initiates a new southern gyre whilst the persistent remnants of the previous years' southern gyre give rise to the new northern gyre. And so the cycle repeats.

Incorporation of a realistic basin topography and of synoptic real time data from satellite-mounted scatterometers may be expected to still further improve the relationship between predicted and observed water movements. These updating aspects of model technique may also be anticipated to be of particular relevance to the understanding of interannual variation and variability.

It must be emphasized that most of the studies relating to the movement of water masses in the Indian Ocean at present relate to the surface waters and the same is true of the model predictions. Much less is known of the movement of the deeper waters, an unfortunate omission in view of the importance to the region both of upwelling and of the deep anoxic layers with their periodic incursion into the surface and sub-surface waters of the north-eastern parts of the basin.

Oxygen levels in the Arabian Sea decline rapidly with depth, particularly north of 20°N and can reach levels below 1ml l^{-1}. (Fig.6) Significant local differences in relation to eddies have however been observed. Studies on the eddy patterns in the general region of the Gulf of Oman, Murray Ridge and off the coast of Pakistan were described by Dr G.S. Quraishee. Satellite imagery from NOAA-6 has indicated the presence of both warm core and cold core eddies during the S.W. monsoon in the northern Arabian Sea. During May to September cold water associated with upwelling is observed extending up to 400km off the Arabian Coast and also there is a weaker region of upwelling along the Pakistan coast west of Karachi extending up to 200km offshore. Both upwelling regions are associated with cyclonic gyres but between them in the Murray Ridge area there lies an anticyclonic eddy with a warm core. The northern edge of this eddy can extend over the Pakistan coastal shelf and in these near shore waters the current speed at 20m is some 0.32m sec^{-1} whilst offshore it increases to 0.56m sec^{-1}. Sinking of high salinity water occurs in the centre of the anticyclonic gyre, and possibly as a result of this, the oxygen levels at 100m in the eddy field can be greater than 3mll^{-1}. Nutrient rich water is advected into the centre of the eddy from the two upwelling areas and the zooplankton in the area is rich. More detailed studies are merited to correlate the intensity of the eddy with productivity.

The topography of the Murray Ridge does not appear to contribute to the eddy field though a northward intrusion of cold water below 500m has been observed through the ridge passage. At the junction of the Murray Ridge with the Pakistan coast the varying orientation and slopes of the shelf to east and west of the ridge appears to contribute to the creation of a broad upwelling zone though further observations are needed to support these inferances.

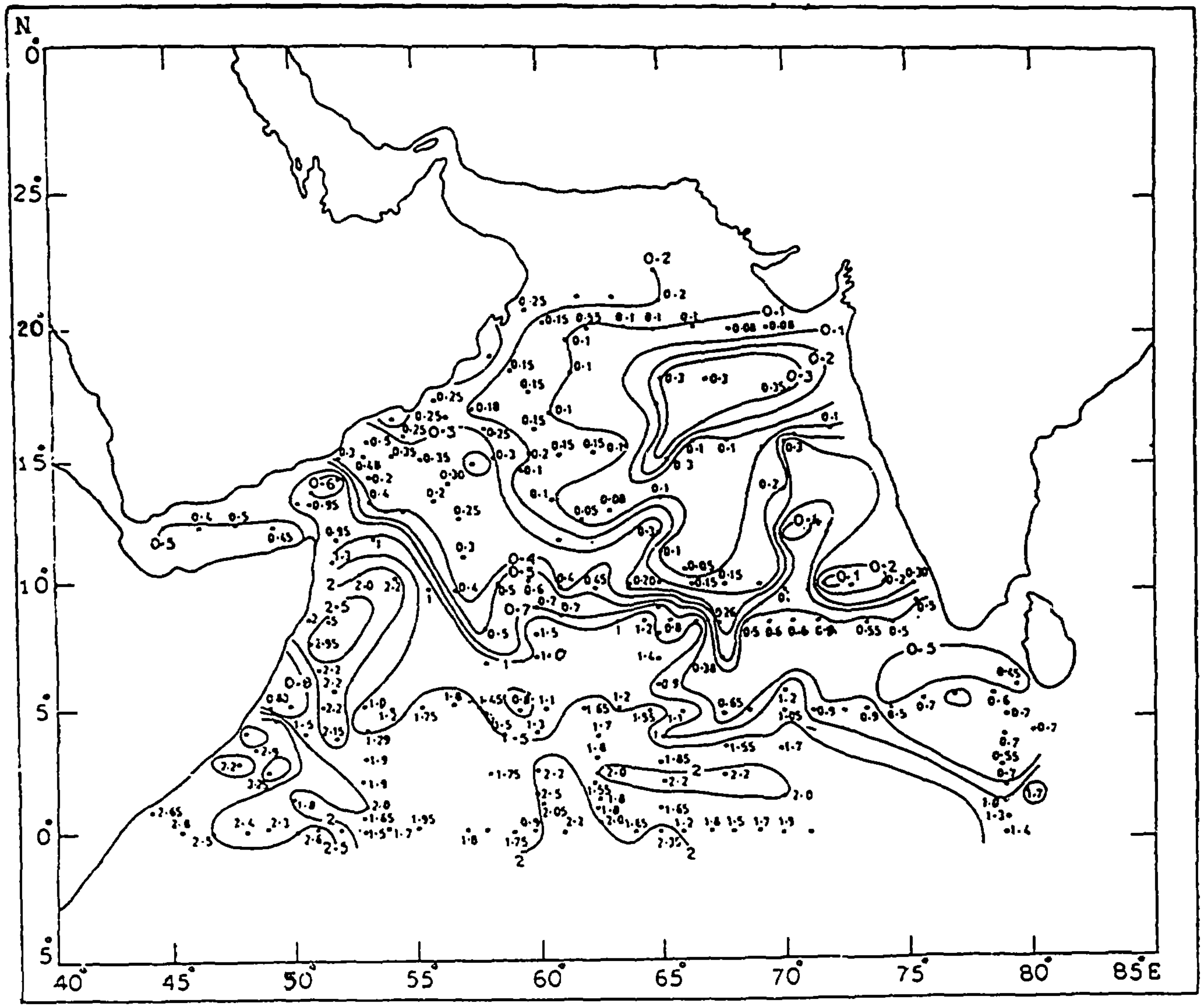


FIG. 6a Concentration of oxygen in the oxygen minimum layer in the Arabian Sea during the South West Monsoon (May-August) (units in ml ℓ^{-1}) Unpublished figure courtesy Professor G.S. Sharma, Cochin.

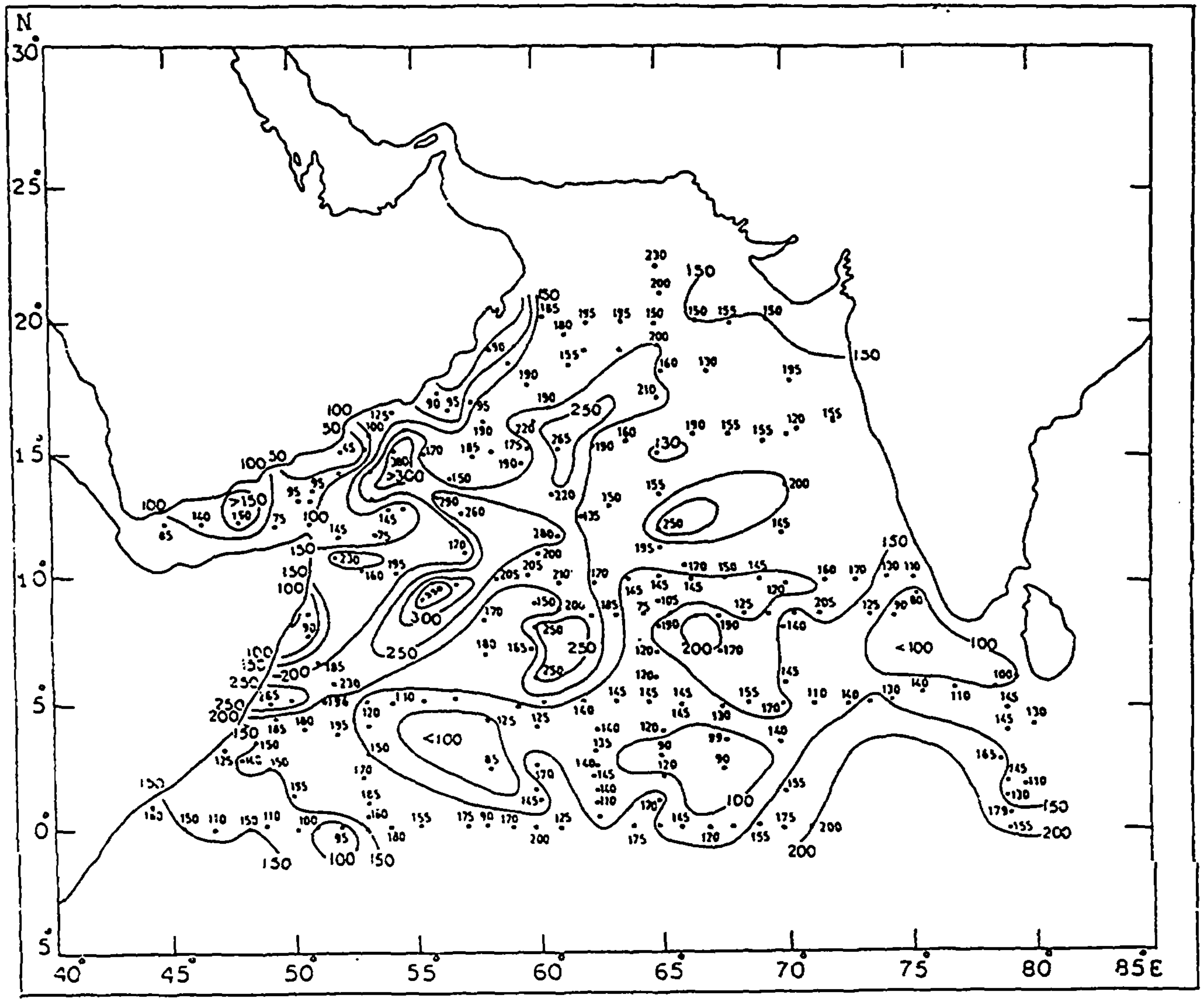


FIG. 6b Topography of the oxygen minimum layer during the South-West Monsoon (May-August) (units in metres).
Unpublished figure courtesy Professor G. S. Sharma, Cochin.

4.1.3.2 Correlation of faunal distribution with waters of low O_2 content

During the SW monsoon the upwelling off the Pakistan coast may abut the shelf zone. As a result, sub-surface water with a low oxygen concentration can flow onto the shelf and remain there until the monsoon reversal in December. Discussing this phenomenon Dr S.M.Haq indicated that the significance of the low oxygen levels to the biota was still only poorly understood. Physiological stress to the benthos is predictable and this may also extend to organisms in the surface waters on those occasions when the low O_2 water penetration is pronounced. It remains uncertain however whether the concentration of fish and shrimps along the coast and creeks of Sind province co-incidental with the period of upwelling represents a migratory avoidance of the low O_2 water. This does however seem likely. It is also uncertain whether the somewhat limited slope/shelf benthos in this region is correlated with intolerance of low oxygen levels. In order for proper fishing management programmes to be adopted there is a need for further information in this context on (1) the physiological tolerance and distribution of species, particularly those of commercial importance (2) the residence time of low oxygen water on the shelf and (3) models to predict the likely severity of occurrence of upwelling. Attention must also be given to ensuring that there is an adequate knowledge of the effects of pollution in the creeks and backwaters which are important nursery grounds for the marine fauna.

4.1.3.3 Maintenance of low O_2 zones

The precise reason for the occurrence and maintenance of the deoxygenated zones in the Arabian Sea and North East Indian Ocean still appears to be in some doubt. Authorities concurred as to the importance of the role of organic inputs from the high productivity regions of the upwelling areas but the relative influence of the various contributing factors - input of deep aged water from the Banda Sea; the stabilizing influence of input of dense saline waters from the Red Sea or input of diluted waters by the major riverine systems of the Indian sub-continent - remains to be assessed.

4.1.4 Chemical Oceanography

A secondary chemical effect resulting from the low O_2 levels in sub-surface waters is the reduction of nitrate, (Fig.7) and Drs. Sen Gupta and Naqui suggest that the Northern Indian Ocean may account for up to 10% of global marine denitrification.

The same authors, in a wide ranging review presented by Dr. Morcos, referred to another chemical feature in which the Indian Ocean is unusual, namely the calcium:chlorinity ratio. High ratios are found compared with average values elsewhere. This fact may be due to (1) the high river run-off in a relatively small area and (2) excessive levels of Ca at the surface related to high biological productivity.

Stagnation of water at intermediate levels results in high total CO_2 content at these levels. The partial pressure of CO_2 in surface waters can also exceed atmospheric levels implying that there should be a net transport of the gas in the water-air direction.

A study by Scott Fowler of heavy metal concentrations (Cu, Zu, Cd, Pb, and Hg) from the surface waters of the Gulf and Arabian Sea coast of Oman, indicates that in general the levels of heavy metals are low. There are however a number of sites, mostly in the vicinity of industrial complexes, where there are localized regions with higher levels. Copper concentrations along the coast of U.A.E. tend to be somewhat higher than in the waters of Bahrain and Oman, whilst Cd levels are low but with measurably higher concentration off the Gulf coast of Oman than in the more open waters of the Arabian Sea coast. Copper and zinc levels are appreciably less along the Arabian peninsula than have been reported off the Indian sub-continent. Mercury levels are generally very low in the Gulf.

Given the sensitivity of trace metal analysis to the method used, the importance of standardization of technique and the need for intercalibration of analytical systems seem to merit particular attention.

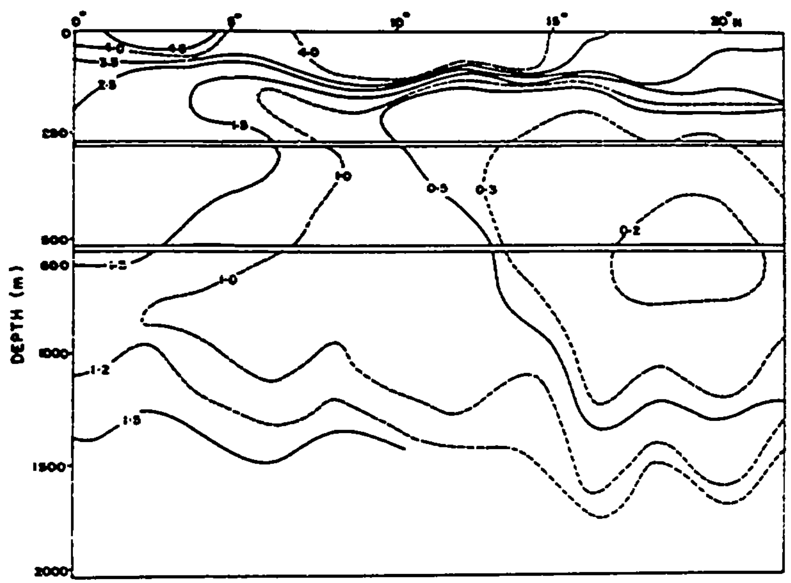


Fig.7a Vertical section showing distribution of oxygen (ml.l^{-1}) along 65°E longitude from equator to 22°N latitude (from Sen Gupta et al, 1976).

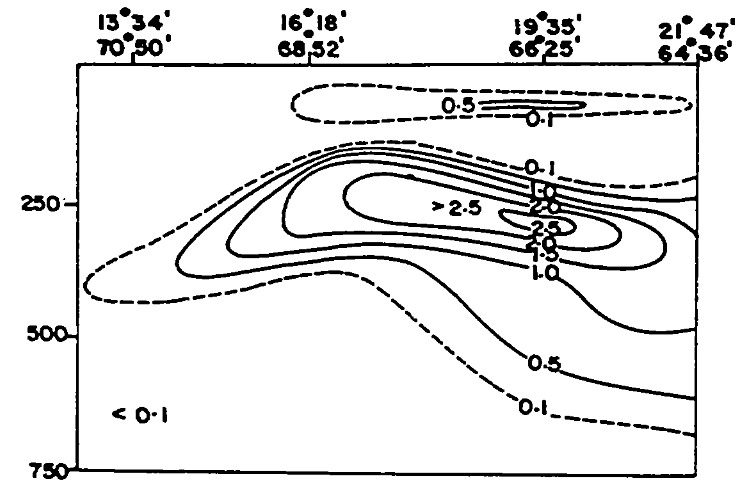


Fig.7b Distribution of nitrite-nitrogen (μ mol l^{-1}) along the same section as in Fig.7a (from Naqvi and Qasim, 1983).

The concentration of heavy metal ions such as Hg, Cu and Pb, in the tissues of fish and plankton off the Indian coast is reported as being less than the levels recorded in many industrial countries.

4.1.5 Upwelling in relation to productivity.

Nowhere in the world's oceans is upwelling so pronounced a feature of the system as in the northern Indian Ocean, the estimated 50,000 square kilometers of the upwelling zone off the Somali coast during the south-west monsoon far surpassing comparable upwelling zones elsewhere. In addition, the summer monsoon also results in extensive upwelling off the coast of Pakistan.

The relationship between upwelling and productivity was examined by Dr Sharon Smith. Comparison of data from the 1964 cruise of RRS DISCOVERY during the I.I.O.E. and the more recent (1979) cruise of R/V ISELIN shows common features in the upwelling off the Somali coast in the two years. The indications are that there can be two centres of upwelling in the region. In both years, the highest surface concentration of chlorophyll a between Mombassa (4°S) and Cabo Guadafui (12°N) lay off Ras Harun where a level of some 4-5mg m^{-3} was reached. Sea surface temperatures in this region are lower than elsewhere along the coast and the surface nitrate levels show a strong correlation with temperature. A good biological indicator of the upwelling is the copepod *Calanoides carinatus*. This species, though absent from the surface waters during the northerly monsoon, occurred in numbers in excess of 100m ^{3}, both near Ras Harun (10°N) and in the more southerly upwelling zone near 5°N in the summer of both 1964 and 1979.

Remarkable growth rates were observed in this copepod with daily dry weight increments reaching as much as 14% a value far in excess of the typical growth rates of 3 to 6% per day for comparable species elsewhere. The distribution of the species is strongly temperature correlated, the females descending to circa 100m when the surface temperature exceeds 20°C.

The topic of variability and scale in relation to the biological effects was stressed in a review by Dr Angel. At time/space scales of more than a few days and larger than 100m physical processes tend to dominate the spatial variability of the biological processes. Naturally, in the Northern Indian Ocean, the forces dominating these controlling factors are the reversing monsoonal circulation, upwelling and low oxygen regions. Knowledge of the physico-chemical processes is thus fundamental to the interpretation of basic biological responses such as the control of productivity and the tuning of life cycles and distributive processes to seasonal variables. Attention also has to be given however to the shorter scales of space and time in which the behaviour patterns of organisms and their ability to adapt may modify the direct influence of the environmental variables. Much remains to be done in evaluating the importance of such biological determinants as well as the influence of the broad brush effects of the physico-chemical events.

4.1.6 Fish stocks in the Arabian Sea and Northern Indian Ocean

Reviews of recent studies on fish stocks in the region were provided by Professor J. Gjøsaeter and Dr S.S. Venema.

Describing the findings of studies made from the R\V DR FRIDJOFT NANSEN in the period 1975-83, Professor Gjøsaeter drew attention to the substantial stocks of mesopelagic fish in the Arabian Sea. Echo sounder studies (38KHz) backed by the use of commercial mid water trawls (750m^2 opening, 200mm general mesh with 9mm mesh in the Cod end) indicated a total abundance of mesopelagic fish in the northern and western Arabian Sea of some 60-150 million tons whilst in the Gulf of Oman the biomass is circa 6-20 million tons. The Gulf of Oman is considered potentially the best region for exploitation of stocks.

The fish, the most common species of which was *Benthosema pterotum*, display vertical migration being largely at 250-350m during the day whilst at night most of the population is in the upper 100m. Where density is large there may also be concentrations at 150-200m during the day. The rise from the day depth starts about 1 hour after sunset. Fishing in the shallower day depth the mean catch obtained was 5 tonnes h^{-1} and the highest catch 100 tonnes h^{-1}. Catch rates from other depths were generally low. At night shipboard lights drive the fish from the surface to circa 40-50m where they may be more readily trawled.

TABLE 1 Comparison of 1981 reported fish landings with the estimated regional sustainable potential of pelagic and demersal fish in the Arabian Sea, the Gulfs and Red Sea. After S.C. Venema. (All values in thousands of tonnes.)
(From Angel, M.V. Ed., 1984, p.1016)

LANDINGS 1981

	Cephalopods + Miscellaneous	Crustacea	Tuna	Fish		Potential[1] Fish		Exploitation Rate % Fish	
				Demersal	Pelagic	Demersal	Pelagic	Demersal	Pelagic
Somalia	–	0.8	–	5.0	5.0	81	378	6	1
PDRY[2]	9.6	–	–	21.1	8.5	44.	171	48	5
Oman	–	–	–	8.5	61.5	32	299	27	21
Gulf States	–	14.2	–	46.5	81.7	160	336	29	24
Pakistan	2.8	30.0	9.5	132.5	86.7	185[5]	280[5]	72	31
N.W.India [3]	17.5	108.5	1.4	313.3	66.3	440[6]	200?	71	33?
S.W.India [4]	23.3	43.9	10.4	73.4	314.5	180[6]	800[7]	41	39
Maldives	–	–	29.3	2.5	3.0	25?	30?	10?	10?
Red Sea	?	?	?	19.5	(57.0)[9]	80[8]	80[8]	24	(71)[9]

1. Lower estimates based on Dr Fridjoft Nansen data for Somalia, PDRY & Oman.
2. Includes Socotra.
3 States Gugarat and Maharashtra (Central Marine Fisheries Research Institute 1982).
4. States Goa, Karnataka Kerala & Lakshadweep (Central Marine Fisheries Res. Inst. 1982)
5. Given by Chikuni (Appleyard *et al* 1981)
6. 180,000 for S.W. India as given by Shomura, N.W. Indian 50% of Shomura's estimate.
7. Subject to large fluctuations.
8. Sanders & Kedidi 1981.
9. Probably too high due to lack of recent data from Ethiopia.

B.pterotum appears to have a short life cycle. It grows fast reaching 4cm in about six months. At this age the fish spawn and probably then die. Possibly related to the reproductive cycle a higher biomass is observed during the winter and spring than in the summer and autumn.

Stock density rather than total biomass is the critical factor in respect of potential for commercial exploitation. Observed density was highest in the Gulf of Oman at 220 g m^2 in the spring of 1975. For the gulf of Aden two out of seven cruises indicated densities in excess of 100g m^{-2}.Only one of the six cruises off Pakistan gave catches at this level. High densities were often noted at the shelf breaks extending a few nautical miles offshore.

In many areas however stock density may be too low to justify a fishery and in consequence a careful assessment of the economics of exploitation of the mesopelagic fish stocks is needed.

Dr S.C.Venema reviewed F.A.O.'s and other studies on the fishery potential of the northern Indian Ocean. The discovery of upwelling and related high primary productivity off the S.W. of Arabia, Somalia and the Malabar coast of Indian led originally to high expectations in terms of harvestable fish resources. Estimates in the 1960's suggested yields might be comparable with those of the Peruvian anchovy i.e. of up to about 10m.t.y^{-1}. However during the subsequent decade estimates of the pelagic and demersal fishery potential of the Arabian Sea have been revised to around four million tonnes. Estimates based on the echo-integrator since the mid seventies now enable some further updating of the fishery potential (Table 1) though problems remain in respect of conversion of biomass to yield and also in assessing the economic potential of the substantial stocks of mesopelagic fish.

In respect of other organisms shrimp catches in the Arabian Gulf have fallen from the peak of 12000 tonnes in 1973/74, possibly as a result of overfishing, though environmental factors could also be involved. Another small source of shrimp has been located in Oman's Gulf of Masirah and a further stock occurs off the Yemen Arab Republic.

The deep sea lobster *Peurulus sewelli* and related species occur at 200-600m off Yemen, Somalia, Kenya and the Indian west coast. The predicted sustainable yield off Yemen is reported to be some 200 tonnes of tails per annum. The Somalia catch is already substantial. Spring lobster are landed in quantity in Somalia (800 tonnes); Indian west coast (1200 tonnes); Pakistan (200 tonnes) and probably also in Oman and the Red Sea.

Estimates of cephalopods in the eastern Arabian Sea put thequantity at some 100-150,000 tonnes of which only about 10% is currently being caught. Stocks of cuttlefish have been harvested off Yemen by foreign fleets; in 1977 up to 16,000 tonnes were taken. Good yields are predicted off Oman.

Summarising the overall position Venema concludes that:

(1) the potential for cephalopods is probably higher than current landings.

(2) Crustacea are generally fished at over the level of maximum yield except in a few small areas such as for shrimp off the Yemen Arab Republic, and Gulf of Masirah and for deep sea lobsters off India.

(3) The potential for tuna may be greater than the present catch, in particular for the more tropical form of skipjack and small yellow-fin tuna.

(4) For fish even the most conservative stock assessment values suggest that the potential is underestimated for both demersal and pelagic forms. The highest existing exploitation is for demersal fish off India. Pelagic resourses are under-utilised, particularly off Somalia.

Closer co-operation between marine and fishery biologists is seen as a means of contributing to a better understanding of the dynamics of the Arabian Sea and its resources.

4.2 The Red Sea and related areas.

4.2.1 Morphology

Giving an outline description of the Red Sea, Zohair A Nawab, noted that the water body occupies an elongated depression straddling the crest of the regionally domed Arabian-Nubian shield. The sea extends some 1932 km from latitude 12° 3'N to latitude 28° N where it bifurcates into the Gulfs of Suez and Aqaba. The width ranges from 160km in the north to 354 km near latitude 16°N. Southward it tapers to 29° at Bab el Mandab. Three morphological zones are recognisable, the shelves, the main trough and an axial trough. Typically the shelves are some 10-40 miles wide sloping gently from the coast down to 200m, descending to 550m on the edge of the trough which itself slopes to 1100m. South of 24°N a deep axial trough develops within the main trough and reaches 2850m.

4.2.2 Circulation & Chemistry

The major elements in the circulation pattern were described in a paper by Drs. A. Poisson and S. Morcos as a background to recent studies of the biogeochemical cycles made in 1982 from the R/V MARION DUFRESNE. Factors influencing the circulation are the net loss of water by evaporation, the narrowness and shallowness of the Strait at Bab el Mandab and the seasonal reversal of the windstress in the southern part. During the winter the surface flows north sinking in the northern region as a result of the density increase consequent upon evaporation and cooling. The water mass returns south as a relatively warm, high salinity sub-surface water and eventually there is a discharge over the shallow sill (110m) at Bab el Mandab into the Gulf of Aden. In this winter period the northerly movement of the surface water persists despite the weak northerly winds prevailing at this time. During the summer a different current pattern is observed when the stronger monsoon winds effect a southerly flow of water in the southern region of the Red Sea and there is a compensatory upwelling in the northern part. At this time there is a sub-surface inflow of cool relatively low salinity water over the southern sill whilst warmer more saline water flows out into the Gulf of Aden. The maximum inflow occurs in August-November and minimum in May-July. However, estimates of the inflow and outflow at Bab el Mandab tend to vary considerably suggesting that more remains to be done before the dynamics of the system can be completely modelled. Similarly knowledge of the biogeochemical cycles is also incomplete since until very recently the preponderance of chemical measurements have been made during the winter period.

Oxygen levels in the Red Sea tend to be relatively low partly because of the high temperature and salinity but also as a result of low primary productivity and the absence of strong winds to facilitate downward mixing. Three regions can be recognised (a) water above the thermocline where oxygen tends towards saturation (b) an oxygen minimum in intermediate water (c) deep water with oxygen levels higher than those of the intermediate water.

During the winter the surface inflow of water at Bab el Mandab is near saturation but levels in the sub-surface outflow are lower. In the Gulf of Aden there is a substantial O_2 gradient at 75-100m during the winter implying rather little mixing across this layer. CO_2 increases in the intermediate water of the Gulf of Aden during the summer again presumably because of poor mixing with the surface waters.

Nitrate levels are substantially depleted in the surface waters of the Red Sea dropping to some 20% of the level in the intermediate water flowing in from the Gulf of Aden. Some features of the nitrate input and outflow are understood but again more information is needed before a complete budget can be attempted.

As in the Mediterranean, silicate concentrations in the deep waters of the Red Sea are low. Typically they are only some 10% of the levels at equivalent depths in the Arabian Sea. Generally in the Red Sea in both the upper and in the deeper waters there is pattern of increasing depletion from south to north with the effect being most marked in the surface waters. Biological activity seems to be at least partly responsible.

In conclusion, Drs Poisson and Morcos, indicated that the two cruises of R/V MARION DUFRESNE, in June and October 1982, revealed an inflowing current at intermediate depth in the Strait of Bab el-Mandab in October 1982. the distribution of nitrate, phosphate and partial pressure of CO_2 give an evidence of a supply to the Red Sea that can compensate for the loss by the outflowing current. This summer regime has to be taken in consideration when calculating the salt and chemical budget of the Red Sea.

4.2.3 Biology and productivity

As noted by Professor Halim, the physical features profoundly influence the faunal elements. Penetration of deep water forms is limited by the sill whilst the recruitment of pelagic organisms to the Red Sea from the Gulf of Aden, their northward movement within the Red Sea basin and the fluctuations in biomass and primary productivity are governed by the circulation pattern driven by the periodic monsoon wind system.

Typically, both primary productivity and secondary production in the zooplankton are higher during the north-east monsoon period, than during the summer, the reverse of the situation pertaining in the Arabian Sea. Both diversity of zooplankton and productivity tend to be higher in the region south of the zone at about 20° to 25°N where wind convergence occurs in summer. Diversity is also greater in the winter than in the summer, partly due to winter recruitment from the Gulf of Aden so that of all copepods, 92% are present primarily in the winter and only 62% in the summer.

Overall, the species diversity is reduced relative to that of the Indian Ocean, but there is an assembly of indigenous species of dinoflagellates, tintinnids, copepods and chaetognaths which appears well adapted to the particular conditions of the Red Sea. The major part of the plankton biomass is associated with the upper waters, some 95% of the total being located in the top 1000m. Some species have been described as endemic to the Red Sea, but confirmation of their precise status must await more detailed studies in the surrounding areas.

Further knowledge is needed with regard to the distribution and productivity of some copepods, but initial studies indicate a correlation between current patterns and distribution. For example, *Euchaeta marina* disappears from the surface waters in winter and is then located in the mesopelagic region.

The inshore waters of the Red Sea are notable for some of the finest coral reef systems in the world; biological complexes with a substantial species diversity which have been given a high status for conservation and protection by the World Wildlife Fund and by the International Union for the Conservation of Nature and Natural Resources (I.U.C.N). Considering the systematic and distributional aspects of coral studies, Professor Scheer outlined the history of surveys within the Red Sea and Indian Ocean and current information on the distribution of the various coral biotypes and on the ecological factors which influence distribution. Natural environmental factors established as being of particular importance in determining the distribution of corals include temperature, ocean currents and salinity. Temperature is probably the most important single factor for hermatypic corals, an average temperature in excess of 20°C being necessary. The high temperatures extending to considerable depths (21°C at 100m) thus particularly favour the development of reefs in the area and some 161 hermatypic species are known from the Red Sea. In the relatively shallow Gulf of Suez, the water cools in winter and there are only a few reefs, each with a restricted number of species. Only 15 species of coral occur in the Arabian Gulf. In this case it may be the rather high temperatures (up to 40°C) and high salinities (42-45°/∞) which are responsible. Further factors affecting corals adversely are sediment load in the water and reduced salinity. In consequence, areas such as the mouths of the Indus, Ganges and Euphrates lack corals. It is however necessary to remember, when assessing present coral inventories, that in the case of the less obvious or less common forms, the apparent absence of a species may owe more to the absence of competent coral systematists in the area than to any real absence of corals. Continued surveying is necessary to establish real geographical limits and the ecological factors controlling species distribution.

Taking up the ecological theme, Professor Mergner considered some current interests and future needs for coral studies. He suggested that priority be given to the influence of abiotic factors on community structure, distribution and species diversity; interspecific and intergeneric competition both between corals and between corals and other sessile organisms; the qualitative analyses of coral assemblages of different reef zones; the ecological conditions of important associated animal groups such as sponges, molluscs, echinoderms, fish, etc; the behaviour of reef animals; and lastly, the effects of pollution and physical manipulation of reef systems. Protection of reefs to ensure their preservation is considered desirable, but it is important not to regard reef systems as being static entities.

Account must be taken of the finely balanced forces, both physical and biological, which maintain the dynamic steady state. The influence of both seasonal and longer term trends on this steady state must be understood and so too must be the relative importance of abiotic and biotic factors. Of particular relevance to this last point was a question from Professor Halim as to the extent of any north-south change in diversity of coral faunas in the Red Sea and the observation in reply that increase in diversity is a local effect, the greatest variety, for example, being found in the Gulf of Aqaba. It appears probable that where abiotic features are relatively stable, certain species are favoured and gain dominance. Where there is more variability physical in conditions, so too the biotic variability is greater. In discussion, the two way transfer of energy between reefs and other elements of the marine fauna was also high-lighted as a means of establishing the importance of the role of reefs in participating in and, influencing the overall ecological balance of the region.

Faunal movements

Since the opening of the Suez Canal in 1868, the Red Sea and the Gulf of Suez have been instrumental in providing new elements in the fauna of the Eastern Mediterranean. Discussing the factors favouring transfer of species to the Mediterranean, Professor A.A.Aleem noted that, though the northern end of the canal is affected by dilution with fresh water in the autumn, elsewhere the salinity is generally high. Also the net flow is in the direction Red Sea to Mediterranean for most of the year. Currently there are 131 species of benthic algae in the canal by comparison with only 36 species in 1924 and it must be concluded therefore that the process of transfer of species is continuing rather than complete. Within the canal, hydrographic factors result in vertical zonation and three to four algal belts can be distinguished on the canal banks and pier supports. Horizontally, the Red Sea species decrease in the direction Suez to Port Said, but dominate in the Bitter Lakes and also in the bottom flora. Some 30 species of Indo-Pacific algae have now successfully colonised parts of the Eastern Mediterranean. By contrast, only two species of macroalgae from the Mediterranean *(Caulerpa prolifera)* and *(Halopteris scopovia)* have been transferred through the canal to become established in the Gulf of Suez. Of the higher plants, the sea grasses *Halophila ovalis* and *Thalassia hemprichii* have recently been observed in the canal and *H.stipulacea* has completed passage through the system and is established in the Mediterranean. None of the Mediterranean species of sea grass have penetrated into either the canal or the Red Sea.

Faunal elements including barnacles, hydroids, sponges, ascidians, ophiuroids and crustaceans from the Red Sea have also been recorded in the Canal and, as observed by Professor N. Dowidar, numerous Red Sea species are now known to have entered the Mediterranean. A few of the fish have been so successful in the new environment as to have achieved the status of commercial species.

4.2.4 Exploitation and Pollution limitation

Increased commercial activity in the Red Sea area, have occasioned concern in relation to preservation of the fauna. During the meeting three studies were described in relation to attempts to minimise the effect of exploitation of (a) metaliferous brines and (b) hydrocarbon.

4.2.4.1 Red Sea brines.

The hot brine pool discovered during the IIOE by the ATLANTIS II is in one of some 15 deeps many of which contain mineralised muds. Of these the Atlantis II deep itself has the greatest economic potential. Located at Lat 21°-22'N, Long 38°E and covering an area of some 60 square km at a depth of 2200m, the bottom deposits are estimated to contain substantial reserves of Zn, Cu and Ag with in addition, varying amounts of other metals including gold, cadmium, cobalt, lead, manganese, iron and other trace metals with an overall assessed value (in 1970 terms) of some $3.5 billion.

In 1974 the Saudi-Sudanese Red Sea Commission was established to undertake studies of the potential for mineral exploitation and the means by which this could be achieved with the minimum consequences for the fauna. The Commission's contractors have inter alia initiated airborne magnetic surveys, shipborne gravity and seismic reflection profiling, and environmental research covering reefs, baseline biological surveys, toxicity tests and studies on the behaviour of mine tailings.

The results of the pre-pilot mining test (PPMT) conducted in the spring of 1979 were described by Dr Z.A.Nawab. During the test, sediment from the deep was pumped to the surface vessel by a 12.5cm pipeline using a multistage periferal pump and an ultrafine grain floatation technique to separate the ore. A total of some 119,000 tons of mud was processed and the resultant ore concentrate of 4400kg yielded Zn(32%), Cu 5.3%, Ag 620g ton^{-1}, Co 80g ton^{-1}, Au 7g ton^{-1}.

Assuming that the results of the PPMT can be taken as an accurate guide, it was suggested that mining of the sediments may be viewed with reasonable optimism as a commercial proposition.

It was recommended that tailings should be disposed of into the axial trough at a distance from the areas to be mined. For environmental reasons, the minimum recommended depth for tailings release was set at 1000 to 1100m.

Following the satisfactory completion of the PPMT the Commission will now implement the next phase in the planned progression towards a commercial mining programme by undertaking a Pilot Mining Operation (P.M.O.). The scale of the P.M.O. is intended to be some tenfold greater than the PPMT though only 10% of full scale mining. The P.M.O. is planned to provide the information necessary to optimise equipment design and operation for the full scale exercise, and to provide further information on the cost comparability of mining operations.

Discussing studies which form part of the environmental research project within the framework of the "Atlantis II Deep Metaliferous Sediments Development Programme" of the Saudi Sudanese Red Sea Joint Commission, Dr. H. Thiel drew attention to features of the distribution of both plankton and benthos in the oceanic region of the Red Sea basin. The results indicate that the epipelagic zone to 100m has the most species. The mesopelagic zone is characterized by species showing a pronounced vertical migration with the greatest density of zooplankton at 200 metres by night and at 700 metres by day . An interesting feature of this migration is that there is a marked oxygen minimum at around 400m in the water column and the species moving across this zone are presumably well adapted physiologically to tolerate low oxygen levels.

The deeper waters of the Red Sea have a low level of both dissolved organic matter and particulates by comparison with other seas and the deep water fauna itself is also limited by comparison with benthos elsewhere. Rather little biological activity is known from the substratum in deep water. Some evidence of bioturbation has been noted but caution is necessary in relating animal density merely to physical evidence of disturbance since burrow spoil heaps may potentially remain undisturbed for extended periods even though the burrow itself is no longer occupied.

Mirroring the limited nature of the macro-benthos, meiobenthos is also low by comparison with that of other seas.

A major unresolved area in the Red Sea is the question of the determination of energy budgets for the fauna. High temperatures are found, 21°C throughout the deep water, so that respiratory utilization of energy may possibly constitute a larger part of the energy budget in relation to growth and reproduction than is the case in organisms in other seas. Whether the low faunal density by comparison with, say, the Arctic Ocean can be attributed to such a factor remains for investigation. Other areas where information is deficient are in regard to microbiological activity and the exchange of energy between reef organisms and other communities.

Taking up the question of the means of disposal of the tailings of mining the deep brines so that there is minimal biological consequence, Dr Y.B. Abu Gidieri summarised some of the primary matters for consideration.

(a) Release of appreciable amounts of the metals currently located within the metaliferous deposits could significantly increase the concentration of the trace element composition within the Red Sea basin;

(b) the processes of sorption and co-precipitation are thought to be important in the Red Sea in regulating the natural background levels of nutrients and probably to be responsible for the decline in phosphate, nitrate and silicate levels below the concentration maxima in the intermediate waters;

(c) surface discharge would increase turbidity. Taken together with the fact that there is little vertical migration below 100 m and that the benthos is limited, these considerations lead to the conclusion that it would be desirable to discharge the tailings at depth, preferably below 1000-1100 m. The biological oxygen demand of tailings is likely to be low and the chemical oxygen demand is assessed at only about 1% of deep water O_2 availability. Increased O_2 demand is unlikely therefore to constitute a problem. Predictions indicate that up to 1500km^2 of sea bed could be physically smothered by tailings and perhaps some $^1/_{25}$ to $^1/_{50}$ of the zone within the central graben might in consequence became azoic. Nevertheless the populations of the remaining areas should continue to sustain deep water benthic communities and such deep water disposal is preferable to shallower release where more substantial populations would be exposed to the effects of both metal ion toxicity and physical clogging by sediment.

The effect of the discharge on nutrient and metal ion levels is not entirely predictable and additional study during the P.M.O. is merited. The problem concerns the ultimate balance of complementary effects and release of metals into the water columns. The tailings could supplement removal of nutrients by scavenging. Equally however interaction with clay particles might secondarily bind released metal ions and thereby diminish metal loads. Such processes may therefore either assist in limiting the dispersion of toxic materials or increase the metal load. Nevertheless,deep water disposal in the central graben should limit areas affected and serve to ensure the continued integrity of pelagic and shelf fisheries, and of coral reefs.

4.2.4.2 Industrial development.

In the past the processes associated with production, refining and shipping of oil, together with the introduction of other industrial activities have resulted in numerous instances of pollution in the Red Sea in general and the Gulf of Suez in particular. Drawing attention to the prediction that oil production in this latter vicinity could substantially increase during the 1980's Dr B. Dicks stressed the importance of measures to limit environmental damage so as to ensure the preservation of the wide range of tropical marine habitats many of which are internationally recognised for their scientific, economic and recreational value.

Some change in the environment is the price of any development but as Dicks observed two key questions commonly posed are 'at what point does biological damage become significant' and 'for how long must monitoring continue to assess the effects of change.' No simple criteria are available to answer these points since the complexities of both the natural communities and the nature of the anthropogenic impact vary. Dicks however illustrated the way in which close co-operation between industrial developers and ecologists can serve to minimise ecological effects by reference to the building of a marine terminal in the Gulf of Suez at Ras Budran. Following an initiative of the Suez Oil Company an environmental management scheme was prepared prior to the commencement of construction of this terminal which has served to limit environmental damage.

Initial surveys indicated that the proposed development area comprised diverse marine communities with fringing reefs, near-shore lagoons and sea grass beds. There was however no indication that the communities were sufficiently unique to merit absolute preservation., through re-location of the terminal site. Conclusions and recommendations incorporating suggestions to limit faunal damage included:-

(a) the most environmentally rich and susceptible habitats are the barrier coral reef and inshore lagoons at Ras Budran. Consequently development should

(i) make maximum use of natural breaks in the reef for the location of pipelines,

(ii) ensure that the natural long shore flow in the lagoon is not interrupted by provision of channels through the jetties,

(iii) restrict the width of pipeline pathways as far as practicable,

(iv) locate discharge of effluent material offshore of the reef system in regions where currents will carry the discharge away from the reef,

(v) provide mooring buoys to limit the risk of anchor damage to reefs. It was recommended that the oil-spill contingency plan should not include provision for the use of dispersants within the lagoon.

A post construction survey of the site suggested that as a result of the measures adopted only some 5% of the survey area up to 1km off shore had been significantly affected, much of this being accounted for by the physical introduction of structures and of some silting between the jetty and pipelines.

This example of harmonious co-operation between ecologists and industrialists provides a valuable precedent for the procedures which might be adopted for other developments. As Dicks pointed out however whilst standardised recommendations might seem desirable it is probably not practicable to adopt rigid standards; a measure of flexibility is needed to allow easy adaptation to the field conditions. A necessary pre-requisite for environmental judgements is a suitable data base and to date that base is incomplete in the Red Sea. Governments, industry and the scientific community together have a responsibility to design and execute further studies and to interpret the data on which future development decisions must be based.

4.2.4.3 Oil spills.

Another form of environmental insult, oil pollution, formed the theme of a review of Dr M. Bebehani in which the extent and environmental effects of some recent major spills in the sea area of the ROPME[1] states were discussed.The Region encompasses two very different zones, the Arabian Gulf and the Gulf of Oman. The Arabian Gulf is a shallow semi-enclosed sea (average depth 31m) with a surface area of some 239,000km and a flushing time of some 3 to 5½ years. The shores are predominately muddy though there are some rocky regions. By contrast the Gulf of Oman is deep with a narrow shelf zone and mainly rocky western shores. Some muddy shores and mangroves are present and the eastern coasts are largely muddy and sandy.

North of the Straits of Hormuz there are 34 offshore oilfields with a total of some 800 operational platforms, mostly in Saudi, Iranian and U.A.E. waters. Associated with these fields there are several thousand kilometres of pipeline.

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[1]Regional Organisation for the Protection of the Marine Environment (Bahrain, Iran, Iraq, Kuwait, Qatar, Oman, Saudi Arabia and U.A.E.)

Oil release has resulted from a variety of causes: drill blow outs, accidents during well maintenance, production water, pipeline rupture during loading and off loading and in transport.

All told however it is estimated that only about 10% of the releases in the area can be attributed to accidents. Nevertheless some recent events have resulted in substantial environmental contamination. Amongst those singled out for consideration were the Hasbah blow out (October 1980), the 'Bahrain' spill of 1980 and the Nawruz spill of 1983.

The Hasbah blow out on October 2nd 1980 involved a platform some 140km from the northern shores of Saudi Arabia. About 50,000 barrels of oil were lost over a 10 day period and by 25th October an area of approximately 5000 square miles was affected. Eventually part of the oil came ashore extending for some 110km along the northern and western coasts of Qatar. Spraying did not prove particularly effective on the thick oil but the use of skimmers enabled recovery of about 15,000 barrels.

The Bahrain spill in the same year originated from an unknown source north-west of Bahrain and some 20,000 barrels of crude contaminated the shores of that state. Within a month the oil had penetrated up to half a metre into inshore sediments.

The Nawruz event is the largest spill to have occurred in the Gulf and on a world scale is only exceeded by the IXTOC 1 release. The former spill began early in 1983 with the collapse of an Iranian platform (3) and was exacerbated on March 1 and 2 by military action directed at platforms 5 and 9 in the field. It is estimated that the loss rate from the three platforms amounts to about 4000-5000 barrels a day though, if the burning wells are extinguished without capping of the source, this release rate could increase. By August there was contamination of the Saudi Arabian and Bahrain coastline though some of this may be due to tanker discharge rather than the Nawruz oil. Considerable mortality of marine animals including dugong, dolphin, turtle, sea snakes, and various fish and bird species has been reported along the eastern coastline of Saudi Arabia since the Nawruz spill but uncertainty remains as to whether the spill itself is the cause.

Comment was made with regard to the sensitivity of coral reef, coastal lagoon, mangrove and sea grass bed communities to oil and examples cited where populations of crustaceans had been eliminated at least in the short term. The need for more information on the effects of dispersants on corals and on the fate of oil in the food chain was pressed.

General proposals for limiting and combating oil pollution in the area included:-

(1) Establishment of acceptable standards for discharge of waste water.

(2) Legislation requiring commercial companies to release statistics on oil discharges and any information they may acquire on the environmental impact of oil.

(3) Establishment of regional co-operative programmes in information exchange regarding oil pollution.

(4) Encouragement of Universities in the region to play a more important role in pollution research particularly in relation to base-line taxonomic and ecological studies and in relation to the environmental effects of oil.

(5) Encouragement of ROPME states to expedite ratification of the Marine Pollution MARPOL 1973-78 Convention.

(6) Implementation of the Kuwait Action Plan projects, especially projects 9, 11 and 16 which concern oil pollution and its effects on the marine environment.

4.2.4.4 Engineering Works, Aswan High Dam.

Environmental effects of a different kind have resulted in the Eastern Mediterranean following the construction of the Aswan High Dam. Discussing this topic Professor N. Dowidar pointed out that the average annual discharge of the Nile is now some 4 to 5 billion m^3 or roughly 10% of the level prior to construction of the dam. The autumnal floods used to be particularly important in providing the nutrients which initiated a major phytoplankton bloom in what is generally a relatively oligotrophic area. In the post-dam period however work co-sponsored by the University of Alexandria's Department of Oceanography and the U.S.Agency for International Development has shown a marked decline in the plankton in the coastal waters off Alexandria, and in particular there has been a diminution of the autumnal bloom.

The average chlorophyll a, biomass of 33.3 mg chl a m^{-2} confirms the oligotrophic nature of this region. Primary plankton productivity is higher (16.3mg $Cm^{-2}h^{-1}$) than in offshore waters (12.07 mg $Cm^{-2}h^{-1}$). The standing crop was however higher in slope waters than inshore. Nano- and picoplankton constitute the major part of both the chlorophyll a and the primary productivity. Vertical profiling indicates a deep chlorophyll maximum at 70-150m. The autumnal blooms now achieves only about 1% of typical values prior to 1965 when it used to start inshore and extend up to 7km offshore before algal numbers declined to less 25% of inshore levels.

Associated with the decline in primary production there has been a decline in commercial marine catches, particularly in respect of the pelagic planktoniferous forms. Catches of sardines fell from 18000 tons in 1962 to 46 tons in 1968 though with some subsequent recovery; catches since 1978 have increased somewhat.

5. THE ROUND TABLE DISCUSSIONS

The two main objectives of these discussions were to identify gaps in marine scientific knowledge of the region and to suggest marine scientific research projects which could benefit from international co-operation. To facilitate discussions over such a broad range of disciplines, an initial working document was prepared by the IOC Secretariat based on replies to a questionnaire sent earlier to the invited speakers and to some potential participants. These replies were later compiled and edited by Dr.M.Gerges (IOC) and were made available to the Round Table as Document IOC/INF 539. Moreover, it was decided to divide up the Round Table into 5 working groups according to discipline as follows: geology and geophysics, physical oceanography, chemical oceanography and pollution, biological oceanography and fisheries, and interdisciplinary studies (Annex XIII). Each group had a Chairman /Rapporteur who reported back to a final plenary meeting which was chaired by Dr. Martin V.Angel. The reports of these working groups have been supplemented with items from the above mentioned document to highlight the many similar aspects which emerged from the discussion. The outcome of the Round Table Discussions is presented below.

5.1 Geology and Geophysics

During the IIOE some of the basic research carried out made a major contribution to the theory of plate tectonics and sea-floor spreading. However, since then little progress has been made in the study of the structure of the Indian Ocean basin and there are extensive gaps in the coverage. Specific areas now need to be examined in detail in the context of concepts that have been evolved and tested elsewhere. A major need is to develop the technical capabilities of the Indian Ocean maritime states so that they can undertake regional marine geoscientific studies on the scale that is necessary. Future co-operative programmes should be designed to bridge this gap.

5.1.1. Bathymetric, magnetic and gravity surveys are needed in the regions N.E. of Madagascar, S.W. of Sri Lanka and in the Somali Basin.

5.1.2. Passive Continental Margins

Continental margins with their thick accumulations of sediments are the source of a significant proportion of known world oil and gas reserves. The margins of the Indian Ocean have not been studied in anything like the detail which the passive margins of the Atlantic have received. Their study will be of considerable importance in providing and understanding information on both their evolution and resource potential.

5.1.3 Nature of aseismic ridges and plateaux

The two aseismic ridges (Chagos - Laccadive and 90° East) and various plateaux (Mascarene, Seychelles, etc.) have received little attention. Geological and geophysical studies are needed to provide information on the nature of the crust, the evolution of surface crustal rocks and their resource potential.

5.1.4 Gulf of Aden

A better knowledge of the marine geology and geophysics of the gulf is important for understanding the evolution of the Gulf vis-a-vis the Red Sea. A detailed geological-geophysical survey would fill a major gap in the coverage by previous surveys.

5.1.5 The structure of the Oman and Makran Subductive Zone

This region is of particular interest to the elucidation of the means by which superficial sediments are deformed by active subduction processes.

5.1.6 Basement rocks: stratigraphy of oceanic basins

The earlier phases of the Deep Sea Drilling Project provided a wealth of information on the stratigraphy and geological history of the Indian Ocean basins. Analyses of the samples and data have raised new questions and pinpointed a number of important gaps. Further drilling in some of the basins and other geomorphic features would greatly enhance our knowledge. However, a modest, but useful, start can be made by collecting samples of exposed rocks by conventional dredging.

5.1.7 Superficial sediments

Superficial sediments can provide valuable data for biological studies, applied geology and environmental geology, on long term climatic variation, identification and origin of geochemical and detrital fluxes and location of mineral resources. The studies should concern mainly sediments of Quaternary age and involve lithological facies mapping, sediment structure analyses by bathymetric charting, geomorphological analysis and short-wave length profiling. Additional research is needed on sedimentary dynamics to identify and quantify the full range of fluxes and geochemical interactions (see 5.6.2).

Areas of special interest include:

5.1.7.1. Northern Red Sea

A region small in area, but subject to major sedimentological exchanges during the Quaternary; oscillating hot and cold periods resulted in fluctuations between fluvial and aeolian inputs (see 5.6.2). Furthermore tectonics have played a major role in the region. Additional information on the dynamics of sediments in the Red Sea is needed and also on geochemical and ecological balances.

5.1.7.2. Northern Indian Ocean

Knowledge of combined influence of aeolian and terrigenous inputs (from the Indus) and volcanic activity in the region is desirable.

5.1.8 Palaeoclimates, upwelling and monsoons

Studies on the continental margins off Somalia, Arabia and Western India would give information on the long temporal and spatial variability of the monsoon cycle and the associated upwelling (see 5.2.5 and 5.6.2.). This would provide a baseline for the assessment of future variations in climatic patterns and on the processes associated with phosphatisation along the continental margins and over sea-mounts.

5.1.9 Seismic observations

A more closely spaced network of seismic observations is needed to cover the Arabian and African continental margins and many of the islands.

5.1.10 Marine mineral exploration

The Indian Ocean contains a wide variety of terrigenous mineral placers, biogenic (corals and shales) and chemogenic deposits. Their exploration will add to the global inventory of mineral resources and to our understanding of the formation of marine mineral deposits. Mineral exploration should be supplemented by basic scientific studies and environmental risk analysis. Risk evaluation should be conducted during the exploratory phase of any operation.

5.1.10.1. Terrigenous placers

Wide areas are still to be explored. Sediment distributions, relict sediments, sea level changes and neotectonics need to be studied in parallel.

5.1.10.2 Biogenic sediments

Banks and atolls need to be explored for the existence of commercially exploitable deposits of shales, corals and calcareous sands. Scientific studies of the generation of these biogenic deposits are needed to determine how they are formed and how biological productivity is related to their formation.

5.1.10.3 Chemogenic deposits.

5.1.10.3.A Phosphorites. Exploration in upwelling areas and non-depositional environments on the continental margins of Somalia, Arabia and Western India, also on sea-mounts. The interrelationships between phosphorite formation, upwelling and productivity needs to be studied.

5.1.10.3.B Polymetallic nodules. Exploration is needed of paramarginal and submarginal basins and sea-mounts (e.g. Somali and Madagascar basins) combined with investigations into the relationship between equatorial high productivity and paramarginal nodule deposits.

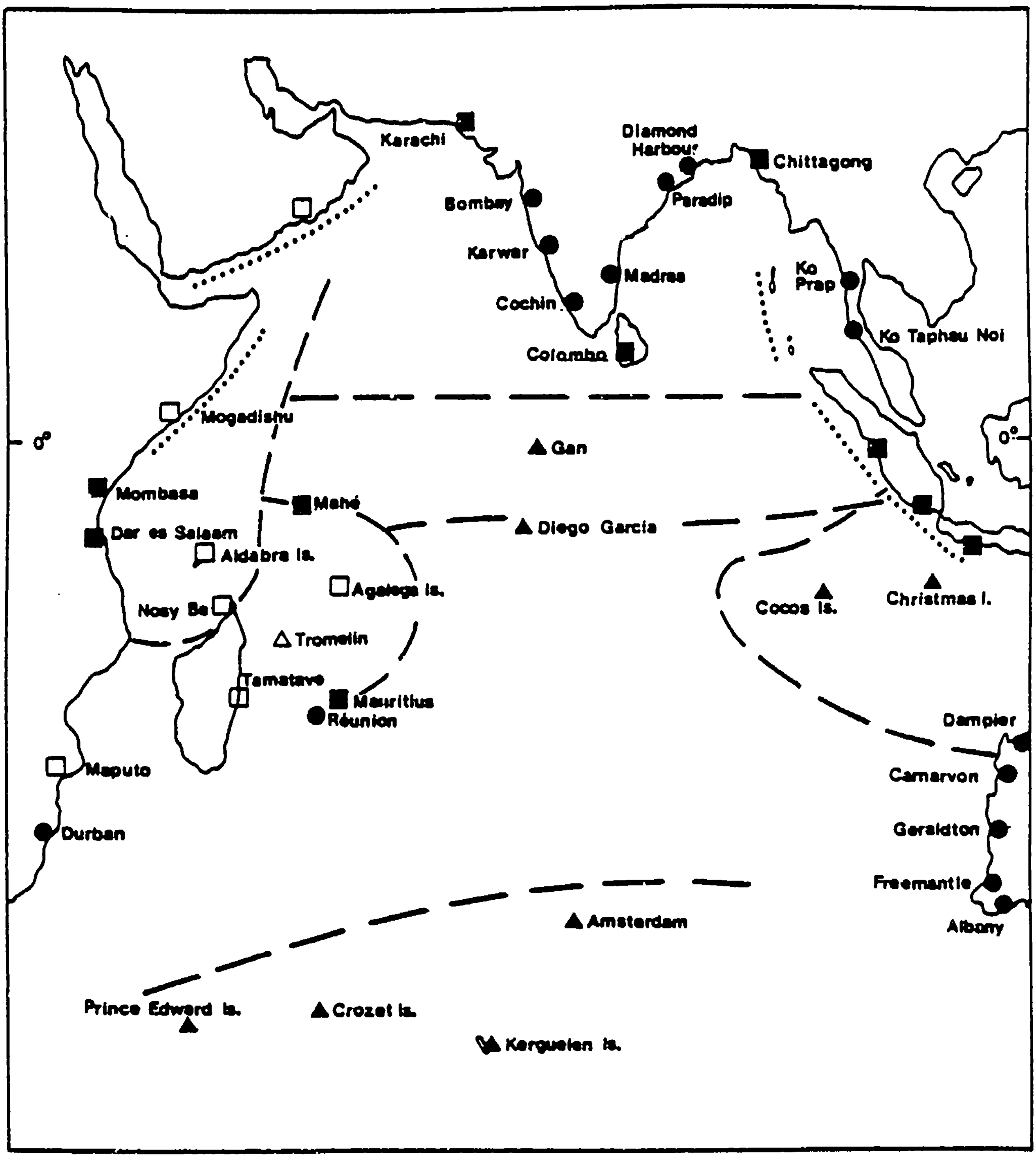

FIG. 8

● Need coordination only.
□ ■ Need training, equipment.
▲ Need special technology.
••••• Need investigation.

An Indian Ocean sea level network

(From: Committee on Climatic Changes and the Ocean (CCCO), 1983.)

5.2. PHYSICAL OCEANOGRAPHY

This group in its summary emphasised the following points:-

(a) In identifying important scientific problems it is difficult to ignore the mechanisms whereby they can be investigated. Recommendations therefore have been divided into those which are scientific and those which relate to the structure in which the science may best proceed.

(b) Existing and projected programmes already identified by individual groups and international organisations should be supported, and participation by countries of the region must be encouraged.

(c) There are many scales pertinent to physical oceanography, so a broad classification has been used:-

Horizontal coastal zone, enclosed and semi-enclosed seas, and the deep-sea region; vertical - surface and near-surface, intermediate depths and deep water.

5.2.1 Sea Level data

There is a serious lack of data which relate to storm surges, sea level changes and current variability, and provide boundary conditions for numerical models. Gaps in the present network (Fig.8) should be filled using sophisticated gauges when data on long period fluctuations are needed or simpler gauges where appropriate. At least one deep sea gauge is needed.

5.2.2 Estuarine and lagoonal circulation

Studies are needed so improved models can be devised which will support future inshore ecological and pollution studies (see 5.5.3. and 5.6.6.)

5.2.3 Red Sea

The physical oceanography of this semi-enclosed sea is poorly known. There is a need to account for deep water formation, the midwater oxygen minimum, the distribution of other non-conservative properties, the seasonal variability in circulation and the exchanges through the Suez Canal and the Straits of Bab el Mandab. (see 5.3.5, 5.5.2. and 5.6.1). Refer also to the "The Marine Science programme for the Red Sea" (UNESCO Technical Papers in Marine Science No.25).

5.2.4 Deep Arabian Gulf Water

The outflow and eventual fate of this water need to be investigated (see 5.3.2).

5.2.5 Climatic variations

The recommendations of the Indian Ocean panel of the joint SCOR/IOC CCCO on physical oceanography and related climatic problems should be followed. A number of other topics were emphasised because of their relevance to regional climate and productivity, and could be tackled item by item:-

5.2.5.1 Seasonal cycle of the Somali Current system.

a) The breakdown of the two-gyre system.

b) Processes related to the onset of the N.E. monsoon and the fate of the northern gyre.

c) The link with zonal current systems and the importance of local versus remote forcing.

d) The cross equatorial undercurrents and their significance for the transport of mass, heat and salt.

e) The dynamics of the upwelling.

5.2.5.2. The equatorial jet during the monsoon transition phase and its significance to heat and mass distribution.

5.2.5.3 The seasonal variation of the South Equatorial Current (SEC) and its redistribution at the western boundary.

5.2.5.4. The relation between Arabian Sea surface temperature variations and climate, rainfall over the Indian subcontinent including estimates of heat budget components (advection, surface fluxes and upwelling).

5.2.5.5. The importance of southern hemisphere variability (winds, SST)on the northern hemisphere monsoon.

5.2.5.6. The cross equatorial fluxes of heat, salt and mass in the Central and Eastern Indian Ocean.

5.2.5.7. The magnitude and annual cycle of the Indo-Pacific through-flow.

5.2.6 Arabian Sea Bottom Water

Movement of bottom water into the Arabian Sea and Central Indian Ocean needs study and the value of some chemical parameters as tracers evaluated.

5.2.7 Observational data.

The achievement of the scientific aims listed above will necessitate both specific aimed experiments, and regular widespread observations requiring broad international co-operation, e.g.:-

5.2.7.1. XBT programme. A ship of opportunity programme in support of ocean-atmosphere interaction studies (Fig.9).

5.2.7.2. Satellite imagery. Improved access to satellite imagery will encourage its large scale use in regional studies.

5.2.7.3. Meteorological data. Organisations which can provide meteorological data need to be identified and publicised. Where there are gaps in the coverage, nations should be encouraged to fill them.

5.2.7.4. Data Centre. A regional data centre needs to be established (see 5.6.7).

5.2.7.5 Communication. The IOC should consider publishing and regularly updating a bibliography of the region, and a bulletin reporting on work in progress and plans in development. This would provide the necessary information for the development of collaboration (see 5.6.8).

5.2.8 Previous Recommendations

These recommendations are not exhaustive, and those emanating from previous meetings on the Indian Ocean should be reviewed by IOC (i.e.: ROPME, CINCWIO, ALECSO, etc). For the Gulf region note also the "Final Act of the Kuwait Regional Conference of Plenipotentiaries on the Protection and Development of the Marine Environment and the Coastal Areas."

5.3. Chemical Oceanography

There is an obvious lack of chemical data from the region compared with other oceanic area. Previous expeditions have highlighted many important problems but have been unable to resolve them because of inadequate coverage in both time and space. Answers will only be forthcoming when the regional laboratories are able to generate the required data. these data will be enhanced in value if communication and co-operation both within the region and between interested researchers outside the region is encouraged and developed. Initially priority should

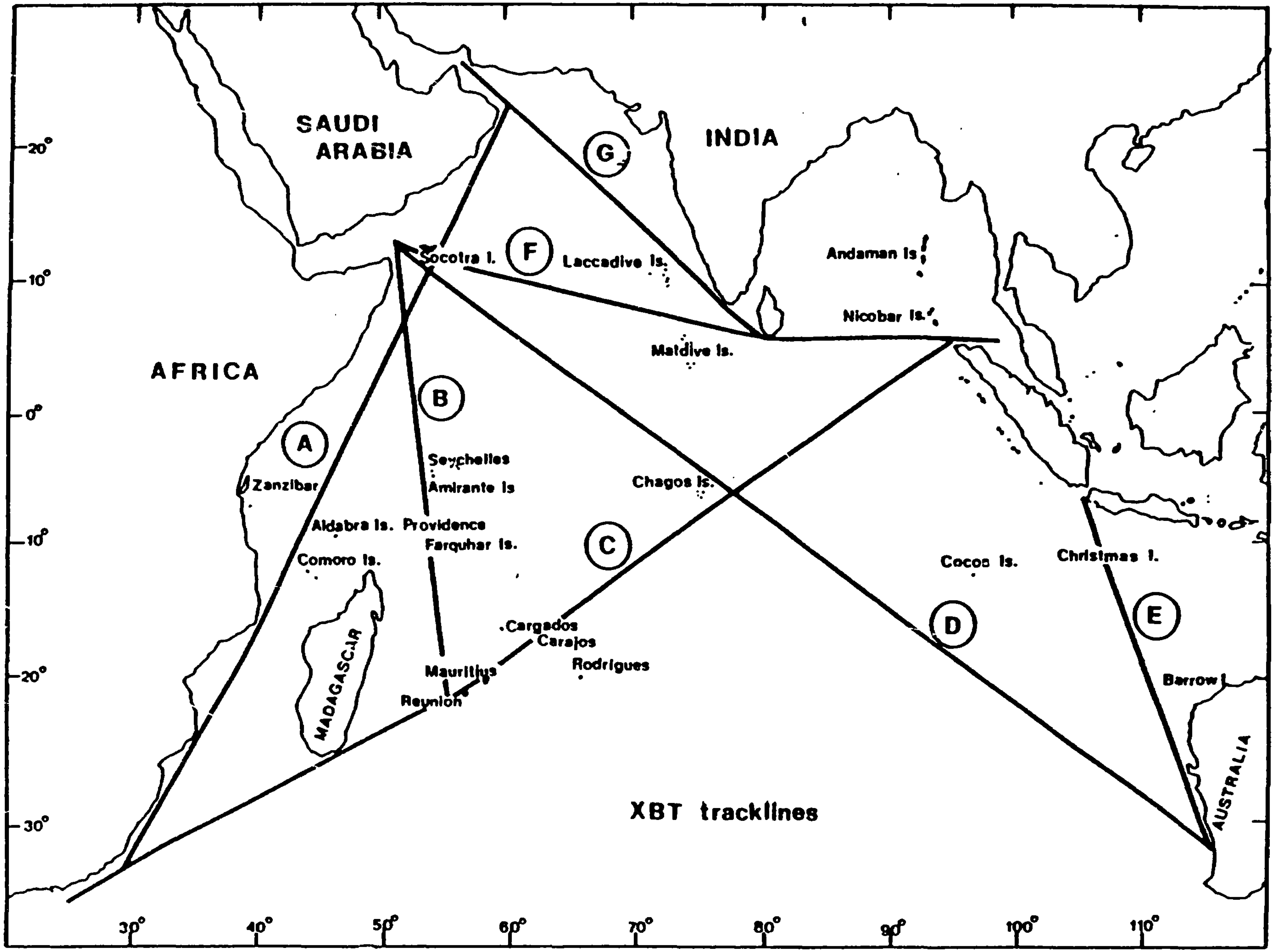

FIG. 9 XBT Tracklines (from: Committee on Climatic Changes and the Ocean (CCCO), 1983)

be given to the measurement of parameters which can be assayed by reliable methods (temperature, salinity, alkalinity, pH and nutrients, i.e. phosphates, nitrates, nitrites, ammonia, silicates). Programmes of long term collection on a regular basis should be initiated and maintained. Intercalibration exercises are essential to ensure the necessary high quality of the data. Results should be archived in a data centre.

Specific problems are as follows:-

5.3.1 Chemical cycles related to productivity.

5.3.2. Chemical budgets of semi-enclosed basins

The rates of exchange through important straits such as Bab el Mandab, Hormouz and Tyran should be measured and monitored over seasonal and year-to-year time scales (see 5.2.3, 5.6.1).

5.3.3. Chemistry of upwelling zones.

5.3.4. The significance of the fluvial input of the Indus to the particulate and dissolved organic content of the Northern Indian Ocean.

5.3.5 The relation of the oxygen minimum with the source waters and the vertical flux of organic matter down through the water column, and its influence on the nitrogen cycle.

5.3.6. The quantification of the penetration of man-released CO_2 into the deep ocean and the role of the ocean in buffering possible climatic effects of the atmospheric build up.

5.3.7 Background levels of heavy metals

Monitoring programmes of pollution have the problem of determining whether the sources of heavy metals are natural or anthropogenic. In unknown or poorly known marine environments estimates of natural input are based on the mean metal content of the Earth's crust. However, the input of terrigenous materials is influenced by the local vegetation which is under climatic control. Furthermore, the flux of heavy metals across a freshwater/seawater interface is very much dependent on the local hydrodynamic regime and the chemistry of the suspended particulates. Considerable effort needs to be made to quantify inputs i.e. aeolian, fluviatile (both from arid regions e.g. via the Nile Delta, and from monsoonal regions e.g. via the Indus) and from deep-sea hydrothermal inputs (e.g. Red Sea brines). Intercalibration exercises to compare sampling and analytical methodology will be essential to avoid the accumulation of conflicting data that is bedevilling interpretation in other oceans.

5.3.8. Influence of deep-sea mining.

Present theory derived from laboratory experiments will not allow the accurate prediction of metal exchange from resuspended Red Sea muds and the sea water, because of the high reactivity of the muds and the very high *in situ* water temperatures. Before full-scale exploitation of this resource is undertaken the level of probable exchange should be estimated in the context of an adequate circulation model of the Red Sea. Otherwise it will not be possible to derive an adequate environmental impact assessment.

5.3.9 Particulate chemistry

The chemistry and flux pattern of particulates especially POC (particulate organic carbon) needs to be studied in the Arabian Sea and more oligotrophic regions to assess the relative importance of upwelling and fluviatile input (via the Indus) to the sedimentary regime. This is required for understanding the geochemistry, pollutant pathways, sediment characteristics and deep-sea ecosystem structure in the region.

Study is needed of the influence of the oxygen minimum on the vertical distribution pattern of organic detritus and the dynamics of the processes involved in generation, recycling and sedimentation from the water column.

5.4 POLLUTION

5.4.1 Oil

Throughout the North-west Indian Ocean region there is a chronic problem of oil pollution not only because of the vast reserves being exploited in the region, but also because of the massive quantities being transported across the region by shipping.

5.4.1.1. Quantification. Pollution levels in the open sea areas, in sediments and on beaches need to be quantified and the chemical state analysed. The effects of microbial degradation need to be assessed to investigate whether it results in concentration of toxic fractions or the separation of toxic metals from the oil.

5.4.1.2. Influence of oil on commercially important organisms and on regions of aesthetic or conservation values needs to be assessed and monitored particularly in harsh physical environments such as the Northern Red Sea and the ROPME sea area.

5.4.1.3 Fate of pollutant oil needs to be studied.

5.4.2 Metals

The quantification and assessment of the ecological impact of metal pollution in the region is poorly understood. Sources need to be identified and the emanating plumes of pollutants followed. Particular problems are presented by water de-salination plants, chlor-alkali plants, industrial complexes, sea floor mining (e.g. in the Red Sea), sewage outflows, ship repair and antifouling activities. Particular attention should be paid to the most hazardous metals - mercury, nickel, cadmium, lead and vanadium, but metals likely to be introduced in considerable amounts e.g. Cu^{++}, and those used in antifouling materials e.g. tin, may also merit study in sensitive areas, as does the flux of these metals through marine ecosystems and their accumulation in sediments and commercially important species. The exploitation of phosphate ores in the Gulf of Aqaba and the Qusier area in the Northern Red Sea is leading to pollution that requires investigation. Continued biogeochemical studies of the Atlantis II Deep prior to and during the Pilot Mining Operation (PMO) is desirable.

5.4.3 Sewage

Most cities in the region discharge substantial quantities of raw or partially-treated sewage into the sea. The effects of this pollution on marine ecosystems and on human health need to be assessed.

5.4.4. Theory

There is a great need for theoretical studies on the pattern of movement and fluxes of pollutants within the ecosystem, so that monitoring may be better designed and so become more efficient.

5.4.5 Physical effects

The influence of raised salinity in association with desalination plants and raised temperature attendant upon a variety of industrial activities should be assessed in regions where existing high temperatures and salinities are limiting factors on faunal diversity.

5.4.6 Red Sea Commission. The collaborative interdisciplinary studies initiated by the Red Sea Commission are noted as a model which might be followed with advantage in other developments in the region.

5.5 BIOLOGICAL OCEANOGRAPHY

Despite the long history of biological study in the region, the descriptive basis is inadequate. There is a major need for good, well illustrated taxonomic handbooks. High-tech developments, e.g. laser disc methodology allowing concentration of stored material and rapid search procedures, may eventually help to solve this information problem.

Biological investigations can be tackled usefully at any level from single species (autecological studies) to ecosystem studies (synecology). As far as possible seasonal cycles should be included in such studies.

The Indian Ocean ecosystem may be considered under three headings, shallow-water and reefs, deep sea, and fisheries.

5.5.1 Shallow-water and reef ecosystems

Shallow water communities are the most accessible to laboratories lacking vessels for deep water studies and yet few of these communities have been adequately described. Detailed studies are needed of coral reefs, mangrove and sea grass communities particularly in areas which are vulnerable to despoilation by man's activities. Lagoons and coastal backwaters with potential for mariculture should be included in such study.

5.5.1.1. Inventory. Each coastal state should be encouraged to draw up an inventory of their coastal ecosystems, so that priority can be given to the management and protection of the most vulnerable. Landsat imagery would provide a powerful tool for the initial large scale mapping.

5.5.1.2. Mapping. Mapping of ecosystems at all scales is a powerful tool for analysing the factors controlling the structure of the communities (e.g. recognition of zonation).

5.5.1.3. Autecological studies. Community analysis and studies on the functioning of inshore communities (e.g. energy flow and budgets) need to be undertaken for key ecotones, but especially coral reef communities and mangroves. These will lead to:-

5.5.1.4. Synecological studies - of key species in each ecotone or of commercially important organisms, including reproductive strategies, life history and population dynamics studies. Knowledge of the potential for recruitment is important in assessing the likely rate of recovery of damaged ecosystems.

5.5.1.5. Conservation. The establishment of marine parks in specific areas (e.g. Red Sea and Gulf region) will help to conserve small areas of high amenity value. However, much broader initiatives are urgently needed. In the Red Sea the Jeddah Convention provides a blue print for such initiatives. This convention should be signed, ratified and implemented by the Red Sea states as quickly as possible. Similar conventions should be drawn up for other areas (e.g. the gulf) as a matter of urgency.

5.5.2 Deep-water studies

5.5.2.1 Benthic studies

There is an almost total lack of deep benthic studies in the region. Sampling programmes need to be developed, but there will be considerable problems with taxonomy unless the few specialists in the world can be encouraged to collaborate in a major programme. Specific areas of interest are (a) the link between surface production and benthic production via sedimentary processes, particularly in regions underlying the oxygen minimum and areas of seasonal upwelling; (b) rate processes within the communities involving feeding rates and efficiencies, respiration rates, and energy and material flows; (c) life history characteristics and seasonality; (d) trophic relationships.

5.5.2.2. Primary production and phytoplankton studies

The quantity and quality of primary production need to be evaluated in eutrophic (upwelling) and oligotrophic regions. Particular attention should be paid to the Somali Current region where conditions oscillate between extreme oligotrophic and eutrophic with the change in monsoons. The variations in standing crop and production in both time and space need to be studied in relation to the physical and chemical environment. The significance of nanoplankton should be assessed. The role of phytoplankton in fluxes of metallic ions is of considerable interest both scientifically and in assessing pollutant pathways.

Intercalibration of all techniques of sampling and quantification is essential.

5.5.2.3. Secondary production.

These studies should be conducted in parallel with those on primary production, and should include microzooplankton as well as classical "net" plankton. Topics of particular interest include:-

5.5.2.3.A The relationship between primary and secondary production.

5.5.2.3.B Recycling processes both relative to primary production and nutrient cycles. The relative importance of macroheterotrophic and microheterotrophic processes in energy conversion is needed on a seasonal basis and in relation to low O_2 waters.

5.5.2.3.C Behaviour and physiology of mesopelagic fauna especially in relation to the oxygen minimum in the Arabian Sea.

5.5.2.3.D Food chain dynamics.

5.5.2.3.E The response of plankton to the physical variability especially mesoscale eddies.

5.5.2.3.F The influence of environmental extremes on benthos zooplankton, nekton and micronekton e.g. the effects of the high temperature and salinity of the Red Sea and Arabian Gulf both within the semi-enclosed basins and as outflows into the Arabian Sea.

5.5.2.4 Microbiology. The general need for a better understanding of bacteriological processes in the region is stressed.

5.5.3 Fisheries

The trend towards studying fishery problems in isolation from other disciplines should be reversed; fish are as much a part of the total ecosystem as any other element. Areas of specific interest are:-

5.5.3.1. Life histories and population dynamics of commercial species.

5.5.3.2. The interrelationship between productivity and its variability over long time-scales and sustainable yields and recruitment.

5.5.3.3. Larval ecology of commercial species.

5.5.3.4. The ecology of shallow water inshore stocks e.g. the shrimp resources of the Arabian Gulf.

5.5.3.5. Improvement in methods of data collection and exchange.

5.5.3.6. The inter-regional comparison of the biological characteristics of species from different geographic areas.

5.5.3.7. Education of local fishermen on the importance of regulating mesh size and limiting catch rates.

5.5.3.8. The development of mariculture.

5.5.4 Interrelationship with physical processes.

The dominant influence of physical and chemical processes at certain time/space scales may result in prediction of biological processes being 'relatively' straightforward once adequate models of the physical processes have been derived. Such interaction needs to be investigated in relation to the monsoon cycles, the formation of the oxygen minimum zone, and the influence of mesoscale features. Identification and study of species which might serve as indicators for the ultimate fate of dispersed upwelled water is needed.

5.6. Interdisciplinary Studies

5.6.1. Suez Canal

The Suez Canal and its associated lakes join two totally different zoogeographical units, the Mediterranean and the Red Sea. The Canal is a water-way of considerable economic and strategic importance and provides a route along which migrant species can move from one system to another. An interdisciplinary study of this linear feature would show if the Canal can be treated as a one or two dimensional analogue of large features such as the Gulfs of Suez and Aqaba or even the whole of the Red Sea. It would provide information as to whether the migrations are continuous or episodic, and how water nutrients and pollutants may move along the Canal in spite of the modifying influence of the Bitter Lakes. Existing bilateral collaborative projects could provide the basic framework for long term collaborative programmes which would provide a data base and training for future oceanographers in data collection and management, and sampling design.

5.6.2 Sedimentation and particulates.

Other groups have touched on the significance of understanding the sedimentary fluxes in the region (see 5.3.9). An important aspect would be to provide data on long time-scale climatic variability especially if sediments in the high sedimentation regime within the influence of the oxygen minimum are varved. Subfossil remains of surface plankton, fish otoliths and scales and benthic species, together with pollen and isotope ratios could provide information on the level of natural variability that occurs within the communities (see 5.1.7).

5.6.3 Gyres, upwelling and monsoons

The seasonal cycle of monsoon winds influences many aspects of the physical, biological and chemical environment. There are also large interannual variations. The time and space scales involved necessitate a multi-ship programme complemented by full satellite coverage, preferably giving a real-time input into the sampling design. The development of numerical models should allow the programme to be optimised to test and elaborate hypotheses. The quasi-stable gyres, that occur for example in the Gulf of Oman and which may also be a source of a major fish resource (i.e. of mesopelagic fish), would be fruitful targets for research into the deep ocean. Techniques required would range from standard (e.g. water bottle and vertical nets) to sophisticated (e.g. continuously undulating profilers, Swallow and satellite tracked floats, multi-sampling net systems, etc).

5.6.4 <u>Long time series.</u>

A major problem facing us is to learn how to distinguish the effects of man-induced environment changes from the 'noise' effects of natural variability produced by climatic fluctuations. A method of attempting this is to collect long time series of observations together with a full set of climatic data. To be useful a time series has to span 50-100 generations of a species so only in warm inshore regions where life cycles of zooplankton take days or a few weeks could such time series provide useful data within a sensible time span. It was suggested that a number of inshore stations be established in the Indian Ocean region where weekly observations on surface temperature, salinity, phytoplankton and zooplankton, community abundance and structure, nutrient concentrations, tidal condition, oxygen levels should be made together with with the collection of full weather data (insolation, rain, winds, air temperature,... etc). The programme would provide on-the-job training on sampling, analysis and data handling as well as establishing a unique network of time series data.

5.6.5. <u>Oxygen minimum</u>

This was discussed extensively by other groups (see 5.3.5 and 5.5.2.1.). In relation to shelf and slope regions it particularly merits study in the Pakistan region.

5.6.6. <u>Inshore oceanography.</u>

See 5.2.2. and 5.5.3.4. The ecological effects of coastal barriers, pipe lines and other physical barriers to water or sediment movement should be evaluated in relation to ecosystem effects, particularly where nursery grounds of important species may be affected.

5.6.7. Data exchange and intercalibration experiments

Several groups expressed the need for a regional data centre dealing with physical, chemical, biological and fishery data. Satellite data need to be made more available. Taxonomic reference collections and data retrieval systems need to be developed (see 5.2.7.4.).

A role for TEMA* was foreseen in stimulating and facilitating the interaction of scientific groups in connection with intercalibration exercises and training in techniques.

5.6.8. Co-operation and Communication.

Co-operation and communication are recognised prerequisites for successful study on a synoptic scale. Communication and the first stage of interaction between groups could be initiated by the formation of an international society with the responsibility of mounting scientific meetings and discussion groups and issuing a news letter or journal summarising current research in the area.

On another level there are already in existence international bodies whose mechanisms could be used as a catalyst for establishing co-operative programmes either independently or in relation to existing I.O.C. activities in the area. International organisations with existing or planned programmes in the region include:-

5.6.8.1 I.O.C. -related subsidiary bodies:

CINCWIO for the North and Central Western Indian Ocean.

IOCINDIO for the Central Indian Ocean (Planned).

5.6.8.2. The ALECSO Programme for the Red Sea and Gulf of Aden Environment (PERSGA).

5.6.8.3. The UNEP Regional Seas Programme in the Gulf, the Kuwait Action Plan (KAP) and the related Regional Organisation for the Protection of the Marine Environment in the Gulf (ROPME);

5.6.8.4. The Food and Agriculture Organisation (FAO); the Indian Ocean Fisheries Community.

5.6.8.5. Existing Activities and Organisations working in the region.

* TEMA : Training, Education and Mutual Assistance.

The FAO maintains an active interest here, through the UNDP project which supports the R/V DR FRIDTJOF NANSEN and has arranged for this vessel to remain for some further time in the Arabian Sea. Its presence provides an opportunity for collaborative interchange of oceanographic data. Co-ordination with surveys in the N.W. region of the Indian sub-continent and in inshore waters by smaller vessels is considered highly desirable.

The FAO/DANIDA project on 'Training in Fish Stock Assessment" provides assistance in the form of training courses and supporting services to fishery biologists in the area (Somalia, Egypt, India and probably Pakistan). The FAO -Red Sea project also occasionally conducts training courses.

Research groups identified by IOC (IOC/INF 539 1983) as being active in the region or planning to extend previous interests include:-

- Oceanography Department of Alexandria University.
- Institute of Oceanography and Fisheries of the Academy of Scientific Research and Technology (Interests : Education and Research in all aspects of marine science).
- National Institute of Oceanography (NIO) India - (wide range interests).
- Institute of Oceanographic Sciences (IOS) U.K. (Geophysics and Marine Biology).
- Dunstaffnage Marine Research Laboratory of the Scottish Marine Biological Association, Oban, Argyll, Scotland, U.K. (All aspects of marine research with particular interest in the environmental-problems).
- Laboratoire d' Oceanographie Physique du Museum National d'Histoire Naturelle, Paris, France. (Interests:- XBT sections, seasonal cycle of current systems).
- Institut fur Hydrobiologie und Fischereiwissenschaft, Universitat Hamburg, F.R.Germany (Zooplankton and Benthic Ecology).
- Lehrstuhl fur Specielle Zoologie, Ruhr - Universitat, Bochum, F.R.Germany (Marine ecology with special reference to coral reef communities).

. Department of Fisheries Biology, University of Bergen, Norway (Biomass studies, mesopelagic fish resources).

. Brookhaven National Laboratory, Associated Universities Inc. New York U.S.A. (Food chain dynamics, basic oceanic variables, quantitative investigation of biological processes).

. Department of Meteorology, the Florida State University, Tallahassee, Florida, U.S.A. (Numerical modelling of physical parameters).

More details of the interests of these organisations are given in IOC/INF.539 and this document should be consulted in relation to the possible extent of co-operation in research and/or training of personnel which might be available.

A high level of proficiency is required if the scientists of the area are to make the optimum use of the potential for co-operative research and this factor underlies the I.O.C's policy of incorporating the components of its Training, Education and Mutual Assistance (TEMA) programme in all scientific aspects of the Commission. The advice of the TEMA secretariat, IOC Paris, may be sought in determining appropriate forms of training and suitable training bodies.

REFERENCES

ANGEL, Martin V., Ed. 1984. Marine Science of the North-West Indian Ocean and Adjacent Waters. Proceedings of the Mabahiss/John Murray International Symposium, Alexandria, Egypt, 3-6 September 1983, Deep-Sea Research, Vol. 31, Nos. 6-8A, p. 571-1035.

Committee on Climatic Changes and the Ocean (CCCO), 1983. IOC/Unesco/SCOR/ICSU CCCO Panel on Indian Ocean Climatic Studies, First Session, 21-23 March 1983, Unesco, Paris, 9 pp. and 17 annexes.

FAOUZI, H. 1939. The Voyage of the Egyptian Ship 'MABAHISS' to the Indian Ocean with the Sir John Murray Expedition. A Memorial Book, Fouad I Institute of Hydrobiology and Fisheries. Imprimerie nationale, Le Caire, 123 pp.

NAQVI, S.W.A., and S.Z. Qasim. 1983. Inorganic nitrogen and nitrate reduction in the Arabian Sea. Indian Journal of Marine Sciences, Vol. 12, p. 21-26.

SEN GUPTA, R., M.D. Rajagopal and S.Z. Qasim. 1976. Relationships between dissolved oxygen and nutrients in the north-western Indian Ocean. Indian Journal of Marine Sciences, Vol. 5, p. 201-211.

SEWELL, R.B.S. (Unpublished) 'Narrative of John Murray Expedition 1933/34'. In a 50th anniversary volume, edited by A. L. Rice, to be published by Unesco in 1985/86.

TCHERNIA, P. 1978. Descriptive Regional Oceanography. Pergamon Marine Series, Vol. 3, Oxford, 254 pp.

UNESCO 1976. Marine Science Programme for the Red Sea. Unesco Technical Papers in Marine Science, No. 25, Unesco, Paris, 21 pp.

WARREN, B.A. 1978. Bottom water transport through the southwest Indian Ridge. Deep-Sea Research, Vol. 25, p. 315-322.

WYRTKI, K. 1971. Oceanographic Atlas of the International Indian Ocean Expedition. National Science Foundation, U.S. Government Printing Office, 531 pp.

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Dr. Huseyin Uysal
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Dr. Soterios Varnavas
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Patras, GREECE.

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Prof. Michel Vigneaux
Director,
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University of Bordeaux,
Talence, FRANCE.

Prof. Frederick J. Vine
School of Environmental Sciences,
University of East Anglia,
Norwich, U.K.

Dr. Robert S. White
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University of Cambridge,
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Cambridge, U.K.

Prof. Warren S. Wooster
Institute of Marine Studies,
University of Washington,
Seattle,
Washington 98105, U.S.A.

ANNEX II

COMPOSITION OF WORKING GROUPS OF THE ROUND-TABLE DISCUSSIONS

Biology and Fisheries Oceanography

R.R.Abdallah
M.Al-Badri
A.R.Brand
N.M.Dowidar
S.El-Zarka
Jan A. Fallows
M.M.Fouda
J.Gjøsaeter
Y.Halim
W.R.Hamza
S.M.Haq
N.A.Hussein
G.Léger
A.P.M.Lockwood
H.Mergner
G. Schoer
Sharon Smith
H.Thiel
P.A. Tyler-Chairman\Rapporteur
S.C.Venema

Physical Oceanography

G.H.I.Afifi
A.Akyarli
Pascale Delecluse
A.Edwards
A.El-Gindy
M.I.El-Sabh
Michele Fieux
A.A.Hamed
N.Hilaly
M.E.Luther
G.S.Quraishee-Chairman/Rapporteur
G.F.Soliman
J.C.Swallow
N.Taspinar.

Chemical Oceanography and Pollution

M.Behbehani
B.Dicks
Mrs F.El-Nady
S.Fowler
A. Hanna
C.Latouche
M.El-Mofty
S.A.Morcos
A.Poisson-Chairman/Rapporteur
S.Stanley

Geology and Geophysics

R.Dolan
S.K.El-Wakeel
A.Ferragne
R.W.Girdler
E.Izdar
E.Nakoman
E.Refai
H.N.Siddiquie-Chairman/Rapporteur
M.F.Vigneaux
F.J.Vine
R.S.White

Interdisciplinary

M.V.Angel-Chairman/Rapporteur
F.E.Grousset
A.F.A.Ghobashy
D.Krause
R.T.Leah
Sharon Smith
S.C.Venema

ANNEX III

The Egyptian Committee for the celebration of the 50th Anniversary of MABAHISS/John Murray Expedition.

Chairman: Prof. Dr. Mahmoud Al-Hadary
President of Alexandria University

Members:

From Alexandria University

Prof. Dr. Abdel-Salam M. Shalaby
Dean, Faculty of Science, Alexandria University

Prof. Dr. Ali M.El-Maghraby
Head, Oceanography Department, Faculty of Science, Alexandria University.

Prof. Dr. Saad L.El-Wakeel
Oceanography Dept., Faculty of Science, Alexandria University.

Prof. Dr. Youssef Halim
Oceanography Dept., Faculty of Science, Alexandria University.

Prof. Dr. Sayed H. Sharaf El-Din
Oceanography Dept., Faculty of Science, Alexandria University.

From the Academy of Scientific Research and Technology

Prof. Dr. Ahmed R. Bayoumi
Director, Institute of Oceanography and Fisheries

In their personal capacities:

Prof. Dr. Hamed A.F.Gohar
Formerly Director of Institute of Oceanography and Fisheries.

Prof. Dr. Hussain Faouzi
Formerly : Member of MABAHISS/John Murray Expedition;
Director of Hydrobiological Institute, Alexandria,
Dean, Faculty of Science, Head, Dept. of Oceanography;
and Vice-President of Alexandria University,
Undersecretary, Ministry of National Guidance.

Prof. Dr. Mohmoud M.Ramadan
Formerly : Head, Zoology Dept. and Dean of Faculty of Science,
Alexandria University.

ANNEX IV

Meeting on commemorating the 50th Anniversary of the John Murray Expedition held during the Joint Oceanographic Assembly, Halifax, 9 August 1982

List of Participants

Dr. Martin V. ANGEL,
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Wormley, Godalming,
Surrey, GU8 5UB, U.K.

Dr. Ahmad Al-Refai BAYOUMI,
Institute of Oceanography and Fisheries, A.S.R.T.,
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Cairo, EGYPT.

Prof. Henry CHARNOCK,
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University of Southampton,
Southampton SO9 5NH, U.K.

Prof. Ronald I. CURRIE,
Dunstaffnage Marine Research Laboratory,
P. O. Box 3,
Oban, Argyll PA34 4AD,
SCOTLAND (U.K.)

Sir George DEACON,
Institute of Oceanographic Sciences,
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Surrey GU8 5UB, U.K.

Mr. Naim DOWIDAR,
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Faculty of Science,
University of Alexandria,
Alexandria, EGYPT.

Dr. Mohammed EL SABH,
Département d'Océanographie,
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CANADA G5L 3A1.

Dr. Sayad Z. EL-SAYED,
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College Station,
Texas 77843, U.S.A.

Prof. Altaf EZZAT,
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University of Alexandria,
Alexandria, EGYPT.

Mr. G. E. HEMMEN,
The Royal Society,
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London, SW1Y 5AG, U.K.

Dr. Dale C. KRAUSE,
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Dr. Selim MORCOS,
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Unesco,
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75700 Paris, FRANCE.

Dr. Sayad SHARAF-EL-DIN,
Dept. of Oceanography,
Faculty of Science,
University of Alexandria,
Alexandria, EGYPT.

Dr. Eric SIMPSON,
President, SCOR
Department of Oceanography,
Dalhousie University,
Halifax,
Nova Scotia B3H 4J1,
CA[illegible]

ANNEX V

THE ROYAL SOCIETY

BRITISH NATIONAL COMMITTEE ON OCEANIC RESEARCH

John Murray Expedition 50th Anniversary

At an informal meeting held in the rooms of the Royal Society, London on 22 November 1982 to discuss plans for celebrating in September 1983 the fiftieth anniversary of the sailing from Alexandria of the Mabahiss/John Murray Expedition

Present: Sir Arnold Burgen, Foreign Secretary, Royal Society (Chairman)

Professor S.K. El-Wakeel - Chairman Egyptian Preparatory Committee Director of Department of Oceanography, University of Alexandria

Professor A. Bayoumi - Egyptian delegate to IOC; Director Institute of Oceanography and Fisheries, Cairo

Professor H.A.F. Gohar - Formerly Director of the Institute of Oceanography and Fisheries, Cairo and formerly Director, Red Sea Marine Biology Station

Dr S. Morcos - UNESCO Division of Marine Sciences

Dr M.V. Angel - Institute of Oceanographic Sciences, UK and Coordinator of UK interests in the symposium

Professor R.J.H. Beverton - UK delegate to IOC

Professor H. Charnock, Chairman, Royal Society British National Committee on Oceanic Research (BNCOR)

Dr D. Cronan - Imperial College, University of London representing British university earth science interests

Professor R.I. Currie - Chairman, NERC Advisory Committee on International Oceanographic Affairs (ACIOA)

Sir George Deacon - Formerly Director Institute of Oceanographic Sciences, UK

Dr R. Padgham, Secretary, ACIOA

Dr D.R. Stoddart, University of Cambridge

In attendance:

Mr G.E. Hemmen, Royal Society, UK

Mr L.U. Mole, Royal Society, UK

ANNEX VI

WELCOMING ADDRESS by

Prof. Dr. Mahmoud AL-HADARY. The President of Alexandria University.

This Symposium has great significance, taking us back 50 years to the commissioning of the MABAHISS, the first Egyptian research vessel, and to the notable cruise which provides the title for our Conference.

The Expedition, jointly staffed by English and Egyptian scientists, earned a major place in the history of the study of the Indian Ocean and it is appropriate indeed that a cruise of such significance had its genesis in Alexandria, a city we know as the 'bride of the Mediterranean'. The cruise in its turn has had its significance for Alexandria in the role the expedition played in initiating the interest in oceanography which ultimately led to the formation of the Department of Oceanography in the University.

It is appropriate therefore that the University in collaboration with the Faculty of Science have taken this opportunity to request that the ownership of the research vessel MABAHISS be transferred to the University and we have succeeded in this. The idea is to restore this historic vessel and transform it into an oceanographic museum affiliated to the new building of the Oceanography Department. This will be an important tourist site, especially as we have located the greater part of the documents and original equipment of the vessel and the photographs and names of the people who participated in this historic expedition. I am pleased to inform you that relevant studies concerning the installation of the vessel in its new place have been done, and we hope to be able to get the financial support for the forthcoming phase of the project to have the vessel as a permanent museum for the city of Alexandria.

On this occasion I would like to express our appreciation for all those who have contributed scientifically and physically for the success of this Symposium. Special thanks are due to the international organisation such as UNESCO and the Intergovernmental Oceanographic Commission, the Royal Society, the Natural Environment Research Council of the United Kingdom, the Ministry of Higher Education and the Academy of Scientific Research and Technology of Egypt, the Arab Maritime Academy, the Office of Naval Research of the U.S.A. in London, the Department of Cultural and Scientific Relations of the French Ministry of Foreign Affairs, the Universities and Marine Science Centres in the U.K., the Marine Science Centre of Basrah University in Iraq, the Kuwait Institute of Scientific Research, the Department of Marine Sciences of Qatar University, the Geological Institute in Bordeaux University - France, the Saudi-Soudanese Commission for the Exploitation of the Red Sea Mineral Resources, for all their scientific and financial support which have made a major contribution to the success of the Symposium. May I express the wish that each participant here today may encourage others interested in the history of oceanography to come and visit Alexandria and see this new museum which historically adds to the heritage of the City of Alexandria.

Finally, I wish you all success in your work and sincerely hope that you will be able to produce an international co-operative programme for oceanographic research in the area under discussion. I also wish continued prosperity to our University as a thriving centre in both the scientific and applied fields of oceanography.

ANNEX VII

OPENING ADDRESS by

Dr Martin V. Angel - U.K. Representative

Fifty years ago a group of men set out from this teeming metropolis on an exploration of an unknown ocean. For that time, it was a remarkable group of men because it included people from two nations, one developed the other developing, working together as equals. A cooperation that still stands today as an example for us to follow. Perhaps even now,we know less about the Indian Ocean than any other ocean, and at this meeting we will be discussing more about our ignorance than about our knowledge. The unenlightened might question whether or not this really matters, but it is becoming clear that the Earth with its limited resources, is not divided up into independent systems of land, sea, air and freshwater, but is an entity with each system interacting with every other system. So if we are to understand and come to terms with processes on land such as desertification, we need to know how climate is controlled, which leads us back to needing to know how the oceans interact with the atmosphere.

Our planet is threatened by the accelerating growth of human population with its ever increasing demands on resources and its senseless abuses of the environment. Today, as every other day for the last six months thousands of barrels of crude oil are pouring from the war-damaged well-heads in the Gulf. This is an environmental abuse which we cannot ignore because this gross act of folly threatens not only the two nations in conflict, not only the other states which share the waters of the Gulf, but it threatens us all because the despoilation of any part of our global ecosystem is a threat to the whole entity. To me it is grossly immoral, surely to the nations involved it must be "HARAAM". Even without these urgent needs, seeking scientific understanding of the Indian Ocean is still a precious goal. Man is too divided by the differences of race, creed, culture, economics and politics. Through all science there is a coming together of minds which leads to mutual understanding via the rational language of science, and this is particularly true for oceanography not only because it is multidisciplinary but also because, of necessity, it is multinational. The attainment of good science is a high ideal; the aim of this meeting, through this coming together of the peoples of many nations is to strive towards this high ideal. The British, one of the original partners in the John Murray Expedition were greatly honoured by the invitation by our hosts in Alexandria to co-sponsor this symposium and consequently substantial financial support has been given by the Natural Environment Research Council, the Royal Society and the British Council. The Chairman of N.E.R.C., Sir Herman Bondi, and the President of the Royal Society, Sir Anthony Huxley, both send their best wishes for the success of the Symposium. I hope our hosts, the University of Alexandria, will greatly benefit from this Symposium especially through their younger staff and research students being able to sit in on some of our proceedings.

Great things have small beginnings. This not so small beginning I am sure will lead to great things. We have both the challenge and the responsibility to follow in the wake of the MABAHISS, to renew the inspiration of that great man of oceanography, John Murray, who links us with the great CHALLENGER Expedition and whose bequest led to the Expedition we commemorate today, to seek knowledge in a sea of confusion, and to blend our disparate abilities into a single tool to find ways to keep our planet habitable.

Thank you.

ANNEX VIII

OPENING ADDRESS by

Dr Dale C. Krause - UNESCO Representative

Ladies and Gentlemen,

It is a great honour and pleasure for me to speak to you on behalf of UNESCO on this important occasion of the celebration of the 50th Anniversary of the John Murray/MABAHISS Expedition.

At first thought, this Anniversary might seem to concern only Egypt and the United Kingdom. However, on further reflection one appreciated that it is a real first, not only for British and Egyptian oceanographers, but for the world oceanographic community at large, for the story of the Egyptian research vessel's nine month voyage in the Indian Ocean in 1933/a934 carrying the John Murray Expedition was a landmark in the growth of international co-operation in marine sciences. Long before the U.N. Conference on the Law of the Sea debated international relationships in matters of scientific research in the seas, scientists and authorities from those two countries were able to agree on a joint venture that set an unprecedented example of a successful effort in the newly emerging field of marine sciences. The people who made that agreement were guided by their common sense, deep understanding of the objectives of the mission, mutual respect for national needs and, finally, a realistic assessment of what each partner could contribute to the common cause of the expedition.

A careful study of the memorandum on the agreement between the two parties shows how these elements were fused together. Today we give credit to the authors of that agreement for their foresight and wisdom. But it was not the soundness of this agreement but the sincerity and devotion in its execution that ensured the success of the expedition. We owe much to these courageous people who carried it out, as well as to those engaged in its preparatory and concluding phases. The real success of the expedition lies in the human element where a team of scientists, officers and sailors - about thirty Egyptians and eight British, endured relatively severe conditions in a small, crowded and uncomfortable ship for a period of nine months. This proved to be a "melting pot" which resulted in a highly integrated community.

Those of us oceanographers who have worked on research vessels in the Indian Ocean or in other tropical regions and who know how great is the inconvenience caused by a breakdown of the air-conditioning system on board - can only wonder at the fortitude and tolerance of those people, who with no air-conditioning system at all, were able to overcome the adverse conditions offered on the cruise of the MABAHISS.

It is fair to say that the expedition has contributed to the understanding of the Northern Indian Ocean and remains one of the main sources of information on many aspects of this region. Oceanographers know that the John Murray Expedition was typical of the expeditions in which classical oceanographic disciplines were used in surveying the unknown or little known, oceans, as opposed to the problem oriented investigations that in part marked the International Indian Ocean Expedition and which became the standard approach in subsequent years.

However, the lesson of the John Murray/MABAHISS Expedition does not end with the mere fulfilment of the task assigned to it. The repercussions of the venture, in Egypt in particular, and the region in general, far exceeded the expectations of the Expedition planners and authors of the bilateral agreement. Elements of these expectations can be traced in the text of this bilateral agreement where the Egyptians showed a keen interest in upgrading the Research Vessel MABAHISS for future work and training the officers and crew to undertake further investigations. the fact that the Red Sea was left to the Egyptians to explore with the Research Vessel 'MABAHISS' at some future date, demonstrated the confidence of both the British and the Egyptians in the emerging capabilities of the young scientific community in Egypt. The Egyptian expedition to the Red Sea did indeed follow some months later but the Research Vessel MABAHISS's research activities in that area were cut short after this expedition by conditions obtaining before and during World War II.

In the ensuing impact of the expedition, the most significant event was the establishment, in 1948, of the Department of Oceanography in the University of Alexandria by two Egyptian scientists,who, 15 years earlier, participated in the John Murray/MABAHISS Expedition. We remember today the persistent efforts of Professor Hussein Faouzi and the late Professor Abdel Fatah Mohamed that led to the establishment of this University Deparlment. The need for such a department was questioned for many years, until it became evident that it would play a significant national as well as regional role in the field of marine sciences. The turning point for this Department of Oceanography, the oldest in the Arab and African countries, came in the early seventies when there was a spectacular rise in the demand for oceanographic research both in Egypt and the surrounding regions.

The U.N. Conference on the Law of the Sea (UNCLOS) helped the public to become aware of the economic importance of tapping the renewable resources of the sea and the need to protect the marine environment, and many countries of the region, whether oil producing or not, made considerable efforts to achieve new competence in marine sciences and technology. Marine scientists from Egypt, mostly staff or graduates of the Alexandria Department of Oceanography, helped in establishing teaching and research institutions in different Arab and African countries.

The growth of marine science in the region is a spectacular phenomenon and can be traced back in many instances of the influence of people who were directly or indirectly associated with the John Murray/MABAHISS Expedition. A chain reaction that began modestly over 50 years ago has now exceeded the wildest hopes of the generation that was intimately associated with the planning and execution of the expedition.

Ladies and Gentlemen, the above reflections may explain why UNESCO became so interested in a venture that might appear on the surface to have been a routine exercise. In fact this venture turned out to be one of the most early experiments in science and technology transfer. It is because of this and the many lessons learned from the expedition, as well as the opportunities that we hope will arise from the present deliberations, that the General Conference of UNESCO in its 21st session in November 1980, authorized the Director General of UNESCO to support the scientific activities associated with the celebration of the 50th

Anniversary of the John Murray Expedition, 1933/1934 on the Egyptian Research Vessel 'MABAHISS'. In addition to the present International Symposium for which UNESCO gave full support both technically and materially, there is also the question of preserving the Research Vessel 'MABAHISS'. As you know 'MABAHISS' after a long career has been retired from active service. A research vessel with such a remarkable history should be preserved for future generations as a museum and an instrument for public guidance, as well as a tourist attraction. This is why the Egyptian Committee entrusted the University of Alexandria with this difficult but rewarding task. In doing this Egypt will preserve one of the world's important historical research vessels, just as other old research vessels with a significant role in the history of ocean exploration are preserved proudly in their countries of origin. I may give here the example of the Norwegian Research Vessel "FRAM" which was used by Fridtjof Nansen to explore the (Arctic) North Polar Seas, and the British ship 'DISCOVERY' used to explore the Antarctic (South Polar Ocean). Both these ships, among others, have been preserved and are considered as national monuments of both educational and touristic worth.

When the decision of the Egyptian Authorities to preserve 'MABAHISS' and convert it to a museum came to the attention of the Director General of UNESCO, Mr Amadou Mahtar B'Bow, he promptly decided to make a further contribution through UNESCO for this purpose. We in UNESCO sincerely hope that this contribution will raise interest in and strengthen the efforts of the restoration of 'MABAHISS'.

Before I conclude, Mr President, let me convey to you the greetings of the Director General of UNESCO, Mr Amadou Mahtar M'Bow, and his desire that the 50th Anniversary of the 'MABAHISS'/John Murray Expedition will mark a successful step on the road towards the development of marine sciences in the region, as did the Expedition itself, 50 years ago.

Thank you.

ANNEX IX

OPENING SPEECH by

Dr Selim A. Morcos - I.O.C. Representative

I am pleased indeed to be here today and to have the opportunity to address you at this opening ceremony on behalf of the chairman of the Intergovernmental Oceanographic Commission, Professor Inocencio Ronquillo, and the Secretary of the Commission, Dr Mario Ruivo. Dr Ruivo had hoped to attend this meeting personally but owing to unavoidable last moment commitments at Headquarters, relating to the UNESCO's Executive Board meeting, was unable to attend as originally planned.

The John Murray Expedition to the Red Sea, the North-West Indian Ocean and the Adjacent Gulfs on board the Egyptian Research Vessel 'MABAHISS' in 1933-34 is, from all points of view, a prime example of international co-operation in the study and exploration of the ocean.

The results of this early successful example of international co-operation have reached far beyond the significantly important explorations and the invaluable scientific information of modern knowledge in many aspects of oceanography in the region and was an early precursor of the International Indian Ocean Expedition initiated by SCOR and later co-ordinated by the I.O.C.

Certainly, most of you know that the I.O.C. has played an active role in promoting co-operative international oceanography investigations in the different regions of the World Ocean. The I.O.C. has thus developed a system for international co-operation which permits the participation of all countries, interested in Oceanography, and promotes world-wide co-ordination.

The I.O.C. has established regional subsidiary bodies for the region of the Indian Ocean and its adjacent waters; namely the Programme Group for the Co-operative Investigations of the Northern and Central Western Indian Ocean (CINCWIO) and the Programme Group for the Central Indian Ocean (IOCINDIO).

When the I.O.C. Assembly, at its twelfth session, accepted with great pleasure the invitation to co-sponsor the present symposium, one of its main objectives was to make good use of the Symposium's outcome as a basis for the planning of its future cooperative marine science activities in these regions. With this in view, the Round Table discussion, to be held during the last one and a half days of the present Symposium, has been planned with two main objectives. First, to identify the main gaps in marine scientific knowledge of the region, and, second, to discuss and suggest co-operative research projects that could benefit from international co-operation, particularly under the I.O.C. subsidiary bodies of this region which I have just mentioned.

It is strongly hoped that with the experience that you have in your respective fields of specialization and your active participation in this Round Table discussion, these objectives will be attained. It is true that occasions for scientific discussions are always useful, and so much more so when they involve, as in our case today, people actively associated with the study of common problems within such diversified scientific and economic structure as in the region with which we are concerned. However, it should be borne in mind that the idea is indeed not to create new bodies, but rather to co-ordinate the activities with existing I.O.C. subsidiary bodies or with other organisations having relevant ongoing or planned marine scientific activities in the region. It is therefore hoped that in the light of the scientific presentations during the Symposium and the equally important discussions among the colleagues from various countries represented in this gathering, and based on your objective discussions in the Round Table, a few well-identified and promising research problems will be formulated as concrete practical recommendations to be brought to the attention of the Seventeenth session of the I.O.C. Executive Council and of the I.O.C's regional subsidiary bodies to be considered for eventual implementation through, or in co-operation with, other appropriate international bodies.

Needless to say that international co-operation is the best way to deal with the multidisciplinary oceanographic research. No single nation can solve all of the complex problems of oceanography alone. We are indeed in a period in which the nations of the world, under a multitude of pressures, are, in fact, rediscovering the sea, re-evaluating its importance and redefining its role in the affairs of mankind. The distinguished participants gathered here today are well aware of these facts, which are for most of you the reason for your professional interest in, and the challenge you are facing in your scientific work.

The I.O.C. Secretariat has no doubt that this Symposium will generate new knowledge on the region and will create the momentum necessary for promoting the co-operative regional investigations. I should like to express the I.O.C's gratitude to Alexandria University and the Egyptian Academy of Scientific Research and Technology for their continued co-operation with our Commission, resulting in the convening of the present symposium which is an example of such fruitful co-operation, and to the Royal Society and the Natural Environmental Research Council of the U.K. and the U.S. Office of Naval Research in London for their support.

I should also like to thank all the individual scientists who contributed to the preparation of the Round-Table Discussion, for having responded to the relevant I.O.C. questionnaire. To all the participants of the symposium I wish great success in their presentations and very fruitful discussions leading to a very successful conclusion and practical recommendations.

Lastly, I should like to congratulate the symposium's organizers and co-ordinators for having assumed this responsibility and for having made this important event a reality.

Thank you.

ANNEX X

CLOSING REMARKS & VOTE OF THANKS

A. Closing remarks by Dr D.C.Krause (UNESCO)

"I would like to speak in the name of the Director General of UNESCO, Mr. Amadou Mahtar M'Bow, and for my other colleagues in UNESCO and its Intergovernmental Oceanographic Commission. I am very satisfied with the results of this symposium celebrating the 50th Anniversary of the John Murray/MABAHISS Expedition.

Each paper has advanced the field to new frontiers and each has set my own mind to considering relevant research of both disciplinary and inter-disciplinary nature. This workshop has been remarkably effective in stimulating interdisciplinary thinking. I think the key scientific factor here has been the recent dramatic advances in understanding of the Indian Ocean resulting from satellite oceanography and numerical oceanographic modelling. This now permits us to ask precise and answerable questions in a way that could not be done previously. Our science continues to be vigorous and exciting.

Through the papers, the scientific frontier has been well established. The applied science aspects were also covered; to this observer it seems that the applied marine sciences need to ensure a rapid input of the latest oceanographic advances into their work, because these advances will so strongly affect the experimental design and interpretation of the data.

The strength of the symposium lies of course with the participants. We are fortunate to have had highly competent participants representing a wide range of specialists and nationalities, who are particularly interested in mutual co-operation. Moreover, you have further approached the topic matter in a truly interdisciplinary manner.

It is useful to identify gaps and omissions in the discussions so that these can be taken into consideration in the future work and co-operation that will result from this symposium.

Three scientific topics seemed under-considered : sedimentation, especially the interdisciplinary linkages; submarine volcanism (rift volcanism and associated phenomena); and satellite oceanography (satellite remote sensing). There was only minor discussion of major new technology; e.g. satellite sensors, multibeam sounders, high speed large computers, technology for information and data management, etc.

There was little discussion on the barriers to oceanographic co-operation in the region. Examples of such barriers in the region and/ or in most of the countries are the following:

- lack of adequate research funding - this is the most important single barrier in my opinion.
- lack of comprehensive national scientific policy and lack of national commitment to oceanographic research.
- lack of manpower, training and physical infrastructure, (in part due to the above two points), including lack of scientific counterparts.
- poor scientific communications between the scientists within the region and with scientists outside the region.
- possible and actual legal barriers created as the result of the Third UN Conference on the Law of the Sea.

There was also no organized discussion on follow-up of the recommendations arrived at during the symposium. Such follow-up will rest with all of you as you return to your other duties as it shall with us in UNESCO and its IOC. In the long term, such follow-up will be the most important result of this symposium.

I wish to express our appreciation for the efforts of the national organizers of the symposium: Prcf. El Wakeel and his staff in Egypt and Dr Angel and his staff in the United Kingdom. We wish to thank the other organizations which, in addition to UNESCO's Division of Marine Sciences and the IOC, provided support: Alexandria University, the Academy of Scientific Research and Technology (Egypt), the Royal Society (U.K.), the Natural Environment Research Council (U.K.) and the U.S. Office of Naval of Research.

Finally, I wish to thank the participants themselves who freely provided their time and efforts. I hope you will all look back with satisfaction to the symposium as I am sure I shall."

B. Vote of thanks on behalf of the participants: Dr Manef Behbehani.

Rising to thank the sponsors and organisers of the meeting Dr Behbehani drew attention to the achievements of the symposium particularly in respect of high-lighting what had been accomplished already in marine science in the region, what could be done with existing facilities and what needed to be done but which could not be achieved locally without additional financial and technical support.

Noting with regret that not all the countries of the area had been represented at the meeting he urged the importance of building up the expertise, facilities and capabilities and asked the international agencies and other experts present to continue their efforts to find means of assisting the development of marine science in the Indian Ocean regions.

On behalf of the participants it was requested that the thanks of all be conveyed to the President of the University and the Governor of Alexandria for the hospitality of the University and the City during the meeting.

C. Closing comments by Dr M.V.Angel

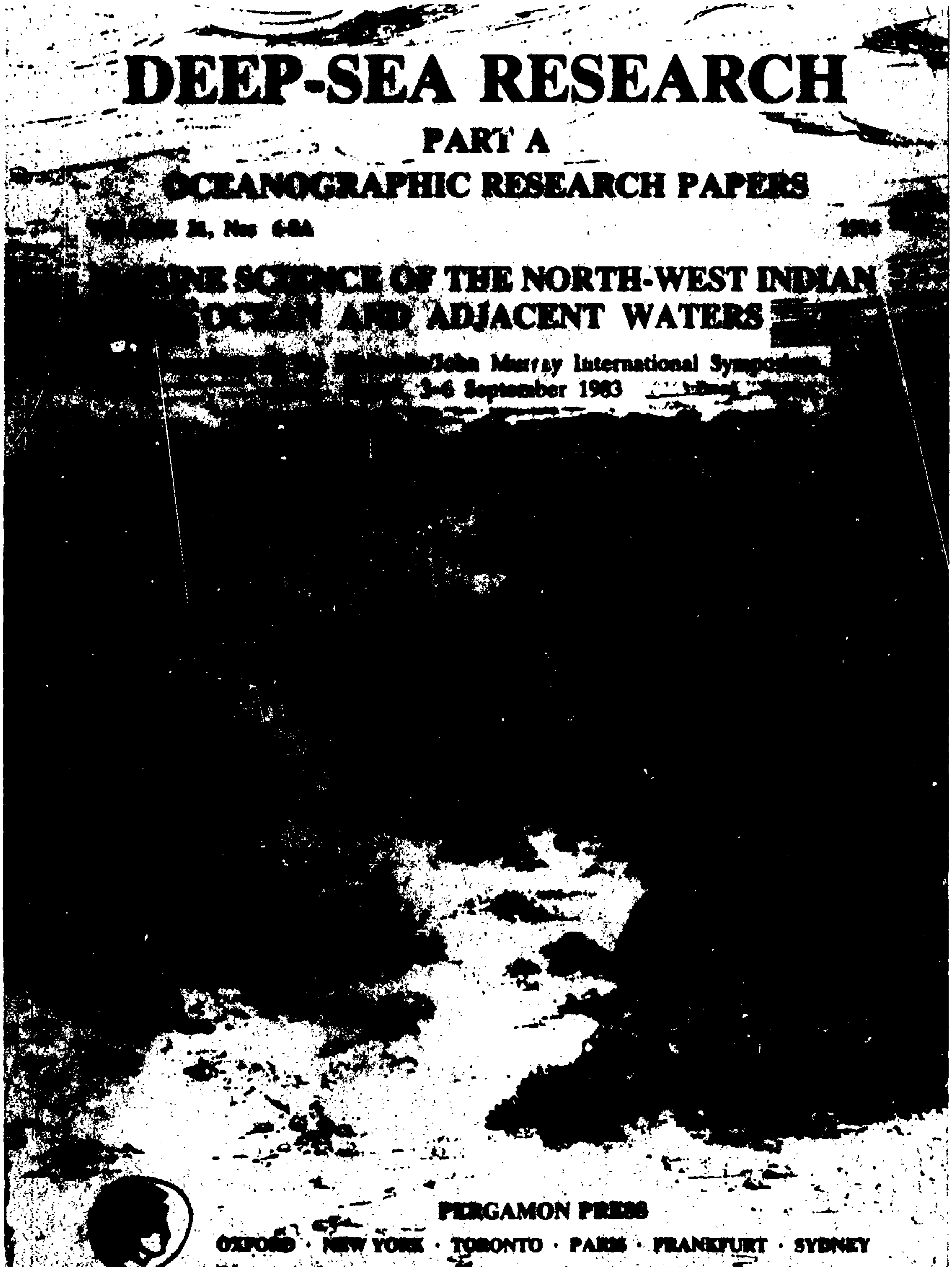
On behalf of the Convenors, Martin Angel conveyed thanks to the University of Alexandria and its President, H.E. Professor El Hadary, the Governor of Alexandria, H.E. Mr Mohamed F.Mo'az, the national and international bodies which had contributed support and to the University and U.K. staff whose efforts had contributed so much to the efficient administration of the meeting; Mrs Pamela Talbot merited particular mention.

The symposium had had a high objective, to catalogue a new renaissance of marine science in the area and had served to show how many marine problems of world interest could usefully be studied in the region. The detailed recommendations should be of value to the development of new national and international programmes. Lastly a contribution had been made to that vital first step in establishing new research programmes, the making of new friends and contacts.

D. Closing remarks by the Dean of Science.

Dr Shalaby expressed his favourable impressions of the meeting and on, behalf of the President of the University thanked the convenors Professor S.K. El-Wakeel and Dr M.V.Angel and the agencies which had supported the meeting, particularly I.O.C., UNESCO and the National Academy of Science of Egypt. Special thanks were also due to Professor H. Faouzi for his spirited contribution to the meeting and infectious enthusiasm; a stimulus indeed to present and future generations of marine scientists. It was indeed a historic occasion 50 years ago in which he participated.

ANNEX XI : ABSTRACTS OF PAPERS PRESENTED



Proceedings of the Mabahiss John Murray International Symposium, Egypt 3-6 September 1983

Contents

THE SIGNIFICANCE OF THE JOHN MURRAY / MABAHISS EXPEDITION TO THE ARABIAN SEA

G.E.R. Deacon and A.L. Rice

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The significance of a major scientific undertaking such as an extensive research cruise can be considered under two main headings. First, what might be termed the political implications, affecting institutions and the availability of funding for particular areas of research, or the direction taken by the careers of individuals; these effects are essentially relatively short-term, although the repercussions may be long lasting. Second, the scientific results, usually embodied in the expedition reports or in independent publications, tend to be rather less ephemeral and may become important decades after their appearance. Such a separation is by no means clear, but the extremes are readily identifiable.

For example, in the case of the most famous of all oceanographic expeditions, that of H.M.S. 'CHALLENGER', at least some of the political effects are obvious. Overseas, it encouraged several nations to mount their own expeditions so that there was a burgeoning of deep-sea research in the 1880s and 1890s (see Yonge, 1972). At home, the results were more equivocal. Two of the 'CHALLENGER' scientists (Buchanan and Murray) were established by the expedition into marine careers in which they became increasingly influential. In Murray's case the expedition also led to the acquisition of considerable personal wealth (Burstyn, 1975) and, through this, to the funding of oceanographic projects such as the 'MICHAEL SARS' Expedition (Murray and Hjort, 1912) and, of course, the John Murray Expedition itself. But the British Government, having found itself funding the first example of "big science" (Burstyn, 1968), seemed reluctant to become involved in deep-sea work again; it did not do so, in any major way, for almost half a century, although the official "memory" of the financial wrangles which surrounded the 'CHALLENGER' Expedition, and particularly the publication of the Reports, can hardly have lasted much beyond the turn of the century.

The scientific results were clearly of considerable immediate significance since they answered many of the current questions about oceanic biology, chemistry, physics and geology - and, of course, posed many more. In both cases they profoundly influenced the direction of oceanographic research in the decades following the expedition. One hundred years on, the 'CHALLENGER' results are largely of historical interest, though in some areas, such as systematic zoology which occupied the bulk of the scientific reports, they have a lasting value, while changing concepts may even now lead to re-interpretation of the results which may consequently assume an unexpected new significance (see, for instance, Rice, 1983).

Although the John Murray/'MABAHISS' Expedition does not compare with that of H.M.S. 'CHALLENGER' in geographical extent, duration, aims, achievements or, indeed, costs, its significance and influence can be considered under the same headings.

JOHN MURRAY / MABAHISS EXPEDITION VERSUS THE INTERNATIONAL INDIAN OCEAN EXPEDITION (IIOE) IN RETROSPECT

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ABSTRACT

In addition to its scientific achievements, the John Murray/Mabahiss Expedition was a unique experiment in technology transfer and it pioneered bilateral relations in the field of oceanography, at a time when the Law of the Sea was not even an embryonic concept. The Expedition will be remembered for its profound influence on the development of oceanography in Egypt, and subsequently in several Arab and African countries, as well as for its socio-economic impact in Egypt.

The International Indian Ocean Expedition (IIOE) was an elaborate exercise involving both the most sophisticated developments in oceanography of the day and the full complexity of international relations which necessitated the scientific, coordinating and supporting mechanisms of SCOR, IOC and Unesco combined.

Each exercise separated by 25 years represented a significant event in the development of oceanography. Each was a natural product of the prevailing state of the art and the international climate. Oceanography had made a quantum jump in technology in the intervening quarter of a century, which had put the cost of deep sea oceanography quite beyond the financial capabilities of many developing countries, an important factor to bear in mind when comparing the impact of the John Murray/Mabahiss Expedition on Egypt with that of the IIOE, on the Indian Ocean countries.

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INTERNATIONAL STUDIES OF THE INDIAN OCEAN, 1959-1965

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ABSTRACT

An oceanographic exploration of much of the Indian Ocean took place during 1959-1965 in the framework of the International Indian Ocean Expedition. Organised and coordinated by international organisations, the Expedition involved 23 countries, many from outside the region. An analysis is made of the role of international organisations, the nature of planning and coordination, the relative importance of fundamental and applied research, the published products of the Expedition, and its benefits to developed and developing countries. Some lessons for the organisation of future cooperative ventures are suggested.

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THE EGYPTIAN EXPEDITION TO THE RED SEA 1934/35

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ABSTRACT

Six months after the return of the Egyptian Research Vessel 'MABAHISS' from its nine month voyage in the Indian Ocean with the John Murray Expedition, an Egyptian Expedition was sent to the Northern Red Sea from December 1934 to February 1935. During these two months, 'MABAHISS' carried out four cruises in order to collect samples and make observations on the geology of small isolated islands, algae, coral reef formation, bottom fauna, bottom sediments, bathymetry, and physical and chemical oceanography. Using the newly developed echosounder, the ship made a detailed bathymetric survey of the Northern Red Sea and Gulf of Aqaba, where the deepest spots, which became known as "Mabahiss Deep I" and "Mabahiss Deep II" respectively, were discovered in the two basins. 'MABAHISS' made 10 oceanographic sections and 103 stations of which 47 were oceanographic stations. Equipped with more accurate equipment than the Austrian 'POLA' Expedition (1895-1896), the 'MABAHISS' investigations in physical and chemical oceanography revealed several major phenomena for the first time, such as the adiabatic increase of temperature in the Gulf of Aqaba, and the intermediate layer of minimum oxygen and the intermediate maximum of phosphate in the Red Sea. The exchange of water between the Red Sea and Gulf of Aqaba in the Strait of Tiran, the formation of deep and bottom water in winter in the Northern Red Sea, and the circulation north of 24°N in the Red Sea, were described for the first time.

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THE DEVELOPMENT OF MARINE SCIENCE IN EGYPT

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ABSTRACT

On the occasion of the 50th anniversary of the Mabahiss/John Murray Expedition to the Indian Ocean, a review is given on development of marine science in Egypt and the main institutions devoted to education and research. The contributions of Egyptian oceanographers working along the Mediterranean and Red Sea coasts of Egypt since 1930 in all the fields of oceanography are summarised.

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SOME ASPECTS OF THE PHYSICAL OCEANOGRAPHY OF THE INDIAN OCEAN

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It seems appropriate in this review to concentrate on those physical topics that are likely to be of interest to other marine scientists - that would have interested Seymour Sewell and his colleagues in the 'MABAHISS'. The topics chosen are, first, upwelling in the Arabian Sea, and secondly those aspects of the circulation that may affect the dissolved oxygen concentration at intermediate depths there.

This is a much narrower field than the title originally assigned by the organisers of the symposium. However, those two topics can be linked to quite a wide range of features of the Indian Ocean in general. Readers who may be disappointed by this narrow choice of subjects are referred to a review with exactly that title, published ten years ago by Wyrtki (1973), which did indeed cover the whole Indian Ocean.

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CIRCULATION IN THE NORTH ARABIAN SEA AT MURRAY RIDGE DURING S.W. MONSOON

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ABSTRACT

Circulation in the Arabian Sea north of 20°N has been observed to contain warm and cold core eddies. These have been confirmed from various investigations during the International Indian Ocean Expedition (1962-67) and subsequent oceanographic surveys. Satellite imageries using records of high resolution infrared radiometer have also delineated these eddies with more clarity. The eddy circulation appears to get intensified and in some areas persists in the SW monsoon (May-September). These months are dominated by upwelling along the Arabian coast and the cold water plumes and wedges extend eastward. Upwelling, comparatively weak, also appears along the Pakistan coast, west of Karachi. In the middle of these two upwelled cold water areas an anticyclonic eddy is found with warm core. Records generally show that this eddy circulation is repeated in the S.W. monsoon. Interaction of permanent seabed topographic features like the Murray Ridge and continental shelf on the eddy field, if any, has been studied. This eddy circulation favoured the vertical and horizontal mixing of nutrient rich water.

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CYCLONES AND STORM SURGES IN THE ARABIAN SEA: A BRIEF REVIEW

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ABSTRACT

The frequencies and tracks of tropical cyclones over the Arabian Sea are reviewed. Storm surge-causing tropical cyclones occur predominantly either during pre-monsoon or during post-monsoon seasons. Large amplitude wind waves and tides also occur in the Arabian Sea, thus making the west coast of the Indian subcontinent a potentially hazardous zone.

CHEMICAL OCEANOGRAPHY OF THE INDIAN OCEAN, NORTH OF THE EQUATOR

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ABSTRACT

Chemical oceanographic studies in the North Indian Ocean have revealed several interesting and unique features. These are caused by the diverse conditions prevailing in the area which include immense river runoff in the northeast (Bay of Bengal) and a large excess of evaporation over precipitation and runoff in the northwest (Arabian Sea, Persian Gulf and Red Sea), resulting in the formation of several low- and high-salinity water masses. The occurrence of coastal upwelling seasonally makes the region highly fertile, and the existence of the Asian landmass, forming the northern boundary, prevents quick renewal of subsurface layers. Consequently, dissolved oxygen gets severely depleted below the thermocline and reducing conditions prevail at intermediate depths (ca. 150-1200m) resulting in the reduction of nitrate (denitrification). The North Indian Ocean may contribute up to 10% of the global marine denitrification. The "denitrified" nitrogen, when combined with the rate of photosynthetic production reaching below the euphotic zone, gives the average residence time of water between 75 and 1200m as 43-51 years. The inorganic nutrient concentrations in the subsurface layers are very high in close proximity of the euphotic zone. The two-layered circulation leads to an active recycling of nutrients. The presence of organic fractions of nitrogen and phosphorus in significant concentrations in the deep water suggest that oxidation of organic matter is incomplete even at great depths. The relationships between the apparent oxygen utilization (AOU) and nutrients and the stoichiometric composition of organic matter, deduced from the oxidative ratios and by analysis of plankton, are not very different from other oceanic areas.

Higher nutrients and lower oxygen concentrations occur in the bottom layer as compared to the overlying water column in deep waters of the Bay of Bengal and Arabian Sea, suggesting that considerable quantities of organic matter reach the deep-sea floor, probably as fecal pellets, and get oxidized in the bottom layer. Very high silicate concentrations occur in the bottom water, especially in the Arabian Sea, decreasing steadily southward, indicating the solution of diatomaceous sediments from the sea floor. The silicate-rich waters appear to move southward over the north-bound, silicate-poor bottom water, resulting in the occurrence of a deep silicate maximum.

The calcium : chlorinity ratio in the North Indian Ocean is appreciably higher than the oceanic averages. This is probably due to: (1) a high rate of river runoff in a relatively small area; and (2) excessive stripping of calcium at the surface associated with high biological productivity and its subsequent addition and regeneration in the bottom waters. The upward flux of calcium appears to be higher than in other oceanic areas. Other major constituents investigated (fluoride and magnesium) do not show any anomaly.

The partial pressure of carbon dioxide in surface waters of the North Indian Ocean is higher than that in the atmosphere which results in a net flux of carbon dioxide from the sea to the atmosphere. Stagnation of intermediate layers, coupled with high organic productivity at the surface, results in high total carbon dioxide content at these levels.

An increase in carbonate ion concentration occurs with depth in deep waters (>1000m). Calcite saturation depth varies from 1000 to 3000m, increasing progressively southward. The lysocline lies at about 4000m depth, while the carbonate critical depth is located at 4800-5100m. The lysocline appears to be related to the "critical carbonate ion concentration" of 90 ± 5 µm kg^{-1}.

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SOME ASPECTS OF BIOGEOCHEMICAL CYCLES IN THE RED SEA WITH SPECIAL REFERENCE TO NEW OBSERVATIONS MADE IN SUMMER 1982

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ABSTRACT

Recent data of some parameters of the carbon dioxide system in the Red Sea are presented and discussed in relation to the distribution of nutrients, water budget and general circulation in the Red Sea. Special attention is focussed on the variation of distribution of these parameters from winter to summer, and on the two regimes of circulation in the straits of Bab-el-Mandab. This is based mainly on the measurements made on the 'METEOR' in December 1964 and the new data collected during two recent cruises on the R/V 'MARION-DUFRESNE' in June and October 1982.

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DISSOLVED AND PARTICULATE TRACE METALS IN COASTAL WATERS OF THE GULF AND WESTERN ARABIAN SEA

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ABSTRACT

Concentrations of chemical species of selected heavy metals (Cu, Zn, Cd, Hg and Pb) were determined in surface waters from a series of coastal sites in Bahrain, United Arab Emirates (UAE) and the Sultanate of Oman. Analyses were carried out on bulk sea water samples as well as on suspended particulates by anodic stripping voltammetry. Heavy metal concentrations were relatively low with the exception of some "hot spots" which occurred in the vicinity of industrial and port activities. Average copper levels along the coast of UAE were generally higher than those measured in sea water from either Bahrain or Oman. Waters from the more populated and industrialised northwest coast of Oman were found to contain approximately 3 to 4-fold higher Cd and Zn (pH 4-4.5) concentrations than those from the southern coast, an undeveloped region adjacent to the more open waters of the Arabian Sea. Possible reasons for the observed regional variations in trace metal concentrations in Oman are discussed in terms of natural and anthropogenic input sources. Average concentrations in the Gulf (inside the Strait of Hormuz) were 510 ng l^{-1} (Cu), 340 ng l^{-1} (Zn), 20 ng l^{-1} (Cd), 16 ng l^{-1} (Hg) and 76 ng l^{-1} (Pb); in the western Arabian Sea along the coast of Oman concentrations averaged 290 ng l^{-1} (Cu), 180 ng l^{-1} (Zn), 37 ng l^{-1} (Cd), 11 ng l^{-1} (Hg) and 80 ng l^{-1} (Pb). Ranges of concentrations for these metals in Gulf and western Arabian Sea waters approach those which have been reported for open surface waters of the Atlantic, Pacific, Indian Oceans and the Mediterranean Sea indicating that, in general, the coastal waters of this region are not impacted by metal pollution and that the existing natural levels can be used as a point of reference for future pollutant studies.

ACTIVE AND PASSIVE PLATE BOUNDARIES AROUND THE GULF OF OMAN, NORTH-WEST INDIAN OCEAN

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ABSTRACT

Three different types of plate boundaries are found on the three sides of the Gulf of Oman in the north-west Indian Ocean. The structure and tectonics of each of these boundaries is discussed using mainly marine geophysical data obtained from cruises in the region between 1975 and 1980. To the north lies the Makran subduction zone which has developed an excellent example of an accretionary prism on the over-riding (Eurasian) plate. On the south-western boundary is the passive continental margin of Oman, exhibiting large tilted crustal blocks formed during rifting of the margin of the Arabian plate and now completely buried by sediment. Thirdly, the Murray Ridge to the south-east forms a continuation of the Owen Fracture Zone separating the oceanic parts of the Indian and the Arabian plates, but is presently undergoing extension.

"Our results had been most interesting, for we had traced under the sea three great hill ranges running out from the coast in the neighbourhood of Karachi towards the west and south-west. The northernmost range runs nearly due west into the Gulf of Oman, parallel to the Baluchistan coast, while two others run as I have already mentioned+, in a south-west direction with a deep gulley between them with a depth of about 2000 fathoms, whereas the main area of the Gulf of Oman has a depth of only some 1850 fathoms."

+... to the more northerly ridge we gave the name of the Murray Ridge ..."

"... the depth [of the seafloor across the Oman continental margin] varied with amazing rapidity"

Extracts from the Seymour-Sewell diaries of the John Murray-Mabahiss expedition 1933-34 (Rice, 1983).

THE EVOLUTION OF THE GULF OF ADEN AND RED SEA IN SPACE AND TIME

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ABSTRACT

The evolution of the Gulf of Aden and Red Sea is reviewed in the l'ght of the 1933 John Murray Expedition and modern concepts of plate tectonics and propagati-g rifts.

The John Murray Expedition was notable for the discovery of (i) the remarkable symmetry of the Carlsberg Ridge, (ii) the oceanic composition of the rocks dredged and (iii) the SW-NE structures in the Gulf of Aden, the main features of fracture zones being described. The connection of the East African rifts, Gulf of Aden, Carlsberg and mid-Atlantic rifts was also recognised - a major step towards the appreciation of plate boundaries.

The plate setting of the Gulf of Aden, Red Sea and Gulfs of Suez and Aqaba is described. Three stages of evolution are recognised, (i) the propagation of a crack about 40 My ago from the Arabian Sea westwards through the Gulf of Aden and northwards through the Red Sea terminating north of the present Gulf of Suez and forming an early rift system, (ii) major reactivation and separation of the Gulf of Aden and Red Sea beginning about 25 My ago with the propagation of a new NNE crack forming the early Gulf of Aqaba/Dead Sea system along which 62km of shear took place, and (iii) further reactivation and separation of the Gulf of Aden and Red Sea starting about 5My ago with a further 45km shear movement along the Aqaba/Dead Sea rift. The Gulf of Aden and Red Sea evolved in response to NE-SW tensional stresses, and for each phase the crack propagated westwards through the Gulf of Aden and northwards through the Red Sea, the oldest and widest parts being in the eastern Gulf of Aden.

SUPERFICIAL MINERAL RESOURCES OF THE INDIAN OCEAN

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ABSTRACT

The sea floor of the Indian Ocean and the continental margins bordering the ocean are covered by a wide variety of terrigenous, biogenous and anthigenic mineral deposits.

The humid tropical climate of some of the land areas bordering the Indian Ocean accelerates weathering of the source rocks. This coupled with the large river runoff and wave and current conditions favour the formation of a variety of placer deposits. The beach and offshore placer deposits of the Indian Ocean may be some of the largest in the world.

The biogenous deposits in the Indian Ocean comprise the corals on shallow banks and on the continental shelves and the oozes in the deep sea. A study of these deposits is needed to acquire a better understanding of their formation, turnover, regeneration rates and sustainable yields.

The anthigenic deposits in the Indian Ocean comprise the phosphorites and the polymetallic nodules. Occurrences of phosphorite deposits have been found both along continental margins (South Africa and Western India) and around seamounts (Eastern and Western Indian Ocean). The continental margins of South Africa, East Africa, Southern Arabia, Western India and the Andamans are marked by strong upwelling and provide non-depositional environments which are conducive to the formation of phosphorite.

The polymetallic nodules in the Indian Ocean cover an area of 10-15 $.10^6$ km^2 and the resources are estimated to be about 1.5 $.10^{11}$ tonnes. A study of over 900 chemical analyses from 350 stations shows that the deposits in most of the basins are submarginal; in the Central Indian Ocean they are paramarginal (Ni + Cu + Co >2.47% and concentrations >5kg.m^{-2}).

Most of the exploration for minerals even on the continental margins of the Indian Ocean has been carried out by the developed countries from outside the region and little work has been carried out by the countries bordering the Indian Ocean. The development of capabilities within the region for exploration of the mineral resources should receive a high priority. The exploration of the mineral resources of the Indian Ocean would not only add to an inventory of the resources in the world oceans but also lead to a greater understanding of the formation of marine mineral deposits.

RED SEA MINING: A NEW ERA

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ABSTRACT

Along the median line of the Red Sea runs a very deep fault which acts as a major channel connecting the mantle with the crust. Hydrothermal mineralised solutions migrate up through the fault towards the surface. Hot brine pools form at the intersection of the major fault with the transform faults.

Since the discovery of these hot brines in the Red Sea over 20 years ago, a systematic exploration of the Red Sea has been carried out by many different groups. More than 15 deeps, were found, some of them lined with metalliferous muds. It was established that the muds of the Atlantis II Deep offer the best economic potential.

In 1974, Saudi Arabia and Sudan signed an agreement which set up the Saudi-Sudanese Red Sea Commission. Both countries agreed to divide the Red Sea area between latitude 18°N and 24°N into three zones. Each country has exclusive sovereign rights to the area nearest to its coastline, both have common but equal rights to the common zone where the depth exceeds 1000m.

During its first three years, the Red Sea CCommission has carried out a very comprehensive programme, involving surveying and exploration by airborne magnetics, shipborne gravity and seismic reflection surveys; physical oceanography was studied, and environmental research has been carried out on reef ecology, biological baselines, toxicity tests and behaviour of tailing discharge.

A pre-pilot Mining Test (PPMT) was carried out successfully during the spring months of 1979. The main target was to mine the metalliferous muds in depths exceeding 2000m and pump the diluted mud up to the surface for flotation onboard the mining vessel. The PPMT established the technical feasibility and environmental acceptability of Red Sea metalliferous muds mining so the next phase is to perform a Pilot Mining Operation (PMO).

The scale of the PMO will be ten times larger than the PPMT, and about one tenth of the future Commercial Mining (CM). The Pilot Mining Operation will improve technical experience and help in the design of the equipment needed for eventual commercial mining.

IMPACTS OF MINING ON CENTRAL RED SEA ENVIRONMENT

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ABSTRACT

The mining of the Atlantis II deep will result in a significant input of heavy metals into the Red Sea. Quantities of dissolved compounds will result in major changes in the trace element composition of the water masses. The dissolution of minerals resulting in the release of toxic chemicals including zinc, copper, cadmium and mercury remains of fundamental concern which will require further study.

The regime for discharge of tailings must be designed to minimise the dispersal of the solids, and also the fluids together with their dissolved leached constituents. If the discharges occur deep down the waste will be confined to the deep waters in the central graben, where the absence of significant upwelling combined with the natural chemical processes of removal via sorption will restrict the dispersal of the toxic substances.

Research on biological activity within the epipelagic and mesopelagic zones has led to the recommendation that all wastes should be restricted to the bottom water below 1100 metres. A consideration of the likely effect upon benthos and water chemistry has demonstrated that tailings will have to be confined to the central graben, in order to protect local fisheries and the vulnerable reef and seabed environments of the coasts and the Central Trough. However, discharge of the tailings at depth would also limit the transmission of the tailing pollutants through the food web. It should, therefore, confine the effects of mining to a limited portion of the Red Sea biota. The shallower release of tailings within the zone of diel migration by plankton and nekton would expose a large community of organisms to the pollutants and result in the vertical transport of heavy metals up the water column.

BIOLOGICAL OCEANOGRAPHY OF THE RED SEA OCEANIC SYSTEM

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ABSTRACT

1. In 1977, 1979 and 1980-81, investigations were carried out which were aimed at evaluating the potential risks from mining metalliferous muds precipitated in the Atlantis II Deep of the central Red Sea. This environmental research was initiated by the Saudi Sudanese Red Sea Joint Commission in order to avoid any danger for the Red Sea ecosystem. The broad environmental research programme covered coherent studies in physical, chemical, biological, and geological oceanography as well as toxicological investigations in the oceanic and in reef zones. We summarise the results from our biological field studies in the open sea.

OIL POLLUTION IN THE RED SEA - ENVIRONMENTAL MONITORING OF AN OILFIELD IN A CORAL AREA, GULF OF SUEZ

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ABSTRACT

The Red Sea is rapidly developing as one of the world's largest offshore oil production areas. It also comprises a wide range of tropical marine habitats, many of which are internationally recognised for their conservation, scientific, economic or recreational value. Past oil production, refining and transport have resulted in chronic pollution of some areas, and environmental programmes to protect new areas of development from pollution damage are assuming increasing importance.

At the initiative of an Egyptian oil company operating in the Gulf of Suez, an environmental protection and management scheme has been prepared for a new offshore oilfield and marine terminal at Ras Budran. This paper describes the form of the scheme and the results of its component environmental surveys.

The development area comprises rich and diverse marine communities of fringing coral reefs, nearshore lagoons, seagrass beds, sandy beaches and fine sediments offshore. A baseline survey was designed following detailed discussion of the scope of the development with the company and a preliminary site visit, and the fieldwork was completed in October 1980. On the basis of the findings of the survey, a series of recommendations was made to the company, aimed at reducing environmental impacts during construction and operation to a minimum and acceptable level. These were subsequently implemented and the results of a post-construction survey in February 1983 are reported which show that environmental damage to the nearshore habitats during the construction phase had been relatively small and localised. Recently, the biological information obtained from the two surveys has also been incorporated into oil spill contingency plans.

THE ECOLOGICAL RESEARCH ON CORAL REEFS OF THE RED SEA

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ABSTRACT

Klunzinger (1872) characterised the zonation of the coral reef near Al-Qusayr, Egypt with the help of indicator species. He identified a Stylophora-zone among other zones and established the first biophysiographic zonation of a coral reef which is, in many respects, still valid today. Since then, ecological research work on coral reefs has developed to its present understanding of one of the most complicated and densely populated ecosystems on Earth.

Much biological and ecological work has been done on the coral reefs along the Red Sea coasts. This is not surprising, because the Red Sea is the coral sea closest to Europe and has attracted the interest of European investigators for over 200 years. With few exceptions, this interest has been concentrated on a limited number of coastal sites: Jeddah, Al-Qunfudhah, Al-Luhayyah and Al-Mukha along the east coast, and Assab, Mesewa, Al-Qusayr and As-Suways along the west coast. Although the early coral reef workers were primarily interested in collecting animals, they also made some informal observations on the habitats of the species they collected. However, full ecological statements were rare - with the exception of those of Klunzinger (1872).

Research centres have been established and active programmes continue on the Sudanese coast at Dungunab (since 1907), Sawakin and Bur Sudan (since 1963 when the first ecological investigations on Bur Sudan coral reefs occurred (Mergner, 1967), and in 1974 and 1976 respectively the biological stations at Sawakin and Bur Sudan were established), on the Egyptian coast at Al-Ghardaqa (since 1930), on the Sinai coast at Eilat (since 1968) and on the Jordan coast at Al-Aqabah (since 1972). New research centres continue to open, such as along the east coast at Jeddah.

The special interest of the ecology of Red Sea coral reefs is that it encompasses a broad range of problems: the influence of abiotic factors on the community structure, distribution and species diversity of corals and the biophysiographic zonation of coral reefs, the interspecific and intergeneric competition of corals and other sessile animals and algae within the reef, the qualitative and quantitative analysis of the coral assemblages of different reef zones and the ecology of several important reef animal groups (sponges, molluscs, echinoderms, fishes, etc.). Closely connected with these problems is an interest in the behaviour of reef animals, and finally reef ecologists cannot ignore the urgency of the problems associated with the pollution and conservation of coral reefs in the Red Sea.

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THE DISTRIBUTION OF REEF-CORALS IN THE INDIAN OCEAN WITH A HISTORICAL REVIEW OF ITS INVESTIGATION

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Hessisches Landesmuseum Darmstadt, F.R.G.

ABSTRACT

The investigation of corals started with Forskål in the Red Sea in 1775. The knowledge of the corals of the Indian Ocean was acquired and enlarged during many expeditions. In 1954, Wells compiled a table showing the distribution of Indo-Pacific hermatypic coral genera, and presented the data on a map of the Indo-Pacific, including ten locations for the Indian Ocean.

More recent expeditions have continued to enlarge our knowledge and in 1971 Rosen again compiled a similar table, but only for the Indian Ocean. Rosen plotted the numbers of genera found at 57 locations on a map. In the 12 years since Rosen's paper much more information has been published, and so the map has been updated. The plot of numbers of genera at 53 locations shows a belt of high diversity extending from South Mozambique to the Maldives including Madagascar, Mauritius, the Seychelles and the Chagos Archipelago. Further centres occur in the Red Sea, including the Gulf of Aqaba, and the area near Phuket in Thailand.

A comparison of the corals of the Indian and Pacific Oceans shows that a great number of coral genera is common to both oceans, so there is a uniform Indo-Pacific Reef Region which contrasts with the Atlantic Reef Region. The Indian Ocean has 11 endemic coral genera.

Some of the ecological factors controlling the horizontal distribution of the corals are temperature, salinity, currents and sedimentation. But hostile animals and pollution are of influence. Finally, the time which has been spent investigating reefs and collecting corals can seriously limit our knowledge of the distribution of coral genera, and introduces an element of uncertainty into our interpretations of the data.

The main aim of this report is to examine the latest information on the distribution of reef coral genera in the Indian Ocean and adjacent waters, supplemented with data from my own collections of the Gulf of Suez, the Red Sea and the Indian Ocean to the Strait of Malacca made during the 2nd 'XARIFA' Expedition 1957-58, led by Dr. Hans Hass (Scheer, 1971).

This paper is dedicated to Prof.Dr. Hans Hass, the pioneer of underwater research and leader of the 'XARIFA' Expeditions, for his 65th birthday.

THE SUEZ CANAL AS A HABITAT AND PATHWAY FOR MARINE ALGAE AND SEAGRASSES

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ABSTRACT

The Suez Canal supports a diversified benthic algal flora; 133 species of benthic algae are now known from the Canal, as compared with only 24 in 1924.

The vertical and horizontal distribution of algae is considered in relation to hydrographic factors. The algae display zonation and 3-4 algal belts are distinguished on the Canal banks on buoys and pier supports. Associated fauna include Balanus amphitrite and Brachidontes variabilis, together with various hydroids, sponges, ascidians, asteroids, ophiuroids and crustaceans. Merceriella enigmatica thrives well in brackish water habitats.

The algal flora in the Bitter Lakes resembles that in the Red Sea. The number of Red Sea species decreases from Suez to Port Said in the littoral zone. On the other hand, bottom algae predominantly belong to Red Sea flora.

Thirty of the species of algae found belong to the Indo-Pacific flora; half of these are new records to the Canal. Several of these Indo-Pacific algae have recently become established in the Eastern Mediterranean, whereas only two of the Mediterranean macro-algal flora (viz. Caulerpa prolifera and Halopteris scoparia) have been found in the Gulf of Suez.

Two seagrasses, Halophila ovalis and Thalassia hemprichii, are recorded for the first time in the Canal. Only Halophila stipulacea has found its way into the Mediterranean via the Suez Canal, but none of the Mediterranean seagrasses is found either in the Canal or in the Red Sea.

DISTRIBUTION AND ECOLOGY OF SEAGRASS COMMUNITIES IN THE WESTERN INDIAN OCEAN

A.A. Aleem

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INTRODUCTION

Since the classical works of Ascherson (1871) and Ostenfeld (1927), little work has been made on the distribution and ecology of tropical marine phanerogams, particularly in the Indian Ocean. MacNae and Kalk (1958) described the distribution of seagrasses at Inhaca Island, Mozambique. Pichon (1964) and Mauge (1967) studied the fauna in the seagrassbeds of the Tulier Reef, Madagascar, and Taylor (1971) and Taylor and Lewis (1968) studied both the flora and fauna of seagrassbeds at Mahé, in the Seychelles Islands. It is clear from the works of Den Hartog (1970) Stoddart (1973) and McRoy and Helfferich (1977) that there are few recent botanical studies on Indian Ocean seagrasses, and Dawes (1981) was unable to quote any quantitative studies on the standing stocks of seagrasses from the Indian Ocean.

During the International Indian Ocean Expedition, the author had the opportunity to join "Cruise 9" of the R/V 'ANTON BRUUN' during November-December 1964. This cruise was scheduled to study shallow water biology around islands in the Indian Ocean. Algae and seagrasses were studied particularly in Mombasa (Kenya), but also on the Islands of Latham, Aldabra, Comores, Farquhar, Amirante and the Seychelles (Fig.1). Results of this survey are presented here and can be compared with previous observations made in the Red Sea and in the Eastern Mediterranean (Aleem, 1955, 1962, 1979, 1980).

DEEP-WATER BIOLOGICAL PROCESSES IN THE NORTHWEST REGION OF THE INDIAN OCEAN

M.V. Angel

Institute of Oceanographic Sciences (N.E.R.C.),
Wormley, Godalming, Surrey, U.K.

SUMMARY

As a result of the initial studies conducted during the John Murray Expedition with the follow-up of the International Indian Ocean Expedition and the continuing work by coastal states in the region, much of the basic descriptive groundwork on the biological systems of the Indian Ocean has been completed. Some gaps still exist, for example in the knowledge of deep-living pelagic and benthic communities. However, as the dominating physical processes in the region become better known, the Indian Ocean is becoming an attractive region in which to examine the linking of space/time relationships between physical and biological processes. The conceptual framework has been provided by Haury, McGowan and Wiebe (1978), and this framework has been examined in the context of the Indian Ocean system and of recent developments in biological oceanography.

At mega- and macro-scales, the region offers a wide variety of phenomena whose biological implications need to be explored. These range from the reversing annual monsoon cycle, the major zone of almost negligible oxygen concentration, the unique deep water characteristics of the Red Sea, and the influence of these phenomena on sedimentation into the deep ocean. The adaptation of life history characteristics to the unusual physical regimes and the build up of long time series of short life-cycle organisms are suggested as potentially profitable areas of research.

At meso-scales, once again the region provides a range of types of features, which with the development of the ability to carry out real-time synoptic surveys of the surface temperature field by remote-sensing, could provide nearly ideal conditions for studying the influence of meso-scale eddies on biological systems. The rapid development in the understanding of the physics of these eddies (Robinson, 1983), is providing an excellent basis on which to develop biological studies.

At finer scales down to the scale of the ambit of the individual organism, there is still considerable uncertainty about the chemico-physical characteristics of the environment, and how much the individual organism is able to exploit or is at the mercy of such small-scale processes. There are extreme problems in measurement at very fine scales which may continue to preclude rapid development in the understanding of the interrelationships dominating biological interactions at such scales. Yet it is at these scales that biologists with limited logistic resources can contribute extensively through careful and thorough observational studies.

BIOLOGICAL INDICATIONS OF ACTIVE UPWELLING IN THE NORTHWESTERN INDIAN OCEAN IN 1964 AND 1979, AND A COMPARISON WITH PERU AND NORTHWEST AFRICA

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ABSTRACT

When surface properties of the northwestern Indian Ocean observed during the southwest monsoon of 1964 (R.R.S. 'DISCOVERY') are compared with those of 1979 (R.V. 'ISELIN'), the area of upwelling around Ras Hafun (near 10°N) showed the clearest similarity in the two years. The highest surface concentration of chlorophyll <u>a</u> between Mombasa (4°S) and Cabo Guardafui (12°N) occurred near Ras Hafun in both years and was between 4 and 5 mg m^{-3}. Sea-surface temperatures around Ras Hafun were lower than elsewhere along the coast, and surface nitrate was higher. The abundance of the copepod <u>Calanoides</u> <u>carinatus</u> was >100 m^{-3} there and near 5°N in both years. The age-structure of this dominant copepod suggests active reproduction in both years.

Major dissimilarities between 1964 and 1979 were observed in the vertical distribution of temperature and nitrate near 5°N, which suggested that upwelling there in August 1964 was less intense than in July 1979. The intensity of upwelling near 5°N probably reached a peak in July both years, implying a relatively stable annual cycle for the upwellings off Somalia. The relationship of primary productivity and chlorophyll <u>a</u> observed off Somalia is very similar to that observed off Peru, and standing stocks of net zooplankton are also similar, but both are quite different from northwestern Africa. Perhaps the most striking difference, however, is the areal of extent of upwelling off Somalia which is considerably larger than that of the other two upwelling areas.

PLANKTON OF THE RED SEA AND THE ARABIAN GULF

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ABSTRACT

Though presenting some similarities, the Red Sea and the Arabian Gulf differ much in their configuration, hydrography and plankton populations. Both the recruitment of pelagic organisms into the Red Sea from the Gulf of Aden and their subsequent northward diffusion within the Red Sea basin, and the fluctuations in biomass and primary productivity are governed by the circulation pattern, which is itself dependent on the periodical Monsoon wind system. The species diversity of Red Sea plankton is reduced relative to the Indian Ocean, but much higher than that of the Arabian Gulf. An indigenous assemblage of dinoflagellates, tintinnids, copepods and chaetognath species, however, appears to be well adapted to the conditions of this sea. Their wide distributions do not depend on the seasonal inflow. As a rule both the primary productivity and the zooplankton biomass are higher during the NE monsoon. The southern Red Sea is more productive than the northern with the two zones being separated by a low-productivity discontinuity zone at about 20° to 25°N, which is the zone of wind convergence in summer. More than 95% of the zooplankton biomass occurs in the upper 1000m and several endemic species have been reported.

The Arabian Gulf is a vast, relatively shallow lagoon connected to the Gulf of Oman through the narrow strait of Hormuz. Circulation is anti-clockwise. Along the Iranian coast salinity rises from 36.6‰ near the strait to 40.6‰ in the NE Gulf and even higher along the Arabian coast. The Indian Ocean bathypelagic species as well as the dinoflagellate "Schattenarten" are completely missing from the Gulf. The species diversity is much poorer than that of either the Gulf of Oman or the Red Sea. An indigenous community, however, has developed which at first sight appears to be uniformly distributed especially along the Iranian coast, which is dominated by copepods and myodocopid ostracods. Some horizontal zonation is observable. Both nutrient and biomass concentrations are higher in mid-basin than in coastal waters. The Shatt-el-Arab to Kuwait area where estuarine components are not uncommon, and cladocerans replace ostracods in importance, is more productive and more diversified than the Trucial coast.

PHYTOPLANKTON BIOMASS AND PRIMARY PRODUCTIVITY
OF THE SOUTH-EASTERN MEDITERRANEAN

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ABSTRACT

The quantitative distribution of chlorophyll a standing crop and primary productivity of the south-eastern Mediterranean waters off the Egyptian coast were studied during four seasons in 1982. The average concentrations of chlorophyll a varied between 73.2 $mg.m^{-2}$ in winter and 7.1 $mg.m^{-2}$ in summer, the annual mean being 33.3 $mg.m^{-2}$. The average rate of carbon fixation varied between 4.82 $mg.C.m^{-2}.h^{-1}$ in spring and 35.68 $mg.C.m^{-2}.h^{-1}$ in autumn. The average value of ^{14}C primary productivity integrated for the euphotic zone in the study area amounted to 0.15 $g.C.m^{-2}.h^{-1}$. In both the neritic and oceanic waters the nano- and pico-plankton fractions formed the major fraction of both chlorophyll standing crop and primary productivity. Vertical profiles at the offshore stations indicated the presence of a deep chlorophyll maximum at depths 70-150m. The results are discussed and compared with the conditions which prevailed prior to the building of the Aswan High Dam.

FISHERY RESOURCES IN THE NORTH ARABIAN SEA AND ADJACENT WATERS

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INTRODUCTION

The Arabian Sea has drawn the attention of oceanographers and marine biologists because of its unique oceanographic phenomena. The reported upwellings and related high primary production off southwest Arabia, Somalia and the Malabar coast of India, have led to high expectation in terms of harvestable fish resources (Cushing, 1971, 1971a, 1973; Gulland, 1971; FAO/IPFC, 1967).

Schaefer (FAO/IPFC, 1967) had estimated that the potential yield of the resources off southern Arabia, the Gulf of Aden and Somalia would be of the same order as that of the anchovy fisheries in Peru, viz. around 10 million tonnes.

Subrahmanyan (as reported in Gulland, 1971) estimated the potential of pelagic fish off the west coast of India at 1,119,000 tonnes based on a comparison with the North Sea, while Shomura put it at 500,000 tonnes. Shomura (Gulland, 1971) estimated a potential of demersal fish of 1,430,000 tonnes for India and Pakistan, and an additional 800-850 thousand tonnes for Somalia, the People's Democratic Republic of Yemen and Oman. The total, pelagic and demersal production for the Arabian Sea was put at around 4 million tonnes based on Cushing's calculations. The above estimates were all very rough and can now be replaced by better ores for practically the entire area.

The rapid developments in stock assessment by acoustic methods, in particular the echo integrator in the late sixties, made it possible to survey large areas in a relatively short time span with one large vessel. A UNDP/FAO project aiming at assessing the resources off southwest India was subcontracted to the Institute of Marine Research in Bergen, Norway, and the R/V 'RASTRELLIGER', built in Norway, became the flagship of the UNDP/FAO fleet of research vessels. FAO, through the Indian Ocean Programme, later entered into a trust fund agreement with NORAD for the construction and operation of the R/V 'DR. FRIDTJOF NANSEN', an improved version of the 'RASTRELLIGER', and equipped with all then available acoustic instruments for resource surveys. A plan for a two-year survey of the waters from Pakistan to northern Kenya was executed in 1975 and 1976, with an extension under a bilateral agreement for the first six months of 1977 in Pakistan. The survey was very successful. The existence of a large biomass of fish was confirmed, however the bulk of this biomass consisted of mesopelagic fish, a resource suitable for the production of fishmeal, of which the economical feasibility of harvesting is as yet unknown.

In 1979 the R/V 'DR FRIDTJOF NANSEN' returned to the Gulfs of Oman and Aden to study further the resources of mesopelagic fish, and in 1981 a similar survey was made followed by very short surveys of the waters off Djibouti and the Gulf of Suez. In 1983, the 'DR FRIDTJOF NANSEN', funded by NORAD and a global UNDP/FAO project, returned once again to the Arabian Sea for a longer term programme. The harvestability of mesopelagic fish was tested with success in the Gulf of Oman in January/February. The other resources of Oman were assessed in March. After a short survey in the Maldives in August, the first of its kind in that country, the vessel will proceed to Pakistan and Iran to start another series of surveys in that area, followed by Oman and the Gulf of Aden.

The estimates of standing biomass, and the potential yields derived therefrom, obtained through all these surveys and other assessments including a few examples of classical stock assessments, will be compared with actual landings, as reported in the FAO Statistical Yearbook (FAO, 1983) to assess sustainable levels of exploitation and the possibilities for development. Attention will also be paid to the relationship between climatic variability in oceanographic phenomena and fluctuations in the abundance of living resources, in particular tuna.

This review includes the Arabian Sea from the Maldives to Somalia, the Gulfs between Iran and the Arabian peninsula, the Gulf of Aden and to a limited extent the Red Sea. The fish resources will be discussed by major surveys or areas, while tunas, crustaceans and cephalopods will be dealt with separately. Mesopelagic fish resources were described by Gjøsaeter (1984).

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MESOPELAGIC FISH, A LARGE POTENTIAL RESOURCE IN THE ARABIAN SEA

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ABSTRACT

The mesopelagic fish fauna in the Arabian Sea was studied on cruises with R/V 'DR. FRIDTJOF NANSEN' conducted during the period 1975-1983. Abundances were estimated using 38kHz echo-sounders and electronic integrators. The echorecordings were also used to study behaviour. Samples of the fish were collected using commercial sized pelagic trawls.

During daytime the mesopelagic fish were found in a layer between 250-350m depth. In areas with high concentrations of Benthosema pterotum an additional very dense layer was usually bound at depths between 150-200m. During night-time, most of the fish are found in the upper 100m, but usually some remain at deep waters (200-350m).

The total abundance of mesopelagic fish in the Northern and Western Arabian Sea is estimated to be about 100.10^6 tonnes. In the Gulf of Oman which was surveyed eight times, the estimated biomass ranged between $6\text{-}20.10^6$ tonnes.

Using a trawl with an opening of about $750m^2$ the mean catch rate in the shallowest daytime layer was about 5 $tonnes.h^{-1}$. The highest catch rate obtained was about 100 $tonnes.h^{-1}$. The catch rates from the deeper layers were low.

The most abundant fish, B. pterotum, has a fast growth rate and reaches a length of 4cm in about 6 months. At this stage they spawn and most fish probably die after spawning.

ANNEX XII

LIST OF POSTERS

Hilaly, N., Esen, I.I. and Gopalakrishnan, T.C.
Thermal pollution in the Arabian Gulf: a case study.

Ghobashy, Prof. Dr. Abdel Fattah A.
The fouling organisms in the Damietta Estuary.

Fouda, Moustafa M., Saleh, Moustafa A., Saleh, Magdy A. and Saleh, Mahmoud A.
Impact of oil pollution on the coastal biota of the Egyptian Red Sea and the urgency for conservation.

Uysal, H. and Tuncer, S.
Accumulation of some heavy metals (Cu, Mn, Zn, Fe, Cd, Hg) in certain organs and tissues of scad (*Trachurus trachurus* L.) and anchovy (*Engraulis oncrasicholus* L.) in the Bay of Izmir.

Tuncer, S. and Uysal, H.
The distribution of total mercury in sediment samples of Izmir Bay and its accumulation in sole (*Solea vulgaris*).

Soyupak, S., Gökcay, C.F. and Ozhan, E.
Assessment of physical, chemical, biological and hydrodynamic characteristics of near field marine environment at a future nuclear powerplant to be sited on the East Mediterranean Coast.

Gökcay, C.F., Soyupak, S and Ozhan, E.
An initial assessment of possible fish entrainment at a future nuclear power plant to be sited on the East Mediterranean Coast.

Murty, T.S. and M.I. El-Sabh
Storm surges and tides in the Arabian Sea.

Moussa, A.A., Moussa, K.A. and El-Mamoney, M.H.
Texture of sediments from the intertidal zone along the Egyptian Red Sea Coast.

Beltagy, A.I.
Geochemistry of some North Red Sea sediments.

Hanna, R.G.M.
Chemical study of some Red Sea fishes: Approximate composition.

Brand, A.R.
Marine and coastal research studies by the University of Liverpool.

Aleem, A.A.
Distribution and ecology of seagrass communities in the western Indian Ocean.

Halim, Y.
Dinoflagellates of the Arab Gulf.

Thiel, H.
Environmental studies in the Atlantis II-Deep Metalliferous Sediment Development Programme.

Stanley, Simon and Edwards, A.
Environmental studies at Mina Al Sahl, Sultanate of Oman.

Edwards, A.
An evaporative - diffusive model of the salt balance of an Abu Dhabi lagoon.

Vine, F.
Geological evolution of the north western Indian Ocean.

ANNEX XIII

PROGRAMME OF SPEAKERS AND TITLES

SATURDAY, 3RD SEPTEMBER 1983

Opening Session

1030

INTRODUCTION - Prof. S.K.El-Wakeel

WELCOMING ADDRESS - President of the University of Alexandria,
Prof. Dr. Mahmooud El-Hadary
Governor of Alexandria, H.E.Mr. Mohamed F.Mo'az
Prof. A.S.Shalaby, Dean Faculty of Science.

ADDRESSES President of the Egyptian Academy of Scientific Research and Technology - given by the Vice President, Prof. Dr. A.A.Latif.

U.K. Representative
Dr. M.V.Angel.

UNESCO Representative
Dr. Dale Krause

IOC Representative
Dr. S. Morcos.

1130 RECEPTION by University of Alexandria

1200 Professor Hussein Faouzi, Expedition Biologist
Reminiscences of the John Murray Expedition.

First Session

HISTORICAL PERSPECTIVES

Chairman: Dr. A.L.Rice (U.K.)
Co-Chairman: Professor A.A.Aleem (Egypt)

1430-1500 Sir George Deacon, FRS (U.K.)
Scientific results of the John Murray Expedition
(Paper read by Dr. A.L.Rice)

1500-1530 Dr. S. Morcos (Egypt)
The Egyptian Expedition to the Red Sea, 1934-35.

1530-1600 Professor Warren S. Wooster (U.S.A.)
The International Indian Ocean Expedition.

1600-1630 Break

1630-1700 Professor A.A.Aleem and Dr. S.A.Morcos (Egypt)
MABAHISS/John Murray Expedition versus IIOE in retrospect

1700-1730 Professor S.K.El-Wakeel (Egypt)
The development of marine science in Egypt.

SUNDAY, 4TH SEPTEMBER 1984

Morning Session

PHYSICAL OCEANOGRAPHY AND CIRCULATION

Chairman: Dr. J.C.Swallow (U.K.)
Co-Chairman: Professor S.H.Sharaf El-Din (Egypt)

0900–0945 Dr J.C.Swallow (U.K.)
Physical oceanography of the Indian Ocean

0945–1010 Dr. Michèle Fieux (France)
Marine climatology and near-surface circulation of the western Indian Ocean.

1010–1035 Dr Pascale Delecluse (France)
Jets and eddies in the western Indian Ocean

1035–1105 Break

1105–1130 Dr.G.S.Quraishee (India)
The John Murray Ridge and its influence on circulation in the N.E.Arabian Sea

1130–1155 Dr. M.Luther and Professor J.J.O'Brien (U.S.A.)
Modelling of the seasonal circulation in the Arabian basin

1155–1220 Dr. Sharon Smith (U.S.A.)
Biological indications of active upwelling in the northwest Indian Ocean in 1964 and 1979.

1220–1415 Lunch

Afternoon Session

CHEMICAL OCEANOGRAPHY AND POLLUTION

Chairman: Dr. M.V.Angel (U.K.)
Co-Chairman: Dr.M.Behbehani (Kuwait)

1415–1440 Dr R.Sen Gupta and Dr. S.W.A. Naqvi (India)
Chemical oceanography of the Indian Ocean, north of the equator. (summary read by Dr. S.A.Morcos).

1440–1505 Dr. M. Behbehani (Kuwait)
Oil pollution in the sea area of ROPME states with special reference to recent incidents.

1505–1530 Dr S.A.Morcos (Egypt) and Dr. A. Poisson (France)
Some aspects of geobiochemical cycles in the Red Sea.

1530–1600 Break

1600–1630 Dr. Scott Fowler, Dr. Huynh-Hgoc and Dr.R.Fukai (Monaco)
Trace metals in coastal waters from the Gulf and Western Arabian Sea.

1630–1700 Dr. B. Dicks (U.K.)
Oil pollution in the Red Sea – environmental monitoring of an oil-field in a coral area, Gulf of Suez.

DEEP SEA BIOLOGY

1700–1745 Dr. M.V.Angel (U.K.)
Biological processes in the northwest region of the Indian Ocean.

MONDAY, 5TH SEPTEMBER 1983

Morning Session

DEEP SEA BIOLOGY

Chairman: Dr. M.V.Angel (U.K.)
Co-Chairman: Dr. Y.Halim (Egypt)

0900–0925 Dr. H.Thiel and Dr. H.Weikert (F.R.G.)
Biological oceanography of the Red Sea oceanic system.

0925–0950 Professor Y.Halim (Egypt)
Plankton of the Red Sea and Arabian Gulf.

SHALLOW-WATER BIOLOGY

0950–1035 Professor H.Mergner (F.R.G.)
The ecological research on coral reefs of the Red Sea

1035–1100 Professor N. Dowidar (Egypt)
Phytoplankton populations and primary production in the S.E.Mediterranean.

1100–1130 Break

1130–1155 Dr. G. Scheer (F.R.G.)
The coral fauna of the Indian Ocean with an historical review of its investigation.

1155–1220 Professor A.A.Aleem (Egypt)
The Suez Canal as a habitat and pathway for marine algae and seagrasses.

1220–1615 Lunch and Visit to MABAHISS

Afternoon Session

LIVING RESOURCES

1615–1700 Mr. Siebren C. Venema (FAO/Rome)
Fishery resources in the North Arabian Sea and adjacent waters.

1700–1725 Professor J. Gjøsaeter (Norway)
Mesopelagic fish, a large potential resource in the Arabian Sea.

1725-1750 Dr.S.M.Haq (IOC) and Dr. J.A.Khan (Pakistan)
Factors affecting the distribution and abundance of zooplankton and ichthyoplankton in the Northern Arabian Sea.

TUESDAY, 6TH SEPTEMBER 1983

Morning Session

MARINE GEOLOGY AND GEOPHYSICS

Chairman: Professor F.Vine, FRS (U.K.)
Co-Chairman: Professor S.K.El-Wakeel (Egypt)

0900-0945 Professor F.Vine (U.K.)
Geology and geophysics of the northwestern Indian Ocean

0945-1010 Dr.R.W.Girdler (U.K.)
The evolution of the northern Red Sea

1010-1035 Dr.R.S.White (U.K.)
Tectonics of the Gulf of Oman, northwest Indian Ocean

1033-1100 Break

NON-LIVING RESOURCES

Chairman: Dr. H.Siddiquie (India)
Co-Chairman: Professor Yousif B.Abu Gideiri (Saudi/Sudanese Red Sea Joint Commission)

1100-1145 Dr H.Siddiquie (India)
Non-living resources of the western Indian Ocean.

1145-1210 Dr. Zohair A. Nawab (Saudi/Sudanese Red Sea Joint Commission) Red Sea mining is a new era. (Read by Prof. Abu Gideiri).

1210-1235 Professor Yousif B. Abu Gideiri (Saudi/Sudanese Red Sea Joint Commission)
Environmental implication of mining in central Red Sea.

These lectures were supplemented by a film.

1235-1415 Lunch

Afternoon Session

1415-17830 Round Table Discussion on Future Research Programme in the North-Western Indian Ocean.

The full session was introduced by Dr. M.V. ANGEL and Dr. S.M.HAQ.
Further information by G.Lèger on French initiatives in the region and Dr. S.A.Morcos on UNESCO Technical Reports. After the full session the meeting divided into five Working Groups.

WEDNESDAY 7TH SEPTEMBER 1983

0900-1030	Round Table Discussion
1030-1100	Break
1100-1230	Round Table Discussion
1230-14154	Lunch
1415-1545	Round Table Discussion
1545-1615	Break
1615-1730	Round Table Discussion
1730	Closing Session

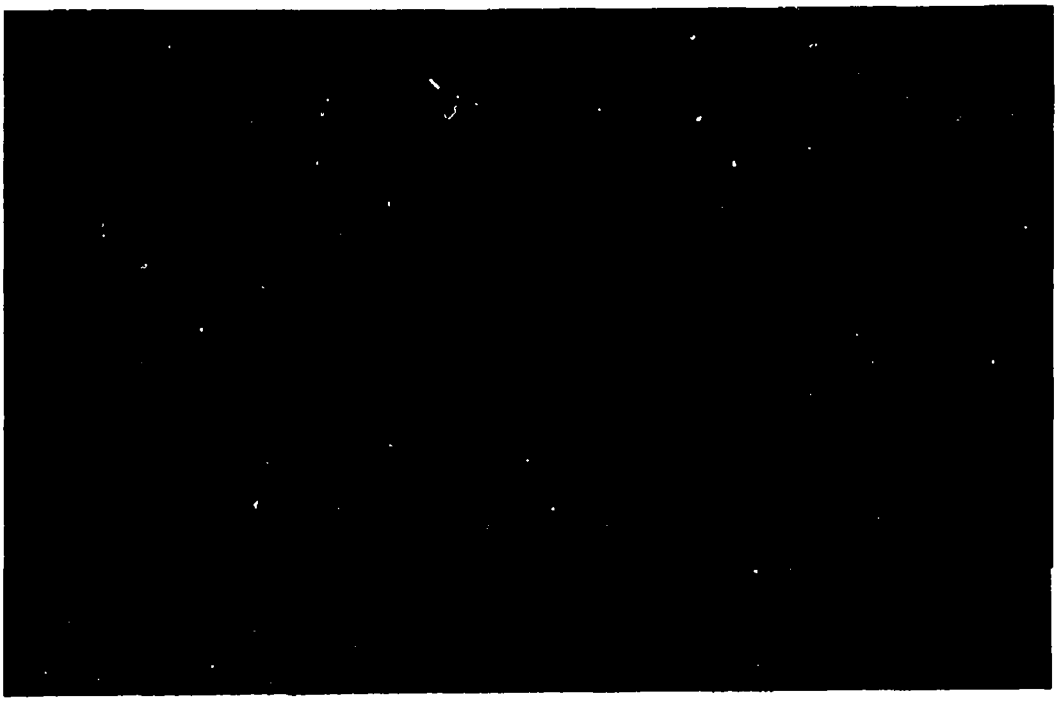

FIG. 10 - Visit of the MABAHISS/John Murray International Symposium to the R/V "MABAHISS" in the Western Harbour, Alexandria (photo by S. Morcos).

FIG. 11 - Dr. Hussein Faouzi, Marine Biologist and Medical Surgeon on R/V "MABAHISS" 1933/34, surrounded by Symposium participants (From left to right: Dr. J. Swallow, Miss (Dr.) M. Fieux, Dr. S. Morcos, Dr. H. Faouzi, Mrs. M. Swallow and Dr. S. K. El-Wakeel) (photo by S. Morcos).

ANNEX XIV

THE VISIT TO THE R/V MABAHISS

On the third day of the meeting, an opportunity was made available for the participants to visit the venerable centre of the Conference's interest, the MABAHISS (Figs.10 & 11, photos by S. Morcos). Originally built as a coaster on Tyneside, she lacked most of even the limited creature comforts to be expected in modern research vessels, and it was salutary to consider the fortitude of the John Murray Expedition scientists and crew enduring such conditions for an extended period in tropical waters. Now retired from her years in the Egyptian Customs and Coastal Patrol, she is currently being restored for action with a view to conversion as a floating museum to the history of oceanography and nautical science in the region.

UNESCO REPORTS IN MARINE SCIENCE

Title of numbers which are out of stock

No.		Year
3	Benthic ecology and sedimentation of the south Atlantic continental platform Report of the seminar organized by Unesco in Montevideo, Uruguay, 9-12 May 1978	1979
13	Seminario Latinoamericano sobre Enseñanza de la Oceanografía Informe final del Seminario organizado por la Unesco en São Paulo, Brasil, 17-20 de noviembre de 1978	1981