

# **Intergovernmental Oceanographic Commission**

Workshop report No. 7



## **Report of the Scientific Workshop to initiate planning for a co-operative investigation in the North and Central Western Indian Ocean**

Nairobi, Kenya, 25 March - 2 April 1976

organized within the International Decade of Ocean Exploration (IDOE)  
held under the sponsorship of

the Intergovernmental Oceanographic Commission (of Unesco)  
the Food and Agriculture Organization of the United Nations  
(Indian Ocean Fishery Commission)

the United Nations Educational, Scientific and Cultural Organization  
the East African Community

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

Workshop report no.7



REPORT OF THE IOC/FAO(IOFC)/UNESCO/EAC SCIENTIFIC WORKSHOP  
TO INITIATE PLANNING FOR A CO-OPERATIVE INVESTIGATION IN  
THE NORTH AND CENTRAL WESTERN INDIAN OCEAN

Nairobi, Kenya, 25 March-2 April 1976

Unesco

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<u>No.</u>	<u>Title</u>	<u>Publishing Body</u>	<u>Languages</u>
1.	CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia Report of the IDOE Workshop on; Bangkok, Thailand, 24-29 September 1973. UNDP (CCOP) 158 p.	Office of the Project Manager UNDP/CCOP c/o IDCAP Sala Santitham Bangkok 2, Thailand	English
2.	CICAR Ichthyoplankton Workshop, Mexico City, 16-27 July 1974. (Unesco Technical Paper in Marine Science, No. 20)	Division of Marine Sciences, Unesco, Place de Fontenoy, 75700 Paris, France	English Spanish
3.	Report of the IOC/GEOM/ICSSEM International Workshop on Marine Pollution in the Mediterranean, Monte Carlo, 9-14 September 1974.	IOC, Unesco, Place de Fontenoy 75700 Paris France	English French Spanish
4.	Report of the Workshop on the Phenomenon known as "El Niño", Guayaquil, Ecuador, 4-12 December 1974.	FAO 00100 - Rome Italy	English Spanish
5.	IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources, Kingston, Jamaica, 17-22 February, 1975.	IOC, Unesco, Place de Fontenoy 75700 Paris, France	English Spanish
6.	Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific, Suva, Fiji, 1-6 September 1975.	IOC, Unesco, Place de Fontenoy 75700 Paris, France	English
7.	Report of the Scientific Workshop to initiate planning for a co-operative investigation in the North and Central Western Indian Ocean, organized within the IDOE under the sponsorship of IOC/FAO(IOFC)/UNESCO/EAC, Nairobi, Kenya, 25 March - 2 April 1976.	IOC, Unesco,	Full text(English only) Extract and Recommendations: French Spanish Russian

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## I. BACKGROUND

The Intergovernmental Oceanographic Commission (IOC), during the eighth session of its Assembly, received a proposal from the delegation of Kenya calling for a Co-operative Investigation in the North and Central Western Indian Ocean. The Assembly recognized that the results of the earlier International Indian Ocean Expedition (IIOE) had indicated that the circulation and associated upwelling processes in the North and Central Western Indian Ocean are of major scientific and economic importance.

The Assembly was informed of various ongoing and planned activities in the region, particularly surveys of the living resources of the area. These surveys were to be sponsored by the United Nations Development Programme (UNDP) and managed by the Food and Agriculture Organization of the UN (FAO). It was also recognized that the countries of the East African Community (EAC) had already established a mechanism which could serve as a nucleus for broad state co-operative oceanographic investigations of the region.

The Assembly concluded that in this region the effective development of marine resources, the development of sound environmental forecasting methods, and the efficient protection of the coastal and open-ocean environment, all necessitated an improved understanding of the seasonal and long-term variability of the current system (particularly coastal currents) and of upwelling processes. The Commission therefore instructed its Secretary, jointly with the FAO (IOFC) and the EAC representatives, to investigate the ways and means by which a co-operative investigation in the area could be initiated (see IOC resolution VIII-16).

At the suggestion of FAO, the Secretary IOC decided, with the co-operation of FAO, EAC and Unesco to convene a scientific workshop to evaluate the needs for scientific studies of the region and, if this evaluation determined that such studies were warranted, to develop a programme for these studies.

A Steering Committee was formed and this met in the headquarters of the East African Marine Fisheries Research Organization (EAMFRO), in Zanzibar from 29 September to 1 October 1975. The following guidelines for the planning of the Scientific Workshop were adopted:

- (i) To maximize the scientific input from, and the interest of, the developing countries of the region, a seminar should be held, followed by a scientific workshop of about 30 persons;
- (ii) The workshop should keep in mind the following objectives -
  - a) the output of the investigation should provide the countries of the region with an improved understanding of the oceanography of the area, which they can utilize in their programme of resource investigation and development;
  - b) it is essential that the fullest possible participation of the countries of the region is ensured. To this end, it is most important that the workshop devote full attention to the needs of the countries of the region for training and for the development of the infrastructure which will be needed to implement future research.

The Steering Committee suggested that the workshop should have the following terms of reference:

- (i) to review the existing knowledge of the ocean environment in the area of investigation with special reference to the coastal environment; and to identify gaps in our knowledge which need to be filled to ensure an enhanced rational utilization of the marine resources of the region;
- (ii) to identify the requirements of present resource development programmes for oceanographic information in the area;
- (iii) to suggest scientific programmes which can be carried out
  - on a national basis with some mechanism for exchange of information and co-ordination,
  - as inter-country programmes based on regional co-operation,
  - as ventures between countries from outside and those inside the region participating in CINCHIO.
- (iv) to review the existing infrastructures and marine science capabilities of the countries of the region and to determine which programmes can be realistically carried out under present conditions;
- (v) to suggest additional programmes which can be carried out in the future if the marine science capabilities of the countries in the region are improved through intensified programmes of training and education which should be an integral part of any CINCHIO programme.

The sponsoring organizations agreed that the seminar and workshop should be held in the spring of 1976 and it met in fact from 25 March to 2 April 1976 at the Unesco Regional Office for Science and Technology for Africa in Nairobi.

## II. RECOMMENDATIONS ADOPTED BY THE WORKSHOP

### Recommendation 1

Considering the importance of informing the scientific community of the contributions presented at the Seminar,

It is recommended that the papers presented at the workshop be published as soon as possible by the Intergovernmental Oceanographic Commission of Unesco.

### Recommendation 2

Noting that many papers presented in the Seminar included bibliographies related to the CINCHIO region, which would be of great utility to those who investigate the region,

It is recommended that the IOC arrange for financial support for the micro-film copying of the bibliographies (not including those which were included in the Collected Reprints of the International Indian Ocean Expedition) and the acquisition of microfilm readers for use by interested institutions of the region.

### Recommendation 3

Considering the interest of the countries of the region in the further development of their marine science capabilities and their need for special measures to enable them to participate more effectively in CINCWIO activities,

#### It is recommended

- that the IOC, with the support of Unesco, FAO (Indian Ocean Fishery Commission) (IOFC) and the East African Community promote a meeting of the countries of the region to:
  - (i) agree on the elements of the programme recommended by this Workshop which can be carried out by the countries of the region with the support and assistance of the international scientific community, and
  - (ii) establish a joint mechanism to co-ordinate and execute these projects;
- that this mechanism (when established) set up a "Technical Advisory Group" consisting of consultants, who, because of their wide expertise and interest in the region, can provide sound scientific advice and guidance for the execution of the programme;
- that the IOC, its individual Member States and other international organizations be invited to provide financial and technical support for this "Technical Advisory Group"; and
- that the mechanism should co-ordinate these efforts of the countries of the region with those of scientific institutions outside the region which are also conducting research in support of CINCWIO.

### Recommendation 4

Recognizing that the success of the CINCWIO programme depends on the success of a series of both small-scale and large-scale oceanographic investigations which in turn require the acquisition and effective utilization of scientific equipment, the logistic support of research vessels which in some cases will be operating far from their home ports, and the exchange and rotation of scientific personnel,

#### It is recommended

- that the Member States of IOC, working through the Commission, develop and implement programmes of research for the nearshore CINCWIO region which complement those of the countries in the region,
- that they similarly develop and implement research programmes for the deep-ocean sections of the CINCWIO region and adjacent areas, and
- that they provide strong support to assist the countries of the region in developing their programmes of research and in improving their capabilities to conduct such research, and

- that the countries of the region assist in the implementation of the research conducted under this programme by, among other things, facilitating,
  - (i) the shipment into the region of scientific equipment and its transfer among participating laboratories and vessels,
  - (ii) the processing of requests for research vessel clearances,
  - (iii) arrangements for necessary logistic support for research vessels, and
  - (iv) the processing of visa applications and related formalities for scientists and technicians.

#### Recommendation 5

Recognizing that the CINCWIO Programme can benefit from, as well as contribute to, the IOC Ocean Services programmes such as the Integrated Global Ocean Station System (IGOSS) and International Oceanographic Data Exchange (IODE);

#### It is recommended that:

- the regional mechanism for CINCWIO determine the types of IGOSS and IODE oceanographic services and products which would be most useful to the CINCWIO, and that the mechanism work closely with the IOC Working Committees for IGOSS and IODE to arrange for these services and products;
- all vessels participating in CINCWIO provide for their programmes to take regular BATHY (Bathymograph) and TESAC (Temperature, Salinity, Currents) observations and to transmit these observations to shore centres in accordance with appropriate IOC operational procedures; and
- all participants in CINCWIO give special attention to the timely submission of ROSCOP forms and collected data in accordance with IOC's standard procedures for international oceanographic data exchange.

#### Recommendation 6

#### Nearshore Physical and Chemical Oceanography

#### It is recommended that:

A survey of the coastal circulation be undertaken over several years along the coast of eastern Africa from latitude 10°S to latitude 11°N.

- The work along the coasts of Tanzania and Kenya (Region I) be carried out by EAMFRO vessels and EAMFRO personnel in consultation with, and with the participation of, oceanographers from IOC Member States.
- The work along the coast of Somalia (Region II) be carried out by a Somali fisheries research vessel and Somali scientists, and that, when appropriate, Somalia invite scientists from other IOC Member States to participate in this research.
- The necessary oceanographic equipment be furnished, via IOC or by bilateral arrangements, to the participating nations in Regions I and II.



- Four wind-recording stations be installed at Obbia, Ras Mabber, Ras Hafun, and Ras Asir, possibly with the assistance of the World Meteorological Organization's Voluntary Assistance Programme (WMO/VAP).
- IOC invite its Member States to arrange for their oceanographers to assist EAMFRO in implementing its participation in CINCWIO.
- IOC arrange within the next three years for training at a suitable level in marine science of 25 nationals from the CINCWIO region, if possible at Universities of its Member States.
- Unattended temperature, pressure and current meter moorings be provided and maintained by IOC Member States to be deployed in Regions I and II.
- An Oceanographic Support Centre for CINCWIO be established;  
Such a centre is considered of vital importance to the entire programme. During the first two years of its existence, its main functions will be :
  - Co-ordination and planning of fieldwork
  - Collection of data
  - Reduction of data
  - Preliminary data analysis
  - Dissemination of information
  - Training on a technical and basic scientific level.

At an advanced stage this centre is envisaged to grow into a major facility for support of research and the training of marine scientists of the region. It is considered essential that the centre has convenient access to a major harbour facility.

- IOC assist in the establishment of national research laboratories in CINCWIO countries in which such laboratories do not exist in order to facilitate more effective participation by these countries in CINCWIO.

#### Recommendation 7

##### Deep-ocean Physical and Chemical Oceanography

It is recommended that, as a necessary complement to the proposed long-term coastal oceanographic programme, large-scale oceanographic surveys be made of the productive region south of the equator in the north-east monsoon and of the Somali current system in the south-west monsoon. Ideally, these surveys should occur within the special observing periods of the First GARP Global Experiment (FGGE), i.e. in early 1979.

#### Recommendation 8

##### Geology and Geophysics (in order of importance)

- A -

Considering the need for the countries of the CINCWIO region to increase their knowledge of their continental shelves and recognizing the need to improve the capabilities of these countries to conduct marine geology and geophysics research,

It is recommended that:

- Broad-scale geological and geophysical surveys be undertaken along the coasts of Somalia, Kenya, Tanzania and Madagascar, and
- The infrastructure of the oceanographic organizations in the CINCWIO countries encourage competent oceanographic institutions from outside the region to undertake such surveys and associated training of nationals from the CINCWIO region.

- B -

Recognizing that substantial capability already exists within the region for geological and geophysical studies on land,

It is recommended that:

- The heavy minerals research project proposed in the report be carried out by the existing institutions in the region, particularly the pilot processing plant in Dar-es-Salaam, and
- Interested developed countries provide needed laboratory equipment and overseas training for advanced experts.

- C -

Recognizing that improved knowledge of the nature of the ocean bottom in fishing areas can be used to improve the efficiency of fishing operations,

It is recommended that fishing boats and research vessels be encouraged to collect bottom samples which could serve as the basis for improved charts of bottom materials and geology.

Recommendation 9

Fisheries and Biological Oceanography (each project in this recommendation has been assigned a priority as indicated in the Table (See Annex)).

- A -

International

It is recommended that:

- 1 - A survey be made with a small or medium stern trawler within the latitudes 1°N and 8°S between November and March to estimate pelagic stocks by acoustic methods and capture; demersal stocks should also be sampled. The region of biological interest is up to about 50 miles offshore.

- 2 - A survey should be made with a large stern trawler using acoustic methods and capture in the area of the Somali current from 5°N to Cape Guardafui and into the Gulf of Aden as far as 47°E for a period of twelve months, but primarily during the S.W. monsoon and the two inter-monsoonal periods.

- B -

#### Inter-regional

##### It is recommended that:

- 3 - Exploratory surveys be made for crustacea and elasmobranchs both in shallow water (with a 10-14m vessel) and in deep water.
- 4 - The stocks of certain fishes be assessed for the purposes of further exploitation and of management. Those in the first category (i.e. to be assessed for further exploitation) are:

- (i) Shoaling pelagic species in the Zanzibar Channel;
- (ii) Tuna-like fishes off Somalia;
- (iii) Stocks exploited by artisanal fisheries off Somalia; and
- (iv) Demersal stocks in the Mauritius-Seychelles arc.

Those in the second category (i.e., management) are:

- (i) Deep water crustacea;
- (ii) Neritic lobsters;
- (iii) The multispecies stocks on the reef;
- (iv) Turtles (because of lack of enforcement of endangered species regulations in certain areas); and
- (v) Prawns (in certain areas).

- 5 - The seasonal movement of the thermocline and oxygen minimum layer be studied with respect to both demersal and pelagic fish stocks.
- 6 - The migratory patterns of tuna and tuna-like fishes be studied within the coastal and near-coastal regions.
- 7 - A survey of mangrove trees be made.

- C -

#### Local

##### It is recommended that:

- 8 - The circulation within a mangrove swamp be studied in order to understand better the migration circuits of shrimps.
- 9 - The circulation around a reef be studied in order to understand how fish and crustacea are retained there in the light of suspected upwellings.

- 10 - The seasonal distribution of brackish water within coastal waters be studied and that river flow rates be established to understand the distribution of euryhaline species.
- 11 - The distribution of fish eggs and larvae within the CINCWIO area be studied.
- 12 - A study be made of the possible relationship between dead corals and ciguatera, particularly as coral may be killed by trawling.
- 13 - A study be made of the source of clupeid poisoning in Madagascar because of the potential danger in human consumption.
- 14 - Steps be taken as soon as possible to initiate and develop the mariculture of appropriate species in the region as one way of developing and improving the living resources of the area.

- D -

#### General

##### It is recommended that:

- 15 - Tanks for experimental physiology be established at the CINCWIO Support Center.
- 16 - A full biological study of certain animals, reef fishes, Carangids, Sardinella, Scomberomorus, Rastrelliger, Rays and Yellowfin be carried out, in particular their reproductive status.
- 17 - Preliminary studies be made of the structure and function of certain ecosystems, particularly those identified elsewhere in this report.
- 18 - A centre for taxonomic expertise and curation be established within the region.
- 19 - The unpublished information gathered by scientists that have visited the region briefly should be obtained from them, if possible.

Recommended Priorities  
for Projects in Recommendation 9:  
Fisheries and Biological Oceanography

Projects	Priority Assigned	Scientific Man/year Required	Type of Scientists Required
1	High	2	1 Biologist + 1 Senior Instrument Specialist
2	High	3	2 Biologists + 1 Senior Instrument Specialist
3	High	6	Biologist
4	High	8	7 Biologists + 1 Mathematician
5	Low	1	Biologist
6	Low	1	Biologist
7	Medium	1	Forester
8	Medium	2	Biologists with physical oceanographic training
9	Medium	2	" " " " "
10	Low	1	" " " " "
11	Low	3 ?	Biologist
12	High in certain regions	1/12	Specialist
13	Low	?	?
14	High	?	?
15	High	-	-
16	High	3	Biologists
17	Medium	1	Ecologist in a University Dept.
18	High	2	Permanent taxonomist + curator
19	Low	-	-

Note : It should be assumed in the above Table that one man/year of scientific effort required two man/years of assistant support, except in the cases of Projects 11 and 16. Project 11 will require six man/years and Project 16 ten man/years of assistant support.

Recommendation 10

Marine pollution

It is strongly recommended that the sponsoring agencies of the Workshop look seriously into the problem of marine pollution so that at a later stage of CINCWIO, the national laboratories in the region will be able to execute jointly some pilot projects on the level of pollutants on the species which are most important to the economy of the area.

Recommendation 11

Infrastructure and Training and Education

- A -

Recognizing the need that the countries of the CINCWIO region must in the long term assume the primary responsibility for scientific investigations related to the development of their resources, for environmental forecasting, for control of marine pollution, etc.,

It is recommended that the countries of the region bear in mind:

- (i) the importance of marine science and technology for their economic development and for reducing their technological dependence by enabling them to make the proper utilization of their marine resources;
- (ii) that marine research is a complex activity requiring extremely careful planning; large investments of funds, human resources and equipment; and pragmatic continuity;
- (iii) that the development of marine sciences in all countries must of necessity be supported by a national commitment and the assignment of a high priority in the nation's plans for investment and development. In this regard, it is important to recall previous decisions and recommendations aimed at awakening national consciousness, at all levels, to the vital importance of marine science to economic development and general well-being, and to ensure by means of the communications media and other forms of education the desired level of public awareness and commitment, and
- (iv) that international assistance be considered supplementary to national efforts.

It is further recommended that the countries of the region, with the co-operation of the IOC, the other ICSPRO agencies, and interested ICC Member States, establish a CINCWIO Oceanographic Support Centre within the region to fulfil the responsibilities outlined for this centre in the body of the report.

- B -

Noting the need in the CINCWIO region for the establishment of self-sustaining marine science infrastructures which will meet the countries' requirements for building their marine research capabilities and for obtaining expert advice on their utilization and management of marine

resources,

It is recommended that :

- the IOC and the other ICSPRO agencies co-operate in providing the training of the personnel necessary for the operation of these infrastructures;
- the coastal states of the CINCWIO region identify as early as possible, preferably by early 1977, national institutions and individuals who can participate in the CINCWIO programme;
- UNDP and other funding agencies provide the financial support required for the travel, living costs, tuition and other expenses related to the training of nationals from the CINCWIO area;
- In addition, that the developed Member States of IOC, particularly those participating in the CINCWIO, make every effort to provide on a bilateral or multilateral basis or through international organizations a sufficient number of training awards (fellowships, assistantships, etc.) to make a critical impact on the development of marine science capabilities in the region, specifically that at least 50 training awards be granted over a period of time in the various disciplines of marine science to meet the needs outlined by the specialized scientific committees of the CINCWIO Workshop.
- The countries from outside the region participating in the CINCWIO consider as a priority item the training of personnel from the CINCWIO area in their universities and research institutions and aboard their research vessels;
- Marine scientists from the region be given full opportunity to participate in the development of the research programmes carried out by the IOC's Member States in the CINCWIO region and to participate in the analysis and evaluation of the data collected by these programmes.

- C -

Noting that there is an urgent need for training local scientists to take up the various investigations in physical oceanography and coastal oceanography of the region and to participate actively in the CINCWIO programmes,

Noting further that several oceanographers will be needed for the various national oceanographic institutes of the region, which may be established during the CINCWIO, the First GARP Global Experiment (FGGE) and the Monsoon Experiment (MONEX) programmes, and

Recognizing that the annual intake for an M. Sc. course in Oceanography should initially be around six students, with Bachelor's level background in Physics, Chemistry, Biology, Mathematics, Meteorology or Engineering,

It is recommended that:

- Unesco support one of the universities of the countries of the CINCWIO area, which is suitably located and is interested in starting a Master's Level course in Oceanography, with the staff and facilities necessary for establishing a curriculum on Oceanography.
- The IOC and its Member States from outside the region participating in the CINCWIO assist in the strengthening of existing institutions within the region so that they can be utilized fully on a national or a regional basis, specifically:
  - (a) by identifying senior marine scientists and professors on sabbatical leave capable of working on the problems of the region and of providing a significant portion of their support during their stay in the region and
  - (b) by developing for the CINCWIO region a Voluntary Assistance Programme (VAP), similar to the one successfully developed by the World Meteorological Organization, to provide the countries of the region with basic oceanographic instrumentation and laboratory equipment.

- D -

Noting that it is often possible to make useful measurements of environmental variables with sufficient accuracy for biological and ecological research using very simple instruments which can be manufactured locally in the spirit of 'appropriate technology';

Noting further that this approach, in addition to making it possible to conduct survey work at many localities simultaneously, minimizes the need for highly trained technicians, encourages more direct local appreciation of technological problems, and develops technological self-reliance among the countries in the region,

It is recommended that:

- The countries of the CINCWIO region emphasize this approach both in the planning and executing of locally-based research programmes and in the training of their marine scientists and technicians.
- The institutions within the region offer all support to visiting scientists to ensure effective utilization of their expertise.

### III SUMMARY OF THE PROCEEDINGS

#### III.A GENERAL

The meeting was opened on the morning of Thursday 25 March 1976 by Mr. George E.B. Kitaka, the Chairman of the meeting. Mr. Kitaka introduced Chief Olu Ibukun, Head of the Unesco Regional Office for Science and Technology for Africa, who welcomed the participants on behalf of Unesco. Chief Olu Ibukun then introduced the keynote speaker, Mr. Yuda Komora, Permanent



Secretary of the Ministry of Tourism and Wildlife of the Republic of Kenya. Mr. Komora welcomed the participants on behalf of the Republic of Kenya and in his address stressed the importance of this Workshop and similar activities to the countries of the region. He emphasized the need for these countries to build their capabilities in the marine sciences so that they could make the most effective use of the marine environment and its resources.

Following the keynote address, Mr. Kitaka opened the seminar. Twenty-five papers were presented during the seminar which continued until the morning of Saturday 27 March.

The Workshop was opened on the morning of Monday 29 March 1976 by the Chairman, who presented the participants with the terms of reference which had been prepared by the Steering Committee. These terms of reference defined the Workshop's tasks as : reviewing the existing knowledge of the region and identifying gaps in that knowledge; identifying requirements for oceanographic data and information to fill these gaps and recommending programmes to meet these requirements; reviewing existing structures and capabilities of the countries of the region and recommending programmes to improve them; recommending new programmes which could be carried out in view of these newly-improved capabilities; assigning priorities for all of the programme recommendations; and recommending a mechanism for future programme co-ordination.

The Chairman proposed that, following the Steering Committee proposal, the Workshop be divided into three sub-groups to deal with (A) physical and chemical oceanography, and marine geology and geophysics; (B) fisheries and biological oceanography; and (C) infrastructure, and training and education. The participants agreed and selected Prof. Henry Stommel as convenor of sub-group (A), Dr. David Cushing as convenor of sub-group (B) and Prof. Mohammed Hyder as convenor of sub-group (C). Sub-groups (A) and (B) met in parallel sessions during the first part of the Workshop. Short plenary sessions were held every morning and most of the fourth day when the recommendations and reports of sub-groups (A) and (B) were adopted. Sub-Group (C) met essentially as a committee of the whole during the latter part of the meeting. The Workshop met in a final plenary session on Friday 2 April 1976, to adopt the recommendations and report of sub-group (C).

The Workshop closed at 12.30 on Friday 2 April 1976.

### III.B SUB-GROUP (A) - PHYSICAL AND CHEMICAL OCEANOGRAPHY, AND MARINE GEOLOGY AND GEOPHYSICS

#### III.B (a) Nearshore Physical and Chemical Oceanography

The current system of the north-western Indian Ocean shows a complete reversal with the change of the monsoon wind system. The physical, chemical and biological processes in the near-coastal zone of the eastern African

countries are strongly affected by these changes of the atmospheric and oceanic circulation system. As a consequence, the practical use of the coastal areas for fisheries, marine transportation and recreation is strongly influenced.

A programme is proposed, under the auspices of the IOC, to investigate the processes in the coastal zone of eastern Africa in co-operation with the East African community, Somalia and other IOC Member States.

In the first phase this programme will be mainly a data collection programme. Special survey programmes will have to be developed later.

#### Recommended programmes and priority of execution

This includes a minimal programme to get effective research in the region underway. Thus all of these should be considered to be of a high priority.

#### Long-term recording and repeated stations

In order to understand better the seasonal variations of the CINCWIO coastal area, repeated measurements with ships and self-recording instruments have to be undertaken.

The proposed measurements off the coasts of Kenya and Tanzania (referred to as Region I) are listed in Table 1. There should be five EAMFRO ship stations in this region (see Fig. 1) in order to provide temperature and salinity data and samples for biological and chemical analysis. In shallow water the profiles should be measured to the bottom, in deeper areas only to intermediate depths. Currents should be measured by means of Ekman-type current meters or by parachute drogues. Wind and sea state should be recorded routinely at every station.

Furthermore, it is strongly recommended that four unattended temperature-pressure recorders be deployed at the positions indicated in Figure 1. These instruments are currently not available at the laboratories of the region. It is recommended that IOC arrange for these laboratories to be provided with 12 instruments (this includes spare instruments). These recorders should be located at a depth of about 60 metres and can work continuously for up to six months. They should be deployed, retrieved and maintained by EAMFRO ships. Wind data which is necessary to complete the analysis of the data sets, is currently being obtained by a sufficiently dense net of standard meteorological stations along the coast.

This programme should be executed over approximately the next five years.

The measurements proposed off the coast of Somalia (Region II) are listed in Table 2. In the initial phase, measurements should include primarily data on physical parameters and oxygen. Ship stations should be occupied by a fishery research vessel of the Somali Ministry of Fisheries three times during the summer monsoon (March-September) along three sections roughly perpendicular to the coast off Mogadiscio, off Obbia and off Ras Hafun (see Fig. 1). The distance between adjacent stations along each section should be ten miles. The northernmost section should consist of

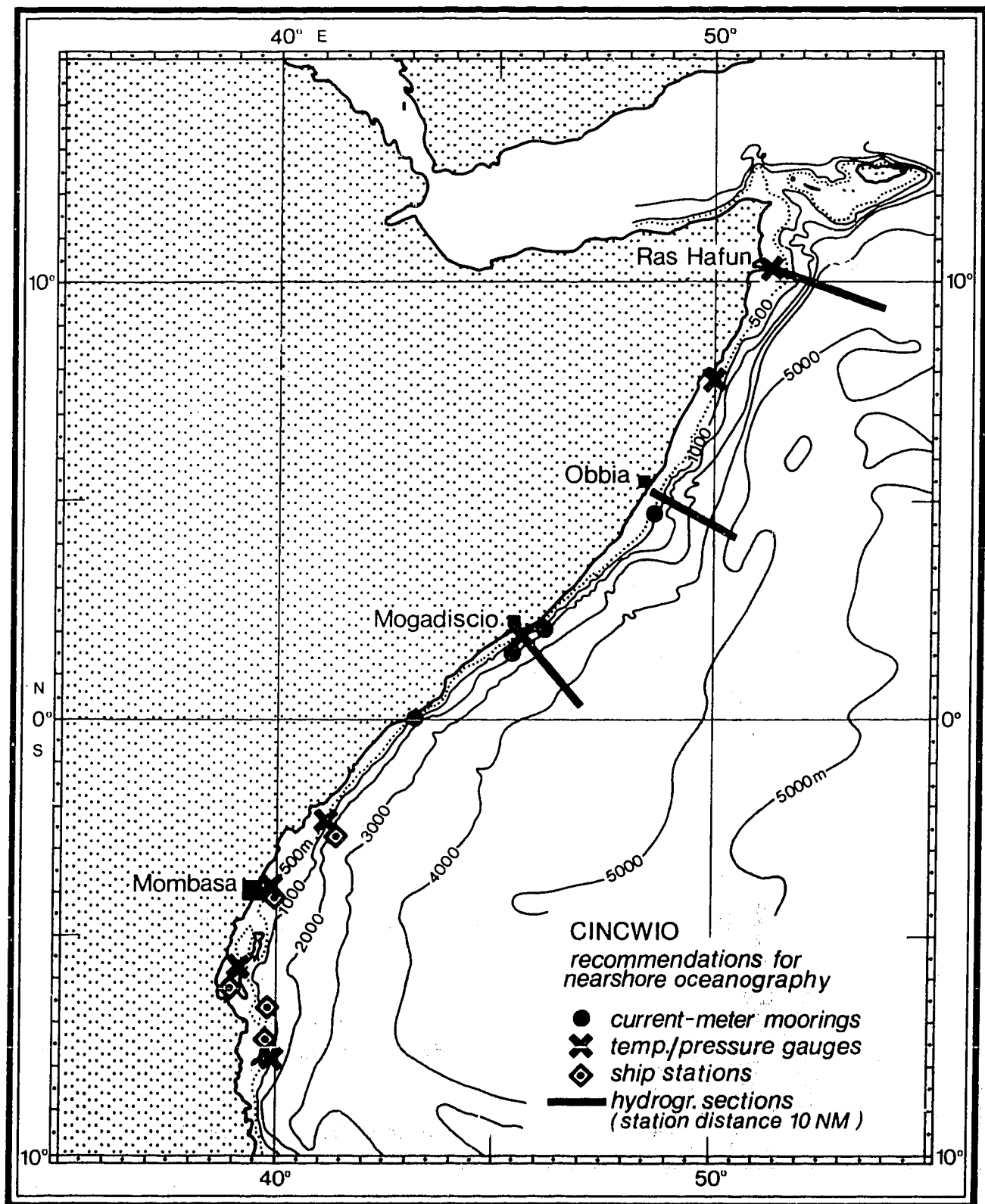


Fig. 1

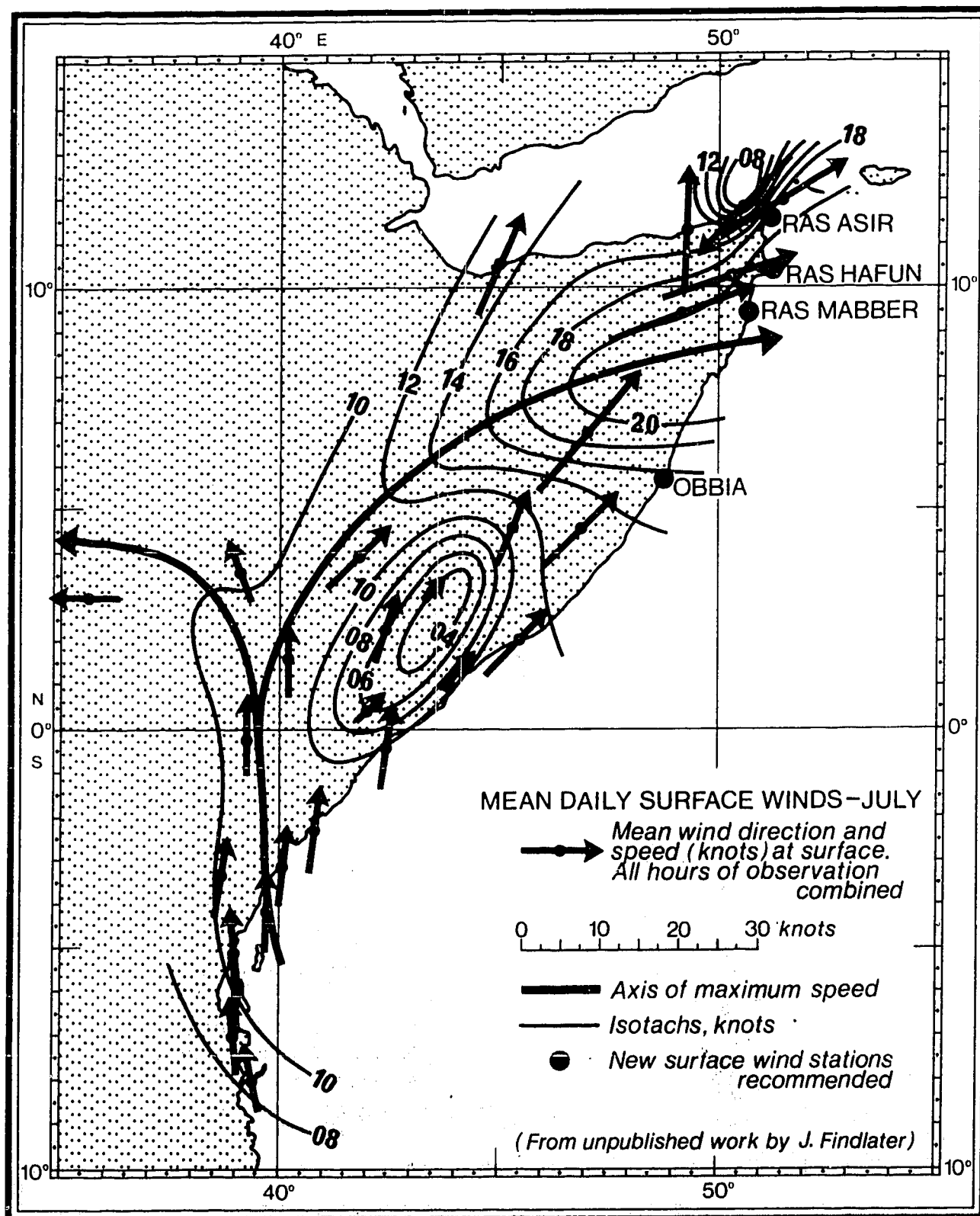


Fig. 2

15 stations, the other sections of 12 stations each. In order to carry out the proposed oceanographic stations the ship will have to be equipped with an oceanographic winch, as well as some sampling and analysis equipment. It is recommended that this equipment be furnished via the IOC.

Furthermore, the installation of three unattended temperature-pressure recorders and of four current meter moorings is recommended at the positions indicated in Fig. 1. These instruments and their mooring equipment should be provided by IOC Member States. The deployment, retrieval and maintenance of these instruments after their half-year recording period should be carried out in co-operation with research vessels of Somalia.

During the South-west Monsoon the core of an intense, low-level jet is located over northern Somalia. There presently exist no wind-recording instruments in this area. It is therefore proposed to install, in addition to the existing meteorological stations in other areas, four stations in northern Somalia at Obbia, Ras Mabber, Ras Hafun and Ras Asir (Fig. 2). If the equipment needed for these stations is not available in Somalia, it is recommended that such equipment be provided by the WMO Voluntary Assistance Programme. In this case, Somalia should install, operate and maintain the equipment.

Oxygen measurements should be conducted at the four new stations. Sea state and wind observations should be recorded during the work along the sections. It is proposed that an attempt be made to measure currents using parachute drifters or profiling current meters.

#### Long-shore sampling with ships of opportunity

A tanker XBT programme has already been established within the framework of the Index programme. It would be very useful to augment this programme by collecting additional surface temperature measurements from merchant ships which regularly service East African ports. Some of these ships are known to travel along the coast at about 30 miles offshore. Sea surface temperature measurements in this zone would be particularly useful for upwelling studies. Following previous positive experience, it is recommended that EAMFRO approach "Southern Line" to enlist their co-operation in obtaining the above measurements.

To obtain meaningful data the ships will have to be equipped with continuously recording instruments. It is recommended that such instruments be provided by IOC. It might also be useful to have ships of opportunity obtain water samples for later analysis ashore. However, no specific recommendation is made in this respect. EAMFRO offered to collect surface temperature measurements and to collect water samples for laboratory analysis from its vessels operating in the area.

#### Special programme

The programme outlined above will not entirely solve the problems involved in the coastal circulation off eastern Africa. Therefore, it will be necessary, after the first few years of these programmes, to carry out special multi-ship surveys in the area (see Fig. 1).

The optimum time for such surveys will be 1979 when a very good meteorological coverage of the CINCWIO area will be achieved. It is proposed to carry out two such investigations in co-ordination with the work recommended by the deep-ocean physical and chemical oceanography group. The first should be conducted during the North-east Monsoon off the coast of Kenya and Tanzania, the second during the South-west Monsoon off the coast of Somalia.

Interested scientists are encouraged to formulate their ideas about such programmes.

#### Available ship and shore facilities

Discussions indicated that the following ships and shore facilities might be available over the next few years to implement the research programmes outlined above:

##### (a) Ships

1. New EAMFRO ship: EAMFRO has ordered a new stern trawler. She is 40 metres (122 feet) long with two laboratories and will be able to accomodate up to eight scientists. She is expected to be available by May 1977.
2. "Mbudya" (Tanzania): this is a 26.2 metres (80 feet) fishing vessel which could be used for the CINCWIO programme.
3. "Shakwe" (Kenya): this is a 24.7 metres (75 feet) stern trawler built in 1969 which could be used when available for the CINCWIO programme.
4. 13.1 metres (40 feet) fibre glass launch : This is now being built for EAMFRO (Mombasa) and is expected to be available in June 1976.

##### (b) Laboratory facilities

1. Zanzibar : main EAMFRO laboratory.
2. Mombasa : an EAMFRO sub-station is under construction and will take up operation in September 1976.
3. Dar-es-Salaam :
  - i) An EAMFRO sub-station is planned and construction is expected to start in July 1976. It will be operated in co-operation with the University of Dar-es-Salaam and the Tanzania Fisheries Department.
  - ii) Marine biology laboratory, University of Dar-es-Salaam.

### III.B (b) Deep-ocean Physical and Chemical Oceanography

A large-scale physical oceanographic survey of each biologically productive region is recommended, in addition to the long-term monitoring scheme proposed by the sub-group on coastal oceanography. These surveys are an essential step in attempting to understand the physical processes that determine when and where the productive regions occur.

1. One productive region appears to be off the coasts of Kenya and Tanzania during the north-east monsoon at the junction of the south-going Somali current, the north-going East African coastal current, and the origin of the Equatorial countercurrent. This region did not receive much attention from physical oceanographers during the International Indian Ocean Expedition (I.I.O.E.). A physical oceanographic survey should be made during the period November—January, of the area between latitudes 1°N and 8°S from the coast to 47°E, approximately.
2. A survey of the Somali current region should be made during April-July (four months) in which a number of physical oceanographic sections are occupied every three weeks, repeated five or six times, together with current measurements by whatever means available. To achieve the necessary coverage, as many as three large research vessels will probably be needed. The sections should be distributed between latitudes 4°S and 11°N and may need to extend 200 miles offshore in the northern part.

It is desirable to extend this Somali Current survey, whenever possible, into the region east of Socotra as a contribution to studies of the near-surface layer of the Arabian Sea in the South-west monsoon.

Ideally, these two surveys should be made during late 1978 or 1979, to take advantage of the enhanced meteorological information that will be available during FGGE and MONEX, and so as to relate them to the equatorial current studies which may be conducted at the same time.

If any meridional sections are planned during expeditionary cruises in the CINCWIO region, planners are invited to consider working on standard meridians. Longitudes 55°E and 49°E are suggested. In the latter case, it may be most appropriate to make a meridional section extending from the south as far as 2°N, and thence north-west towards the coast of Somalia.

### III.B (c) Marine Geology and Geophysics

The sub-group related its discussion of past work, future needs, and recommendations to perceived economic benefits to coastal states in the CINCWIO region. These discussions are summarized below. The topics of the discussion are listed in order of accessibility from shore.

#### Heavy minerals

Economic deposits of heavy minerals on beaches of the CINCWIO region appear to be restricted to ilmenite and rutile, possibly supplemented by garnet, zircon, kyanite, and monazite. No mining is in progress, but

a pilot processing plant in Dar-es-Salaam has been established as a joint project of Tanzania and Romania. Some background information is available within the CINCWIO region regarding the sources, distributions, concentrations, and reserves of heavy minerals. This information should be supplemented by new knowledge of geomorphology (streams and both raised and lowered shorelines), stratigraphy (source rocks, transitional deposits, peneplanation), and sedimentology (mean times and rates of erosion, transportation and deposition) which should be obtained by the national geological surveys and universities. It is recommended that direct assays be made of 5-ton samples of natural concentrates of promising heavy mineral deposits. The CINCWIO coastal states should ship these samples to Dar-es-Salaam for processing, since this would be simpler than transporting the processing plant throughout the region.

### Shore and shelf materials

#### - Bottom materials

The sea-bed of the continental shelf and the near-shore zone consist of mud, sand, coral and rock. Coastal states in other regions have used charts of the distribution of these materials to improve the efficiency of bottom trawling for fish, molluscs, and crustaceans. Similarly, the collection of rocks samples from offshore areas would permit an extension of geological maps of the land onto the adjacent continental shelf. Such extended maps would aid exploration for oil, gas, phosphorite, and other hard minerals. Shells of oysters and other intertidal animals can be radiocarbon dated to provide information on the past (30,000 years) stand-stills of sea level to aid the search for submerged deposits of heavy minerals.

Similarly, coral reefs must be studied more thoroughly in order to learn more about their species composition and structure, in order to evaluate their contribution to fisheries of the region. We recommend that fishing boats, and research vessels be encouraged to retain samples of bottom materials which they happen to obtain in their trawls or other gear (even on anchors) and to deliver these samples to nearby marine laboratories. When enough samples have been accumulated, geologists from geological surveys or universities can use these materials as the basis for making charts of bottom materials and geological maps.

#### - Suspended matter

Suspended matter generally consists of both organic and inorganic components. The organic component includes primarily the carapaces and tissues of plankton which are especially abundant in areas and times of upwelling; the inorganic component includes clay and other mineral grains which reach maximum concentrations in coastal areas of stream outflow after periods of stream flooding. It is recommended that seasonal distributions and concentrations of both kinds of suspended matter (plus nutrients) be measured both by visiting research vessels and by local research ships. Such information should be useful in predicting the areas of concentrations of fish.

#### - Oil and gas

Previous work by national geological surveys and by oil companies has shown that large oil and gas deposits are unlikely to occur on the land areas of the coastal states in the CINCWIO region; only small and difficult-to-find deposits are likely. In contrast, the strata of the continental shelf are thicker, more often marine in origin and much more likely to contain



economic concentrations of oil and gas. Oil companies have obtained the most information about the structure and stratigraphy of the continental shelf, but they tend to keep this high-cost information secret. Similar but less detailed information of the same sort can be obtained by oceanographic research vessels as a by-product of reconnaissance studies of the continental margins. Such studies have as their primary purpose obtaining information on the general structure of the margins which can be used for inferring the origin and history of continents and ocean basins.

Much has yet to be learned about the source beds, reservoir beds, structural traps, and thickness of strata beneath the continental shelves in the CINCWIO region. Therefore, we recommend that the coastal states of the CINCWIO region actively encourage visits of oceanographic research ships to conduct geophysical studies of the continental shelves. In this way the coastal states concerned will not only learn more about their continental shelves, but will also have maximum opportunity to help plan the cruises and to secure the geophysical (seismic, magnetic and gravity) training for their scientists that is expensive and difficult to obtain otherwise.

- Earthquake positioning

The interest of the countries of the region in potential damage by earthquakes has led in recent years to the planning of seismograph networks in the region. These networks can be supplemented by surface-suspended and bottom-mounted seismographs placed on the continental shelves by oceanographic research vessels. We recommend that IOC Member States operating vessels which visit the region be encouraged to assist in the placing of seismographs on the shelves. The data collected can be co-ordinated with those of the land-based seismographs which have been established by national geological surveys and universities.

- Manganese nodules

Large deposits of Manganese Nodules have been located in the past only in areas where detrital and biogenic sediments are deposited slowly or not at all. The deep-ocean floor off east Africa is not such a region because the total thickness of the sediments on the oceanic basement probably exceeds 10 km. No optimism should therefore be held for economic return from the mining of manganese nodules immediately off these coasts.

- International co-operation

The conduct of the types of marine geological and geophysical programmes recommended above would be greatly aided if permission for research vessels to work on the continental shelf were provided expeditiously by coastal states in the CINCWIO region. This would facilitate close co-operation in the planning of cruises and would assist in making the most effective arrangements for the training of scientists from the region.

III.C SUB-GROUP (B) - FISHERIES AND BIOLOGICAL OCEANOGRAPHY

The Biological Group divided its work into two fields of concentration: ecosystems and resources. Within each field, the Group considered different offshore areas - reefs, pelagic areas etc. The following report is divided accordingly.

III.C (a) Ecosystems in the CINCWIO region

III.C (a) i) Coral Reefs

1 : Lagoon Areas and Boat Channels

The maximum depth in this zone is two to three metres at high tide. The substrates are varied and may consist of sand, dead coral, living coral, angiosperms - turtle grass and, most important, encrusting algae. Important fish in these areas are Siganus, Mugil, Lethrinids, Lutianids, Mullidae, parrot fishes and wrasses. Amongst invertebrates the Octopus and Panulirus ornatus are important.

The zone has already been heavily exploited by traditional fisheries, utilizing traps, seines and a slight handline effort. With the exception of Siganus oramin, the Lethrinids and Lutianids, the biology of the fish from this area is not well known. The zone may be important as a nursery ground for juveniles of reef and outer reef species.

2 : Reefs

Reef surfaces are frequently exposed at low tides. Reef fronts extend to the lower limit of growth at approximately 15 metres. Substrates consist of Scleractinian coral massifs of various structures depending on species, with small sandy patches. The reef surfaces are frequently covered with algae and reef fronts often with encrusting algae. Important fish are Lethrinids, Scolopsis spp., Scarids, Lutianids, Caesio spp., Carangids, Acanthurids, the spiny lobster Panulirus longipes, and P. ornatus.

This zone is also heavily exploited at present by traditional gear, with handlines, seines and traps being important. Scaridae, Scolopsis and Lethrinids are important but little is known of their biology. Approximate yields are presently about 4-5 tons/km<sup>2</sup> and this may be at or near the upper limit.

3 : Shelf

This area extends from the foot of the reef slope, usually over an area of coral rubble of varying degree of 'roughness', to the shoulder of the continental shelf at a depth of 80-120 m. The width is variable depending on the gradient. Substrates vary from very rough folded bottoms to fine sand and may be bare or covered with sponges, Alcyonaria, Gorgonians and Hydroids. Important fishes in this zone are : Lutianids, Serranids, Sharks, Denticids, Carangids, Naso (exploited by traps in Mauritius) and Caesio spp. (unexploited in Mauritius).

The larger species in this zone are available to lines and are under-exploited. They differ from the shallow water species and may have juveniles which do not utilize shallow water nursery grounds. Some knowledge of the biology and population is available. Several species in this area are toxic. Approximate yields may vary between three and 20 tons/km<sup>2</sup>. The average for the North Kenya Banks is approximately 8 tons/km<sup>2</sup>.

4 : Coastal Pelagic Stocks

Coastal pelagic stocks in the coral reef area, defined for CINCWIO purposes to extend from 4°N of the equator to 20°S of the equator, include small schooling pelagic species (e.g. Clupeoids, mackerels and small horse-

mackerel species) and larger mainly schooling species (e.g. Scombroids, Carangids, Barracuda).

4.a : Small schooling species

The main groups are roundherrings (Dussumieria; and Etrumeus to the north of 4°S) and sardines (Sardinella, Herklotsichthys and others of estuaries, e.g. Hilsa, Pellona). The main species are Sardinella gibbosa, S. albelli, S. sirm. S. longiceps, characteristic of upwelling areas, is not known south of Mombasa (Lat. 4°S). Herklotsichthys spp. are important in local fisheries of the Seychelles and East Africa. Scombroids - mackerels (Rastrelliger; Scomber) are found to the north of the equator and south of Madagascar. Carangids - Scads (Deceperus, Selar, Atule; Trachurus sp.) can be found outside the equatorial region. Leiognathids - pony fishes (Gazza, Secutor and Leiognathus) exist in the region as well.

4.b : Larger schooling species

The larger pelagic species include mainly Scomberomorus spp., barracuda spp., Rachycentron, larger carangids and many others.

5 : Decapod Crustacea, Molluscs and Holothurians

The spiny lobsters constitute the most important Crustacea within the coral reefs. The species which one can name within the reef areas of the CINCWIO region are Panulirus ornatus, P. longipes, P. versicolor, and P. penicillatus. Of these four species, P. ornatus, P. longipes and P. versicolor account for most of the catches of lobsters from Madagascar, Mozambique, Tanzania, Kenya and Somalia. P. penicillatus is the important species in Mauritius. In the Gulf of Aden, P. homarus is the dominant species.

Typical production figures available for yearly catches of lobsters in the region are as follows:

Country	Catch	Year
Mozambique	(No figures)	
Tanzania	26.7 metric tons	1971
Kenya	57 metric tons	1975
Somalia	(No figures)	
S. Yemen	(No figures)	
Madagascar	132 metric tons	1975
Mauritius	20 metric tons	
Seychelles	(No figures)	

The major molluscan components within the reef areas are the shells which are of value as curios such as Cypraea spp., Cassius spp., and Tridachna gigas.

Of the many species of holothurian known to occur in the area, Holothuria scabra is of commercial value. Sun-dried sea cucumber is being exported from Tanzania. The export figures are given in the annual reports of the FAO Fisheries Division.

III.C (a) ii) : Coral Free Areas/Inter-Reef Area

The area is considered to be represented by trawlable grounds, excluding the estuarine environment.

Such ground is found in the central areas of the oceanic banks, the North Madagascar Bank, the North Kenya Banks, the Zanzibar and Mafia Channels, the Somali Coast and the Gulf of Aden. Substrates usually consist of sand and coral rubble in various proportions, but some sandy mud areas are found in Madagascar and N. Somalia. Usually the substrates become softer with depth.

1 : From the surface to 20 metres

The most important groups in this layer are Rays and Sharks fished by longlines and gill nets on the eastern African coast and Oceanic Banks. Nemipetrus is common in trawl catches throughout the CINCWIO area. Other groups of minor importance are Trichiurus Carangidae, Sphyraenidae and Mullidae.

2 : From 20 to 100 metres

South of the equator, the densities of larger species are low, although stocks worth exploiting exist off Madagascar. The most important species are Mullidae, Nemipterus and Saurida spp. Trawling near rough ground may produce Lutianidae and Serranids. Also important are Sparids. The Sparids, Lethrinids and Serranids are important to trawl fisheries in the north of the CINCWIO region. Approximately 1000 tons was taken from the Gulf of Aden/Somalia during trawling in this zone in 1975.

3 : Depths greater than 100 metres

At depths greater than 100 m, the population changes. The area is exploitable by trawls throughout the CINCWIO region, and by lines in the southern part of the area. The most important groups to trawl fisheries are Pristipomoides spp., Sparids, Carangids and Saurida spp. and Sharks; to line fishing - Pristipomoides, Epinephelids, Etelids, Polysteganus spp. and Sharks; to gill net fishing - Squalids (around Mauritius).

The fish are little known and at present are exploited in only a few parts of the CINCWIO region, (e.g. trawling off the Somali coast, line fishing off Mauritius and the Comoros).

III.C (a) iii) : Mangrove Swamps

Within the CINCWIO region, mangrove vegetation extends along the coasts of Mozambique, Tanzania, Kenya and the southern part of Somalia. Madagascar also has mangrove forests in the northern part of its west and east coasts. MacNae (1974) has given a general account of the mangrove forests and fisheries of the Indian Ocean. A detailed survey of a mangrove area near Par-es-Salaam was also carried out by McCusker (Ph.D. Thesis).

The main resources of mangrove forests are timber and bark, fish

(such as mullets), oysters, and mangrove crab. These forests also serve as nursery areas for penaeid shrimp. Timber from mangrove forests is being utilized for constructional purposes and also as firewood. Production of prawns from mangrove area is estimated by MacNae to be 2300 tons per year in Mozambique and 4300 tons per year in Madagascar. Landings of mangrove crabs in Madagascar have been estimated to be 380 metric tons per year and in Kenya from 15 to 20 metric tons.

### III. C (a) iv) Somali Upwelling Region

#### 1 : Pelagic Stocks

Regions of upwelling and areas influenced by upwelled waters include the eastern section of the Gulf of Aden and the east coast of Somalia from Ras Asir south to about 4°N (i.e. non-coralline zone). The pelagic stocks in these areas include epi-pelagic fishes, meso- and bathy-pelagic resources and others. The production potentials of these stocks remain unknown. The following groups may be considered of potential commercial importance.

##### 1.a : Epi-pelagic Stocks

The species occurring in this region are : Clupeoids (round herrings, Dussumeria acuta, Etrumeus teres); sardines (Sardinella longiceps; S. sirm, S. gibbosa, S. albella and S. melanura being of lesser importance); anchovies (Engraulis japonicus, Stolephorus spp.); scombroids ; (Rastrelliger kangurta, Scomber japonicus) and Carangids-scads (Decapterus spp. - D. dayi, D. urraides, D. macrosoma, Selar crumenophthalmus, Trachurus spp.).

During the North Arabian Sea Survey of the R/V Fridtjof Nansen, small schooling epi-pelagic fish concentrations were located north of Ras Binnah (Somalia). Echo-recordings of sardines and horse-mackerels covers an area of approximately 100 square nautical miles, between the 30 metre and 500 metre contours. In the rest of the northern part of the CINCWIO region small pelagic fish were found scattered in a number of localities.

Catches of sardines, anchovies, mackerels and horse-mackerels are taken seasonally (October-March) off the north coast of Somalia in the lamp and tuna bait fisheries. Catches reportedly range up to 30 tons per set.

Two interesting features in these areas are the presence of so-called anti-tropical species (e.g. Engraulis and Etrumeus) which are now known to enter the tropical zone and the location at depth (200 m) of various so-called epi-pelagic species (e.g. Scomber, Trachurus and Decapterus spp.).

##### 1.b : Meso- and Bathy-pelagic Resources

On the same survey, scattering layers of meso/bathy-pelagic fish were found throughout the North Arabian Sea. These layers were recorded at depths of between 100 and 500 metres during the day, but migration into surface waters was evident at dusk. In the CINCWIO region, survey results indicate that mesopelagic fish form dense schools or layers in daytime. Larger concentrations have been located off the north-east coast of Somalia, in the western Gulf of Aden and in the Gulf of Oman.

Samples from the layers were dominated either by lantern fish (Myctophidae) or cardinal fish (Apogonidae : Synagrops adeni); many other groups were also represented.

Catches with a mid-water trawl ranged up to 5000 kilograms, with catch rates of up to ten tons per trawl hour. The production potentials of these resources remain unknown.

#### 1.c : Others

Other, apparently larger-volume, pelagic resources in the upwelling zone include the red oceanic swimming crab (Charbdis edwardsi), the mantis shrimp (Oratosquilla investigatoris) and porcupine fish (Diodon). These species have been located in large swarms or schools, both inshore and off-shore, but their value as protein resources is in doubt.

In addition, dolphins, whales (Cetacea) and marine turtles are seasonally common in the upwelling region. Turtles, particularly the green turtle (*Chelonia mydas*), have been intensively exploited for export on feeding grounds off the north-east coast of Somalia. The status of the stock is not known, but recent data indicate that the turtle stocks of the countries of the Western Indian Ocean are not isolated. Therefore, international co-operation in conservation of green turtles is essential.

### III.C (a) v) Deep-ocean Water

The pelagic oceanic ecosystem is characterized by the presence of a predominance of organisms which complete their life cycles in the high seas. These organisms do not require a substrate and are not directly influenced by land masses (e.g. reduced salinities in estuaries resulting from land run-offs).

While the geographical boundary of the pelagic oceanic regime can be placed at the margin of the shelves of continents and oceanic islands, it should be stressed that many pelagic species spend considerable periods in coastal waters, i.e. inshore of the continental or oceanic island shelves.

### III.C (b) Resources of the Ecosystems

#### III.C (b) 1) : Coral Reef Areas

##### 1 : Coastal Pelagic Stocks

##### 1.a : Production

The total annual production is not known. In areas commercially fished, catches have been reported as follows:

##### Zanzibar lamp fishery:

Year	Total Catch m. tons	Catch/Night Vessels m. tons
1963	567	2.1
1964	230	1.3
1965	336	1.8
1966	245	2.2
1975	(300)	?

The mean catch/night per vessel (1963- 1966) was 1.8 metric tons of sardines and other small schooling pelagic fish. The composition of catches has been recorded as follows:

<u>Group</u>	<u>Composition</u> (by weight)
Clupeoids	61
Mackerel ( <i>Rastrelliger</i> )	10
Carangids	8
Leiognathids	14
Others	7

Landings of one 50 ton dipnet off Dar-es-Salaam in 1965 was 224,000 pounds and the composition (by weight) was *Sardinella*, 66%; *Rastrelliger* (plus small carangids), 28%; and other fish, 6%. Clupeoid catches in Mauritius have been reported at 35 tons per annum, with no indication of further production potential. In other areas there is no data available on production.

#### 1.b : Production potentials

Production might be increased in all areas where at present there is fishing activity (except Mauritius). Fisheries might also be developed along the north-east coast of Madagascar, in Safala Bay (Mozambique) and on the North Kenya Banks. There are no estimates of standing stocks in the north and only very preliminary surveys (both fishing and acoustic) have been carried out.

Future assessment surveys should be carried out in the Safala Bay area, in the Mafia and Zanzibar channels, and on the North Kenya Banks.

#### 1.c : Biology

The biology of even the more important commercial species in this region is still very poorly known. Some data on size, on age and growth, and on spawning seasons are available for *Herklosichthys* spp., and some *Sardinella* spp. for the Zanzibar channel area.

Preliminary data on some larger netritic pelagic fish, notably barracuda, larger carangids and *Scomberomorus* spp. are also available.

### III.C (b) ii) Coral-Free Areas of the Sea Bed

#### 1 : Decapod Crustacea

The major group of Crustacea in the coral-free area are the penaeids which are abundant in the estuarine region where the bottom is muddy. The species of commercial importance in the CINCWIO region are : *Penaeus indicus*, *P. monodon*, *P. Japonicus*, *P. latisulcatus*, *Metapenaeus monocerus*, *M. stebbingi* and *Trachypenaeus curvirostris*. *P. indicus* is the dominant species in Mozambique, Tanzania, Kenya and Madagascar, whereas in the Gulf of Aden the principal species is *P. semisulcatus*.

In areas of sandy bottoms the sand lobster (Thenus orientalis), the portunid crab (Portunus pelagicus) and P.sanguinolentus are of importance. In Mauritius, there is a possibility of developing a fishery for the crab Ranina ranina which is known to occur at depths greater than 20 metres.

Production figures for prawns in the various regions are:

Country	Annual Catch	Year
Mozambique	3,300 metric tons	1973
Tanzania	364.3 metric tons	1971
Kenya	149 metric tons	1975
Somalia	(No figures)	
South Yemen	(No figures)	
Madagascar	4,900 metric tons	1972
Mauritius	(No figures)	
Seychelles	(No figures)	

### III.C (b) iii) Somali Upwelling

It would be useful in assessing the resources of the region if surveys could be made in the following areas:

1. In the area 1°N to 8°S, up to 50 miles offshore during the north-east monsoon from November to March. A 50 m stern trawler, capable of acoustic survey and capture, should be used.
2. In the Somali current in the area between 5°N and Cape Guardafui extending into the Gulf of Aden as far as 47°E for a period of twelve months. A 70m stern trawler, capable of acoustic survey and capture should be used.

In the Somali extension survey, echo sounder records of fish abundance should be preserved. Zooplankton observations might be taken if the Indian Ocean Biological Centre, Cochin, is prepared to count them.

### III.C (b) iv) Deep-Ocean Regions

The pelagic fishery resources of commercial importance in the CINCWIO region can be separated into several categories. These are (1) subsurface tunas, (2) surface tunas, (3) billfishes, (4) squids and cuttle fish, (5) sharks and (6) dolphin fish.

The larger tunas in the Indian Ocean have been harvested with longline gear since the early 1950's. Based on a recent analysis of longline fishing data, the fishery is reported to be catching all of the principal tuna species at maximum sustainable yield levels. These yield levels were estimated at 35,000 metric tons for yellowfin tuna; 25,000-26,000 metric tons for albacore, 28,000-30,000 metric tons for bigeye tuna; and 35,000-40,000 metric tons for southern bluefin tuna. The prospects of a substantial increase in the longline catch through increased fishing does not appear to be hopeful.



In the CINCWIO region, several species of tuna occur in surface waters and can be taken with surface fishing gear, pole and line with live bait, purse seine, gill net and troll gear. Species which may be of commercial importance include yellowfin tuna, skipjack tuna, frigate tuna and kawakawa. At present a small pole and line fishing industry exists in Madagascar for skipjack tuna and yellowfin tuna.

The present Indian Ocean catches of skipjack tuna and surface caught yellowfin tuna are 40,000 -45,000 metric tons and 10,000-15,000 metric tons respectively. The potential yield for skipjack tuna for the entire Indian Ocean is estimated to be 360,000 metric tons. The potential yield for surface-caught yellowfin tuna is unknown.

Among the several species of other small tunas and tuna-like fishes present in the CINCWIO region, the species belonging to the genera of Auxis, Euthynnus, Scomberomorus and Acanthocybium represent resources which could be developed commercially.

The bullfishes are taken predominantly with longline gear. The annual catch in the Indian Ocean in recent years has been less than 6,800 metric tons. Although stock assessment studies for the several species of billfishes are lacking, the general view is that increased production through increased effort is not likely.

Other species and groups which need to be studied to determine if they could be commercially developed in the CINCWIO region include squids and cuttle fish, dolphin fish (Coryphaena hipparas) and sharks. Very little is known of the biology and stock size of these organisms in the Indian Ocean. However, their importance in other oceans indicates they should also be studied in the CINCWIO region.

### III.C (c) Resources, Evaluation and Improvement

#### III.C (c) i) Exploration

##### (a) Crustacea

- A. A trawl survey for shrimps off mangrove areas should be made; a preliminary examination of old hydrographic charts and surveys might prove useful.
- B. A trawl survey for deep water stocks should be made along the coast.

##### (b) Skipjack

As a fishery is developing in the Madagascar, Seychelles, Comoro area, an exploratory survey might not be needed.

III.C (c) ii) Statistics

As Dr. S. Bannerji (IOFC) has recently toured the area on a mission of statistics improvement, there is no need for the problem to be examined further.

III.C (c) iii) Fish Population Assessment

Three problems were raised:

- (a) Can Schaefer-like models be used in multi-species fisheries? In the last two years, attempts have been made to do this in ICNAF and a number of papers on the subject have been published.
- (b) In the Gulf of Thailand multi-species fisheries are effectively treated as a single stock of biomass; however, there are signs that a change in species composition has occurred.
- (c) In the management of shrimp populations, reference was made to the fishery in the Gulf of Mexico. It is necessary to distinguish penaeids from the deep water animals. Branding and laser methods were discussed, in addition to sphyryion tags; the possibility of using experimental facilities were also raised.

Resources were classed as exploited and underexploited:

- Exploited resources

- (i) Deep water crustacea in Somalia and N. Kenya; but some exploration may be needed at greater depths
- (ii) Neritic lobster stocks
- (iii) The multi-species reef fisheries should not in general be further exploited
- (iv) Billfishes and tuna-like fishes, which are probably fully exploited
- (v) Elasmobranch resources.

- Underexploited resources

- (i) Shoaling pelagic species in the Zanzibar Channel
- (ii) Tuna-like fishes off the north coast of Somalia
- (iii) Artisanal fisheries off Somalia
- (iv) Tuna-like fishes in the whole Indian Ocean if the Japanese, Koreans and Taiwanese continue to withdraw from the area.

### III.C (c) iv) Aquaculture

Aquaculture is in an early stage of development in this region and steps are being taken to initiate culturing of oysters (Crossostrea cucullata) in Dar-es-Salaam and Mombasa. A survey conducted by a Japanese Shrimp Culture Mission has indicated suitable localities for the establishment of prawn culture in Tanzania coastal waters.

### III.C (c) v) Taxonomy

In tropical waters the taxonomic problems are formidable:

- (a) Part of the R/V Fridtjov Nansen cruise collection has been identified by specialists in the Federal Republic of Germany and in the United Kingdom; the collection of identified material will be deposited in the region.
- (b) The R/V Professor Mesyatsev collections will be treated in a similar way.
- (c) Taxonomic and curating skills should be developed in the CINCWIO region; some taxonomists are willing to travel to help with the problem.

### III.C (c) vi) Data Collections

There is an assemblage of unpublished information in the log books and records of transient scientific visitors. Bibliographies (of published material) should be used to obtain access to this material. A certain number of internal reports should also be made available.

Facilities should be made available for the storage of data at the CINCWIO Oceanographic Support Centre (see III.D (b) below).

### III.C (d) Biological Oceanography

The Group decided that if the objectives of the CINCWIO programme are to be achieved in so far as fisheries are concerned, the following questions must be asked of the biological oceanographers:

1. Is potential production in the Somali upwelling area diverted in the food chain to resources difficult to use?

We should establish first whether such a diversion occurs and if it does what the nature of the diversion is.

2. What is the migration circuit of shrimps in estuaries, mangrove swamps, reefs and in deep water?

We should survey shrimp resources first and investigate the biology second.

3. What is the relationship between the fringing reefs and the mangrove swamps? For example : the reefs are broken by fresh water, but they protect the shore.

4. Does the seasonal movement of the thermocline on the shelf affect the distribution of fishes there?
5. What is the seasonal distribution of brackish water?
6. What is the seasonal movement of the oxygen minimum layer above the shelf and in the deep ocean?
7. What is the reproductive status of fishes in the area by area and season?
8. What is the distribution of eggs and larvae by area and season?
9. What is the migratory pattern of the billfishes and the shoaling tuna-like fishes?
10. On which species should biological study be concentrated?
11. How can the structure and function of certain ecosystems be defined?
12. Do dead corals (perhaps killed by trawlers) generate fish toxins?
13. What causes clupeoid poisoning?

### III.D SUB-GROUP (C) - INFRASTRUCTURE, AND TRAINING AND EDUCATION

#### III.D (a) Philosophy

The Chairman of the Sub-group - Professor Mohammed Hyder - presented his views on the basic philosophy behind the development of marine science in the region. The group concurred strongly with the major points put forward and decided to adopt these as a basis for their future discussion and the preparation of appropriate recommendations.

The activities of CINCWIO should have a very important impact on the exploitation of the Indian Ocean by the countries of the region, by leading to an understanding of the exploitation potential of the North and Central Western Indian Ocean. At this stage of our development, none of the coastal states in the CINCWIO region can afford to direct scarce manpower resources towards an activity that is likely to lead only to a satisfaction of national and international scientific palates. The dichotomy between the International scientist (seeking a global interpretation of oceanographic phenomena) and the regional scientist (seeking a scientific understanding of his area - initially, at any rate, as a basis for improving the economic and social well-being of his fellow countrymen through the exploitation of such resources as exist) is at this juncture more likely hypothetical than real.

The countries bordering on the North and Central Western Indian Ocean are firstly interested in obtaining food and secondly in extracting a form of livelihood. The traditional pattern among the coastal peoples of the area

have been fishing and farming. The seasonal monsoon rains have been periods of low fishing and intensified farming activity and the dry seasons have seen a reversal in this pattern. By and large both these activities have been at a subsistence level. Since political independence the nations' efforts to raise the fishing activity to higher economic levels has demonstrated only too lamentably the lack of modern gear, manpower and technological and financial resources.

If the coastal states in the CINCWIO region wish to exploit the resources of the Indian Ocean for the economic benefit of their people, sooner or later they will have to develop the competence to evaluate the potential of these resources and to exploit them effectively and rationally. The corollary to this is obvious: the coastal states of the region should be the ones to conceive and encourage regional co-operative programmes, such as CINCWIO.

CINCWIO will provide the coastal states of the region with an opportunity to accomplish the following:

- (a) to learn to ask the right scientific questions, the answers to which are relevant in both the formulation of exploitation practices and in asking yet further questions;
- (b) to learn to plan the kind of co-operative scientific investigations which should continue with an increasing local contribution;
- (c) to learn to analyse and evaluate the resulting data which can be transmitted with reasonable confidence to exploitation agencies for their use; and
- (d) to make the maximum use of CINCWIO in order to acquire at least some of the technical manpower resources necessary for mounting a programme such as CINCWIO;

After discussion of these points, the Group decided to:

- (i) take stock of the resident competence and of the training facilities available in the area;
- (ii) assess, in practical terms, the level of competence needed for local staff in order to participate in CINCWIO;
- (iii) determine how to train suitable manpower and strengthen existing institutions;
- (iv) determine how the CINCWIO research programme can be used to train the necessary staff.

It was emphasized that the coastal states of the CINCWIO region (i) need

local scientists to provide a backbone of continuity in accumulating observations at various points, and (ii) need to develop a capability of manufacture, utilize and maintain simplified oceanographic tools and equipment which can be used in making observations.

In order to develop a series of recommendations on the training and education aspects of the CINCWIO programme, the Group first prepared two information tables. The first (Table 3) summarizes the facilities which are available within the coastal states of the region to support the CINCWIO research programme. The second (Table 4) summarizes the manpower resources currently available within the coastal states of the region in those disciplines that are relevant to the CINCWIO research programme.

Sub-group (C) also considered reports from sub-groups (A) and (B) on their estimates of manpower and facilities needed by the coastal states of the region to implement the CINCWIO programme. Sub-group A (physical and chemical oceanography) indicated that the following numbers and types of personnel would be required over the next two or three years to carry out the near-coastal physical and chemical oceanography programme recommended for Regions I and II:

- (i) Five physical oceanographers (one senior Ph.D. in dynamical oceanography, one M.Sc., and two junior oceanographers, possibly graduate students).
- (ii) Four sea-going marine technicians (two electronics, two mechanical).
- (iii) Six land-based technicians who would work at sea 30% of their time (three electronics, three mechanical).
- (iv) Three data-processing staff (one with computer-programming experience, two general).
- (v) One general office assistant.
- (vi) One librarian/clerk
- (vii) Two or three secretaries.

Sub-group (A) (marine geology and geophysics) provided the following analysis of the manpower and resources in the region relative to the programme it had recommended:

#### 1. Heavy minerals

- (a) Some local manpower resources are available in Kenya and Tanzania. The University of Dar-es-Salaam can offer training facilities for other coastal states in the CINCWIO region.
- (b) Advanced overseas training should be arranged for about four postgraduates (for four to six months).
- (c) Laboratory equipment worth about \$US 40,000 which had been ordered through Unesco was not delivered due to lack of funds. It is requested that IOC seek funds for the acquisition of this equipment - either through the ICSPRO agencies or IOC Member States.

## 2. Shore and shelf materials

Geological surveys or universities in the countries of the region could provide all of the necessary manpower.

## 3. Oil and gas

- (a) Research in this area could best be carried out by research vessels from outside the region. These vessels should be well-equipped for geophysical studies, including bottom sampling.
- (b) Training opportunities should be provided aboard such vessels for about 30 local trainees. This could be accomplished by a single research programme of three to four months during which seven or eight local trainees would be trained on each three-week cruise.
- (c) Local scientists should also have an opportunity to participate in the evaluation of cruise results at institutions abroad.

## 4. Earthquake positioning

Training in this field should be combined with the training outlined under paragraph (3) above. Geologists and/or geophysicists who are at present available in the coastal states of the CINCWIO region, could be trained in the operation of seismographic equipment aboard research vessels.

### III.D (b) An Oceanographic Support Centre for CINCWIO

The recommendations herein envision a greatly expanded programme of data collection in the coastal areas of eastern Africa. A diverse suite of measurements will be made over a large geographical area under widely differing conditions by individual groups with differing technical capabilities. It is essential therefore that there be active central co-ordination so that the limited resources of people and equipment can be used to maximum efficiency. The establishment of an Oceanographic Support Centre is considered essential to the CINCWIO programme. The work of the Centre should be exclusively mission-oriented (over the first several years at least) and is conceived as the minimal structure consistent with the task at hand. The energy and drive of individuals involved will determine the success of the whole programme. This small group of individuals should be identified in the immediate future so that the recommended programmes can be initiated.

The functions of the Centre fall naturally into seven groupings, all related to the necessity of early implementation of the CINCWIO programme recommendations:

Co-ordination,  
Operations Support,  
Data Collection,  
Data Reduction,  
Data Analysis,  
Dissemination, and  
Training.

### Co-ordination

Many different collection platforms will be used - from committed national research vessels, to ships-of-opportunity, to unattended instruments and moorings. The relative importance of the different measurements and platforms will change with the seasons. The Centre will be the only source of information on the timetables of the various participants and hence should be responsible for developing opportunities and for influencing schedules for maximum results.

### Operations Support

The Support Centre should be responsible for instrument repair and calibration using both its own facilities and those of co-operating national laboratories and workshops. It should be responsible also for intercalibration of all measurements. This is crucial because of the number of participants groups, the areal overlap of their responsibilities and the variety of techniques which they will be using. The Centre should provide a central supply point for equipment and materials on a permanent or interim basis. Thus, small bottles, data forms, chemical reagents and standards would be supplied where necessary. Exchange or loan of equipment between the participating nations would be arranged through the Centre. Supply of permanent equipment (e.g. wind and temperature recorders through the assistance of the IOC, etc) would be canvassed by the Centre.

### Data Collection

Since the technical capacities of the collaborating nations cover a wide range, the Centre will fulfil an active support function. This should include the organization and instrumentation of ships-of-opportunity for collection of surface data and the processing of samples collected by the ships of participating nations when the latter are not themselves in a position to perform the analyses.

### Data Reduction

This should involve the digitalization of analogue records; exercising of quality control on physical, chemical and biological measurements; preparation of distribution maps; and the inventoring and storage of the data in standard formats.

### Data Analysis

Data should be integrated at the descriptive level and the different measurements inter-related with a view to identifying mechanistic relationships.



### Dissemination

The Centre should bear the responsibility of disseminating all the CINCWIO data both in the standard IOC formats and in special combinations or forms at the request of individual investigators or nations. Thus the preliminary results of routine surveys would be circulated to interested parties with as little delay as possible, with formal annual data reports and summaries being made available to the world at large.

The Centre should also prepare and distribute an informal newsletter summarizing recent developments in the programme and providing information as to planned activities and future opportunities for research, training and education.

### Training

This is the most important long-term activity of the Centre. The Centre's initial organization should maximize the educational opportunities at all levels for scientists, technicians and students of the countries of the CINCWIO region. Many individuals should be able to gain field experience by participating in the extensive research programme proposed. Such participation should be actively encouraged, both on a national and an international basis.

The Centre should be able to provide additional opportunities for training within its programme for laboratory analyses, equipment maintenance, data analysis and dissemination etc. During the early stages of the Centre's development, some outside maintenance may be necessary for these programmes. Such assistance should be provided by resident and/or visiting scientists primarily at the Centre itself or at academic institutions in the region. Additional training should be offered by academic institutions in other interested countries.

The CINCWIO training programme should initially be aimed at improving the overall capability of the countries in the region to participate in CINCWIO research. This can be achieved through well-planned collaboration between the Centre and the Universities and other educational institutions in the region. In this collaboration the Centre should fulfil a function similar to that of a marine research field station. That is, it should provide field experience and other on-the-job training to complement the academic education of scientists and technicians at all levels.

The facilities to be available at the Centre must enable it to fulfil the functions outlined above. While it would be ill-advised to duplicate capabilities already existing in the local participating nations, the Centre should possess the following:

1. Equipment repair and calibration facilities, i.e., small well-equipped machine and electronic shops.
2. A laboratory for biological and chemical analysis. Initially, this

should contain equipment for the measurement of salinity and basic nutrients. As it develops it can expand to include more advanced instrumentation for analysis of additional nutrients and for analysis of pollutants in economically important marine organisms.

3. Offices for data reduction, drafting etc.
4. Areas for storage of equipment and data.
5. A library - either convenient access to a national library or a collection of relevant books and journals.
6. Conference room and classroom facilities for meetings, discussions and training courses.

It was reiterated that the Centre should be established as soon as possible, that it should be small and mission-oriented, and that it should have sufficient backing from the participating nations to make it a major source of initiative for the on-going activities of the programme. It can be anticipated that the Centre could grow and develop with the programme and become a major facility for support oceanographic research in the Western Indian Ocean. However, the immediate requirements is for the establishment of a small, active group. Success of the CINCWIO programme is contingent upon this.

TABLE 1 : PROGRAMMES IN TANZANIA AND KENYA COASTAL AREAS (REGION I)

<u>Variables</u>	<u>Locations</u>	<u>Depth range</u>	<u>Frequency</u>	<u>Method</u>
Temperature	5 stations (see fig. 1)	Surface to bottom	1/month	Ship station
	4 positions (see fig. 1)	Surface to 60 m	1/hour	Unattended temperature-pressure recorders
Salinity	5 stations	Surface to bottom	1/month	Ship station Conductivity
Wind	At all meteorological stations along the coast and at all ship stations			
Current	3 stations	Surface to bottom	1/month	Ekman current meters/parachute drogues
Oxygen	5 stations	Surface to bottom	1/month	Titration
Vertical Zooplankton	5 stations	Euphotic zone	1/month	Volumetric
Phosphates	5 stations	Surface to bottom	1/month	Colorimetric
Silicates	5 stations	Surface to bottom	1/month	Colorimetric
Nitrates	5 stations	Surface to bottom	1/month	Colorimetric
Ammonia	5 stations	Surface to bottom	1/month	Colorimetric
Turbidity	5 stations	Surface to bottom	1/month	Secchi Disc/Turbidity meter

Notes on Table 1 :

1. This programme should be conducted by EAMPRO over a five-year period with the cooperation of institutions in the coastal countries. IOC should be a major sponsor of this programme and should assist in providing necessary equipment and other scientific and technical assistance.
2. It is recommended that action be initiated as soon as possible to ensure that this programme becomes fully operational by late 1977.

TABLE 2 : PROGRAMMES IN SOMALI COASTAL AREAS (REGION II)

Variables	Location	Depth range	Frequency	Method
Temperature	Along 3 sections off Mogadiscio, Obbia, Ras Hafun (see Fig. 1)	Surface to bottom	3 times during summer monsoon (March-Sept)	Ship Station
	3 positions (see Fig. 1)	Surface to 40 m.	1/hour	Unattended temperature-pressure recorders
Salinity	along 3 sections (see temperature)	Surface to bottom	3 times during summer monsoon (March-Sept)	Ship station conductivity
Wind	At all existing meteorological stations along the coast; at the proposed stations at Obbia, Ras Mabber, Ras Hafun and Ras Asir; and on all ship stations (see Fig. 2)			
Current	eventually during execution of series	0-100m	3 times during summer monsoon	Profiling current meter/ parachute drogues
	4 positions (see Fig. 1)	100-1000m	1/hour	moored current meters
Oxygen	(same as salinity)	(same as salinity)	(same as salinity)	Ship station Oxygen sonde
Chlorophyll Vertical Zooplankton Phosphates Silicates Nitrates Ammonia Turbidity	(a programme to collect these chemical measurements should be implemented at a later date as the institutions in the region develop their capabilities in this respect)			

Notes on Table 2 :

1. This programme should be initiated in March 1977 by the Somali Fisheries Ministry (S.M.F.). The IOC should support this programme strongly, particularly by providing scientific and technical equipment and advice. The programme should begin gradually and build slowly.
2. Because more development is required in this region, it was considered premature to limit this programme to a set time period.

**TABLE 3 : LIST OF FACILITIES AVAILABLE FOR RESEARCH IN MARINE SCIENCES  
IN THE COUNTRIES OF THE CINCHIO REGION**

	MAURITIUS	MADAGASCAR	TANZANIA	KENYA	SOMALIA	EAMPRO
Laboratory Equipment	Marine Chemistry	Marine Biology, Physical Oceanography, Fisheries	Marine Biology, Physical Oceanography	none	none	Physical Oceanography, Fisheries
Field Equipment	Marine biology, Chemical analysis	Physical Oceanographic and Marine Biological sampling, G.E.K.	Bottom samplers, Plankton water samplers, etc.	none	none	Sampling equipment for physical oceanography and fisheries
Research vessels	(a) 26 m combination fishery vessel (b) 10 m inshore boat	(a) 11 m trawler; (b) 14.5 m trawler; (c) 63.5 m ship for physical oceanography	26.2 m fishing vessel	24.7 m stern trawler	Fishery research vessel	(a) 38.3 m (118 ft) side trawler (b) 40 m (122 ft) stern trawler on order
Other boats	small boats available for lagoon work	none	(a) 10 m in-board boat (b) 6 m out-board boat	none	none	(a) 10 m launch in Zanzibar (b) 13.1 m launch for Mombasa on order

TABLE 3 continued

	MAURITIUS	MADAGASCAR	TANZANIA	KENYA	SOMALIA	EASTRO
Aquaria	Construction planned 1977/78	(a) Nosy-bé (b) Tuléar	Large aquarium with running water	None	none	(a) Zanzibar (b) one planned for Mombasa
Laboratory Facilities	A laboratory planned for 1977/78 will include wet and dry labs, and hatcheries	(a) Tuléar (b) Nosy-Bé (c) Majunga (d) Tananarive	Three laboratories	One Laboratory	none	(a) Zanzibar (b) Mombasa (c) One planned for Dar-es-Salaam
Libraries	(a) Univ. of Mauritius (b) Museum (c) Limited facilities at Ministry of Fisheries	(a) Nosy-Bé-good (b) Tananarive (c) Tuléar-limited	(a) University (b) Fisheries Ins. Lab.	Nairobi - Fisheries Department	Planned as part of National Library	(a) Zanzibar (b) Planned at Mombasa
Special Equipment	none	(a) Decca Hi-Fix (b) Spectrophotometer (c) Salinometer	Spectrophotometer Salinometer Scuba gear	none	none	(a) Spectrophotometer (b) Autoanalyzer (c) Salinometer



TABLE 3 continued

	HAUT VUS	MADAGASCAR	TANZANIA	KENYA	SOMALIA	ZAMBIA
Data Collection and Storage	none	(a) Tulear (b) Nosy Bé	Limited facilities for data storage	none	none	none
Museums and Collections	Port Louis	none	none	Nairobi	none	Zanzibar
Maintenance and Repair of Boats and Equipment	(a) Boats-yes (b) Electronics - limited	(a) Boats-Yes (b) Electronics-none (c) Optical-yes	(a) Boats-yes (b) Electronics-none	(a) Boats-Yes (b) Electronics - none	(a) Boats-Yes (b) Electronics - none	(a) Boats-yes (b) Electronics - yes (c) Mechanical equipment - yes
Computers	(a) Olivetti P-652 (b) NCR-2	(a) BM 1130...2 (b) BM 360140.3 (c) NCR .....1	One at University - Mathematics Department	none	none	(a) Olivetti P-101 (b) Olivetti P-604

TABLE 4 : LIST OF AVAILABLE EXPERTISE AND TRAINEES IN MARINE SCIENCES IN THE COUNTRIES OF THE CINGWIO REGION

		<u>MAURITIUS</u>		<u>MADAGASCAR</u>		<u>TANZANIA</u>		<u>KENYA</u>		<u>SOMALIA</u>		<u>RAFRO (EAC)</u>
		Univer- sity	Other	Univer- sity	Other	Univer- sity	Other	Univer- sity	Other	Univer- sity	Other	
	No. of Experts	None	None	None	3+	1?	None	1	None	None	None	2
PHYSICAL OCEANOGRAPHY AND MARINE METEOROLOGY	No. of Trainees											
CHEMICAL  OCEANOGRAPHY	No. of Experts	None	None	None	None	None	None	None	None	None	None	None
	No. of trainees											
FISHERIES	No. of Experts	None	6	?	3	1	?	None	None	None	None	13 inclu- ding one Oceanogra- pher
	No. of Trainees		2				60					12
CONSERVATION AND POLLUTION	No. of Experts	None	None	None	None	None	None	None	None	None	None	None
	No. of Trainees											
BIOLOGICAL  OCEANOGRAPHY	No. of Experts	None	None	7	None	6	None	2			None	None
	No. of Trainees				None	4	None					
MARINE  GEOLOGY	No. of Experts	None	None	?	None	2		1		None	None	None
	No. of Trainees			?	None	?						

Notes on Table 4 :

1. A question mark indicates that there was some reason to believe that the country indicated did have people in that area listed, but that no definitive information was available.
2. A blank space indicates that no information was available for this category.

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V. LIST OF PAPERS PRESENTED OR DISTRIBUTED

Introduction to the oceanography of the area - Professor Henry Stommel

Notes on the climatology of Eastern Africa and the West Indian Ocean -  
Mr. John Findlater

Air/sea interaction in the CINCWIO area - Dr. B.N. Filjushkin

Equatorial currents of the Western Indian Ocean - Dr. John C. Swallow

Western Boundary Currents including the upwelling systems - Dr. Walter  
O. Düing

Theoretical models of the Indian Ocean circulation with reference to  
the study area - Dr. D.W. Moore

The oceanography of the East African Coast - Mr. A. Winters  
(presented by Dr. D. Cushing)

General problems and investigations in India in the field of coastal  
oceanography - Dr. V.V.R. Varadachari

Aspects of coastal geology - Dr. V. Cilek

Review of marine geology off North-eastern Africa - Dr. K.O. Emery

Chemistry of surface waters in upwelling areas - Dr. John M. Edmond

Production regimes in the tropical and sub-tropical Indian Ocean -  
Dr. T. Wyatt

Coastal pelagic fishes - Dr. D.A. Shubnikov

Pelagic fishes and fisheries of the Indian Ocean - Mr. Richard S. Shomura  
and Dr. Richard N. Uchida (presented by Mr. Shomura)

Recent trends in demersal fisheries in the CINCWIO area - Dr. John Tarbit

Present state of our knowledge of decapod crustaceans from the North and  
Central Western Indian Ocean - Dr. C. Sankarankutty

Coral reef ecology and conservation - Dr. R.L. Jachowski  
(not presented)

Pollution problems - Dr. G. Tomczak

Marine science training and education in Eastern Africa - Professor Mohammed  
Hyder.



VI. LIST OF ACRONYMS AND ABBREVIATIONS

ALECSO	Arab League Educational, Cultural and Scientific Organization
BATHY	Bathymograph
CCOP (of ESCAP)	Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas
CCOP/SOPAC (of ESCAP)	Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas
CICAR (of IOC)	Co-operative Investigations of the Caribbean and Adjacent Regions
CINCWIO (of IOC)	Co-operative Investigations in the North and Central Western Indian Ocean
EAC	East African Community
EAMFRO	East African Marine Fisheries Research Organization
ESCAP (ex ECAFE)	Economic and Social Commission for Asia and the Pacific
FAO	Food and Agriculture Organization of the United Nations
FGGE	First GARP Global Experiment (of WMO/ICSU)
GARP	Global Atmospheric Research Programme (of WMO/ICSU)
GFCM (of FAO)	General Fisheries Council for the Mediterranean
ICNAF	International Commission for the Northwest Atlantic Fisheries
ICSEM	International Commission for the Scientific Exploration of the Mediterranean
ICSPRO	Inter-secretariat Committee on Scientific Programmes Relating to Oceanography
IDOE	International Decade of Ocean Exploration
IGOSS (of IOC/WMO)	Integrated Global Ocean Station System
IIOE (of IOC)	International Indian Ocean Expedition
IOC	Intergovernmental Oceanographic Commission
IODE (of IOC)	International Oceanographic Data Exchange
IOFC (of FAO)	Indian Ocean Fishery Commission
MONEX	Monsoon Experiment
NIO (India)	National Institute of Oceanography, Goa
NMFS (USA)	National Marine Fisheries Service
NOAA (USA)	National Oceanic and Atmospheric Administration
ORSTOM	Office de la Recherche scientifique et technique Outre Mer
ROSCOP	Report of Observations/Samples collected by Oceanographic Programmes
TEMA (IOC)	Training, Education and Mutual Assistance
TESAC	Temperature, Salinity and Currents report
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VAP	Voluntary Assistance Programme
VNIRO	All-Union Research Institute of Marine Fisheries and Oceanography, Moscow
WMO	World Meteorological Organization
XBT	Expendable bathymograph