SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

proceedings

volume 3 / number 1

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

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PROCEEDINGS

OF THE

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Volume 3, Number 1

1 May 1967
La Jolla, California

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Report of the Executive Committee Meeting

Jerusalem, 6 - 8 February 1967

The meeting of the SCOR EXECUTIVE Committee was held at the Israel Academy of Sciences and Humanities, Jerusalem 6 - 8 February 1967, with the President, Captain Luis Capurro in the chair. The business meeting was preceded by a tour of southern Israel and a visit to the new Marine Biological Research Station in Eilat, under the auspices of the Hebrew University of Jerusalem; after the business meeting there was a tour of northern Israel and a visit to the Sea Fisheries Research Station in Haifa, under the auspices of the National Council for Research and Development and the Administration for Oceanographic and Limnological Research.

Both in Eilat and in Jerusalem visiting participants in the SCOR meeting had the opportunity to discuss problems of mutual scientific interest with Israeli scientists. On the evening of 7 February, the following public lectures were presented at the Academy:

Captain Luis R. A. Capurro "Oceanography from Space"

Professor Trygve Braarud "The Hydrographical Background for Differences in Phytoplankton Abundance and Composition within a Norwegian Area"

Professor Heinz Steinitz "The Immigration of Red Sea Organisms in the Mediterranean Sea - Results and Problems".

The lectures were followed by a reception by Professor A. Katzir-Katchalsky, President of the Academy.

A list of those who participated in the Executive Meeting is given in Annex I. The agenda followed in this meeting serves as an outline for the report which follows.

1. Organization and Finance

1.1 Report of the Secretary

Amendments to the SCOR Constitution proposed at the last General Meeting were accepted by the ICSU Executive Committee and are now in effect. The new ex officio members of the Executive Committee were invited to the Jerusalem meeting and have been routinely receiving copies of pertinent correspondence.

During the Eighth General SCOR Meeting, Professor Cagliotti, President of the Consiglio Nazionale delle Ricerche of Italy, proposed that the Consiglio publish the papers presented at the Symposium on Variability. Professors Stewart and Braarud agreed to serve as Editors for the volume. At the present meeting, Professor Aliverti reported a further proposal, that publication be in a regular scientific journal, subsidized as necessary by the Consiglio which would require approximately 100 copies for its own use. This proposal was accepted by the Executive Committee, and the Secretary was instructed to explore the matter with appropriate publications. It was noted that Professors Stewart and Braarud should continue to serve as Editors, that they should prepare an appropriate foreward for the volume, and that SCOR would require sufficient copies for distribution to Members and to National Committees.

1.2 Budget

An estimate of SCOR expenses in 1966 and a tentative budget for 1967 are given in Annex II. Despite the steady increase in SCOR activities, financial support from UNESCO and ICSU, together with national contributions, appears to be adequate for the work planned in 1967. In this connection the Executive noted with appreciation that the Standing Finance Committee of ICSU had agreed to grant a subvention of $4000 for 1967.

2. Working Groups

2.1 Report on existing groups

WG 10. Oceanographic Tables and Standards (with ICES, IAPO and UNESCO):

In accordance with a recommendation of the General Meeting, Dr. F. H. Fisher (USA) and Prof. Dr. W. Kroebel (FRG) have been added to the Panel. Dr. Fisher will serve in place of Professor Miyake, as a SCOR nominee. Professor Kroebel was nominated by IAPO.

The first section of new International Oceanographic Tables, comprising tables for computation of sea water salinity from measurements of conductivity ratio, has been published by Unesco and the National Insti-

tute of Oceanography, U. K. Another table relating refractive index to salinity is in final form. Measurements of specific gravity are being made at NIO and Kiel, but the measurement of absolute density has not yet been possible (it is estimated that $100,000 is required to finance this work). The panel is also considering production of a standard table for oxygen solubility. The next meeting is scheduled for October 1967 in Bern (in connection with the IAPO General Assembly).

During the discussion of this working group, Dr. Deacon reported that the refractive index tables were now ready for printing, and suggested that the absolute density measurements might be made by the U. S. Bureau of Standards. It was also learned that thermal expansion measurements would be made in Leningrad using water samples from the collection of Dr. Cox. Professor Dietrich reported studies in his country on the specific gravity of coastal waters and on the measurement of isothermal compressibility.

The Executive Committee applauded the successful efforts of the working group and of the National Institute of Oceanography of Great Britain, and UNESCO, in completing the first section of the new International Oceanographic Tables. The hope was expressed that a new Foreward would be prepared that would more adequately describe the history of events leading to preparation of the tables and the role of organizations such as ICES, IAPO and SCOR in sponsoring and stimulating this work.

WG 12. Abstracts and Bibliography: It will be recalled that during the last SCOR General Meeting it was decided to discontinue this group and to keep under review the possibility of further activity when it was clear how SCOR could most effectively contribute to solution of the problem. Since then a member of the group, Dr. F. Model, has completed the "Report on the bibliographic comparison of Current Bibliography for Aquatic Sciences and Fisheries, FAO, with Hydrographische Dokumentation, DHI." The German National Committee suggested that this report could serve as material for a discussion of further activities of WG 12.

The Executive Committee congratulated Dr. Model on his important contribution and decided to bring the report to the attention of UNESCO and FAO. In this connection, Dr. Fedorov reported that UNESCO has established a new Department of Information; existence of this Department may facilitate more effective collaboration with FAO on the solution of problems of marine science documentation. Dr. Ruivo reported that FAO planned to work closely with Dr. Model in implementing some of his recommendations. The Executive Committee decided to invite Dr. Model and Professor Saul Saila to serve as rapporteurs on this subject, advising SCOR from time to time on recent developments in the field and on possible actions that should be taken.

Dr. Ruivo reported that FAO was considering an increase in the list of journals covered by their publication "Current Contents in Marine

Sciences". The Executive Committee agreed to assist through correspondence in revision of the list.

WG 13. Zooplankton Sampling Methods (with ICES and UNESCO):

This group now consists of the Chairman (Dr. J. H. Fraser), conveners of the four working parties (Mr. Currie, Dr. Bé, Mr. Tranter and Mr. Foxton) and Dr. G. Hempel. The group has examined proposals for establishment of a new working group on zooplankton laboratory methods (see item 2.2) and for cosponsoring (with SCIBP) a Plankton Statistics Center (see item 4.4). As suggested at the last SCOR General Meeting, Dr. Fraser has published a note describing the activities and conclusions of the WG in Nature (vol. 211, no. 5052, pp. 915-916, 1966). The group is continuing its work in preparing the final integrated report which is to be published by UNESCO, together with papers presented at the Symposium on the Hydrodynamics of Plankton Samplers (Sydney, 1966) as No. 2 in the series of UNESCO monographs on methodology.

The Executive Committee agreed that when the final report had been received, it would be forwarded to UNESCO with a recommendation concerning the mode of publication. Professor Braarud commented that eventually field tests of recommended equipment would be required; a new working group may be required for that purpose.

WG 15. Photosynthetic Radiant Energy (with UNESCO and IAPO):

This group met in Karuizawa, Japan, 15-19 August 1966. A report of the meeting has been published by Unesco (Technical Papers in Marine Science No. 5). A feature of this group has been the assignment of specific projects of research and development to individual members. Progress has been such that instrumental field trials are proposed for May 1968 in the Gulf of California. These trials would last two weeks and would involve members Jerlov, Ivanoff, Ochakovsky, Tyler and Jitts; Mr. Tyler has agreed to arrange for suitable ship facilities. Full trials are proposed for the summer of 1969 in the waters between the Canaries and the west African coast; a suitably equipped ship must be found.

The Executive Committee agreed to encourage organization of the proposed field trials. With regard to a proposal that a symposium on hydrooptics be held early in 1968, it was decided to defer action pending further discussion with the WG Chairman, Mr. Tyler.

WG 18. Biological Data (with ACMRR): At the last General Meeting it was decided to retain this group until the present Executive Meeting, with its work being carried on by correspondence with the initiative of its chairman, Dr. Hempel. The future of the group was discussed by ACMRR at its Fourth Session (Rome, 16-21 January 1967); the Committee expressed appreciation of the work done by this group, noted that important decisions

await work in progress in several biological fields (especially on methodology) and recommended to SCOR that the group be dissolved pending further progress, or specific demands of WDC's or FAO (in connection with its Fisheries Data Center).

The Executive Committee agreed to discharge the working group with appreciation of their contribution, and to handle further problems relating to biological data exchange on an ad hoc basis until the need for another working group is clear.

WG 19. Micropaleontology of Bottom Sediments: Subsequent to informal meetings of this group in Moscow during the Second International Oceanographic Congress, the symposium "Micropaleontology of Marine Bottom Sediments" has been scheduled for 10-18 September 1967 at the University of Cambridge, England. Invitations have been issued to about 100 specialists. Funds will be required for invited lecturers and members of the working group as well as for Russian-English interpretation. Dr. Fedorov reported that UNESCO will provide $5000; a similar amount can be supplied from SCOR funds. It was decided to ask National Committees to support participation of their scientists, including if possible invited lecturers. With regard to the additional terms of reference proposed by the working group (see Proceedings, vol. 2, p. 47), it was agreed to defer decision on the future of the group until after the symposium.

WG 20. Radiocarbon Estimation of Primary Production (with ICES and UNESCO): This group met in Copenhagen, 24-26 October 1966. A final report was received in time for consideration at the Executive Meeting, which was informed that UNESCO intends to publish it as Number 6 in the series "UNESCO Technical Papers in Marine Science".

The working group noted the request of the IBP PM Section to consider the estimation of primary production under a variety of unusual conditions and to study methods for estimating the production of phytobenthos, but felt these matters could not be adequately covered in the time available and with the present membership of the group. The Executive Committee decided to establish a separate working group for considering the former problem (see 2.2 below). With regard to phytobenthos, it was agreed that this problem could best be studied by the IBP PM Section. The Executive Committee also agreed to discharge WG 20, thanking them for their important work.

WG 21. Continuous Current Velocity Measurements (with IAPO and UNESCO): The first meeting of this group is scheduled for 17-19 April 1967 at the National Institute of Oceanography of Great Britain. In July it is planned to conduct a field experiment of intercomparison of current meters at the Woods Hole Oceanographic Institution. The Executive Com-

mittee was gratified by the development of this work. It noted the importance of completing arrangements for obtaining and shipping essential items of equipment well in advance of the July trials.

WG 22. Marine Pollution (with ACMRR): This group met in Paris, 12-14 December 1966; it considered terms of reference for the IOC Working Group on the same subject, prepared an annotated agenda for its first meeting, and recommended various preparatory actions to the IOC Secretariat. The report is given in Annex III.

The Executive Committee agreed that the working group had performed a valuable service; its report has been made available to the IOC Bureau, and the group can now be discharged. Suggestions were made informally to the IOC Secretary concerning implementation of the recommendations and selection of experts to prepare the necessary background papers.

2.2 Establishment of new groups

WG 23. Zooplankton Laboratory Methods (with UNESCO):
During the Eighth General Meeting, it was decided to refer to WG 13 a proposal for establishing a working group to examine problems of preservation of zooplankton samples, preservation of microplankton and estimation of biomass. Dr. Fraser, WG 13 Chairman, after correspondence with his colleagues, forwarded a recommendation to establish such a group. It was suggested that this be a SCOR organization, and that it follow the pattern of WG 13, namely with working parties to consider specific aspects of the problem. These working parties would be as follows:

w.p. 1: preservation of zooplankton samples, including chemical methods, freeze-drying, radioactive methods, buffering and labelling. Membership should include one taxonomist, a member with experience of biomass studies, and a chemist with experience in preservation (not necessarily of marine samples).

w.p. 2: preservation of microplankton, with membership and coverage as above.

w.p. 3: estimation of biomass from samples collected at sea, methods of subsampling and counting (closely related to work of proposed Plankton Statistics Center: see item 4.4).

The International Council for the Exploration of the Sea has adopted the following resolution (C. Res. 1966/3:9):

"It was decided that SCOR be encouraged in their proposals to set up a Working Group to consider the Standardization of Plankton Methods in the Laboratory, and that (a) they be asked to include some ICES'

personnel in the membership of the working parties under the Group; (b) that one of the aims should be to produce a booklet on phytoplankton methods."

The Executive Committee, after considering these recommendations, decided to establish a working group with the following terms of reference:

"To suggest methods for preserving zooplankton samples for taxonomic study and for biomass determination."
It was agreed that the group should include experts in various important plankton groups, together with a histologist and a chemist. At its first meeting a decision can be made on the establishment of separate working parties, as suggested by WG 13.

WG 24. Estimation of Primary Production under Special Conditions (with IBP/PM): In view of the request of IBP/PB referred to above (see 2.1, WG 20), the Executive Committee decided to establish a working group with the following terms of reference:

"To review and suggest the best methods for estimating primary production under special conditions, such as those found beneath the polar ice, and the turbid conditions found in estuaries, heavily polluted waters and exceptionally eutrophic or oligotrophic waters."
If IBP/PM agrees to the joint establishment of this group, the nomination of members and arrangements for the first meeting will be made in consultation with the Chairman of IBP/PM, Dr. Ketchum.

WG 25. Nutrient Chemistry: At the last General Meeting, the Secretary was instructed to correspond with officials of ICES, IBP, UNESCO and IAPO to obtain more specific information on existing activities related to the standardization of marine chemical methods. This information could form the basis for formulation of the most effective role of SCOR. The following has been learned.

I.C.E.S.: At its last Statutory Meeting, ICES established a Sub-Committee on Chemical Analysis of Sea Water under the Hydrographical Committee. This Sub-Committee has the following membership: K. Grasshoff (Chairman), K. Palmork, P. Jones, K. Koroleff, V. Olsen, E. Føyn, S. H. Fonselius, F. Mosetti, U. Stefansson, H. Postma and A. Simonov. The terms of reference are:

1) To arrange and to supervise, especially in connection with multiship surveys, intercalibration tests for organizations and institutes working in the ICES' area.

2) To collaborate with relevant SCOR Working Groups in intercalibration work on a wider scale, whenever appropriate.

3) To assist the laboratories in exchange and distribution of technical information, such as information on modifications of the methods used and/or introduction of new apparatus in particular by means of a regular distribution of mimeographed news-sheets covering items of the latest development in the field.

4) To arrange and encourage the arrangement of training courses for technicians in chemical analysis of sea water and related matters, especially to assist countries and institutes not having adequate facilities for such training at present.

I.A.P.O.: There is a Committee on Chemical Oceanography, with Dr. Carritt as Chairman, but no group concerned specifically with nutrient chemistry.

I.B.P.: Under the PM Section's Working Group on Methodology, there is a Subgroup concerned with the application of marine chemical methods to brackish and turbid waters. This Subgroup is working closely with the PF Section's Committee on the Analysis of Freshwaters. Membership is Raymont (Chairman), Krey, Føyn and Postma. Postma acts as liason between this group and the ICES Sub-Committee. The group is not planning to prepare a manual, but it is hoped they will come up with a definitive statement of the precautions to be used with various methods when they are applied in brackish and turbid waters. The Chairman of the PM Section, Dr. Ketchum, has suggested that SCOR locate and publish the results of intercomparisons of chemical methods already made, and help in establishing criteria for the way in which intercomparisons should be carried out.

Discussion of possible SCOR action elicited the following concepts:

Despite the existence of various working groups, as described above, SCOR cannot avoid action because of its broad responsibility in problems of oceanographic methodology resulting from SCOR's advisory role vis-a-vis UNESCO and IOC. The most urgent requirement for standardization or intercalibration of chemical methods arises in the case of international cooperative investigations; in its review of such investigations, SCOR should stress the necessity for solution of methodological problems prior to commencement of the field phase. However, problems of standardization and intercalibration exist even in the absence of formal cooperative programs because of the international character of oceanographic data exchange. UNESCO has made an important contribution by collecting and making available the results of intercomparison experiments. Although some large laboratories are changing to automatic methods for nutrient analysis, many smaller laboratories, particularly in developing countries, must continue to use more classical methods. Such laboratories often need advice on the methods best suited to their needs. At the present time, the substances most requiring standard of comparable methods for their analysis are total

phosphorus, phosphate, nitrate, nitrite, ammonia and silicate.

In view of these considerations, the Executive Committee decided to establish a small working group with the following terms of reference:

"To advise SCOR on the most effective steps it could take to stimulate effective activity in the standardization and/or intercomparison of nutrient analyses, including the practicability of designating reference methods."

WG 26. Implementation of UN Resolution on Resources of the Sea (with ACMRR): On 6 December 1966, the General Assembly of the United Nations adopted a Resolution on the Resources of the Sea (see Annex IV). This resolution called for a comprehensive survey of activities in marine science and technology carried out by various organizations, member states, universities, scientific and technological institutes, etc. In addition it called for the formulation of proposals covering the most effective arrangements for expanded international co-operative activities directed towards better understanding of the marine environment through science and in the exploitation and development of marine resources, together with strengthening marine education and training programs.

During the Fourth Session of FAO's Advisory Committee on Marine Resources Research (Rome, 16-21 January 1967), it was recommended that a joint ACMRR-SCOR working group be established to advise the Director-General of FAO on the scientific aspects of what the methods, scope and content of the comprehensive survey should be, insofar as the study of marine fishery resources was concerned (see Annex V). The ACMRR further proposed that this joint working group undertake an examination of broader aspects of the UN Resolution by examination of three specific points (see later).

From an administrative point of view, the ACMRR suggested that the members of the joint group should be nominated by the Chairman of ACMRR and the President of SCOR, should be appointed by the Director-General of FAO, should report directly to the Director-General but also make its advice available to IOC.

Further consideration was given to the resolution by the IOC Bureau and Consultative Council (Monaco, 30 January - 2 February 1967), which, inter alia, decided to establish an IOC Working Group on the intergovernmental aspects of implementation of the resolution. In addition, it was decided to ask SCOR and ACMRR to advise the IOC on the scientific aspects of implementation of the resolution.

In discussion of these proposals, the SCOR Executive agreed to the establishment of the joint ACMRR/SCOR Working Group, but felt it should be organized in the usual way, ACMRR members being appointed by FAO and SCOR members being appointed by SCOR. It was recognized that a preliminary report should be available for consideration by the IOC Working

Group (scheduled to meet on 18-21 September 1967); this would require meeting perhaps in July, although a second meeting in early 1968 might also be necessary. It was decided to designate approximately six members, the same number being nominated by ACMRR. The following terms of reference were proposed:

1) To consider the request to ICSU of the Director-General of FAO, to co-operate with ACMRR in advising him on the scientific aspects of what the methods, scope and content of the comprehensive survey called for by the UN resolution should be, insofar as the study of marine fishery resources is concerned.

2) To consider the request of the IOC Bureau to advise the IOC on the scientific aspects of the implementation of the UN resolution.

3) To consider the following specific points:

a. Identification of problems in marine science and technology that require some form of international co-operation for their effective investigation and for the effective application of their results;

b. Examination of the forms of co-operation required and of their impact on the scientists and institutions concerned:

c. Examination of the manner in which existing international organizations deal with the problems and the forms of cooperation referred to above.

The Joint ACMRR/SCOR Working Group should examine these matters from the point of view of the scientists and laboratories concerned. It is assumed that inter-governmental bodies, such as the recently created IOC Working Group on inter-governmental aspects will examine these problems from the governmental point of view.

3. Relation with United Nations Organization

3.1 Advisory matters concerning UNESCO/IOC

IOC Working Group on Mutual Assistance: At the first meeting of this group, the SCOR representative, Dr. Humphrey, was elected Chairman. A second meeting is scheduled to be held prior to the Fifth Session of IOC, in Cairo, 15-17 October 1967. Another SCOR representative will be disignated prior to this meeting.

IOC Working Group on Oceanographic Data Exchange: At the Sixth Meeting of the IOC Bureau and Consultative Council, the Bureau recommended that the report of this Working Group, including the proposed

changes in the Provisional Guide for the International Exchange of Oceanographic Data, be transmitted to SCOR with a request that SCOR send its opinion to CIG. Upon its receipt, the report was transmitted to the President of CIG, with the following statement:

"Because of the organization of the World Data Center system under CIG, SCOR has a certain formal responsibility for approval of changes to this section of the Guide. However, SCOR has no specific working group on the subject, having chosen to participate actively in the appropriate IOC working group. Thus, upon approval of the revisions by the IOC Bureau, SCOR will undoubtedly recommend to CIG that the revised document be accepted."

During its Seventh Meeting (Monaco, 30 January - 2 February 1967), the IOC Bureau and Consultative Council approved the proposed revisions in the Provisional Guide and, subject to approval by CIG, instructed the Secretary to publish the second revised edition of the Manual on International Oceanographic Data Exchange. The Executive Committee, in accordance with its earlier statement, agreed to recommend to CIG that the revised document be accepted.

Cooperative Study of the South Mediterranean and Levant Basin: During the last SCOR General Meeting it was decided to defer action on the evaluation of this proposal until the nature and extent of national interest in the program became more clear. The IOC Bureau and Consultative Council, at its Seventh Meeting, after considering the results of an enquiry made by the IOC Secretary, recommended the adoption of the "Cooperative Study in the Mediterranean" as an official program of the IOC, to be undertaken jointly with ICSEM and GFCM. Enlargement of the program to cover the entire Mediterranean was approved, and further development of an expanded scientific program is to be ensured by a small group composed of the IOC Secretary and representatives of ICSEM and GFCM. The Executive Committee wished to record its gratification at the progress being made in development of this project, and offered its assistance to the above-mentioned group, should it be desired.

New Proposals for Cooperative Investigations: During its Seventh Meeting, the IOC Bureau and Consultative Council asked SCOR and ACMRR to study new proposals of the USSR (on the Comprehensive Study of the Southern Ocean) (see Annex VI) and of the Netherlands (on the Cooperative Study of the Caribbean Sea) (see Annex VII) and to report its observations to the Fifth Session of the Commission. The Bureau was also aware of Professor Kort's proposal "The international project of studying the North Atlantic dynamics and hydrology" (see Annex VIII), prepared for SCOR in accordance with IOC Resolution IV-14. Finally, the Bureau noted the "intention of SCOR to report to the Vth IOC Session on the progress of examining scientific aspects of organizing a Cooperative Study of the South Pacific." (see 6.1 below).

In view of the increasing number of requests for evaluation of scientific aspects of such proposals, it appears necessary for SCOR to develop procedures for obtaining effective evaluations. The Executive Committee agreed that such procedures should include circulation of the proposals to National Committees, to selected experts, and to appropriate scientific bodies, with a request for comment and recommendations. The results of these inquiries would then be circulated to members of the Executive Committee for discussion by correspondence and at a subsequent Executive Meeting. Although such procedures may appear slow, an attempt would be made to expedite them; in any case, the Executive Committee felt that "instant advice" would not be so useful in the long run as the advice resulting from careful consideration by scientists familiar with the problem.

It was noted that the Caribbean and Southern Ocean proposals, which had been officially presented to the IOC, would be circulated to governments by the IOC Secretariat. Although Professor Kort's proposal had not yet been reviewed by National Committees, the Executive Committee decided to ask the IOC Secretary to include that proposal in his governmental distribution, in order to permit early consideration by IOC Members.

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The IOC Bureau also requested SCOR action with regard to the Third International Oceanographic Congress (see 7.1 below).

3.2 Relation with FAO/ACMRR

The ACMRR meeting was held in Rome, 16-21 January 1967. SCOR was represented by its Secretary, in accordance with a previous decision of the SCOR Executive that one of its members should attend future ACMRR meetings. ACMRR decisions concerning matters of interest to SCOR are reported in appropriate sections elsewhere in this report.

3.3 Relation with WMO

The representative of WMO, Dr. Rosenan, reported on the establishment of a joint WMO/IOC panel of experts to coordinate meteorological and oceanographic requirements for ocean data stations.

4. Relation with ICSU and constituent bodies

4.1 Relation with IAPO

Professor R. W. Stewart, on behalf of SCOR, attended the meeting of the IAMPA/IAPO Joint Committee on Air-Sea Interaction, at Kyoto in September. A report of this meeting has been circulated to the Executive. No specific action by SCOR seems to be called for at present.

The Secretary of IAPO, Professor Hela, has suggested the possibility of holding SCOR Working Group meetings in Bern at the time of the IAPO General Assembly (25 September to 7 October 1967). It is understood that UNESCO is arranging for WG 10, the Joint Panel on Oceanographic Tables and Standards, to meet at that time. There are no plans at present for any other SCOR WG to meet then.

The IAPO Working Group on Deep Sea Tides met in La Jolla, 16-20 January 1967, with the financial assistance of SCOR, IAPO and UNESCO. The report of this meeting is given in Annex IX.

4.2 Relation with SCAR

SCOR joined with SCAR, IAPO and IUBS in sponsoring the Symposium on Antarctic Oceanography held in Santiago, Chile, 13-16 September 1966. The Symposium was followed by the Ninth Meeting of SCAR, at which SCOR was represented by its President, Captain Capurro.

The following recommendation was adopted by the SCAR Working Group on Oceanography:

"The SCAR Working Group on Oceanography, having reviewed past and present scientific studies in the Antarctic, considers that every possible effort should be devoted to learning more about the structure, the mechanism, and the biological and other implications of the Antarctic Convergence (polar frontal system). SCAR, therefore, requests that SCOR should consider forming a Working Group on the Antarctic Convergence to advise on what observations and scientific studies could be made to improve our knowledge of the subject. SCAR would be pleased to participate in any appropriate way."

Consideration was also given to problems associated with the freezing of sea water, the formation of bottom water and studies of Antarctic benthos, and small groups were established to prepare propositions for work in these fields. No action with respect to these problems is expected from SCOR at the present time.

The Executive Committee, considering that the proposed working group was closely related to the question of the proposed Comprehensive Study of the Southern Ocean referred to above (see section 3.1), decided to defer action on the SCAR recommendation until its next meeting when the results of the inquiries to National Committees and experts would be available. Some members felt that publication of Antarctic data subsequent to 1959 (earlier data were reported in IGY Oceanography Report No. 2, published by WDC-A in 1961) would be useful stimulus to interest in Antarctic oceanography; Dr. Fedorov, on behalf of UNESCO, agreed to explore this possibility with WDC's A and B.

4.3 Relation with IBP

IIOE Symposium:

The following resolution was adopted by the Second Meeting of the IBP/PM Sectional Committee (Paris, April 1966):

"The IBP/PM Committee notes widespread interest in the IBP/PM results of the International Indian Ocean Expeditions and realizes that at present many of the results are not yet sufficiently advanced to permit a comprehensive presentation at the Second International Oceanographic Congress. The Committee would thus welcome consideration by SCOR and IOC/UNESCO of a symposium on the Biological Results of the International Indian Ocean Expedition and suggests early 1969 as an appropriate time. If this suggestion is acted upon favorably, the IBP/PM Committee would be pleased to participate and cosponsor the symposium. Considering the applications of the results of the International Indian Ocean Expeditions for the development of fisheries of the regions, the participation of FAO and Indo-Pacific Fisheries Council in a symposium of this kind seems most desirable."

This proposal was considered by the ACMRR which recommended that its Secretariat maintain contact with IBP and other potential sponsoring organizations, and that FAO be advised to offer support for such a symposium in case it could be arranged for it to also include fishery resources appraisal as a special objective, and that UNESCO/IOC be informed accordingly and their cosponsorship solicited.

The Executive Committee agreed that it would be appropriate to hold a Symposium on the Biological Results of the International Indian Ocean Expedition in early 1969, and welcomed the interest of UNESCO and FAO in making this possible. It was decided to request Dr. Humphrey to act on behalf of SCOR and in cooperation with other interested parties to develop more detailed plans for the organization of this symposium.

Plankton Statistics Center: In a letter of 5 May 1966, Mr. R. M. Cassie advised that the New Zealand National Committee for Oceanic Research had commended to SCOR the desirability of cosponsoring the Plankton Statistics Center initiated by the IBP/PM Committee. Mr. Cassie pointed out that in view of the limited term of existence of IBP, the manual of methods to be produced by the Center would benefit from endorsement from a permanent body such as SCOR.

Copies of Mr. Cassie's detailed proposal were referred to Dr. Fraser, as Chairman of the SCOR Working Group 13 on Zooplankton Sampling Methods. After consideration by members of the Working Group, Dr. Fraser transmitted the following recommendation:

"We all agree that the subject of statistical treatment of sam-

ples needs to be tackled, and while there are advantages and disadvantages in setting up one unit to do this, and to site it in New Zealand, we know of no other method which is acceptable and also feasible in that there is someone both able and willing to do it. We have had the benefit of criticism of Cassie's programme from persons who are not members of WG 13 but who are well qualified to comment.

The most important criticism is to the effect that our knowledge of the behavioural patterns that cause marked variations in the plankton at sea is not adequate to enable statistical methods to be properly used. Normal behaviour should not be regarded as a sampling error when distribution is being considered statistically. Other criticisms are that the programme is too narrow in its approach; that it will lead to a new text book with examples drawn from plankton instead of from wider fields which will not really satisfy; that in 3 years only a fraction of the problems can be tackled.

It seems likely that any shortcomings in the Cassie project could be aired, and suggestions for amendment could be made, at a Symposium on the quantitative aspects of plankton sampling organised prior to the actual start of the unit. The unit might benefit very much from such a symposium.

The unit could not be a success unless it was adequately staffed by trained personnel as well as by trainees, and we consider that UNESCO fellowships or other means of providing staff should be attractive enough to do this. One problem of the unit may be the acquisition of suitable data and one of our members has suggested a liaison between the unit and IOBC with the possible choice of a fellow from the IOBC sorting staff. It is also suggested that the unit should contain someone well acquainted with routine sampling at sea so that the outcome, in addition to being theoretically satisfying should also be practicable (Cassie has himself commented on this at the foot of p. 3 of his programme).

We agree that it would be useful to have the recommendations of the unit published as one of the FAO series on Statistical Methods in Fisheries Research.

WG 13 thus recommend SCOR to advise UNESCO to support this unit with adequate staff to do the work. It is also recommended that SCOR should consider the advisability of organising a symposium at which details on the programme can be discussed."

In considering this matter, the Executive Committee felt that plans for the Center were developing satisfactorily and that immediate action was not required by SCOR in order for the Center to be established. Therefore it seemed appropriate to defer action until next year when the most useful contribution of SCOR could be more clearly determined.

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Other action in relation to IBP includes establishment of a new working group in response to an IBP recommendation (see 2.2 WG 24).

5. Relation with other international organizations

5.1 Relation with International Hydrographic Bureau

The SCOR President, Captain Luis R. A. Capurro, was asked to represent SCOR at the Ninth International Hydrographic Conference (Monaco, 18 April to 3 May 1967).

6. Future SCOR Activities

6.1 Exploration of the South Pacific

During the Executive Meeting in Marseille (October 1965), Professor Wooster was asked to formulate a scheme for the oceanographic exploration of the South Pacific. Accordingly letters were written to a number of scientists asking for statements on the important scientific questions concerning the South Pacific that merit large scale and intensive investigation. As answers to these letters were received, they were distributed to members of the Executive, principally in summary reports of 29 June and 15 August 1966.

The original list to which the inquiry was sent was not intended to be comprehensive, but included only a small sample of people likely to be interested in the investigation of the South Pacific. Replies were received from the following scientists: Henry Stommel, Klaus Wyrtki, J. D. H. Strickland, J. L. Reid, Jr., R. B. Montgomery, Bruce Heezen, J.A. McGowan, M. B. Schaefer, John Ryther, Jerome Namias, Henri Rotschi, M. Wauthy, M. Legand, Richard Rosenblatt, H. W. Menard, W. R. Riedel and R. L. Fisher. Most comments indicate the great scientific importance of the region, but leave unresolved the political or administrative question of how best to stimulate increased scientific activity there.

Interest in the region is evidenced by the number of major cruises now being organized for work there. Zonal sections of physical oceanographic observations at 28°, 35°, and 42° S will be made by ELTANIN and OCEANOGRAPHER. Meridional sections of physical and biological observations, extending to 20° S between the coast and 126° W will be made in February-March and August-September 1967 by research vessels participating in the EASTROPAC program. Geological and geophysical work in the southwest Pacific is scheduled on ARGO during the NOVA Expedition.

The Executive Committee, in considering this matter, noted the desire expressed by the IOC Bureau for a report to the Fifth Session of the Commission (see 3.1 above). Some members felt that in view of the great

scientific importance of the region there was no need to do more than draw attention to the desirability of more intensive investigations there. For this purpose, the proposed symposium on oceanography of the South Pacific (see 7.5 below) should be effective. In addition, it was decided to stimulate the preparation and publication of review papers on the present status of scientific knowledge of the South Pacific and on the problems remaining to be investigated there.

6.2 International Directory of Oceanographers

Most oceanographers are familiar with "An International Directory of Oceanographers", the Fourth Edition of which was published by the U. S. National Academy of Sciences - National Research Council in 1964. The First Edition of this directory appeared in 1950 and listed 750 scientists from 48 countries. Subsequent editions appeared in 1955 and 1960, and by the time of the Fourth Edition, the list had grown to 2563 names from 93 countries. This edition was prepared as a staff activity of the U. S. National Committee for SCOR, was distributed at no cost to each of the individuals identified in the Directory, and was sold to others by the NAS Publications Office.

In a letter of 7 October 1966, the Executive Secretary of the U.S. Committee wrote "While recognizing the need for a continuation of this series of directories, the Committee on Oceanography does not feel that an international directory should be prepared by a national organization. Therefore, the Committee suggests that the next edition be prepared under the auspices of SCOR and suggests that this item be added to the agenda for the next SCOR Executive Committee meeting. Of course, the Committee as the U.S. National Committee to SCOR would be happy to cooperate to the extent of helping to identify U. S. nationals for a 5th edition."

The Executive Committee felt that this task could more effectively be undertaken by an intergovernmental body such as UNESCO. A proper role for SCOR, together with ACMRR, would be to advise on the criteria for inclusion in such a directory and on mechanisms for assembling the required information. Accordingly it was decided to explore the matter in correspondence with the secretariats of UNESCO and FAO, and to return to it at the next Executive Meeting.

7. Other Business

7.1 Third International Oceanographic Congress

A formal invitation has been received from the Government of Chile for the Third Congress to be held in Valparaiso in 1971. The IOC Bureau thanked the Chilean Government for this invitation, and asked SCOR, together with ACMRR, to consider the most effective way of organizing any future

oceanographic congresses. During the Fifth IOC Session a decision could then be taken on the date, location and method of organization of the Congress. The Executive Committee decided to ask National Committees for comments and suggestions on this matter, which would be further discussed in correspondence among Executive members prior to the next Executive meeting.

7.2 Further revision of SCOR Constitution

Some interest in SCOR membership has been shown by a country which has no formal relationship with ICSU. It has been pointed out that SCOR is one of the few ICSU committees that requires adherence to ICSU as a condition for membership. The Executive Committee decided to request the ICSU Executive Committee to amend the SCOR Constitution by deleting the words "adheres to ICSU and" in Article 2 a.

7.3 Time and place of next meeting

Because of the series of meetings between 25 September and 28 October, the only convenient time for the next Executive Meeting appears to be 11-13 October 1967. This coincides with the last few days of the ICES meeting in Hamburg and precedes the meeting of the IOC Working Group on Mutual Assistance scheduled for 16-18 October. The Secretary was instructed to arrange for the meeting to be held in either Warnemünde or Kiel.

7.4 Time and place of next General Meeting

It was agreed that the next General Meeting should be held in May or June 1968 and should include a symposium on oceanography of the South Pacific. It is anticipated that the meeting will be held either in the United States or in the United Kingdom. The Secretary was instructed to obtain additional information on the possibilities of holding the meeting in one of these locations, and in consultation with other members of the Executive Committee, to proceed with organization of the meeting.

The Executive Committee expressed its gratitude to Professor A. Katzir-Katchalsky, President of the Israeli Academy of Sciences and Humanities, to the other officers and staff of the Academy, and to other Israeli scientists and representatives of sponsoring organizations, for their effective arrangements and generous hospitability on the occasion of the Executive Meeting.

SCOR EXECUTIVE MEETING

Jerusalem, 6-8 February 1967

List of Participants

MEMBERS OF EXECUTIVE COMMITTEE

Captain Luis R. A. Capurro (Argentina) - President
Dr. George F. Humphrey (Australia) - Retiring President
Professor Trygve Braarud (Norway) - Vice President
Professor Vladimir G. Kort (USSR) - Vice President
Professor Warren S. Wooster (USA) - Secretary

OTHER MEMBERS OF SCOR

Professor G. Aliverti (Italy)
Dr. G. E. R. Deacon (UK)
Professor G. Dietrich (FRG)
Dr. E. Gilat (Israel)

REPRESENTATIVES OF INTERNATIONAL BODIES

Dr. K. N. Fedorov (UNESCO/IOC)
Dr. N. Rosnan (WMO)
Dr. M. Ruivo (FAO/ACMRR)
Professor T. Braarud (ICES)

OTHER PARTICIPANTS

Dr. M. Avidor (Israel)
Commodore Y. Ben Nun (Israel)
Dr. G. Böhnecke (FRG)
Admiral L. Di Paola (Italy)
Mr. F. Furnestin (France)
Mr. G. E. Hemmen (UK)
Dr. B. Kimor (Israel)
Dr. A. Klein (Israel)
Professor C. Morelli (Italy)
Dr. D. Neev (Israel)
Dr. O. H. Oren (Israel)
Professor M. Shilo (Israel)
Professor H. Steinitz (Israel)
Professor K. Sugawara (Japan)
Dr. G. Tomczak (FRG)
Professor H. E. Wertheimer (Israel)

ESTIMATE OF SCOR FINANCES, CALENDAR 1966

BALANCE as of 1 January 1966

In Rome	$ 6,427.30
In La Jolla	11,609.92
	$ 18,037.22

INCOME

UNESCO General Contract	$ 9,000.00
UNESCO NODC Contract	952.13
ICSU (UNESCO) Subvention	4,000.00
AAAS Second Congress Fund	20,280.67
National Contributions	13,589.71
Sale of Proceedings	4.00
	$ 47,826.51

EXPENDITURES

Working Group expenses				$ 13,518.94
WG 12	$ 19.00	WG 19	$ 1,013.37	
WG 13	6,003.90	WG 20	1,908.30	
WG 15	3,853.02	WG 22	698.60	
WG 18	22.75		$13,518.94	
Executive Committee expenses				5,035.50
Representation at other meetings				2,279.54
Office expenses, cable and telephone				2,269.86
Publications				1,026.53
Second Congress				19,315.21
NODC Contract				952.13
Indian Rupee devaluation				363.95
SCAR/SCOR Symposium				2,000.00
				$ 46,761.66

BALANCE as of 31 December 1966

In Rome	$ 12,103.03
In La Jolla	6,999.04
	$ 19,102.07

ESTIMATE OF SCOR FINANCES, CALENDAR 1967

BALANCE as of 1 January 1967				$19,102.07
INCOME (Estimate)				
UNESCO General Contract				$11,250.00
ICSU (UNESCO) Subvention				4,000.00
National Contributions				13,500.00
				$28,750.00
EXPENDITURES (Estimate)				
Working Group expenses				$20,500.00
WG 10	$2,000	WG 24	$1,500	
WG 19	7,000	WG 25	1,500	
WG 21	2,500	WG 26	4,000	
WG 23	2,000			
Executive Committee expenses				5,000.00
Representation at other meetings				2,000.00
Office expenses				2,500.00
Publications				1,000.00
				$31,000.00

REPORT OF SCOR/ACMRR WORKING GROUP 22 ON MARINE POLLUTION

1. In accordance with Recommendation 6.30 of the 6th Meeting of the IOC Bureau with the Consultative Council, the SCOR/ACMRR Working Group on Marine Pollution met in Paris on 12-14 December, 1966. Present were:

Nominated by SCOR:
D. W. Pritchard, Chairman
O. Kinne

Nominated by ACMRR:
P. Korringa
A. J. Lee

Secretariat:
S. J. Holt, FAO
A. Y. Takenouti, IOC
R. J. Hurley, IOC

N. Popov, nominated by SCOR, was unable to attend.

2. The Working Group concerned itself with the preparation of the terms of reference of the IOC Working Group on Marine Pollution and a draft agenda, with annotations, for its first meeting. In addition, the Working Group drew up recommendations to the IOC Secretariat concerning the preparations for this first meeting.

3. The Working Group's proposals are appended.

Recommendations to IOC Secretariat concerning preparations for the Meeting of the IOC Working Group on Marine Pollution

A. Documents to be made available

1. Draft agenda, annotation, and tabular analysis prepared by SCOR/ACMRR Working Group.

2. Working papers (to be prepared by consultants for the IOC Secretariat) on the following subjects:

a) oceanographic processes determining the fate of pollutants in the sea (Agenda Item 6). This paper should cover both the physical and biological processes of movement and diffusion, the biological and chemical processes of degradation, the biological and geo-chemical processes of accumulation and removal, and the bio-chemical processes of interaction. Hence preparation may require the joint efforts of at least two authors;

b) biological reactions as indicators and criteria of pollution and its effects (Agenda Item 5). This paper should consider organismic reactions suitable to serve as indicators for the assessment of the kind and degree of pollution in a given body of water, as well as the effects of pollutants on i) ecosystems and on ii) parts thereof. Examples under i): changes in species composition; successions; local distributions; rates of turn-over and breeding activities. Examples under ii): lethal doses; rates of reproduction, growth, metabolism, and activity; and intra- and interspecific relationships.

3. Reports on the activities of other international organizations relating to marine pollution, with particular reference to the oceanographic aspects:

   a) specialized Agencies (FAO, IMCO, IAEA)

   b) inter-governmental bodies (ICES, IPFC, GFCM, EURATOM, OECD)

   c) non-governmental bodies (IAWPR, SCIBP, IAPO).

4. The analysis by the ACC Sub-Committee on Marine Science and its Applications of the questionnaires it circulated to governments, together with a review of the information which was excluded from the questionnaires because such information had already been submitted to IMCO or IAEA. This analysis should include a detailed list of the pollutants reported in the responses to the questionnaire.

5. A report on marine resource aspects of pollution by ACMRR.

6. A short bibliography of key references.

B. Other preparations and suggestions

1. It is suggested that the meeting of the IOC Working Group on Marine Pollution be held in Paris in June or July 1967 for a period of 4 days.

2. Observers should be invited from those organizations listed in 3b) and 3c) above, as well as representatives from the specialized agencies concerned, SCOR and ACMRR.

DRAFT AGENDA FOR THE IOC WORKING GROUP ON MARINE POLLUTION

1. Opening of meeting. Election of Officers

2. Adoption of the Agenda

3. Terms of reference of the Working Group. Definition of Marine Pollution

4. Types of Pollution and their effects

5. Methods for the Measurement and Assay of Marine Pollution

6. The Fate of Pollutants in the Marine Environment

7. Proposals for IOC action

8. Any other business

9. Closing of meeting

Annotation to the Proposed Agenda
for the meeting of the
IOC WORKING GROUP ON MARINE POLLUTION

Agenda Item 3.

Under this item the Working Group is invited to consider and amend as necessary the following draft terms and definition prepared by the SCOR/ACMRR Working Group.

a) Terms of Reference: (Based on IOC Resolution IV-10).

To consider and report to the fifth session of the IOC on the question of how the Commission can further the national and international studies of oceanographic processes relevant to marine pollution, its effect and its control.

b) The following is proposed as a definition of marine pollution for the purpose of the IOC Working Group:

> "Introduction by man of substances into the marine environment resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to maritime activities including fishing, and reduction of amenities."

Deleterious effects on the marine environments may be produced as a result of actions of man other than the introduction of a substance. The construction of a barrier across an estuary might produce deleterious effects elsewhere, and the overfishing of a marine population would be a definite example of such action. The above definition excludes such actions from the term "marine pollution". The shock wave from an explosion also produces deleterious effects, but is not by this definition "marine pollution", though the chemical products released by the explosion may be pollutants.

It should also be noted that acts which in one case might be deleterious and hence be acts of pollution might, in another case, be beneficial, and hence not acts of pollution. For example, the discharge of a heated effluent might in some cases be deleterious while in other cases it might be beneficial, or, at least, not harmful.

The term "harm to living resources" is to be taken in a broad sense, and is intended to include not only harm to commercially important species, but also any disruption of the environment which would tend to destablize the eco-system.

Agenda Item 4:

Under this item the Working Group is invited to consider and, if necessary, amend and expand the main categories of pollutants given in the appended table, and to identify their effects, according to the four categories referred to in the draft definition and in the heading of the table.

Agenda Item 5:

The Working Group is invited to consider, for each category of pollution, the adequacy of existing methods for its detection and measurement, and for assessment of its effects. It is intended that discussion of methods for assessing the effects of pollution on marine resources should include both field studies and laboratory investigations for improving methods and for establishing criteria of pollution and of its biological effects.

The Working Group should identify the further research required to meet these ends.

Agenda Item 6:

Under this item the Working Group should consider the oceanographic determinants of the fate of pollutants, identifying the physical, chemical (including geochemical and biochemical), and biological processes which lead to changes in distribution (dispersion, accumulation and removal) and modification (degradation) of the various categories of pollutants.

The Working Group should review the status of research on these processes and identify the further research required both in the laboratory and in the field.

Agenda Item 7:

Under this item the Working Group is invited to consider possible IOC action pertinent to Agenda items 5 and 6. Possible types of action might include the following:

a) To recommend that member states undertake, for the purpose of providing a scientific basis of pollution control, such oceanographic and related research as is required to identify, measure, evaluate and ameliorate effects of marine pollution.

b) To consider and recommend international co-operative programmes of research required to identify, measure, evaluate and ameliorate the effects of marine pollution.

c) To facilitate the exchange of data and scientific information related to the identification, measurement, evaluation and amelioration of the effects of marine pollution.

d) In co-operation with other organizations concerned, to promote the application of the results of oceanographic research in the formulation and execution of pollution control measures.

In proposing such actions, the Working Group should take account of the related activities of UNESCO, of other agencies of the U. N. Family and of other international organizations.

Annotation to Proposed Agenda of the IOC WORKING GROUP ON MARINE POLLUTION

This Table lists the Major Categories of Pollution, and, for each type of pollution, the General Categories of Effect most frequently associated with that pollution type are indicated by the crosses in the appropriate column. Where it has been possible to make a judgement, the most important category of effect for the particular type of pollution is further indicated by a parenthesis around the cross.

The final column of this table gives reference numbers to footnotes wherein illustrative examples of the categories of pollution are given.

General Categories of Effect

Major Categories of Pollution		Harm to living resources	Hazards to human health	Hindrance to maritime activities	Reduction of Amenities	Reference to illustrative examples
Domestic sewage (including waste from food processing	Direct microbial	-	(x)	-	x	1
	Indirect microbial	-	(x)	x	-	2
	Eutrophication and related processes	(x)	x	x	(x)	3
Industrial waste products	Heavy Metals	x	(x)	x	-	4
	Petro-Chemical	-	x	x	-	5
	Oils, etc.	-	-	x	(x)	6
	Pulp and Paper Wastes	(x)	-	-	x	7
	Pesticides	x	(x)	-	-	8
	Detergents	x	-	-	x	9
	Radioactive Materials	-	(x)	x	-	10
	Heat	x	-	x	-	11
	Solid Objects	-	-	x	x	12
	Dredging Spoil	x	-	x	-	13

Footnotes to Table

1. Direct contamination of beaches near discharges of inadequately treated sewage can lead to bacterial and virus infections and non-aesthetic conditions with consequent adverse effects on tourism.

2. Bacterial or virus infection can be caused by eating raw shellfish harvested from areas contaminated by sewage and this also leads to adverse effects on the fishing industry.

3. Discharge of sewage or other organic wastes leads to increases in nutrient salts and changes in their proportions in the sea and so to quantitative and qualitative changes in the phytoplankton which may
   a) have adverse effects on shellfish;
   b) if they involve increases in toxic species, lead to poisoning by eating contaminated shellfish;
   c) lead to non-aesthetic conditions resulting from the mass production, mass mortality and decomposition of marine organisms.

4. Filter-feeding invertebrates and also fish larvae, etc., which are sensitive to changes in the quantities of certain elements normally rare in sea water, take in metals, such as copper, zinc, and mercury, originating from industrial wastes. This causes in various circumstances the death of the organisms, the spoiling of the flavour of shellfish and the poisoning of consumers of the organisms.

5. Wastes from petro-chemical industry cause spoiling of the flavour of marine products and danger to man through the consumption of organisms in which carcinogens have accumulated.

6. Oily substances may clog nets, spoil the flavour of fish and shellfish, kill sea-birds, contaminate beaches. Some methods of treating oil on beaches and on the sea surface involve the use of materials toxic to marine life.

7. Sulphite effluents with high biological oxygen demand cause non-aesthetic conditions, destruction of shellfish beds and hindrance to migrating fishes.

8. Insecticides and residues, such as chlorinated hydrocarbons and organic phosphorus compounds, are persistent and highly toxic to marine arthropods and may accumulate in other organisms with consequent health hazards to predators including birds and man.

9. The SCOR/ACMRR working group is not aware of any specific examples, but, considering that detergents have a high phosphorus content, is of the opinion that the bio-degradation of the short-chain detergents could add to the eutrophication effect of domestic waste.

10. Because of the rigid control exercised over the atomic energy industry since its inception, the Working Group has no examples of adverse effects brought about by the discharge into the sea of radioactive effluents. There exist, however, the potential dangers of nuclear accidents as hazards to health. Of particular concern are the radioactive isotopes of those elements which are normally rare in sea-water and which are readily taken up by marine organisms.

11. Under certain conditions warm water discharges from large electrical power plants can lead to:
    a) excessive growth of vegetation which interferes with navigation;
    b) increase in fouling and boring organisms on vessels and structures;
    c) thermal blocks which interfere with migrations of fish;
    d) when associated with other types of discharge, increased microbiological activity and thereby oxygen depletion with consequent adverse effects on living marine resources.

12. Floating and sunken solid objects, such as drums, wire, bottles, timber, vehicles, plastic articles and other persistent materials, can:
    a) interfere with navigation and fishing operations;
    b) provide a habitat for boring organisms;
    c) when washed up on shores, reduce amenities;
    d) adversely affect the benthic habitat.

13. Discharge of clay, silt, etc. from dredging, and also possibly from mining and drilling operations, may
    a) increase the turbidity of the water with adverse consequences to marine life;
    b) cover hard bottom with soft layers which impede spawning of fish and settling of shellfish;
    c) because of high nutrient content of interstitial water, add to the nutrient salt concentration of the sea and hence to the problems associated with eutrophication;
    d) interfere with navigation and fishing operations.

RESOLUTION 2172 (XXI) ADOPTED BY THE UN GENERAL ASSEMBLY AT ITS TWENTY-FIRST SESSION, 6 DECEMBER 1966

RESOURCES OF THE SEA

The General Assembly,

Recognizing the need for a greater knowledge of the oceans and of the opportunities available for the utilization of their resources, living and mineral,

Realizing that the effective exploitation and development of these resources can raise the economic level of peoples throughout the world, and in particular of the developing countries,

Taking into account with appreciation the activities in the field of resources of the sea at present being undertaken by the United Nations, the United Nations Educational, Scientific and Cultural Organization and, in particular, its Inter-governmental Oceanographic Commission, the Food and Agriculture Organization of the United Nations and, in particular, its Committee on Fisheries, the World Meteorological Organization, the Advisory Committee on the Application of Science and Technology to Development, other intergovernmental organizations concerned, various Governments, universities, scientific and technological institutions and other interested organizations,

Considering the need to maximize international co-operative efforts for the further development of marine science and technology and to avoid duplication or overlapping of efforts in this field,

1. Endorses Economic and Social Council resolution 1112 (XL) of 7 March 1966 requesting the Secretary-General to make a survey of the present state of knowledge of the resources of the sea beyond the continental shelf, excluding fish, and of the techniques for exploiting these resources;

2. Requests the Secretary-General - in co-operation with the United Nations Educational, Scientific and Cultural Organization and, in particular, its Inter-governmental Oceanographic Commission, the Food and Agriculture Organization of the United Nations and, in particular, its Committee on Fisheries, the World Meteorological Organization, other intergovernmental organizations concerned, and the Governments of interested Member States, and utilizing, inter alia, such voluntary services as may be offered - to undertake, in addition to the survey requested by the Economic and Social Council, a comprehensive survey of activities in marine science and technology, including that relating to mineral resources develop-

ment, undertaken by members of the United Nations family of organizations, various Member States and intergovernmental organizations concerned, as well as by universities, scientific and technological institutes and other interested organizations;

3. Requests the Secretary-General, in co-operation with the United Nations Educational, Scientific and Cultural Organization and, in particular, its Inter-governmental Oceanographic Commission and the Food and Agriculture Organization of the United Nations, and in particular, its Committee on Fisheries, and in the light of the above-mentioned comprehensive survey to formulate proposals for:

(a) Ensuring the most effective arrangements for an expanded programme of international co-operation to assist in a better understanding of the marine environment through science and in the exploitation and development of marine resources, with due regard to the conservation of fish stocks;

(b) Initiating and strengthening marine education and training programmes, bearing in mind the close interrelationship between marine and other sciences;

4. Requests the Secretary-General to set up a small group of experts to be selected, as far as possible, from the specialized agencies and intergovernmental organizations concerned, to assist him in the preparation of the comprehensive survey called for in paragraph 2 above and in the formulation of the proposals referred to in paragraph 3 above;

5. Requests that the survey and proposals prepared by the Secretary-General be submitted to the Advisory Committee on the Application of Science and Technology to Development for its comments;

6. Requests the Secretary-General to submit his survey and proposals, together with the comments of the Advisory Committee, to the General Assembly at its twenty-third session, through the Economic and Social Council.

ANNEX V

EXTRACT FROM DRAFT REPORT OF FOURTH SESSION OF ACMRR (ROME, 16-21 JANUARY 1967)

5.1 UN Resolution on Resources of the Sea

The Committee had before it a request for advice from the Director-General of FAO. The Director-General referred to the Resolution on the Resources of the Sea adopted by the General Assembly of the United Nations on 6 December 1966 [A/Res/2172(XXI)]. FAO (with COFI) and UNESCO (with IOC), together with other agencies such as WMO, were envisaged in the Resolution to cooperate with the Secretary General of the UN in the preparation of a comprehensive survey of activities in marine science and technology undertaken by members of the UN family of organizations, various member states and inter-governmental organizations concerned as well as by universities, scientific and technological institutes and other interested organizations. In the light of this comprehensive survey it was intended to formulate proposals for:

(a) Ensuring the most effective arrangements for an expanded program of international cooperation to assist in a better understanding of the marine environment through science and in the exploitation and development of marine resources, with due regard to the conservation of fish stocks;

(b) Initiating and strengthening marine education and training programs, bearing in mind the close interrelationship between marine and other sciences.

In the formulation of these proposals only FAO (with COFI) and UNESCO (with IOC) were expected to cooperate with the UN.

The Director-General desired advice from ACMRR, within its terms of reference, on what the methods, scope and content of this comprehensive survey should be.

The Committee recognized that the action contemplated in the UN Resolution could be valuable in improving international cooperation in regard to the study of the sea and its resources. As regards the marine fishery resources the Committee recalled, however, the recent action of the FAO Conference in strengthening the fishery activities of FAO and its role in international cooperation through the establishment of the Committee on Fisheries and the Department of Fisheries. A promising start had been made

in this respect and it was most important that this process of strengthening continue at least at the rate envisaged by the Director-General at the time of the 13th Session of the FAO Conference.

Because of the close inter-relations between the marine fishery resources and their environment and of the respective roles of FAO and UNESCO in regard to these, the most effective collaboration was desirable between FAO and UNESCO. The Committee itself had an important part to play in ensuring this because of its advisory status vis-a-vis FAO and the IOC. The aims of the UN Resolution as far as the study of marine fishery resources and their environment was concerned could, in the near future, best be forwarded by the further improvement of the collaboration between FAO and UNESCO rather than by some entirely new arrangements.

The Committee, moreover, noted the rapid increase in knowledge of the intimate relationships between the dynamics of the atmosphere and the ocean and the growing need for increased cooperation and coordination of planning and work among scientists concerned with both the atmosphere and the ocean. It was indeed essential that marine and atmosphere research should be expanded sharply by the world community so that the problems which were arising so rapidly in the development and management of fisheries could be brought to solution. Again, because of the close interrelation of marine resources and their environment, the advice desired by the Director-General could best be given by a joint working group of the ACMRR and SCOR. The Committee accordingly recommends that the Director-General request the President of ICSU to solicit the cooperation of SCOR with a view to the establishment of such a group. The members of the group should be nominated by the Chairman of ACMRR and the President of SCOR and should be appointed by the Director-General of FAO. The group should be representative of the various disciplines involved and should advise the Director-General on the scientific aspects of what the methods, scope and content of the comprehensive survey called for by the UN Resolution should be, insofar as the study of marine fishery resources was concerned. The group should be free to seek necessary information and advice from other sources, particularly from advisory bodies of other interested agencies. The group should report directly to the Director-General but its advice should also be available to the IOC, and the Committee decided to draw the attention of the IOC Bureau and Consultative Council especially to its views on this subject.

Although the Director-General had sought advice from the Committee only with respect to the conduct of the survey of activities, the Committee considered that it should express to him its views on certain wider issues implicit in the UN Resolution, especially with respect to Paragraph 3 of the Resolution.

The Committee recognized that the proposals requested in Paragraph 3 of the Resolution were likely to have important influence on

institutional arrangements for international activities in marine sciences and technology in the future, and on the arrangements under which the problems of rational resources use are examined and negotiated internationally. It noted, however, that whilst the Resolution provided on the one hand for the assembly of information on the status of knowledge of the seas and on activities to increase this knowledge, and on the other hand for the formulation of proposals for arrangements with respect to international cooperation, it did not provide for the assembly of information on the institutional forms and procedures under which international action with respect to the seas has been proceeding on an extensive scale for many years. The Committee pointed out that the experience in this field, beginning with ICES in 1902, was extensive. It further pointed out that it had itself just completed the first stage of a study of these matters with respect to FAO's own regional fishery bodies and had identified certain matters requiring further study. It considered that it was proper for it to draw the attention of the Director-General to this matter and to suggest to him that he request the working group proposed above to make some study of the following matters, and to collaborate with the Secretary-General's group of experts in its examination of these matters, namely,

1) Identification of problems in marine science and technology and related fields that require some form of international cooperation for their effective investigation and for the effective application of their results;

2) Examination of the form of cooperation required and of their impact on the scientists and institutions concerned;

3) Examination of the manner in which existing international organizations deal with the problems and the forms of cooperation referred to above.

Furthermore the Committee referred to the technical and organizational changes taking place in world fisheries which are of unprecedented speed and magnitude. These changes are modifying not only the patterns of exploitation of marine resources but also the patterns of international relations in respect of both scientific and commercial interest and which are of considerable political significance. In consequence of these changes new ideas are emerging with regard to the theory and practice of fisheries management, at both national and international level. The Committee considered that to ignore either the industrial changes or the new ideas in the formulation of the proposals set out in Paragraph 3 could lead to the formulated proposals being quite inadequate for the situation that will exist when

action is to be taken on them. Although the intention might be to deal with this aspect in another stage, the Committee considered that action in this respect should be initiated without delay and noted that for this purpose there was available to it a draft of a chapter of FAO's SOFA, dealing with the Management of Fisheries Resources, which by its clear and imaginative treatment of the subject, provided an excellent starting point for further study of this subject. The Committee therefore proposes to undertake a study of the matters set out in the SOFA chapter and to consider and advise on how the forms of international cooperation might need to be adjusted so as effectively to meet the need of these matters.

The Committee noted that the comprehensive survey of activities as well as the proposals to be formulated in the light of it were to be prepared with the assistance of a small group of experts to be selected as far as possible from the specialized agencies and inter-governmental organizations concerned. The Committee felt that the nomination of experts from among the advisors of the agencies and organizations should not be excluded. It also considered it essential that the close cooperation of appropriate staff members be secured and that the relevant work of FAO, for instance the Indicative World Plan and the Analytical Compendium of International Fishery Bodies and of other international organizations concerned with fisheries which was being prepared under the auspices of COFI, be fully taken into account.

STATEMENT CONCERNING THE NEED FOR COMPREHENSIVE STUDIES OF THE SOUTHERN OCEAN

presented by the USSR Delegation for consideration
by the Intergovernmental Oceanographic Commission

1. Present knowledge of the problem

During the Antarctic oceanographic expeditions in the International Geophysical Year valuable material was obtained which threw new light on some aspects of the heat and dynamic regime of the Southern Ocean. Certain progress has been achieved both in understanding the exchange of physical properties between the extensive South Polar Basin and the adjacent parts of the World Ocean and in ascertaining the characteristic features of the hydrological regime of the Southern Ocean itself.

2. Programme of investigations

Future investigations in Antarctica should be coordinated by a general programme aimed at solving the following primary tasks:

1) Long-term changes of water and heat exchange in the Southern Ocean

At present data are almost absent on the variability in the intensity of large-scale circulation in the South Polar Basin. Moreover, the lack of systematic observational data from the regions between 30°and 50° south latitude makes it impossible to determine in detail the character of water and heat exchange between the Antarctic waters and the adjacent parts of the World Ocean. Investigations aimed at the solution of this important problem will make it possible to elucidate the effects of the Antarctic region on the climate and weather of the Earth as a whole, as well as on the formation of thermostructures of the deep ocean layers.

2) Characteristics of the deep-water circulation in the Southern Ocean

Up to now there has been no direct data on the characteristics of the deep-water movements in the Southern Ocean. Due to the general zonal distribution of the main hydrological elements and the latitudinal trend of circulation processes, only an approximate estimation of the meridional water transport velocity is possible using all data available. Systematized direct instrumental measurements of the current velocity and direction in the bottom layers of the Southern Ocean moderate latitudes will be used in addition to solving at last the question of whether the "antarctic" characteristics

of the ocean deep and bottom waters are a result of direct advection of these waters to the north or a consequence of diffusion and turbulent processes. As a result of the Antarctic bottom water sampling it will be possible to estimate the mechanism of the deep-water oxygen consumption in the World Ocean which is very important both from the scientific and practical points of view.

3) Origin and dynamics of frontal zones

Only few attempts have been made so far to prove the dynamic origin of the Antarctic frontal zones. The lack of special data does not make it possible to clear up this important question. Data available have allowed us to ascertain only an approximate average position of the frontal zones in the Southern Ocean. However, there is every reason to assume the existence of rather considerable seasonal and long-term deviations from this average position of as yet unknown magnitudes.

Questions connected with the origin, structure and position of the frontal zones are of paramount importance for the studies of the hydrological regime of the Antarctic Basin.

4) Conditions under which the Antarctic water is formed

Special observations within the continental slope area in the vicinity of the thickest ice shelf yield data showing under what hydrometeorological conditions and in what particular periods does the surface water with negative temperature sink and move northward from the Antarctic coast.

5) Characteristics of the winter hydrological regime of the Southern Ocean

Most hydrological data were collected during a relatively warm period in Antarctica. Therefore there is almost no information on the hydrological conditions of the Southern Ocean in winter, i.e. during a considerable stretch of time (from May to September). This gap should be filled up in order to have a complete idea about the variability of the water structure and dynamics of the Southern Ocean.

6) Heat balance of the Southern Ocean

The processes of heat exchange between the ocean and the atmosphere and those of heat re-distribution in the South Polar waters are known only in the most general fashion. Meteorological and oceanographic observations necessary for estimating the annual course of separate heat balance components in the Southern Ocean are almost absent.

7) Variability of the hydrochemical regime of the Southern Ocean

Hydrochemical investigations in the Southern Ocean have yielded extensive data to form an idea about the general hydrochemical structure of its waters and the distribution of a number of elements. However, the material available is quite inadequate for solving such questions as the chemical balance of the Southern Ocean and its chemical exchange with the rest of the World Ocean; the effects of ice regime and continental ice run-off on the hydrochemical structure of the Southern Ocean; the effects of the Antarctic water chemistry on the biological productivity of the Southern Ocean.

The solution of the above-mentioned tasks calls for an extensive programme of research cruises in the Southern Ocean.

3. Proposed plan of operations

1) Repeated standard observations in four different seasons along three standard cross-sections coinciding with the arbitrary boundaries between the Atlantic, Indian and Pacific sectors of the Southern Ocean, i.e. along 20^{o} east longitude (the Antarctic - South Africa), 140^{o} east longitude (the Antarctic - New Zealand) and 70^{o} west longitude (the Antarctic - South America) during 10 - 15 years.

The following main types of work are to be planned:

a) Observations of temperature, salinity and chemical elements at standard levels down to 2000 m at all the stations 60 - 90 miles apart.

b) Temperature and salinity observations at all depths from the surface to the bottom at all the stations 180 miles apart.

c) Current measurements by current recorders through the whole of the ocean thickness at diurnal buoy stations 180 miles apart.

Observations are made each time simultaneously and in one direction from three ships.

While carrying out hydrological observations along the standard cross-sections the same ships might be used for any measurements in some other disciplines during specially assigned time intervals.

2) Repeated deep-sea hydrological observations at oceanic test sites in the Antarctic Convergence Zone in each of the three sectors of the Southern Ocean during 3 - 5 years in different synoptic periods. The

test sites mentioned are chosen after the reconnaissance determination of the Convergence position has been made. They have the form of a cross with one side of about 60 - 100 miles stretching along the frontal zone and the other side of about 200 miles perpendicular to the zone. At the test sites detailed observations are made of the vertical and horizontal structures of hydrological characteristics.

3) Complex observations along meridional sections along the central parts of the Pacific, Atlantic and Indian Oceans from the Antarctic coasts to the sub-Arctic regions. This part of the programme also includes standard deep-sea temperature and salinity observations at stations 160 - 180 miles apart. No less than half of the stations are performed down to the bottom. The cross-sections are arranged as follows:

(i) In the Atlantic Ocean from the Weddell Sea northward across the African-Antarctic and Northern-African basins.

(ii) In the Indian Ocean from the Davis Sea along 90^{o} east longitude to the Indian coasts.

(iii) In the Pacific Ocean from the Antarctic coast along 150^{o} west longitude to the Gulf of Alaska. The above-mentioned sections should be, at least, three times repeated at five-year intervals.

4) Test site hydrological surveys in the areas of thick shelf glacier outlets.

The work is done at meridionally stretching test sites selected beforehand. The test sites should include regions from the glacier edge to the foot of the continental slope. Observations here should be repeated in different seasons during 3 - 5 years including deep-sea measurements of the main hydrological and hydrochemical elements as well as current measurements from autonomous buoy stations with current recorders. The sides of the test sites are 5^{o} of latitude and 3^{o} of longitude.

5) Hydrological surveys in the Southern Ocean in winter.

The above surveys are carried out along the system of meridional sections from the continents to 35^{o} - 40^{o} south latitude over the entire Antarctic region at 20^{o} longitude intervals. Since such investigations will require considerable time and funds they may be accomplished during several years in succession in each sector of Antarctica. About 350 deep-sea-hydrological stations are planned to be performed along 16 meridional sections.

6) Organization of shore, island, land ice and ship hydrometeorological stations with an extensive programme of actinometric observations.

The above-mentioned observations should be made by all countries participating in the Antarctic exploration.

The investigation made under the proposed programme will yield data on the long-term variability of the heat and dynamic regime of the Southern Ocean, its interaction with the adjacent oceans. It will be possible to elucidate regularities in the effect of the Southern Ocean on atmospheric and oceanic circulation and to apply the knowledge of these regularities to developing methods of the long-term Earth's weather and climate forecasts as well as long-term oceanological forecasts (heat and chemical regime of the oceans). These investigations will also enrich our knowledge of navigational conditions in the Southern Ocean in any season of the year.

OUTLINE FOR A SCIENTIFIC PROGRAM OF COOPERATIVE INVESTIGATION IN THE CARIBBEAN AND ADJACENT REGIONS

presented by the Netherlands Delegation for consideration by the Intergovernmental Oceanographic Commission

General

For the whole of oceanography the Caribbean area is of outstanding interest. Topographically it is one of the most intricate regions on earth. Deep basins and large and small trenches are surrounded by low lying and mountainous continental areas, by ocean floor, and by ridges, with a great variety of islands.

This is a highly seismic and volcanic area, in which huge rivers debouch, and it is also in contact with arid and tropical rainy regions, and there is abundance of coral reefs. As far as water circulation, sedimentation, coastal development, biology, chemistry of deep and surface waters are concerned, few regions of like extent can compete with the Caribbean realm in diversity and interest. It is rendered a particularly attractive field for cooperative study because it is not too extensive, so that a jointly undertaken program can be expected to provide answers to a number of fundamental questions, in addition to solving problems of more local interest. But also from a more utilitarian point of view the potential of the Caribbean Sea for mineral resources, building materials, etc. is sufficiently promising to warrant a major effort to secure basic understanding as a foundation for directed research.

At this stage it would not be appropriate to delimit the area precisely. It should take in the Caribbean and the adjoining margins of the Atlantic and of the Gulf of Mexico. The continental shelf and slope of the northern part of South America as far as the mouth of the Amazon, should be included as a source of much mud carried into the Caribbean. For geophysical studies it might be a good policy to extend the area further out into the Atlantic than for other objects of marine research.

The present summary is not meant as a final plan. It is hoped, however, that the present statement of a number of problems and objectives can form a basis on which to discuss the desirability of carrying out an international project. If the proposal is thought promising, the next step might be for all those interested in participation to offer more detailed plans with suggestions on the contributions they could make.

An excellent synopsis of the aims, problems and methods of

ocean studies has recently been published by the Inter-Governmental Oceanographic Commission of Unesco: Draft of a general scientific framework for world ocean study.

Physical Oceanography

Although the Caribbean Sea is certainly not one of the least known oceanic areas, oceanographically, it offers still many problems which need concentrated oceanographic investigation.

One such problem concerns the renewal of the deep waters in the Caribbean basins. The question is, whether this renewal takes place more or less continuously, or intermittently, or only occasionally. The influence of internal heat, conversion of CO_2 to O_2 and tidal friction is unknown. In order to clarify these points, repeated oceanographic measurements, including current measurements and age determinations, should be made, both in the passages between the islands and in the basins.

Also, the inner circulation of the deep waters of the Caribbean is still insufficiently known, as are also the gradual changes which various properties of these water masses undergo during extended isolation. Pertinent observations should be made in different seasons, preferably during a number of years.

In this connection it may be noted that conditions in summer are significantly less well known than are those in winter.

Further items of a program of desired investigations include:

Continuous sea level measurements at as many points around the area as is practicable, in connection with, among other things, the problem of the trade winds upon sea level and upon the transport of water towards the Gulf of Mexico, which again influences the transport of the Gulf Stream system.

Extensive investigation of the energy exchange of the sea with the atmosphere (additional to what has been done by the U. S. National Hurricane Research Project).

A synoptic study of the phenomena and the dynamics of upwelling off the coasts of Venezuela and Colombia.

Hydrographic surveys should be carried out in all areas outside territorial waters where nautical charts show deficiencies. Doubtful hydrographic data should be eliminated from the entire region. Deep sea sounding lines should be made in those areas where the General Bathymetric Chart of the Ocean, published by the IHB, needs further information. Of

great importance are vertical and horizontal tidal measurements, simultaneously wherever possible, with automatically recording tide ganges and current meters (29 days series). Attention should be given to strengthening of the geodetic connections between the islands and the continent where necessary and repeated measurements of the magnetic variation in different parts of the Caribbean.

Marine Geology and Geophysics

Marine geologists and geophysicists have most of their problems in common, but methods of research and aspects on which to lay emphasis tend to differ. In the present case the structure, crustal movements and history of the basins and ridges are closely linked with the geology of the islands, but they also call for marine geophysical investigations by seismic, acoustic, magnetic, heat-flow, and gravity methods and geodetic surveys. However, bathymetry and the geologists' sediment cores are likewise important clues in these matters.

As we are dealing with one of the topographically most diversified and structurally most active regions of the earth's crust, study of the development is of much more than regional interest. Even if the widely held opinion that we are dealing with an orogenic belt in a state of high activity is not true, it is certain that many aspects of ancient geosynclines can be clarified by study of this region. The manner and time in which connections and barriers between the America's were established and destroyed is also of great importance to many branches of geology and to biogeography.

The great diversity in sediment sources (volcanoes, rivers, of all sizes, coastal abrasion, reefs and plankton) of which the products are distributed by currents, slumps, turbidity currents, and wind or are dropped straight to the bottom renders this area a compact natural laboratory for sedimentation. Results would throw much light on accumulation in ancient basins. Profiler methods can show the thickness, structure, and deformational history of the fills accumulated below the basin floors. The present geophysical structure is of paramount interest because the major problem facing crustal investigations is the origin of the contrast between continents and oceans. It is obvious that this cannot be solved without detailed information on such basins as those of the Caribbean, where present deep-sea floors occupy areas that apparently were above sea level in the recent geological past.

Information sought on the crust below the sea will come partly from the application of routine investigations on a large number of crossings, but also by more intensive study of several key areas. An example is the Gulf of Venezuela with the adjoining Lake Maracaibo. This forms a compact subject to study that bids fair to be rewarding from all oceanographical points of view, but it has the additional attraction of promising to throw light on the origin of petroleum.

Bottom and beach samples and photographs should be collected as widely as possible. By coring in those places where continuous seismic profiling reveals the presence of older strata near the surface, an attempt should be made to reach Tertiary strata. In this way invaluable material could be obtained to clarify the history of the Ice Age, and some of its influence on sedimentation. The pre-Quaternary sediments should also be more representative of the more remote geological past. Later attempts at deep ocean drilling could profit from information on the upper few dozen metres of sediments.

The enormous masses of fine sediment moving westward along the northern margin of South America are usually attributed to the Amazon River. But doubt has also been expressed on account of the mineralogy of the mud. The manner and rate in which the movement takes place, and the location where the ultimate deposition takes place are intriguing questions still unanswered. In this respect a further study of the Guiana Basin is indicated.

Continental and island terraces are found to have widely differing structures. Investigations, including the north coast of South America, would form welcome additions to our knowledge on these informations.

All opportunities to locate deposits of possible economic value in shallow water should be taken, although it would not be the task of the investigators to make assessments of exploitability.

Especially the northern part of the area has been surveyed fairly intensively. It is this circumstance that facilitates a general planning for the southern part and the study of special problems in the whole area.

Chemical Oceanography

Problems in chemical oceanography are closely related to those of physics, biology and geology. Studies of chemical compounds will greatly contribute to a better understanding of the water circulation in the deep sea basins. Accurate measurements of carbon dioxide, oxygen and nutrients in deep water will increase our knowledge of changes in the oxygen-carbon dioxide system in the last century. Investigation of the distribution of nutrients in surface waters will increase our knowledge of areas of upwelling water and, in combination with physical measurements, of the conditions which cause changes in these areas. Measurements of primary production and plankton studies will provide insight in the generation of plankton blooms and the production of organic matter. A study of the composition of dissolved organic matter in upwelling areas would be very rewarding.

Much attention has already been given in recent years to the chemistry of anoxic basins, such as the Cariaco Trench, but expansion and repetition of these studies will be of great value for an evaluation of time changes.

A most promising line of research is a study of the transport and distribution of particulate matter. Very high concentrations of suspended materials occur along the north coast of South America. Presumably most of these are brought into the ocean by the Amazon River. Detailed studies have been carried out in relatively small coastal zones; it would be of great importance to connect these by a research project covering the whole area. An attempt should be made to follow the transport of the mud to its final destination on the ocean floor. This attempt should be more successful here than anywhere else in the ocean, since the Amazon carries more material to the sea than any other river. Techniques to measure particulate matter in extremely low concentrations should be used and the chemical and mineralogical properties of the materials should be determined.

To evaluate the influence of high concentrations of suspended matter, investigations in the coastal areas should also include measurements of dissolved chemical compounds and of organic production.

Biology

In the Caribbean region a number of biological stations are actively engaged in various aspects of marine biology. Research subjects should therefore be selected in accordance with these activities.

In view of the great variations of biotopes an ecological and faunistical investigation of bottom faunas would be of considerable interest. Such an investigation should be carried out in close cooperation with sedimentologists and oceanographers in order to obtain a good insight into the distribution of bottom animals in relation to environmental conditions. Attention should be focused on the least investigated areas, such as the eastern Caribbean.

Also of great value would be an investigation of the pelagic macrofauna, if possible including larval stages. Plankton investigations are considered of value only if coordinated with measurements of primary production, nutrients and general oceanographic measurements.

Additional investigations can be carried out from landbased facilities, such as the Caribbean Marine Biological Institute of Curacao. The investigations should include taxonomical and ecological studies of macro- and microfauna, ecology of coral reefs and sandwelling invertebrates. Most of the samples collected on board ship are to be analysed in local laboratories.

Observations of whales, fishes and birds during the work at stations and institutes can provide important additional information, not only about these species themselves, but also about plankton concentrations.

For much of the biological work close cooperation with fishery investigations, such as the present FAO projects, will be necessary. This will especially be of importance if a study of the distribution of fishes by mid-water trawling would be included in the programme.

Conclusion

On page 24 of the Draft of a General Scientific Framework for World Ocean Study it is said: "The future of the Intergovernmental Oceanographic Commission will depend on its effectiveness in fostering scientific research of the world oceans."

This skeleton plan for co-operative scientific research in an important ocean area is laid before the I. O. C. in the hope it is agreeable to the Members of the Commission to the extent that many will be found willing to participate.

It is also hoped that the Intergovernmental Oceanographic Commission, in that case, will find the possibilities to accept responsibility for this Co-operative Investigation so as to "foster scientific research in the world oceans."

AN INTERNATIONAL PROJECT FOR STUDYING NORTH ATLANTIC DYNAMICS AND HYDROLOGY

Prepared by Professor V. G. Kort, Institute of Oceanology, Moscow

Editorial Note: IOC Resolution IV-14 concerning the North Atlantic Ocean, requested "SCOR and ACMRR in cooperation with ICES and ICNAF and taking into account all the work in progress, to study the possibility of developing cooperative investigations of this region reporting their recommendations to the next session of the Commission including, if feasible, suggested plans for its conduct." Professor Kort prepared the following project in response to a SCOR request that he set forth his ideas on the subject.

TO THE INTERNATIONAL PROJECT OF STUDYING THE NORTH ATLANTIC DYNAMICS AND HYDROLOGY

I. The main problems of studies

As many-year studies have shown, the oceanic circulation in the North Atlantic is one of the most important links in the system of motion of the World Ocean water masses. Now, we may already take for granted the great influence produced by the water circulation in the North Atlantic (directly or through atmospheric processes) on the climate and weather in Western Europe and the eastern part of North America, on the distribution and variations in the abundance of food fishes and on the navigational conditions in the northern part of the Atlantic Ocean. However, the conducted studies and the collected data are still far from being adequate for solving a number of problems connected with the possibility of predicting one or another change in the above-mentioned influence. Moreover, the physics of many processes and phenomena determining and controlling the influence of the North Atlantic circulation on the nature of geophysical and biological processes in the Northern Hemisphere is not yet clear in many respects.

Thus, for example, for the most exhaustively studied current of the North Atlantic system - the Gulf Stream - there are some questions to be answered concerning the deviation of this current from the coasts of the continent, its vertical structure, the origin of meanders, their size and position in the stream, their essentially non-stationary character, etc. Almost absent are data on the different time scale fluctuations in mass transport and on the variability in heat and salt content; the role of Florida and Antilles currents in the genesis of the Gulf Stream proper is still obscure, etc. Most of these questions can be still in larger part concerned with other links of the

North Atlantic oceanic circulation. So far, there remains to be essentially not verified one more rather well-distributed pattern of the large-scale interaction between the oceanic and atmospheric circulations in the North Atlantic. According to this pattern the intensification of trade winds and equatorial drift current dependent on the former ones results in increasing heat transport from the accumulation region to the Gulf Stream system. Further advancement of this positive heat anomaly leads to stirring up of atmospheric activity at the polar front and, consequently, to the intensification of westward transport and trade winds. As fast as the positive heat anomaly goes out of the polar frontal zone and is replaced by colder water, the atmospheric activity above the polar front grows weak. This results in wind and current attenuation in middle and low latitudes. Simultaneously, as the positive heat anomaly moves to the Arctic front, the atmosphere processes above the northern parts of the Atlantic become intensified. The wind and current attenuation in low latitudes slows down heat transport by the Gulf Stream system with the result that conditions are created for decelerating processes in high latitudes (at the Arctic front). When this deceleration begins heat accumulated in the equatorial region in this relatively quiet time stirs up atmospheric activity at the polar front contributing to a new intensification of atmospheric activity in the trade wind zone and to the appearance of a new wave of the positive heat anomaly. The investigations made by the Soviet scientists show that the duration of such a cycle of the interaction between the oceanic and atmospheric circulations in the North Atlantic equals, approximately, 4 years. Thus, the irregular northward displacement of oceanic heat observed within the North Atlantic current system causes a continuous evolution of atmospheric processes. At the same time, atmosphere exerts a reverse and a very active influence on the state of the ocean. The above-mentioned process of atmospheric and oceanic circulation variability is of a pronounced oscillating character (with a period of 4 years) in which self-regulation is inherent. The analysis of the sea level fluctuations in the North Atlantic shows a well pronounced synchronism in the dynamic interaction between the oceanic circulation (its drift component) and the field of tangential forces of the atmospheric circulation. Further specification of the relationships in the regime of the large-scale interation between the ocean and the atmosphere on the example of the North Atlantic would be of paramount importance for the development and improvement of longterm weather and climate forecasts, for fishing predictions and for solving many other geophysical and oceanographic problems.

Finally, despite the fact that the North Atlantic has been comparatively more covered by oceanographic survey than other areas of the World Ocean, there are still many purely regional problems there to be solved. Thus, there are only scarce data on the Antilles and Guiana currents and on their role in the Gulf Stream regime; the character of water exchange between the Atlantic Ocean, the Caribbean Sea and the Gulf of Mexico has not yet been studied; the branching of the North Atlantic current into separate flows and the dynamic state of the Sargasso Sea are not quite clear either.

The above-mentioned still incomplete number of problems pertaining to the North Atlantic is indicative of an extremely great urgency in the development of researches in this part of the World Ocean.

The experience of international cooperation in the Tropical Atlantic studies under the "EQUALANT" programme convinces one in realizability of solving major problems of the North Atlantic on the basis of close international cooperation and collaboration. Proceeding from the enumerated problems the international programme of studying the system of the North Atlantic currents should include three main kinds of investigations:

a) regional oceanographic surveys,
b) special studies at hydrographic polygons,
c) many-year observations at fixed stations and along oceanographic sections.

II. Programme of studies

1. Regional oceanographic surveys in the poorly studied regions of the North Atlantic:

1) Guiana current,
2) Antilles current,
3) Yucatan current,
4) Sargasso Sea,
5) Polar oceanographic front,
6) The branching area of the North Atlantic current
7) The area of deep water upwelling off North-West Africa.

The oceanographic surveys are made in each of the regions simultaneously from several ships (the number of ships is determined by the necessity in maximum synchronizing the surveys) in the summer and winter seasons during 3-4 years. The duration of operations during each survey should not exceed 2-3 weeks. In addition to the fulfillment of the whole integrity of hydrological observations, the programme of the surveys should provide for mooring buoy stations with current meters at the most important points of the regions under study.

2. Special studies in the Gulf Stream.

Data available on the structure of the velocity fields in the ocean indicate the extreme complexity and variability of the latter ones. For example, Fuglister's work on the results of the Gulf Stream surveys have shown the existence in it of a continuous spectrum of the velocity field variations ranging from the smallscale fluctuations up to space-time variations of 1000 km and 1 year.

The example cited shows that the dynamical studies in the ocean require, first of all, that the space-time structure of the dynamical processes should be thoroughly investigated. Such studies can be realized only through specialized cruise operations which will include observations of current velocities and temperature at long-time stations with a duration, at best, of about 1 year, made simultaneously at many points.

The analysis of such observations would yield detailed characteristics of the structure of the velocity and temperature fields in the ocean (correlation and spectrum functions, etc.); spatial and time scales of different types of disturbances; Reynolds stresses, lateral friction and inertial effects in the ocean current dynamics.

Besides, these studies will make it possible to elucidate the questions of energy balance in the ocean current system. To ascertain the above-mentioned problems the Gulf Stream system and the North Atlantic current are the most convenient objects.

To study the above problems and basic regularities in the Gulf Stream dynamical structure it is necessary to conduct surveys, at least, at two conjugate hydrographic polygons located in regions with different dynamical regimes (the area of the western boundary current deviation and the meandering area).

Polygon No. 1. At the Hatteras Cape traverse in the main flow of the Gulf Stream a T-shape polygon is placed composed of 13 anchor buoy stations: 9 stations - at a section across the current and 4 stations - along the current axis. The length of the transverse section is 48 miles and that of the longitudinal one - 24 miles, with a distance between stations of 6 miles. At 50, 100, 250, 500, 1000, 2000, 3000 and 4000 m depths autonomous instruments are placed for the measurements of current velocities and water temperature. Minimum intervals in the measurements are 5 minutes, the duration of the surveys being 3 months.

Polygon No. 2. In the meandering area a T-shape polygon of 13 buoys is placed. A transverse section along the meridian 60°W stretches from 37°N to 41°N (9 stations) a longitudinal section - along the parallel 39°N from 60°W to 62°W (4 stations). The stations are spaced 30 miles apart. The depths at which observations are made are the same plus 750 m depth. The duration of work is 6 months.

In the vicinity of each buoy station temperature and salinity measurements are made with the aid of hydrographical casts and sounders once a week at Polygon No. 1 and twice a week at Polygon No. 2.

In addition to this, along the Gulf Stream flow between Polygons Nos. 1 and 2 current and temperature measurements, as frequent as

possible, are made with the aid of GEK, neutral buoyancy pingers (Swallow's pingers), the thermistor chain and aircraft radiation thermometers.

In the presence of artificial Earth satellites with polar orbits above the area under study, the spatial variability of the Gulf Stream flow is determined with the aid of drift buoys furnished with active reflectors.

The duration of work at Polygon No. 1 has been determined on the basis of the prevailing frequency in time-space variations in days and miles, while at Polygon No. 2 - in weeks and tens of miles.

3. Many-year hydrological observations at "standard thermic sections" and in the areas of weather ship anchorages.

As it has been pointed out above, the development of methods for long-term oceanographic and meteorological forecasts is impossible without understanding the regularities of the large-scale interaction between the ocean and the atmosphere. The North Atlantic is the most characteristic region in this respect.

To study the processes of this kind the programme envisages the arrangement of many-year (6-10) systematic (seasonal) observations at the following standard thermic sections:

1) From Halifax to NE;
2) From St. Johns to SE;
3) Norfolk - Bermudas;
4) Florida Strait;
5) From San Luis to NE;
6) Dakar - Green Cape Ils;
7) From Brest to W;
8) From Bergen to NW.

The length of each section is determined by the necessity of a certitude in crossing one or another flow in the system of the North Atlantic currents.

The programme of studies at the standard thermic sections includes temperature measurements at all standard depths from the surface down to 2000 m depth with the help of thermosounders or ordinary deep-sea thermometers. The duration of ship operations at such sections may be from 3 to 5 days. The observations in the Florida Strait are made with the aid of a communication cable. Many-year thermometric series obtained in this way can be used to estimate variations in heat content of the baroclinic layer of each flow in the North Atlantic current system over many years. The comparison of the many-year variations of thermal stress in the North Atlantic cur-

rents with atmospheric processes would make it possible to reveal the basic peculiarities in the large-scale interaction between the ocean and the atmosphere in the North Atlantic.

A many-year series of electromagnetic measurements in the Florida Strait would characterize the variations in mass transport by the Florida current which is a very important addition to the analysis of variability of the North Atlantic currents.

To study the inter-year thermal stress variations the thermometric measurements are made at the sections not seldom than once a season; to study the seasonal variations the sections are repeated every month.

For the measurements of one month frequency the section between Norfolk and Bermuda (section No. 3) and Bergen section in the Norwegian Sea (section No. 8) should be considered as the most representative ones.

One of the indispensable conditions of conducting observations at the standard thermic sections is their accomplishment at one physical moment. To synchronize these observations it is necessary to work out a strictly coordinated International calendar of "hydrological days".

To raise the statistical value of thermometric observations at the standard sections and for a more broad coverage of the spectrum of variations in the thermal stress of the North Atlantic current system it is necessary to organize systematic (daily) thermometric deep-sea measurements from weather ships A, B, C, D, E, K and M located in the North Atlantic under the programme of observations at the standard sections. The meteorological programme of weather ships should include standard actinometric measurements.

The system of many-year observations of heat content variations in the ocean should also spread over the most representative shore and island hydrometeorological stations of the states of the North Atlantic basin.

The total duration of the many-year observations at the standard thermic sections of 6-10 years is a minimum one and is determined by the necessity of a certain coverage by observations of one-two four-year cycles in the distribution of thermic anomalies in the North Atlantic waters and of their interaction with atmospheric processes. Thus, the main objective of these studies would be at the first stage (6-10 years) the establishing of the mechanism of the large-scale interaction between the ocean and the atmosphere in the North Atlantic and the accumulation of data for statistical characteristics of seasonal variability of the processes going on in the ocean and atmosphere.

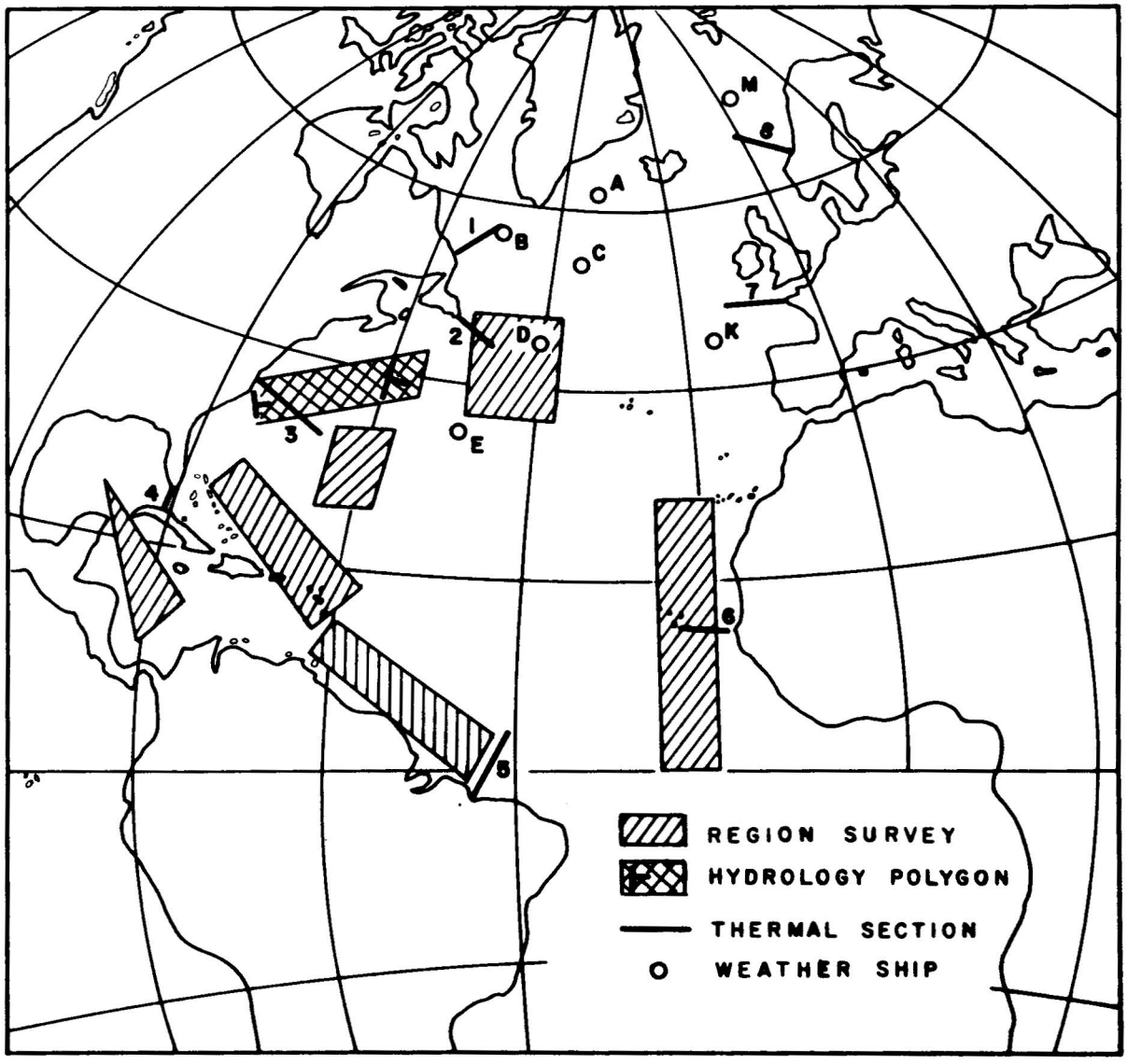
III. Manpower and equipment required.

A detailed estimation of the manpower and equipment required for the fulfillment of the outlined research programme is most appropriate to be made after this plan is approved in principle by the Intergovernmental Oceanographic Commission. At the present stage the scope of expenditure is estimated by the total ship time required for the fulfillment of the research programme:

a) regional oceanographic surveys - 450-510 ship months or 37-43 ship years;
b) conjugate hydrographic polygons in the Gulf Stream system - 30-35 ship months or 2.5 ship years;
6 aircraft surveys with the aid of the radiation thermometers;
c) many-year observations at "standard thermic sections" - 420-700 ship months or 35-58 years.

The total ship time demand, taking into consideration the duration of the studies of the whole programme, is 22 ship years. The above estimation proceeds from that 4-6 ships will take part in regional oceanographic surveys in each separate region with the duration of work of 2-3 weeks. In the surveys at the conjugate hydrographic polygons in the Gulf Stream 5-7 ships will participate during 6 months. For observations at the standard thermic stations 8 ships a year will take part in the surveys with the total duration of work of 22 days for each of the 6 ships and of 60 days for each of the 2 ships.

Location of regions to study, standard sections, hydrographic polygons and weather ships can be seen from the attachment.


M
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REGION SURVEY
HYDROLOGY POLYGON
THERMAL SECTION
WEATHER SHIP

REPORT OF MEETING OF IAPO WORKING GROUP ON DEEP SEA TIDES

La Jolla, 16-20 January 1967

1. The Meeting.

With the generous financial assistance of SCOR, UNESCO, and IAPO, all members were represented, and spent 16 January ashore, and 17-20 January at sea:

Members or Representatives

Capt. Luis Capurro	Argentina
Mr. David Cartwright	England
Mr. G. C. Dohler	Canada
Capt. Marc Eyries	France
Mr. Walter Munk	U. S. A.
Mr. Toshihiko Teramoto	Japan
Mr. S. S. Voit	USSR
Mr. Hartwig Weidemann	Germany
Mr. D. E. White	Australia

Observers

Dr. Merle Hendershott	U. S. A.
Mr. Frank Snodgrass	U. S. A.

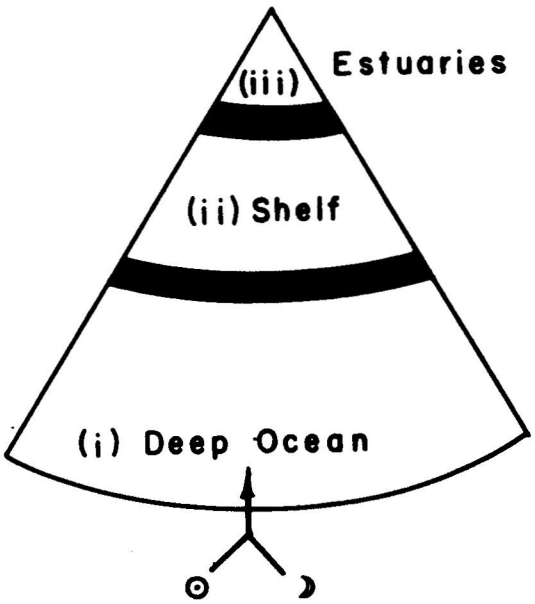
Monday, 16 January was spent at the Institute of Geophysics and Planetary Physics (a laboratory closely associated with the Scripps Institution of Oceanography). Monday morning Mr. Snodgrass led a discussion of his deep sea tide gauge, and of other instruments. Monday afternoon, Mr. Cartwright led a general discussion, including a summary by Hendershott of the theoretical problem, by Mr. Eyries of his recent measurements with the AFEGPO gauge. All members joined in a discussion of future problems.

Tuesday through Friday was spent at sea aboard the Ellen B. Scripps. The Snodgrass instrument was dropped Tuesday afternoon east of San Clemente Island (about 90 km from coast) at a depth of 1.25 km., and recovered Friday morning by acoustical recall. Pressure, temperature and the current vector were recorded in situ at 2-minute intervals, and monitored from the surface every 8 hours. Acoustic search patterns were run Wednes-

day and Thursday. Upon return to port Friday afternoon, the magnetic record tape was immediately fed to the computer and some preliminary tabulations were available next morning. Some missing characters on the tape will delay the analysis. Except for the tape problem everything worked, and in this sense the demonstration was non-typical.

2. A Restatement of the General Problem. (Cartwright)

With such costly and laborious sea going operations, it is important to obtain as much guidance from theory as possible as to where measurements can be most profitably made. Mr. Cartwright drew a pie-shaped sketch:



Tidal dynamics divide the sea into three zones with more or less distinct boundaries.

(i) The deep ocean, where the exciting forces of the Moon and Sun are important, conditions are supposedly linear, but Coriolis forces vary greatly;

(ii) The shelf zones, where the tides are essentially driven by, but co-oscillate with, the system generated

in (i), water is shallow, but the departure from linearity is weak;

(iii) The estuarine zones driven by the tides in (ii), characterized by strong non-linearity and dissipation of energy by bottom friction. (Energy is also lost from the surface tide in zones (i) and (ii) by bottom-induced coupling with internal wave modes).

In all these zones, but especially (i) and (ii), we wish to define contours of the in-phase and quadrature components (with respect to the equilibrium tide) of tidal height ζ and current vector $\underline{u}$. The above quantities are functions of position and frequency, and it is worth remarking that while computations cover all spacial positions at a single frequency within each tidal species, the measurements we contemplate are limited in space, but will give all relevant information in frequency, including separation of spherical harmonics of degrees 2 and 3.

Ideally, the tides in any zone could be computed from the equations of motion if either ζ or $\underline{u}$ is defined along its boundaries. ($\underline{u} \cdot \underline{n} = 0$ is sufficient for coastlines). If, therefore, we could trust the accuracy of the equation and the numerical processes involved in their solution, the only measurements we need make would be along the boundaries. The shelf edge is especially commendable for measuring because it enables one to compute outwards to zone (i) and inwards to zones (ii) and (iii). A certain amount of spacial coverage is also required here because of the rapid change of $\underline{u}$ (less so ζ) with depth. Probably, conditions at both 200 m and 1000 m should be measured.

In some areas, the shelf conditions could be extrapolated from the known tides along the coast, though this would depend on the number of coastal tide gauges and how complicated the shape of the coastline. Methods are now being evolved for purifying coastal tide records of their non-linear content, and for computing frictional dissipation. However, extrapolation from the coast is dubious where the continental shelf is wide.

Measurements along the shelf margin must, therefore, form an essential part of our program, especially for participants whose equipment is not designed for great depths. But it is also certain that the interior regions cannot be left entirely to calculation, and some, perhaps many, observations will have to be made there also. Whether a coarse grid of stations covering the whole ocean should be used, or whether one should determine the positions of the amphidromes (as functions of frequency) is not yet clear. Most important is to check tidal characteristics in areas which calculations show to be sensitive to small changes in boundary and dissipative conditions.

The areas most likely to be sensitive are where the tidal contours appear crowded. In this respect, the conventional cotidal charts may be deceptive, because of the crowding of cotidal lines around amphidromes. Spacial gradients of in-phase and quadrature ζ and u are probably more informative as a guide to density of measurements. Perhaps areas of crowded contours should be left entirely to measurement, in order to avoid fine meshes in the computation.

3. Hansen's Statement

We were fortunate to receive just prior to the meeting a report from Dr. W. Hansen* (Preliminary Scheme of Deep Sea Tidal Measurements based on Tidal theory; Mitteilung VI, Inst. f. Meereskunde der Universität Hamburg). This report is being circulated in full among members of our Working Group. In brief, Hansen visualized four stages of the experimental program:

(i) profiles normal to shore with measurements (height and current) extending from the shelf to the deep sea, possibly in two dimensions (Bay of Biscay, off N. California, etc.).

(ii) some areas of special tidal interest, such as the Asiatic coast of the Pacific.

(iii) the North-Atlantic, South-Atlantic and Indian Oceans with a 15^{o} grid in deep water, closer grid on the shelf.

(iv) South and Middle-Pacific. Hansen would give no special consideration to amphidromes, inasmuch as these are frequency-dependent features representing (in a broader context) an area of small amplitude.

4. Hendershott's Statement

Hendershott made three important points which will be subject of an early publication:

(i) relaxation methods are limited to such forcing

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* Co-chairman (with S. Voit) of the sub-working group on theoretical tides; other members: Hendershott, Pekeris, Redfield, Yoshida.

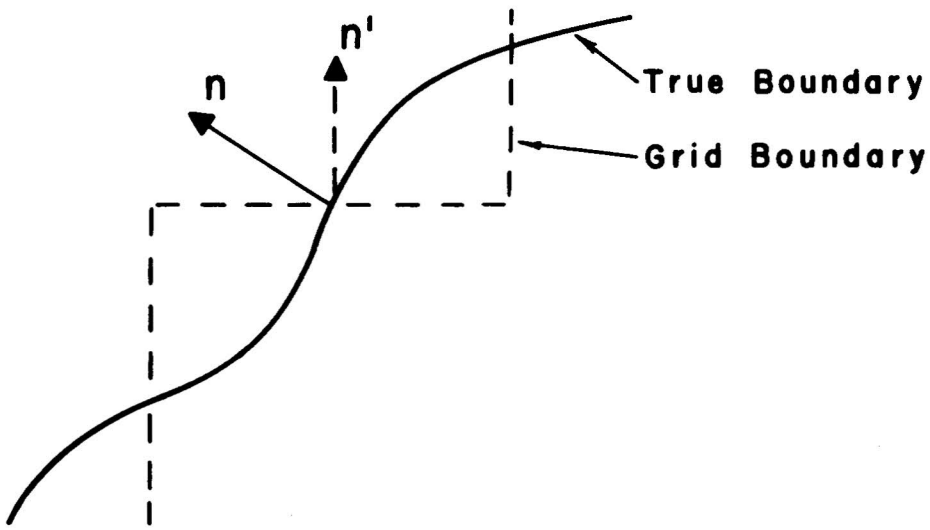
frequencies, σ , that are intermediate between the resonant frequencies, σ_o , associated with gravity and planetary waves:

$$\sigma_o^P < \sigma < \sigma_o^B$$

In the Pacific, $\sigma_o^B \sim$ 2 cycles per day, $\sigma_o^P \simeq 0.15$ cycles per day and so this may be fatal.

(ii) in the <u>direct</u> method, employ a mesh Δ the normal modes vary somewhat with mesh, $\sigma_o = \sigma_o(\Delta)$ and it is essential for convergence that $\sigma_o(\Delta) \neq \sigma$ in the interval $\Delta_{coarse} > \Delta > \Delta_{fine}$ as the mesh size is reduced.

(iii) Hendershott finds that at the grid boundary



approximating the true boundary, the boundary condition should be $v_n = 0$, not $v_{n'} = 0$.

(iv) there is some question as to whether the LaPlace equation applied to a bumpy bottom gives the appropriate scattering condition for surface tides in the pressure of internal stratification.

Hendershott reviewed a suggestion by Munk of placing the boundary at the shelf transition (somewhere within the 200 m and 100 m contours, say, see Cartwright sketch) and defining a complex impedance $r = u/\zeta$ along this boundary. The impedance can be measured, or for simple regions it can be reasonably estimated.

5. The Transition Problem.

All concerned have emphasized the importance of the transition problem between shelf and deep water. There is, furthermore, an indication of the development of a variety of shallow-off-shore instruments by the Dutch* (250 m), Canadians (80 m), French (150 m), USA (ESSA), etc. We may, therefore, expect within the next few years an intensive effort by various nations to investigate the tidal transition off their respective shelves, using instruments of various designs and principles. This is most encouraging. We propose that results be promptly distributed through our Working Group, and also be made available for improved boundary conditions to the theoretical problem.

6. The Deep Sea Problem.

Here the Working Group feels that the emphasis should be placed in regions where, according to theory, the in-phase component X and out-of-phase compenent Y are linear, steep functions of position, and sensitive to boundary conditions. Amphidromes may or may not fulfill these conditions.

In some ways our thinking has moved towards initial emphasis on the transition problem. Yet the doubt expressed by Hendershott concerning the completeness of the La Place equation, and the general absence of

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*Van Grandelle: New Tidal Measurements in Antarctica. Hydrographic Newsletter, Netherlands Hydrographer, 1:5, Sept. 1966.

open sea observations, makes some limited efforts attractive even at this time.

Eyries has made the only deep measurements so far. This preliminary result indicates that the deep-sea cotidal lines may be even simpler than those previously inferred from coastal observations. Overtides decrease seawards, as expected, except for a puzzling apparent increase in M_3.

At the moment the USA and French gauges are in a moderately advanced stage, and would become commercially available within a couple of years. ($\sim$ \$25,000 ???). We feel that it would be healthier for the program if additional independent instrumental developments (perhaps along quite different lines) were to take place. Cross-calibrations of different instruments remains an important problem.

7. The Estuary Problem.

This is generally beyond the scope of this Working Group, but we wish to report a Canadian effort by Dohler involving off-shore recording in the Bay of Fundy and in the St. Lawrence River. The Canada shallow instrument is being developed for this purpose.

8. Recommendations concerning standards.

These are substantially unchanged from those suggested in our first Working Paper: precision at least 1 cm, sampling at least once per hour. For the transition instrument we recommend an operating depth of 10 m to 200 m, possibly to 1000 m, for the deep-sea instrument to at least 5000 m.

With regard to duration we urge a lower limit of 1 month, not a fortnight, as previously suggested. Cartwright supports this request from the point of view of information theory. Whatever method of analysis is used, one wants to separate the amplitude of tidal groups at a spacing of 1 cycle/month. If one calculates the variance of error due to the noise content of tidal record in any group as a function of duration T, one finds that for

$$T = \frac{1}{2} \quad \frac{3}{4} \quad 1 \quad 1\frac{1}{4} \quad 1\frac{1}{2} \quad \text{months}$$

variances are in the ratio

$$8.1 \qquad 1.8 \qquad 1 \qquad 0.9 \qquad 0.8$$

In other words, the expected error falls rapidly up to T = 1 month, then falls slowly.

There is strong support from all quarters, theoretical, experimental, economical, to record the current as well as the pressure variations. We will coordinate this effort with a SCOR Committee on ocean currents. Weidemann suggests measuring current gradients (hence stress). The IGPP current meter (developed by Caldwell) is based on a hot wire principle, this poorly separates components, and uses too much power (~ 10 watts). It has the advantage of going down to 1 mm/sec. Teramoto has developed an acoustic meter which measures the difference of downstream and upstream total sound velocities, (c + u) - (c - u). The present model has a precision of 1 cm/sec. for 30 sec. readings, and further improvements are in sight. It clearly separates components, and used less than 1 watt.

Theoretical considerations would indicate an Ekman-type bottom boundary layer of typically 10 m thickness. The current should be measured above this layer. The IGPP current meter is only 2 m above bottom.

9. Next Meeting in Switzerland.

For those members of the Working Group that can afford the Swiss registration fee of $100, there will be a chance of a meeting in Bern.

Eyries will briefly review the activities and plans of various members of our Working Group, and he urges all of us to send him the necessary material (it can be brief) by July. In the meanwhile, in a preliminary way and of course quite unbinding, the situation was reported as follows:

Capurro: The newly founded Argentina Institute of Oceanography plans to measure tides on the shelf, later in deep water. Brazil might do likewise. Satellite navigation is a must.

Cartwright: There are plans for purchasing 3 (?) instruments for work on the transition problem.

Dohler: Canada will soon have a tidal current survey vessel. Will build shallow instruments and might purchase deep instruments.

Eyries: Plans to study the shelf in the Bay of Biscay to depths of 400 m, and to greater depth by 1969-70. In 1968 might explore the region of the North Atlantic amphidrome.

Munk: Did not know the latest plans of ESSA and Hawaii. Scripps is planning 3 instruments on the North Pacific M_2 amphidrome in August 1967 (remarks in this working paper not withstanding).

Teramoto: Will acquire deep vibrotrons in several months, and plans work from a 3200 ton new vessel.

Voit: Will emphasize theoretical work, and will explore opportunities for experimental work.

Weidemann: (speaking for Hansen and the D.H.I.) will continue North Sea Work and hopes for plans to do deep measurements.

White: Is committed to build a Snodgrass-type instrument and hopes to buy a few, for work south of Cangoroo Island and elsewhere.

We are off to a grinding start.

MEETINGS OF SCOR AND ASSOCIATED ORGANIZATIONS IN 1967-68

1967

17-19 April	Wormley (UK)	SCOR/IAPO/UNESCO WG 21, Continuous Current Velocity Measurements
18 April-3 May	Monaco	9th International Hydrographic Conference
May	Bangkok (?)	IOC Internat. Coord. Grp. for Cooperative Study of Kuroshio
12-14 June	Paris	IOC Internat. Coord. Grp. for Internat. Coop. Invest. Tropical Atlantic, Edit. Comm.
5 July-2 August	Woods Hole	SCOR/IAPO/UNESCO WG 21, Continuous Current Velocity Measurements, field trials
17-21 July	near Rome	SCOR/ACMRR WG 26, Scientific Aspects, UN Resolution on Resources of the Sea
14-16 August	Paris or Hamburg	IOC WG on Oceanographic Aspects of Marine Pollution
10-18 September	Cambridge (UK)	SCOR Symposium on Micropaleontology of Marine Bottom Sediments
18-21 September	Paris or Netherlands	IOC WG on Governmental Aspects, UN Resolution on Resources of the Sea
25 September-7 October	Switzerland	14th IUGG General Assembly; IAPO Meeting (Bern); SCOR/ICES IAPO/UNESCO WG 10, Oceanographic Tables and Standards
September or October	Switzerland	IOC WG on Ocean-Atmosphere Interaction

ABBREVIATIONS

AAAS	American Association for the Advancement of Science
ACMRR	Advisory Committee on Marine Resources Research, FAO
CIG	Comite International de Geophysique
COFI	Committee on Fisheries (FAO)
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
DDR	Deutsche Demokratische Republik
DHI	Deutsches Hydrographisches Institut
ESSA	Environmental Science Services Administration (USA)
EURATOM	European Atomic Energy Community
FAO	Food and Agriculture Organization of the United Nations
FRG	Federal Republic of Germany
GFCM	General Fisheries Council for the Mediterranean
IAEA	International Atomic Energy Agency
IAMAP	International Association of Meteorology and Atmospheric Physics
IAPO	International Association of Physical Oceanography
IAWPR	International Association of Water Pollution Research
IBP	International Biological Programme
ICES	International Council for the Exploration of the Sea
ICNAF	International Commission for Northwest Atlantic Fisheries
ICSEM	International Commission for the Scientific Exploration of the Mediterranean
ICSU	International Council of Scientific Unions
IGGP	Institution of Geophysics and Planetary Physics, University of California
IGU	International Geographical Union
IGY	International Geophysical Year
IIOE	International Indian Ocean Expedition
IMCO	Intergovernmental Maritime Consultative Organization
IOBC	Indian Ocean Biological Center
IOC	Intergovernmental Oceanographic Commission
IPFC	Indo-Pacific Fisheries Council
IUB	International Union of Biochemistry
IUBS	International Union of Biological Sciences
IUGG	International Union of Geodesy and Geophysics
IUGS	International Union of Geological Sciences
IUPAP	International Union of Pure and Applied Physics
IUPS	International Union of Physiological Sciences
NAS	National Academy of Sciences (USA)
NIO	National Institute of Oceanography (United Kingdom)
NODC	National Oceanographic Data Center (USA)
OECD	Organization for Economic Cooperation and Development
PF	Productivity-Freshwater (IBP Section)
PM	Productivity-Marine (IBP Section)
SCAR	Scientific Committee on Antarctic Research
SCIBP	Special Committee for the International Biological Programme
SCOR	Scientific Committee on Oceanic Research
SOFA	State of Food and Agriculture (FAO)
UN	United Nations
UNESCO	United Nations Education, Scientific and Cultural Organization
WDC	World Data Center
WG	Working Group
WMO	World Meteorological Organization

September or October	Geneva	WMO/IOC Expert Panel on Coord. Oceanogr. Meteorol. Requirements Network Observing Stations
9-15 October	Hamburg	55th Stat. Session ICES
11-13 October	Warnemünde or Kiel	SCOR Executive Meeting
15-17 October	Cairo	IOC WG on Mutual Assistance
19-28 October	Paris	5th IOC Session

1968

May	La Jolla	SCOR/IAPO/UNESCO WG 15, Photosynthetic Radiant Energy, field trials
May or June	La Jolla	9th SCOR General Meeting