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REPORT ON ASIAN TRIP MADE IN ORDER TO GATHER INFORMATION
ABOUT MARINE BIOLOGICAL RESEARCH FACILITIES AND THE
FORTHCOMING INTERNATIONAL INDIAN OCEAN EXPEDITION

AUGUST 18 - SEPTEMBER 26, 1960

For:

The National Science Foundation
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From:

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I. Introduction

The International Indian Ocean Expedition comes into existence as the result of a proposal from the Special Committee on Oceanic Research of the International Council of Scientific Unions. This expedition calls for the cooperation of all willing maritime nations in the promotion of a broad-scale attack on the basic oceanographic problems, both biological and physical, of this little known ocean. Plans of a preliminary nature were formulated by Indian Ocean Working Groups of SCOR at sessions held in July and August, 1960 respectively in Copenhagen and Helsinki. These plans are now under further consideration by the individual countries, and agreement on national programs is still some distance from attainment in many cases. Furthermore, the extent and nature of possible international cooperation remain to be worked out.

Participation by the United States in this expedition is a joint responsibility among the National Academy of Sciences, the National Science Foundation, and the Department of the Navy. The Committee on Oceanography of the National Academy of Sciences-National Research Council is responsible for the scientific program. The National Science Foundation is asked to coordinate the participation by U. S. Government agencies and to provide financial support. The Department of the Navy will make oceanographic vessels available and finance much of their operation by principal United States oceanographic institutions.

The early plans from the biological working-group suggested the establishment of a taxonomic classification center in India to handle the incoming Indian Ocean material and discussed the training of nationals from the Indian Ocean area. The possible extent of United States' financial involvement in these phases of the expedition were also discussed. In view of its immediate concern with these questions and its lack of on-the-spot information on the biological working centers in the Indian Ocean area, the National Science Foundation decided on the present one-man survey of the situation. The hurried trip I made in behalf of NSF from August 18 to September 26 took me to half a hundred laboratories, research organizations and independent departments, mostly interested in the forthcoming Indian Ocean Survey in a direct way. My trip was in the nature of an exploratory probe of the potential interest of the Asiatic biologists in the Indian Ocean venture and of the resources in facilities and trained manpower that might be made available for the work if needed.

It at once became apparent that as an independent biological observer I was coming into possession of a large number of opinions, from persons of various backgrounds, that might properly be sifted and transmitted for the benefit of program planners beyond those of the National Science Foundation. I exchanged views with biologists I met, and the resultant report attempts to reflect some of the combined thinking from these interviews. The opinions given must be my own responsibility, as I was

not able to gather notes in leisurely fashion that would enable me to speak more than tentatively for others. These notes are presented in the hope that they may be useful in expressing some composite points of view on a ramified biological undertaking of considerable complexity.

II. Fundamental Problems

Whereas the biological program for the Indian Ocean Survey remains unclear at this time for most participating countries with the possible exception of the U.S.S.R., it can be foreseen from the probable number of ships involved, that with even a very modest biological effort overall, a large amount of biological material will come to hand. Some countries, the United States for one, are even now trying to increase their biological objectives. What is to be done with this material? Is every nation going to hang on to its own, laboratory by laboratory and ship by ship? Obviously some materials and some observations will be the unquestioned property of the investigator who has planned and carried out their gathering. On the other hand, much material will be gathered that can more usefully be turned over to others for final reporting.

A cooperative expedition of this kind, under international auspices, presents a unique opportunity for substantial scientific accomplishment in all phases of oceanography. The accomplishments should receive wide attention and solidify the interest of widely scattered specialists. In the biological field the consensus is that interested specialists should be drawn into the work on as wide a scale as possible, for no one is confident that the taxonomic work on these collections, for instance, could possibly be handled in a short time or even adequately by the scientific workers available. It is apparent to all that some animal groups will doubtless remain unstudied until a worker as yet unknown is found whose interest can be whetted by these attractive opportunities. One of the fervent hopes is that the Indian Ocean Expedition will provide a training ground for new biological oceanographers. The planners of research programs should not lose sight of this need.

Gathering of the biological data will presumably net specimens in quantity, but the kinds -- planktonic, nektonic, or benthic -- and their value for different uses will depend on the design of the experiment. It is presumed that care will be exercised to see that all vessels gathering biological information will also be measuring physical-chemical properties of the sea-water, light intensities at different depths, etc., but provision should be made to assure adequacy of the sampling and of the data pertaining thereto in the interest of ultimate ecological, biogeographical and systematic results.

A need has also been expressed for some ship to measure the energy coefficients involved in the rise and fall of the planktonic layer in response to different intensities of light. The mechanism of this movement

presents a significant physiological problem of wide interest.

There is extensive agreement among biologists I have interviewed that a sensible procedure for the handling of sizeable quantities of biological material would be to have the various ships unload their take at a central port for preliminary sorting by a large staff. Principal museums of the world do not have the space to handle such a staff. Oceanographic laboratories elsewhere have been suggested, but the logical place for such a sorting center is on the shores of the Indian Ocean itself. Are suitable sites for this available?

The estimates vary appreciably, but minimal figures predict that it will take $2\frac{1}{2}$ times as long for a staff to rough sort collections on shore as it takes the same number of people to gather the material at sea. This rough sorting can be done by technical aides with but brief training. After this preliminary separation of the collections down to macroplankton size, the time will be ripe to assemble specialists well suited to the task of making rapid final sorting and rough analysis of the materials. Fish and the larger invertebrates offer few serious problems of rough classification, the macroplankton few more. The microplankton defy complete sorting, but it is most important to have a specialist's verdict as to the percentages of different classes, orders, families or genera involved. Technical aides should be provided to note the verdicts as pronounced and to take directions for carrying out the final subsampling and disposition of the materials.

Securing of the specialists should not present a serious problem. I found qualified people volunteering their help in country after country, and many people should be available on a short-term basis, a few weeks at a time.

Principal decisions to be reached include:

1. Agreement of participants in the biological oceanographic program to bring or send their biological collections to an agreed upon sorting center (or centers).

2. Presuming that one center is to be established in India, is there promise of sufficient biological activity in the southern Indian Ocean to warrant starting another center in western Australia and/or South Africa?

3. Agreement on division of the materials. Some orders have several taxonomic specialists — some have none. Interim working groups of high ranking marine biologists should get together to settle these questions. They could be appropriately called upon to determine who would like to study what and to attempt to find adequate coverage for all the important groups of organisms.

4. Where should the sorting center be located? Perhaps this decision may soon be made by ICSU officials, but it is to be hoped that a substantial body of biological opinion will be sought for guidance.

5. Who should be invited to do final sorting? The working groups mentioned under "3" could be responsible for handling this.

III. The Primary Sorting Center

An area in which the National Science Foundation required additional information was the matter of adequacy of facilities and personnel for the considerable task of handling a large volume of mass collections of the sort to be anticipated from the Indian Ocean Expedition. A main purpose of my visit to India was to get some meaningful answers to this question.

What are the principal requirements for a primary sorting center?

1. An adequate biological library. This is rated first because a good library will demonstrate its worth innumerable times and is a "must." It is scarcely enough that a photocopy of a needed work can be obtained in a week; the book should be on the shelves when needed. A good library cannot be moved around as can people, so its location is an important consideration.

2. A laboratory on the immediate coast with docking facilities would be desirable. At all events, port facilities in the area adequate to accommodate participating oceanographic vessels seem almost essential. I think this is second only to the library in importance.

3. Adequate living accommodations for visiting scientists. This is probably third in importance because comfortable living quarters and acceptable eating facilities must be available, not only for foreign specialists but for Indian scientists brought in for the period. The overall environment of the community should be conducive to efficient, pleasant work. These two things can be considered together in making a rating. Living facilities could be created if they did not already exist, but existence of such a need should be noted in considering relative merits.

4. Accessibility. This is considered from the point of view of the visiting scientific staff. Considerable coming and going can be anticipated on the part of trained personnel.

5. Adequate work space. This need is difficult to estimate, but let us assume that laboratory facilities must be provided for some 50 to 60 people. There may be 10 or 12 specialists at a time working with 3 to 5 technical aides apiece. Most of this staff will need adequate

microscopic equipment and ample table space. Others will need typewriters, dissection equipment, etc., and there should be a packing and shipping department. Assuming that the center will be in India, the physical needs should not be prohibitive in cost. Laboratory space might be rented or if necessary built without too much expense except that land could be a limiting factor in the populous cities. The building should provide adequate protection against the weather, but air conditioning would perhaps not be necessary. The ceiling fan makes office work comfortable in India in most seasons, but provision should be made for ample sorting and storage space and good lighting. Equipment for laboratories and offices for a center of this size should be purchased for the project. As it is assumed that these facilities could be provided from scratch, if necessary, at whatever site is chosen, this important item rates no higher than fifth on my list.

6. A core of permanent resident marine biologists available to assist the center in solving day to day operational problems of supplies, information, etc.

7. A supply of trained manpower. This is available in India but not all in one place. It is assumed that much of this must be mobilized and brought to the center, hence the present location of these people is not of primary importance. Adequate numbers of graduate students, people with M. Sc. and Ph. D. degrees or the equivalent, and others who have some familiarity with marine groups and are eager to learn how to apply their talents to the work of the center should be available for the period of the Expedition.

A number of marine biological centers are located in India, but no one of them meets all of the above requirements. I visited those in Bombay, Cochin, Trivandrum, Mandapam Camp, Madras, Waltair and Calcutta. I believe the only one of some significance for the present purpose that I missed is Porto Novo, but it is smaller than those considered. As the marine biological work in Trivandrum is transferring to Cochin in 1961, Cochin-Trivandrum are considered as one in the tabulation on page 6. This tabulation indicates the relative merits of the various centers as judged by the set of criteria listed above.

The rating has been attempted in two different ways: first, on the basis of a 1 to 3 scale in which 1 stands for very good, 2 for fair, 3 for unsatisfactory; and second, in relative order of merit. The characteristics selected for tabulation to me seem important, but they are of course arbitrarily chosen. They may well be challenged as to their relative importance on good grounds. I have attempted to approach the preparation of this table as impartially and objectively as possible, but I recognize how hazardous it is for one hurried observer to attempt thus to summarize his impressions. I trust that these data will be viewed in this light and utilized so far as possible in conjunction with data from other unbiased sources.

Requirement		#1	#2		#3		#4		Subtotals		#5		#6		#7		Totals
Scale		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
BOMBAY		2		1		1		1		5		2		1		2	17
			2		3		1		1		7		5		3		
COCHIN-TRIVANDRUM		2		1		2		2		7		1		2		3	13
			4		1		6		4		15		2		5		24
MANDAPAM CAMP		3		3		3		3		12		1		1		2	16
			6		6		5		6		23		1		1		30
MADRAS		2		2		1		1		6		3		3		2	14
			3		5		2		3		13		4		6		26
WALTHAM		3		2		2		2		9		2		1		1	13
			5		2		4		5		16		3		2		22
CALCUTTA		1		1		2		1		5		3		1		2	11
			1		3		3		1		8		6		4		24

#1 Library
#2 Dock facilities
#3 Guest accommodations
#4 Accessibility
#5 Working space
#6 Permanent staff
#7 Trained manpower

Scale 1 - Value rating
Scale 2 - Relative merit

Statistics can be used to show various things, of course, and perhaps a proof of this is that I myself was surprised at the results when I drew up the chart on page 6. Bombay leads in all the totals except one in which it ties for first with Calcutta, and Calcutta has two seconds and a third. These two cities do not have bonafide marine biological research laboratories with facilities of the type available or now building at Cochin, Mandapam Camp and Waltair, for instance, yet they score higher in the overall rating on the strength of other qualities. The table also shows the intermediate category of Madras, Cochin, and Waltair, any one of which would probably be suitable for the sorting center, and the lesser desirability of Mandapam Camp, even though here is found the single most active research center in marine biology in India.

The subtotals shown are of interest, as the first four requirements are considered to be the most important. Considering these subtotals, therefore, is one method of weighting the more important requirements. As compared with the totals, the subtotals are more favorable to Calcutta and Madras and less favorable to Mandapam Camp.

IV. Research and Training Centers in India

Work in marine biology in India is carried on by the national government and by some of the individual state governments through their universities or research laboratories. A very minor fraction, if any, is done by private universities or laboratories.

The national government supports marine biological research under two different administrative set-ups. The Zoological Survey of India is, I believe, an independent office of the federal government. A number of staff officers are engaged in basic research in marine biological problems, most of which are systematic in nature. Their work is greatly aided by the proximity of the Indian Museum, which is likewise in Calcutta and houses the national collections and an extensive research library - the best for the purpose in the country. The laboratories are rather well equipped but crowded, and the present quarters are inadequate in other respects. A projected new building, for which a site has been selected almost next door to the Indian Museum will be a welcome improvement when it is eventually built. The Zoological Survey of India does not have in Calcutta a marine laboratory in any sense, and facilities for experiment, such as an aquarium, are not maintained. I believe, however, that some personnel have utilized ship time for estuarine research, but I am not sure what agency provided the vessel.

A larger research program in this field is conducted by the Ministry of Food and Agriculture of the Government of India through its Central Marine Fisheries Research Station at Mandapam Camp. Substations of this

are located in Bombay, Ernakulam (Cochin), Madras, Waltair, and elsewhere. While solutions to applied problems in marine fisheries are urgently needed in India and consequently earnestly sought for by this agency, appreciable amounts of basic research are also being done at Mandapam and a few of the substations. These laboratories ordinarily do not provide training facilities for graduate students, I believe.

Marine laboratories connected with the universities, on the other hand, seemed to be giving a considerably larger proportion of their efforts to basic research. All that I visited were training centers for a number of graduate students. The emphasis on student training varied, for in some institutions this took most of the time of the staff, whereas in others it was more incidental and interfered less with personal research projects of staff members. The zoology departments in the universities in the coastal cities are strongly oriented toward marine biology. The lists of dissertation titles as well as the research interests of the staff members reinforced this impression. The following data I trust are essentially correct, but I do not know whether all of these students are preparing dissertations on marine subjects.

Bombay - Taraporevala Aquarium: professional staff, 7; graduate students, 8, Ph. D. candidates, 6, M. Sc. candidates, 2.

Institute of Science: Zoology Department, professional staff, 7; graduate students, 20, Ph. D. and M. Sc. candidates, 10 each.

Cochin - Oceanographic Laboratory, University of Kerala: professional staff here, 4, the number in Trivandrum who will move here in 1961 when the new laboratory is completed, not determined; graduate students are working for M. Sc. and Ph. D. degrees but numbers not available.

Madras - University of Madras: Department of Zoology, professional staff, 3; graduate students at least 16, Ph. D. candidates, 6 or more, M. Sc. candidates, 10.

Waltair- Andhra University: Department of Zoology, professional staff, 5(?); graduate students, total unknown, Ph. D. and D. Sc. candidates, 12 in all.

Calcutta-University of Calcutta: no data.

It was a pleasure to visit successively the principal Indian centers of marine biological research and training. All have talented, progressive leadership, good research programs, and obvious enthusiasm for the tasks before them. Their students are writing high quality, thorough dissertations. The professional staff is often small and facilities can be modernized or supplemented to advantage, but all in all the resources of these laboratories are quite adequate to meet the expected demands of the Indian Ocean Expedition.

V. Laboratory Needs of the Indian Ocean Expedition

A limited number of biologists will be able to participate in the oceanographic cruises of the Expedition, and of these presumably the majority will spend but a limited amount of time thus. Certainly there will be substantial amounts of biological work done on shipboard, but much of the available time will be spent on gathering and recording data and collections. Many types of work cannot be undertaken at all until the material is available in a laboratory on land. Many people will require much more sophisticated laboratories and equipment than can be provided at sea.

It is foreseen that studies connected with this Expedition will be carried out in laboratories in many countries around the world in keeping with the international group of biological oceanographers involved. Preparations for these studies will be made largely on an individual basis.

On the other hand, it would be desirable if one reasonably complete laboratory could be provided near the heart of the whole operation that would permit biologists to carry out some experimental work on the spot. It is quite conceivable that problems will arise that call for quick incisive answers while materials or time are available. The Expedition presents special opportunities over the short term, and it would be highly desirable if participating scientists could make full use of these by having available strategically located laboratory facilities including a dock and temperature controlled salt water aquaria.

Certainly the best arrangement would be to have this laboratory in India at the site of the primary sorting center. The requirements for the one are rather parallel to those for the other. From the point of view of convenience to the center of operations, southern India would be preferred. It would be possible for an oceanographic vessel to work out of such a station for cruises of relatively short duration in either the Arabian Sea, the Bay of Bengal, or south to the equator or the reefs of the Laccadive Sea. Smaller boats could also use these facilities for short (1-2 day) special-purpose cruises and collecting trips.

Ceylon offers the Colombo area (no other is nearly as convenient), but the scientific manpower situation is appreciably better in India, as is the breadth of interest in these problems, and available facilities including libraries.

Cochin is attractively located on the southwest coast of India with good laboratory facilities including an aquarium under construction. The new building should be completed in the spring of 1961. It is conveniently located in a fine harbor with docking facilities, but I do not know how large a ship can be accommodated. Two of the three Indian oceanographic vessels are stationed here. Its library and staff of faculty and graduate

students will be rather adequate when those from the University of Kerala, at Trivandrum, are brought here in 1961 and joined with those of the Oceanographic Laboratory. These reunited operations will become the Department of Biological Oceanography of the University of Kerala.

In Cochin the problems of biological interest are numerous (the fisheries are more productive on the west coast of India than on the east), and suitable living conditions can be made available in a small town atmosphere.

Mandapam Camp on the east coast, the other southernmost marine facility in India, is even more rural than Cochin, and though it is on the rail route to Ceylon it is quite isolated transportation-wise. It does offer good experimental facilities, including aquaria and salt water ponds, and a dock for small boats. Ships crossing the Indian Ocean could not be accommodated here.

Waltair is attractive for harbor and supply operations, with a thriving oceanographic program in progress at Andhra University, and a new marine laboratory under construction by the Department of Zoology a kilometer from the water; but it is up the east coast nearly as far as Bombay is up the west coast with perhaps less to offer of marine biological interest.

If a primary sorting center with a marine laboratory in connection emerges from the present planning stage somewhat along the lines mentioned here, it is obvious that a facility will be developed considerably beyond any that is now available or anticipated in India with Indian funds. This facility should be actively operated in behalf of the Indian Ocean Expedition for at least 2 or 3 years, but presumably it would then revert to the Indian marine biologists. It would be a valuable research facility for further development of marine science in South Asia.

VI. International Cooperation

The ramifications of the International Indian Ocean Expedition are very broad and many branches of science are included. Considering only the potential biological problems, scientists from all continents except South America are already involved. With so many scientists and their interests to consider, it is not strange that the biological planning for the Expedition has progressed slowly. Marine biologists of the United States are now, however, rapidly developing their program, but it is by no means as yet so finalized as that of the physical oceanographers.

It is not possible to predict as yet how many United States biologists will participate nor on what ships. Neither is it known what opportunities can be offered to biologists of other countries for shipboard training or visits to American laboratories in connection with the Expedition. These and other questions must have answers.

But the feeling has been expressed by the marine biologists of the United States, as well as by others questioned on the point, that the Indian Ocean Expedition offers a splendid opportunity for utilizing all the talents that can be recruited to make the big task easier. We sincerely hope that the training opportunities, the gathering of the data, and the reporting of the results can be widely shared among all those who are sincerely interested and themselves have some talent to contribute. In my quick trip through South Asia I found abundant enthusiasm and sincere offers of cooperation from many scientists. We now look for further unfoldment of the plans that can draw on these and thus bring some of the biological problems of the Indian Ocean to solution.