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EVALUATION

Cooperative Marine Technology Program for the Middle East

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Preface

The authors were asked by AID to evaluate the Cooperative Marine Technology Program for the Middle East. Part I of this report, prepared by Herman Pollack, evaluates the degree and quality of cooperation developed under the Program. Part II, prepared by Dr. Clarence P. Idyll, evaluates the scientific and technical performance and achievements of the Program.

Four principal criteria were utilized in evaluating the degree of success in achieving the cooperation objectives of the Program:

1. The number of contacts made for cooperative purposes.
2. The content and quality of the contacts.
3. The attitudes of the Egyptian and Israeli participants toward cooperation with each other.
4. Comparisons with bilateral cooperation elsewhere.

These are discussed in the text of the report.

The Marine Technology Program has been documented in depth. This material was reviewed thoroughly and with care. However, most of the information needed for the evaluation was obtained by an extensive series of interviews in the United States, Egypt and Israel. See Appendix for a list of those interviewed.

Does the Marine Technology Program serve as a model for other Middle East cooperative ventures? We doubt it. The Marine Technology Program was designed and fitted to circumstances unique to Egypt and Israel in 1978-1979. Much of its character arises out of Egypt being alone among Arab nations in having accorded diplomatic recognition to and being formally at peace with the State of Israel. Much of the pattern

of Egyptian behavior arose out of its efforts to avoid the ill will of other Arab States. Presumably a political settlement will precede any expansion of cooperation between Israel and other Arab States. Egypt will no longer be unique and the Arab League blacklist will no longer be maintained. In short, a different bilateral relationship should be anticipated. However, we expect the feature of a U.S. broker and intermediary will prove desirable in new programs especially in initiating cooperative relationships.

We are both grateful for the opportunity to examine in detail this unusual program of international cooperation in science and technology. It is an activity beset with more difficulties and problems than any other program of international cooperation known to us. Its accomplishments, in the field of cooperation, modest though they may be, are a basis for hope in peace over time in the Middle East.

SUMMARY

EVALUATION

Cooperative Marine Technology Program for the Middle East

Part I - Cooperation

Political relations between Egypt and Israel have been the determinant of the tone and pace of relationships and cooperation in the Marine Technology Program. Israeli policy has been to press for "normalization" of relationships. Egyptian policy has been to proceed with much caution in developing relations with Israel influenced by the simultaneous need to repair and maintain its relations with other Arab countries and by the fact that it had over 30 years of war and animosity to contend with. Ensuring the return of the Sinai on the agreed schedule also was a factor in determining the Egyptian approach to relations with Israel.

Several factors constrain the approach of the Egyptian scientist to his Israeli counterpart. First, there is the policy of the Egyptian government on relations with Israel. This was reflected in a Foreign Office memorandum which in early 1980 was distributed, among others, to Egyptian universities.

Another major factor determining the scientist's approach is the threat of the Arab League blacklist. Egyptian scientists are paid very poorly. Many depend on income from consulting for or tours of duty with Arab states for continuing sustenance and financial security. They therefore abstain from doing those things which might place them on a blacklist.

There are also social and cultural pressures from colleagues and friends who do not approve of cooperative relationships with the Israelis.

As a consequence of these several factors a pattern of behavior is discernible whereby Egyptian scientists do not visit Israel; do not publish jointly with Israelis; do not write directly to Israelis; and do not extend written invitations to Israelis to visit Egypt. However, Egyptian scientists do meet with Israelis on neutral grounds with third parties present and to receive Israelis when they appear in Egypt as tourists or at the invitation of non-Egyptians.

The history of the cooperative relationship in the Marine Technology Program falls into three periods. The first lasting to the end of 1981 saw no Egyptian or Israeli crossing their common border. Only Americans did. There were several meetings in the United States and elsewhere. January to June 1982 was the camelot period of the relationship. Israelis visited Egypt individually, in small groups and in large groups. Most of the Egyptian and Israeli principal investigators attended a major conference at Al Ghardaqa at the end of April 1982 following which most of the Israeli principal investigators visited the facilities of their Egyptian counterparts. However, even during this period, the visits were on the initiative of the Israelis, or under the sponsorship of an American. Since June 1982, concomitant with the invasion of Lebanon, the relationship dampened and following the Beirut Massacre and withdrawal of the Egyptian Ambassador in September 1982, the relationship fell into a deep freeze.

Considering that cooperation in marine technology started from point zero and was confronted by understandable but nevertheless onerous Egyptian

limitations as well as very formidable historic, political and cultural obstacles, the Marine Technology Program has a surprisingly creditable record in establishing contacts between related specialists in Egypt and Israel. A basis for accelerated development of cooperation between the Egyptian and Israeli participants is now in place. Such development would occur if permitted or encouraged by the political and foreign policies of the two governments.

Against the norm of worldwide international cooperation in science, the Marine Technology Program fares ambiguously. On the negative side, there has been no exchange or interaction among students nor has there been a balance in the visits of senior personnel since no senior Egyptians have visited Israel. Written communications have not been direct, but usually through the Americn participant. On the positive side, Egyptians and Israelis have met several times in large groups and slightly more frequently on an individual basis in and out of Egypt in pursuit of the cooperative aspects of the program. Reports have been exchanged even though through a third party. When political relations permitted, the level of cooperative activity was high.

Without exception all of the Egyptian PIs seem to welcome interaction with Israeli scientists and indicate a readiness and a desire to intensify relationships when external restraints were removed. The Israeli scientists all continue to view the relationships in a positive vein, but give the impression of being a bit discouraged by the present inactivity, while nevertheless understanding the responsible political factors.

The brokerage and stimulation activities of the American participants was essential not only to the creation of the Program but to its

development as well. An active Amnerican middle man role, albeit at a considerably lower level of intensity, remains essential, at least until there is a marked improvement in Egyptian-Israeli political relations. Were the American role to cease entirely, i.e., should the Program terminate, it is not likely that cooperation in Marine Technology would be resumed in the foreseeable future. This cooperation has not been driven as much by scientific necessity as by political considerations.

The question then boils down to U.S. policy. If U.S. policy objectives call for the development of Egyptian-Israeli relations, then the Marine Technology Program, revised and simplified in light of experience, deserves continued support. Previous investments have created a substantial basis for further development.

Several general comments bring Part I to a close.

Part II - Science

The AID program produced worthwhile science. Some projects resulted in new information that will be of interest and usefulness to scientists in many parts of the world; some of the information will be of most use to Egypt and Israel, sometimes jointly, sometimes more locally. Predictably, some projects were more productive scientifically than others, and in one or two cases results were small.

The program improved the ability of scientists and research groups to perform oceanography and related research. All three national groups benefitted, with the Egyptians probably receiving the biggest boost. This was partly because Egyptian oceanographic science is farther behind than in the other two countries. As a consequence of this gap, and for administrative and bureaucratic reasons, less was accomplished by the Egyptian

team in the course of the program. But overall, useful advances were made by all three groups of scientists.

The scientific goal of the program was "to develop useful techniques to assist the Middle East nations to increase their food supply; derive economic advantage from living marine resources; protect their eroding shorelines; and achieve greater utilization of their lakes for water and food." Each of the seven projects had its own set of objectives. In every case, and more notably in some than others, these objectives proved to be too ambitious. It is not uncommon for this to be the case when scientific programs are being planned, but in the present instance goals were particularly unrealistic in terms of the time available for accomplishing them. The fault lay not so much with the architects of the program, although in the short time available to them to lay out the plans for the research they made some mistakes in judgment, but in not being able to foresee the unusually complex and difficult entanglements that national and international bureaucracies would present, with kinds of delays that most programs do not have to face. In any case, a significant amount of the failure of some projects to meet their goals does not lie with the scientists but with matters outside their control.

Among the projects which have produced the most valuable information which has been or promises to be of practical use to scientists, to industry, or to government officials responsible for management of public resources, are the primary productivity studies off the coast, performed by both countries, the work on coastal process and erosion, done by both countries, the studies of Lake Kinneret in Israel, and some of the aquaculture projects in Israel. This does not list all of the valuable projects, but it is enough to indicate that more

progress was made in Israel than in Egypt under this program. This was inevitable in view of the base from which the Egyptian scientists were obliged to begin their work. This was expected by the managers and architects of the program while it was being put together.

Egyptian scientists engaged in the program were handicapped by several circumstances:

1. There are a large number of scientists in Egypt, especially in the Government since university education is free and all graduates are guaranteed jobs. This results in inadequate salaries in universities and government, and forces scientists to take second or third jobs or to accept positions outside the country.

2. There is a difficult bureaucracy at several levels.

3. There has been a history until recent times of isolation from Western science, and from the science of the rest of the world in general.

As a consequence of this complex of difficulties faced by Egyptian scientists, it is not surprising that they have found it harder to perform under the AID program than the Americans or the Israelis. The result has been a difference in the amount accomplished under the program, a difference in the level of sophistication of work, with the Egyptian research being more basic, and usually directed to simpler problems. A practical consequence has been that in some of the Egyptian projects too much data were collected both for the needs of the research and in terms of the ability of the research team to analyze them. Better definition of objectives, which would have focussed more precisely on expected and desired scientific and practical outcomes, would have led to better procedures for data collection and analysis.

The role of United States scientists has been critical in this program. Apart from the essential role of serving as a means of communication

between Egyptian and Israeli scientists, Americans have been able to offer advice and technical expertise of value to both countries. Of course, this flow of information has not been one way, and the United States scientists have benefitted as well; Egyptian scientists have made contributions to the Americans and Israelis have world-class expertise in certain areas of lake and aquaculture research. Scientists from the United States were especially helpful, and even essential, in the planning and early execution of a number of projects, notably the primary production study, the shore processes, the lakes studies, and certain of the more technical aspects of the aquaculture projects. In addition, the American collaborators in many cases were able to provide equipment, and knowledge of how to install and use it. The plan from the beginning has been to phase out the amount of American scientific participation in the program, and this will be possible if Phase II proceeds. But there is still need for some U.S. participation, and in some projects the amount will be substantial.

From the scientific point of view this program is incomplete. Even if the full amount of time planned had been available, perhaps none of the projects would have been fully completed since more work was planned than could reasonably be finished in the time available. Add to that the political and administrative difficulties, and the result is that much remains to be done scientifically. The first phase of the program succeeded in erecting the research apparatus -- assembling and training the staffs, buying, installing and learning how to use the equipment, building and equipping facilities. Much of that has been done, and more productive work can be expected in the future.

Some of such work will be done whether there is continued support by AID or not, but in most of the projects the research will be at a reduced level of effort, and in some the work will cease. Without a Phase II, the project on biological productivity will be reduced in both countries to limited observations from small boats; essentially the offshore oceanography project will cease. The study of shore processes will continue, but without continued AID support it may lose its essential current measuring instruments, since these are so complicated that Egyptian and Israeli technicians may not be able to maintain them. In lakes management, Israel will continue at a high level, Egypt will probably abandon the research. In the fish nutrition work, Israel will continue, Egypt will reduce or stop this work. The three aquaculture projects will continue in Israel, at various levels of intensity regardless of continued AID help; in Egypt their present levels and kinds of research will be greatly reduced and changed.

In some cases projects of the AID program were responsible for launching either Israel or Egypt, or both countries, into a particular area of aquatic research; in other cases it strengthened and accelerated ongoing programs. In every project the ability of scientists and research groups was strengthened and encouraged to perform this kind of study. And, in sum, scientific progress was good, even without taking into account the unusual delays and difficulties that were encountered.

PART I

Evaluation of Cooperation

This section provides an evaluation of the "success of the Cooperative Marine Technology cooperative agreement, and this project model in general, in developing contacts and ties between Egypt and Israel." [1/]

We will begin with a discussion of the general political background and the problems faced by the Egyptian scientists which together so dramatically influence the development and implementation of cooperation between Egyptian and Israeli scientists in the Marine Technology Program and with a brief look at the general nature of scientific cooperation itself.

Political Background

As a general rule, international scientific relations are heavily influenced by the foreign policies and internal politics and economies of the participating countries. Even when such relations are at their freest, it is because the governments are willing or wish to have it so. Strained political relations between two countries result in strained relationships in science, as well as other fields. This is especially the case with Egypt and Israel where the state of peace is less than five years old and it was preceded by over 30 years of a state of war during which no relationships existed in science or any other area. Indeed, the political relations between Egypt and Israel have been determinant of the tone and pace of scientific cooperation. A few highlights will suffice to place this in perspective.

1/ Statement of Work, Contract for Evaluation of Marine Technology, NEB-0150-C-00-3015-00.

In the case of Israel, it has been the government's policy to press for "normalization" of relationships across the board - in diplomacy, commerce and industry, tourism, culture, science, technology and other fields. The Israeli academic community responded to this national objective by actively seeking to establish working and cooperative relationships with the counterpart Egyptian community and by organizing committees to coordinate university initiatives in relations with Egyptians. Similarly, the Israeli Institute for Oceanographic and Limnological Research (IOLR) welcomed and pursued vigorously the opportunity afforded by the U. S. initiative in marine technology cooperation to develop cooperative relationships with the oceanographic and acquaculture experts of Egypt.

In the case of Egypt, a major consideration of policy through April 1982 was to assure the implementation of the agreement regarding the return of the Sinai. While the Sinai remained in Israeli control, it provided leverage to both countries. The Israelis employed the implicit threat of delay in returning the Sinai to promote normalization activities. The Egyptians argued that normalization was difficult to achieve as long as Egyptian territory was under Israeli control.

Egypt also faced the necessity of repairing and maintaining its relations with other Arab countries as it managed its evolving relationships with Israel.

Additionally, the Egyptian government has to deal with a populace which over a period of 35 years, had become accustomed to thinking of Israel as <u>the</u> enemy. Within Egypt there are many who continue to so regard Israel. The reverse holds for Israel, except in its case the enemy is not just Egypt, but the Arab nations as a whole.

These and related considerations have led the Egyptian government to proceed at a slow and cautious pace with the development of scientific and other relations with Israel.

As will be noted, the highest level of cooperation attained in the Marine Technology program occurred in the final stages of or immediately after the withdrawal of Israel from the Sinai which was completed on April 25, 1982. Political relations were then at their peak. The lowest level of cooperative activity followed the Israeli invasion of Lebanon and the Beirut Massacre which has had a chilling effect on Egyptian-Israeli political relationships.

While the Academy of Scientific Research and Technology (ASRT) has considerable latitude in its operations, it is nevertheless an agency of the Egyptian government funded through and reporting to the Ministry of Education and Scientific Research. Similarly, the IOLR is a unit of the Israeli Ministry of Energy and Infrastructure. Accordingly, both are responsive to governmental guidance which in the first case calls for caution and slowness and in the latter case encourages the promptest possible establishment of normal relations. Alexandria University, like most other Egyptian universities is in a somewhat analagous position. Although it enjoys considerable academic freedom, it is nevertheless publicly funded and its President is appointed by the Minister of Education and Scientific Research. He too is expected to be responsive to the policies of the Egyptian government. However, the university appears to enjoy greater leeway than does ASRT.

Constraints on Egyptian Academics

A major constraint on the approach of the Egyptian academic scientist

to contacts and cooperation with an Israeli counterpart arises from the threat of being placed on an Arab League blacklist. A word of explanation is in order.

As is well-known, salary scales in Egypt, and particularly in the universities and government agencies, are too low to sustain a minimum standard of living for a professional person and his family. As a consequence, in order to meet their continuing needs it is customary for scientists and other academics to "supplement" their income by taking payment for additional activities of various kinds. Thus, the Marine Technology project pays each Egyptian principal investigator (PI) a 100% supplement of his salary. Several of the Egyptian participants are also continuing other supplementary activities including the provision of consulting or other services to other Arab nation governments or institutions.

To provide a nest egg for old age or other purposes large numbers of Egyptian scientists and other professionals take on multi-year assignments teaching or practicing their professions in the richer Arab states, thereby increasing their income by a multiple of 5 or more. They tend to do this while in the full maturity of their careers, when their appeal is highest and they can command the most money.

The implications are very serious indeed to an Egyptian professor who is blacklisted from such employment for he may be losing a key option to present and future financial security. In addition, he would call attention to himself and be exposed to cultural, social and other pressures from those in Egypt whose animosity to Israel continues at a high level.

In the course of the interviews, several references were made to a memorandum of the Egyptian Foreign Office in early 1980 on the

relations with Israelis which were about to evolve under the Camp David accords and subsequent bilateral agreements. This memorandum was made available to senior officials in Egyptian universities among others.

As a result of the blacklist threat, the government's memorandum, and peer and social pressure, there has emerged a pattern of acceptable and non-acceptable behavior on the part of Egyptian participants in the Marine Technology Program with respect to their Israeli counterparts.

Under this pattern, the following activities appear not to be acceptable:

- o A visit to Israel to consult or collaborate with an Israeli peer or to attend, and especially to participate in a meeting or symposium.
- o A direct written communication to an Israeli.
- o A joint publication with an Israeli.
- o A written or other official invitation to an Israeli to visit an Egyptian university or other professional facility.

However, the following activities are apparently acceptable:

- o Meeting with Israeli peers in the United States or on other neutral ground with third parties present to discuss various aspects of the Marine Technology Program.
- o Exchanges of view or information with Israelis at international professional meetings, provided the sessions are not tete-a-tete.
- o Receiving and providing hospitality to Israelis in Egypt when they appear on their own initiative as tourists or at the invitation of a non-Egyptian.

These criteria do not apparently hold for Israeli relationships conducted under the wing of the Egyptian Ministry of Agriculture. A bilateral Egyptian-Israeli agreement, in the form of a Memorandum of Understanding between the two Ministries of Agriculture for cooperation in

agricultural development has existed since March 25, 1980. Under it a seminar on Soil and Water was held in Israel attended by a delegation of Egyptians. In all, 50 or so Egyptians have visited Israel, mainly in small groups, in execution of projects under the agreement. Some of these were university scientists considered to be visiting Israel to discharge an assignment from a government ministry. Therefore, the visit is not considered discretionary with the individual nor is it taken on his initiative.

A further factor is that the moving force behind the continuing relationship in agriculture is Youssef Walli, the Egyptian Minister of Agriculture. He has for some years been prominently in the forefront of the Egyptian leadership community espousing closer relations with Israel on problems of common concern arising from a common environment.

Nature of International Cooperation

The degree of cooperation achieved between Egyptian and Israeli marine scientists should be considered in the context of international cooperation generally.

The content, intensity and modalities of international cooperation in science vary enormously. Suffice it to say for purposes of this paper that the bulk of international cooperation is in the form of the exchange of information. At its simplest, it involves merely the exchange of publications or articles. It progresses through attendance and exchange of ideas and information at international meetings to short term visits to facilities. Further along, would be an extended visit to do research at a foreign laboratory to teach at a foreign university. Collaborative

research modes range from jointly planned research which is conducted independently to the far more rare joint conduct and financing of research at a single site, the highest form of cooperation. The best-known illustration is the Center for Nuclear Energy Research (CERN) in Switzerland.

Other forms of cooperation would involve joint use of a single facility, training of students from undergraduate to post-doctoral levels, provision to foreign scientists of access to environments of special or unique interest.

Innumerable mutations and permutations of this skeleton ordering of international scientific cooperation exist.

Cooperation in Marine Technology

The history of the cooperative relations between Egypt and Israel in the Marine Technology Program falls into three distinctive time periods.

To end of 1981

At the time the Marine Technology program was planned and initiated in 1979-1980 the Egyptians were insistent that they were not ready to cooperate directly with the Israelis but were willing to participate in a bilateral with the United States which would parallel an Israeli bilateral with the United States. It was understood that in practice these would be transformed into a trilateral and that the long range objective was a direct Egyptian-Israeli relationship.

The dual bilateral model was in effect at the time of the San Diego meeting in August 1980. The fact that the three national groups were able to meet together, creating a de facto trilateral model was itself a concession on the part of the Egyptians. However, until early 1982 the program proceeded in accordance with the dual bilateral mode. Until early 1982 only Americans crossed the Egypt-Israel border. No Israeli scientist in this program visited his Egyptian counterpart nor did any Egyptian visit his Israeli counterpart.

There were several instances of trilateralism. One was the joint 3-day visit of Professor Sharif El Din, the leading personality in the Alexandria University group participating in this Program and Thomas Berman, an Israeli scientist, to Texas A&M at College Station, Texas in June 1981. For three days they were housed together in the home of Dr. S. Z. El Sayed, the U.S. Scientific Director of the Program. They

worked together in planning the research program on biological productivity of the coastal Mediterranean. A solid basis for a strong personal and professional relationship was established.

In September 1981 Drs. Meyers (USA), Kissil (Israel) and Ishak (Egypt) met in Venice on the occasion of the World Conference on Aquaculture and discussed research plans on fish nutrition.

January to June 1982.

In marked contrast, the period from the beginning of January 1982 to mid-June 1982 was one of considerable Egyptian-Israeli interaction in the Marine Technology Program. This was the period of the last phases of the Sinai transfer - completed on April 25, 1982 - when political relations between the two countries reached their highest peak.

This camelot period began with a visit by Dr. Collette Serruya, the Coordinator for the Israeli side and several of her colleagues to Cairo in response to an invitation from Dr. Henrickson, a Hansen Foundation Trustee, to attend a reception the Foundation was giving for Dr. Youssef Walli, the Egyptian Minister of Agriculture. She decided to take along Dr. Abraham Golik and Dr. Hillel Gordin, two of the Israeli PIs.

In Cairo she called upon Dr. Bayoumi and subsequently met with the PIs from Alexandria University and the Institute of Oceanography and Fisheries (IOF). At the reception for Minister Walli, she had an opportunity for a long talk with Dr. Badran, President of the Egyptian Academy of Scientific Research and Technology. Dr. Badran impressed the Israelis with a somewhat dramatic statement in support of cooperation.

During this meeting she raised the possibility of a visit by Dr. Badran

and Dr. Bayoumi to Israel as guests of the Israeli Minister of Electricity and Infrastructure. Upon her return to Israel she worked up a plan for the visit and in February 1982 sent Dr. Badran a preliminary planning letter and in May a formal invitation. She also discussed the visit with Dr. Bayoumi during the Al Ghardaqa meeting at the end of April. Incidentally, this visit did not take place, possibly because of the Lebanon invasion and possibly because the visit had never, in fact, been agreed to.

During the Cairo visits, Dr. Serruya raised several other points which testify to the new mood that was to prevail for 6 months. In a letter of January 20, 1982 to Dr. Badran she referred not only to the proposed visit but also to a proposal she had made to have an Egyptian engineer, who was to be trained in the United States to maintain wave measurement equipment, service not only the equipment used by the Egyptians but also that used by the Israelis. She referred to agreements to have Egyptian and Israeli scientists communicate by exchange of letters, reports and visits; to informal meetings of counterpart scientists after the prospective Al Ghardaqa conference in April 1982; and lastly on the principle of exchange of students.

In February 1982 on a personal visit to Egypt, Dr. Golik visited Alexandria to talk to his counterpart, Dr. A. El Khafagy about wave measurements.

In March, in conjunction with a meeting of the International Oceanographic Commission of UNESCO in Paris, Dr. Robert Abel, General Manager of the Marine Technology Program, arranged a coordinating committee meeting attended by Dr. Serruya and Dr. Bayoumi and others. Plans for the future were discussed and work was done on the First Annual Report.

On April 24, 1982, on the occasion of the 50th Anniversary of the Bio-

logical Field Station at Al Ghardaqa on the Red Sea, an international meeting was held, sponsored by several American and several Egyptian organizations. On the American side, these included the ONR, EPA and the American Institute for Biological Science which extended the invitation to the Israeli scientists. On the Egyptian side these included the ASRT and IOF. With the exception of Dr. Berman and Dr. Wohlforth, all of the Israeli Principal Investigators attended the Al Ghardaqa meeting as did all of the Egyptian PIs save Dr. Ezzat, and most of the American PIs. The conference was very successful, the good spirits benefiting from the completion of the Sinai withdrawal on April 25. Participants in the Marine Technology Program held a series of separate sessions discussing current operations and future plans and reviewing the First Annual Report. At this conference, Dr. Abel made the first public announcement of the Marine Technology Program.

On the heels of the Al Ghardaqa conference all of the attending Israeli PIs visited their counterparts at their home facilities in Egypt.

Dr. Gophen's post-conference visit to Alexandria led to an invitation to return at the end of June which he did in the company of Drs. Drenner and Vinyard.

So all told, in a space of little over 5 months there occurred the Serruya meeting with Badran and Bayoumi in Cairo in January 1982; the initiation of the invitation to Badran and Bayoumi to visit Israel and the subsequent correspondence; the discussions in Paris in March; the 6-day conference at Al Ghardaqa; the post conference tours; and the late June-early July visit by Dr. Gophen to Alexandria. In addition, at least several phone calls were exchanged during this period. Plans for several future visits, seminars and such were made.

It may be noted that even during this camelot period the model followed earlier by the Egyptians for the relationships with the Israelis did not materially change. The invitations to Dr. Serruya to visit Cairo was made by an American, in this case at his own initiative. The invitations to the Israelis to attend the Al Ghardaqa conference were similarly made by an American organization but with Egyptian concurrence. None of the post conference tours were the result of written or formal invitations. No Egyptian visited Israeli.

June 1982 to date.

This intensification of activity was slowed considerably by the Israeli invasion of Lebanon on June 6, 1982. However, the Gophen visit to Alexandria at the end of June 1982 which had been planned before the invasion was consummated. A meeting of several American, Egyptian and Israeli PIs in Halifax in August 1982 on the occasion of the international meeting did not take place largely because the Israeli PIs were members of the Israeli military reserve and unable to leave Israel because of the Lebanon invasion.

The Beirut massacre on September 16-18, 1982, followed by the September 20, 1982 withdrawal of the Egyptian Ambassador from Tel Aviv has put a deep freeze on the cooperative relationship. Tentative plans for a large seminar or workshop in Egypt in the fall of 1982, to review the Program to date and to make plans for Phase II of the program have not been pursued, nor have several tentative plans made before June for additional Israeli PI visits to Alexandria. No cooperative activity has taken place since September 1982.

Although not certain, it is believed that the Egyptian PIs would still be willing to meet with Israeli PIs in the United States or other

neutral ground to discuss various aspects of the various technology program.

Conclusions

Assessment of Cooperation

Considering that cooperation in marine technology started from point zero and was confronted by understandable but nevertheless onerous Egyptian limitations as well as very formidable historic, political and cultural obstacles, the Marine Technology Program has a surprisingly creditable record in establishing contacts between related specialists in Egypt and Israel. With few exceptions the counterpart Egyptian and Israeli PIs had met from 3 to 6 times. In several instances warm personal relationships were established. On the whole, sound professional relationships were created. A basis for accelerated development of relationships between the Egyptian and Israeli participants is now in place. Had the Lebanese invasion and the Beirut massacre not occurred, the spirit and activity that marked the first half of 1982 would probably have continued through the second half of 1982. The major event in that period would probably have been the workshop in Cairo or Alexandria planned for the fall of 1982 to review the experience to date and to formulate Phase II of the Program.

Against the norm of worldwide international cooperation in science, the Marine Technology Program fares ambiguously. On the negative side, there has been no exchange or interaction among students despite the agreement "in principle" nor has there been a balance in the visits of senior personnel since no senior Egyptians have visited Israel. Written communications have not been direct, but usually through the American

participant. On the positive side, Egyptians and Israelis have met several times in large groups and slightly more frequently on an individual basis in and out of Egypt in pursuit of the cooperative aspects of the program. Reports have been exchanged even though through a third party. When political relations permitted the level of cooperative activity was high.

Subjects of research were cooperatively agreed to by all participants but the research program itself was developed by each country in bilateral discussions with the Americans. Pragmatic considerations ruled out the possibility of joint research by Egyptians and Israelis. Some integrated research does exist, i.e., common research separable only by geographic location or research conducted under a single plan. This is the case for example in the Bioloigical Productivity, Shore Processes and Monosex Tilapia projects. However, research in Egypt and Israel in the Lake Management Project has relatively little in common except certain techniques of data collection and processing.

Without exception all of the Egyptian PIs seem to welcome interaction with Israeli scientists and indicate a readiness and a desire to intensify relationships when external restraints were removed. The Israeli scientists all continue to view the relationships in a positive vein, but give the impression of being a bit discouraged by the present inactivity, while nevertheless understanding the responsible political factors.

The American Role

The brokerage and stimulation activities of the American partici-

pants was essential not only to the creation of the Program but to its development as well. They were the initiators of every large meeting of Egyptian-Israeli PIs from San Diego to Al Ghardaqa and to many of the individual Israeli visits to Egypt. They also served as the principal channel of communication between Egyptian and Israeli carrying information and documents between the two countries or forwarding reports received from one to the other.

All of the American PIs were conscious of the intention that their role diminish as time passed and Egyptian and Israeli became accustomed to working with each other. To a marked degree, the reduction of the American presence has already taken place - in part because of intent and in part because travel funds have become scarce.

However, an active American middle man role, albeit at a considerably lower level of intensity, remains essential, at least until there is a marked improvement in Egyptian-Israeli political relations. At this point in time, the only possibility of continued Egyptian-Israeli contact and cooperation lies in American hosting of multi-participant meetings on neutral ground or in American sponsorship of and participation in individual Israeli PI visits to their counterparts in Egypt. The need for a continuing American activity in technical assistance and in training is discussed in the sections of this paper assessing the achievement of scientific goals.

Were the American role to cease entirely, i.e., should the Program terminate, it is not likely that cooperation in Marine Technology would be resumed in the foreseeable future. This cooperation, dependent on U.S. financial support, has not been driven as much by scientific necessity,

as by political considerations. Keep in mind that should Egypt wish scientific support, it is available from American and other Western sources.

The question then boils down to U.S. policy. If U.S. policy objectives call for the development of Egyptian-Israeli relations, then the Marine Technology Program, revised and simplified in light of experience, deserves continued support. Previous investments have created a substantial basis for further development. To obtain maximum return from any future U.S. investment, it should be made contingent upon high level Egyptian and Israeli commitment to seeking greater cooperation than was evidenced in Phase I.

General Comments

One impression common to both Egypt and Israel is that the scientists involved are more interested in the finances available under the program and the opportunity to work with leading American scientists than in building relationships with each other.

Although not investigated in any depth, several references to delayed receipt of funds were encountered. It appears that this problem which posed serious handicaps early in the program has been overcome. However, future plans should be carefully designed to ensure that the movement of funds is not a cause of delay.

Since the Egyptian Ministry of Agriculture is embarking on a major aquaculture development effort, including graduate scientific training for over 40 students, thought should be given in any program extension to the participation of the Ministry of Agriculture.

The Marine Technology Program, the first of the Regional Cooperation projects, is but one of four ongoing projects. We were surprised to find that there was practially no linkage among the four project managers and therefore no exchange of information, experience or expertise. Since each project was dealing with essentially the same set of problems in attempting to promote cooperation between Egypt and Israel, an opportunity to profit mutually from each other's experience has not been exploited. As a matter of urgency, AID should take steps to establish a working linkage.

A final word. The Marine Technology program has been expensive. In terms of its ability to promote contacts and cooperative ties, has it been a good investment? An objective answer is not possible, for such statistics as might be compiled would have little meaning apart from the unusual background of Egypt-Israel political relations and those of the Mid-East generally. Subjectively, my answer is in the affirmative based in part on the testimony of the participants but more on the realization that despite the slight prospects that any cooperative relationship could be brought into being so soon after the Peace Treaty, so much has been accomplished. Considerable good will and mutual confidence now exists among the affected scientists. The subjects of cooperation are topics of high economic importance to both countries. As a consequence, there is a basis for some optimism about the long-term growth of cooperation, subject only to the provisos that political conditions are favorable and appropriate funds are available.

PART II

Biological Productivity of the Southeastern Mediterranean in the Post-High Dam (Aswan) Period.

The Problem

The principal practical objective of a study of the marine and estuarine waters of Egypt and Israel is to increase and manage rationally the production of food from those waters. This requires a detailed knowledge of the physical, chemical and biological characteristics of the marine and inshore areas, especially changes that have taken place since the completion of the Aswan High Dam in 1964. Historically the Nile River had a profound influence on the productivity of the waters of the Mediterranean Sea near its outlet, through nutrients and fresh water discharge. After 1964 it became clear that the influence of the river had changed significantly. An immediate change was a dramatic drop in the commercial fish catch, especially that of the sardine, *Sardinella aurata*. The total Egyptian fish catch dropped from about 38,000 tons in 1962 (just before the dam went into operation) to 8,500 tons in 1969; the sardine catch fell from 18,000 tons to 600 tons in the same period. What is not known is how the changes wrought by the High Dam operate to change the productivity of the area, and how this knowledge can be put to work to safeguard what remains.

This project has been described in one of the reports as the "anchor project" of the whole cooperative AID program, since it is designed to lead to an understanding of ability of the Mediterranean to sustain biological populations, including fish. Moreover, the research can have broader implications for the science of oceanography. The Mediterranean is an area of low biological productivity, an "oligotrophic region."

Such areas of the ocean are of more than ordinary interest to science, partly because they sometimes produce more fish than the measured primary productivity suggests should be there. Obviously some fundamental measurements of amounts of substance or energy, and of rates of flux from one trophic level to another, are wrong. Consequently, this project can serve as a model for similar studies of other oligotrophic sections of the ocean.

There is a long history of oceanography in the Mediterranean, but there never has been a concentrated effort to study the biological oceanography of the southeastern sector. There was a Russian study made in the middle 1960s which provides some baseline data, and a cruise by the University of Miami ship "Pillsbury" in 1965, just after the dam went into operation.

Objectives

The underlying objective was: "To study the changes in the distribution, abundance, species composition and the metabolic activity of the organisms at the lower trophic levels (e.g., phytoplankton, zooplankton), as influenced by the curtailment of the Nile effluent, and how these changes affect the commercially important fish and shellfish in the eastern Mediterranean region." Specific research objectives were set out as follows:

1. Study of the geographic and seasonal distributions and standing crop of the phytoplankton, zooplankton and ichthyoplankton.

2. Determination of the primary productivity of the water column.

3. Determination of the potential utilization of phytoplankton as a source of representative zooplankters of the Nile region.

4. Study of the distribution of phytoplankton in relation to water color and satellite imagery, using Coastal Zone Color Scanner data from Nimbus 7.

5. Study of the phytoplankton standing crop and primary production in relation to:

   a. Radiant energy, light penetration.

   b. Inorganic nutrient salts concentrations.

   c. Hydrographic features in the study area, e.g., haloclines, theromclines, nutriclines, mixed layers, turbulence.

It is important to note that the problem of unravelling the extremely complex environmental fabric of the ocean ecosystem of the Southeastern Mediterranean is an enormous one, and that it is a task requiring many years of scientific effort. A start can be made in the life of the AID project but it is certain that the problem will not be solved in that time.

Egypt

Data Collection

Egypt had no background in oceanography, and possessed no ship or equipment for this study. A small and inadequate ship was used for the first cruise; later a tug (25.5 meters long) was obtained and converted for research purposes, and it served adequately. The equipment was provided and installed by the American scientists, who accompanied the Egyptians on the first (and some other) cruises.

Five cruises were completed by Egypt. These took place along the continental shelf region of the Mediterranean, from El-Agami in the west to El-Arish (i.e.,covering most of the Egyptian Mediterranean coast.) The dates of the cruises and the number of stations occupied on each were as follows:

17-27 August, 1981.....	20	stations
22 Dec. 1981-4 Jan.1982.....	33	"
15-26 April 1982.....	35	"
17-25 August 1982.....	34	"
23-30 November 1982.....	30	"

The stations were located on north-south transpects at various distances off the coast. The water column from top to bottom was sampled, and plankton hauls taken. The area off the Bardawil Lagoon received the greatest attention because it may be an area of upwelling (which is especially significant to fishery production), and detailed measures of its productivity were therefore of special importance.

Physical parameters measured included temperature, salinity, oxygen, light penetration and incident surface radiation. Chemical parameters were: nitrates, nitrites, phosphates, silicates, particulate and dissolved organic matter, total suspended matter. Large numbers of biological observations were taken: phytoplankton standing crop, primary productivity, species composition of the phytoplankton, species composition and standing crop of the zooplankton, (including the ichthyoplankton). Finally, remote sensing data from Nimbus 7 were obtained and examined for corelation with information obtained from ship observations.

Results

Results of the Egyptian cruises confirm that drastic changes have taken place in the hydrography and biological productivity of the continental shelf waters off Egypt. The low level of nutrients assumed for the region has also been confirmed, as has the higher level of primary productivity for the Egyptian coastal waters compared to those of Israel.

These five cruises represent the first intensive modern study of the biological oceanography of this area. A large amount of baseline data has been collected, which will serve as a foundation for the understanding of the local marine ecosystem:

a. A water temperature regime has been obtained showing horizontal and vertical distribution. A sharp thermal front was discovered 10-12 kilometers off the coast.

b. A salinity regime was obtained.

c. Distribution of chlorophyll a was mapped. The standing crop of chlorophyll a showed a horizontal stratification, with a gradient of increasing values toward the shore. There was a deep chlorophyll maximum layer, with which a strong association was detected with plankton concentrations.

d. Primary productivity was measured using C^{14} techniques. These were the first reliable estimates of primary productivity and standing crops of phytoplankton ever made in this region. Of great interest was the finding that nannoplankton (very small individuals of the phytoplankton) made up a significant part of the phytoplankton population. This aspect of the work poses some sampling problems, and the scientists are not satisfied with the validity or accuracy of the sampling or the measurements involved.

e. A systematic study of the zooplanton included the first attention given in this region to the ichthyoplankton (fish eggs and larvae). It was found that there are four dominant groups of fish in the plankton, dominated by the scombrids (mackerel family)

In addition to the data gained from the cruises, the experience and training provided to Egyptian scientists and students was highly useful. United States scientists accompanied many of the cruises, and their assistance has resulted in the Egyptian group feeling confident of being able to carry out this work in the future. The Egyptian senior investigators regard this as one of the most useful contributions of the AID program.

Israel

Israel had little experience in oceanography before the AID program started. For the AID project it secured and outfitted a ship. As in Egypt, much of the equipment was supplied by the United States collaborators, and American scientists were aboard for many of the cruises. The Israelis have conducted 5 cruises:

22-30 July 1981.....10 stations
10-15 December 1981.....10 "
9-13 April 1982..... 8 "
August 1982.....10 "
February 1983..... (cruise was under way of time of writing)

The methods used and the parameters of oceanographic data collected were similar to those of the Egyptians

The results show that off Israel there are two bodies of ocean water, a narrow coastal strip more or less covering the continental shelf, and offshore water. The coastal strip is about ten times as productive as the offshore water; it is the principal support of the fisheries, and requires the bulk of the research effort.

The July cruise revealed sharp chlorophyll and thermal fronts, with higher values for both parameters in inshore waters. Of interest is the confirmation of this finding by satellite data from the Coastal Zone Color Scanner of Nimbus 7, obtained during the same month two years earlier. It will be useful to discover from additional data whether this is a seasonal feature.

A maximum in the chlorophyll values was discovered at 80-125 meters depth, confirming similar observations by the Egyptians. These values are related to the primary productivity of the region, which was confirmed to be oligtrophic. High clarity of water is one manifestation of this, and one Secchi disc observation was made at 36 feet, only 6 miles offshore; this approaches a record for ocean water clarity. One difficulty encountered was that values for some measurements were so low in these waters that they approached the lower limits of the measuring devices, taxing their ability to make reliable observations. This poses a challenge to the scientists.

Among the strongest results are those concerning the phytoplankton, to which strong emphasis was given. Considerable information has been made available on the community structure and species composition of the plant plankton. For many of the samples plankton analysis was performed on live material on board the ship. This was found to be strongly advantageous since some of the small and delicate specimans (both plant and animal) disintegrate on preservation, and some data are thus lost if examination is delayed. A good deal of attention was paid to indicator species -- those that may be characteristic of particular kinds of water masses.

The phytoplankton research showed that the contribution of the nannoplankton (small individuals) was proportionately very great -- the same finding made by the Egyptians. This may be related and help to explain the anomaly that the apparent primary productivity of these waters is lower than seems correct in view of production of fishes and other high trophic level organisms.

Primary productivity values were lower than those measured in the 1960s. Some measurements made during the AID project (e.g., C^{14}) were not made during the earlier cruises; it is therefore hard to make evaluations of the effect of the High Dam, but the data available confirm the impoverishment of the sea after the effects of the dam began. Of considerable theoretical and practical interest is the question whether the observed higher values for productivity of the inshore waters are derived from nutrients carried from off the Egyptian coast or are from local upwellings or shore sources. Better insights on this question will come after planned computer analyses have been made of existing data on biomass and synthetic potential, which are available by seasonal and geographic area.

United States Contribution

United States scientists made strong contributions to this project. The Egyptian and Israeli scientists were for the most part unfamiliar and inexperienced in seagoing cruises with modern oceanographic gear, and Americans did much of the planning for cruises, and calibrating, ordering and installing of gear and equipment, and assisting with the field work. Some of the analysis was performed by U.S. scientists, including analysis of the primary productivity data. Americans were responsible for obtaining permission to use the Coastal Zone Color Scanner data from the satellite Nimbus 7, and for the analysis of these data. This adds dimension to the project that may eventually be very significant. U. S. oceanographers will contribute in this respect as long as a continued interest is shown in this work, since a new and improved imaging system and computer has been established at Texas A&M University to process CZCS data.

Evaluation

This has been a worthwhile project from the scientific point of view. It has launched Egypt and Israel into oceanographic science, an area of endeavor where these countries had almost no previous activity. The project has provided the first observations of the biological oceanography of the region on an intensive basis with modern equipment and procedures. This has provided baseline data that will permit evaluation later of seasonal and longterm variations in oceanic conditions. It has provided a beginning of the understanding of the primary productivity and of the ability of the region to support commercial stocks of fish.

Notwithstanding these advances in knowledge, the project is much short of providing an understanding of the effects of the marine ecosystem off

Egypt and Israel of the Aswan High Dam. In fact, of course, this should not have been expected in the time allowed, and the scientists involved should not have and probably did not expect such a result. Yet the design of the project was clearly done hurriedly, and more was promised implicitly and explicitly than could be delivered.

If a realistic view is taken of the project, it can be said that as much has been accomplished as could be expected given the base from which the work was launched. Clearly the experience and training supplied by the cruises and by the analysis of the data that has resulted, has been of significant value to Egyptian and Israeli science. Much of this will not be lost regardless of what happens next.

A weakness of the project has been the failure to carry out analysis of some of the data collected. This has been especially serious in Egypt although it has occurred in Israel too. Initially, the problem stems from the quantity of data collected; this was probably more than necessary to obtain the required level of understanding. In Egypt, for example, hundreds of plankton samples were taken, and remain unanalyzed. But whether it is really true that too much data was collected, it seems clear that the Egyptians have inadequate capacity or determination to process and analyze the samples, both in terms of skills and manpower. Some of the specialized work, including identification of the species of plant and animal plankton, and an estimation of quantities caught, has apparently not yet been mastered. And it appears that the emphasis of the senior scientists in Egypt is focused on the training of their graduate students, to the detriment of the research associated with the project. Samples are being held for students so that they can use the data for theses and dissertations. Offers

by both Israeli and American specialists to do part of the analysis have been refused. A consequence is that a considerable amount of the biological data is not available, and this makes conclusions and comparisons with the Israeli results hard to reach.

This project will probably cease at the end of the AID support, whether this year or at the end of the Phase II if it is supported. The Egyptian government apparently does not put a high priority on this kind of research, where the practical payoff is not obvious. The scientists hope to receive enough support later for a series of small boat cruises, from which part of the kinds of data collected up to now can continue to be collected. Even this limited kind of program will be of value to the country, and will be a useful contribution by AID. The vessel situation is the same in Israel; when the AID project ends the platform for offshore work supplied by the AID-financed vessel will no longer be available.

Coastal Management and Shore Processes of the Southeastern Mediterranean

The Problem

The shape, structure and changes in the beaches and other features of the shoreline of the Mediterranean coasts of Egypt and Israel are significantly influenced by the sediment delivered into the sea by the Nile River, and by the water currents which sweep the coast. Since the completion of the Aswan High Dam in 1964 the quantities of sediment carried by the river into the sea have diminished to nearly zero. The consequences of this change to the shorelines of the two countries have been profound, with damaging erosion having taken place in some stretches of beach, and far more serious changes being threatened. The coast of Egypt is under much more immediate threat than that of Israel. The promontory off Rosetta, for example, is eroding at a rapid rate, and a lighthouse that was 2 km inland in 1975 is now offshore. Sand that over millenia accumulated from contributions of the Nile is no longer being renewed, and beaches are being thinned as sediment is carried away by currents. Beaches to the east and north in Egypt and Israel are benefitting temporarily, but gradually the whole shoreline is being eroded.

In Egypt the danger is very serious. Not only are promontories like that of Rosetta eroding, but the thin sand barrier between the sea and the coastal lakes is being worn away. These lakes are essential as producers of fish and other food for Egypt, but they also serve as protection for the delta area. If the beach barriers are breached by erosion the sea will invade and destroy the lakes, and will then rapidly erode the silt of the delta farming area which is the foundation of the food production system of the nation.

The "Nile littoral cell" is a unit of ocean water which extends from the Nile delta east and then northward to Haifa Bay near the northern boundary of Israel. This is a dynamic unit, where the sediment transport, the currents and other characteristics of the ocean and beaches interact. It must be studied as a unit if it is to be understood properly, and if intelligent management and engineering control is to be exercised. This requires co-operative study by both countries involved; it cannot be solved by either Israel or Egypt alone.

A further set of needs for information on shore processes includes the plans being considered by the Egyptian government to construct a canal between the Mediterranean and the Qatara Depression. Costly mistakes could result from this unless more information is available on shore processes, and on possible erosion and other effects. Similarly, the Israeli government is considering a canal connecting the Mediterranean with the Dead Sea; the effects of this cannot now be predicted.

Objectives

An understanding of the effects of the loss of sand delivered into the Mediterranean by the Nile following the construction of the Aswan High Dam, including the consequences on shore erosion, requires detailed information on ocean waves, especially their direction. The need for this kind of data has been realized for some time, and a limited amount of it has been collected in the past. Data on wave height and period go back to at least 1972, but the vital information on wave direction had not been collected until the AID program began. The transport of sand is controlled by waves to a large degree, with the "wave climate" determining the longshore movement of the sediment. Hence, the principal objective of the project has been to obtain accurate measurements of currents along the

coast as a means of determining sediment movement. In addition, related objectives have been established; the full range are included in the following:

1. Determine the wave climate in nearshore waters in order to define the onshore and longshore sediment transport potential, and apply this information to identify areas of erosion and accretion along beaches and near coastal structures.

2. Measure the prevailing currents on the continental shelf and determine their importance as driving forces for sediment transport.

3. Estimate the local coastal changes and sediment transport rates on the bases of recurrent surveys of beach profiles, especially in the vicinity of man-made structures and along areas of known erosion/accretion.

4. Study the processes now modifying the continental shelf and determine the sediment types and transport paths over the shelf.

5. Estimate the reservoir of available sand that is present on beaches and under the adjacent nearshore waters of the shelf.

6. Apply the principles of shore processes to the solution of erosion and of the coastal engineering concerns.

Egypt

Data Collection

Data on water currents have been obtained from the meter made and installed with the assistance of the Scripps group. It was placed on an existing offshore platform at Abu-Quir Bay, and went into operation in November 1981. This instrument, a Cassette Acquisition System (CAS), has two sensors recording wave height and phase difference (i.e., direction of the wave). It has experienced several breakdowns, during which data were lost, but the data which have been obtained have been highly valuable; their quality is improving. This kind of information has never been available before in Egypt.

The second instrument has just been obtained. It will be installed (or already has been) off the Bardawil Lagoon. It will be attached to the sea

bottom and will have three instead of two sensors, and will therefore provide more data.

Egyptian scientists have obtained a large amount of data on beach profiles. This work had been under way a long time before the AID program beban, and 60 additional profiles were obtained in 1981 and 1982. In addition, repetitive profiles have been obtained at critical areas: 56 off Rosetta and 37 off Burullas.

Results

Egypt

Data collected by the Egyptians from their CAS instrument have proved to be of great value in understanding the wave climate of that coast. Integrated with the Israeli data, it can be shown that waves induced by storms, which are vectors of sand transport, are delayed arriving in Israel by one or two days after those waves were detected along the Egyptian coast.

The information from the data gathered so far provides a preliminary basis for construction of a wave climate on the coast, necessary for proper control strategies.

Egypt has a large body of data on beach profiles. With the assistance of the Scripps group, these are being analyzed in two ways. One is by comparison of the shape of profiles over repeated observations, and the other is by a procedure called the eigen function. Useful knowledge of the fate of beaches is at hand as a consequence of these activities.

Egyptian scientists have put out a number of reports; these are largely compilations of data. More rigorous scientific papers are planned.

Israel

Data Collection

Wave gauges commonly record measurements of the amplitude of a wave, and many also measure wave length or period. Measurements of wave direction are less common, and this parameter is of greatest importance in determining wave direction. The latter component determines sediment transport, since if the wave comes at an angle it can carry sediment. Wave direction is harder to measure than the other parameters and the solution to this problem constitutes an important contribution by Dr. Inman at Scripps.

Data from these instruments are recorded on tape in cassettes, which are removed from the instrument at intervals. Analysis of the data on the cassettes have been performed at Scripps, with the collaboration of an Israeli scientist in training there. Since these instruments represent a new design they have been subject to some breakdown in the early stages. The first one installed in Israel at Haifa, not far from the Institute, operated only one week before it broke down and was removed. Instead a simpler instrument, also designed and made at Scripps, was used. This latter device, a SAS, has provided data for four years, having been bought and installed under an ONR grant. It is run twice a day for twenty minutes each time.

A second CAS has been obtained very recently and it will be installed (with the help of an engingeer from Scripps) at Ashkelon. This location is about as far away from the location of the first CAS as is possible in Israel. The first CAS will be replaced, near the location of the SAS offshore from Haifa.

If the two CAS instruments perform in as well coordinated a manner as expected, and if the magnitude of difference is constant, data from

the two will provide wave climate and sand transport information for any part of the Israeli coast. A one-day computer run should then be able to provide recommendations for any coastal community of the country.

The new installations will be put in deeper water than the first one was, since it has been found that waves were bigger than expected and that they broke before they reached the instrument. They will be placed in 8-1/2 feet instead of 6.

This system is the only direction-measuring wave system in the Mediterranean and one of the few in the world.

Results

Israel

In the Mediterranean there are three "windows" through which storms blow against the Israeli-Egyptian coast. These have different origins and characteristics, including their ability to transport sand along the shore. A paper by Dr. Carmel analyzes 20 storms; of these 14 came through the central window and 6 through the southern window. Some of the findings are of general international scientific interest.

The wave current results show that transport of sediment is a result of storm wave energy.

The water current data reveals some anomolies. These data show that there are two peaks of wave height, in winter and summer, and two peaks of energy flux (i.e., the amount of energy per unit time per unit length). While there is an annual net transport of sediment to the north, nonetheless there are periods of the year when the transport is to the south. This variability is of importance in a practical sense in constructing control devices. The amount of sand transport decreases progressively to the north, ceasing at Haifa Bay.

The fourth task set out in the objectives, to determine the limit of northbound Nile sand, has been solved. This limit is opposite Akko, in Haifa Bay. This has been determined by observing the character of the sand involved. Since Nile sand is quartzite and sand from the Israeli coast is calcium carbonate, the disappearance of quartzite sand at Akko shows that its transport stops there. It is still not certain whether this is caused by the direction and decay of the wave energy by the influence of drowned ridges that occur in the region, or for some other reason.

Task five, to determine the amount and location of sand available offshore, has been approached through observations by the Israeli Geological Survey, which performed sub-bottom profiles. These data require analysis.

The final task, to decide strategies for repairing or protecting the coastline, depends on the first five. In Israel it has been possible to improve the quality of this kind of advice. Yet the anomolies observed in sediment behavior in response to man-made changes along the coast are puzzling to the scientists and engineers, and while understanding is increasing, more research is necessary to be confident of the advice offered.

Evaluation

The project on the study of shore processes has been successful in promoting science and engineering in Egypt and Israel. At the pure scientific level it has generated information of value and interest to the international scientific community. Two papers, authored jointly by Israeli and United States scientists, have been published in the scientific journals,

and other papers presenting tables of data and certain general information have been issued.

The project has stimulated improved insights on the part of the Egyptian and Israeli participants into the nature of the scientific and practical problems facing them. One essential aspect of this is interaction among scientists, during which they exchange ideas and information, and gain insights into problems through discussion. Clearly this would not have occurred in the absence of the project. The project has shown science administrators and government officials of the two countries the nature and magnitude of the problem, often in quantitative terms. This raising of official awareness in the need for research and the magnitude and direction it should take is a necessary preliminary to effective work.

The project has succeeded in creating an integrated attack on a problem which can only be solved through cooperative efforts by the two countries. This clearly would not have been possible otherwise, and this may be the most important contribution of the AID-supported activity. The project work has improved the capacity of both groups to perform this kind of science. Prior to the project Egypt had background in the study of shore processes, but many of its experts had left for other activities, and despite the urgency of the problems facing the country, too little work was going forward. In Israel there were virtually no scientists focussing on this kind of problem. As a consequence of the project, an Israeli high energy physicist was given 2-1/2 years of training at Scripps which provided him with skills and background which will help Israel to perform more useful work in shore processes and protection. Further, both countries have been provided through the project with sophisticated and expensive equipment of the latest design without which this kind of research would be far less effective.

The project has improved the ability of scientists in both countries to make recommendations for actions which are necessary to avoid damage to shorelines and beaches or to restore areas already damaged. It is true that shore processes above these coasts are still inadequately understood, and that there are puzzling anomalies in the behavior of currents and sand deposition, but these uncertainties are slowly being resolved and the quality of advice that is possible to give to shore communities and to the government has been improved in Egypt and Israel.

The need for continuation of the project is strong. The danger to the coastline of Egypt, and the lesser but still significant threat to Israel's beaches, have not diminished; rather these have increased with time. The strong impetus and momentum created by this project, which is providing both countries with the kinds of information necessary to save the coasts, should not be lost. The first phase of the project has largely been one of assembling and working out the bugs in equipment, of training personnel, and of defining the nature of the problems. Thus, an apparatus is now in place for taking advantage of the progress made.

There seems little doubt that if AID does not fund Phase II of the project it will collapse. Israel may continue it at a reduced level but it seems likely that Egypt will stop most of its operations. The United States collaborators believe that the Egyptians and perhaps the Israelis will not be able to maintain the critical current sensing instruments, and that after the first breakdown (which will inevitably occur) the project will cease. Moreover, Egypt has not yet sent a scientist to Scripps for training, and without this background (which has already been gained in Israel) Egypt will find it hard to continue the work at the most effective level. About three years are required for such training.

Technicians from Egypt also require training in the maintenance of the instruments. Finally, additional instruments are required; the scientists state that a minimum of three are required off the Israeli coast, and four off Egypt including one off Sinai.

Lake Manzalah, Egypt and Lake Kinneret, Israel: Scientific Basis for Lake Management

The Problem

The problems associated with lake management differ substantially between Egypt and Israel -- so much so that despite a pretence by managers of the project that the two research efforts are related, there is in fact very little common ground to support collaboration.

Egypt

The problem faced by Egypt relates strongly to the need for food for the population, and the circumstances that poor use is being made of the potential of the delta lakes to produce food. Of the several delta lakes, the one chosen for study is the largest (some 171,000 hectares) and is the one which produces about half the fish caught in these lakes. Lake Manzalah is in the eastern part of the delta, and has connections with the waters of the Nile, the Suez Canal and the sea. The size and contributions of these water sources has changed over the years, and this with the other changes has resulted in significant alterations of the lake ecosystem, to the detriment of the fisheries and the environment.

The delta lakes are being underutilized for food partly because of lack of conservation and management practices. The changes in salinity that have taken place in the last twenty years have changed the species of fish present, and have reduced their numbers. These salinity changes have also enormously increased the quantities of floating plants present, causing ecological and practical problems. Among the most damaging of other changes has been an increase in pollution, largely from agricultural areas adjacent to the lake; from these wastes and pesticide/herbicide chemicals pour into the lake. Other changes are that water from the lake is used for irrigation, and that changes in the Nile following the building of the Aswan High Dam have changed

the amount of water flowing into the lake and have raised the water table.

All of these factors have made more urgent the necessity to develop rational management schemes for controlling the water supply and use in the lake, and for controlling the fisheries. Such management programs cannot be put in place without a great amount of information on the ecology of the lake and its inhabitants, to be obtained through research.

Objectives

The basic objective of the study of Lake Manzalah is to increase and stabilize the production of food. In pursuit of this a complex ecological study of the lake and its inhabitants is required. This is a massive undertaking requiring many kinds of expertise and much labor. The proposals and other reports of the project did not provide a specific list of objectives, but the following have been implied from the material provided:

1. To conduct a limnological survey of the lake, collecting chemical, physical and biological information on the lake and its biota.
2. To survey the fisheries of the lake, including observations on the species caught, the quantities caught, the kinds and quantities of gear, and the number of fishermen.
3. To relate the fish community to the lake tropic dynamic system, by studying the kinds and quantities of food consumed and the kinds and quantities of food organisms available.

These data were to be used to develop a modelling system for the lake environment, including a management regime for the fisheries and another for the water budget.

Data Collection

After a late start, caused in part by the loss of the principal investigator, the Egyptian scientists have collected a truly impressive amount of data on

Lake Manzalah. Until October 1981 no work on this project had been performed, but since then 14 months of data have been collected, involving chemical/physical observations of the water, sediment samples, observations of the kinds and quantities of the fish, and several aspects of their biology, and observations of the fishery and of the gear involved.

1. Water samples were taken from between 50 and 70 stations on the lake and at its drains. These were taken once a month, with 3-4 days being spent each sampling period. Samples were taken at the surface, and if the water was more than a meter deep a second sample was taken at that depth. The parameters studied included temperature, salinity, pH, alkalinity, dissolved oxygen, nutrient salts, suspended solids, trace elements, major cations and anions, primary productivity (C^{14}), biomass (chlorophyll), phytoplankton, and zooplankton.

2. Fish were caught by experimental fishing with three kinds of commercial gear to test the efficiency and selectivity characteristics of these gears. The numbers of each kind of gear were estimated, as were the number of fishing vessels and fishermen. The amounts of fish landed in the commercial fishery were estimated by species and by gear, and these estimates compared with the official statistics reported by the Ministry of Agriculture.

3. Samples were taken from the commercial catch and from the experimental fishing, and the fish identified and measured. This was done every three months over periods of 12-15 days in each of five areas.

4. Stomach contents of fish were examined to determine food web relationships.

5. Rates of mortality, age analysis and migration information were obtained for some of the principal fish species of the lake.

Results

As a result of this work the first comprehensive data are available on limnological conditions in an Egyptian delta lake. Comparisons are now possible of a number of physical, chemical and biological variables among the several basins of the lake, and among seasons. Reports have been issued including charts of the distributions of temperature, salinity and other factors over the lake at different times. The amount of information is substantial.

Salinity patterns show that there are several biotypes in the lake, separated to one degree or another by physical barriers such as mudbanks. Oxygen values are high, so that this is not usually a limiting factor for fish and other organisms. C^{14} and other data reveal that the lake is highly productive, especially in the eastern part. Much of the nutrients in the lake probably come from the water draining into the lake.

The experimental fishing trials revealed that there are significant differences in efficiency and in selectivity among the three commercial gears tested. Among the fish caught in these trials, and from data from the commercial fishery, it has been found that 15 families of fish are represented in the catch, with the dominant species captured being the tilapias; they constitute 85% of production. Mullet are next, with about 10% overall, but showing dominance in the northern part of the lake. Sea bass, eels and other species trail in abundance. Marine fish predominate in the northern part of the lake. The data on size distributions, age, and mortality rates have been analyzed only for tilapia. It was found that most of the fish caught were 1 and 2 years old; 3 and 4 year old fish were rare, suggesting a high rate of fishing.

Stomach analyses have provided preliminary data on the food of some fish species, and have made a start on the understanding of the food web in the lake.

Analysis of sediment samples have given data on sediment dating and deposition of rates of chemicals, including pesticides and herbicides.

Training in limnology in Egypt is inadequate. The students lack access to basic textbooks and their equipment is only fair. For example, the "institute" at the lake is only a base for sampling from the launch, and it has no equipment. The laboratory in Alexandria is only for preserved, dead specimens. No course is offered in limnology, so that students who want to work in this field should be trained abroad. Plans have been made to send two students to Texas A&M University for chemistry and one to Michigan for fisheries.

About 8 to 10 students were used in this project, and some of them will use its data for their theses (two MS and two PhD students).

Evaluation

Recognizing that the Egyptian scientists on this project started nearly from zero in terms of experience and background in limnology, and only a little farther ahead on fishery biology, the amount of progress made is impressive. Furthermore, much of the information accumulated will be valuable in providing base material for future research, and eventually for constructing the management models required to make optimum uses of the lake, and of similar lakes.

The limnological sampling program was comprehensive, as was that for the study of the fisheries. The weakness has been that far too much has been attempted, and the result is a large amount of chemical data and biological samples in storage, with incomplete and inadequate analysis of a significant part of it. In particular the biological samples have been incompletely examined and some of the data wasted. For example, much of the plankton has not been sorted or identified. Even if this is done later some information will be lost since many of the delicate organisms vanish in preservative. As another example, age analysis and mortality rates have not been done except for one fish, the tilapia. This is not too suprising, since both of these procedures are technically difficult, and require special skills not learned quickly.

The error here and in other segments of the work was failure to set focused objectives and to design an achievable sampling and analysis program to fulfill these objectives. There is a strong flavor here of collecting data for its own sake, with little regard to define the expected end results. It seems likely that sampling would have been reduced if better planning had taken place.

Yet, in the end the work has been useful, and while it could have been better if planning had been better, classical limnology and simple fishery biology have been carried out, the results of which are the kinds necessary as preliminaries to more sophisticated and useful work. Probably no more could have been expected under the circumstances.

Israel

The Problem

The problems associated with making optimum use of Lake Kinneret in Israel are substantially different from those facing Egypt in respect to the delta lakes. Lake Kinneret is the only fresh water lake of any size in Israel, and is a vital source of fresh water for the country, supplying 60-65% of the drinking water and 30-35% of water for all purposes. As early as the 1960s it was realized that the lake was a key to the survival of the nation, and that policies and procedures had to be developed quickly to ensure the continued availability and high quality of the water. Consequently a research program whose quality is now world class. Information has been collected which make Lake Kinneret one of the best known lakes in the world.

The principal concern of the lake project in Israel is to develop strategies for keeping the water pure, especially to avoid or control blooms of the planktonic algae, *Peridinium*. Among the methods of control are to limit the amount of nutrients in the lake, and to encourage fish that consume the algae. The most important of such fish grazers is a cichlid, the Galilee St. Peter's fish, *Sarotherodon galilaeus*. Fortunately, this species is the most desirable and valuable of the commercial fishes caught in the lake, so that an abundance of the species favors both high water quality and fishing.

Despite the substantial information about the lake ecosystem, there are gaps in essential knowledge. For example, harvest of St. Peter's fish has declined, and it has not been clear why this occurred. One theory was that competition with other species, some of which were being stocked in the lake, was responsible. In order to judge the validity of this theory much better knowledge of the food webs in the lake was necessary, as was information about feeding behavior and food selectivity of the various fish species which might be competitors, especially the blue tilapia, (or Jordan St. Peter's fish *Oreochromis aureus*)

an exotic species which has been heavily stocked in the lake for several years.

A secondary concern of the project has been to develop means for increasing and maximizing the production of useful fish, especially St. Peter's fish. Better data on its biology and its relationships with other animals and plants in the lake are necessary to accomplish this.

Objectives

The objectives of the lakes project in Israel were to:

1. Study the competitive interaction between St. Peter's fish and other species in the lake, by examining their feeding ecology and food selectivity.
2. Study the impact on the plankton communities of consumption of plankton by fish.
3. Study the role of fish in the energy flow and water quality in the lake.

Data Collection

Data were collected in several ways in pursuit of the objective to study feeding behavior and food selectivity of St. Peter's fish and competing species.

1. Bimonthly samples were collected of fish for examinations of the kinds and amounts of food in their intestinal tracts. Sampling was principally of fingerlings in the littoral zone.
2. Observations were made of feeding behavior. This work was done in the laboratory and then outdoors in bag experiments. The observations were made principally with videotape equipment supplied and operated by Dr. Ray Drenner of Texas Christian University. His contribution to the research was critical, since he supplied a machine and a technique unfamiliar to the Israelis, and of great value to them. Observations were concentrated on St. Peter's fish, the blue tilapia and the "sardine" or bleak. The information collected was the mechanics of food collection and the degree of selection used.

3. Observations were made in enclosures in the lake of the effects on plankton populations of predation by fish.

4. Some data were collected on the feeding of the catfish Clariss lazera. This is a fish-eating species which devours the young of St. Peter's fish and the sardine.

Results

The most significant conclusion from the work has been that St. Peter's fish and the blue tilapia are direct competitors for the food available in the lake. They have the same selectivity for zooplankton and phytoplankton and the same filtering rate in feeding. Fingerlings of both species feed on zooplankton using visual particulate attacks: they must be able to see the prey. St. Peter's fish needs zooplankton in the summer, at a time when zooplankton populations are at a low ebb. It is then that competitition from the blue tilapia is critical, and the lower the populations of that fish the better for the welfare of the St. Peter's fish. Competition between the two species is also high for fingerlings in the fall and early winter, especially in the littoral zone.

A further mark against the blue tilapia is that it does not feed on Peridinium (the planktonic alga that is the principal cause of water pollution) at any time of the year as does St. Peter's fish in the spring. This helps to explain the strong relationship between the kinds and amounts of fish and the quality of the water in the lake.

There are now revealed two parallel food chains in the lake: the chain involving Peridinium-St. Peter's fish, and that involving nannoplankton-zooplankton-fish (including sardines, St. Peter's fish, blue tilapia and others).

Evaluation

This research has produced results of considerable scientific value, and perhaps of greater significance is a project of this nature, results which have led to specific and far-reaching recommendations to the Government of Israel. A more complete and confidence-invoking management regime for the protection of the quality of the water and the fisheries of the lake can result.

This project started from one of the most advanced scientific bases of any in the AID cooperative program, and the one where Israel had the advantage of considerable experience and success with the kind of research to be carried out. Israel built on that good base and produced excellent results of substantial scientific and practical value.

This project was one of the most successful collaborations between the United States and Israeli or Egyptian scientists. Dr. Drenner and Dr. Vinyard worked at Lake Kinneret directly on the project. Moreover, they were able to introduce to Israeli scientists new techniques and a highly useful unfamiliar piece of equipment (the video recorder) which was significant in promoting the success of the research.

Fish Nutrition in Marine Fish in Mariculture

The Problem

Information on the nutritional requirements of fish raised in farms is far behind that for terrestrial animals, and the level of knowledge for brackish and marine fishes falls much short of that for fresh water fishes. This lack of data inhibits the formulation of diets which will provide optimum growth and survival of fish crops, and therefore prevents the most efficient and cost-effective systems of culture from being used. This is a universal problem over the world, but the specific kinds of information needed varies by country. The problem is substantially different among the three countries involved here, so that three different sets of objectives and experimental strategies were set out for the nutrition experiments.

Israel

Objectives

The ultimate objective of the work in Israel is to develop optimum feeds for the gilthead bream, *Sparus auratus*. The research group in Israel at the aquaculture laboratory in Elat has been studying this species and its culture since 1972 and has accumulated considerable information on many aspects of its culture in captivity. The project research has been an extension and elaboration of this work. The particular studies during the past months under AID support have included tests of the effects of feeding the bream diets containing different kinds of oil, at different feeding levels. A related study has been to determine optimum protein/energy ratios.

The specific objectives were to examine the effects of three factors on growth, conversion efficiency, consumption rate and composition changes in gilthead bream:

1. Determine whether fish oil or soybean oil produced the best results when fed to gilthead bream.
2. To test the relative efficacies of protein levels of 36 and 40%.
3. To test the relative efficacies of protein/energy levels of 85 and 105 milligrams of protein per kilocalory.

Data Collection

The experiments were conducted in 24 round fiberglass tanks, using 8 treatments and 3 replicates per treatment. Each tank was stocked with 15 fish of 45-50 grams average weight; these were grown for 178 days. Fish were fed to satiation twice a day, six days a week. Samples of fish were taken at the start and finish of the experiments to determine body composition by proximate analysis; diets were analyzed in the same way.

Results

Fish fed with fish oil (capelin oil) grew better than those fed soybean oil; the best growth from all diets was obtained from the 105 mg protein per Kcal energy PE ratio at the 40% protein level. Similarly, the best conversion was obtained in 3 of 4 cases with fish oil diets; the best conversion occurred at the 105 mg/Kcal ration and the 40% protein level. Protein did not affect consumption but oil type and amount did; the more soybean oil in the diet the less food consumed, i.e., soybean oil is less attractive to fish than fish oil. But fish oil did not affect consumption. Protein energy ratios (weight gain divided by protein intake) for fish oil were significantly higher than those for soybean oil. Some

data are available on body composition, but this is yet incomplete. Results so far show that fish eating soybean oil had higher residues of oil in the flesh than those eating fish oil.

As a result of these experiments it will be possible to formulate better, more efficient feeds for Sparus, which are cheaper by 20%.

These experiments will be repeated for smaller individuals. This aspect was planned for the present phase of the AID work, but delays in completing the new aquaculture research facility prevented it being done. Also, the objective of formulating feeds using the new information remains to be done.

Egypt

Objectives

The general objective of the fish nutrition project in Egypt was to develop an efficient feed and feeding system for cultured fish based on locally available raw materials, including agriculture products and crop wastes. To do this, information is required on the food and the feeding habits of the fish being cultured, their nutritional requirements, and biochemical analyses of the fish flesh and the stomach contents. The specific objectives were:

1. To determine the nutritional requirements of gilthead bream and mullet (Mugil capito).

2. To formulate pelleted fish feeds from locally available raw materials, and to evaluate their effectiveness on the growth and conversion rates of the two species above.

3. To measure the responses of such rations on a number of fish species raised in a polyculture situation.

Data Collection

Several waste products from agriculture activities were prepared as possible ingredients for fish feeds: tomato pulp, citrus pulp, pea sheaths, chicken manure. These were sundried to 10% moisture and powdered. Activated sewage waste was also prepared by being oven-dried to 7% moisture. Other unconventional feed sources were prepared including beer wastes and aquatic weeds. Among the conventional raw materials used were wheat bran, rice bran, fish meal, cottonseed meal, sesame meal, and bone meal. All of these were subjected to chemical analysis: for moisture content, crude protein, crude fat, crude fiber, nitrogenous free extract, ash, amino acids, calcium, phosphorus and potassium.

Fish flesh from bream and mullet was analyzed four times a year (i.e. each season). Fish were sampled from three regions; samples of 20 were used. The stomach contents were also subjected to analysis: moisture, fat, and ash.

Results

Tables reporting contents of moisture, crude protein fat and fiber, nitrogen-free extract and ash are presented in reports. These results show that some of these locally available raw materials can be used in formulating fish feeds, to substitute for ingredients which are scarce or expensive.

Tables are presented reporting the chemical composition of the flesh and the stomach contents of the mullet (*Muqil capito*) from Alexandria, Damietta and Fayoum. Data included moisture, protein, fat and ash. Measurements were made in the summer (June to August) and the autumn (September to November.) Similar data are presented for the bream (*Chrysopherys auratus*)

from Alexandria and Damietta. The results indicate that there are variations in relative amounts of the parameters measured with season and with location. The fat content was higher for the bream than for the mullet. Additional data are available for the other two seasons of the year. A total of two years of data have been collected.

Five experimental diets were formulated using the raw materials that were analyzed, which are non-competitive with needs for livestock and poultry feeds. For example, chicken manure and activated sewage sludge were used as substitutes for fish meal. These feeds were prepared in pelleted form. Their average protein content was 30%.

Tests were begun on the use of the newly formulated feeds on carp and tilapia, using glass aquaria.

Participation by the United States

This is one of the few projects in the AID work where experimental work was done in U.S. laboratories. In Baton Rouge this included analysis of fish flesh and feed samples for crude protein, fiber and ash, crude fat, moisture, and calcium/phosphorus ratios. Work was also done on the effects of a caretonoid pigment, astaxantin, on the external color, the flesh color, and the viability of eggs of the gilthead bream. Astaxantin-rich oil was shipped to Elat for testing there. Shrimp hydrolosates were prepared for the diets of bream.

At Texas A. and M. red drum (*Sciaenops ocellata*) were used in nutrition experiments. The university's low salinity recirculating water system was stocked with drum in May 1981, and fed pelleted rations of two types for

six weeks. Fish on trout starter are found to outgrow those fed on catfish starter.

A major objective of the U.S. team was to provide training for Israeli and Egyptian students. To improve the facilities available for the training of foreign students under the project, Texas A. and M. installed a hammer mill, additional aquaria, and a tissue homogenizer; the recirculating water system was expanded and improved.

The plans to train Egyptian students were not carried out since none came to Texas A. and M. University. Six were interviewed and three sent in applications, but unfortunately none of these were complete, and no Egyptian students have been trained yet under the project.

An Israeli student who had worked with Dr. Tandler at Elat underwent training at the master's level at Texas A. and M. He had planned to do research on small gilthead bream, and 250 individuals were carried from Elat by Dr. William Neill. These died, and a local species, the pinfish was substituted. Studies included food maintenance levels, assimilation efficients (intake/output measurements) and proximate analysis of body tissues.

A workshop on the culture of marine fishes was held in Charleston, South Carolina, in February 1982. At the conference several papers were presented on the gilthead bream. This included some by Israeli scientists, although none of them attended. There was no participation by Egyptians. The proceedings are expected to be published early in 1983.

Dr. Stickney prepared a bibliography of papers on the culture of the family Sparidae (which includes the breams).

Evaluation

Useful research on the nutrition of some cultures fish species was accomplished under this project. The work was not especially well integrated among the three countries. This was partly because the species of special interest to one group was not of interest to the others. Israeli scientists are concentrating on the gilthead bream, *Sparus aratus*. This is of little or no interest to Egypt at the moment although it is an indigenous fish; it does not occur nor is it studied in the United States. The species of special interest to Egypt is the mullet (*Mugil* spp.); Israel has little interest in it and would not have worked on it except for the sake of cooperation with Egypt.

The levels of background in fish nutrition, including the facilities available for research, differ substantially in Egypt and Israel. As a consequence the kind of research accomplished was of a different level of sophistication, and the results of a different order. Israel has a world class research facility for this work. Its scientists carried out research under the AID project that was a continuation and extension of work that had been under way there for several years. The project gave useful support to the Israeli scientists by salary support and by supplying equipment and supplies; in this way, and through contact with United States researchers, the project helped and accelerated Israeli science.

Facilities for nutrition research in Egypt are not good, although they have been improved with the support of the project. Dr. Stickney

supplied specifications and other information and advice to Egypt for the construction of a fish nutrition laboratory, but this has not yet been built. The work done in Egypt was of a preliminary nature, consisting of data on some chemical characteristics of certain raw materials that may be suitable as ingredients for fish feed, and chemical analyses of fish flesh and food consumed. These kinds of data are necessary preliminaries to other nutrition research, and will help Egypt take the next steps in this field. The project stimulated this work, which might not have begun otherwise.

All three research teams fell short of accomplishing the stated objectives of the fish nutrition research. As mentioned, the U.S. fell short of its training goals for lack of foreign students. A group of gilthead bream on which research was to have been performed died, so that a local species from the Gulf of Mexico had to be used instead. Egypt did not complete its goals since no experiments were conducted on feeding comparisons of different diets in polyculture, and few experiments were done on nutritional requirements of bream and mullet. Israel came closer to completing the work planned, but no feeds were formulated using the data from the other work, and comparisons of the effects of oil and other variables in the diets of small bream, like those completed for the larger sizes, were not performed as planned.

A continuation of the project into Phase II would be desirable at some level. In particular, Egypt needs to train fish nutrition scientists, and its facilities for research in this area need to be strengthened. Israel plans to continue this kind of work in any case, but further support would continue to accelerate and strengthen

their activity. The benefits of increased collaboration between Egypt and Israel in this field are as strong as ever, and continuation of the project would be the best way of promoting this.

Production of Monosex Tilapia

The Problem

The title of this project is misleading. It implies that the only objective is to improve the techniques for producing all-male populations of tilapia, whereas the research is considerably broader than that, involving studies leading to optimum culture systems generally.

The problems faced and the objectives of the project are the same for both Egypt and Israel. The problem to be solved by the project is to improve already relatively successful systems of culture for the group of cichlid fishes called tilapias. These are among the most promising for tropical fish culture: they grow well on a variety of foods; they are widely tolerant to ranges of temperature, salinity and oxygen content; they are good table fish. Paradoxically, a major problem faced by tilapia farmers is high reproductive success. These fish spawn at a small size, below the preferred market size, and they produce such large quantities of young that more fry are present than can be fed adequately to produce good growth. The resulting stunted size of the fish available for harvest reduces profits. Considerable progress has been made to overcome this problem, the solution being to induce the female fish to produce only male offspring. This can be done by genetic means, through certain crosses between particular species of tilapia, or by endocrine manipulation, involving the feeding of certain hormones to breeding females.

The remaining large area of research involved in this project is to investigate culture practices with a view to improving them. This includes finding the best species for particular places and systems; the best kinds of food and feeding systems to use; the best ways of employing manures as feed supplements; the various species that serve best as part of polyculture systems; and the best proportions of the various species to use.

Objectives

1. To produce all-male stocks of tilapia through hybridization or feeding of hormones.

2. To seek optimal methods for monoculture of male tilapia stocks, including tests of manuring of water, and varying feeds and feeding schedules.

3. To seek optimal methods for polyculture of male tilapia stocks with carps, mullets, and other species, including piscivorous species that could eat young accidently produced.

Egypt

Data Collection

Stocks of *Tilapia nilotica* were established at the Barrage Station. These fish were used for sex reversal experiments using hormone feeding and hybridization, and for stock density trials.

Fish were fed three levels of testosterone: 20, 40 and 60 mcg/g in the diet. Fish were fed for two months.

Tilapia nilotica females were crossed with *T. aurea* males which had been brought from Israel by Dr. Gordin in April 1982. These fish spawned in June.

Results

Fish fed an artificial diet fabricated to include plant material from local sources and including 23.5% protein were compared for growth and productivity by weight. Growth was good, the fish reaching market size (over 150 grams) in three months. It appeared that it would not be economic to maintain the fish in culture longer than three months since added weight was not enough to compensate for added cost of feeding and maintenance. There were differences in the results of fish held at different densities: fish at 2 per square meter of surface showed the best growth; fish at 3 per square meter showed the best overall productivity by weight.

Three levels of testosterone were fed to experimental Tilapia nilotica. Those fed 20 mg/kg showed 89% sex reversal, those 40 mg/kg, 91%, and those fed 60 mg/kg, 86% sex reversal. These results are similar to those obtained in Israel.

Israel

Data Collection

The characteristics of greatest interest in tilapia culture are the proportion of males (seeking all male stocks); the growth rates, which may differ substantially in the first compared to the second years of life; resistance to low temperature; the survival rate; the market characteristics, including color (dark color is less desirable than light color, red external color may be desirable since red fish have a relatively high retail value in the Mediterranean countries); and dress-out weight.

In Israel four different interspecific hybrids were produced by genetic crossing and these were tested for the above characteristics.

Results

Results of tests with the four hybrids are as follows:

1. Tilapia mossambica x T. hornorum: This hybrid produced 100% male fish; it exhibited poor growth during the first year and even worse during the second; it was relatively resistant to low temperature; it was dark in color.

2. T. mossambica x. T. aurea: This hybrid produced high proportions of male fish (to 94%); its growth rates (first and second years) were fair; survival was good; it was the most cold resistant of the hybrids tested.

3. T. nilotica x T. hornorum: This hybrid produced 100% males; it exhibited the fastest growth of the hybrids tested (along with T. nilotica and T. aureus); its survival was exceptionally good; its resistance to low temperature was poor (only 30% over winter); it was dark in color. Of considerable interest was

the finding that there were significant differences between the results obtained from crossing T. nilotica from Ghana with specimens of the same species but of stock obtained from the Ivory Coast, the former being superior. This opens up a new area of difficulty since results will have to be tested not only different species of fish but with many different strains of the same species.

4. T. nilotica x T. aureus: This hybrid showed varying proportions of males, 65-95%, but no all-male broods; growth was good; survival was good; their color was light.

Evaluation

Israel is one of the few places in the world where facilities are available -- at the station at Dor, south of Haifa -- for extensive testing of groups of fish with different characteristics. (Auburn University, the U.S. collaborator in the AID program is another.) This is of importance since, while the obvious first essential step in obtaining the most satisfactory species or hybrids of tilapia for culture is to produce large numbers of individuals, this is only the first step. It is still necessary to test these for various desirable characteristics. This kind of testing has been inadequately done for the most part. The AID work has paid commendable attention to this phase of the work. It appears that some of the most useful work on tilapia hybridization, including testing of the characteristics important to culture, has been carried out under the auspices of AID.

Significant progress has been made under the project toward the original objective of improving information about the production of all-male strains of tilapia, and of determining their characteristics. This has been helped by a better than usual record of coordination and cooperation among the three countries. Visits have been exchanged several times, with scientists from each country visiting both of the others (this is the only project where this took

place). Extensive exchange took place of publications, research results and techniques.

This was one of the projects in the AID program where some of the research was performed in a United States laboratory. At Auburn several crosses were made among tilapia strains, and the progeny were tested for the characteristics of interest: *T. nilotica* x *T. hornorum*; *T. mossambica* x *T. hornorum*; *T. aureus* x *T. nilotica*.

Active research will continue on the tilpia problem at Auburn and in Israel whether the AID support continues or not. It is less certain that work will continue in Egypt if Phase II of AID support does not materialize. In any case, research in all three places would be accelerated and improved if the AID help. The momentum achieved is valuable, and it would be desirable to maintain it.

Controlled Reproduction of Commercially Important Finfish

The Problem

The Mediterranean is well known as a relatively unproductive sea. The quantity of fish produced from it falls far short of demand, so that farming of fish is essential if food needs are to be satisfied. There are long histories of fish culture practices both in Egypt and Israel, but expansion has been slowed in both countries for lack of sufficient fry to stock ponds. Moreover, efficient commercial fish farming is handicapped because for many species fry are only available from wild stocks, and therefore only at times of the year when natural spawning supplies them; these periods may not be long enough, or many come at the best times for good commercial practice.

In Egypt mullet culture includes raising fish in ponds and releasing wild fry into lakes for natural growth and later capture. Catches in Lake Quarum, one of the principal lakes where the latter kind of culture takes place, have fallen in recent years, and pressure to increase stocking there has been handicapped by shortages of fry. Releases in the lake rose from one million in 1971 to 22 million in 1981; further expansion will be hard because there are not enough fry from wild stocks. Shortages are made worse by high mortalities which occur from poor handling practices. Increases in the numbers of fry caught from wild stocks are opposed by mullet fishermen along the coast because they fear reductions in the size of natural populations following removal of fry from the area. Finally, the Government has several projects under way (under the auspices of the World Bank, AID and other agencies) to increase substantially the scale of fish farming in Egypt, including mullet culture, and the needs for seed for such farms will put a strain on the present collecting system.

Egypt

Objectives

The general objective of this project in Egypt was to increase the understanding of the reproductive process of mullet in order to control the maturation of the fish's gonads and allow induced, controlled breeding. Specific objectives were listed as follows:

1. To study the reproductive cycle by observing the seasonal occurence of mullet fry in the wild.
    a. by studying the gonadal development to define the breeding season
    b. by surveying the seasonal occurence and distribution of mullet fry
2. To review the potential of mullet (*Mugil cephalus*) and related species for culture in Egypt, by examining the available literature.
3. To establish a broodstock of mullet in captivity.
    a. by stimulation of gonad maturity through environmental control
        1) by manipulation of temperature and photoperiod
        2) by establishment of optimum pond conditions
    b. by development of broodstock husbandry methods
4. To induce mullet to spawn in captivity
    a. through injection of gonadotropins and steroids
    b. through injections of luteinizing hormone-releasing hormone (LH-RH)

Data Collection

Literature on mullet culture, especially aspects of its reproduction, relevant to problems in Egypt were collected and examined. This work was facilitated by Dr. James Kuo, the American collaborator on the project. A report is planned on this effort.

For study of the reproductive cycle, samples were collected monthly of mullet gonads. Ten to 30 fish were included in each sample. Data are available

for 22 months. These fish were examined morphologically and histologically.

Fry were collected monthly from stations along the Mediterranean coast; 22 months of such data are available. In addition, landing statistics for mullet from Lake Quarum had been collected, and statistics of numbers of fry released. These data were taken before the AID work started, and they served as background for the project.

No data were collected on the remaining objectives.

Results

A better knowledge has been obtained of the literature referring to mullet culture.

The reproductive cycle of mullet in the wild has been determined. Spawning takes place from August to November, with a peak in September and October. This information is backed up by continued observations of the seasonal occurrence of fry along the coast.

No results were obtained on the establishment of brood stock in captivity or induced spawning.

Evaluation

Progress on this project in Egypt was the poorest of any in the program. It seems certain that part of this consequence of administrative problems beyond the control of the principal investigator, but how much this is true is not clear. The work is sophisticated, and it requires the ability to control environmental conditions such as water temperature and length of daylight under artificial holding conditions. Facilities for such research are inadequate in Egypt. Ponds were not built during the whole period of the project, and are still not available; they are said to be under construction but their building is under the control of a government entity outside the aquaculture group, which therefore cannot influence the pace of work. Other bureaucratic hindrances, such

as unavailability of funds for certain activities seem to have held back progress.

Israel

The Problem

Israeli scientists concentrated on the culture of the gilthead bream in the course of the AID project on controlled reproduction of marine species. This was a continuation of research that began in Elat in 1975. The emphasis here has been to develop a product valuable in the export market rather than one strictly for domestic consumption.

The emphasis of this work in the beginning was to increase knowledge of the reproductive biology of the bream. It was felt that this was essential before manipulation of the maturation and spawning was attempted. Concern was felt about the possible effects of injected hormones on the fish.

Following studies of reproductive biology, injections of hormones were tried, with enough success that induced spawning of bream is now routine. Smaller amounts of hormones are used: 200 international units compared with 50,000 units employed by Kuo and associates in induction of spawning by mullet. This is felt to pose fewer risks to the health of the animals involved.

The work on bream was supplemented in the AID project by some research on mullet. This was undertaken not because of new interest by Israel in mullet but in order to collaborate with the Egyptians. Work started as it did with the bream, in attempts to learn more about the reproductive biology of the mullet. In the first phase of the AID project no attempts were planned to induce spawning by injection of hormones.

Objectives

The objectives of Israel in the research on the gilthead bream were:

1. To stimulate gonad development by

   a. manipulation of photoperiod and temperature regimes

      1) monitoring gametogenesis (vitellogenesis and spermatogenesis)

      2) determining the stimulatory role of temperature and photoperiod on gonad development

   b. hormonal stimulation of gonal development

      1) determining the effectiveness of LH-RH on gametogenesis

      2) monitoring the influence of LH-RH on hypophyseal gonadotropic cell, activity and gonadotropin surge in the plasma

2. Induced spawning

   a. stimulation of spawning by environmental manipulation

   b. induction of spontaneous spawning by temperature preconditioning

   c. induced spawning or LH-RH

Data Collection

For mullet, the annual pattern of occurrence of mullet in the Gulf of Aqaba was observed through sampling. Radioimunoassays for estradiol and testosterone were developed. These methods were verified by liquid gas chromatographs to correlate histological data with gonad development.

For gilthead bream the same radioimunoassays were developed as for mullet. The biosynthetic and metabolic pathways of steroidogenesis were investigated, as was the relationship between steroidogenesis and gonad development.

Results

Information is now available on the seasonal occurrence of mullet fry in the Gulf of Aqaba: from the end of February through April. This species in this area matures in two and one half years; few females showed vitellogenesis in their first or second years, but did in their third year. Vitellogenetic

oocytes of 500 microns diameter appear in November and December, and the natural breeding season is from December to February.

Two seasons of data are available on the concentrations in the mullet blood of steroid hormones in relation to the development of oocytes.

Captive bream and mullet broodstocks have been established. The gonad cycles of bream were defined.

Important results were obtained from the experiments on environmental manipulation of gonad maturation. The lengthening of the photoperiod by half a minute a day was effective. It was found that the bream's ability to detect attenuation of day length is acute; extending the day as much as one and one half minutes was not effective, while one half to one minute produced good results. Mature eggs were produced within 90 days of the beginning of such an experiment. A quarter of a million fertilized eggs were produced per day from nine to ten pairs of fish. From these, incubation was satisfactory. Larval survival was not as good as necessary, and further improvement of techniques here is required.

Spawning of seabream was obtained by injections of human chorionic gonadotropin (HCG). But it was later discovered that the same fish that had responded to such treatment failed to show the same response in another season. This may be related to the short half life of HCG in the blood, or to improper (especially too large) doses. Further work on this will include the use of LH-RH from the Shanghai Bio-Chemical Research Institute of the Academia Sinica in China, which has been obtained through the efforts of Dr. Kuo. A long step forward is the conclusion that a combination of injections of testosterone and gonadotropin with photoperiod manipulation is the most effective combination of treatments for inducing spawning of bream.

Evaluation

This research in Israel has advanced the knowledge of bream reproduction very usefully, and will be helpful in guiding this kind of research on cultured fish of other species. The practical results will be to increase the length of time during the year when young can be produced for farming.

The research team at Elat had already developed some of the techniques for induced breeding of gilthead bream. What the AID project contributed was strengthening of the capacity of the group to continue and expand the work. For example, a significant amount of basic equipment was supplied with AID money; this was described by the scientists as being of tremendous importance. The research team was increased in size by AID support. This included support for graduate students, three of which were helped financially--two from Tel Aviv University (one used the data for his thesis) and one from the Hebrew University.

This is one project which included no research at all by the United States collaborating scientists. It had been planned in the beginning that Dr. James Kuo would carry out some laboratory studies in his facilities at the Oceanic Institute in Hawaii, but he later left there. He served as a consultant to the project, and was able to contribute importantly through his experience and advice.

Israel will continue this kind of work regardless of whether the AID support is continued. However, the scope of the work will be reduced without a second phase. In particular, the mullet work, which is of special interest to Egypt, will cease. If AID support is continued, Israeli scientists will begin research on the effects of injections of hormones for the purpose of inducing spawning in mullet.

Development of Intensive Fish Culture in Seawater Ponds

The underlying reason for this project is to develop techniques for increasing supplies of food by raising fish in ponds. A great deal of experience is available in several parts of the world in methods of fresh water pond culture but much less is known about brackish or saltwater fish pond management. In Israel and Egypt better use of such ponds would be valuable, since there is a strong need for food, and because fresh water is in short supply. The latter is especially the case in Israel, where the expansion of fresh water pond fish culture has been stopped because the water is needed for other purposes; Egypt is also suffering from a lack of fresh water.

The study of brackish and salt ponds for fish has been conducted at Elat, Israel since 1975, with the emphasis on the culture of the gilthead bream, but including studies of other species that could be raised with the bream. The work has focused on problems arising from the natural processes in the ponds, including the occasional occurrence of phytoplankton blooms which can produce supersaturation of oxygen by high photosynthesis. This can result in death of fish through gas bubble disease. This condition may be followed by collapse of the algal population and subsequent oxygen depletion and massive deaths of fish. In addition, the loading of organic compounds into pond bottom sediments can cause them to become anaerobic, and therefore harmful or even lethal to fish. Studies of these phenomena and of ways to prevent them or to neutralize their effects are necessary if more efficient brackish and marine fish ponds and their management are to be designed.

In Egypt fresh water pond culture has been practised since ancient times, but always on a trial and error basis, with little scientific

research to guide local practices. For salt ponds the background of experience is missing, and there has been virtually no scientific work performed in the country.

Egypt

Objectives

Several species of brackish and marine fish--mullet, tilapia, sole, gilthead bream--are stocked in Lake Quaron, the lake being used in this project. Because of ecological conditions in the lake none of these species spawns there, so that fry must be caught in the estuaries to keep the populations going.

The original objective of the project was to study monoculture and polyculture of mullet and gilthead bream, in ponds that were to be constructed at the lake. Optimum stocking rates were to be sought, and different stocks of mullet from several sources were to be tested for their culture potentials. This kind of work was abandoned when ponds could not be built. Instead, mesh-sided enclosures were constructed in the lake and the objectives shifted to the following:

1. To understand the pattern of distribution and seasons of availability of fish seed
2. To develop nursery management techniques to increase survival and growth rates of the juvenile stages
3. To develop the technology of the polyculture system in brackish water
4. To identify the ecological processes required for maximum production

Data Collection

In pursuit of the first of the modified objectives, to determine the pattern of distribution of young fish, collections were made of fry of two

species of mullet (Mugil cephalus and M. capito) every two weeks for a year. It is estimated that data of this kind are required over three to four years to determine the variability in seasons of occurrence of the fish fry.

Few data were collected on the development of nursery techniques; some work was started on mullet fry in fresh and saline waters but none on other species.

Few data were collected on the study of polyculture systems in brackish water. Literature was reviewed; examination was made of the contents of the stomachs of two species of mullet, bream, and two species of tilapia. Samples for this work were taken four times a year to obtain seasonal differences in food. Fifty fish were taken in each sample. This work was done by two students (one a junior student and one pursuing a Ph.D.).

Data for the study of the ecological processes required for maximum production involved taking of water and biota samples on a monthly basis. Parameters measured included: water depth, transparency, air and water temperature, salinity, pH, oxygen content, alkalinity, dissolved salts, nutrient salts, and soil samples. Phytoplankton samples were taken monthly, as were samples by dredge of the bottom fauna in the lake adjacent to the net enclosures.

Experiments were started on culture practices. Tilapia were placed in the net enclosures: 16 enclosures, 16x16x1.5x2 meters. The stocking rate was 100 per cubic meter. Each of four sections of four ponds were fed differently, and there were four replicates.

Results

Fry of one of the two species of mullet, Mugil cephalus, were found to be most abundant between August and November, and fry of the other,

M. capito, from February to April or May. These results make it possible to advise fish farmers when it is most efficient to catch mullet fry. Also, it was discovered that these two species are found in waters of lower salinity than three other species of mullet; all of the latter are of lower commercial value than cephalus and capito and this information on preferred habitat can help avoid catching less valuable seed for stocking.

Growth of mullet in fresh water ponds over three months was better than growth in seawater salinities. However, since comparisons were made between growth of mullet stocked at the rate of 1,000 fry per cubic meter in three fresh water ponds and mullet stocked at rates from 500 to 5,000 per cubic meter in mesh cages in the saline lake, the effects of stocking rates will have affected results.

For the bream it was discovered that fish survived better if they were held for three months in net cages before being placed in ponds; survival was 45% compared to 20% in standard commercial practices.

Considerable information is available from this work on the physical/chemical characteristics of the lake water adjacent to the net cages. Plankton samples showed that most of the plant organisms were diatoms. The relative abundance of the principal plankton species was recorded; bottom organisms were identified and counted.

Evaluation

This project fell far short of fulfilling the objectives set out originally, which involved the study of monoculture and polyculture of mullet and gilthead bream. And it achieved only limited success in fulfilling the modified objectives:

1. One year's data are available on the distribution of mullet fry,

2. Tentative and somewhat unsatisfactory results are available comparing the survival rates of fish raised in fresh water compared to those raised in salt water. The experiment ran only briefly and was poorly designed, with different stocking rates.

3. No data were collected on polyculture.

4. Several months' data are available on physical, chemical, and biological variables in the part of the lake where the net enclosures were built. These data will be of use, and are a necessary preliminary or accompaniment to the controlled experiments which must eventually be made to complete the planned research.

It seems certain that part (and perhaps a determining part) of the reason for the failure to make more progress in this project was beyond the control of the scientists involved: delays in receiving money and multiple bureaucratic barriers. It is not possible here to judge how much of this is true.

On the positive side, the construction of net enclosures in the lake was a good substitute for the ponds that could not be built, and it should be possible to design and conduct useful experiments that eventually will go a long way toward solving the problems posed by this project.

Israel

Objectives

The overall objective of the Israeli research was to study the ecology of seawater fish ponds. This research is a continuation and expansion of work begun in 1974. In the earlier work, fish were raised in cages in the Dahab Lagoon, showing remarkable growth. For comparison, studies under AID support were begun on ponds, concentrating on their ecology under the heavy feeding regime required to achieve fast growth. The specific objectives were to:

1. Measure primary productivity and describe the nutrient cycle in the ponds

2. Measure the effects on fish growth of different fish densities and other variables

3. Measure oyster growth rates

Data Collection

The gilthead bream continued to be the species studied. The research was conducted in four ponds which were already in existence (instead of new ponds which had been planned but which were delayed in construction because of failure to transfer the money quickly enough). In order to keep the salinity at desired levels (preventing it from rising too high through evaporation) new salt water was pumped into the ponds from a well near the sea. The fish were fed twice a day six days a week. Effluent from the ponds was run into experimental oyster beds constructed nearby. The quantitites of water run into the oyster beds were controlled experimentally, thereby controlling the quantities of algae supplied to the oysters from this source. The fish and oysters were sampled periodically and their growth and condition noted. Water samples were taken daily and the following measurements made: dissolved oxygen, pH, dissolved inorganic NO_2, NO_3, NH_4, orthophosphate and silicate, algal particulate protein nitrogen, algal cell density, light attentuation in ponds, flow rates in ponds. Nutrient input to the ponds from the well water was measured.

Results

Valuable results have emerged from this study of pond ecology.

1. It appears possible with proper manipulation of conditions to achieve a satisfactory integrated pond system for the gilthead bream, *Sparus*.

2. Simultaneous high production of fish, phytoplankton, and oysters can be achieved. Outstanding growth and production of both fish and oysters were obtained under certain sets of of conditions.

3. High densities of fish can be maintained without detriment to their growth as long as good water quality is maintained; stocking rates in excess of one kg of fish per cubic meter of water were satisfactory. Thus, appropriate management strategies for water quality can lead to better use of pond space and can increase yields significantly.

4. The limiting factor for phytoplankton was orthophosphate, with nitrogenous compounds being always in excess. If orthophosphate is added production is increased until light becomes a limiting factor.

5. Only about half the phosphorus and nitrogen entering the ponds was accounted for. The fate of the rest should be traced; it may end up in the sediment.

6. The very high phytoplankton blooms in the fish ponds serve usefully as food for oysters, and a productive integrated system has been designed yielding valuable quantities of fish and oysters simultaneously.

Evaluation

Significant results were obtained from this research. Perhaps the most useful outcome has been the example set by these scientists in penetrating the basic foundations of the biology and chemistry of the fish, plant, water, and soil interactions of the pond system. This kind of fundamental information provides more trustworthy guides for management of a fish pond that the usual trial and error approaches.

The importance of high quality of water in fish ponds is confirmed by this work, with specific information having been provided concerning management actions of importance. A practical result which may later be of high value to commercial fish farmers is the development of a system whereby a combination of gilthead bream, oysters and phytoplankton can be maintained simultaneously, and so complement each other that the water

from the fish ponds is cleansed by the oysters and can be reused, while the wastes from the oysters help to fertilize the water used by the fish and thus increase its ability to produce food for the bream.

Overall, good progress was made here to design a satisfactory integrated fish pond system.

Interaction between United States and Middle East scientists in the project was small, although discussions between American and Egyptian scientists were of help in designing the exper nts in Egypt, and consultation of this kind is seen by the Egyptians as desirable. Dr. Strawn planned to make comparisons of culture characteristics of several stocks of mullet from different countries, and had fish shipped to Texas A&M University for these experiments. All but part of the last shipment died, and this work was very limited. Strawn had no input into the Israeli experiments. Dr. William Neill assisted in a student project involving an American who did research in Israel on the bioenergetics of the gilthead bream. This work has been productive, resulting in the erection of a bioenergetics model for this species; the Israelis would like to see this work continued.

A great deal of information is still needed about fish pond ecology and optimum management practices for commercial culture. The research will slow or cease in Egypt if AID support is withdrawn now. This will not be the case in Israel, where the research conducted was a continuation and extension of studies already underway. Nonetheless, continued AID support would accelerate and benefit the Israeli effort, and could lead to collaboration between the two national groups in a way that has not been possible in the preliminary phases now ending.

Summary

In the project on Biological Productivity of the Southeastern Mediterranean, worthwhile science has been done. This project launched both Egypt and Israel into ocean science, and made possible the first observations of biological oceanography on an intensive basis with modern gear and procedures. The work has produced background data which are essential for future research of this kind. The project did not meet all its objectives; these were too ambitious for this to be possible. Some of the data, especially biological information, has not been completely analyzed in Egypt.

The project on Coastal Management and Shore Processes has been very successful. It has generated information of value to international scientists. It has stimulated insights by the Egyptian and Israeli scientists of the practical problems faced, and has shown administrators the nature and magnitude of the problem; it has improved the ability of the scientific teams to make recommendations for the protection and restoration of the shorelines. The equipment used is sophisticated, and Egypt and Israel may not be able without continued help to maintain it in working order.

The Lake Management project was started by Egypt with a weaker base than by Israel. After a delayed start Egypt has collected an impressive amount of information on its lake; this will supply the basis for observing trends in lake ecology. Too much was attempted by Egypt, and much data are not analyzed, especially biological information. Israel continued research under AID that had been started some years before. Results of the new work have been excellent;

they have led to important and potentially far-reaching recommendations to the government for fishery management procedures which promise to improve both the water quality and the fish production of the lake.

The project on Fish Nutrition accomplished useful research. The work was not well integrated among the three countries, and each worked for the most part on species and problems of interest only to themselves. The level of background in fish nutrition research in Egypt was lower than that in Israel, and research in the former country was preliminary; it was largely chemical determinations of raw materials available for fish food, and of fish flesh. In Israel the research was a continuation of work that had been under way before the AID program started; AID strengthened and accelerated it. The results will improve the efficiency and lower the costs of diets fed to gilthead bream.

The project on Tilapia produced valuable results, especially in Israel, where one of the few facilities exists to conduct such research on a large scale. Hybrids were produced by crossing a number of different species of tilapia, and the resulting fish were tested for several characteristics useful to fish farming. Results will be of practical value; but new difficulties were uncovered, and extensive additional research has been shown necessary.

In the project on Induced Spawning of fish little was accomplished in Egypt. Some blame must be laid to administrative problems, some to inadequate facilities. Such facilities are still under construction. In Israel substantial progress was made in gaining an understanding of the biology of bream and mullet, a necessary prerequisite to experiments on induced spawning through environmental manipulation and the feeding

of hormones. Techniques have been developed by this and earlier work which enable bream to be induced to spawn when young are needed.

The project on Pond Management fell short of accomplishing its objectives in Egypt when ponds needed for experiments were not built. The work was redesigned using net enclosures in the lake, and this proved to be a promising approach. A good deal of data was obtained which will lay the basis for future research. In Israel good progress was made in determining the chemical and biological bases for successful pond management in general. An excellent integrated pond system was designed using gilthead bream, oysters and planktonic algae.

List of Interviewees

In USA

Robert Abel	- President, New Jersey Marine Sciences Consortium, Director of Marine Technology Program.
George E. Assousa	- Managing Director, Trust for International Development and Partners for International Development; participated in organization of Marine Technology Program.
Naaman Belkind	- Embassy of Israel; Scientific Counselor.
Donald Brown	- past Director of AID Mission, Egypt.
Richard Brown	- AID Oman/Persian Gulf and Regional Cooperation Desk; Project Director, Marine Technology Program.
Stephen Cohen	- CUNY; Program Director, Images and Conflict Project.
Carolyn Coleman	- AID Project Officer, Office of Egypt Affairs.
Jay Davenport	- NAS; Staff Director, NAS-ASRT Egypt Program.
R. W. Drenner	- Texas Christian University; PI*, Lake Management.
Twig Johnson	- AID, Office of Evaluations.
Dr. Yehia Kabil	- Embassy of Egypt; Director, Cultural and Educational Bureau.
Ali Khady	- Auburn University, graduate student; employed by Egyptian Ministry of Agriculture; visited Israel in June 1982 to deliver fish for breeding.
Wingate Lloyd	- Department of State; Director, Office of Egyptian Affairs.
Samuel P. Meyers	- Louisiana State University, PI, Fish Nutrition.
Katherine Morrison	- Research Planning Institute, Inc.; attended conference at Al Ghardaqa.
Robert Morrow	- AID, Agriculture Officer.

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* Principal Investigator

Ismael E. Moubarek	-	World Bank Program Director; formerly, coastal engineer with ASRT.
William H. Neill	-	Texas A&M University; PI, Intensive Pond Culture.
Michael Norvelle	-	San Diego State University Foundation; Program Director, Cooperative Arid Lands Research Program.
Ray Ontel	-	Executive Director of Hansen Foundation.
Sayed Z. El Sayed	-	Texas A&M University ; Scientific Director, Marine Technology Program.
R. O. Smitherman	-	Auburn University; PI, Monosex Tilapia.
R. K. Strawn	-	Texas A&M University; PI, Intensive Pond Culture.
R. R. Stickney	-	Texas A&M University; PI, Fish Nutrition.
Mary Frances Thompson	-	American Institute of Biological Science; International Conference Coordinator.
Earl A. Western	-	NIH; Program Director, Cooperative Program in Medical Research.
Judy Wills	-	AID, Evaluation Officer.

In Egypt

Naim Abou-Taleb	-	University of Alexandria; Chairman, Computer Science; former Minister of Transportation, former Governor of Alexandria Governate
Alfred R. Atherton	-	U. S. Ambassador to Egypt.
A. R. Bayoumi	-	Director, IOF*; Coordinator for Egypt, Marine Technology Program.
Mohamed Dessouki	-	Ministry of Agriculture; Undersecretary for International Programs.
Naim M. Dowidar	-	Alexandria University; PI, Biological Productivity and Lake Management.
A. R. El-Bolock	-	IOF; PI, Controlled Reproduction.

* Institute of Oceanography and Fisheries.

S. H. Sharaf El-Din	-	University of Alexandria; Coordinator for Alexandria University Projects; PI, Biological Productivity.
Mahmoud El-Hadery	-	President, University of Alexandria.
A. Ezzat	-	University of Alexandria; PI, Lake Management.
Mohamed Fazey	-	Vice-President, ASRT*.
Richard Frankel	-	AID Mission; Program Officer for Cooperative Projects.
A. A. Khafagy	-	Director, Coastal Research Institute, Alexandria; PI, Coastal Management.
Mounir M. Ishak	-	IOF; PI, Fish Nutrition and Intensive Pond Culture.
Hassan Ismael	-	past President, ASRT.
W. D. Labib	-	IOF; PI, Monosex Tilapia.
Elizabeth Martella	-	AID Mission; Agriculture program officer.
Ahmed S. El-Nockrashy	-	ASRT; Director of International Programs.
Robert Mitchell	-	AID Mission, Science and Technology Advisor.
Leo Packer	-	NAS/NRC Resident Program Director of NAS-ASRT Egypt Program.
James Riley	-	AID Mission, Director of Science and Technology Division.
Arnold Radi	-	AID Mission; Office Director, Agriculture
Stephanie Sagebiel	-	U. S. Embassy, Science Officer.
Shimon Samir	-	Director, the Israeli Academic Center in Cairo.
A. M. Shalaby	-	University of Alexandria; Dean, Faculty of Science.
Mohamed Shaalan	-	Chairman, Department of Neuropsychiatry, Al-Alzah University; PI, Images and Conflicts Program.
Thomas Vrebalovich	-	U. S. Embassy; Counselor for Scientific and Technological Affairs

*Egyptian Academy of Scientific Research and Technology.

Janice Weber	- AID Mission; Science and Technology Advisor.
Adolph Wilburn	- AID Mission; Director, Office of Education and Training.

In Israel

Moshe Amir	- Hebrew University; Authority for Research and Development, Coordinator U.S. sponsored Research Programs.
Ammon Barak	- Hebrew University, Director, Authority for Research and Development.
Tom Berman	- IOLR*; PI, Biological Productivity.
Zev Carmel	- IOLR; Investigator, Coastal Management.
Abraham Golik	- IOLR; PI, Coastal Management.
Moshe Gophen	- Kinneret Limnological Laboratory, Lake Management.
Hillel Gordin	- IOLR; PI, Intensive Pond Culture and Controlled Reproduction.
Dennis Jett	- U. S. Embassy, Economic and Science Officer.
Alex Keyman	- Hebrew University; Vice-President.
Baruch Kimore	- IOLR; Investigator, Biological Productivity
Dan Kurtzer	- U. S. Embassy; political officer.
Samuel Lewis	- U.S. Ambassador to Israel.
Yohay Ben Nun	- Past Director General, IOLR.
Al Persi	- U. S. Embassy.
Samuel Pohoryles	- Ministry of Agriculture; coordinates cooperation with Egyptian Ministry of Agriculture.
Colette Serruya	- Director General, Israel Institute for Oceanographic and Limnological Research; Coordinator for Israel of Marine Technology Program.

* Israeli Institute for Oceanographic and Limnological Research.

M. Shilo	-	Hebrew University; Head of Center for Marine Research.
Ariel L. Szeskin	-	Ministry of Agriculture, Rural Planning and Development Authority.
Giora Wolhforth	-	IOLR; PI, Monosex Tilapia.