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ANNUAL REPORT FOR FY 1974

THE INTERNATIONAL CENTER FOR AQUACULTURE

Auburn University Agricultural Experiment Station
Auburn, Alabama 36830

E.W. Shell, Director
Project: AID/csd-2780

December 3, 1974

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211(d) Annual Report
Date December 2, 1974

Title: To Strengthen Specialized Competency in Aquaculture, Specifically the International Center for Aquaculture
Grantee: International Center for Aquaculture
Auburn University, Auburn, Alabama
Director: Dr. E.W. Shell

A. Statistical Summary:

Period of Grant: June 25, 1970 to June 30, 1975 Amount of Grant $800,000
Expenditures for Report Year $188,412.06 Accumulated $629,567.82
Anticipated for next year $170,432.18

B. Narative Summary:

Grant funds were utilized to purchase 48.4 man-months of academic staff time, 29.0 man-months of secretarial time, 22.4 man-months of graduate research assistant time and 47.9 man-months of field labor. The academic staff and support personnel produced 13 major scientific papers. They also conducted research on seven extramural grant projects.

Library acquisitions with grant funds included 273 books and 7 periodicals. Seven of the grant-funded academic staff taught nine academic courses during the year. A total of 161 students (87 Americans and 74 foreign students) were enrolled in these courses. Seventeen students (10 American and 7 foreign) were awarded graduate degrees during the year. Grant-funded staff served as major professors for nine of these graduates.

Approximately 60 visitors came to the Center on business related to international development. The visitors came from 15 different countries. Special tours, demonstrations and seminars were arranged for several of them. A number of Peace Corps Volunteers visited the Center before going abroad to their assignments.

Grant-funded staff participated in approximately 4.5 man-months of international service activities over-seas during the year. They also provided 9.8 man-months of campus coordination and 3.6 man-months of technical support for AID Mission-funded projects in Brazil, El Salvador, Panama and the Philippines.

I. General Background and Purpose of the Grant

Aquaculture is becoming increasingly important in developing countries as a means of providing increased quantities of the protein needed for more adequate diets and as an important contribution to economic growth. It utilizes infertile lands and runoff waters plus agricultural wastes and surpluses to intensively grow crops of high quality proteins in the form of fish and other aquatic animals, thus greatly increasing the ability of each country to supply the protein needed by its own people. Aquaculture can be used to grow high quality protein locally where it is most needed, thus reducing the cost of transportation, processing and refrigeration. It also provides additional needed income and employment for farmers.

Auburn University has received worldwide recognition for its leadership in warmwater fisheries generally and aquaculture specifically. The University has committed itself to assist developing nations to increase their supplies of high quality protein and improve their economic well being through improved methods of aquaculture. No other American university presently has the capability of providing this type of assistance.

This Grant is being utilized by Auburn University to strengthen its research, teaching, extension and other service capabilities in aquaculture. As a consequence, more significant contributions will be made by the University in promoting aquaculture in developing countries. In addition, the Grant is being used to develop methods and procedures for making the University's competence in aquaculture more readily available for those who need it.

II. Objectives of the Grant

A. Objectives Restated

The objectives of the program are:

1. To add to the faculty, experts with competence in selected fields so as to provide broader technical assistance in aquaculture to developing nations.

2. To develop a library containing worldwide literature on aquaculture and more effective methods of dissemination of information on aquaculture.

3. To provide training and educational opportunities through short courses, symposia, and University courses for professional staff members of A.I.D., other federal agencies and private foundations, for students interested in careers in international development, for Peace Corps Volunteers and for foreign nationals.

4. To develop a worldwide collection of data on important food fishes and other aquatic organisms presently cultured or that appear suitable for culture.

B. Review of Objectives

The four primary objectives as approved in the Grant proposal are still appropriate to the goal of strengthening the International Center for Aquaculture at Auburn; however, as specific phases of each objective have been completed, or the relative importance of an objective has diminished emphases have been re-directed to other priority areas.

Objective 1. To add to the faculty, experts with competence in selected fields so as to provide broader technical assistance in aquaculture to developing nations.

Under Objective 1, in the first year, a core of expertise was established in the various aspects of aquaculture. Since that time this core staff has been involved in research, training and extension in

aquaculture. This Objective has been the primary one from the beginning of the Grant. Special emphasis has been given to aspects of aquaculture that are of greatest importance in the solution of problems in developing countries. Because of funding limitation the size of the core-staff has remained relatively static since the beginning of the Grant; however, numerous changes have been made in the scientists comprising the core. Scientists brought to the campus as part of the core-staff have been shifted partially and then completely to other projects as the over-all fisheries and acquaculture program of the University has developed. Also, relatively few of the core-staff have been funded entirely from the Grant. Generally they have held joint appointments between the Grant and other projects. These joint appointments have resulted in a larger number of scientific specialties being represented on the core-staff than would be possible otherwise. In the past fiscal year seven different scientists representing seven scientific specialties related to aquaculture comprised the core-staff.

Development of a core-staff also implies on-going research, training and extension activities on the part of those staff members. All members of the core-staff took part in these activities. The results of these efforts are detailed in the following section on "Accomplishments".

Objective 2. To develop a library containing worldwide literature on aquaculture and more effective methods of dissemination of information on aquaculture.

More attention has been devoted to Objective 2 this past fiscal year than in previous years. The University Library staff has been most helpful in locating materials from various international sources for addition to the

Library. These materials have been catalogued and included in the regular Library holdings where they are available to all students and staff for study. In addition the core-staff has located and recommended a wide variety of materials to be included in the collection. Materials sent to the International Center from other countries on an exchange basis have also been placed in the collection.

Virtually no progress has been made in developing more effective methods of dissemination of information on aquaculture. It is becoming increasingly clear that this part of Objective 2 cannot be effectively accomplished without additional funding, staff and mechanisms for dissemination. Dissemination of information is an important aspect of international aquacultural development, but to accomplish it will require more emphasis and effort than is possible under the present Grant.

> Objective 3. To provide training and educational opportunities through short courses, symposia and University courses for professional staff members of A.I. D., other Federal agencies and private foundations, for students interested in careers in international development, for Peace Corps Volunteers and for foreign ~~materials~~ nationals.

Probably more concerted effort has been devoted to this Objective than any of the others. Training and education have probably required more staff time than either research or extension. Activities related to this Objective are also described in another section on "Accomplishments". Developing countries, through USAID support have benefitted greatly from staff efforts in this area. Approximately one-half of our entire graduate training program involves foreign nationals who have come to

Auburn to study acquaculture and fisheries. With additional funding, efforts related to this Objective can be increased significantly. In future Grants, more emphasis should be placed on training and education and especially on continuing education to maintain the level of competence of trainees after they return to their duty stations.

Objective 1. To develop a world-wide collection of data on important food fishes and other aquatic organisms presently cultured or that appear suitable for culture.

This Objective has received relatively little specific attention, although additions to the Library under Objective 2 have emphasized data on important or potentially important food fishes. Here as in the case of Objective 2 little or no consideration was given to planning or implementing a utilization mode for information collected. This deficiency should be corrected in future Grants.

III. Accomplishments

A. Personnel on the Project

Following is a list of personnel who received Grant funds as part of their salary during the report year.

Name	Position	Man-Months
Dr. E.W. Shell	Director	5.0
Dr. D.D. Moss	Assistant Director	1.4
Dr. C.E. Boyd	Associate Professor	4.4
Dr. R.T. Lovell	Associate Professor	3.7
Dr. M.M. Pamatmat	Associate Professor	6.6
Dr. R.O. Smitherman	Associate Professor	5.1
Dr. D.R. Bayne	Assistant Professor	0.4
Dr. W.D. Davies	Assistant Professor	1.5
Dr. J.L. Gaines	Assistant Professor	6.6
Ms. E.W. Scarsbrook	Research Associate	12.0
Mr. C.D. Depoisiter	Technical Assistant	4.5
Ms. C.B. Sherrer	Senior Clerk	5.0
Ms. R.E. Grant	Typist A	0.9
Ms. C.B. Hawke	Typist A	7.5
Ms. E.C. Talley	Typist A	8.0
Ms. P.M. Argo	Typist	6.3
Ms. A.C. Tucker	Typist	1.3

Mr. D.E. Alston	Graduate Research Assist	4.0 [1]
Mr. R.L. Babnats	Graduate Research Assist.	1.0
Mr. M.C. Braid	Graduate Research Assist.	1.0
Mr. R.L. Busch	Graduate Research Assist.	4.0
Mr. R.E. Buttermore	Graduate Research Assist.	3.2
Mr. J.P. Hawke	Graduate Research Assist.	3.3
Mr. C. McVea	Graduate Research Assist.	2.3
Mr. V.E. Mezainis	Graduate Research Assist.	0.3
Mr. P.W. Perschbacher	Graduate Research Assist.	0.3
Mr. J.H. Schachte	Graduate Research Assist.	0.7
Mr. P.W. Taylor	Graduate Research Assist.	2.0
Mr. J.L. Williamson	Graduate Research Assist.	0.3

B. Research Projects

A majority of the personnel funded under the Grant participated in research projects during the year. Following is a summary of the research accomplishments. A more detailed description of the results of specific research projects is presented in Appendix I. Research supported at least in part by Grant funds resulted in 13 major research publications during the year. A list of these publications is presented in Appendix II.

[1] Graduate Research Assistants are generally expected to spend 1/3 time on activities related to their stipend and under normal circumstances do not contribute more than 4.0 man-months to a project in a year.

Name	Research Interests	Number of Research Projects	Number of Publications
Dr. C.E. Boyd	Aquatic ecology and nutrient cycles in aquaculture	4	4
Dr. R.T. Lovell	Fish nutrition and fish processing and technology	7	6
Dr. M.M. Pamatmat	Aquatic ecology and aquaculture	3	0
Dr. R.O. Smitherman	Aquaculture	4	0
Dr. W.D. Davies	Fisheries management	7	3
Dr. J.L. Gaines	Fish pathology	1	0
Mr. D.E. Alston	Culture of fish food organisms (with Dr. J.S. Dendy)	1	0
Mr. R.L. Busch	Induced spawning of fish (with Dr. W.L. Shelton)	1	0
Mr. R.E. Buttermore	Pen culture of channel catfish (with Dr. M.M. Pamatmat)	1	1 [1]
Mr. J.P. Hawke	Diseases of fish in natural water (with Dr. J.A. Plumb).	1	0
Mr. C. McVea	Effects of water hyacinths of fish production (with Dr. C.E. Boyd)	1	0
Mr. V.E. Mezainis	Oxidation of organic matter in fish culture ponds (with Dr. M.M. Pamatmat)	1	0

[1] Research Thesis

Mr. P.W. Pershbacher	Effect of grazing by Tilapia on productivity of phytoplankton (with Dr. C.E. Boyd)	1	0
Mr. P.W. Taylor	Life history of an amoeba parasitic on Tilapia (with Dr. W.A. Rogers)	1	0
Mr. J.L. Williamson	Polyculture (with Dr. R.O. Smitherman)	1	0

C. Research Work by Foreign Graduate Students

Six foreign students received graduate degrees from Auburn during the year. Each student was required to submit a thesis or dissertation based on their original research. Although none of these students were supported directly on Grant funds, all of them utilized equipment and supplies benefited from the availability of field labor or received guidance and information from staff time which was purchased with Grant funds. Names, country and title of the thesis or dissertation for each student follows:

Name	Thesis or Dissertation
Sopa Areerat (Thailand)	The immune response of channel catfish to the fish parasite Ichthyophthirus multifilis (Directed by Dr. R. Allison).
Arsenio Camacho (Philippines)	Characterization of thiamine deficiencies in channel catfish fed heated and non-heated catfish processing wastes (Directed by Dr. R.T. Lovell).
Tawan Chookajorn (Thailand)	Preimpoundment age and growth of the bluegill sunfish in the proposed West Point Reservoir, Alabama and Georgia (Directed by Dr. W.L. Shelton).
Rafael Guerrero (Philippines)	The use of synthetic androgens for the production of monosex male Tilapia aurea (Directed by Dr. W.L. Shelton).

Vanida Koonsoongnoen (Thailand)	Protein Quality of Catfish Processing Waste for Channel Catfish Fingerlings (Directed by Dr. R.T. Lovell).
Jorge Tres-Dick (Guatemala)	Interrelationships Between Quantity and Quality of Protein in Feeds for Channel Catfish in Intensive Pond Culture (Directed by Dr. R.T. Lovell).

D. Teaching Activities

Seven of the staff members on the Grant taught a total of nine courses during the year. Seven of the staff supervised thesis research projects for graduate students. A summary of each person's teaching activities follows:

Professors	Courses Taught	No. of Graduate Students Supervised
Dr. E.W. Shell	Seminar in aquaculture research techniques	4
Dr. D.D. Moss	Pond construction	0
Dr. C.E. Boyd	Water quality and aquatic productivity and nutrient cycles in aquaculture	7 (3) [1]
Dr. R.T. Lovell	Fish nutrition	10 (10)
Dr. M.M. Pamatmat	None	4 (2)
Dr. R.O. Smitherman	Aquaculture	5 (3)
Dr. W.D. Davies	Fisheries biology and Advanced fisheries biology	6 (3)
Dr. D.R. Bayne	None	0
Dr. J.L. Gaines	Fish morphology	0

[1] Number in parenthesis indicates number of graduate students that were foreign nationals.

The Department utilized Grant funds to bring three outstanding scientists to campus to present seminars during the year. These were:

Dr. Raymond Johnson. President of the American Fisheries Society and Deputy Director, Division of Environmental Systems and Resources, National Science Foundation, Washington, D.C.

Dr. Jon Stanley. U.S. Department of Interior, Fish Farming Experimental Station, Stuttgart, Arkansas.

Dr. Robert Anderson. Leader, Missouri Cooperative Fisheries Unit, University of Missouri, Columbia, Missouri.

E. International Service Activities

All of the academic staff on the Grant participated in International Service Activities during the year. Seven of them visited other countries in connection with these activities. A total of approximately 4.5 man-months of time was spent in these countries. Information of these visits are summarized as follows:

Professor	Activity and Dates
E.W. Shell	Participated in TAC working group on Aquaculture, Spoleto, Italy, July 10 - 19, 1973.
	Participated in Philippines Conference on Fish Estates and reviewed progress of Fisheries Project in the Philippines, October 22 - November 3, 1973.
D.D. Moss	Planned aquacultural research station in Colombia at request of AID, May 27 - June 7, 1974.

R.T. Lovell	Attended FAO Conference on Fishery Products in Japan. Reviewed Japanese research in fish nutrition, December 2 - 18, 1973.
	Provided short-term assistance in fish nutrition to fisheries project in Northeast Brazil, November 19 - November 29, 1973.
M.M. Pamatmat	Reviewed aquacultural research in Scotland, Germany, Sweden and Norway, June 15 - 30, 1973.
R.O. Smitherman	Attended a meeting on Aquaculture sponsored by the American Association for the Advancement of Science in Mexico City, July 1 - 3, 1973.
	Surveyed potential for aquacultural development in Haiti at request of AID, August 20 - 31, 1973.
	Attended symposium on mullet culture held in Israel, May 31 - June 9, 1974.
D.R. Bayne	Surveyed nuisance aquatic plants in reservoir in Morocco at request of AID, March 21 - 30, 1974.
W.D. Davies	Participated in FAO Symposium in Methodology for the Survey, Monitoring and Appraisal of Fishery Resources in Lakes and Large Rivers, held in Scotland, April 29 - May 6, 1974.

Funds from the Grant were also used by other Departmental staff for international service activities. Dr. Ray Allison visited Thailand, October 12 - 18, 1973, to discuss plans for holding an international aquacultural symposium there. Professor E.E. Prather conducted a survey of the potential for aquaculture in Jamaica during the period June 17 - 29, 1974.

F. Library Acquisitions

During the year, 272 books were purchased with Grant funds. Emphasis in selection of titles was given to those on aquaculture, aquaculture-related subjects, and fishes found in developing countries. A total of seven subscriptions to scientific journals were also purchased. Grant funds are utilized only to pay the initial year of a subscription. After the initial year funds are used to continue the subscriptions.

IV. Impact of Grant Supported Activities in Developing Institutional Capabilities

Auburn has been involved in international fisheries work for a number of years. The University realizes the potential and value of service in this area, however, without financial support provided by the Grant the present degree of involvement would not be possible. The Grant allowed the Department to maintain and in some instances to increase its international capabilities in inland fisheries and aquaculture.

Grant funds were used to purchase the following personnel:

Personnel Category	Man-Months
Academic	48.4
Secretarial	29.0
Graduate Research Assistants	22.4
Field Labor	47.9

The personnel time purchased with Grant funds contributed significantly to the support of various aspects of the Department's program in inland fisheries and aquaculture. The personnel allowed the Department to do more research, teach additional courses, supervise and advise more graduate students and do a more effective job of extending the Department's special capabilities both within the U.S. and abroad.

The Academic Staff with support from the laboratory technician, secretaries, graduate research assistants and field labor produced 13 major research publications during the year. The graduate research assistants funded from the

Grant conducted research as part of their degree requirements. Three of these research projects were used as sources of data for thesis.

Because of the availability of the staff funded from the Grant, the Department has been able to attract a number of research grants and contracts that it could not otherwise have handled. In the past year the Grant-funded Staff was involved in seven different research projects supported by other than State appropriated University funds. Several of these research projects will result in information that will have direct transferability to developing countries.

Grant-funded Staff taught nine courses (36 quarter-hours of credit) during the year (see page 10). The University paid most of the costs for teaching the courses, but because of the use of the Grant funds, more specialists were available for teaching these courses. Nine courses per 12-month academic year would be approximately a full-time teaching load for one professor if he were supported entirely by University teaching funds. Obviously, a single individual could not adequately teach the wide variety of courses offered. By combining teaching funds and Grant funds into joint appointments, seven different teachers were available to teach the nine courses.

Sixteen students (nine foreign) were admitted to the graduate program in the Department during the year. Grant-funded staff served as major professors for ten of these. Including the new students admitted, 67 graduate students were enrolled in the program at some time during the year.

Seventeen students received advanced degrees during the year. These degrees were awarded as follows:

Nationality of Recipient	Degree Awarded	
	M.S.	Ph.D.
American	9	1
Foreign	4	3
	13	4

Staff employed with Grant funds served as major professors for nine of these students.

The academic personnel time purchased with Grant funds was an important factor in making it possible for the Department to enroll such a large number of graduate students.

The Department offered 40 courses during the year. The distribution of courses and the number of students enrolled are presented in the following table.

Quarter	No. of Courses	Number of Students Enrolled[1]	
		American	Foreign
Summer, 1973	9	55	63
Fall, 1973	10	91	78
Winter, 1974	11	75	55
Spring, 1974	10	55	57
Totals	40	276	253

[1]Students take more than one of the courses each quarter.

V. Utilization of Institutional Resources in International Development

The Department and the International Center played a significant role in international development during the year. Staff employed with Grant funds participated in approximately 4.5 man-months of international service activities. These activities are described in detail in Section III D.

In addition to those activities already mentioned, Auburn provided technical assistance in inland fisheries and aquaculture to four countries. These projects were made possible by AID Mission funded contracts. The countries were: Brazil (AID/csd-2270, T.O. 8), El Salvador (AID/la-688), Panama (AID/la-684) and the Philippines (AID/ea-180). Resident Auburn staff were provided for each of those projects as follows: Brazil (2), El Salvador (1), Panama (1) and the Philippines (2).

The Department and Center provided 9.8 man-months of campus coordination and 3.6 man-months of technical backstopping for the AID-funded country projects.

Approximately 60 visitors representing 15 countries came to Auburn to discuss international development during the year. A list of these visitors is presented in Appendix III. Special tours, demonstrations and seminars were arranged for several of the visitors.

The Department and Center are becoming increasingly involved with the programs of Peace Corps Volunteers. One group of Volunteers from Michigan State University spent several days at Auburn as part of their training program before leaving for their assignments. The staff responded

to a number of requests for information and advice from Volunteers in various developing countries. Auburn staff in El Salvador and the Philippines provided direct assistance and supervision for several Volunteers in those countries.

During the year, Auburn entered into an agreement for cooperative research on breeding schemes for the genetic improvement of edible fish with the Hebrew University of Jersalem in Israel. The project is supported by funds from the United States - Israel Binational Science Foundation.

In the past most of the support for Auburn's efforts in international development has come from AID. In the future more of our work will probably be supported directly by the involved countries themselves. During the year the Department entered into an agreement to provide technical assistance and management for a 1,000-acre fish farm in Mid-Western State in Nigeria, Africa. We will supervise construction of the farm, the production of fish and their processing and marketing. The Mid-Western State government in Nigeria is providing funds for the project. After seven years, the farm will be operated by the State.

Of the 17 students receiving advanced degrees, 8 of them are involved to some degree in international development. All of the foreign students returned to their home country to begin work in fisheries and aquaculture. One American student went to Australia to help develop a shrimp farm.

VI. Other Resources for Grant-Related Activities

The primary purpose of the Grant is to strengthen and support the International Center. All funds received by the Department are for the same purpose. Data on the sources of funds and the amount from each source are presented in the following table.

Source of Funds	Amount
State of Alabama Appropriated Funds	
For teaching	$117,907
For research	108,550
Sales Funds	
For sale of food fish and fingerlings	95,697
Federal Appropriated Funds for Research	
USDA - Land-Grant College funds	67,081
Research Grants from other State Governments	91,097
Research Grants from Federal Agencies	51,899
Research Grants from Private Enterprise	48,851
	$581,082

VII. Next Year's Plan of Work and Anticipated Expenditures

We plan to devote attention to all objectives during the next year. More emphasis will be given to some objectives than others. Following are plans for work on each:

A. Adding to the Competence of the Staff of the Center (Objective I)

We plan to continue to add to the competence of the staff by bringing in new staff members when possible, by changing the composition of the staff somewhat, by encouraging a high level of productivity in their teaching and research efforts, and by up-grading their individual abilities through attendance at scientific meetings, seminars and short-courses.

1. Addition of New Grant-Funded Staff and Changes in Staffing Patterns

The proposed staffing pattern for the coming year is shown below. The staffing pattern for the previous year is shown for comparison.

Staff Category	Proposed Man-Months	1973 - 1974 Man-Months
Academic	45.0	48.4
Secretarial	22.2	29.0
Graduate Research Assist.	18.8	22.4
Field and Student Labor	36.0	47.9

As indicated in the table, levels of staffing will be similar in the coming year to those of the past year. Although the amount of effort will

remain relatively constant, the composition of the Grant funded staff will change considerably. Dr. Boyd (aquatic ecologist) who has been supported on Grant funds for three years will be supported entirely on other funds this year. Dr. J.L. Gaines (fish pathologist) is no longer with the University. Ms. E.W. Scarsbrook (aquatic ecologist), Dr. R.O. Smitherman (aquaculturist) and Dr. M.M. Pamatmat (aquatic ecologist) will receive less support from the Grant. Dr. R. Allison (aquaculturist), Dr. E.C. McCoy (aquacultural economist) and Mr. J.R. Snow (acquaculturist) will be added to the Grant staff.

2. Planned Research Projects

Eight members of the Academic Staff on the Grant will be involved in research projects during the year. Research projects for each staff member are as follows:

Dr. E.W. Shell

Factors affecting the survival and growth of the early life history stages of the striped bass Morone saxatilis.

Dr. R. Allison

Intensive fish culture in recirculating systems--with J. Cabrero (El Salvador)

Dr. W.D. Davies

Management of predator-prey fish populations in small ponds.

Dr. R.T. Lovell

a. Determination of true and apparent digestion coefficients in channel catfish for various classes of natural and modified feed materials--with M. Cruz (Philippines)

b. Essentiality of vitamin C in diets for channel catfish cultured in ponds at different stocking rates--with L. Chhorn (Cambodia)

c. Development of economical artificial feeds for aquarium fishes--with M. Boonyaratpalin (Thailand)

d. Consumer products from deboned flesh from tilapia, channel catfish and buffalofish--with K. Apolinario (Phillupines)

e. Net protein utilization (NPU) by channel catfish of animal protein supplements: catfish waste meal, meat and bone meal and casein--with B. Sirikul (Thailand)

Dr. E.W. McCoy

Processing and marketing technology of channel catfish.

Dr. M.M. Pamatmat

a. Microcalorimetry of sediments in fish ponds

b. Dehydrogenase activity as a measure of anaerobic metabolism in sediments

Ms. E.M. Scarsbrook

a. Factors responsible for phytoplankton die-offs

b. Effects of nutrient additions on phytoplankton communities of ponds

c. Effects of lime on fish production in ponds

Dr. R.O. Smitherman

a. Food conversion, yields and competition of channel catfish, tilapia, buffalofish and Israeli carp in polyculture systems--with R. Pretto (Panama)

b. Comparison of food conversion and yields of hybrid blue x channel catfish crosses with channel catfish receiving supplemental feeding

c. Oral administration of androgens and estrogens for sex reversal in tilapia and channel catfish

R.L. Busch

Management of the reproductive cycle in fish using synthetic hormones.

V.E. Mezainis

Oxidation of organic matter in the bottom sediments of aquaculture ponds.

P.W. Pershbacher

Effect of liming on phytoplankton production in Tilapia ponds.

J.L. Williamson

Polyculture as a means of increasing production in ponds.

3. Teaching Activities

Because of changes in the composition of the Academic Staff, they will be teaching fewer courses in the coming year. Dr. Boyd and Dr. Gaines taught a total of three courses which will not be taught by Grant-funded staff this year. One new course will be taught by the staff. Dr. E.C. McCoy w. is on a joint appointment with this Department and the Department of Agricultural Economics will develop and teach a course in aquacultural economics. This is probably the first course of its type to be taught in the U.S.

The amount of supervision for graduate students will remain more or less constant. The ratio between American and international students is also expected to remain the same.

4. Participation in Meetings, Seminars and Shortcourses

Dr. Shell will visit Israel during the year to discuss co-operative efforts in fish breeding research. He will also visit FAO Headquarters in Rome to discuss Auburn's international aquacultural activities.

Mr. J.R. Snow will attend a Conference on Fish Farming in Europe. Other members of the Grant-funded staff are expected to attend the FAO Conference on Aquaculture in Uraguay. Dr. R.O. Smitherman will attend the meeting of the American Fisheries Society in Honolulu and while there he will observe the latest developments in Macrobrachium culture.

5. International Service Activities

The Grant staff is expected to continue to participate in international service and education and training activities in the coming year. Following is a list of the countries to be visited by the Grant staff during the coming year.

Staff Member	Country	Month
Davies	Peru	September, 1974
Pamatmat	France	September, 1974
Moss	Colombia	October, 1974
Davies	Africa	October, 1974
Smitherman	Colombia	October, 1974
Snow	England	December, 1974
Smitherman	Panama	January, 1975
Shell	Israel	January, 1975
Lovell	Brazil	March, 1975
Moss	Thailand	April, 1975

Visits listed are relatively firmly scheduled. There are several other trips planned tentatively. Most of the trips will provide technical assistance to USAIDs in those countries. A few of the trips are for the purpose of attending relevant international meetings on fisheries and aquaculture.

B. Developing the Library (Objective 2)

Less effort will be spent on Objective 2 this year. Most of the materials that pertain primarily to fisheries and aquacultures that are available have already been purchased and cataloged. Important books and periodicals will be purchased and added to the collection. Primary emphasis will be devoted to materials published during the year.

C. Provide Training and Education Opportunities (Objective 3)

More emphasis will be given to Objective 3 this year. A new course on "Aquacultural Economics" will be developed and taught by Dr. McCoy. This is probably the first course of its type to be taught in this country.

The Graduate Program in Aquaculture is growing steadily. The enrollment is up considerably from last year. This increase in graduate enrollment will require additional effort on the part of the Grant staff especially in the supervision of student research.

A majority of the increase in graduate enrollment is coming from former Peace Corps Volunteers who worked on fisheries projects while overseas. Most of them hope to go back to some developing country to work after they complete their degrees here.

It appears that we will be more involved in non-degree, practical type training next year. For example, there is considerable interest in a number of countries in Africa in sending students here for 3 to 6 months to obtain some coursework and practical training. This type of training is going to require that we develop a different approach to training and education than is generally used in Universities. I expect the Grant staff to play a leading role in developing new approaches to meet these needs.

In the past years most of the foreign students trained have been at the M.S. level. These graduates have returned to their respective countries to work on the technical aspects of fisheries there. Now we are beginning to train a few international students at the Ph.D. level. These graduates are expected to return home to teach in the Universities and Colleges. Hopefully, after a period of time some of the training and education responsibility can be shifted to the Universities and Colleges in the developing countries.

We also expect to begin to develop some training and educational projects this year planned primarily for developing countries. We hope to arrange a seminar in aquaculture in Thailand late in 1975. Much of the planning and development will be done in this year and will involve several of the Grant staff.

We are also planning a shortcourse in aquaculture and fisheries economics to be offered to senior fishery officers in the developing countries. To accommodate the large number that are expected to be interested in the shortcourse it may be necessary to hold more than one. Additional shortcourses might be held in Asia, Africa and South America once the best format is developed.

We are vitally interested in developing some means of providing for the continuing education of persons that are trained at the International Center and that return home. These graduates represent a core of well-trained people scattered throughout the developing world. Hopefully we can find some means of keeping their training current and of utilizing them as a vehicle in helping to provide some training to fellow biologists that have not been to Auburn.

I would hope that this aspect of training and education will be given considerable attention if the Grant is extended beyond July, 1975.

D. Collection of Data of Worldwide Food Fishes (Objective 4)

Relatively little emphasis will be given to Objective 4 this year.

E. Estimated Costs of Project Activities

Many of the activities planned for the year are inter-related; consequently it is difficult to divide costs accurately. Estimates of costs related to research, teaching, libraries, consultation and publications are presented in Table I. Best estimates of costs related to categories in the Grant document are presented in Table II.

An estimate of costs for the coming year related to the specific objectives is as follows:

Objective		Cost
Increasing the competence of the staff		$159,532
1. Core staff support	$100,140	
2. Support of research projects	29,092	
3. International service activities	30,300	
Developing the library		3,100
Providing Training and Educational Opportunities		6,800
Collecting Worldwide Data on Fishes		1,000
		$170,432

Table I

Distribution of 211(d) Grant Funds and Contributions From Other Sources of Funding*

Review Period July 2, 1973 to June 30, 1974

(List all grant related activities)	211(d) Expenditures				Non 211(d) Funding Amount
	Period Under Review	Cumulative Total	Projected Next Year	Projected to end of Grant	
e.g. Research	$39,864.27	411,229.27	125.332.18	536,561.45	$441,082
Teaching	6,800.00	109,015.001	7,200.00	116,215.00	118,000
Libraries	4,933.35	11,923.48	3,100.00	15,023.48	1,000
Consultation	31,610.18	67,982.18	30,300.00	98,282.18	12,000
Publication	2,760.80	12,850.16	2,500.00	15,350.16	5,000
Other	2,443.46	16,567.73	2,000.00	18,567.73	4,000
TOTAL	$188,412.06	$629,567.82	$170,432.18	$800,000.00	$581,082

* These figures are your best estimates

Table II

Expenditure Report

(Actual and Projected)

Under Institutional Grant #AID/csd - 2780

Review Period July 1, 1973 to June 30, 1974

(Line Items to Conform to Budget in Grant Document)	Expenditures to Date		Projected expenditures Year				Total
	Period Under Review	Cumulative Total	2	3	4	5	
e.g. Salaries	86,665.96	282,743.57			$100,140.20		$382,883.77
Travel	13,420.18[1]	24,054.57			5,000.00		29,054.57
Equipment	4,471.75	13,981.99			2,000.00		15,981.99
Personnel benefits	11,550.09	32,362.57			17,023.80		49,386.37
Graduate Research Assistants	19,392.50	59,525.34			13,560.00		73,085.34
Supplies, Library and Other	52,911.58[2]	216,899.78			32,708.18		249,607.96
Total	188,412.06	629,567.82			170,432.18		$800,000.00

[1] This budget category is itemized in Appendix IV

[2] This budget category is itemized in Appendix V

Appendix I. Summaries of Research Projects Conducted by Grant-Funded Academic Staff and Graduate Research Assistants

E.W. Shell

Survival of striped bass fry was enhanced by increasing the salinity of the water flowing through the culture jars to 5 ppt as compared to survival of fry cultured in water with 1 ppt salinity. Growth was not affected by increasing the salinity. Striped bass fry receiving either brine shrimp alone or brine shrimp plus dry feed grew at a faster rate than fry receiving only dry feed.

Survival of striped bass fry in ponds was significantly increased by adding salt to raise the salinity to 1 ppt. Survival of fingerlings was also increased by the addition of salt to culture ponds.

C.E. Boyd

Decaying aquatic plants were used as the only sources of nitrogen in cultures of the alga Scenedesmus dimorphus. Decaying phytoplankton (Microcystis, Anabaena, and Euglena) and a decomposing macrophyte (Najas) supported the best algal growth. Decomposition of two macrophytes, Typha and Eichhornia, supported little algal growth, while intermediate growth of S. dimorphus was obtained in cultures with decaying Elodea and Spirogyra. The suitability of decaying plants as sources of nitrogen was generally

greater in plants with higher nitrogen contents. Insufficient nitrogen was mineralized from muds to produce significant growth of S. dimorphus in the cultures.

Bioassay procedures were used to test the effectiveness of muds as sources of phosphorus for algae. One portion of each mud was limed with enough $Ca(OH)_2$ to raise the pH to 6.5. The second portion of each mud was not limed. Various amounts of phosphorus were applied to each limed and unlimed sample. The availability of phosphorus to algae from the limed muds was much greater at almost all levels of added phosphorus.

The effectiveness of four liming agents (calcitic limestone, dolomitic limestone, basic slag and calcium hydroxide) and gypsum in increasing the total hardness and total alkalinity of water and neutralizing the acidity of pond muds was tested in plastic pools. When added in quantities sufficient to satisfy the lime requirements of the muds, all four liming agents increased total hardness from about 12 mg/1 to around 40 or 50 mg/1. Total alkalinity increased from about 20 mg/1 to around 50 or 60 mg/1. The initial pH of the muds was 5.6 and the liming agents caused values to increase by 0.9 to 1.4 pH units. The pH of the waters increased to above 11 for more than one week following application of calcium hydroxide. This pH would be toxic to fish. Immediately after liming, the pH of the waters in pools treated with limestone and slag increased to slightly above 9, a pH level not harmful to pond fish. Applications of gypsum caused an increase in total hardness to about 300 mg/1, had no influence on total alkalinity, and did not neutralize the acidity of muds.

Concentrations of organic matter in bottom muds from 145 ponds varied from 0.77 to 9.66%. Nitrogen values for these ponds ranged from 0.08 to 0.63%. Amounts of organic matter and nitrogen were considerably higher than quantities usually found in agricultural soils of Alabama. However, it is doubtful that enough organic nitrogen is present in ponds for the mineralization of this nitrogen to supply adequate nitrate and ammonia to allow reduction in the nitrogen application rates for ponds. Ponds which had moderate or poor growth of phytoplankton contained muds which were low or very low in soil-test phosphorus. About 1/2 of the ponds with adequate phytoplankton blooms had muds with medium or higher levels of soil-test phosphorus, while the other ponds in this group tested low or very low with respect to phosphorus. All ponds with adequate blooms received additions of phosphorus. The relationship between soil-test phosphorus in the muds, phosphorus additions, and adequate phytoplankton blooms suggest the need for research on the use of soil-test procedures to calculate the proper application rates for phosphorus to ponds.

R.T. Lovell

A pond feeding experiment was conducted with channel catfish to measure the effects of three levels of dietary protein each fed in an all-plant diet, a diet containing one-sixth fishmeal protein, or a diet containing one-third fishmeal protein on growth, uniformity of size, dressing percentage and body composition. The experiment was conducted in 0.1-acre earthen ponds

each stocked with 300 channel catfish using 9 formulated feeds and 3 replications per feed.

The results showed that at this stocking density and feeding schedule an all-plant feed gave satisfactory catfish production. The medium (36%) protein diet is perhaps the best of the all-plant diets because the yield was nearly equal to that of the high (43%) protein plant diet but the cost per pound of catfish was nearer to that of the low (29%) protein diet.

The medium (36%) protein diet containing one-sixth of the protein as fishmeal appeared most desirable when present cost of ingredients is considered. Average yield with this feed was 2,868 pounds per acre, 96% of the fish were of harvestable size at draining and the feed cost per pound of gain was next to the lowest for the nine experimental feeds.

Increasing the fishmeal to the highest level, one-third of the protein, showed a significant response at the lowest total protein percentage (29%) but not at the two higher protein levels. Dressing percentage increased slightly as protein level in diets increased in the all-plant and high fishmeal feeds. There was essentially no difference in dressing percentage among fish fed the three low fishmeal diets.

Body fat was not greatly affected by the level or type of protein in the diets. The high protein fishmeal diets may have produced slightly leaner fish. Source of energy in the diets did not affect the fat content of the fish appreciably. The ratio of protein to energy in the feed did not greatly affect the fat content of the fish over the range used in this study.

Experiments were conducted to determine the effect of forage fish as a protein supplement for pond cultured channel catfish fed an all-plant diet (36% protein). Average yield of catfish per acre was 2,455 pounds on the all-plant diet, 2,110 pounds where the fathead minnow was the forage species, 2,810 pounds where tilapia (aurea) was the forage species and 2,868 pounds where the all-plant diet was supplemented with one-sixth of the protein as fishmeal. The increased yields with tilapia may result from predation by catfish on young tilapia and improved water quality resulting from tilapia feeding on plankton, manure and other forms of organic matter. The fathead minnow was a poor forage fish for channel catfish. Threadfin shad was a better forage species than the fathead minnow but was not as desirable as tilapia.

A swine feeding study indicated that catfish waste meal was at least equal to meat scrap (meat and bone) meal as a source of animal protein as evidenced by gains of swine on production type rations. The catfish waste meal did not affect flavor of the meat or carcass quality.

Catfish waste meal is also a satisfactory source of animal protein for catfish feeds. When it comprises a high percentage of the feed formula it is equal to fish meal; however, when it supplies 12% or less protein to the diet it is slightly inferior to fish meal.

The Protein Efficiency Ratios (PER, which is a biological index of protein quality) of catfish waste and other protein sources determined with fingerling channel catfish showed the following rank in descending order

of protein quality: 1) marine fishmeal; 2) pasteurized catfish waste (non-dried); 3) casein; 4) catfish waste meal; 5) meat scrap (meat and bone) meal.

M.M. Pamatmat

Benthic research on sampling, anaerobic metabolism, microbial biomass distribution, and methods of measuring these in culture ponds was started in 1973. A sediment sampler was developed. A sensitive calorimeter has been set up for measuring very low rates of metabolic heat release. Dehydrogenase activity, a measure of microbial anaerobic metabolism in pond muds, was found to be correlated with concentration of adenosine triphosphate in sediments, a measure of benthic biomass. Technical problems associated with measurements of both dehydrogenase activity and adenosine triphosphate were investigated.

R.O. Smitherman

A comparison of morphometric characteristics of channel catfish from seven different geographical locations was completed on fishes reared under the same environmental conditions at the Southeastern Fish Cultural Laboratory (USDI) and Auburn University Fisheries Research Unit. Highly significant differences existed among strains for all measurements except caudal peduncle width. Strong divergence between these geographically separated strains of channel catfish was indicated. Two of the non-domesticated strains exhibited a large degree of variability with respect to those characteristics having potential use in selective breeding for commercial applications.

An experiment on growth, survival and production of five strains and two crosses of channel catfish, begun in 1972, was completed in 1973. Survival, production, average size at harvest and food conversion was best in the non-domesticated group from the Rio Grande River. This was followed by two strain crosses involving domesticated lines. Production of three domesticated groups apparently descended in inverse relation to the years subjected to inbreeding. A non-domesticated strain from the Warrior River in Alabama, although ranking high in survival, was the least productive of all lines tested.

W.D. Davies

Several stocking procedures designed to produce larger than average bluegill (greater than 0.25 lb) in bass-bluegill ponds are presently being considered. Increasing predation pressures in ponds by overcrowding the bass can limit survival of young-of-the-year bluegill when fingerling bluegill are stocked at the recommended rate of 1,000 - 1,500 per acre. This allows for a maximum or near maximum rate of growth for bluegill. Optimum rates of harvest have not been determined; however, the overcrowded bass-bluegill combination presently being studied has continued to produce good fishing (bluegill > 0.30 lb) when the catch was limited to not more than 25 lbs of bass and 75 lbs of bluegill per acre per year, or approximately one-half the allowable harvest from "balanced" populations.

Stocking 2 - 3 pairs of adult bluegill per acre with fingerling or adult bass in a recently drained or poisoned pond usually results in an overcrowded,

and subsequently stunted, bluegill populations. Without density dependent factors operating to suppress bluegill reproduction, more bluegill are produced than can possibly grow to a harvestable size; the pond is overcrowded from the very beginning. Stocking large numbers of fingerling bass (300 per acre) does not provide sufficient predation pressure to alleviate overcrowding. Also it is unlikely that stocking additional fingerling bass will correct the situation. Past experience has shown that fingerlings stocked at a rate of 400 per acre will compete with bluegill for food.

Channel catfish are highly regarded in the Southeast. Nutritional requirements and feeding rates have been established for intensive culture of channel catfish; however, with recent increases in costs for feed ingredients, some recommendations are no longer practical. This is especially true for recommended protein levels and the desired proportion of protein to come from animal sources. One method for providing protein in intensive culture would be to establish minnow populations as forage. Forage populations, however, often disappear under predation pressure. One 5.2-acre pond was stocked with 2,000 channel catfish per acre and a variety of forage species (tilapia, threadfin shad).

A dense population of threadfin shad was established by stocking shad at the same time as catfish. Some tilapia survived the winter of 1971 - 1972, but had to be restocked in 1973. Catfish used both species as food. Of the 2,162.3 lbs per acre present at draining, 387 lbs or 17.9 per cent was shad. Threadfin shad are able to maintain high population numbers under catfish predation.

J.L. Gaines

Preliminary evaluation was made of the potential of the drug clomiphene citrate for advancing oogenesis in channel catfish. Under laboratory conditions, the chemical which has been used to ovulate goldfish in suboptimal temperature conditions, had no effect on gonadal development of the catfish.

The job on anatomical and histological description of the channel catfish was continued (MO. PL 88-309). Over 500 titles have been obtained in the review of literature. The skin from 22 channel catfish was taken from different areas of the body and sectioned. A description of the skin was prepared. The blood hematocrit picture of channel catfish remained relatively unchanged throughout the year. A sample of 27 males had an average value of 40 ± 10 and 32 females had an average value of 21 ± 10. The musculature and skeletal system of channel catfish were described.

R.L. Busch

Survival of juvenile Asiatic clams was so poor in concrete ponds that the planned experiment was terminated in its early stages. Survival of adult clams was much better; although the presence of an unidentified snail in one concrete pond seemed to be related to an unusual die-off of adult clams in that pond. Clams did not reproduce in the concrete ponds.

R.E. Buttermore

An experiment on intensive culture of channel catfish in combination with tilapia in pens was carried out to determine optimal stocking rate and to

study the apparent importance of natural water circulation through the pens. Channel catfish mortality increased with stocking rate, but the number of surviving fish was still higher at a stocking rate of 800 per pen than at 600 or 400, and net production was directly proportional to the number of survivors. There was an inverse correlation between catfish and tilapia production, but this apparent competitive interaction may simply be the result of more food being available to tilapia as catfish production descreased.

C. McVea

An experiment was conducted to determine the effect of four levels of water hyacinth (Eichhornia crassipes (Mart.) Solms) coverage on phytoplankton, production of a filter-feeding fish, Tilapia aurea, and water quality. The experiment was carried out in a series of twelve earthen ponds approximately 0.1 acre (0.04 ha) in size. Four treatments consisting of four levels of water hyacinths maintained at surface area percentages of 0.0, 5.0, 10.0 and 25.0 were replicated three times. T. aurea were stocked at a rate of 1,000 fish per acre (2,470/ha). The ponds were fertilized at two-week intervals from February 5 to September 9, 1973, at an equivalent rate of 80 pounds of 20-20-0 (N, P_2O_5, K_2O) per acre per application.

Accumulated standing crops for water hyacinths maintained at surface area percentages of 5.0, 10.0 and 25.0 were 2,584.0, 2,243.0 and 1,971.0 g/m^2 dry weight.

Weekly and biweekly sampling of phytoplankton revealed a decrease in average chlorophyll a concentrations from 56.46 ug/1 (0.0% coverage) to

14.42 ug/1 (25.0% coverage). Decreasing concentrations of chlorophyll a in the presence of increasing quantities of water hyacinths corresponded to a similar decrease in phytoplankton numbers. The phytoplankton population in ponds with 0.0% and 5.0% coverage was primarily composed of the Chlorophyta, while the Chrysophyta was abundant in the presence of increasing quantities of hyacinths. Calculated values for species diversity indicated a variety of individuals present in each treatment.

Total fish and tadpole production was positively correlated with gross primary productivity and chlorophyll a concentrations, giving r values of 0.93 and 0.86 respectively. There was a progressive decrease in average fish and tadpole production from 1,004.0 kg/ha (0.0% coverage) to 351.6 kg/ha (25.0% coverage).

Appendix II. List of Publications Resulting from Research Activities of Grant-Funded Staff

C.E. Boyd

Amino acid composition of freshwater algae. Arch. Hydrobiol. 72(1): 1-9.

Biotic interactions between different species of algae. Journal of the Weed Science Society of America, Vol. 21(1): 32 - 37.

The chemical oxygen demand of waters and biological materials from ponds. Trans. of the American Fisheries Society, Vol. 102(3): 606 - 611.

Summer algal communities and primary productivity in fish ponds. Hydrobiologia, Vol. 41(3): 357 - 390.

W.D. Davies

The effects of total dissolved solids, temperature, and pH on the survival of immature striped bass: a reponse surface experiment. The Progressive Fish-Culturist, Vol. 35(3): 157 - 160.

Managing small impoundments and community lakes. Proc. S.E. Assoc. of Game and Fish Commrs., 27th Annual Meeting, 1973. 20 pp.

Rates of temperature acclimation for hatchery reared striped bass fry and fingerlings, Morone saxitillis (Walbaum). Progressive Fish-Culturist, Vol. 35(4).

R.T. Lovell

Absorption by channel catfish of earthy-musty flavor compounds synthesized by cultures of blue-green algae. Trans. of the Am. Fish. Soc., Vol. 102(4): 774 - 777. (with Lewis A. Sackey).

Catfish need Vitamin C. Highlights of Agricultural Research, Vol. 20 (2). Agricultural Expt. Station, Auburn University. 1 p.

Environment-related off-flavors in intensively cultured fish. FAO Technical Conference on Fishery Products, FII: FP/73/E-46. 7 pp.

Essentiality of Vitamin C in feeds for intensively fed caged channel catfish. Journal of Nutrition, Vol. 103(1): 134 - 138.

Put catfish offal to work for you. Fish Farming Industries, October - November, 1973. 3 pp.

Vitamin C ... and crooked back disease. The Catfish Farmer, Vol. 5(3): 31 - 32.

Appendix III. List of Visitors Seeking Information on International Development

Malcolm C. Johnson, Jr. Delta Farm Fisheries P.O. Box 126 Tillar, Arkansas 71670	July 2, 1973
Pedro Godoy I. Incubadoras Protinal, C.A. Valencia, Venezuela	July 18, 1973
John Hummon Agency for International Development Washington, D.C.	July-20, 1973
Felipe Almeda Cruz, Jr. P.O. Box 3418 Manila, Philippines	August 13, 1973
Manuel F. Cruz P.O. Box 3418 Manila, Philippines	August 13, 1973
C.F. Wiedeman, Jr. Thomas H. Miner and Associates, Inc. 903 Oregon Trial Cincinnati, Ohio 45215	August 15, 1973
Wiang Chuapoehuk College of Fisheries Kasetsart University Bangkok, Thailand	August 26 - 29, 1973
Chertchai Amatykul Director Inland Fisheries Division Department of Fisheries Ministry of Aquaculture Bangkok, Thailand	September 4 - 14, 1973

Tupan Ferreira de Souza
Coordenador Geral Do Banco De
Desenvolvimento Do
Rio Grande Do Norte
Leone State in Natal
Brazil — January 25 - 27, 1974

Erildo Moneiro, Jr.
Rua General Osorio, 203-59000
Natal, Rio Grande Do Norte
Brazil — January 25 - 27, 1974

Mr. T.C. Niblock
Director
USAID/Philippines
APO San Francisco 96528 — February 14 - 15, 1974

Hon. E.K. Clark
Minister of Finance
Hon. B.B.E. Idigbe
Minister of Economic Development
and Reconstruction
Hon. B.O.W. Mafeni
Minister of Agriculture and
Natural Resources
C.I. Oshogwe
Mid-Western Farms
Chief E.A.A.E. Wepke, Fisheries Officer
Dr. I.M. Okonjo
Secretary to the Military Governor
O.O. Uzzie
Permanent Secretary of Agriculture
Mid-Western State, Nigeria — February 20, 1974

Joe Akintoba
Joe Simpkins
Roy Blanton, Sr.
Roy Blanton, Jr.
Tiffany Industries
100 Progress Parkway
Maryland Heights, Missours — February 20, 1974

Steven E. Anderson
Fisheries/PTR
% American Embassy
B.P. 697
Kinshasa, Zaire, Africa — March 18 - 22, 1974

Peter I. Tack E.W. Roelofs Micigan State University East Lansing, Michigan	March 20 - 21, 1974
Hans Ackefors Fil. Dr, Docent Havsfiskelaboratoriet Institute of Marine Research S-45300 Lysekil Sweden	March 21 - 22, 1974
Rosie Evans Biological Station University of Bergen Blomsterdalen, Norway	March 26 - 27, 1974
Sergio Fernando Gonzalez Berrido Director School of Fisheries and Food Technology Catholic University Valparaiso, Chile	March 30, 1974
Randy Martin Fred Bell Charles Rockwood Kirshna Kumar Florida State University Talahassee, Florida	April 18, 1974
Daniel W. Bromley Office of Agriculture Agency for International Development Washington, D.C.	April 18, 1974
Glenda Baxder Bonnie Kranzer Manly Johnson Randy Martin Florida State University Talahassee, Florida	May 2 - 3, 1974
David Hughes Oklahoma State University Stillwater, Oklahoma	May 13 - 16, 1974

Frederick J. Laney
International Training Officer
National Oceanic and Atmospheric Adm.
Rockville, Maryland 20852 — Mary 20 - 23, 1974

Paul F. Randel
Animal Nutritionist
Agric. Exper. Station and
College of Agriculture
Mayaguez Campus
University of Puerto Rico
Puerto Rico

Baudelio Gonzalez Bermudez
CIFSA
Rosario, Sinaba
Mexico — June 13 - 14, 1974

L.A.E. Angel Brito Guthierrez
Baseball No. 189 Esq. Nadadores
Mexico 21, D.F. — June 13 - 14, 1974

Ignacio Salinas Arce
CIFSA
Consultores
Peten 543, Col Narvarte
Mexico, D.F. — June 13 - 14, 1974

Y.A. Tang
Fisheries Officer
Fisheries Resources Improvement Service
Fisheries Department
FAO/Headquarters
Rome, Italy — June 14 - 25, 1974

Thomas R. Parks
Food and Plant Sciences Department
Stanford Research Institute
333 Ravenswood Avenue
Menlow Park, California 94025 — June 25, 1974

Mitsutake Miyamura
Japan Air Lines
Consultant for Trade Development
Specialist of Marine Product Industry
929 Andrew Circle
Panama City, Florida 32401 — June 26, 1974

J.J. Sabaut
Fish Nutritionist
Centre National de Recherches Zootechniques
Station de Recherches de Nutrition
Domaine de vilvert
France — September 5 - 6, 1973

T.A. Irabagon
Central Luzon State University
Neuva Ecija
Philippines — September 18, 1973

Kenneth Lightburn
Aquaculture Int.
P.O. Box 180 Plympton
South Australia 5038 — September 20, 1973

Yolanda E. de Melara
Secretary - Program Office
USAID/El Salvador — October 21 - 23, 1973

Charley Shiraishi
Agricultural Programs Office
U.S. Peace Corps
7th Floor Cardinal Building
Herran Cor. F. Agoncillo Street
Manila, Philippines — October 22 - 23, 1973

Pinit Sihapitukgiat
Khon Khaen Fisheries Station
Khon Khaen, Thailand — January 3 - 6, 1974

D.K. Villaluz
Antonio Villaluz
Alfredo Santiago
College of Fisheries
Mindanao State University
Philippines — January 25 - 28, 1974

Paulo Fernando de Oliveira Burgos
Chefe Da Divisao De Recursos Pesqueiros
Da Sudene
Leone State in Recife
Brazil — January 25 - 27, 1974

Jun Ikeda
President
Yokohama Fish Center Co., Ltd.
318 Okazawa-Cho Hodogaya-Ku Yokohama
Japan
June 26, 1974

Sakae Terada
Japan Air Lines
Assistant Manager
Cargo Sales Development Division
Tokyo Building
2-Chome, Marunouchi
Chiyoda-Ku, Tokyo
Japan
June 26, 1974

Jiro Tanaka
Aquaculture Biologist
Chief Researcher
Tokai Regional Fisheries Research Lab.
Nagai Yokosuka, Japan
June 26, 1974

Appendix IV. Itemized List of Travel on Grant Funds

DATE	STAFF	COUNTRY	COST
6/11-6/22/73	W.D. Davies	Guatemala	$ 609.41
(Requested by U.S.A.I.D. Mission to survey Lake Izabal)			
6/14/73	D.D. Moss	Atlanta, Ga.	9.00
(To attend conference with 211-d Institution Recipients)			
6/15-9/24/73	M.M. Pamatmat	Scotland, Germany, Sweden, Norway	1,400.01
(Travel abroad to Scotland, Germany, Sweden, Norway to review aquacultural research)			
7/1-7/3/73	R.O. Smitherman	Mexico City	353.00
(To attend meeting sponsored by American Association for The Advancement of Science)			
7/15-7/16/73	D.D. Moss	Washington, D.C.	169.92
(To confer with U.S.A.I.D. officials)			
9/3-9/15/73	Chertchai Amatyakul	Honolulu/Auburn/ Honolulu	635.93
(To consult with the Director of International Center for Aquaculture regarding the possibility of the Center to co-sponsor with Thai Fisheries Dept. an international Workshop on aquaculture to be held in Thailand in 1974)			
9/6/73	Ray Allison	Tifton/Quitman, Ga.	16.15
(To escort Mr. Chertchai Amatyakul, Director of Inland Fisheries Division in Thailand, to view raceway culture)			
9/12-10/18/73	Ray Allison	Philippines and Bangkok, Thailand	201.08
(To conduct survey assessing aquaculture development of Bicol River Development Project as requested by U.S.A.I.D./ Philippines and a brief stopover in Bangkok to consult with U.S.A.I.D. officials relative to new project agreement)			

DATE	STAFF	COUNTRY	COST
10/7-10/21/73	D.D. Moss		$ 35.12
(Reimbursement for incidental expenses incurred in connection with travel of seminar speakers and international students)			
10/22-11/3/73	E.W.Shell	Philippines	1,520.15
(Requested by U.S.A.I.D.)			
10/28-10/30/73	D.D. Moss	Providence, R.I.	238.73
(To review the program of the International Center for Marine Resources Development)			
11/4-11/5/73	D.D. Moss	Washington,D.C.	172.37
(To confer with U.S.A.I.D. officials)			
11/29-11/30/73	Raymond Johnson		138.89
(To reimburse Dr. Raymond E. Johnson, President of The American Fisheries Society for expenses incurred from Washington, D.C. to Auburn and return to Washington, D.C. to present seminar to Fisheries Graduate Students and present a conference on the National Science Foundation Program to faculty and staff)			
12/2-12/18/73	R.T. Lovell	Tokyo, Japan Seattle, Washington	1,617.00
(To attend Fisheries Product Conference sponsored by FAO and confer with field staff and attend Fish Technology conference in Seattle, Washington)			
12/12-12/14/73	Rob Busch	Yazoo City, Miss.	62.50
(To escort official visitors from Bogota, Colombia (Alfredo Acero and Donald R. Swift) to observe commercial fish culture and fish processing)			
1/10-1/11/74	R.T. Lovell	Washington, D.C.	184.77
(To participate in symposium and demonstration of new fish technology methods)			
1/11/74	Jon G. Stanley		118.54
(To reimburse Dr. Jon G. Stanley, Fisheries Biologist from Stuttgart, Ark. for travel to Auburn to present seminar to Fisheries Graduate Students)			

DATE	STAFF	COUNTRY	COST
4/7-4/11/74	J.S. Dendy	Baton Rouge, La	$ 198.80
(To attend Second International Crayfish Symposium)			
4/15-4/17/74	Ray Allison	Baton Rouge, La.	75.00
(To participate in "Symposium on Diseases of Aquatic Animals of The Gulf Coast Region")			
4/15-5/4/74	Malcolm Johnson	Various states	552.00
(Travel expenses incurred visiting commercial fish farms, research laboratories, feed mills, processing plants and equipment dealers)			
4/16/74	D.D. Moss	Washington, D.C.	150.02
(To confer with U.S.A.I.D. officials)			
4/29-5/6/74	W.D. Davies	Aviemore, Scotland	940.61
(Symposium on Methodology for the Survey, Monitoring and Appraisal of Fishery Resources in Lakes and Large Rivers)			
5/7-5/23/74	Malcolm Johnson	Various states	627.34
(Travel expenses incurred visiting commercial fish farms, research laboratories, feed mills, processing plants and equipment dealers)			
5/13-5/15/74	David Hughes		213.95
(Expenses for travel from Stillwater, Oklahoma to Auburn and return to Stillwater, Oklahoma relative to position as Fishculture Extension Specialist (El Salvador) and to consult with staff regarding Central America Fisheries)			
5/22/74	E.W. Shell D.D. Moss E.W. McCoy	Washington, D.C.	423.81
(To confer with U.S.A.I.D. officials)			
5/31-5/9/74	R.O. Smitherman Malcolm Johnson	Haifa, Israel	448.00
(Advance per diem for travel to Haifa, Israel to attend International Symposium on Mullets and their Culture)			
6/11-6/13/74	R.T. Lovell	Boston, Mass.	290.05
(To attend workshop on fish deboning processes)			
			$13,420.18

DATE	STAFF	COUNTRY	COST
1/20-1/25/74	D.D. Moss	Charleston, S.C.	$ 230.04
(To attend World Mariculture Society meeting)			
1/21-1/25/74	Dallas Alston	Charleston, S.C.	108.48
(To present paper at World Mariculture meeting)			
2/6-2/7/74	D.D. Moss	Washington, D.C.	176.77
(To confer with U.S.A.I.D. officials)			
2/21/74	E.W. Shell D.D. Moss	Washington, D.C.	270.24
(To confer with U.S.A.I.D. officials and Sen John Sparkman)			
2/25-2/26/74	D.D. Moss	Washington, D.C.	185.02
(To confer with U.S.A.I.D. officials			
2/27-3/1/74	R.O. Smitherman	Ft. Valley, Ga.	56.25
(To present paper at Ft. Valley State College)			
2/27-3/1/74	R.O. Anderson		201.55
(Reimburse for travel to Auburn from Columbia, Mo. to present seminar to Fisheries Graduate students)			
3/4-3/8/74	M.M. Pamatmat	Oklahoma City, Ok.	278.76
(To attend conference on the use of wastewater in the production of food and fiber)			
3/21-3/22/74	M.M. Pamatmat	Dauphin Island, Ala.	94.08
(To confer with Dr. George Crozier at Dauphin Island, Ala. Sea Lab. and Edwin May at Ala. Marine Resources Laboratory)			
3/21-3/30/74	D.R. Bayne	Washington, D.C. Morocco	309.28
(Survey aquatic plants in large reservoirs as requested by U.S.A.I.D./Morocco)			
3/28-3/29/74	J.L. Williamson Richard Pretto	Stuttgart, Ark.	104.06
(To obtain experimental fish for research)			
3/29/74	D.D. Moss	Tifton, Ga.	3.50
(To observe trout raceway cultures)			

Appendix V. Itemization of "Supplies, Library, and Other" Category from Table 1

Items	Amount
Hourly field and student labor	17,664.40
Library	4,933.35
Expendable research and office supplies	11,581.68
Telephone and telegraph	4,759.08
Entertainment of guest	15.69
Freight and express charges	190.49
Electricity	26.29
Vehicle maintenance and operation	993.87
Printing and binding	2,760.80
Fees for course attended by senior staff	98.00
Repairs to research and office equipment	347.64
Equipment rental	7,460.16
Services required in support of grant activities	2,004.13
Other general expenses	76.00
	52,911.58