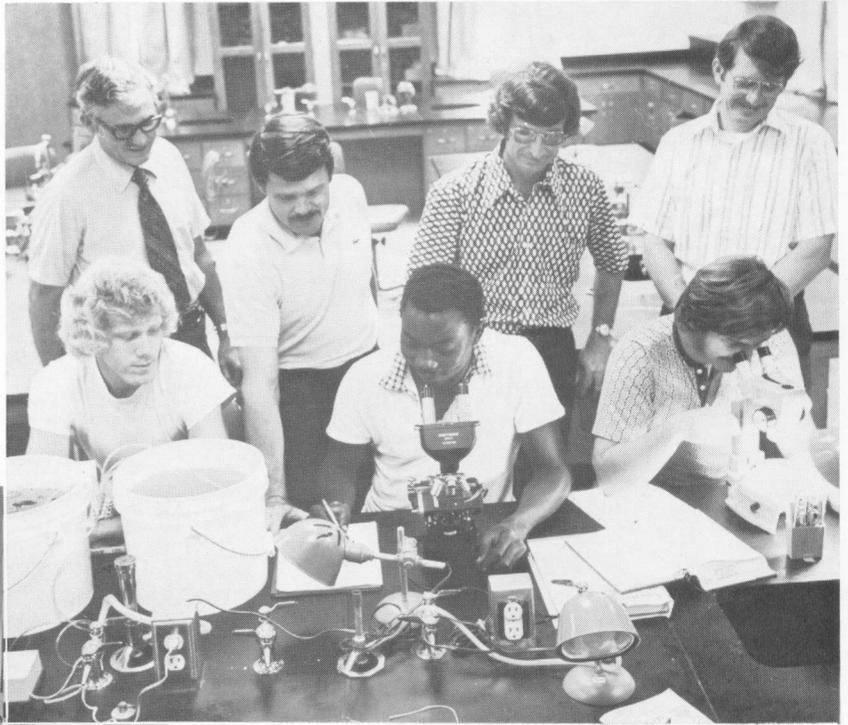


Annual Report for FY 1973



# The International Center for Aquaculture

AGRICULTURAL EXPERIMENT STATION / AUBURN UNIVERSITY  
R. Dennis Rouse, Director Auburn, Alabama



**ABOVE:** Dr. E. W. Shell, Head, Department of Fisheries and Allied Aquacultures, and faculty members D. R. Bayne, R. O. Smitherman, and W. D. Davies make unannounced visit to teaching laboratory where students are examining fish for parasites. **LEFT:** Drs. E. W. Shell and D. D. Moss, Director and Assistant Director, International Center for Aquaculture, examine a new publication on an international fisheries project. **BELOW:** Dr. D. D. Moss orients foreign graduate students from Thailand, Panama, El Salvador, and the Philippines upon their arrival to campus.



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# ANNUAL REPORT FOR FY 1973

## The International Center for Aquaculture

**T**HE INTERNATIONAL CENTER FOR AQUACULTURE was established June 25, 1970, at the Auburn University Agricultural Experiment Station, under authority contained in Section 211 (d) of the Foreign Assistance Act of 1961. The grant (AID/csd 2780) was for the purpose of implementing the project, "To Strengthen Specialized Competency in Aquaculture," under the agreement signed June 25, 1970, by Dr. John H. Hannah for USAID and President Harry M. Philpott for Auburn University.

The following objectives were considered of primary importance in strengthening the competence of the Center.

1. To add experts in selected fields to the faculty.
2. To assemble a library of worldwide literature on aquaculture and develop more effective methods for dissemination of this information.
3. To provide educational opportunities in aquaculture for personnel of AID and other governmental agencies and private foundations, for students interested in international development, and for foreign participant training.
4. To develop a worldwide collection of data on food fishes and other aquatic organisms that appear suitable for culture.

### BACKGROUND AND PURPOSE OF GRANT

Aquaculture is becoming increasingly important to developing countries by providing a significant part of the protein needed for more adequate diets and making an important contribution to economic growth. An important advantage of aquaculture is that it utilizes infertile lands and runoff waters, along with agricultural wastes and surpluses, to intensively grow crops of high quality proteins in the form of fish and other aquatic animals. This greatly increases the ability of each country to supply the protein locally where it is most needed, thus reducing the cost of transportation, processing, and refrigeration, while providing additional needed income and employment for farmers.

Auburn University has committed itself to assist developing nations as they apply improved methods of aquaculture to develop and increase supplies of high quality protein and improve their economic well-being. No other American University has the capability of providing this type of assistance as does Auburn University, which has gained worldwide recognition for its leadership in warm-water fisheries generally and aquaculture specifically.

Growth of the research and training programs at Auburn has been rapid and a broad base of competency has been

developed in aquaculture. Much of the available funding has required special emphasis on problems at the state, regional, and national levels, however, and cannot adequately support the needed international dimensions of the University's program.

This Grant is utilized by Auburn University to strengthen its research, teaching, consultation, and other service capabilities in aquaculture. As a consequence, more significant contributions can be made in developing aquaculture as an effective means of improving nutrition and contributing to the economic growth of developing nations around the world. In addition, the Grant is used to develop methods and procedures by which the University's competence in aquaculture is more readily available for those who need it.

### PERSONNEL ON THE PROJECT

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

<i>Name</i>	<i>Position</i>	<i>Man-months</i>
Dr. H. S. Swingle	Director (July 1, 1972- May 20, 1973)	6.2
Dr. E. W. Shell	Director May 21, 1973- June 30, 1973)	2.1
Dr. C. E. Boyd	Associate Professor	7.8
Dr. R. T. Lovell	Associate Professor	3.2
Dr. W. D. Davies	Assistant Professor	7.4
Dr. J. L. Gaines	Assistant Professor	6.6
Ms. E. W. Scarsbrook	Research Associate	12.0
Ms. M. A. Hodgkins	Laboratory Technician A	1.6
Ms. P. Argo	Typist	2.5
Ms. E. C. Talley	Typist	12.0
Mr. D. E. Alston	Graduate Research Assistant	1.3 <sup>1</sup>
Mr. R. L. Busch	Graduate Research Assistant	4.0
Mr. R. E. Buttermore	Graduate Research Assistant	1.6
Mr. R. K. Goodman	Graduate Research Assistant	2.3
Mr. J. P. Hawke	Graduate Research Assistant	1.3
Mr. J. D. Grogan	Graduate Research Assistant	2.8
Mr. W. L. Lane	Graduate Research Assistant	2.3
Mr. J. W. Miller	Graduate Research Assistant	0.7

<sup>1</sup> Graduate research assistants are generally expected to spend  $\frac{1}{3}$  time on activities related to their stipend and would not contribute more than 4.0 man-months to a project in a year.

## ACCOMPLISHMENTS DURING THE YEAR

### Research Activities

All Grant-funded personnel participated in research projects during the year. Summaries of results obtained from these projects are reported.

#### Aquaculture

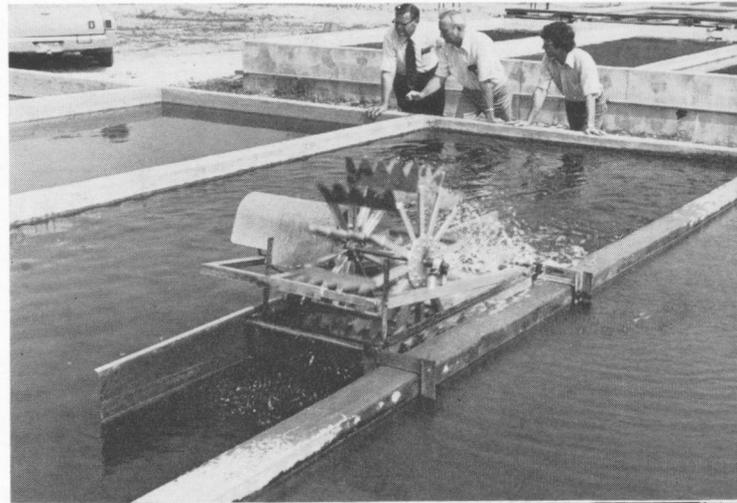
*Tilapia aurea* was stocked at 5,000 per acre with 300 large-mouth bass fry in a split-stocking and fed Auburn No. 3 pelleted feed. Production was 2,121 pounds harvestable fish, including 129 pounds harvestable bass, per acre in 200 days. Net weight gain was 14.27 pounds per day (Swingle).

Striped bass (*Morone saxatilis*) fry cultured in hatching jars and fed brine shrimp the first 18 days followed by a 4-day or 12-day transition to dry feed grew faster than fry receiving brine shrimp throughout the culture period. Effects of increased sodium chloride concentrations on fry survival was studied using twelve, 0.10-acre earthen ponds. Six of the 12 ponds received applications of rock salt to increase the sodium chloride concentration. Mean survival was significantly higher in ponds with increased sodium chloride (Shell).

Reproduction of the Asiatic clam (*Corbicula*) was noted in 20 of the 24 pools comprising five treatments, with rate of reproduction estimated as high as 686 young clams per square foot of pool bottom mud. The *Corbicula* initially cleaned the water so well that submerged aquatic weeds and filamentous algae invaded 14 of the 24 pools containing clams. Fewer fish kills due to oxygen depletion occurred in treatments containing *Corbicula* in suspended trays or *Corbicula* stocked at the heavier concentrations in the pool mud. With *Corbicula* in floating trays, lowest turbidity readings were maintained throughout the summer. Turbidity increased with a decrease in the stocking rate of clams in the pool mud. Clam survival was highest in treatments containing *Corbicula* in floating trays, but survival dropped as the stocking rate of clams in the pool mud decreased. Catfish survival was highest with *Corbicula* in floating trays and in heavier concentrations in the pool mud. The highest average net weight of fish per treatment, average mean fish weight, and best food conversion ratio occurred in the treatment containing about 30 clams per square foot in the pool mud (Busch).

Channel catfish, *Ictalurus punctatus* (Rafinesque), from seven different geographical locations and two interpopulation crosses were stocked in 0.1-acre ponds at a rate of 1,500 per acre at the Auburn University Fisheries Research Unit. The fish were fed a supplemental diet at the rate of 5 percent of their body weight per day for approximately 6 months. When the fish were harvested, 10 fish of "average" size from each of the nine strains tested were used for nine morphometric measurements. Means for each strain were compared statistically. Highly significant differences between strains were found for all measurements except caudal peduncle width. A strong divergence between these geographically separated strains of channel catfish was indicated. Two of the wild strains, those with little or no inbreeding, exhibited a large degree of variability with respect to characteristics that could be of potential use in selective breeding (Goodman).

**TOP:** International Center staff members observe intensive fish culture system in which water is continuously recirculated and aerated. **CENTER:** Graduate students from Central America seine experimental pond in which polyculture systems are being investigated. **BOTTOM:** Graduate students weigh fish in polyculture experiment in which three fish species (buffalo, tilapia, and carp) with overlapping feeding habits were stocked in the same pond.





The effect of an active-carbon, expanded-bed filter on water quality in a closed culture system stocked with channel catfish was evaluated. Water quality parameters measured were ammonia, nitrite, nitrate, dissolved oxygen, temperature, pH, dissolved carbon, particulate carbon, total carbon, turbidity, and carbon dioxide. An analysis of variance was calculated for daily control and experimental tank mean water quality values. Correlation coefficients were calculated among all parameters in each tank and for mean parameter values for the control and experimental tank series. The statistical analysis indicated no significant improvement in water quality in tanks with active-carbon filters (Grogan).

Experiments in a 25.5-acre pond in which channel catfish were stocked in pens at rate of 10 to 15 fish per square meter, along with 2 *Tilapia aurea*, demonstrated that channel catfish, an insect-feeder, must be fed a complete fish feed under pen culture. In contrast, the *Tilapia*, which feed upon plankton entering the pen with inflowing water from the pond itself, developed no deficiencies and no mortality resulted. Harvestable catfish (10-inch or larger) made up 67 percent of the total number and 88.2 percent of the total weight of catfish recovered. Harvestable *Tilapia* (6-inch or larger) accounted for 97.6 percent of total number and 98.8 percent of total weight of *Tilapia* at harvest. Maximum production (19,999 pounds per acre or 19.9 pounds per square meter) was obtained in pens constructed singly with wide spacing (100 feet or more) between pens. Production was lower in pens sharing one or more common sides (Miller).

### Pond Ecology

The rate of oxygen consumption by plankton communities in pond waters is positively correlated with chemical oxygen demand. Respiration increases by about 0.05 milligrams per liter of oxygen per 24 hours with each milligram per liter increase in chemical oxygen demand (COD). The major source of COD in ponds, even those receiving 3,000 pounds per acre fish feed, was carbon fixation by photosynthesis.

Laboratory studies revealed that seven species of blue-green algae excreted substances which inhibited the growth of several species of green algae. Field studies suggested that excretory substances of algal origin favored the persistence of blooms of certain troublesome blue-green algae.

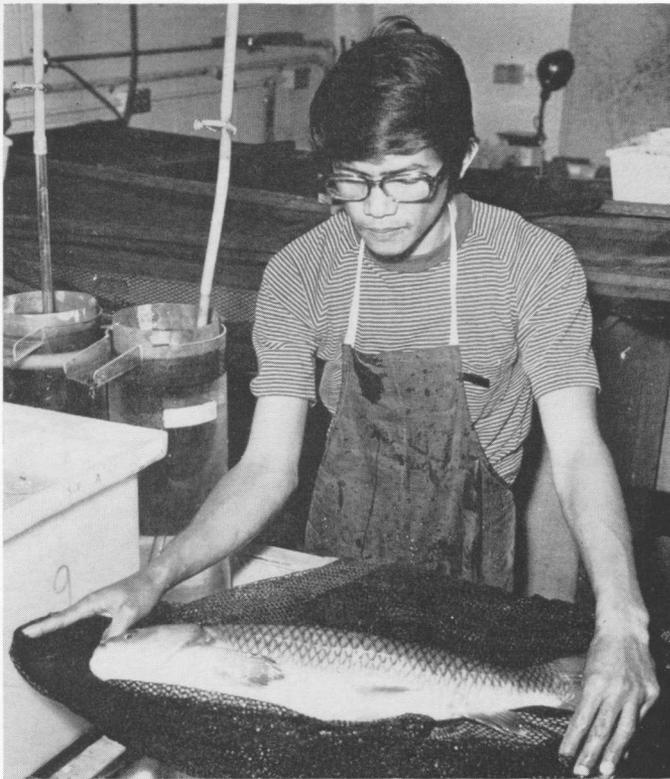
Other laboratory research indicated that phytoplankters can utilize phosphorus from muds for growth. The availability of mud phosphorus can be estimated by extraction with 0.05 N HCL plus 0.25 N H<sub>2</sub>SO<sub>4</sub> and several other extractants.

Concentrations of chlorophyll *a* were proved to be a good estimate of the amount of photosynthesis in pond waters. In experiments using plastic pools, fish production increased with increasing concentrations of chlorophyll *a* (Boyd).

### Fish Nutrition

Past studies (1970-71) demonstrated that high protein feeds (45 percent) produced 24 percent more gain than lower protein feeds (32 percent) when channel catfish were fed in ponds where the maximum safe level of daily feeding was 32 pounds per acre. Research in 1972 proved that increasing available energy levels from 1,000 to 1,300 K calories per pound of high protein feed further increased gains by 12 percent.

**TOP:** Dr. M. M. Pamatmat (biological oceanographer) and graduate student record data about metabolism of bottom mud sample from an estuarine area. **CENTER:** Fish deboner that separates fish flesh from bones and skin is demonstrated by graduate student. Such a product has a potential high market demand for fish sticks and cakes. **BOTTOM:** Dr. R. T. Lovell, Associate Professor of fish nutrition and technology, directs graduate students in a fish nutrition course laboratory experiment.



Graduate student from the Philippines in process of artificially spawning the white amur by injection of hormones.

Catfish fed to harvestable size in concrete ponds on feeds containing appreciable levels of various fats had body fat similar chemically to the fats in the diets. The only fat that adversely affected fresh fish flavor or frozen keeping quality was marine fish fat. This fat gave the catfish a "fishy" flavor and caused the frozen fish to oxidize more readily than those fed other animal or plant fats.

Catfish waste from processing plants was fed in a moist-feed, balanced diet preparation to channel catfish for a 150-day growing period. The moist feed was allowed to ferment and when stored in an air-tight container remained in good condition for 6 months at ambient temperature. Feed conversion for the moist diets containing uncooked waste was 2.11 but dropped to 1.67 when the waste was cooked. The diet containing commercial marine fishmeal gave conversion of 1.12. While it is a useful source of animal protein, catfish waste is inferior to marine fishmeal. Cooking destroys anti-nutritional factors and improves digestibility of collagen in catfish waste (Lovell).

Chymotrypsin, carboxypeptidase, and trypsin were found to be present in the liver and intestine of the white amur and channel catfish, and leucine aminopeptidase was located in the intestine. The liver of the channel catfish was the primary site of carboxypeptidase secretion, while in the white amur the liver seemed to play the dominant role in tryptic, chymotryptic, and carboxypeptidase secretion. There appeared to be a backwash of enzymes from the intestine into the stomach of the channel catfish.

There was no discernible evidence to suggest that enzyme production in either fish was dependent on feeding conditions. Seasonal variation did, however, express effects on the level of carboxypeptidase in the liver of the channel catfish and white amur, and chymotryptic levels in the intestine of the channel catfish (Lane).

## Processing and Technology

Smoked catfish has excellent consumer appeal, keeps well in refrigeration for several months, and represents 45 percent of the original live fish weight. Recommendations for a "hot-smoke" process for catfish were developed and submitted to governmental agencies for review regarding compliance with food safety laws (Lovell).

## Pond Management

In a 25-acre pond where fishing was allowed along the bank halfway around the pond, 54 percent of the total catch was removed during the first 5 days the pond was opened to fishing. About 27 percent of the catch was *Tilapia* and channel catfish, the remainder bluegill, shellcracker, and bass. The number of fishermen decreased rapidly after most of the large catfish had been removed. Closing half the lake did not appear to greatly reduce the rate of catch (Davies).

## Fish Pathology

Studies on the anatomical and histological structure of the channel catfish, *Ictalurus punctatus*, were started this year. The histologic description of the skin was completed, as was the description of the internal anatomy. Hematologic studies, started this year, will continue through next year (Gaines).

## Research by Foreign Graduate Students

Ten foreign students received graduate degrees from Auburn during the year. Each was required to submit a thesis or dissertation based on his original research. Although none of these students was supported directly by Grant funds, all utilized equipment and supplies purchased with Grant funds, benefited from the availability of the field labor hired with Grant funds, or received guidance and information from staff paid on Grant funds. The names, country, and title of thesis or dissertation for each student follow:

- |                                      |  |
|--------------------------------------|--|
| Chailiang Chaitiamvong<br>(Thailand) | Polyculture of Channel Catfish and Common Carp in Ponds.   |
| Charng-ji Chiou<br>(Taiwan)          | The Availability of Mud Phosphorus for Algal Growth.   |
| Sompong Hiranvat<br>(Thailand)       | Preimpoundment Age and Growth of the Redbreast Sunfish, <i>Lepomis auritus</i> , in the Proposed West Point Reservoirs, Alabama and Georgia.             |
| Dilip Mathur<br>(India)              | Ecology of Feeding Fishes in Hala-wakee Creek, Lee and Chambers Counties, Alabama.   |
| Oopathon Pawaputanon<br>(Thailand)   | The Effects of Three Methods of Aeration, of Biofiltration and of Aeration Plus Nutrient Removal with Water Hyacinths on Water Quality in Catfish Ponds. |
| Charoen Phanil<br>(Thailand)         | The Effects of Water Hyacinths on Plankton in Fed Channel Catfish Ponds.   |
| Somsuk Singholka<br>(Thailand)       | Growth and Feed Conversion of Common Carp ( <i>Cyprinus carpio</i> ) Fed at Different Rates in Cages.  |
| Prasert Sitasit<br>(Thailand)        | Dietary Levels of Calcium and Phosphorus for Cage-Cultured Channel Catfish.  |
| Pichit Srimukda<br>(Thailand)        | The Effect of Pen-Culture on the Dissolved Oxygen Concentration in Pens and in Adjacent Water.   |
| Pramont Suwanasart<br>(Thailand)     | Effects of Feeding, Mesh Size, and Stocking Size on the Growth of <i>Tilapia aurea</i> (Steindachner) in Cage-Culture.                                   |

## Research Publications

### Dr. C. E. Boyd

Amino Acid Composition of Freshwater Algae. Arch. Hydrobiol. Vol. 72:1-9.

A Bibliography of Interest in the Utilization of Vascular Aquatic Plants. Economic Botany 26:74-84.

Biotic Interactions between Different Species of Algae. Weed Sci. 21:32-37.

The Chemical Oxygen Demand of Waters and Biological Materials from Ponds. Trans. Amer. Fish. Soc. 102.

Phosphorus Dynamics in Ponds. Proc. Ann. Conf. S.E. Game and Fish Comm. 25:418-426.

Sources of CO<sub>2</sub> for Nuisance Blooms of Algae. Weed Sci. 20:492-497.

Summer Algal Communities and Primary Productivity in Fish Ponds. Arch. Hydrobiol. 41:357-390.

### Dr. R. T. Lovell

Catfish Need Vitamin C. Highlights of Agr. Res. 20(2), Summer 1973. Auburn Univ. (Ala.) Agr. Exp. Sta.

Catfish Processing-Waste Utilization. FAO Fish-Culture Bulletin 4(2):5.

Essentiality of Vitamin D in Feeds for Intensively Fed Caged Channel Catfish. Jour. of Nutr. 103(1):134-138.

Protein Requirements of Cage-Cultured Channel Catfish. Proc. 26th Ann. Conf. S.E. Game and Fish Comm.

### Dr. W. D. Davies

Idade e crescimento da curimata comum, *Prochilodus cearensis*, Steindachner, no agude. "Pereira de Miranda," Pentecoste, Ceara, Brazil. Biol. Tec. DNOCS 29(2) Frt. 1972.

### Dr. J. L. Gaines

*Aeromonas* Induced Deaths Among Fish and Reptiles in an Eutrophic Inland Lake. JAUMH 161(6):603-607. (With E. B. Shotts, L. Martin, and A. K. Prestwood.)

## Teaching Activities

Six project staff members taught eight courses during the year, as summarized below:

**Dr. H. S. Swingle.** Dr. Swingle taught one course during the year, a 5-credit-hour graduate course in aquaculture.

**Dr. E. W. Shell.** Dr. Shell taught a 5-credit-hour graduate course in advanced fisheries biology. He also served as advisor to undergraduate students in the fisheries curriculum and supervised the graduate program for the Department. He was major professor for 14 graduate students, 7 of whom were foreign students.

**Dr. C. E. Boyd.** Dr. Boyd taught three 5-hour courses: nutrient cycles in aquacultures, which was offered two times, and biological productivity and water quality. He served as major professor for five graduate students. Three of these were foreign students.

**Dr. R. T. Lovell.** Dr. Lovell taught two 5-credit-hour courses in fish nutrition and fish processing technology and served as major professor for 11 graduate students. Nine of his graduate students were foreign students.

**Dr. W. D. Davies.** Dr. Davies taught a course in fisheries biology, a 3-credit-hour course. He served as major professor for five graduate students, two of whom were foreign students.

**Dr. J. L. Gaines.** Dr. Gaines taught a course in fish morphology.

A seminar series emphasizing international fisheries devel-

opment was offered for graduate credit during the year. Seminar topics and speakers were as follows:

**August 11, 1972.** Mr. Vanich Varikul, Department of Fisheries, Bangkok, Thailand. "Fisheries Research in Thailand."

**September 8, 1972.** Mr. Josef Scherzer, Director of Fish Ponds, Kibbuz Maayan Zwi, Israel. "Communal Fish Culture Program in Israel."

**September 15, 1972.** Dr. N. K. Fijan, Department of Veterinary Medicine, University Zagreb, Yugoslavia. Major Diseases of European Cultured Fishes."

**September 29, 1972.** Dr. Claude Boyd, Associate Professor, Department of Fisheries and Allied Aquacultures. "Primary Productivity by Aquatic Plants."

**October 6, 1972.** Dr. Thomas Hill, University of Georgia Experiment Station, Tifton, Georgia. "Culture of Catfish and Trout in Rotation in South Georgia."

**October 13, 1972.** Mr. O. L. Green, Fish Culturist, U.S. Warmwater Fish Culture Research Laboratory, Marion, Alabama. "Selective Breeding Programs with Channel Catfish."

**October 20, 1972.** Dr. Bill Davies, Assistant Professor, Department of Fisheries and Allied Aquacultures. "Reservoir Fisheries in Northeast Brazil."

**October 27, 1972.** Mr. Dan Leary, Ph.D. candidate, Department of Fisheries and Allied Aquacultures. "Effects of Dietary Fiber-level on Production of Channel Catfish in Ponds."

**November 3, 1972.** Mr. Malcolm Johnson, Jr., M.S. candidate, Department of Fisheries and Allied Aquacultures. "White Amur."

**November 10, 1972.** Mr. Randell Goodman, M.S. candidate, Department of Fisheries and Allied Aquacultures. "Catfish Genetics Studies."

**November 24, 1972.** Mr. Don Keller and Mr. David Morris, M.S. candidates, Department of Fisheries and Allied Aquacultures. "Age and Growth of Largemouth Bass in Eufaula Reservoir, Alabama."

**January 10, 1973.** Dr. Ilan Paperna, Fish Pathologist, Virginia Institute of Marine Science, Gloucester, Virginia. "Pathology of Fish Diseases in Central Africa."

**January 12, 1973.** Mr. Jack Snow, Director, National Fisheries Station, Marion, Alabama. "Chemical Changes in Bottom Soils in Fish Ponds during a 10-year Period."

**January 19, 1973.** Dr. R. D. Rouse, Dean, School of Agriculture, and Director, Agricultural Experiment Station. "The Progress and Present Status of the Regional Catfish Project, S-83."

**January 26, 1973.** Mr. William Atkins, Commercial Fisherman, Theodore, Alabama. "Commercial Fishing in the Gulf and Tidal Streams of South Alabama."

**February 2, 1973.** Dr. John Greenfield, Regional Fisheries Economist, National Marine Fisheries Service, St. Petersburg, Florida. "Need for Adequate Economic Data in Aquaculture Projects."

**February 9, 1973.** Mr. S. Y. Lin (Retired) Principal Fisheries Biologist, Joint Commission for Rural Reconstruction, Taipei, Taiwan. "Aquaculture in Taiwan."

**February 16, 1973.** Mr. Ed Chamberlin, Deputy Regional Director, U.S. Fish and Wildlife Service, Atlanta, Georgia. "Fisheries Programs of the U.S. Fish and Wildlife Service."

**February 23, 1973.** Mr. I. B. Byrd, Chief, State-Federal Relationships Division, National Marine Fisheries Service, St. Petersburg, Florida. "Regional Federal Aid Programs in Fisheries and Aquaculture."

March 2, 1973. Mr. Hugh Barwick, M.S. candidate, Department of Fisheries and Allied Aquacultures. "Effects of Two Feeding Rates on the Survival and Production of Advanced Fingerling Striped Bass."

Mr. Rob Busch, M.S. candidate, Department of Fisheries and Allied Aquacultures. "Using Clams as Bio-filters in Catfish Cultures."

Mr. Rafael Guerrero, M.S. candidate, Department of Fisheries and Allied Aquacultures. "Sex Reversal in *Tilapia*."

Mr. Somsuk Singholka, M.S. candidate, Department of Fisheries and Allied Aquacultures. "Growth and Feed Conversion of Common Carp fed at Different Rates in Cages."

March 9, 1973. Mr. Arsenio Camacho, M.S. candidate, Department of Fisheries and Allied Aquacultures. "Utilization of Fish Waste in Diets for Fishes."

Mr. Romy D. Fortes, M.S. candidate, Department of Fisheries and Allied Aquacultures. "Studies of Chlorophyll in Pond Waters."

Mr. Pichit Srimukda, M.S. candidate, Department of Fisheries and Allied Aquacultures. "The Effect of Pen Culture on Oxygen Concentration in the Pens and in Adjacent Waters."

Mr. Prasert Sitasit, M.S. candidate, Department of Fisheries and Allied Aquacultures. "Dietary Levels of Calcium and Phosphorus for Cage Cultured Channel Catfish."

### International Service Activities

All academic staff members on the project participated in international service activities during the year. A summary of participation of the staff on foreign assignments and in international seminars follows:

**Dr. H. S. Swingle.** Dr. Swingle participated in a seminar on marine biology and fisheries held under the auspices of the U.S.-Republic of China Cooperative Science Program in La Jolla, California, April 10-13, 1973.

**Dr. E. W. Shell.** Dr. Shell reviewed progress of the Auburn-USAID project in the Philippines (AID/ea-180) during September 22-October 1, 1973. He then traveled to Thailand where he reviewed research and aided in the planning of new research with the Department of Inland Fisheries in that country, October 1-28 (AID/csd-2270, T.O. 9). On his last stop, in Rome, he discussed the International Center's activities with the FAO Fisheries Liaison Officer, October 29-30.

**Dr. R. T. Lovell.** Dr. Lovell visited the Philippines, Thailand, and FAO in Rome with Dr. Shell. In addition, he served as an advisor in fish nutrition and feeding to the Auburn-USAID Project in Panama (AID/la-684), December 17-23, 1972.

**Dr. W. D. Davies.** Dr. Davies attended the FAO-sponsored Technical Conference on Fishery Management and Development held in Vancouver, British Columbia, February 11-23, 1973. He conducted a pre-feasibility survey of fisheries development on Lake Izabal, Guatemala, June 11-22, 1973.

### Library Acquisitions

During the year, 299 books were purchased for the library utilizing Grant funds. A majority of these books are references on fishes of developing countries. These will be used as a source of information on species of fish in these countries that have potential for use in aquaculture.

Grant funds were also used to purchase subscriptions to nine periodicals and a film.

## IMPACT OF GRANT SUPPORTED ACTIVITIES ON INSTITUTIONAL CAPABILITIES

The Grant allowed the Department of Fisheries and Allied Aquacultures and the International Center for Aquaculture to significantly increase its international capabilities and activities without interfering with its traditional programs. Interaction between the international and traditional programs strengthened both. Because of the Grant support, the University is able to take a more active role in international fisheries and aquacultural development through the teaching of foreign students, conducting of relevant research, and extending of information to developing countries. Although the University has been in international work to a limited degree for a number of years, the present degree of involvement would not be possible without support provided by the Grant.

Grant funds were used to purchase the following personnel time during the past year:

Staff category	Man-months
Academic .....	45.2
Laboratory technician .....	1.6
Secretarial .....	14.5
Graduate research assistants .....	16.3
Field labor .....	65.6

Only a fraction of this level of staffing would be available to the Center without funds provided by the Grant.

The academic staff, with support from the laboratory technicians, secretaries, and field labor, produced 13 major research publications during the year. The graduate research assistants funded from the Grant conducted eight research projects, four of which resulted in theses fulfilling requirements for the Master of Science Degree.

The number of research publications and research projects directly attributable to the Grant are indicative of only a portion of the contribution that those funds make to the overall research program. Grant-funded staff regularly collaborate with other staff on research projects.

Three research projects are now being funded by extramural sources that were obtained because of the availability of the specialists employed with Grant funds. Without the field labor purchased with Grant funds it would be extremely difficult to provide the large number of USAID-supported foreign students at Auburn with effective field research experiences.

The academic staff on Grant funds taught seven University courses during the past year, producing a total of 5,841 student-credit hours (177 students x 33 credit hours). Of these, 2,310 student-credit hours were for foreign students. Seventeen of the 33 credit hours taught were in new courses added to the curriculum because of the availability of these specialists on the staff.

Since the Graduate School at Auburn University limits the number of graduate students that can be directed by an individual professor, the graduate training program in fisheries would be considerably smaller without the additional staff available as a result of the Grant. The additional staff permitted acceptance of approximately 15 more graduate students than would have been possible otherwise. Because of the large number of qualified American applicants desiring admission to Auburn, it is unlikely that many foreign students could have been accepted without the additional staff provided by Grant funds. A total of 11 foreign students received advanced degrees during the year. Staff funded from the Grant served as major professors for nine of these.

## UTILIZING INSTITUTIONAL RESOURCES IN INTERNATIONAL DEVELOPMENT

Four Auburn-based staff members participated in on-site reviews of Auburn-USAID Fisheries Development Projects or served as advisors on these projects during the year. These activities required approximately 4.9 man-months.

One staff member served as a consultant to the International Bank for Reconstruction and Development, planning a fisheries development project in Bangladesh. This required 1.7 man-months of service.

Approximately 1 man-month of staff time was spent away from campus participating in an FAO-sponsored seminar, meetings with FAO personnel, and taking part in a seminar sponsored by the United States-Republic of China Cooperative Science Program.

Thirty persons came to the Center during the year on visits related to international fisheries development. The visitors required approximately 170 visitor days of short-term training, seminars, meetings, discussions with individual staff members, tours, and administrative support. A list of these visitors, who came from eight different countries, follows:

<i>Name and title</i>	<i>Dates of visit</i>
Dr. Thomas C. Juelson Peace Corps Volunteer in Fisheries Brazil	July 24-25, 1972
Mr. Vanich Varikul Chief of Inland Fisheries Research Department of Fisheries Bangkok, Thailand	August 4-15, 1972
Mr. Josef Scherzer Director of Fish Ponds 30803 Moayan Zwi D.N. Chat Hacarmel, Israel	September 5-8, 1972
Mr. Fred Laney International Training Office National Marine Fisheries Service Rockville, Maryland	November 1-3, 1972
Mr. Michael Fivez 18th Avenue Helene 2000 Antwerp, Belgium	January 3, 1973
Mr. Manu Potaros Chief Biologist Bankhen Fisheries Station	January 3-April 14, 1973
Mr. Chirdchan Amatayakul Chief of Fisheries Extension Department of Fisheries Bangkok, Thailand	January 3-April 14, 1973
Mr. S. Y. Lin (Retired) Principal Fisheries Biologist Joint Commission for Rural Reconstruction Taipei, Taiwan	February 8-11, 1973
Dr. Joel Bernstein Assistant Administrator Bureau for Technical Assistance Agency for International Development Washington, D.C.	February 8-9, 1973
Mr. Jim Urano Chief, Agricultural Inputs Division Office of Agriculture Agency for International Development Washington, D.C.	February 8-9, 1973
Mr. I. B. Byrd Mr. Paul Hooker National Marine Fisheries Service St. Petersburg, Florida	February 22-23, 1973
Dr. Pietro Ghittino Professor of Pathology University of Torino Italy	March 8, 1973
Dr. Harlan Davis Food and Agriculture Office USAID/El Salvador	March 14-16, 1973
Mr. Stanley Heishman Contract Officer Agency for International Development Washington, D.C.	March 14-16, 1973
Mr. Richard Schneider PCV Project Leader and Six Peace Corps Volunteer Trainees from Michigan State University	March 19-21, 1973
Sr. Jose Cabrero Chief of Fisheries Ministry of Agriculture San Salvador, El Salvador	May 1-31, 1973
Mr. Sibley Kawi Chief, Training Division USAID/Philippines	May 2-3, 1973
Mr. Andy Hernandez USAID/Guatemala	May 15, 1973
Dr. Nelson Marshall Director Center for Marine Resource Development University of Rhode Island	June 9, 1973
Dr. Erven Long Associate Assistant Administrator Bureau of Technical Assistance Agency for International Development Washington, D.C.	June 9, 1973
Mr. Jim Urano Chief, Agricultural Inputs Division Office of Agriculture Agency for International Development Washington, D.C.	June 9, 1973
Sr. Pedro Godoy I. Incubadoras Protinal, C.A. Valencia, Venezuela	July 18, 1973
Mr. John Hummon Agency for International Development Washington, D.C.	July 20, 1973
Dr. Z. H. Shehadeh Fisheries Department Food and Agriculture Organization Rome, Italy	June 29-30, 1973

The Center was responsible for planning and conducting extended special training programs for three visitors from Thailand and one from El Salvador. Copies of these programs are presented in the Appendix.

Twenty-two students (12 American and 10 foreign) received advanced degrees during the year. Twelve of these students are now actively involved in some aspect of international fisheries development. Nine of the foreign students returned to their native countries to continue their work in fisheries development and three of the Americans are involved in international work.

One American student who took a leave of absence from his graduate work to enter the Peace Corps is working on a fisheries project in El Salvador under the direction of the Chief of Party of the Auburn-USAID project (AID/la-688) there. He will use the results of his research there for a thesis.

Two students who received B.S. degrees also joined the Peace Corps. One of them is working with the Auburn-USAID project in El Salvador. The other will work with the Auburn-USAID project (AID/ea-180) in the Philippines.

Twenty-eight students (16 American and 13 foreign) entered the graduate program of the Department during the year. A number of American and foreign students who were qualified for admission could not be accepted because present facilities and staff cannot accommodate more than the approximately 50 graduate students presently enrolled.

USAID funded seven contracts with the University during the year; AID/csd-2270, (worldwide); AID/csd-2270, T.O.9 (Thailand); AID/csd-2270, T.O.4 (Brazil); AID/la-180 (Philippines); AID/la-684 (Panama); AID/la-688 (El Salvador); and AID/csd-2780.

#### OTHER RESOURCES FOR GRANT-RELATED ACTIVITIES

Because the basic purpose of the Grant is to improve and strengthen the International Center for Aquaculture, virtually all other funds received (except those from USAID contract work overseas) are considered to be available for Grant-related activities. The Department and Center received funds from several sources during the year, as given in the following table:

<i>Source of funds</i>	<i>Amount</i>
State of Alabama appropriated funds	
For teaching.....	\$ 48,048
For research.....	82,925

Sales funds	
From sale of food fish and fingerlings.....	19,301
Federal appropriated funds for research	
USDA-Land-Grant College Funds.....	67,000
Research grants from other state governments .....	100,820
Research grants from federal agencies .....	160,800
Research grants from private enterprise.....	54,000
<b>TOTAL.....</b>	<b>\$532,894</b>

The Department and Center occupied a new building, Swingle Hall, in August 1972. Its cost was approximately \$1 million, all of which was appropriated by the Alabama Legislature. These funds represent a significant contribution for Grant-related activities.

#### SUMMARY

Progress was made in meeting all Grant objectives. Grant funds were utilized to purchase 45.2 man-months of academic staff time, 14.5 man-months of secretarial time, 16.3 man-months of graduate research assistant time, and 65.6 man-months of field and student labor. The academic staff funded by the Grant produced 13 major research publications. Graduate research assistants completed eight research projects.

Grant funds were utilized to purchase 299 books, 9 periodicals, and 1 film. Seven University courses, 33 credit hours and 5,841 student-credit hours, were taught by the academic staff. A total of 2,310 of the credit hours were for foreign students. It was possible to accept approximately 15 additional graduate students in the Department as a result of the availability of the Grant-funded staff. Twenty-two students (12 American and 10 foreign) received advanced degrees. Twelve of these are now involved in international development. Three other students joined the Peace Corps and are working with Auburn-USAID projects abroad.

Thirty persons came to the Center on visits related to international fisheries development. These visitors required 170 man-days of training, seminars, and discussions. Staff members of the International Center participated in 6.7 man-months of international fisheries development activities abroad.

Approximately \$636,000 were available from other sources for development of the International Center for Aquaculture.

## APPENDIX

### Special Training Program

#### Program for Mr. Vanich Varikul (Thailand)

- August 4, 1972 Discussions with Dr. H. S. Swingle and Dr. D. D. Moss about the overall fisheries program, International Center for Aquaculture, Auburn University, Auburn, Alabama. Observations of experimental ponds and reservoir construction at the Fisheries Research Unit with Dr. H. S. Swingle. Discussion with Dr. R. T. Lovell on fish feeds. Visit to the new Fisheries Building with Dr. H. S. Swingle.
- August 8 Departed Auburn with Dr. H. S. Swingle for Dauphin Island, Alabama. Visited Alabama Department of Conservation Marine Resources Laboratory, Dauphin Island. Mr. Wayne E. Swingle and Mr. Hugh A. Swingle conducted tour. Observed cage culture of pompano and oyster culture.
- August 9 In the company of Dr. H. S. Swingle and Mr. Wayne E. Swingle, visited new site of experimental pond fish culture to observe construction of ponds.
- August 10 Departed Dauphin Island for Auburn University.
- August 11 Presented seminar on fisheries research in Thailand.
- August 14 Discussed fisheries research in Thailand with Dr. E. W. Shell. Discussed aquatic weeds and aquatic weed control with Dr. J. M. Lawrence. Discussed fish parasites and diseases with Dr. W. A. Rogers. Discussed fish taxonomy with Dr. W. Shelton.
- August 15 Departed Auburn University for Stuttgart, Arkansas, with Dr. Ray Allison and Mr. Catalino Dela Cruz.

#### Program for Mr. Jose Cabrero (El Salvador)

- May 1, 1973 Arrive on Auburn University campus.
- May 2-4 Tour of fisheries research field facilities, small pond experimental area, large pond area, fish holding and counting shed, and fish hatching field laboratory. Review of aquaculture projects being carried out in experimental ponds. Tour of Fisheries Building and various fisheries research laboratories.

- May 7-9 Trip to Tifton, Georgia, to observe raceway culture systems for commercial food-fish production. Also visit to Gold Kist Fish Processing Plant, Quitman, Georgia.
- May 10-11 Review with staff of Department of Fisheries and Allied Aquacultures research programs by major areas including fish taxonomy, fish parasites and diseases, fish technology, fish feeds and nutrition, aquaculture, large impoundments and rivers, sport fish management, and water chemistry.
- May 12-18 Visit to Alabama Marine Resources Laboratory, Dauphin Island, Alabama, to review progress on mariculture projects on oysters, shrimp, and marine fish species. Travel to Marion, Alabama, to observe National Fisheries Station programs concerned with distribution of fish fingerlings to pond owners and hatchery management program. Tour of U.S. Southeastern Fishcultural Laboratories, also located at Marion.
- May 21-25 Trip to selected commercial fish farming areas of Mississippi and Arkansas to observe channel catfish culture operations; visit to the Federal Fish Farming Experimental Station at Stuttgart, Arkansas, to review all station projects concerned with fishculture. Visit Southern Catfish Processors, Inc., a catfish processing plant in Dumas, Arkansas.
- May 28-30 Final week on Auburn University campus and at field research facilities of Department to observe graduate student projects being carried out in the field and pond construction plans of water supply reservoir and for discussions with graduate students regarding their academic and research programs. Review of international fisheries programs of the International Center for Aquaculture, Auburn University.
- May 31 Depart Auburn for return to El Salvador.

#### Program for Mr. Manu Potaros and Mr. Chirdchan Amataykul (Thailand)

- March 16-17, 1973 Observed raceway culture for trout and catfish at Tifton, Georgia, and Gold Kist Fish Processing Plant at Quitman, Georgia, with Drs. R. Allison and J. A. Plumb.
- March 19-20 Visited the Alabama Marine Resources Laboratory, Dauphin Island, Alabama, and the brackishwater experimental aquaculture facilities near Gulf Shores with Drs. E. W. Shell and M. M. Pamatmat.
- March 27-30 Visited the experimental Fish Farming Station, Stuttgart, Arkansas, with Dr. Pamatmat.
- April 4-6 Visited the State Fish Hatchery at Eastaboga, Alabama. Visited trout production farms in Tennessee and National Trout Fisheries Station, Dale Hollow, Tennessee, with Dr. D. D. Moss.

