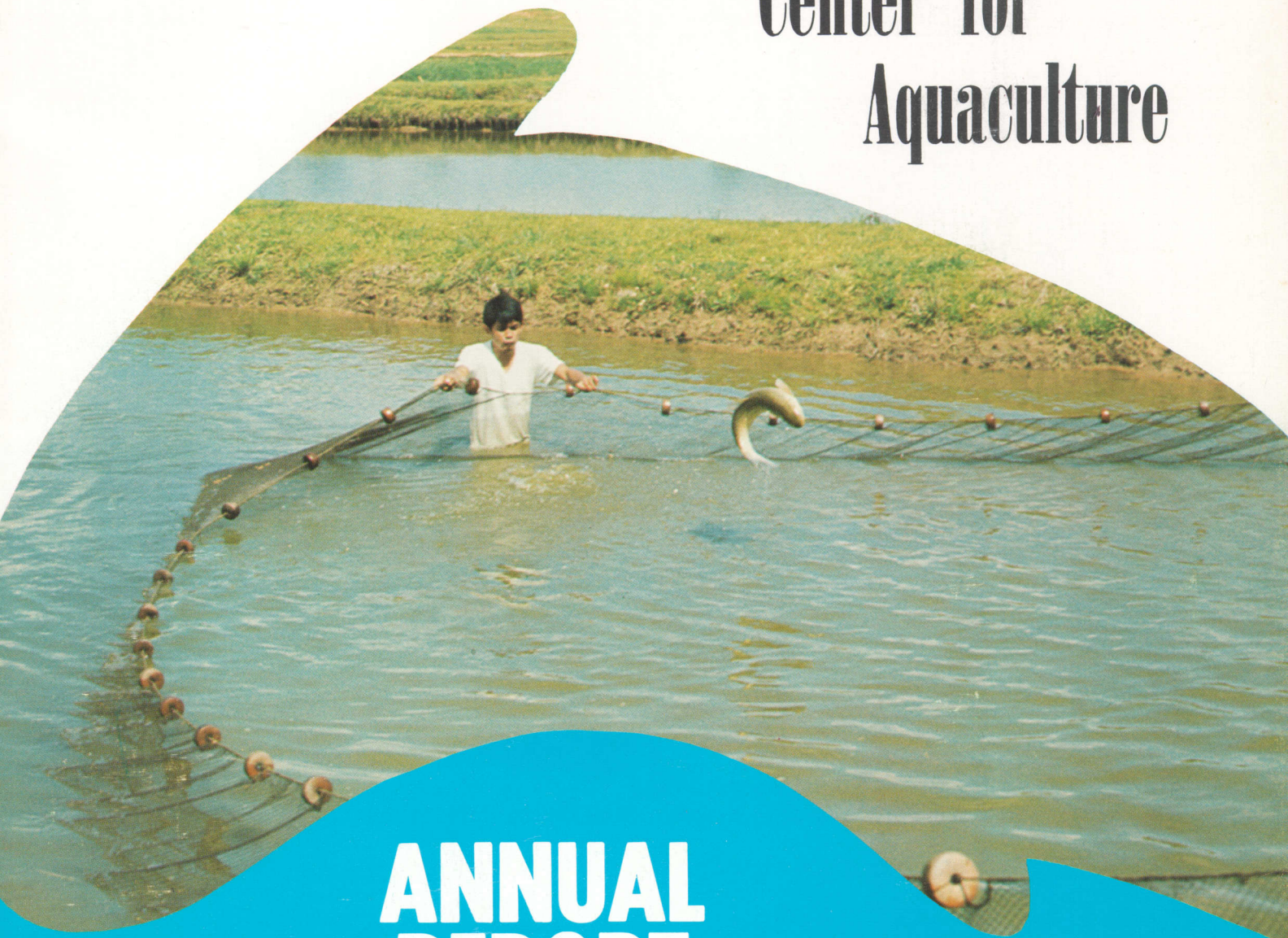
The International Center for Aquaculture



ANNUAL REPORT FOR FY 1974

AGRICULTURAL EXPERIMENT STATION/AUBURN UNIVERSITY
R. DENNIS ROUSE, Director
AUBURN, ALABAMA

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Published 5/76—1M

Auburn University is an equal opportunity employer.

Visiting dignitary observing work of international students (top) and graduate students from Philippines working with intensive fish culture systems (bottom) are characteristic of 1974 activities of the International Center for Aquaculture.

The International Center for Aquaculture

ANNUAL REPORT FOR FY 1974

THE YEAR 1974 can be characterized as a period of significant advances toward objectives of the International Center for Aquaculture at Auburn University. Progress was made through three major programs of the Center: research activities by staff members, service activities by academic faculty, and library acquisitions.

Research activities included studies dealing with aquacultural production with different species, pond ecology, and fish nutrition. In the area of international service, faculty members took part in meetings and other service functions in 16 nations, and visitors from 15 countries came to Auburn for tours, demonstrations, and seminars concerning aquaculture. Such programs were of value to aquacultural endeavors around the globe, as well as serving to advance the fisheries teaching and research programs at Auburn University School of Agriculture and Agricultural Experiment Station.

BACKGROUND OF CENTER

The 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 Compentency 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.

Aquacultural Development Needs

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

Sorting fish harvested from experimental ponds.

TOP—1/10-acre experimental ponds; CENTER—seining for fish in a fish pen enclosure; BOTTOM—channel catfish.

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.

Use of Grant Funds

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.

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

[1] Graduate research assistants are generally expected to spend one-third 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.

ACCOMPLISHMENTS DURING THE YEAR

Research Activities

A majority of the personnel funded under the grant participated in research projects during the year. Following is a summary of the research accomplishments.

Aquaculture

Survival of striped bass fry was enhanced by increasing the salinity of water flowing through culture jars from 1 p.p.t. to 5 p.p.t. 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 p.p.t. Survival of fingerlings was also improved by the addition of salt to culture ponds.

Nutritional requirements and feeding rates have been established for intensive culture of channel catfish; however, with recent increases in costs for feed ingredients, some feeding recommendations are no longer practical. This is especially true for recommendations concerning protein levels and proportion of protein from animal sources. One potential 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, with tilapia and threadfin shad as forage species.

A dense population of threadfin shad was established by stocking shad at the same time as catfish. Some tilapia survived the winter of 1971-72, but had to be restocked in 1973. Catfish used both species as food. Of the 2,162 pounds per acre present at draining, 387 pounds (17.9 percent) was shad. Threadfin shad are able to maintain high population numbers under catfish predation.

An experiment on intensive pen culture of channel catfish in combination with tilapia 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; net production was directly proportional to the number of survivors. There was an inverse correlation between catfish and tilapia production, but this apparently competitive interaction may simply be the result of more food being available to tilapia as catfish production decreased.

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 12 earthen ponds approximately 0.1 acre (0.04 hectare) in size. Four treatments consisting of four levels of water hyacinths maintained at surface area percentages of 0, 5, 10, and 25 were replicated three times. *T. aurea* were stocked at a rate of 1,000 fish per acre (2,470 per hectare). The ponds were fertilized at 2-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, 10, and 25 were 2,584, 2,243, and 1,979 grams per square meter dry weight.

Weekly and biweekly sampling of phytoplankton revealed a decrease in average chlorophyll *a* concentrations from 56.46 ug per liter (0 percent coverage) to 14.42 ug per liter (25 percent 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 and 5 percent 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 kilograms per hectare (0 percent coverage) to 351.6 kilograms per hectare (25 percent coverage).

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 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 ranked high in survival, but was the least productive of all lines tested.

Pond Ecology

Decaying aquatic plants were used as the only source 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

Fertilizing experimental pond.

Adding agricultural lime to a fish pond to increase its fertility.

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 milligrams per liter to around 40 or 50 milligrams per liter. Total alkalinity increased from about 20 milligrams per liter to around 50 or 60 milligrams per liter. 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 1 week following application of calcium hydroxide, which would be toxic to fish. Immediately after liming, the pH of the water 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 milligrams per liter, but had no influence on total alkalinity and did not neutralize the acidity of muds.

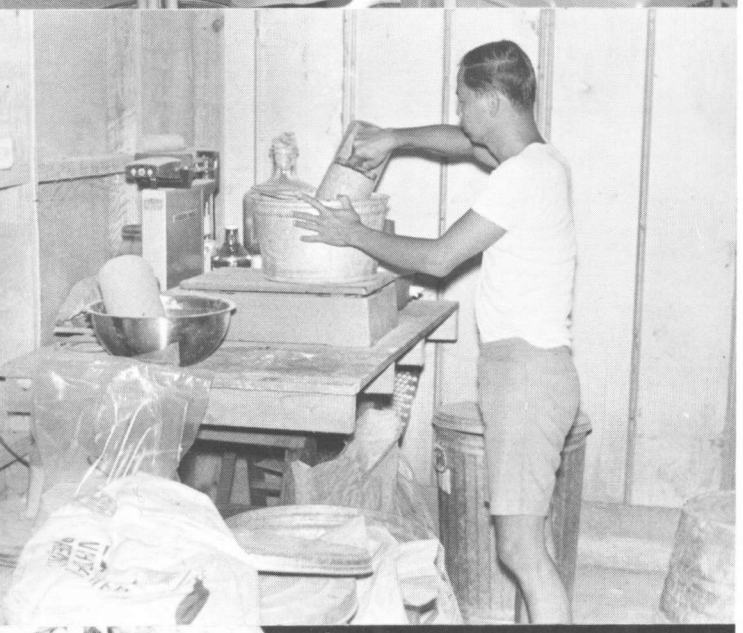
Concentrations of organic matter in bottom muds from 145 ponds varied from 0.77 to 9.66 percent. Nitrogen values for these ponds ranged from 0.08 to 0.63 percent. Both organic matter and nitrogen were considerably higher than quantities usually found in agricultural soils of Alabama. However, it is doubtful that this level of organic nitrogen would supply adequate nitrate and ammonia upon mineralization 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 half 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 in phosphorus. All ponds with adequate blooms received additions of phosphorus. The relationship among soil-test phosphorus in the muds, phosphorus additions, and adequate phytoplankton blooms suggests the need for research on the use of soil-test procedures to calculate the proper application rates for phosphorus to ponds.

Fish Nutrition

A pond feeding experiment was conducted with channel catfish to evaluate three levels of dietary protein in an all-plant diet, a diet containing one-sixth fishmeal protein, or a diet containing one-third fishmeal protein. Effects of the protein levels on growth, uniformity of size, dressing percentage, and body composition were measured. The experiment was conducted in 0.1-acre earthen ponds each stocked with 300 channel catfish using nine formulated feeds and three 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 percent) protein diet is perhaps the best of the all-plant diets. Its yield was nearly equal to that of the high (43 percent) protein plant diet, but the cost per pound of catfish was nearer to that of the low (29 percent) protein diet.

The medium (36 percent) protein diet containing one-



TOP—feeds and nutrition laboratory in Swingle Hall; CENTER—international student preparing experimental fish ration; BOTTOM—processed, farm-raised catfish.

sixth of the protein as fishmeal appears most desirable when present cost of ingredients is considered. Average yield with this feed was 2,868 pounds per acre. Nearly all of the fish (96 percent) 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 fishmeal to the highest level, one-third of the protein, showed a significant response at the lowest total protein percentage (29 percent) 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 level or type of protein or source of energy in the diets. The high protein fishmeal diets may have produced slightly leaner fish. 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 percent 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.

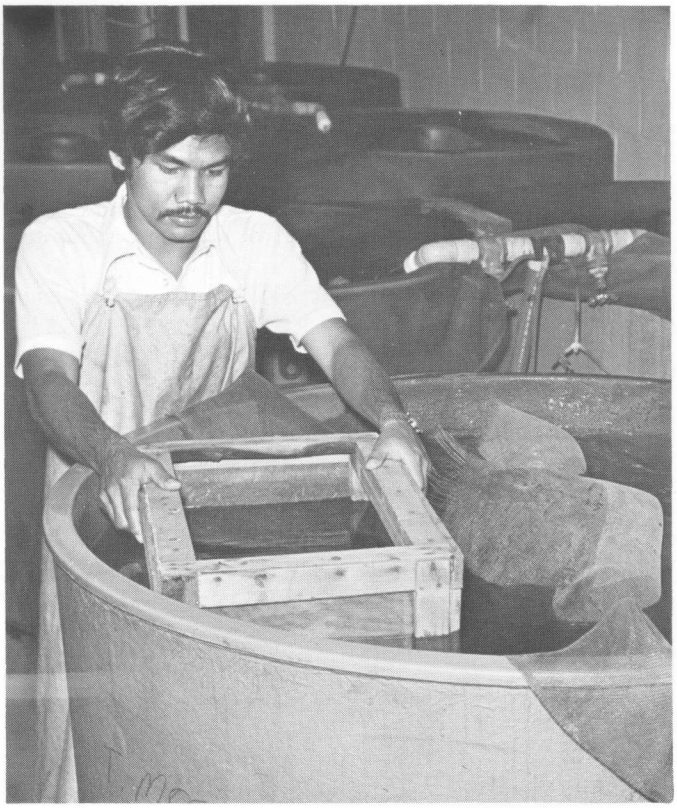
A swine feeding study indicated that catfish waste meal was at least equal to meat scrap (meat and bone) meal as a source of animal protein as evidenced by gains of swine on production type rations. The catfish waste meal did not affect flavor of the meat or carcass quality.

Catfish waste meal is also a satisfactory source of animal protein for catfish feeds. It is equal to fish meal when it comprises a high percentage of the feed formula, but it is slightly inferior to fish meal when it supplies 12 percent or less of total protein.

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.

Research by Foreign Graduate Students

Six foreign students received graduate degrees from Auburn University during the year. Each student was required to submit a thesis or dissertation based on his original research. Although none of these students was supported directly on grant funds, all utilized equipment and supplies, benefited from the availability of field labor, or received guidance and information from staff time which was purchased



Nepali student caring for over-wintered tilapia.

with grant funds. Name, country, and title of the thesis or dissertation for each student follows:

Name	*Thesis or Dissertation*
Sopa Arecrat (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).

Research Publications

Dr. C. E. Boyd

Biotic Interactions between Different Species of Algae. Journal of the Weed Science Society of America, Vol. 21(1): 32-37.

Summer Algal Communities and Primary Production in Fish Ponds. Hydrobiologia, Vol. 41(3): 357-390.

Dr. W. D. Davies

The Effects of Total Dissolved Solids, Temperature, and pH on the Survival of Immature Striped Bass: A Response 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 Ann. Meet. 1973. 20 pp.

Rates of Temperature Acclimation for Hatchery Reared Striped Bass Fry and Fingerlings, *Morone saxitillis* (Walbaum). Progressive Fish Culturist, Vol. 35(4).

Dr. R. T. Lovell

Absorption by Channel Catfish of Earthy-Musty Flavor Compounds Synthesized by Cultures of Blue-Green Algae. Trans. Am. Fish. Soc., Vol. 102(4): 774-777. (With Lewis A. Sackey).

Environment-Related off-Flavors in Intensively Cultured Fish. FAO Technical Conference on Fishery Products, FII: FP/73/E-46. 7 pp.

Put Catfish Offal to Work for You. Fish Farming Industries, Oct.-Nov. 1973. 3 pp.

Vitamin C . . . and Crooked Back Disease. The Catfish Farmer, Vol. 5(3): 31-32.

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:

Staff	*Courses taught*	*Number 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 who were foreign nationals.

The Department utilized grant funds to bring three outstanding scientists to campus to present seminars during the year:

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.

International Service Activities

All of the academic staff on the grant participated in international service activities during the year. Seven visited other countries in connection with these activities. A total of approximately 4.5 man-months of time was spent in these countries. Information concerning these visits is summarized below:

Dr. E. W. Shell. Participated in TAC working group on aquaculture, Spoleto, Italy, July 10-19, 1973. He also took part in Philippines Conference on Fish Estates and reviewed progress of fisheries project in the Philippines, October 22-November 3, 1973.

Dr. D. D. Moss. Planned aquacultural research station in Colombia at request of AID, May 27-June 7, 1974. He at-

tended FAO Conference on Fishery Products in Japan and reviewed Japanese research in fish nutrition, December 2-18, 1973. He provided short-term assistance in fish nutrition to fisheries project in Northeast Brazil, November 19-November 29, 1973.

Dr. M. M. Pamatmat. Reviewed aquacultural research in Scotland, Germany, Sweden, and Norway, June 15-30, 1973.

Dr. 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. He surveyed potential for aquacultural development in Haiti at request of AID, August 20-31, 1973, and attended symposium on mullet culture held in Israel, May 31-June 9, 1974.

Dr. D. R. Bayne. Surveyed nuisance aquatic plants in reservoirs in Morocco at request of AID, March 21-30, 1974.

Dr. W. D. Davies. Participated in FAO Symposium on 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, June 17-29, 1974.

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. Seven subscriptions to scientific journals were purchased. Grant funds are utilized only to pay the initial year of a subscription. Other funds are used to continue the subscriptions.

IMPACT OF GRANT SUPPORTED ACTIVITIES ON INSTITUTIONAL CAPABILITIES

Auburn University has been involved in international fisheries work for a number of years. While realizing the potential and value of service in this area, the present degree of involvement by the University would not be possible without financial support provided by the grant. 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 involvement:

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 United States and abroad.

The academic staff with support from laboratory technicians, secretaries, graduate research assistants, and field labor produced 13 major research publications during the year. 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 theses.

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 research projects supported by other than State appropriated, University funds. Several of these 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. The University paid most of the costs for this teaching, but the grant funds made available more specialists 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. Combining teaching funds and grant funds made possible the joint appointments of seven different teachers who 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 10 of these. Including the new students admitted, an average of 53 graduate students were enrolled each quarter in the program at some time during the year.

Twenty-five students received advanced degrees during the year, as follows:

	Degree awarded	
Origin of recipient	*M.S.*	*Ph.D.*
American	11	2
Foreign	9	3
TOTAL	20	5

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 as follows:

	No. of	*Number of students enrolled*[1]	
Quarter	*courses*	*American*	*Foreign*
Summer 1973	9	55	63
Fall 1973	10	91	78
Winter 1974	11	75	55
Spring 1974	10	55	57
TOTAL	40	276	253

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

UTILIZING 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.

In addition to activities already mentioned, Auburn provided technical assistance in inland fisheries and aquaculture to four countries, through 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.

The Department and Center are becoming increasingly involved with 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 Jerusalem in Israel. The project is supported by funds from the United States – Israel Binational Science Foundation.

Most of the past support for Auburn's efforts in international development has come from AID. In the future, more of this 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. This assistance will include supervision of 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 7 years the farm will be operated by the State.

Of the 25 students receiving advanced degrees, 13 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.

Approximately 60 visitors representing 15 countries came to Auburn to discuss international development during the year. Special tours, demonstrations, and seminars were arranged for several of the visitors. A list of the visitors follows:

Name and address	*Dates of visit*
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.E.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, Missouri	February 20, 1974
Steven E. Anderson Fisheries/PTR c/o American Embassy B. P. 697 Kinshasa, Zaire, Africa	March 18-22, 1974
Peter I. Tack E. W. Roelofs Michigan 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 Tallahassee, 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 Tallahassee, Florida	May 2-3, 1974
David Hughes Oklahoma State University Stillwater, Oklahoma	May 13-16, 1974

Frederick J. Laney
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National Oceanic and Atmospheric Adm.
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Paul F. Randel
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Puerto Rico

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

L.A.E. Angel Brito Guthiérrez
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
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333 Ravenswood Avenue
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Mitsutake Miyamura
Japan Air Lines
Consultant for Trade Development
Specialist of Marine Product Industry
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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
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Japan — June 26, 1974

Sakae Terada
Assistant Manager
Cargo Sales Development Division
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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

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	$177,907
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	48,859
TOTAL	$581,082

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 periodicials. Seven of the grant-funded academic staff taught nine academic courses during the year. A total of 161 students (87 American and 74 foreign students) were enrolled in these courses. Twenty-five students (13 American and 12 foreign) were awarded graduate degrees during the year. Grant-funded staff served as major professors for nine of these graduates.

Approximately 60 visitors from 15 countries came to the Center on business related to international development. 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 overseas 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.

SWINGLE HALL, AUBURN UNIVERSITY