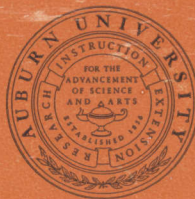


December 1972

the
International
Center for
Aquaculture
annual report for FY
1972



Agricultural Experiment Station
R. Dennis Rouse, Director

Auburn University
Auburn, Alabama

Annual Report for FY 1972

Project: AID / csd 2780

THE INTERNATIONAL CENTER for AQUACULTURE

INTRODUCTION

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 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 develop a library of worldwide literature on aquaculture and 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.

ACCOMPLISHMENTS DURING THE YEAR

Technical Staff

The staff, percentage of time paid under AID/csd-2780 funds, together with their fields of specialization were as follows:

H. S. Swingle, Director, 57 per cent. Specialties: Pond Construction; Aquacultures; Fish Population Dynamics.

E. W. Shell, Professor, 30 per cent. Specialties: Fish Population Dynamics; Fish Physiology and Nutrition.

C. E. Boyd, Assoc. Professor, 100 per cent. Specialties: Aquatic Ecology; Aquatic Plants.

R. T. Lovell, Assoc. Professor, 30 per cent. Specialties: Fish Feeds and Fish Technology.

R. O. Smitherman, Assoc. Professor, 50 per cent until January 1972. Subsequently assigned to a 2-year tour in Panama under AID/la-684 beginning January 1, 1972. Specialty: Aquacultures.

N. B. Jeffrey, Assist. Professor, 50 per cent upon return from 2-year tour in Brazil under AID/csd-2270, T.O. 3 on January 1, 1972. Specialty: Aquacultures.

Other staff members adding to the capability of the Center, but supported entirely by other funds include:

Dr. Ray Allison, Assoc. Professor. Specialties: Fish Parasites; Circulating Water Cultures.

Dr. David R. Bayne, Asst. Professor. Specialties: Aquacultures; Aquatic Plants (Overseas: El Salvador).

Dr. W. D. Davies, Asst. Professor. Specialties: Fish Populations; Reservoir Management (Overseas: Brazil).

Dr. J. S. Dendy, Professor. Specialty: Limnology.

Dr. John H. Grover, Asst. Professor. Specialties: Aquacultures; Limnology (Overseas: Philippines).

Mr. John W. Jensen, Research Assoc. Specialty: Fisheries Extension (Overseas: Brazil).

Dr. J. M. Lawrence, Professor. Specialties: Aquatic Plant Control; Nutrient and Heavy Metal Relationships in Rivers and Impoundments.

Dr. Leonard L. Lovshin, Asst. Professor. Specialty: Aquacultures (Overseas: Brazil).

Dr. D. D. Moss, Professor. Specialties: Aquacultures; Pond Construction.

Dr. John A. Plumb, Asst. Professor. Specialty: Fish Diseases.

Mr. E. E. Prather, Assoc. Professor. Specialties: Fish Cultures; Hatchery Management.

Dr. J. S. Ramsey, Leader, Alabama Cooperative Fishery Unit. Specialty: Fish Taxonomy.

Dr. W. A. Rogers, Assoc. Professor. Specialties: Fish Parasites; Fish Taxonomy.

Dr. H. R. Schmittou, Asst. Professor. Specialties: Aquacultures; Pond Construction (Overseas: Philippines).

Dr. William Shelton, Assistant Leader, Alabama Cooperative Fishery Unit. Specialties: Reservoirs and Streams; Fish Populations.

Technicians:

One Laboratory Technologist.

Graduate Research Assistants and Trainees:

The following graduate research assistants were supported on AID/csd-2780. Their names, per cent of time, and areas of research were:

R. K. Goodman, 33 per cent. Fish Genetics.

J. D. Grogan, 33 per cent. Filters to remove fish wastes from water.

W. L. Lane, 33 per cent. Digestive Physiology.

D. F. Leary, 30 per cent. Fish Nutrition and Fish Feeds.

L. L. Lovshin, 60 per cent. Aquaculture (Use of Plants to Remove Wastes).

J. W. Miller, 33 per cent. Aquaculture (Pen Culture).

Cost of research projects of AID participant trainees from developing countries was also supported in part by AID/csd-2780. These students and their field of research were:

Philippines

Arsenio Camacho. Use of Fish Offal in Fish Feeds.

Catalino De La Cruz. Aquaculture in Recirculated Water.

Romeo Fortes. Relationship of Chlorophyll to Aquatic Productivity.

Rafael Guerrero. Sex Reversal in Tilapia.

Thailand

Kamonporn Tonguthai. Fish Parasites.

Sopa Areerat. Fish Parasites.

Tawan Chookajarn. River Fisheries.

Vanida Koonsoongnoen. Fish Parasites.

Sompong Hiranvat. River Fisheries.

Prasert Sitasit. Use of Plant Proteins in Fish Feeds.

Charoen Phanil. Effect of Water Hyacinths on Plankton Production.

Chaliang Chaitamvong. Use of Common Carp to Clean Pond Waters.

Oopatham Pawaputanon. Circulating Water Fish Culture.

Somsuk Singholka. Cage Culture of Common Carp.

Pichit Srimudka. Effect of Pen Culture on Water Quality.

Pramot Suwanasart. Cage Culture of Tilapia.

Taiwan

Charng-Jyi Chiou. Effect of Soil Phosphorus on Algae Production.

Panama

Remberto Rosas. Fish Processing Technology.

Rene Sanchez. Fish Nutrition.

India

Dilip Mathur. Feeding Dynamics of Stream Fishes.

Ghana

Lewis Sackey. Algal-induced Off-tastes in Fish.

Library of World-Wide Literature on Aquacultures

Progress was continued in enlarging the library on aquacultures. Periodicals from the H. S. Swingle and E. W. Shell personal collections were added to the library of the International Center for Aquaculture. Sets of publications were

sent free of charge from fisheries departments of Thailand, Peru, and Mexico, and to lesser extents those in other countries.

Additional books and periodicals were purchased for the library, including 160 books and subscriptions to 4 periodicals.

Abstracting Service on Publications Dealing with Aquacultures and Inland Fisheries

This service to fisheries divisions and AID Missions in developing countries was continued. Publications and reprints coming to Auburn from all parts of the world are examined and information pertinent to development of aquacultures and inland and coastal fisheries is copied, indexed, and sent abroad every 4 to 6 weeks as sufficient material is accumulated. This service is effective in keeping fisheries officials, the Auburn staff abroad in AID projects, and the Agricultural Officers in AID Missions abreast of recent developments.

When requested, entire articles are copied and made available.

Cross-reference files are being prepared of published information dealing with aquacultures so that information will be readily available. No progress has been made on computerizing this information, partly because several institutions have already done this for various biological subjects or are in the process of doing so. To what extent this will serve aquacultures remains to be seen. Adequate indexing of aquacultural subjects must usually be prepared by personnel intimately involved in aquacultures, as only they would know the importance of publications in this field.

Survey of Aquacultural Developments Abroad

Following the survey of aquacultural developments in Japan and Taiwan in May-June 1971, by Dr. H. R. Schmittou of our staff, a report entitled "Aquaculture Survey in Japan, Project AID/csd-2780" was prepared and published in February 1972.

A similar report on Taiwan is in press.

Survey of Commercial Fish Species and Fishes of Potential Value for Culture in Ecuador

One of the obstacles to development of aquacultures in Central and South America is that little is known about the suitability of native species for culture. The river systems of South America, especially the Amazon River system, contain hundreds of species that are of potential value, but only in the last few years has any attempt been made to evaluate their usefulness for culture. Research on this problem is being conducted in a few experimental ponds in Colombia and Ecuador, with more extensive testing going on in Brazil under a USAID-Auburn University-DNOCS project at the new Fortaleza Fisheries Research Station. Many Central and South American countries have imported fish, including the common carp, tilapias, largemouth bass, and trout. In a few countries imported species are not wanted or allowed by law. Development of aquacultures will be slow in Latin America until satisfactory local species are found. What is needed is a coordinated effort in all these countries to evaluate local species for cultures on the basis of their efficiency in utilization of natural and formulated feeds, diversity of feeding habits, maximum production per acre, acceptability on local and export markets, and costs of production under intensive culture.

Similar information is needed on the adaptability of various species to conditions in reservoirs that are being con-

structed for irrigation, water supply, and power in the underdeveloped countries.

Following an initial survey in Ecuador under AID/csd-2270 by the Auburn University staff in 1969¹, a second trip was made in 1971 to prepare a "Proposed Cooperative Fishery Program."² Because of the urgent need for identifying species for intensive culture and for use in reservoirs, we proposed a coordinated program between the host country, AID, and FAO. We considered a better knowledge of the commercial species of fishes and the potentially useful species of fishes and shrimps of such importance to the development of fisheries in Latin America that we recommended a survey of these species under Auburn project AID/csd-2780. This survey was conducted during the period October 18 to December 4, 1971, and a report of the work is in press. The survey was made by R. Gilbert, a graduate assistant at Auburn, and a consultant, Dr. Tyson Roberts of the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts. A reference collection of commercial species was prepared for the Ecuador Departamento de Piscicultura. A collection of commercial species and species considered potentially useful for aquacultures was retained at Auburn, and a more extensive collection was deposited at the Harvard Museum for identification and classification. A report is being prepared.

Participation of Staff in International Activities

Surveys, Seminars, and International Publications

Six staff members took part in fisheries surveys in El Salvador, Brazil, Nicaragua, Peru, and Thailand.

¹ SWINGLE, H. S. AND F. A. PAGAN. Dec. 20, 1969. Fishculture Survey Report for Ecuador. Project AID/csd-2270.

² SWINGLE, H. S. May 25, 1971. Proposed Cooperative Fishery Program for Ecuador. Project AID/csd-2270.

Dr. H. S. Swingle took part in the February 1972, Mekong Development Panel Seminar sponsored by the Southeast Asia Development Advisory Group (SEADAG) and held in California. He prepared a report entitled, "Relationship of the Thai Fish Culture Program to Production of Fish in the Lower Mekong Area."

Dr. C. E. Boyd took part by invitation in a Canadian symposium on Aquatic Communities held in June 1972, and presented results of research conducted at the Auburn University International Center for Aquaculture.

Dr. E. W. Shell served as editor for preparation of an FAO Manual for Fishculture Research.

Foreign Assignments

Dr. R. O. Smitherman began a 2-year assignment on January 1, 1972, under AID/la-684 project to develop aquacultures in Panama.

Dr. H. R. Schmittou and Dr. J. H. Grover are currently serving a 2-year assignment to the Philippines under AID/ea-180 project to develop aquacultures for both freshwater and brackishwater.

Dr. David R. Bayne began a 2-year tour in El Salvador to develop aquacultures under AID/la-688 project.

Dr. W. D. Davies returned August 1972, from a 2-year assignment in Brazil under AID/csd-2270, T. O. 4.

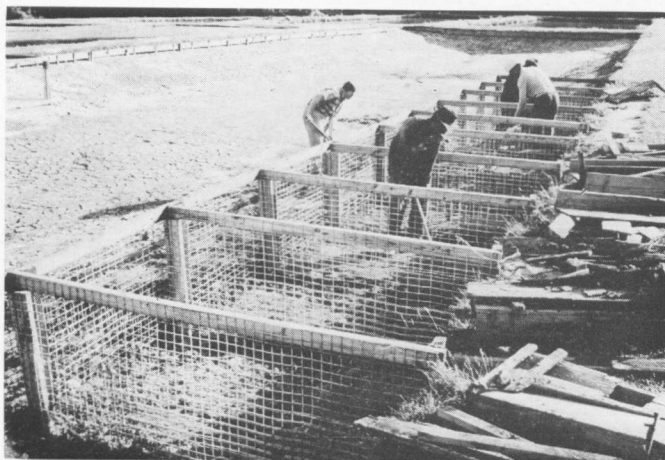
Dr. N. B. Jeffrey returned October 1971, after a 2-year tour in Brazil under AID/csd-2270, T.O. 3. He was replaced by a new member of our staff, Dr. L. L. Lovshin, who arrived in Brazil in June 1972. Another member of our staff, Mr. J. W. Jensen, began a tour of duty in Brazil to develop a fisheries extension program for the Northeast. Both Lovshin and Jensen are under AID/csd-2270, T.O. 8 project.

RESEARCH REPORTS

A summary of the research conducted during FY 72 by staff, graduate research assistants, and graduate students follows:

Fish Breeding and Genetics

This long-term project is proceeding at a satisfactory pace. It is designed to develop improved strains of channel catfish for culture and to develop methods of testing to identify genetic differences. F-2 hybrids and selected strains are currently under tests for rapidity of growth, efficiency in feed conversion, and resistance to a virus disease.



Spawning cages being readied for new population of brood channel catfish. Each pair of catfish will produce 10,000-20,000 fry.

Fish Feeds and Feeding

Ascorbic acid was found to be necessary in the diet of channel catfish. Deficiency in this vitamin resulted in deformed spinal columns, reduced resistance to disease, slower growth, and increased mortality. Humped back in front of the dorsal fin was the most frequent deformity.

Assistance was given in development of fish feeds from locally available materials in Brazil, Thailand, and the Philippines.

Use of "demand" feeders, operated by the fish themselves,



Graduate student stocking cages with fingerling catfish for feeding trials. Production in such cages has reached 400 lb. of fish per cubic meter of water in 180 days.

gave slightly higher production (1,799 pounds/acre) than that obtained by hand feeding (1,599 pounds/acre), but the latter gave more efficient feed conversion (1.29 pounds to produce 1 pound of catfish).

Concentrated Fish Feeds

Lowest feed to fish conversions were obtained with feeds containing 35 and 40 per cent protein. If protein is of good quality, 35 per cent is sufficient. Concentrated feeds are being tested to reduce water pollution.

Increasing Fish Production

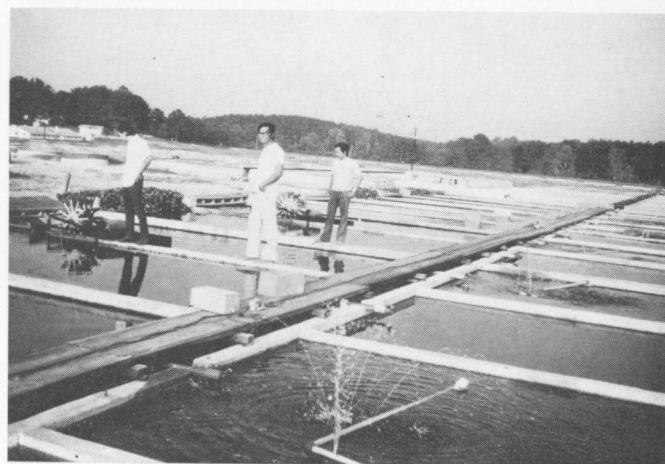
Means for increasing fish production undergoing tests are the use of aeration, biological filtration, and waste control through the use of aquatic plants and animals.

Aeration

Methods of aeration include use of air blowers, water pumps spraying water into the air, water circulation, venturi-pump systems, and paddlewheels. Efficiency of these methods and costs of fish production under these systems are being evaluated.

Biological Filtration

Under this method water from the culture is pumped and sprayed onto the open top of a tower filled with fine gravel. Organisms grow upon the stones and remove particulate matter and nutrients as the water percolates through the tower and returns to the culture pond. Costs for water circulation and other costs of fish production under this method of management are being evaluated. This method of water purification has not proved entirely satisfactory because heavy plankton growth appears in the filtered water. However, it has produced an eight-fold increase in production over check ponds with no filtration.



Advanced graduate students from the Philippines carrying on research on fish production in recirculated water.

Waste Control by Use of Aquatic Plants and Animals

Water Hyacinths. Water hyacinths proved very effective in absorption of nutrients from eutrophic waters. Their presence over 0.1 to 0.05 per cent of the pond surface prevented development of heavy plankton blooms. However, the presence of water hyacinths alone resulted in lower fish production because their presence decreased surface of water available for gaseous interchange with the air. It is evident that methods of water aeration must be added.

Use of the Plankton-Feeding Tilapia. Use of the plankton-feeding tilapia (*T. aurea*) along with channel catfish resulted in 85 per cent increase in yield of catfish (up to 4,485 pounds per acre) plus 525 pounds of harvestable tilapia, or a total of 5,010 pounds of harvestable fish per acre (108 per cent increase over catfish alone). Where this combination of fishes was used in commercial production ponds, total production of harvestable channel catfish was 4,588.6 pounds per acre. This, plus 1,382 pounds of harvestable tilapia, gave a total of 5,971 pounds harvestable fish per acre in 236 days. The S feed conversion value was 1.19 pounds of feed per pound of harvestable fish produced.

These experiments demonstrated that mixed cultures of channel catfish and *T. aurea* yielded higher production at less cost per pound than that obtained by the culture of channel catfish alone.

The Mussel. The mussel (*Corbicula*) is native to Asia but has established itself widely in the United States. It is currently in tests for the reduction of excessive algal blooms in aquacultures.

Cage Culture of Fishes

Culture of *Tilapia aurea* in cages suspended in ponds, where plankton was abundant as a result of commercial production of channel catfish, yielded 131 pounds per cubic meter of cage in 80 days without feeding the tilapia. They utilized plankton present in water that passed through the cage as a result of wind action. There was no reproduction by the tilapia under these conditions and this may be a usable method of growing tilapia in eutrophic waters.

When fine-mesh screen was placed in the bottom of the cage, tilapia deposited eggs on the screen and subsequently incubated the eggs in their mouths. Apparently use of screens too coarse to retain the eggs in the bottom of the cage is necessary to prevent reproduction by these fish.

Feeding the tilapia in cages yielded 317 to 443 pounds tilapia per cubic meter in 80 days. The S feed conversion of tilapia in cages varied from 0.95 to 1.35 for floating pellets and was 1.86 for sinking pellets.

Pen Culture

This research was continued at Auburn and in Thailand to develop methods for intensive culture of fish in fenced-in areas along the margin of reservoirs. The pens extended from the shoreline to water depths of 5 feet. Tests are in progress to determine the life expectancy of bamboo and plastic net fences in coordinated experiments at Auburn and in Thailand. Production in pens stocked with *Tilapia aurea* and channel catfish was 12,660 to 15,688 pounds of fish per acre of pen when feeding was used. Feed conversions ranged from 1.38 to 1.57.

In pens without feeding, production was 2,250 pounds per acre of the plankton-feeding tilapia and only 106 pounds of the insect-feeding catfish. Outside the pens, the standing crop of fish was approximately 400 pounds per acre of catfish-tilapia-bluegill-largemouth bass. This indicated that tilapia in pens were utilizing fish-food organisms that were not being adequately harvested by the fish population free in the pond.

Research is continuing to determine optimum stocking rates and most suitable species for pen culture. This method of culture appears promising for use in developing countries when reservoirs have been constructed for irrigation or local water supplies.

Use of the White Amur for Control of Aquatic Weeds

This fish, when stocked in ponds at rates of 10 to 20 per acre, controlled weeds effectively over a 4-year period without interfering with the growth of bluegill-bass or channel catfish. This species should be especially useful in areas where schistosomiasis occurs. Snails are the alternate host of this parasite. It has been found that snails are principally abundant when marginal waters are filled with aquatic weeds and that most of the snails disappear after the weeds are eliminated. Removal of the weed cover makes snails vulnerable to predation by many species of fishes.

For stocking into established fish populations in reservoirs, this fish must be 6 to 8 inches in total length to survive predation by fish-eating species.

Studies on Algal Blooms

One of the problems in aquacultures worldwide is that of fish kills caused by overabundant blooms of algae and their subsequent die-offs. Blue-green algae are the principal causes of these fish kills. Research demonstrated that the blue-green algae excrete wastes which prevent growth of the more desirable green algae, with the result that there is often a monoculture of blue-green algae. These algae are objectionable because they rise to the surface in hot, still days and form scums that prevent photosynthesis in deeper waters. Companion research on this problem is being conducted in Israel.

Off-Flavors in Fish

Off-flavors occur in fish and other aquatic products both in nature and where under culture. *Anabaena*, a blue-green algae, and *Actinomyces* were found to cause musty off-flavors in fish. They also cause similar odors and taste in city water supplies coming from impoundments. Methods for their control are being studied.

PUBLICATIONS

A list of publications from the International Center for Aquaculture and the Department of Fisheries and Allied Aquacultures follows. Personnel on research supported wholly or in part by this project are marked by asterisks.

*BOYD, CLAUDE. 1971. Leaf Protein From Aquatic Plants. N.W. Pirie (Ed.) Leaf Protein: Agronomy Quality, and Use. IBP Handbook, No. 22, Blackwell Sci. Pub., Oxford p. 44-49.

..... 1971. Limnological Role of Aquatic Macrophytes and Their Relation to Reservoir Management. G. E. Hall (Ed.) Reservoir Fisheries and Limnology. Special Publ. No. 8, Amer. Fish. Soc., Washington, D.C. p. 153-166.

..... 1971. Nutritive Quality of Food in Ecological System. Archiv. Hydrobiol. 68:156-172. (with C. Philip Goodyear.)

CHIEN, SHIH MING. 1971. Dactylogyrids from North American Cyprinids of the Genus *Nocomis*. The *Reciproca* Species Group. J. Parasit. 57(6):1211-1214.

DENDY, J. S. 1971. Disposable Planchets for Weighing Macro-benthos. Progressive Fish-Culturist, 33(3):184. (with G. B. Pardue and L. R. Aggus.)

..... 1971. Phenology of Midges in Experimental Ponds. Proc. of the 4th International Symp. on Chironomidae. The Canadian Entomologist, 103(3):376-380.

GREENE, GEORGE N. 1971. An Experiment on the Effect of Pond Soil on Calcium in Pond Water. Trans. Am. Fish. Soc. 100(3):580-582.

JOHNSON, STERLING K. 1971. North American Distribution Record for *Paraergasilus* Markewitsch, 1937 (Copepoda: Cyclopoidea: Ergasilidae). J. Parasit. 57(5):1051. (with W. A. Rogers.)

*KILGEN, R. H. AND R. O. SMITHERMAN. 1971. Food Habits of the White Amur Stocked in Ponds Alone and in Combination With Other Species. Progressive Fish-Culturist, 33(3): 123-127.

*LIANG, J. K. AND R. T. LOVELL. 1971. Nutritional Value of Water Hyacinth in Channel Catfish Feeds. Hyacinth Control J. 9(1):40-43.

*LOVELL, RICHARD T. 1971. The Off-Flavor Problem in Commercially Cultured Catfish. Proc. Assoc. Southern Ag. Workers, Inc. 68th Ann. Convention p. 139.

..... 1971. Significant Aspects of Feed Preparation for Feeding Catfish. Proc. Ga. Nutritional Conf. (Univ. of Ga.) p. 101.

PLUMB, JOHN. 1971. Channel Catfish Virus Research at Auburn University. Auburn Univ. (Ala.) Ag. Exp. Sta. Prog. Rep. No. 95.

..... 1971. Fish Cell Growth Rates: Quantitative Comparison of RTG-2 Cell Growth at 5 to 25°C. In Vitro, 7(1):42-45. (with K. E. Wolf.)

..... 1971. Tissue Distributions of Channel Catfish Virus. J. Wildl. Dis. 7:213-216.

RAWSON, MAC, JR. 1971. A Redescription of *Anchoradiscus trigangularis* (Summers, 1937) Mizelle, 1941 (Trematoda: Monogenea) From the Bluegill (*Lepomis macrochirus*) Rafinesque. Proc. of Helminthological Soc. of Wash. 38(2): 264-266. (with W. A. Rogers.)

ROGERS, WILMER A. 1971. Principal Diseases of Catfish. Fish Farming Industries, 1971. 2(1):20-26.

..... 1971. *Sebekia oxycephala* (Pentastomida) in Largemouth Bass from Lake St. John, Concordia Parish, Louisiana. J. Parasit., 57(5):1028. (with George H. Dukes, Jr., Robert M. Shealy.)

WILLIAMS, E. H. 1971. Two New Species of *Gyrodactylus* (Trematoda: Monogenea) and a Redescription and New Host Record for *G. prolongis* Hargis, 1955. J. Parasit. 57(4):845-847. (with W. A. Rogers.)

*SWINGLE, H. S. 1972. Relationship of the Thai Fish Culture Program to Production of Fish in the Lower Mekong Area. Mekong Development Panel Seminar, Feb. International Center for Aquaculture. 16 pages.

The following publications were in press at the time this report was prepared.

*BOYD, CLAUDE. Studies on the Biogeochemistry of Boron. I. Concentrations in Surface Waters, Rainfall, and Aquatic Plants. Amer. Midl. Nat. (with W. W. Wahlquist.)

..... A Bibliography of Interest in the Utilization of Vascular Aquatic Plants. Econ. Bot. 25.

..... Phosphorus Dynamics in Ponds. Proc. 25th Ann. Conf. S.E. Assoc. Game and Fish Commrs.

CHIEN, SHIH MING. Dactylogyrids from North American Cyprinids of the Genus *Nocomis*. The *Bellicae* Species Group. J. Parasit.

PLUMB, JOHN. Channel Catfish Virus Disease in Southern United States. Proc. 25th Ann. Conf. S.E. Assoc. Game and Fish Commrs.

..... A Virus-Caused Epizootic of Rainbow Trout (*Salmo gairdneri*) in Minnesota. Trans. Am. Fish. Soc. 101(1).

PRATHER, E. E. Effect of Vitamin Fortification in Auburn No. 2 Fish Feed. Proc. 25th Ann. Conf. S.E. Assoc. Game and Fish Commrs. (with R. T. Lovell.)

*RAMSEY, J. S. Development of Color Pattern in Pond-Reared Young of Five *Micropterus* Species of Southeastern U.S. Proc. 25th Ann. Conf. S.E. Assoc. of Game and Fish Commrs. (with R. O. Smitherman.)*

REEVES, WILLIAM C. Effects of Increased Water Hardness, Source of Fry, and Age at Stocking on Survival of Striped Bass Fry in Earthen Ponds. Proc. 25th Ann. Conf. S.E. Assoc. Game and Fish Commrs. (with Jerome F. Germann.)

SMITH, B. W. Digestibility of Nutrients in Semi-purified Rations by Channel Catfish in Stainless Steel Troughs. Proc. 25th Ann. Conf. S.E. Assoc. Game and Fish Commrs.

*SMITHERMAN, R. O. Observations on Spawning and Growth of Four Species of Basses (*Micropterus*) in Ponds. Proc. 25th Ann. Conf. S.E. Assoc. Game and Fish Commrs.

..... Research on Exotic Fish Species. Proc. Primer Seminario Sobre Piscicultura En Colombia. Presented at Universidad de Caldas, Manizales, Colombia, Jan. 12-16.

*SWINGLE, H. S. Developments of Systems of Aquaculture for India. Indian Journal of Fisheries.

..... Aquaculture: Raising Food Crops in Water. World Farming Magazine.

TRAINING CONDUCTED AND DEGREES AWARDED

Seminars

Seminars were conducted at Auburn for training participants under AID fellowships and for students specializing in aquacultures. Following is a list of guest speakers.

October 1, 1971. Dr. William Shelton, Assistant Leader, Alabama Cooperative Fishery Unit, Auburn University. "The Comparative Reproduction Biology of Gizzard Shad and Threadfin Shad in Lake Texoma, Oklahoma."

October 8, 1971. Dr. John H. Grover, Assistant Professor, Department of Fisheries and Allied Aquacultures, Auburn University. (Now serving 2-year assignment in the Philip-pines.) "Fish and Fishing in North Africa."

October 15, 1971. Dr. Fred Meyer, Chief, Fish Farming Experimental Station, Stuttgart, Arkansas. "Role of Disease and Parasites in Fish Kills."

October 22, 1971. Mr. John Schachte, Graduate Research Assistant, Department of Fisheries and Allied Aquacultures, Auburn University. "Demonstration of an Immune Response in Channel Catfish to *C. columnaris* (Davis)."

October 29, 1971. Mr. Harold Wahlquist, Graduate Research Assistant, Department of Fisheries and Allied Aquacultures, Auburn University. "Age and Growth of Channel Catfish in Alabama-Tombigbee River Drainages."



American and Ghanaian graduate students cooperating on research project.

November 5, 1971. Mr. Malcolm Johnson, Owner, Delta Fish Farm, Tillar, Arkansas. "The Management and Operation of a Private Fish Farm."

November 12, 1971. Mr. Sam Spencer, Chief, Fisheries Section, Game and Fish Division, Alabama Department of Conservation, Montgomery, Alabama. "The Fishery Research Programs of the State Department of Conservation."

November 19, 1971. Dr. C. E. Boyd, Associate Professor, Department of Fisheries and Allied Aquacultures, Auburn University. "Algal Communities in Fish Ponds."

December 3, 1971. Mr. J. F. Germann, Graduate Research Assistant, Department of Fisheries and Allied Aquacultures, Auburn University. "Further Experiments on the Growth and Survival of Striped Bass."

January 7, 1972. Dr. F. Eugene Hester, Chief, Division of Fishery Research, BSWF, U.S. Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C. "The Role of the Division of Fishery Research."

January 14, 1972. Dr. Roger Lee Herman, Libby-Owens Truck and Trout Farms, Owens, Illinois. "Fish Pathology in Trout Culture."

January 21, 1972. Mr. Alex Montgomery, Regional Supervisor, Fishery Services, BSWF, U.S. Fish and Wildlife Service, U.S. Department of the Interior, Atlanta, Georgia. "Southeastern Fisheries Program of the Service."

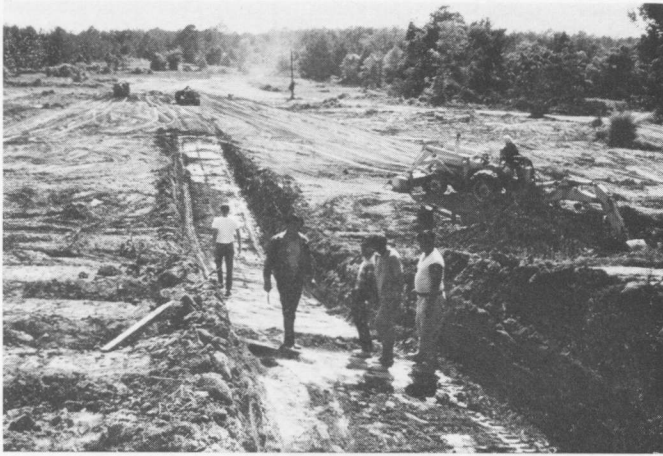
January 28, 1972. Mr. R. J. Gilbert, Graduate Research Assistant, Department of Fisheries and Allied Aquacultures, Auburn University. "Fishes of Ecuador."

February 11, 1972. Dr. Mitsutake Miyamura, Vice President, Marifarms, Inc., Panama City, Florida. "Marifarms Efforts in Shrimp Culture."

Mr. David Bowman, Peace Corps Volunteer, U.S. Peace Corps, Santa Cruz Porrillo Fisheries Station, Santa Cruz Porrillo, El Salvador. "Fishculture in El Salvador."

February 18, 1972. Mr. Wayne E. Swingle, Chief Biologist, Seafoods Division, Alabama Department of Conservation, Marine Resources Laboratory, Dauphin Island, Alabama. "Cultures of Oysters and Trout; Research Conducted by the Seafoods Division."

February 25, 1972. Mr. Philip C. Pierce, AID/W (formerly Aquatic Plant Specialist for AID/Ghana). "The Lake Volta Project."



Pond construction class examining core trench for new dam.

Students in Academic Fisheries Courses

Undergraduate Students (U.S. and Foreign)

During the 1971-72 academic year there was an average of 35 undergraduate students enrolled in courses in Fisheries and Allied Aquacultures each quarter.

Graduate Students

In the 1971-72 academic year there were 48 graduate students enrolled in the Department. Students receiving the M.S. degree in Fisheries Management were: J. H. Addison, U.S.; W. Reeves, U.S.; J. H. Schachte, U.S.; W. H. Tucker,



Graduate students conducting a stream survey.

U.S.; and Kamonporn Tonguthai, Thailand. Those receiving the Ph.D. in Fisheries were: J. L. Gaines, U.S.; J. A. Plumb, U.S.; and H. Wahlquist, U.S.

Number of Students in Courses

A total of 365 students registered in the 23 courses offered during the 1971-72 academic year. The total student credit hours produced was approximately 1,500.

Special Training for Biologists and Officials from Foreign Countries

Short-time training and instruction on the following subjects was given as required: Reservoir construction; experimental pond construction; fish feeds and feeding; limnology; fish cultural methods; aquatic plant utilization and control;



Principles of reservoir management being explained to class containing American and foreign students.

fish parasites and diseases; water quality criteria and analyses; fish processing technology; research methods and records; and circulating water cultures and waste removal.

Staff from the International Center for Aquaculture participated in the training and instruction at Auburn of the following biologists and officials:

Mr. Wittington Kakdna Sikalumbi, Minister of State, Lands and Natural Resources, Zambia. Mr. John Large, State Department, was Mr. Sikalumbi's escort. September 3, 1971.

Sr. Gustavo Casas A., C.I.F.S.A., Consultores en Ingenieria, Fluvio Maritima S.A., Mexico D. F., Mexico. September 27-28, 1971.

Sr. Absalom Lara Vargas, C.I.F.S.A., Consultores en Ingenieria, Fluvio Maritima S.A., Mexico D. F., Mexico. September 27-28, 1971.

Sr. Yunuen Rabadan G., C.I.F.S.A., Consultores en Ingenieria, Fluvio Maritima S.A., Mexico D. F., Mexico. September 27-28, 1971.

Mrs. Indu Mehta, FAO Fellow, Assistant Plant Physiologist with the United Nations Development Program (Special Fund) Chambal Land and Water Use Management Project, Rajasthan, India. October 4-15, 1971.

Sr. Rudolfo Parades Perez, Technical Advisor, Fresh Water Fish, Division de Promocion, Lord Cockrane 351, Miraflores, Lima, Peru. October 9-16, 1971.



International visitors examining pond construction details at Auburn fisheries facility.

Dr. Reynaldo Lantin, Assistant Professor, Power and Machinery Division, Department of Agricultural Engineering, University of the Philippines, Laguna, Philippines. October 12, 1971.

Mr. Felix Gonzales, Deputy Commissioner, Philippines Fisheries Commission, Intramuros, Manila, Philippines. October 20, 1971.

Mr. Dan Tibbs, III, Area Manager, Recruiting Action, Peace Corps/Vista, Atlanta, Georgia. October 20, 1971.

Dr. F. A. Pagan, Department of Marine Sciences, University of Puerto Rico, Mayaguez, Puerto Rico. October 31-November 7, 1971.

Sr. Jose Gonzales, Department of Marine Sciences, University of Puerto Rico, Mayaguez, Puerto Rico. October 31-November 7, 1971.

Mr. S. B. Singh, Central Inland Fisheries Research Sub-Station, Cuttack, Orissa, India. November 2-5, 1971.

Sr. Jorge Carranza, Senior Researcher and Professor, Institute of Biology, University of Mexico, Mexico 20, D. F., Mexico. November 19-22, 1971.

Sr. Jose A. Fernandes, Agronomist, DNOCS, Ceara, Brazil. November 18-24, 1971.

Sr. Jose W. Bezerra e Silva, Chief of Section, DNOCS, Ceara, Brazil. November 18-24, 1971.

Sr. F. H. Nepomuceno, Agronomist. DNOCS, Ceara, Brazil. November 18-24, 1971.

Sr. Edmundo de A. Duarte, Researcher, Fishculture Biology, DNOCS, Ceara, Brazil. November 18-24, 1971.

Mr. Paul Sundheimer, AID Mission, Bogota, Columbia. November 22-24, 1971.

Mauro E. Amutan, Chief, Fisheries Program, National Food and Agricultural Council, Diliman, Quezon City, Philippines. January 30-February 3, 1972.

David Bowman, U.S. Peace Corps, Santa Cruz, Porrillo Fisheries Station, El Salvador. February 9-12, 1972.

Dr. Elvira Tan, National Science Development Board, Philippines. April 1-8.

Pres. Maanyag M. Tamano, Mindanao State University, Marawi, Philippines. April 27, 1972.

Mr. Ernesto Herrera, Chief of Fisheries, Northern Zone, Ministry of Fisheries, Lima, Peru. May 7-27, 1972.

Mahmoud Mohammed Kashid, FAO Fellow, Department of Fisheries, Cairo, Egypt. May 18-19, 1972.

Dr. Frank Sheppard, Chief Agricultural Officer, USAID/Philippines. June 5-6, 1972.

Mr. Shimon Tal, Division of Fisheries, Tel Aviv, Israel. June 9-10, 1972.

Other Visitors to the International Center

An estimated additional 200 visitors came to the Center for advice on problems relating to catfish culture, for identification of parasites and disease, or to become familiar with research results.

These were principally fish farmers, sportsmen, and personnel from other Universities or fisheries divisions.

Groups and professional visitors are listed below.

June 26, 27, 1971	Dr. Lloyd Lamouria, Head-Agricultural Engineering Department, California Tech State University, San Luis Obispo, California.
July 21	Bob Ingram, "South" magazine, Montgomery, Alabama.
July 28	Wayne McLendon and J. W. Kinsey, Georgia Game and Fish Commission, Calhoun, Georgia.
August 2	I. B. Byrd, U.S.D.I.-BCF, St. Petersburg, Florida.
August 3	H. E. Bray, Pompano Beach, Florida.
August 4	Fernando Wong Davila, Lima, Peru.
August 10	John W. Andrews, ARS, Conecuh Co., Alabama.
August 23	Claude Kelley, Charles Kelley, and Archie Hooper, Alabama Department of Conservation.
August 25	A. G. Duke, St. Regis Paper Company, Pensacola, Florida.
Aug. 31-Sept. 3	S.C.S. group from U.S. for Aquaculture Shortcourse.
October 4	H. J. Bowen, The Franklin Institute, Philadelphia, Pennsylvania.
October 5	O. E. Sell, Georgia Experiment Station, Griffin, Georgia.
November 16	Dr. W. R. Willard, Kentucky Medical School, Lexington, Kentucky.
December 1	Tony Calabrese, U.S. Bureau of Commercial Fisheries, Shellfish Laboratory.
December 16	E. T. Burkholder, International Basic Economic Corporation.
January 5, 1972	Lee Scrivner, Georgia-Alabama Bass Club.
January 12	Michael F. Schaible A.E.O. Systems, Inc., Laritano, Florida.
February 11	Dr. Mitsutoko Miyamura, V.P. Mari-Farms, Inc., Panama City, Florida.
February 15	Dr. Damon C. Shelton, Ralston Purina Fish Food Research Division, St. Louis, Missouri.
February 21	Harry Knipp, Motion Picture Producer, Int. Harv. Co., Sheridan, Illinois.
March 3	University of Florida Agricultural Engineering Department (5 persons).
March 22	Mario Pamatmat, University of Washington, Department of Fisheries.
March 27	Dr. Albert Hasler, University of Wisconsin, Madison, Wisconsin.
March 30	Rotary International, Auburn, Alabama.
April 27	Charles Madewell and Barry Gass, TVA, Rural Development.
May 18	Dr. R. B. Wagner and L. R. Sherman, Hercules, Inc., Wilmington, Delaware.
May 23	Ken Riding and 2 other movie men from International Harvester Co.
June 8	R. Mansfield-Jones, AID advisor, Guatemala.



New Fisheries Building at Auburn University.

ADDITIONAL SUPPORT FROM AUBURN UNIVERSITY

The University will have completed one wing of a planned three-wing building to house the Fisheries-Wildlife complex. The completed wing has a total of 26,000 square feet of space and cost \$1,050,000.

The Department was allotted additional space in the form of four brick laboratory buildings with 6,480 square feet of space and an estimated value of \$750,000. This will ensure adequate space for training of participants and graduate students in research as well as academic subjects. It will make available some space for expansion of activities in fisheries and water management.

Additional land (60.4 acres) was purchased at a cost of \$26,000 to provide a site for a new water reservoir pond to supply extra water to the experimental pond area.

Additional funds (\$12,000) were allotted to the Department by the Agricultural Experiment Station to cover increased costs of current research and to initiate new research on commercial fish production.

ADDITIONAL RESEARCH PROJECTS BEGUN IN FY 72

Ecological Factors Associated with Dense Blooms and Die-Offs of Blue-Green Algae

This was proposed as an international cooperative project with Israel to be supported by the National Science Foundation. However, funds did not become available in Israel for international research. The project is being carried on by joint Auburn University Agricultural Experiment Station and AID 2780 funds because dense blooms of blue-green algae are the cause of fish kills in cultures throughout the world.

Fish Parasites and Diseases

Additional funds were made available by two states (Tennessee and Missouri) for research on fish diseases.

Survey of River at Proposed Nuclear Power Site

This is supported by the Alabama Power Company.

Weed Control in Reservoirs

Funds from the U.S. Corps of Engineers support this work.



Fish populations in major reservoirs are sampled with the aid of electrical fish-collection equipment.

ADDITIONAL AID PROJECTS FINANCED BY USAID MISSIONS

The following AID projects were initiated in FY 72:

AID/csd-2270, T.O. 5 – Fishery Survey in Peru.

AID/csd-2270, T.O. 7 – Fisheries in Thailand.

AID/csd-2270, T.O. 8 – Fisheries Research, Training, and Extension in Brazil.

AID/ea-180 – Fisheries Research and Training in the Philippines.

AID/la-684 – Fisheries Research and Training in Panama.

AID/la-688 – Fisheries Research and Training in El Salvador.

OBJECTIVES

To Add Experts in Selected Fields to the Faculty

This has been done to the extent made possible by 211(d) funds. However, in FY 72, six experienced staff members began 2-year tours abroad under our contracts with AID Missions in Brazil, Philippines, Panama, and El Salvador, while one returned from Brazil. Consequently, we find it necessary to recruit new staff members, two on 211(d), one on teaching funds, and one on state funds for research. At the same time, we expect the overseas staff to return to research-teaching jobs at Auburn on completion of their assignments. Their experience will add to the competence of the Center, while their absence detracts from it. For work abroad to be done by experienced personnel trained specifically in the work to which they are assigned, funds are needed for a rotating staff. Provision for 7 man-years, with a minimum of 4, are contained in our worldwide project, AID/csd-2270, but Task Order 6, presently funding the project, provides funds for only 1.0 full-time staff member plus 0.35 man-year for shorttime services. Manpower for servicing shorttime or longtime technical services therefore must come largely from staff on 211(d) or those on University funds.



Pond management class checking fish population balance by siening.



Full stringer shows results of proper pond management.

To Develop a Library of World-Wide Literature on Aquaculture and More Effective Methods for Dissemination of This Information

Development of the library is progressing satisfactorily and will be continued.

The Center has continued to abstract reports of recent developments in Aquaculture and make them available to key personnel in host countries and to Agricultural Officers in other Missions. As soon as sufficient important abstracts are accumulated (6 to 9 weeks), they are indexed and sent abroad by air mail. Copies are sent to key personnel in host country fisheries divisions with the hope that they are made available to all interested biologists. In some cases, copies are also sent directly to heads of local stations working on aquaculture.

We have considered a formal newsletter, but we feel that the FAO periodic publication "Fish Culture Bulletin" serves this purpose.

The problem with published material is to get it cross-referenced so that pertinent information is readily available. We have considered entering the data on computer cards, but several organizations are already doing this to some extent. We are examining these programs to see if they allow retrieval of the detailed information needed by research and extension personnel working on aquacultures.

At present we prepare card files by country, by species, and by subjects of interest to workers in the field.

To Provide Educational Opportunities in Aquaculture For Governmental Agencies, Participant Trainees for AID, FAO and Foundation, and Students Wishing to Specialize in this Field

We feel we are especially qualified to attain this objective because of our staff, long-experienced in research and teaching of various fields related to aquacultures, and the extensive laboratory and field facilities developed at Auburn for research. The experimental pond system of over 240 earthen ponds supplemented by concrete and plastic-lined ponds on a 1,360-acre fisheries research unit is the largest and best in the world. The ponds and their populations of fish, other aquatic animals, and plants are available for laboratory courses dealing with all phases of aquaculture. Graduate students and participant trainees are assigned laboratory and

research space for realistic training for the work in which they will engage.

Our greatest problem is that more and more participant trainees are coming each year, which increases the cost of research and extension training, but funds for this purpose are not made available by either AID Missions or FAO. The average cost of the research problem conducted by trainees is between \$500 and \$1,000 per person per year, including the cost of staff supervision and pond-laboratory operation. These costs therefore come from research funds under 211(d) or Agricultural Experiment Station funds. We feel that we could do a better job of training if we had more staff. Training of participants from other countries requires approximately 3 times as much staff time as training American students, principally because of the short time trainees are here, and to some extent because of language difficulties arising from the precise writing of English required by science.

To Develop a Worldwide Collection of Data on Species Suitable for Aquacultures

This is being done by search of world literature, by Auburn personnel abroad, and by Developing Country personnel when fisheries projects have developed.

The survey of suitable species in Ecuador, as previously mentioned, was for this purpose. It is especially important to identify suitable species in South America, where little is known about utility of native species and use of exotics is often not permissible. Identification of fish sold on local markets, those that become abundant in new reservoirs constructed on rivers, and those in natural lakes would indicate many species of potential value for culture. These must be species that do well in quiet waters, such as ponds or reservoirs, and that have different feeding habits. They must then be placed in experiments to determine their efficiency, production, and acceptability.

SUMMARY

Six staff members received salaries in part from the project. Fifteen additional staff members who were supported on other funds added to capabilities of the Center. Six graduate research assistantships were also supported, and cost of research training projects was supported to the extent of approximately 50 per cent for 4 participant AID trainees from Philippines, 8 from Thailand, and 2 from Panama. An additional research project by a graduate student from Taiwan was also supported.

The International Center Library was increased by 160 books and 4 periodicals. Several private collections, totaling 60 books and 1,000 issues of periodicals, were donated to the library.

Abstracting of papers dealing with various phases of aquacultures was continued, with abstracts sent abroad to AID Missions, to personnel in host countries where AID Missions have fisheries projects, and to other selected officials and biologists.

A survey was made in Ecuador to identify commercial

species of fishes and those potentially promising for aquaculture. A report was published on recent developments in aquacultures in Japan.

Six staff members participated in surveys abroad, 2 in international seminars, and 6 staff members began 2-year tours assigned to fisheries projects in Panama, El Salvador, Philippines, and Brazil. One staff member returned from a 2-year tour in Brazil.

Research included continuation of feeding and testing to develop superior breeds of channel catfish; determination that ascorbic acid was an essential vitamin and must be included in artificial diets for catfish; development of concentrated fish feeds at Auburn and in the Philippines, Thailand, and Brazil; continuing research on biological methods for reducing organic wastes in waters from cultures; cage culture of tilapia with and without feeding; intensive fish culture in pens located in the marginal waters of reservoirs at Auburn and in Thailand; biological weed control using herbivorous fish; studies on causes of plankton blooms and die-offs that cause fish mortality in pond cultures; and studies on the causes and correction of bad flavors in cultured fish.

