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Progress Report on Fisheries Development in Northeastern Brazil

I.

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The author wishes to express his gratitude to all who played a role in this project. The staff at Auburn University, U.S.A.I.D. officials and, most of all, the Brazilians are all due a sincere and everlasting "muito obrigado" for everything.

Progress Report on Fisheries Development in Northeastern Brazil

I. Aquaculture

N. B. JEFFREY[1]

INTRODUCTION

A SURVEY of fisheries problems and possibilities for development in northeastern Brazil was initiated in 1966 by an Auburn University team on a subcontract under a U.S. Bureau of Commercial Fisheries – U.S.A.I.D. contract. Personnel were E. W. Shell, E. E. Prather, and J. S. Dendy. Preliminary investigations were on the potential of the irrigation and water supply reservoirs constructed by DNOCS (National Department of Works Against the Droughts) to supply under management large quantities of fish for local consumption in this food-deficient area. The team recommended the intensive management of ponds for fish production as a productive supplement. Upon return of the team to northeastern Brazil in 1967, a suitable area for a pond research station was located below the dam of the Pereira de Miranda Reservoir at Pentecoste. However, land at this site could not be made available. In 1968 an Auburn team consisting of E. W. Shell, E. E. Prather, and N. B. Jeffrey investigated and approved an alternate site on DNOCS lands near its Training Center. The water supply would come from the General Sampaio-Serrota Reservoir via an irrigation canal. A plan for a modern fishcultural experiment station with 40 experimental ponds was devised by E. E. Prather.

Construction at this site began in early 1969 under a U.S.A.I.D.-DNOCS project with assistance by Mr. Harold Magnusson and Mr. George H. Reese, A.I.D./Brazil. Task Order 3 to Auburn University's worldwide project, A.I.D./csd-2270, was approved and initiated November 21, 1969. Under this contract, the author began a 2-year tour in Northeast Brazil with the primary duty of advising on construction of the experimental station and training DNOCS personnel in developing systems of aquaculture. At the time of his arrival, 20 experimental ponds had been largely completed except for water supply systems.

RESULTS AND DISCUSSION

This report is a summary of work carried out and recommendations made by the author during the tour of duty in Fortaleza, Ceara, Brazil. The tour began on November 21, 1969, and terminated on October 25, 1971.

The scope of work as defined in the contract document was:

1. Assist the National Department of Works Against the Droughts (DNOCS), the Superintendency for the Development of the Northeast (SUDENE), and qualified organizations and individuals in the private sector to program, develop, and implement effective methods of intensive freshwater pond fish culture in Northeast Brazil.

2. Assist the CONVENIO/DPAN (a subdivision of DNOCS for the development of freshwater fisheries in the Northeast) in the development of its Northeast fisheries research program by providing technical assistance in:

   a. the design, construction, and operation of research demonstration facilities specifically designed for intensive freshwater pond fish culture;

   b. the development of freshwater fish culture research activities to provide the most effective combination of species for commercial fish culture, control of fish diseases and parasites, control of weeds, and testing of locally available fish feeds;

   c. the training of local technicians to assist the private sector in establishing intensive freshwater pond fish culture techniques and operations;

   d. the development of DNOCS research facility to participate in the comprehensive and systematic international information exchange system on fish culture techniques.

The following accomplishments were achieved during the period of the contract:

1. A modern research facility consisting of 48 earthen ponds and a laboratory building was constructed. Construction on the facility is continuing.

2. A research program was initially aimed at evaluating species for fish cultural potential. A total of 20 different species of fishes and shrimps was studied in the research program.

3. Brazilian counterparts were trained in basic principles of fish culture and aquacultural research techniques.

4. Contacts between Brazilian counterparts and worldwide fish cultural interests were developed through personal contact and literature exchange.

5. A contract proposal for development of extension activities was initiated between U.S.A.I.D./DNOCS/Auburn University, and an extension of the contract for the position of fish culture advisor was recommended.

6. The author participated as team leader and interpreter during special 10-week training tour, October to December 1971, in which four Brazilian counterparts, Jose Fernandes, Jose Bezerra, Francisco Nepomuceno, and Edmundo Duarte, visited various aquacultural and fisheries research facilities in the United States. The principal objective of this training program was for counterpart personnel to receive first-hand knowledge in areas of fishcultural research, fish hatchery management, and commercial fish farming operations.

[1] Formerly Assistant Professor, Department of Fisheries and Allied Aquacultures; present address: Division of Inland Fisheries, North Carolina Wildlife Resources Commission, Raleigh, North Carolina.

Experimental Facilities for Aquaculture

The pond research facility, located approximately 80 kilometers west of Fortaleza, is probably the best of its type in South America. It presently consists of 48 earthern ponds and a laboratory building. There are 4 ponds of approximately 4,600 square meters each; 37 ponds of approximately 300 to 400 square meters each; and 7 ponds of approximately 1,000 square meters each. The laboratory building (20 × 30 meters) consists of an office, a chemical and dissection laboratory, a feed and net room, a wet laboratory, and eight cement holding tanks. The water supply for the ponds and the laboratory comes from the General Sampaio-Serrota Reservoir complex by way of an irrigation canal.

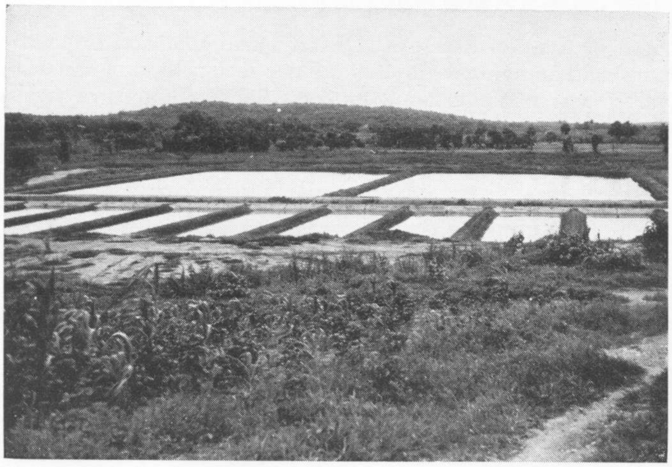

FIG. 1. View of some of the experimental ponds at the DNOCS aquacultural research facility. Ponds in foreground are 350 sq. meters and those in background are 4,600 sq. meters.

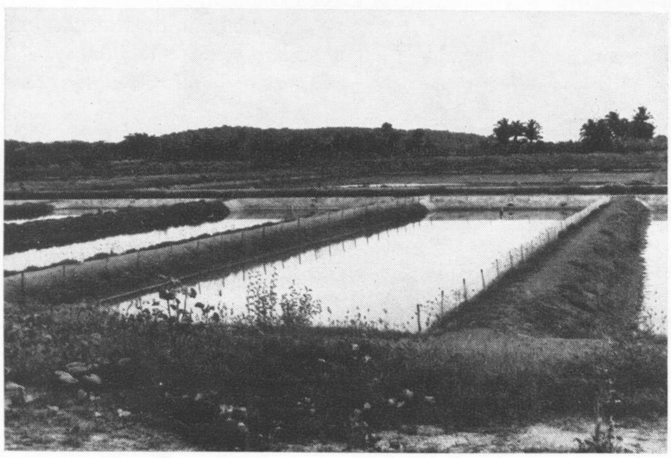

FIG. 2. One of the 350-sq. meter ponds with a nylon net fence to prevent escape of freshwater shrimp (*Macrobrachium* sp.).

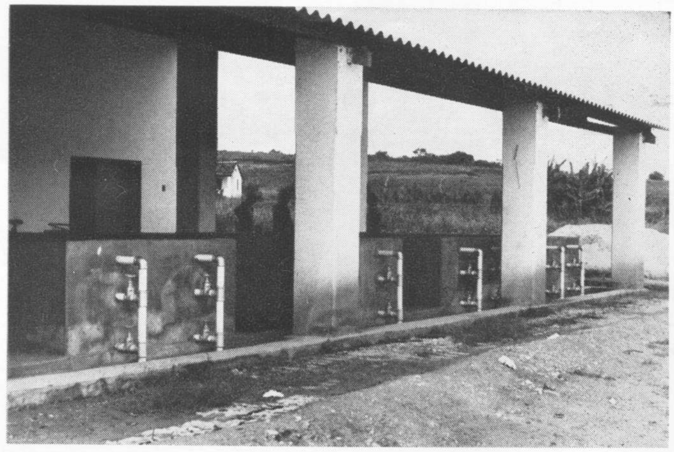

FIG. 3. Laboratory building and cement holding tanks at DNOCS station.

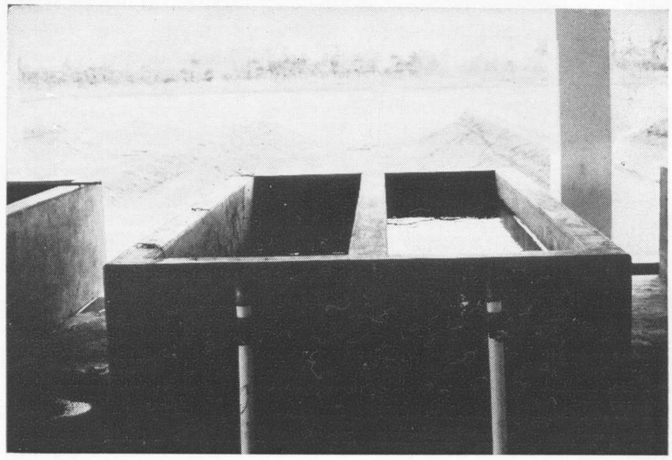

FIG. 4. Closeup of cement holding tanks.

Research Program

A total of 20 species of fishes and shrimps was studied under the research phase of the program. Various levels of fish cultures were evaluated, including natural production, organic and inorganic fertilization, and feeding of prepared rations made with locally-available materials.

Species Research

Apaiari. The apaiari (*Astronotus ocellatus*) is a fish that has been produced for many years by DNOCS hatcheries for stocking in ponds and reservoirs. The apaiari, or oscar as it is known to the aquarium trade, is a food fish in South America. It is easily reproduced in ponds in northeastern Brazil. It is a fish that handles well and is relatively easy to culture. However, its growth from an initial size of 5 grams to 85 grams in 6 months is relatively slow. It is an omnivorous species that becomes more piscivorous with age.

Production of apaiari under various experimental conditions at the research facility is summarized in Table 1. Fish were stocked at 2,800 per hectare and the length of the experiment was 6 months. Each figure represents a mean of two ponds. Ponds used in the experiment were 350 square meters in surface area.

TABLE 1. APAIARI PRODUCTION UNDER THREE EXPERIMENTAL CONDITIONS

Treatment	Mean stocking weight	Mean draining weight	Survival	Net production per pond	Net production
	G.	*G.*	*Pct.*	*G.*	*Kg./ha.*
Natural production	5	28	35.7	1,000	28
Phosphate fertilization	5	43	52.3	2,250	63
Phosphate fertilization plus feeding	5	85	58.4	4,960	139

Even though the apaiari is a species that grows at a moderate rate, it probably should be considered for fish culture in multi-species combinations because of its high market value, the ease with which it can be reproduced, and its resistance to injury during handling. Its possible role might be that of a small predator to control reproduction of other species such as *Tilapia* sp. or to control wild fishes that enter the ponds. Production appears too low for this species to be used as the primary fish in pond culture. However, the small initial size (5 grams) plus the short period of time this fish species was tested prevented proper evaluation of its production potential.

Curimata comum. DNOCS hatcheries have also spawned this species and produced fingerlings for stocking for many years. The curimata comum (*Prochilodus* sp.) is a popular and traditional food fish in northeastern Brazil. It is one of the most abundant fish in total catch in the freshwaters of the Northeast. It is spawned in the DNOCS hatcheries using pituitary injections. The curimata has numerous intramuscular bones and at times a very strong muddy or musty taste. It is primarily a low-cost fish utilized principally by the poorer people, but it is very popular nonetheless because of its availability and low cost in relation to saltwater fishes, meat, and poultry. Its growth under experimental conditions at the DNOCS research facility was slow – from an initial size of 20 grams to 73 grams in 6 months using a stocking rate of 1,250 per hectare and phosphate fertilization. It did not feed upon the hard, pelleted ration but waited until the pellets softened.

The curimata comum is probably not a very good species for fish culture, but it will remain an important fish in the commercial freshwater catch in northeastern Brazil.

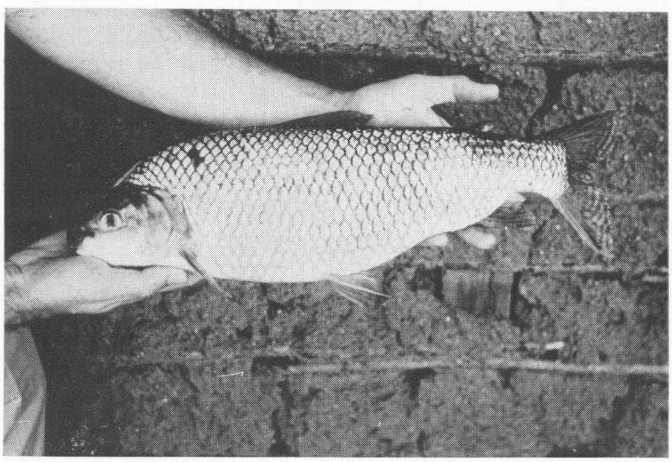

FIG. 5. Curimata (*Prochilodus* sp.) is the most abundant freshwater fish in northeastern Brazil where it is a popular and traditional food fish.

Curimata pacu. The curimata pacu (*Prochilodus* sp.) is very similar in its characteristics to the curimata comum, but it does grow to a larger size. Research results indicate that when this fish was stocked at 625 per hectare, and with phosphate fertilization, it grew from an initial size of 55 grams to 214 grams in 8.5 months.

The curimata pacu is probably suitable for some limited fish cultural operations. Its ready acceptability in the markets of the Northeast combined with its fair growth at relatively low stocking rates might indicate its possible use as a minor species in multi-species combinations. It has been spawned under hatchery conditions using hormone injections.

Tilapia. The tilapias are some of the most efficient and easily cultured pond fishes. *Tilapia rendalli* (formerly *T. melanopleura*) has been spawned and reared by DNOCS since 1950. This particular species is herbivorous. It feeds primarily upon the higher aquatic plants in the pond environment. It does not grow as rapidly as do some other species of tilapia, such as *T. nilotica*. The mean weight of all young-of-the-year *T. rendalli* in experiments stocked only with brood fish was approximately 10 grams after a 6-month growing period. This was the result of the tremendous amount of reproduction. Control of the numbers of small fish using a combination of the tilapia and a piscivorous species will produce larger average sizes of tilapia and a more valuable product.

FIG. 6. *Tilapia rendalli* (formerly *T. melanopleura*). These fish were part of the commercial catch from General Sampaio Reservoir.

Preliminary results indicate that the traira (*Hoplias malabaricus*) and the pescada (*Plagioscion squamosissimus*) may be suitable predators once proper stocking rates of tilapia and the predator species can be established. Experiments should also be conducted to test the tucunare (*Cichla ocellaris*) as a predator species with tilapia.

The net production of a *T. rendalli* and *Hoplias malabaricus* combination is summarized in Table 2. Both species were stocked at 560 per hectare, and the length of the experiment was 188 days.

TABLE 2. PRODUCTION OF *T. rendalli* AND *H. malabaricus* IN COMBINATION

Treatment	Net total production	*H. malabaricus*
	Kg./ha.	*Pct.*
Natural production	170	25
Phosphate fertilization	300	16
Phosphate fertilization plus feeding	500[1]	7

[1] S food conversion = 1.76 kg/feed ration required to produce 1 kg fish.

In summation, *T. rendalli* is herbivorous, but growth and production are less than that for plankton-feeding species of tilapia such as *T. nilotica*. However, *T. rendalli* is already present in Brazil and a sizable population exists in at least one reservoir. Also, it serves as a species which can convert low quality aquatic plant protein to high quality fish protein. It is recommended that this species be considered for stocking in the larger reservoirs and as a minor species in combinations with other tilapia, such as *T. nilotica.*

Traira. This predacious species (*Hoplias malabaricus*) is widely distributed throughout northeastern Brazil. It is widely used for food by the poorer people of the region but is not a preferred species because of its large number of intramuscular bones. The traira reproduces in ponds and had indicated some potential as a predator species to control the reproduction of tilapia. Growth was from 7 grams to 700 grams in an 8-month period with an abundant supply of forage fish available.

The traira is probably not a very good species for fish culture; however, it is present in the waters of the region and its management in many ponds will have to be considered in developing extensive methods of fish culture. Its possible role as a predator in multi-species combinations should be evaluated.

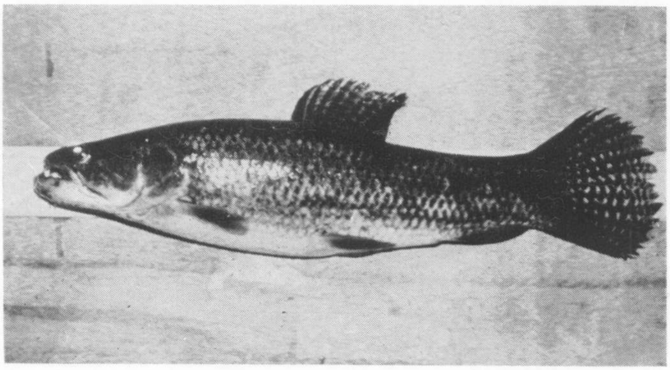

FIG. 7. Traira (*Hoplias malabaricus*), an endemic predacious fish that is distributed throughout northeastern Brazil. This species may be effective in controlling excessive numbers of small tilapia in farm ponds.

FIG. 8. Tucunare pinima (*Cichla temensis*) on the left and tucunare comum (*C. ocellaris*) on the right.

Pescada. The pescada (*Plagioscion squamosissimus*) is also a fish that has been produced by the DNOCS hatcheries for many years. This fish is predacious and feeds mainly on freshwater shrimp. It is a very popular food fish in northeastern Brazil. Stocked in combination with tilapia, its growth in experiments was from an initial weight of 7 grams to 500 grams average in 8 months. This is a good growth rate. The pescada does spawn naturally in

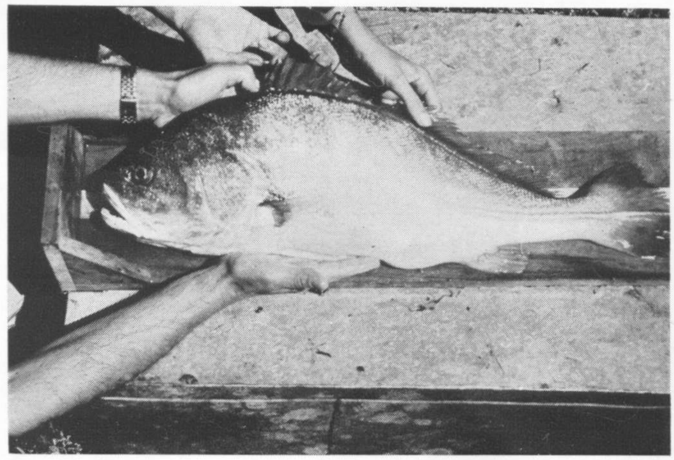

FIG. 9. Pescada (*Plagioscion squamosissimus*). This scianid is a popular freshwater fish in northeastern Brazil.

ponds; however, it is very difficult to handle this species in fish cultural operations. It is very sensitive to changes in temperature and low oxygen levels.

Because of its poor handling qualities and inability to withstand harsh conditions, this fish will not make much of a contribution to intensive forms of fish culture. It might be developed as a predacious species in some form of extensive fish culture.

Mandube. The mandube (*Aegeniosus brevifilis*) is one of the catfishes from the Parnaiba and Sao Francisco river systems. It was reproduced in captivity for the first time by personnel working with this project. A hormone-pituitary injection procedure was used. The eggs were semibuoyant and required approximately 17 hours at 27° to 29° C to hatch. The larvae were extremely cannibalistic. They later all died as a result of an oxygen depletion.

This is an excellent food fish but probably does not offer too much potential for monoculture because of its piscivorous nature. It might be an excellent predator for tilapia culture.

FIG. 10. Mandube (*Aegeniosus brevifilis*). This catfish was spawned for the first time in captivity using pituitary/hormone injections.

Surubim. This species (*Pseudyplatystoma* sp.) is one of the larger catfishes. It is considered an excellent food species where it is available. Experiments in combinations with tilapia proved the surubim to be a voracious predator. It controlled reproduction of tilapia, and, because of the large size of its mouth, it was able to eliminate most of the original brood stock. In fact, it was too voracious a predator for efficient fish culture.

The surubim probably will not make any important contribution to efficient systems of fish culture. It has not been reproduced in captivity.

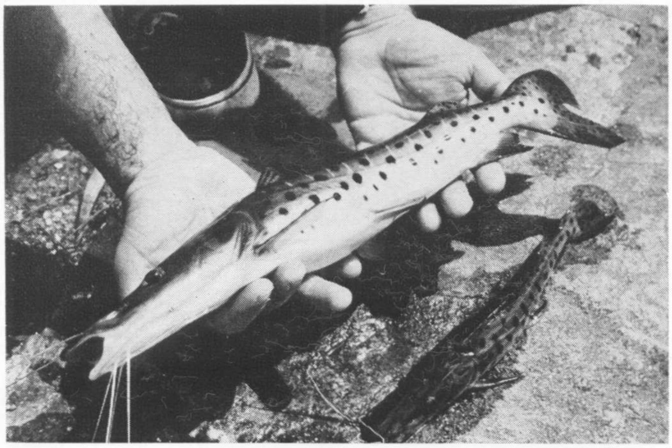

FIG. 11. Surubim (*Pseudoplatystoma* sp.), one of the large piscivorous catfishes occurring in the major rivers.

Mandi. The mandi (*Pimelodus clarias*) is one of the smaller omnivorous species of catfishes. It is an excellent food fish, comparing favorably with the channel catfish (*Ictalurus punctatus*). In experiments the mandi did not grow fast, but this was primarily because of problems with ration composition. Results have not yet been analyzed on a series of experiments with the latest ration formulation.

This fish does consume pelleted ration quite well and appears to be a species that is resistant to injury during handling. It does have sharp spines which cause some problems in seining and handling.

It is recommended that a major effort be placed in studying the mandi. Efforts should be made to reproduce it in captivity. Successful culture of the mandi will depend on the development of suitable rations and spawning techniques.

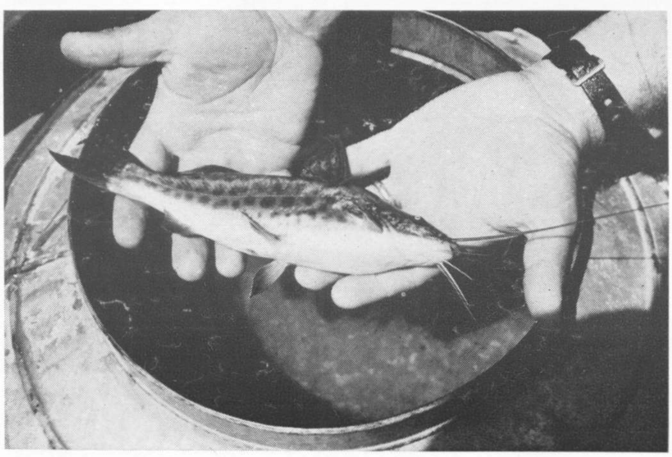

FIG. 12. Mandi (*Pimelodus clarias*). This catfish shows promise for intensive culture systems.

Cangati. This fish (*Trachycoryistes* sp.) is one of the smaller species of catfishes. In experiments it grew very slowly on a prepared ration. The species can be reproduced in captivity using pituitary injections.

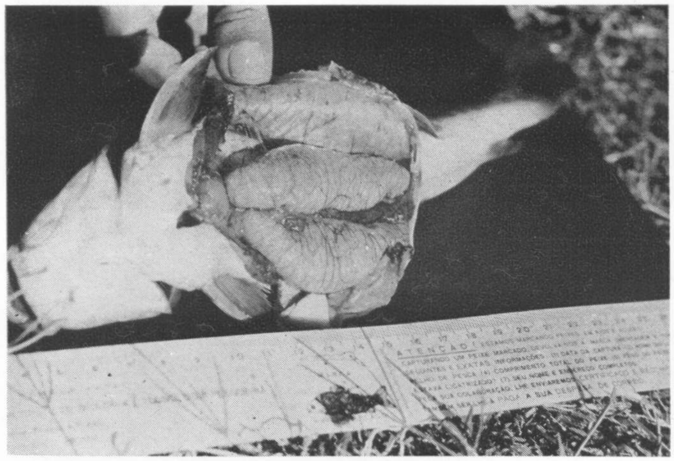

FIG. 13. Well developed ovaries of a female mandi (*P. clarias*).

It is not recommended that further experiments be carried out with this fish.

Tambaqui. The tambaqui (*Myletes bidens*) is one of the larger characins from the Amazon Basin. It is reported to reach a maximum size of 25 kilograms. It is also an excellent food fish. In July 1969, approximately 25 specimens were obtained by DNOCS. The average size on arrival was 19 grams. On March, 1, 1971, the average weight was approximately 3 kilograms. Thus, in less than 2 years, the fish gained almost 3 kilograms. The tambaqui consumes pelleted ration well and has indicated possibilities as a suitable species for fish culture.

A good deal of effort should be placed on trying to learn how to reproduce this fish in captivity. Once reproduction is achieved, the fish could make a significant contribution to fish culture.

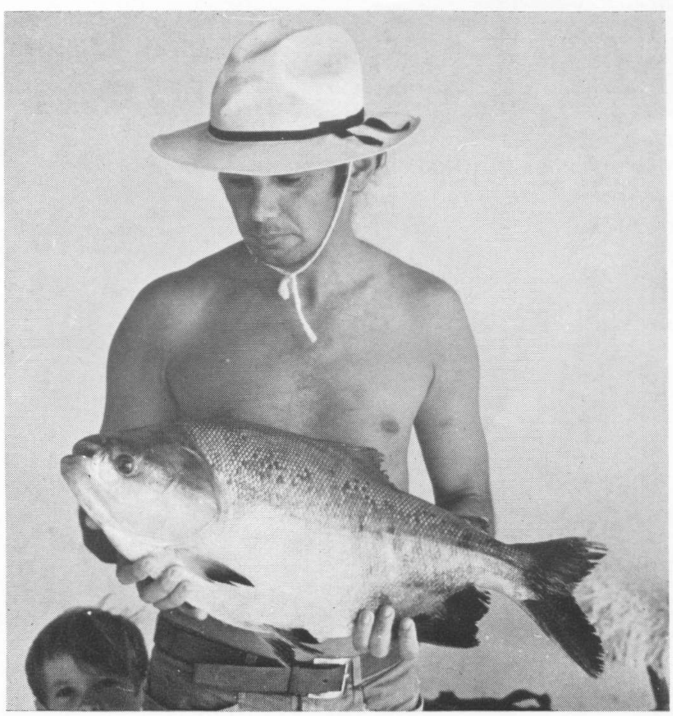

FIG. 14. Fishery biologist Amaury Bezerra de Silva holds a tambaqui (*Myletes bidens*), a large characin from the Amazon River Basin. This fish reaches a size of over 3 kilograms in 2 years.

Pirapitinga. The pirapitinga (*Mylossoma* sp.) is also one of the larger characins from the Amazon Basin. It is reported to reach a maximum size of 5 kilograms and has demonstrated excellent growth. A shipment of 40 specimens, with a mean weight of 20 grams, arrived on June 6, 1970. On March 1, 1971, the average weight was more than 1 kilogram. Thus, in 9 months the fish grew to more than 1 kilogram in size. The same recommendations made for tambaqui would apply here.

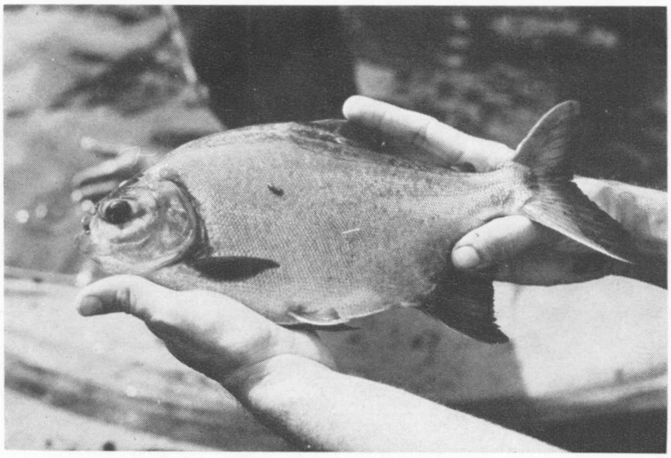

FIG. 15. Pirapitinga (*Mylossoma* sp.) is another large characin from the Amazon River Basin.

Piau verdadeiro. Brood stock of this species (*Leporinus* sp.) is being grown at the DNOCS research facility for future research. No actual research was done with this species during this contract period. Research efforts with this species should be aimed at evaluating its role as a possible mollusk control agent in combination fish cultures and its efficiency in food utilization.

Exotic species. Specimens of four species of exotic fishes – grass carp (*Ctenopharyngodon idella*); silver carp (*Hypophthalmichthys molitrix*); *Tilapia nilotica;* and *T. hornorum* – are being grown for research studies. The grass carp (19 specimens) and the silver carp (6 specimens) were obtained from the Recife Laboratorio de Ciencias de Mar on April 29, 1971. These fish are being grown as brood stock so that in the future induced spawning will provide young fish for use in experiments.

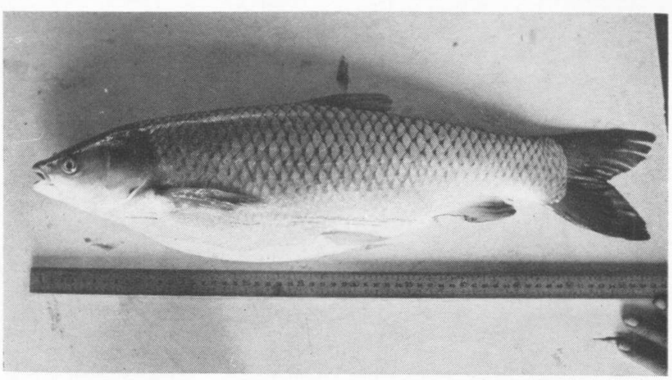

FIG. 16. Grass carp (*Ctenopharyngodon idella*) is a promising species for fish culture and aquatic weed control.

The two species of tilapia were sent to the DNOCS from Africa by Mr. J. Bard of the Centre Technique Forestier Tropical. These fishes are being raised to a suitable size for reproduction so that hybridization between the two species (male *T. hornorum* × female *T. nilotica*) can be accomplished. This cross is reported to produce 100 per cent male offspring.

It is recommended that a great deal of effort be placed in comparative testing of indigenous and exotic species to determine the most efficient combinations of fishes for pond culture and their acceptability on local markets in northeastern Brazil.

In summary, the following indigenous species appear suitable for more intensive research: omnivorous group – Mandi, Tambaqui, Pirapitinga, and Apaiari; piscivorous group – Pescada and Mandube.

FIG. 17. Freshwater shrimp (*Macrobrachium carcinus*). This large male was captured in Serrota Reservoir.

Pitu. The pitu (*Macrobrachium carcinus*) is a large freshwater shrimp of worldwide interest. Culture techniques for the production of juveniles have been developed in Florida, Hawaii, and countries in Asia for related species. The pitu is present in limited numbers in some reservoirs of the Northeast. Female specimens with eggs were captured from Serrota Reservoir, and the eggs were subsequently hatched. The larvae remained alive for only 8 days or less. For survival of the larval shrimp, salinity must remain above 10 p.p.t. After reaching the juvenile stage they migrate to freshwaters where they grow to maturity. Successful culture for this species will depend upon the development of suitable facilities near supplies of fresh and salt water so that the critical water quality conditions required by the young larvae can be maintained. DNOCS should consider the development of a larval raising facility near Fortaleza for the production of postlarval shrimp. This species has potential for culture in the Northeast. One other area that might be investigated is the stocking of pitu in many of the reservoirs that do not have sizable populations of the pitu because of lack of access for the young shrimp that hatched in the downstream brackishwater areas of the rivers.

Research on Feeds

To obtain the higher productions in fish culture, it is necessary to use prepared rations. To evaluate the possibilities of prepared rations, a pelleting machine for experimental rations was ordered. This machine is now being used to produce experimental rations. Staff of the International Center for Aquaculture provided valuable assistance in analyzing samples of locally available agricultural products and in advising on the formulation of the rations .

An excellent report, "Racoes para Piscicultural Intensiva No Nordeste Do Brasil," prepared by Paiva, Freitas, Tavares, and Magnusson, is a summary of the research done in the preparation of rations by DNOCS. The recommendations made in this report should serve as a guide for the preparation of rations for use in Brazil.

Efforts should continue to be made to develop suitable rations for fish cultures, but major emphasis should be placed on the utilization of organic fertilizers. Because of the high costs of the agricultural products required for rations and the traditionally low market value for freshwater fish products, intensive fish culture systems for the near future cannot be based upon feeding prepared rations. Systems that use organic fertilizers such as manure from pigs, chickens, and ducks seem most appropriate for the present.

Counterpart Training

The Brazilians who worked with this project included the entire staff of the Convenio-DPAN at one time or the other (12 to 15 persons). However, the actual technical staff assigned to fish culture included only 3 Brazilians, one of which is also an administrator. With the support of AID Brazil, one of these, Amaury da Silva received 9 months training in fish culture techniques at Auburn University. Two other biologists, Helio Melo and Odilo Dourado, received training in related fishery fields of limnology and fisheries biology. Also, four Brazilian biologists took part in a special 2-month training tour of various fish hatchery, aquaculture, and fisheries research stations in the United States. This group, with Dr. Jeffrey acting as coordinator and interpreter, visited the following facilities:

1. Oct. 22, 1972	Eastern Fish Disease Laboratory U.S. Department of Interior Bureau of Sports Fisheries and Wildlife Kearneysville, West Virginia
2. Oct. 26	Pisgah Forest Fish Hatchery U.S. Department of Interior Bureau of Sport Fisheries and Wildlife Pisgah Forest, North Carolina
3. Oct. 27	North Carolina State Fish Hatchery Marion, North Carolina
4. Nov. 1	School of Marine and Atmospheric Sciences University of Miami Miami, Florida
5. Nov. 2-3	Tropical Atlantic Biological Laboratory National Oceanic and Atmospheric Administration National Marine Fisheries Service Miami, Florida
6. Nov. 4-5	Biological Laboratory National Oceanic and Atmospheric Administration National Marine Fisheries Service St. Petersburg, Florida
7. Nov. 8	Marine Resources Laboratory Alabama Department of Conservation Dauphin Island, Alabama
8. Nov. 9-10	School of Forestry and Wildlife Louisiana State University Baton Rouge, Louisiana
9. Nov. 11-12	Biological Laboratory National Oceanic and Atmospheric Administration National Marine Fisheries Service Galveston, Texas
10. Nov. 15	Department of Wildlife Sciences Texas A & M University College Station, Texas
11. Nov. 16	Warm Water Fish Culture Research Laboratory U.S. Department of Interior Bureau of Sport Fisheries and Wildlife Stuttgart, Arkansas
12. Nov. 17	Kelso Exploratory Fishing and Gear Research Base National Oceanic and Atmospheric Administration National Marine Fisheries Service Kelso, Arkansas
13. Nov. 18-19	Department of Wildlife and Fisheries Mississippi State University State College, Mississippi
14. Nov. 22-30	Department of Fisheries and Allied Aquacultures Auburn University Auburn, Alabama
15. Dec. 6-9	Southeastern Fish Culture Laboratory U.S. Department of Interior Bureau of Sports Fisheries and Wildlife Marion, Alabama
16. Dec. 10-11	Department of Zoology Southern Illinois University Carbondale, Illinois

Formal academic and research training programs for persons in fish culture should be initiated and have been recommended for future contracts. The ultimate success of this entire program will depend on the ability of the Brazilian Nationals to carry out the program without outside technical aid, and it is to this end that the program objectives should be directed.

During the 23 months of this contract, the Brazilian technical staff working with fish culture became familiar with many general techniques in carrying out the research program and to some extent with the general principles underlying aquaculture. Continued technical assistance should increase their rate of development of suitable pond culture methods for Brazil.

RECOMMENDATIONS

Facilities. Construction of more ponds utilizing the available land should continue. Sufficient resources to complete construction of approximately 100 ponds of 1,000 square meters each should be sought. This number should be adequate to furnish the facilities necessary for the comprehensive research and production program. The present facility with 48 ponds and the laboratory is the largest in South America. An all-out effort should be made by DNOCS, U.S.A.I.D., and Auburn University to complete development of this facility and to assure its continued participation in the overall fisheries program of not only northeastern Brazil but the rest of South America. It is recommended that DNOCS establish a permanent annual budget for proper maintenance of this research facility.

Research. The philosophy behind the first 2-year program was one of training and preparation for the future. It was deemed most important for the overall program to train the Brazilian Nationals in principles and methods of fish cultural research for development of culture systems. Many species of fish were used at different levels of culture. This has served to make the Brazilian biologists more knowledgeable of the many possibilities available to them. The program now has at its disposal brood stock of numerous native and exotic species of fish from which to select suitable species for fish culture systems. In the author's opinion, emphasis should be placed on some of the exotics, such as the tilapias and grass carp, for which culture systems already exist. However, such species as the tambaqui, mandi, and pirapitinga should remain an integral part of the research program. These and other endemic species could contribute significantly to a successful fish culture program. Attempts should also be made to secure other species such as the filter feeding catfish, madara (*Hypothalemus edentatas*), from the Amazon Basin. This fish could have worldwide impact as a cultured species.

Counterpart Training. The DNOCS scientists are capable persons who would benefit greatly by additional training in fisheries. Scholarships should be made available to furnish specific advanced degree programs in fish culture.

The Brazilians are aware of the potential the program has for them and the future of fish culture. Technical assistance from U.S.A.I.D. should probably continue for a period of at least 5 years. At the end of this time, the Brazilians will have the necessary facilities and should be adequately trained to carry out a comprehensive program that will greatly benefit not only Brazil but other countries as well.