AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

BATCH #18

1. SUBJECT CLASSIFICATION

A. PRIMARY: Agriculture — AM00-0000-G530

B. SECONDARY: Fisheries--Peru

2. TITLE AND SUBTITLE

Fishculture survey report for Peru

3. AUTHOR(S)

Smitherman,R.O.; Moss,D.D.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1970	48p.	ARC PE639.3.A897

7. REFERENCE ORGANIZATION NAME AND ADDRESS

Auburn

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-RAA-941	
12. DESCRIPTORS	**13. PROJECT NUMBER**
Peru	
	14. CONTRACT NUMBER CSD-2270 GTS
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

FISHCULTURE SURVEY REPORT

FOR PERU

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Project: A.I.D./csd-2270

September 30, 1970

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June 5	Final conferences with officials of U.S.A.I.D. and the Director General, Office of Technical and Economic Cooperation, Ministry of Fisheries.
June 6	Departed Peru.

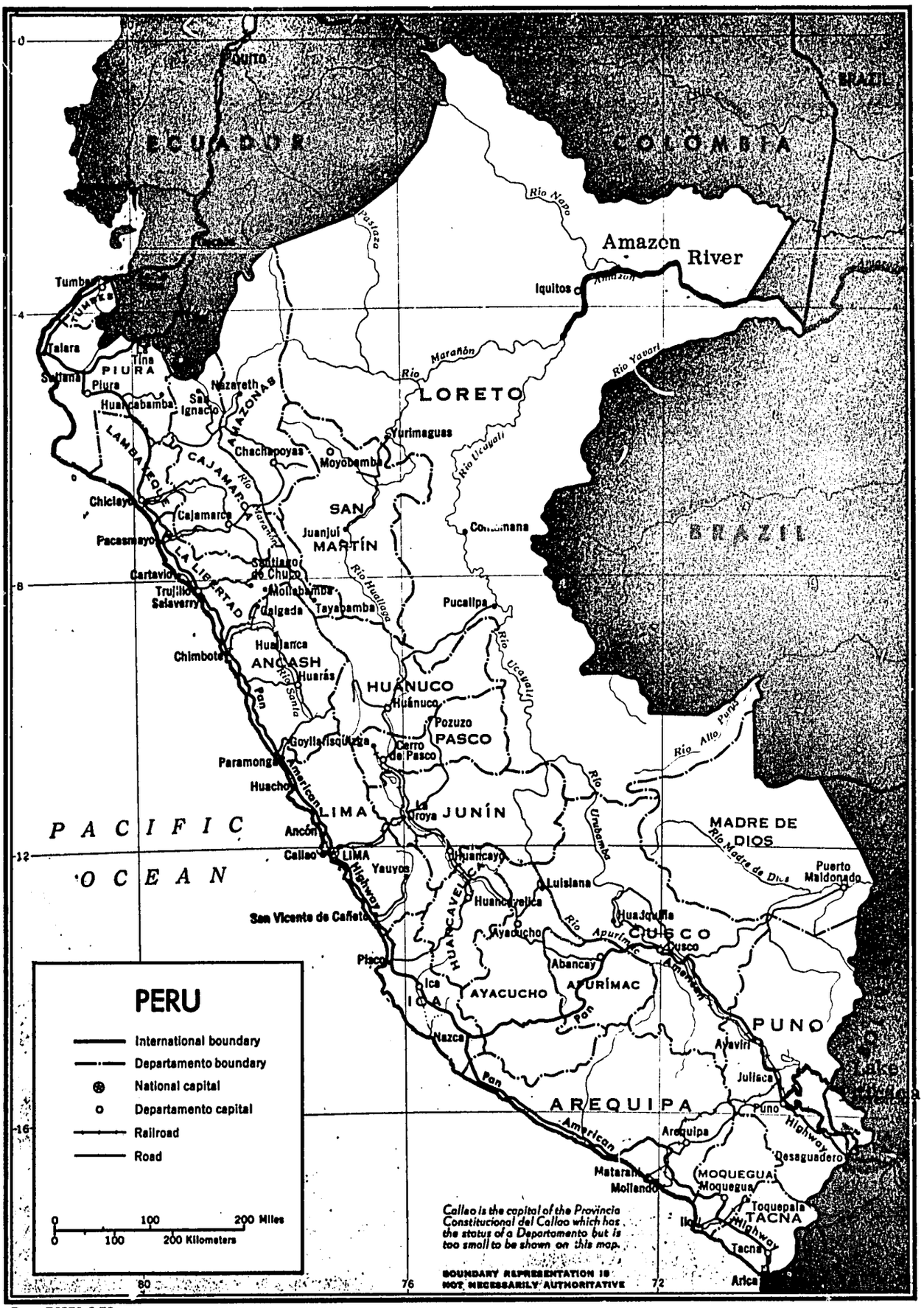

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Figure 1. Map of Peru

2.0 RECOMMENDATIONS

2.01 It is recommended that special training in aquaculture be provided for selected supervisory and technical personnel in the Directorate of Inland Fisheries, Ministry of Fisheries. It is suggested that the training be for a period of approximately 3 months at the U.S.A.I.D.-sponsored fisheries project* in Northeast Brazil.

2.02 Because of the recent drastic decline of the trout fishery in Lake Titicaca as a result of uncontrolled exploitation, it is imperative that the lake and tributary streams remain closed to commercial fishing operations until such time that the trout populations have recovered. It is necessary that the fishery then be regulated so that annual crops are harvested, without exerting a deleterious effect on the populations.

2.03 A program of restocking should be carried out to ensure rapid recovery of the trout fishery. If available, yearling fish should be utilized for stocking purposes; otherwise fingerlings and/or eggs should be planted in selected areas of tributary streams.

2.04 A research station for warmwater fishculture should be established to serve the Amazonas Region. The station should include approximately 100 experimental ponds, with a total of 10 ha of water. Iquitos is not suitable for such a pond research facility since this area is periodically subjected to severe flooding of the Amazon River. Rather, the pond facility should be located in an upland jungle area, possibly near Pucallpa

*Cooperators are: DNOCS (National Department of Works Against Drought); SUDEN (Superintendency for the Development of the Northeast); Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service; and Auburn University.

3.0 FISHCULTURE SURVEY REPORT FOR PERU

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3.01 Introduction

The Auburn Team conducted a survey of fisheries in Peru during May 22 to June 6, 1970. The visit, under the sponsorship of U.S.A.I.D./Peru and the Ministry of Fisheries, Republic of Peru, was for the purpose of providing technical advice in the development of inland fisheries, particularly in aquaculture.

3.02 Geography, Topography and Climate

Peru, with an area of 1,284,640 square km, has a coastline extending for 2,300 km along the Pacific Ocean. It is bordered on the north by Ecuador and Colombia, on the east by Brazil and Bolivia, and on the south by Chile. The Andes Mountains divide the country into three distinct zones. Along the coast is a desert, extending 17 to 170 km inland. The coastal zone, with 11 per cent of the land area, contains more than 40 per cent of the population. In the central zone (sierra) are mountains with peaks over 6,098 m, lofty plateaus and deep valleys. East of the mountains are high and low jungle lands (selva) stretching to the Amazonian plains.

The climate of the coastal zone is arid with an annual rainfall averaging less than 50 mm and temperatures ranging from 13 C to 37 C. The Humboldt

Current, with the upwelling of cold, bottom oceanic waters, keeps temperatures relatively cool. Summer and winter temperatures along the coast average about 23 C and 16 C, respectively.

In the sierra, temperatures range below freezing in the Andes Mountains. In the altiplano region at approximately 3,660 m, summer temperatures average 11 C and winter temperatures 7 C. Rainfall averages from 250 mm to 1,250 mm, with higher rainfall on the eastern slopes.

Climate is tropical in the eastern jungle, with temperatures from 24 C to 35 C, and rainfall between 1,875 mm and 3,125 mm annually.

3.03 Nutritional and Economic Aspects

The population of Peru is 13.6 million with an annual growth of 3.1 per cent. At the present rate, the population will double in approximately 20 years.

One measure of the adequacy of the food supply for a population is the quantity of protein available per capita. The worldwide average protein requirement has been estimated to be 57.3 grams per capita per day, of which 19 grams should be animal protein.

The table on the following page indicates the amounts of protein per capita available in Peru from various sources for the years 1959 - 1961 (U. S. Department of Agriculture, 1964a).

The total average available protein was 51.0, with that from animal sources totaling 12.6 grams per capita per day. Fish accounted for 3.3 grams, or 26 per cent of the total animal protein available. The average available

Product	Grams of Protein per Capita per Day
Cereals	23.7
Sugar, fruits, vegetables	14.7
Meat	5.0
Fish	3.3
Fats	0.2
Milk and cheese	3.3
Eggs	0.8
Total	51.0

protein in 1956 - 1958 was only 48.4 grams per capita per day; this is projected to reach 57.6 grams per capita per day in 1970 (U. S. Department of Agriculture, 1964b). This anticipated increase in food supply would produce a level approximately equal to the average worldwide requirement. Because of unequal distribution of food throughout the country, however, it is likely that many Peruvians would still have inadequate diets.

The rich fish resource, produced principally as the result of the Humboldt Current, has enabled the country to become the world's largest exporter of fish meal. However, only about 2 per cent of the total fish catch in 1968 was utilized for human consumption (Peruvian Times, 1969).

Agricultural resources are limited and generally underdeveloped. With the trend toward urbanization, and inadequate food production to meet the needs, the country imports large quantities of food. Main crops for export are cotton, sugar, rice and coffee. Wheat, corn, potatoes, beans and barley are subsistence crops.

Copper is an important export, ranking near fish meal, while most metals and machinery must be imported.

3.04 Status of the Fisheries

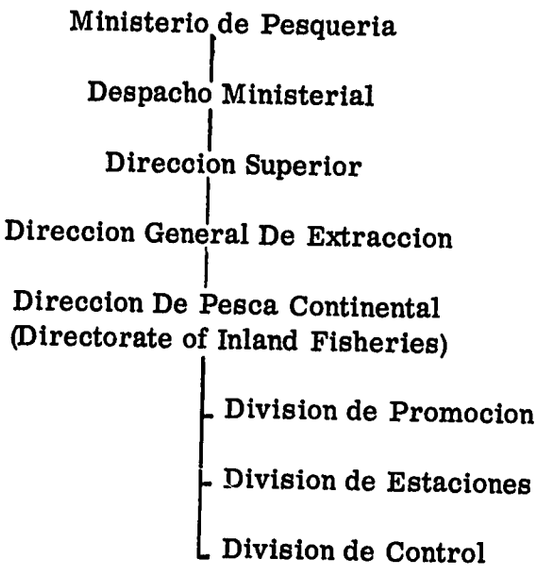
Exploitation of the marine fish resource has been the main emphasis of the fisheries agencies in Peru. Catch of marine fish in 1969 was approximately 9 million metric tons. The 1969 exports of the fish meal industry amounted to U. S. $200.2 million, roughly one-fourth of Peru's total foreign exchange earnings (Peruvian Times, 1970). It is the world's largest and operates a fishing fleet of 1,300 ships and 120 processing plants.

Only a small portion of the catch is used for human consumption. In 1968, when a catch of 10 million tons of fish was reported, only 175,000 tons were utilized as fresh, frozen, canned or salted food. Three freezing plants were operating, utilizing some 16 species not rendered into fish meal. Only one processed fish for local consumption (Peruvian Times, 1968). Better utilization of the edible fish resource is a major objective of the Ministry of Fisheries. The Ministry of Fisheries has announced that it will construct 12 Danish-financed cold storage facilities in the major fishing ports. The lack of refrigeration has been one of the prime obstacles limiting the growth of this sector of the fishing industry.

The inland fish resource of Peru appears vast, but detailed data are not available. Important fisheries include those for freshwater shrimp in the coastal rivers, trout in the sierra regions, and for characins, cichlids, catfishes, and paiche in the jungle rivers.

3.05 Government Divisions Responsible for Fisheries

The responsibility for fishery resources in Peru formerly was vested in the Servicio de Pesqueria (Fisheries Service), Ministry of Agriculture. In 1970, the importance of fisheries in the economy of Peru resulted in the establishment of the Ministry of Fisheries. This Ministry, with some 300 technicians in 32 Divisions, is mainly concerned with commercial marine fisheries but also has a Directorate of Inland Fisheries. Below is the organizational outline of the branch of the Ministry dealing with inland fisheries resources.



A total of 10 supervisory personnel, biologists and engineers, was stationed in the central office of the Directorate of Inland Fisheries at Lima and additional personnel were located at fishery stations and field offices throughout the country. Below is a listing of government fishery stations operating in 1969, with indication of the function, number of personnel, and operating budget.

Station	Created	Functions	Personnel Technical	Personnel Other	Budget (soles)*
Junin	1940	Trout hatchery	1	12	603,900
Loreto	1940	Culture of paiche and other tropical fishes; Exploitation of fishery preserves	2	37	1,358,300
Eulalia	1944	Trout hatchery	1	8	503,800
Cajamarca	1954	Trout hatchery	1	12	338,300
Arequipa	1955	Freshwater shrimp hatchery	1	3	349,800
Ancash	1958	Trout hatchery	1	7	435,700
Huanuco	1958	Trout hatchery	1	5	275,500
Tumbes	1958	Oyster culture	2	5	255,300
Cuzco	1963	Research on suche; Trout hatchery	1	3	204,400
San Martin	1964	Culture of tropical species	2	2	280,500
Medio Mundo	1966	Mullet culture; Freshwater shrimp culture	**	**	**
Sauce	1967	Culture of paiche	1	4	183,800

*43 soles equal $1.00
**Substation of Eulalia; no resident personnel

3.06 Fisheries Training

Peru is unique among countries of Latin America in that a number of universities offer formal college programs in various areas of freshwater and marine fisheries. Following is a list of universities and the principal fishery courses available at each:

Universidad Nacional de la Amazonia Peruana (Iquitos)

Programa de Biologia

Courses:
- Fishery Technology
- Freshwater Fishery Biology
- Ichthyology
- Limnology

Universidad Nacional Agraria La Molina (Lima)

Departamento de Pesqueria

Courses:
- Aquatic Ecology
- Fishculture
- Fisheries Biology
- Fishing Gear and Methods
- Fisheries Technology
- Ichthyopathology

Universidad Nacional Federico Villareal (Lima)

Programa de Oceanografia y Pesqueria

Courses:
- Fisheries Biology
- Fisheries Technology
- Fishing Methods
- Ichthyology
- Limnology
- Oceanography
- Planktology

Universidad Nacional Tecnia del Altiplano (Puno)

Programas de Veterinaria y Agronomia

Course: Fish Culture

Universidad Nacional de Trujillo (Trujillo)

Departamento de Recursos Acuaticos

Courses: Aquaculture
Fishery Biology
Ichthyology
Limnology
Limnological and Oceanographic Methods
Marine Biology

3.07 Inland Fisheries

3.071 Trout Fishery

3.0711 Lake Titicaca

On May 25, 1970, the Auburn Team traveled to Lake Titicaca with biologists of the Ministry of Fisheries for the purpose of assessing the status of the trout fishery. Lake Titicaca, on the Peru-Bolivia border, is 8,446 square km (2,087,000 acres) in area. At 3,813 m altitude, it is the world's highest navigable body of water.

The native fish population of Lake Titicaca was reported to consist of approximately 15 species. The carachi, a small characin, and the suche (Trichomycterus rivulatus), a small catfish, were the most important species in the subsistence fishery.

The carachi is a small scaly fish which grows to 8 inches. It is caught with traps, scoop nets, gill nets, and harpoons. This fish is held in high esteem by the Aymara and Quechlua peoples and in many cases is their only source of animal protein. The carachi and suche were apparently more important as food

to the native peoples than the once-plentiful trout which were not consumed to an appreciable extent because of tradition.

The freshwater pejerrey, Basilichthys bonariensis, introduced in 1958 from Bolivia, also is an important food fish. It is now fished with gill nets throughout the lake, where it grows to 450 mm and 1.8 kg. This fish sells for 5 soles per kg in the local market.

Salmonids were not native to Lake Titicaca. The history of original introductions of trout into the lake from other countries (Mercade, 1968) is presented below:

Common Name	Scientific Name	Form	Date Stocked	Source	Spawning Population Established
Lake trout	Salvelinus namaycush	Eggs	1939	U.S.	Negative*
Brown trout	Salmo trutta	Eggs	1939	Chile	Postive
Lake trout	Salvelinus namaycush	Eggs & Fry	1940	U.S.	Negative**
Rainbow trout	Salmo gairdneri	Fry	1942	Chile	Positive
Lake trout	Salvelinus namaycush	Eggs	1944	U.S.	Negative*
Brook trout	Salvelinus fontinalis	Eggs	1955	U.S.	Positive

*Eggs dead on arrival
**Only two specimens recovered

A hatchery at Chucuito, approximately 25 km from Puno on the Peruvian side of Lake Titicaca, was established in 1939 to 1940 as a joint venture of the governments of Peru and Bolivia to provide trout fingerlings for annual restocking of the lake. The hatchery was designed and construction was supervised by J. A. Smyth, U. S. fishery biologist. The hatchery, operated by the National Technical University of the Altiplano since 1961, stocked the following trouts in Lake Titicaca

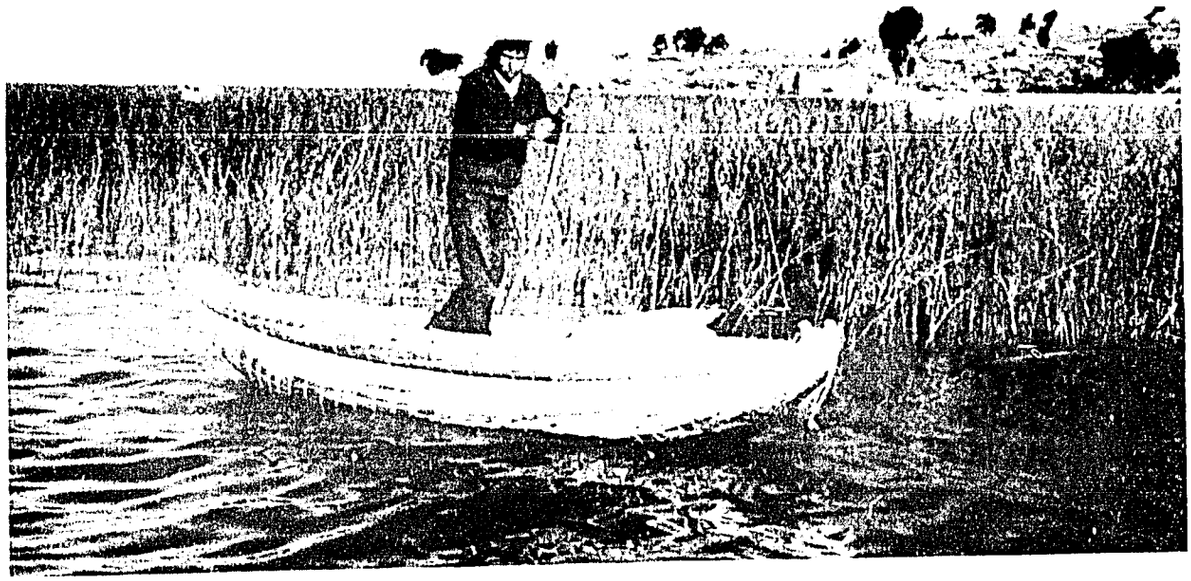


Figure 2. Native fisherman in reed boat, Lake Titicaca.

Figure 3. Rainbow trout, Salmo gairdneri, taken by gill net, Lake Titicaca.

and tributary streams during 1940 to 1969; brown - 16,000; brook - 235,000; rainbow - 8,206,990. Approximately 10,821,000 additional rainbow trout were stocked in the lake during this period from other government hatcheries.

Reproducing populations of brown trout, rainbow trout and brook trout have been established, but lake trout apparently were not successful. Two lake trout specimens about 350 mm in total length were caught by a fisherman in 1946, but none other has been taken nor has there ever been any evidence of reproduction. Of the three successful species, rainbow trout became most significant in the fishery of Lake Titicaca and tributary streams. By 1961, trout were so abundant that a fish cannery was opened at Chucuito. In 1963 and 1964, additional canneries started operation at Juliaca and Vilquechice. Exports of canned trout from Lake Titicaca during 1961 to 1969 are indicated below. Two smaller canneries operated during this period in Bolivia, but production data were not available.

Year	Exports* of Canned Trout from Lake Titicaca (kg)
1961	5,200
1962	55,975
1963	136,284
1964	244,058
1965	248,765
1966	213,565
1967	100,410
1968	91,601
1969	53,040

*Data obtained from the Statistics Division, Customs Superintendency, Republic of Peru. The majority of trout was exported to Europe and the U. S.

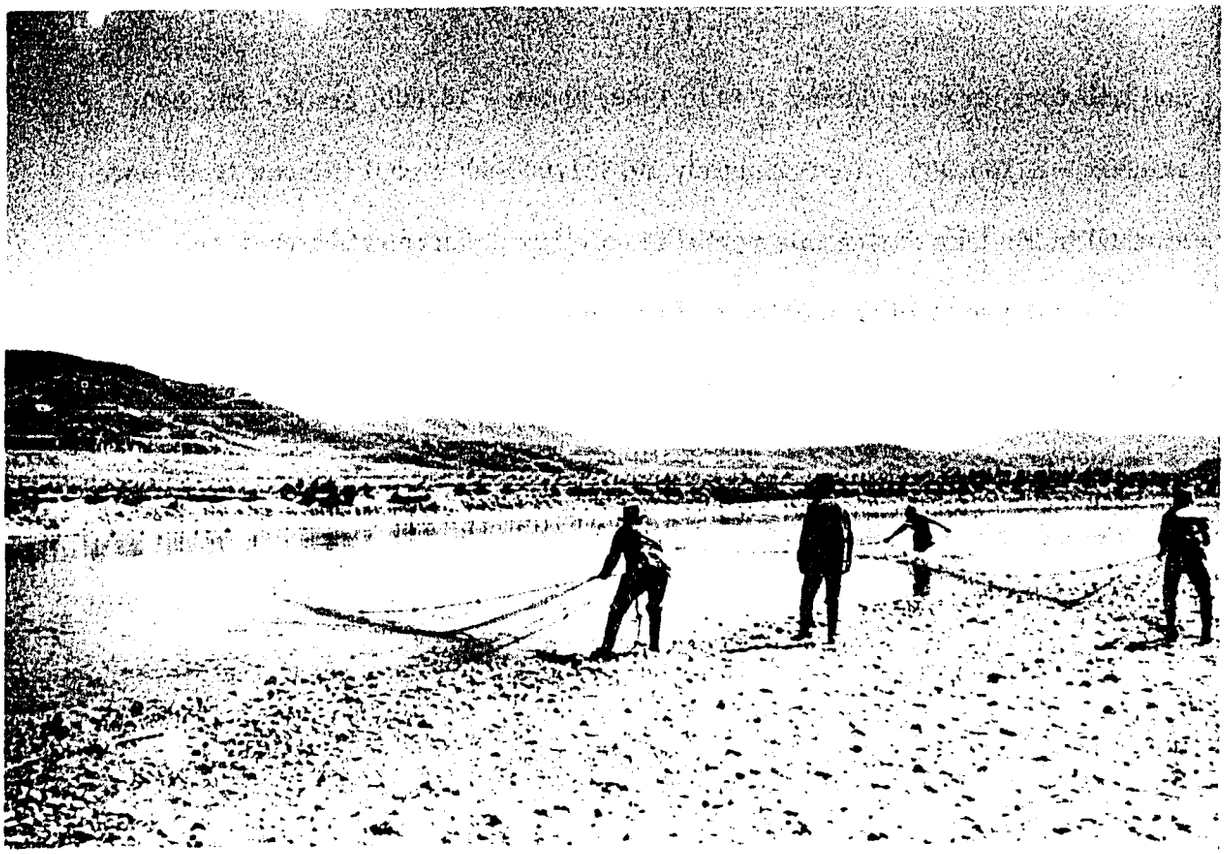
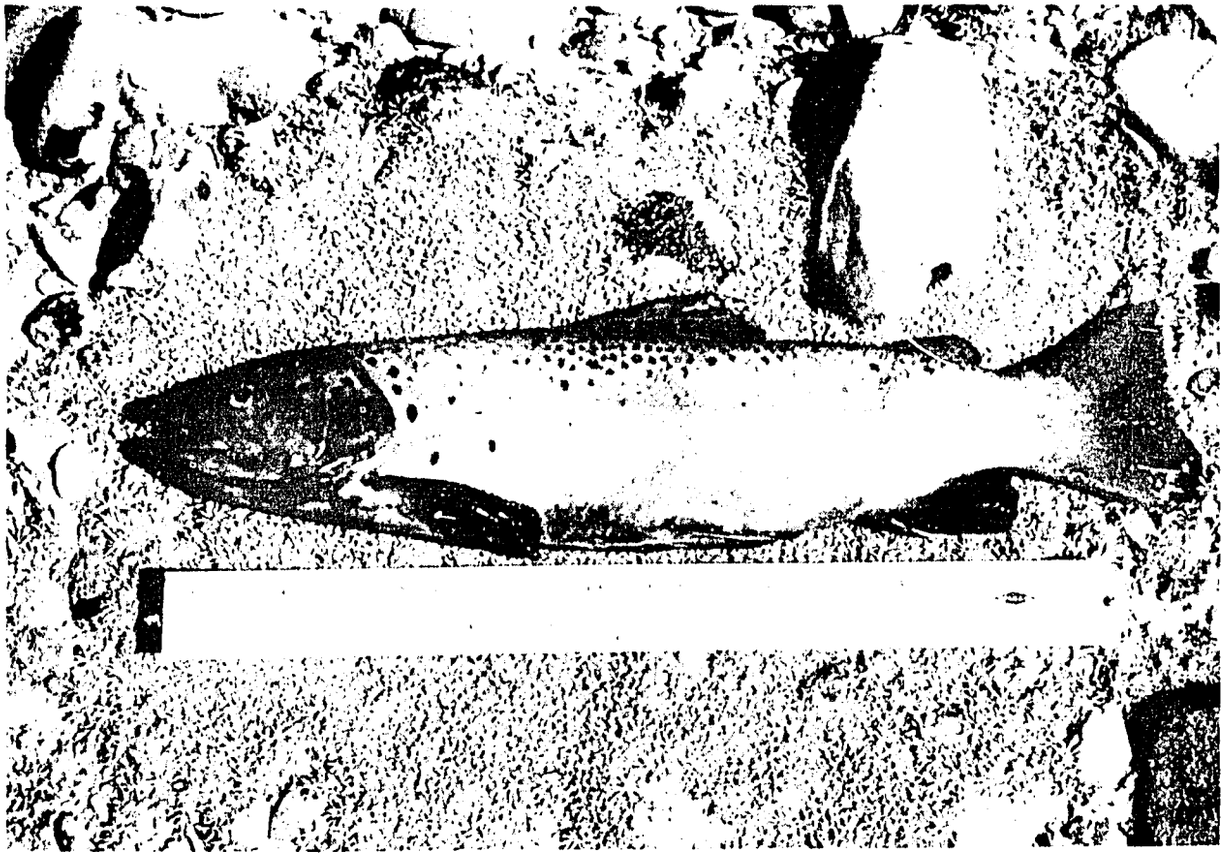


Figure 4. Haul seining for trout in Rio Ilave, tributary to Lake Titicaca.

Figure 5. Brown trout, Salmo trutta, captured from Rio Ilave.



The lake was closed to commercial fishing in late 1969, pending results of investigations planned by the National Technical University of the Altiplano and the Ministry of Fisheries.

It appears that the decline in the rainbow trout fishery was the result of uncontrolled exploitation. The original objective of the trout introductions in Lake Titicaca was to increase protein supply among the local peoples. For several years trout were readily available in the local markets. However, when the canneries began operating, fish largely disappeared from the markets. It was much easier for the fishermen to sell trout to the cannery representatives who came to the villages in trucks, than to carry the catch to local markets. Payment from cannery to fishermen was 18 to 20 soles per kg, probably more than the average campesino could afford. This high price was a powerful incentive to fishermen. A force of 1,000 fishermen were operating 2 to 3 gill nets each during 1967 in the lake proper, some 3 km offshore (Everett, 1967). As the spawning season approached, the fishery would shift to areas near the mouths of the rivers Ilave, Coata, and Ramis. During the spawning season in June to August, some fishermen took huge hauls of rainbow trout illegally from the spawning grounds in the rivers. A closed season to commercial fishing in the lake and the tributary rivers during June 1 to August 15 was imposed for several years, but enforcement was not effective.

Test fishing in Lake Titicaca was carried out at the request of the Auburn Team biologists on May 26 with a 50-m, 75-mm stretch mesh gill net fished near the lake shore. An overnight set of 12 hours yielded a single 350-mm rainbow trout. It was reported that a similar fishing effort in 1965 would have resulted in a catch of 50 to 60 trout.

Also on May 26, the fish population of a tributary stream flowing into Lake Titicaca was sampled by seining. After much effort, a brown trout, about 325 mm in total length, was captured in the Ilave River, at a site located approximately 17 km from the lake. It was reported that rainbow trout were present in such large numbers in that river during the early 1960's that a "truckload" could be captured with a large haul seine within a couple of hours. However, now the rainbow trout is reported to be very scarce in the Ilave River and other streams flowing into Lake Titicaca.

It would certainly appear that commercial fishing in the lake and tributary rivers should remain closed until such time that studies indicate that the trout populations have recovered from overfishing. In addition, a program of restocking should be carried out in the Ilave, Coata and Ramis Rivers in an attempt to establish spawning runs and effect rapid recovery of the trout fishery. In the restocking program, sub-adults should be utilized if available, otherwise fingerling size trout or eggs must be utilized.

After field studies indicate the trout populations have recovered to the extent that a commercial fishery can be sustained, regulations should be promulgated and enforced to prohibit fishing especially during spawning season. An extension program in trout management, with emphasis in training local persons as agents to work closely with fishermen and representatives of the processing industry should also be initiated.

3.0712 Hatcheries and Stocking Program

The Ministry of Fisheries operates a system of 6 trout hatcheries from which streams and lakes of the sierra region are stocked. These stations distributed a total of 23,014,337 rainbow trout fingerlings during the years 1946 to 1969. Below is the production of fingerlings for the years 1965 through 1969:

Station	1965	1966	1967	1968	1969
Cajamarca	304,000	284,850	282,400	-------	18,000
Santa Eulalia	141,000	52,500	104,600	-------	36,000
Junin	195,294	133,332	410,860	364,560	529,000
Puno	102,200	4,600	-------	-------	6,000
Huanuco	313,818	236,920	4,000	-------	119,100
Ancash	674,000	545,000	633,000	876,880	70,000
Total	1,730,312	1,257,202	1,434,860	1,241,440	778,100

3.072 Freshwater Shrimp

Freshwater shrimp constitute a substantial fishery in the coastal rivers of Peru. In the southern coastal rivers, particularly Majes-Camana and Ocona, the species Cryphiops caementarius is most abundant. This species ranges north from Chile to the vicinity of Chimbote, Peru, and is most abundant in the region between 10° S.L. and 30° S.L. Distribution of the shrimp is confined to coastal rivers, where it is found from sea level to a maximum altitude of 1,830 m (Hartman, 1958). North of 10° S.L., Cryphiops caementarius is replaced by river shrimps of the genus Macrobrachium. Apparently the most

abundant species of this genus in Peru is Macrobrachium inca.

Females of these river shrimp apparently migrate downriver to the sea, where egglaying, hatching of eggs, and development of the larval stages take place. The downriver migration of the females takes place in the months of January to July, apparently corresponding to highest water flows. The migration of adult females back upstream is in July to December. Postlarval shrimp move upriver in the months of June to September. Males apparently do not migrate to the saltwater, but mate with females before their journey downstream. The fishery for shrimp is best during the period when the females move downstream. A trap, "izanga", which is woven from sticks, is the primary gear. The trap is placed in the swift current of the rivers with the open mouth of its conical construction facing upstream. The shrimp are swept into the tail of the trap, where the current presses them against the sides and prevents their escape.

It was reported that a decline has occurred in the populations of river shrimp, possibly because of overfishing. In an effort to restore the fishery in certain rivers and stock streams which had no previous population of shrimp, the Ministry of Fisheries operates a station (Arequipa-Camana) specializing in shrimp stocking. Postlarval shrimp are seined from Rio Camana and stocked into other coastal rivers. During the period 1958 to 1969, a total of 5,460,000 postlarval shrimp was transferred to 22 rivers in 7 departments. For 1970, a goal for stocking 1.5 million shrimp has been set.

Another installation, the Medio Mundo Fisheries Station, has as one of its purposes the culture of the river shrimp, C. caementarius. The station,

which has 5 ponds with a total of 0.8 ha surface area, does not have resident staff and therefore is not being effectively utilized. No crops of shrimp have been reared since its establishment in 1966. Efficient use of the facility will not be made until a laboratory and permanent residences for staff are constructed.

3.073 Ornamental Fishes

The Peruvian Amazon is the source of supply for a considerable portion of the aquarium fish industry in Lima and in Miami, Florida, U. S. Thirteen businesses operated in the vicinity of Iquitos, where the Auburn Team visited May 29 to June 3, 1970. One of the most successful was the Popsa Company, which had several hundred concrete holding tanks 1 m x 2 m x 0.5 m, equipped with running water. The tropical fishes were caught from the Amazon and its tributaries by native workers using seines. The fish were hauled by boat for up to several days to the holding tanks at Popsa, treated for disease and shipped by air to Lima or Miami. Medicines and prophylactic chemicals used included acriflavin, potassium permanganate, and terramycin.

Total number of fish shipped in 1969 by the 13 companies, each of which paid an annual export license fee of 3,000 soles ($70) was 11,934,421. The value of the 10,738,993 fish sent to Miami was U. S. $214,780, while the remainder, sent to Lima, was worth 298,857 soles.

Some 84 species are represented in ornamental fishes exported from Iquitos. A list of the 10 most important fishes shipped in 1969, with total numbers and average prices, is indicated on the following page. A checklist of all the known ornamental fishes from the Peruvian Amazon is in Table 1 (Appendix).

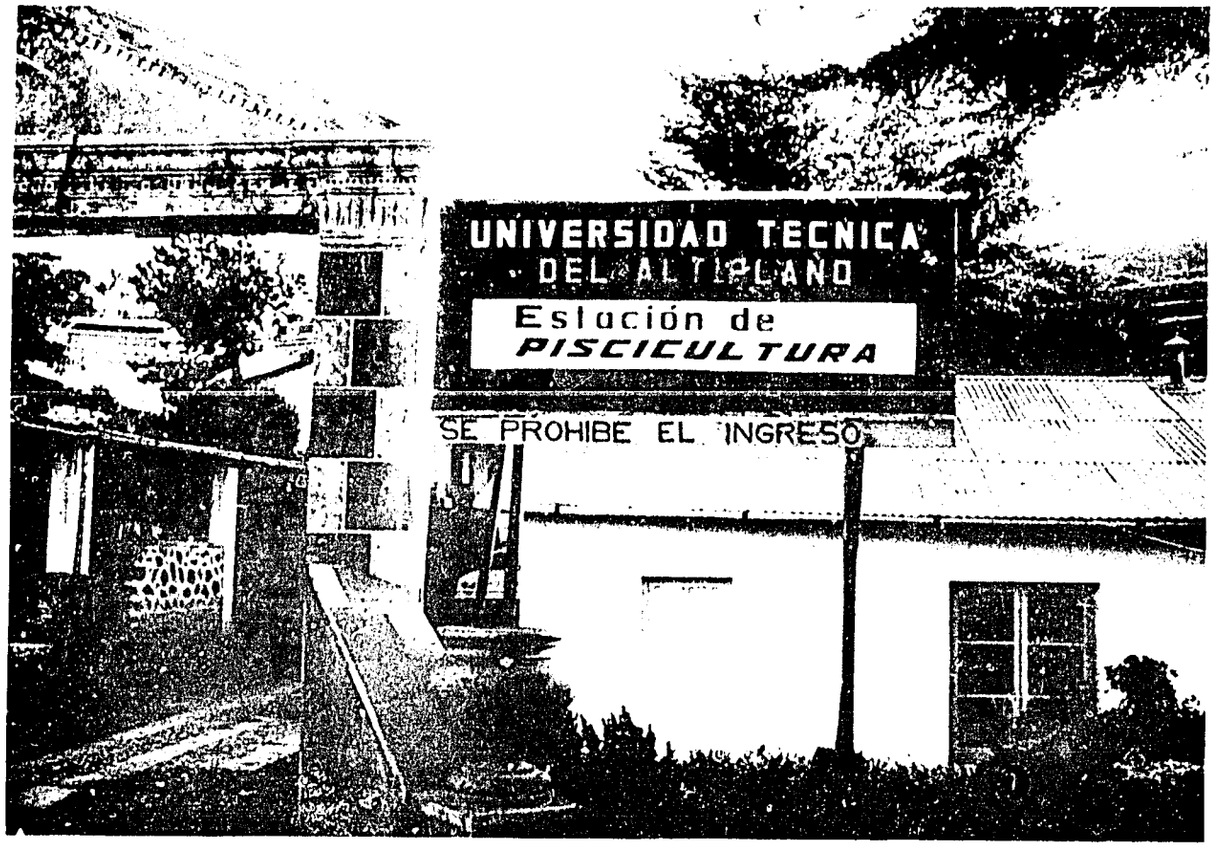
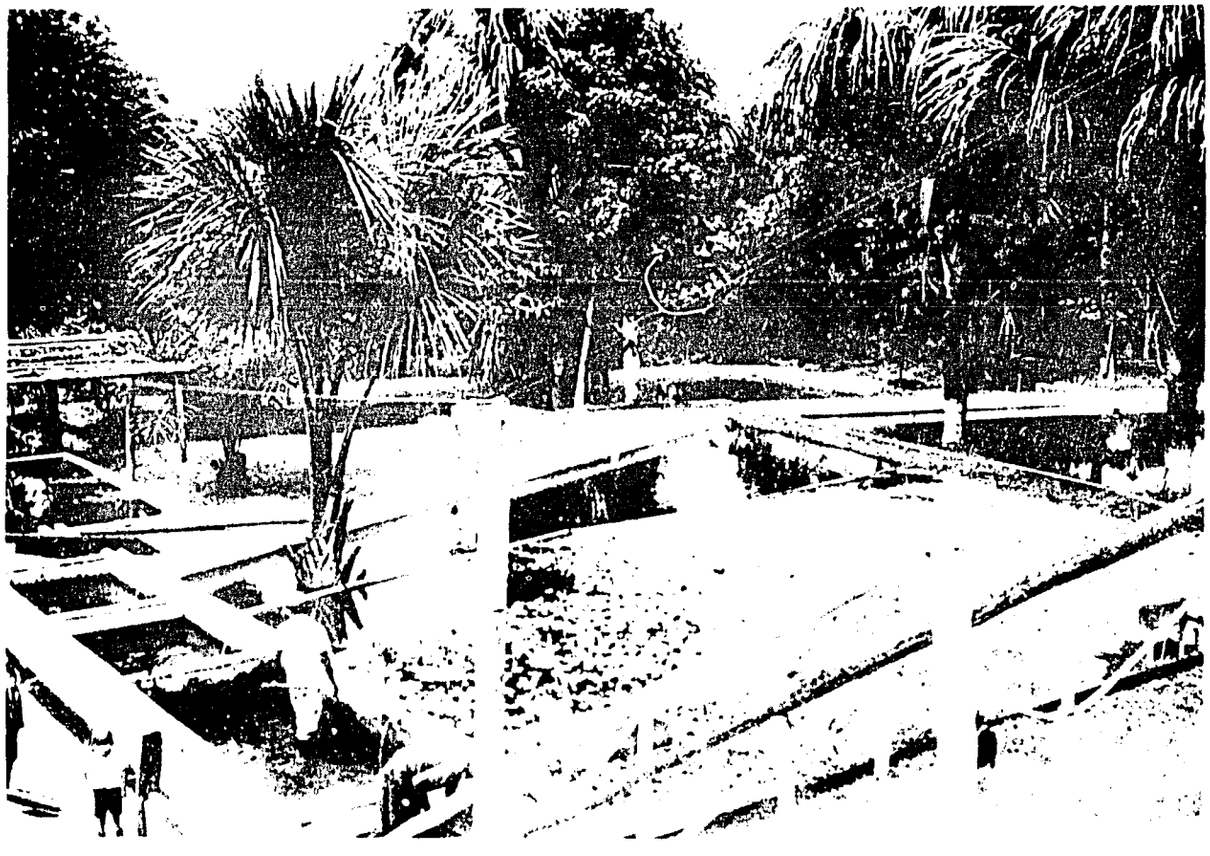


Figure 6. Trout culture station of the National Technical University of the Altiplano, near Chucuito, Lake Titicaca.

Figure 7. Loreto Fisheries Station for tropical fishculture, Iquitos.



Common Name	Scientific Name	Number Exported	Price (U.S. cents)
Neon tetra	Hyphessobrycon innesi	5,179,100	2.0
Punctatus	Corydoras punctatus	813,365	2.5
Perez tetra	Hyphessobrycon rubrostigma	729,390	2.5
Leopard catfish	Corydoras julii	520,760	3.0
Corydoras san juan	Corydoras sp.	412,600	2.0
Otocinclus	Otocinclus affinis	389,315	2.0
Trompa roja	Hemigrammus rhodostomus	260,230	2.5
Elegans	Corydoras elegans	226,849	2.0
Green cat	Corydoras aeneus	212,280	2.5
Blue tetra	Microbrycon cochui	202,850	2.0

3.074 Commercial Fishery in the Amazonas Region

The Peruvian Amazonas Region near Iquitos is accessible only by air and by river. Agricultural production is very limited, and the Amazon River and tributaries provide not only transportation but the major source of animal protein. Iquitos, with a population of approximately 90,000, consumed an estimated 2,350 metric tons of fish in 1969. This is per capita annual consumption of 26.1 kg or 72 grams per capita per day.

The commercial fishery in the Amazon system is done mainly with gill nets and trammel nets used as haul seines. Fishing is best during the dry season from July to December, and fish are very scarce on the market during the flood season the rest of the year. Once fish are caught, there are problems in processing technology in the tropical climate. Fishermen travel considerable distances for their catch, and even with ice the fish are returned to Iquitos in a relatively deteriorated state. The catch is subsequently marketed fresh, or salt-dried.

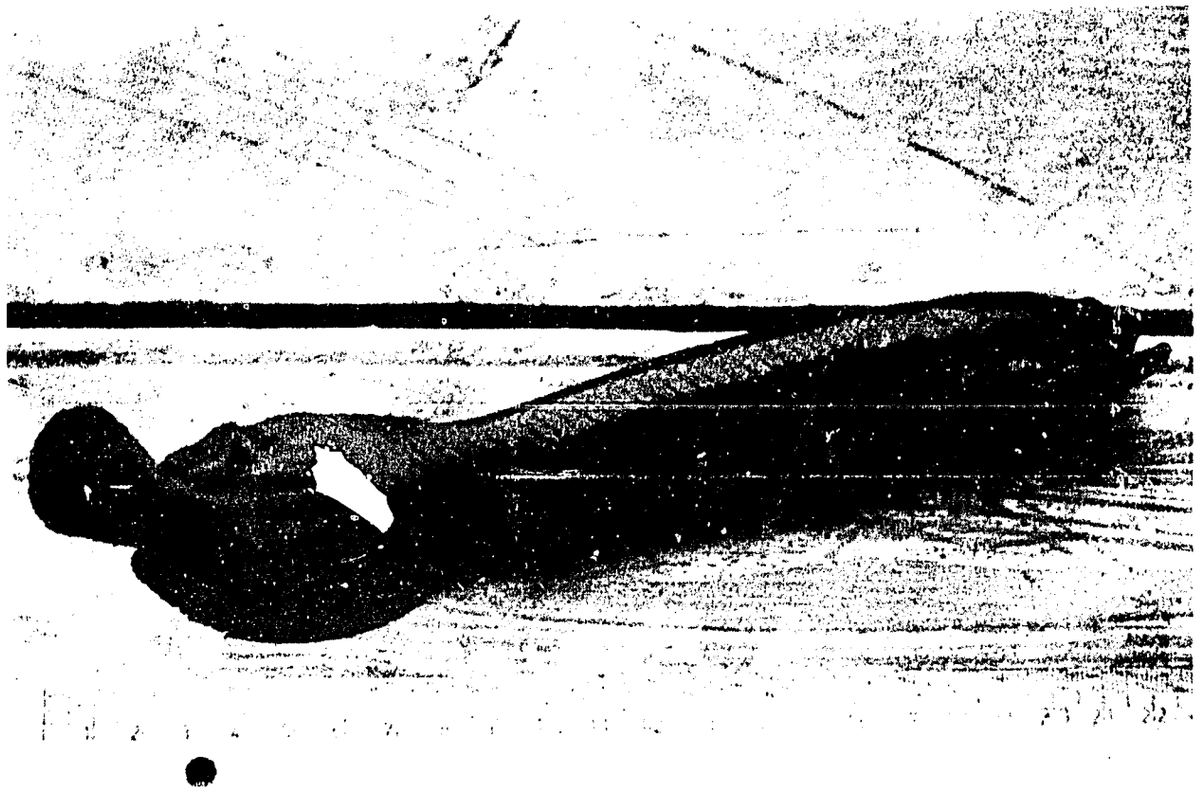
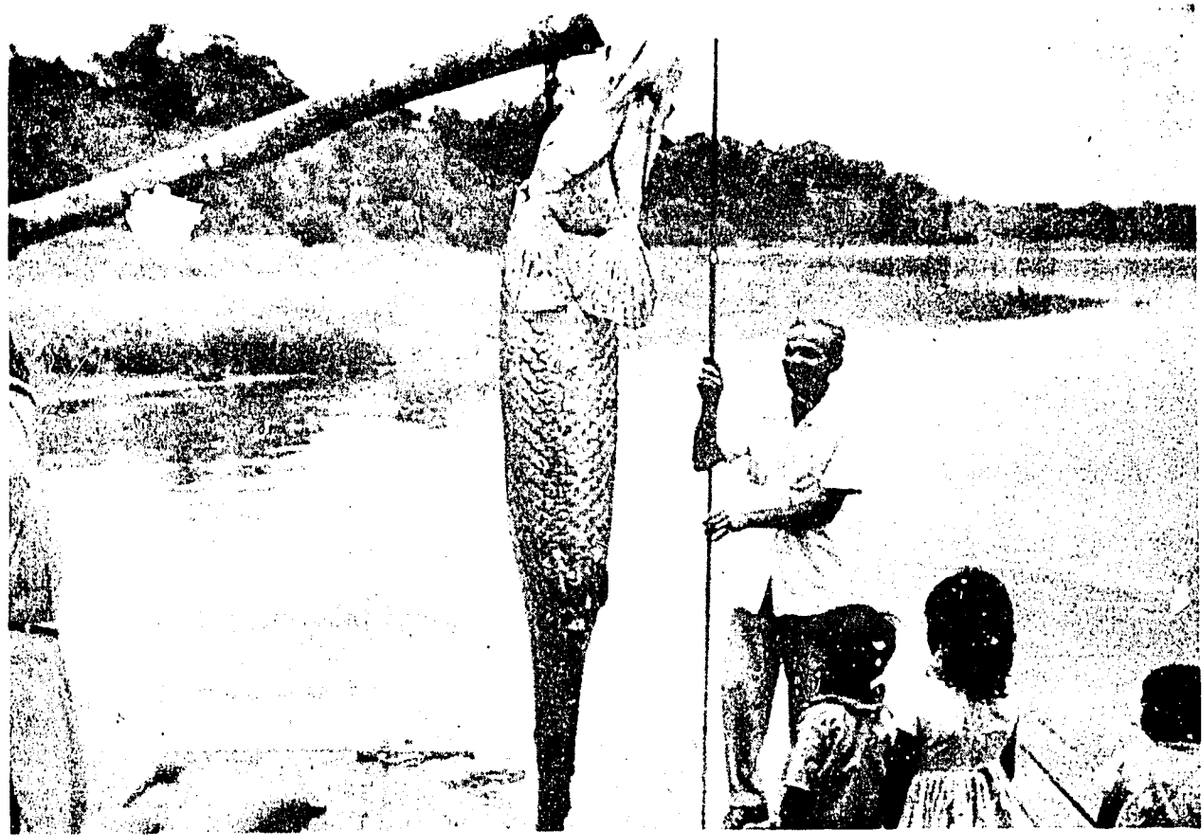


Figure 8. Young of paiche, Arapaima gigas, an important commercial species of the Amazon.

Figure 9. Adult paiche, taken by spear, weighed 150 kg.



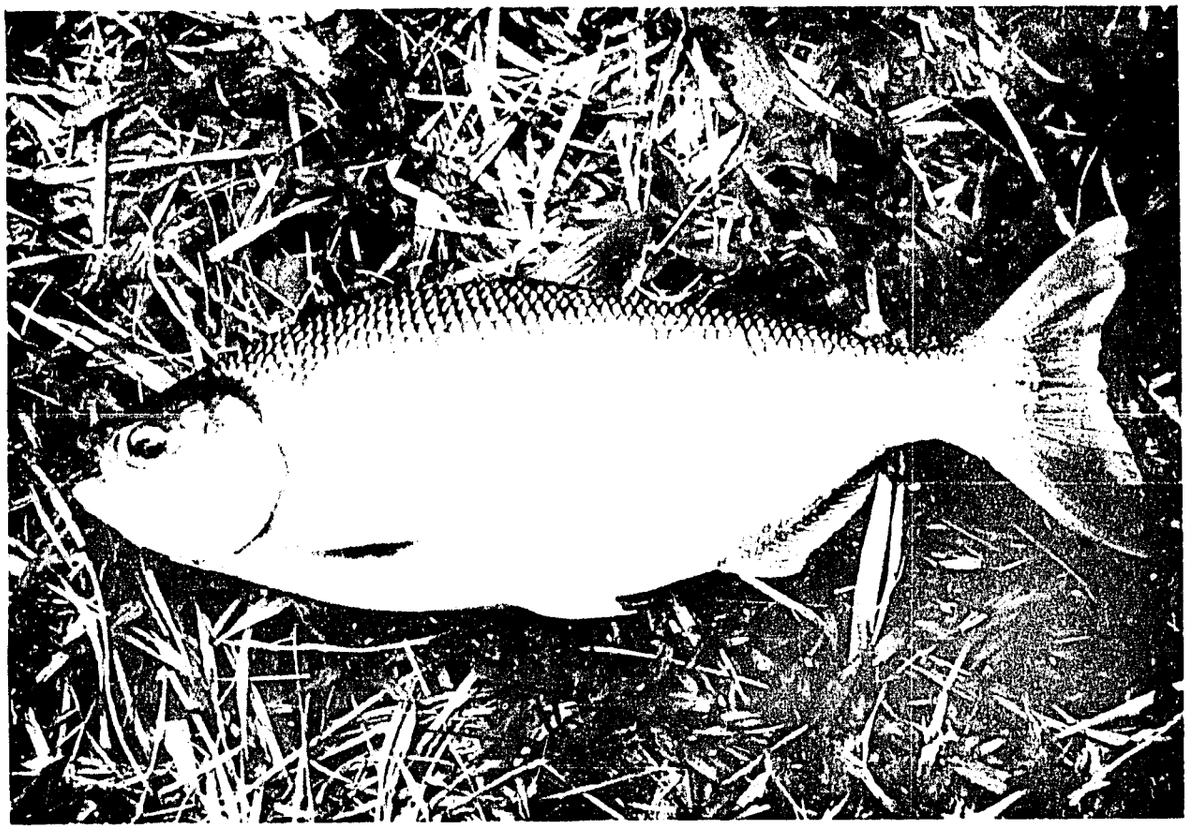


Figure 10 . Sabalo, Brycon sp., the staple fish of the people of the Amazonas Region.

Figure 11 . Tilapia melanopleura, an introduced species, cultured in the Amazonas Region.

Some 500 species of fish are reportedly present in the waters of the upper Amazon River system near Iquitos, approximately 80 species of which are utilized as human food. The table below represents a listing of the 10 most preferred species, with ranking as to order of volume sold in the Iquitos market. Table 2 (Appendix) is a list, furnished by the Ministry of Fisheries, which includes a total of 86 species from waters near Iquitos. Some 50 of these are utilized as human food.

Common Name	Scientific Name	Rank by Popularity	Rank by Volume Marketed Fresh	Avg. Price Soles/kg
Paiche	Arapaima gigas	1	10	48
Sabalo	Brycon sp.	2	9	22
Gamitana	Myletes bidens	3	5	20
Acarahuazu	Astronotus ocellatus	4	7	21
Tucunare	Cichla ocellaris	5	8	22
Boquichico	Prochilodus sp.	6	1	22
Liza	Leporinus sp.	7	4	17
Palometa	Mylossoma sp.	8	3	22
Paco	Colossoma bidens	9	6	20
Carachama	Plecostomus plecostomus	10	2	11

*43 soles = $1.00 U.S.

Fish sold in the market rise in price to approximately 70 soles/kg in the wet season when fishing is difficult and the catch is low.

The Ministry of Fisheries regulates the fishery in certain sanctuary zones near Iquitos. Fish taken in the controlled fishery (mainly paiche) are salted and dried, and sold to residents of the Iquitos area. Purchasers are limited to 1 kg of fish per person at 20 soles per kg for paiche which is one-half the regular market price.

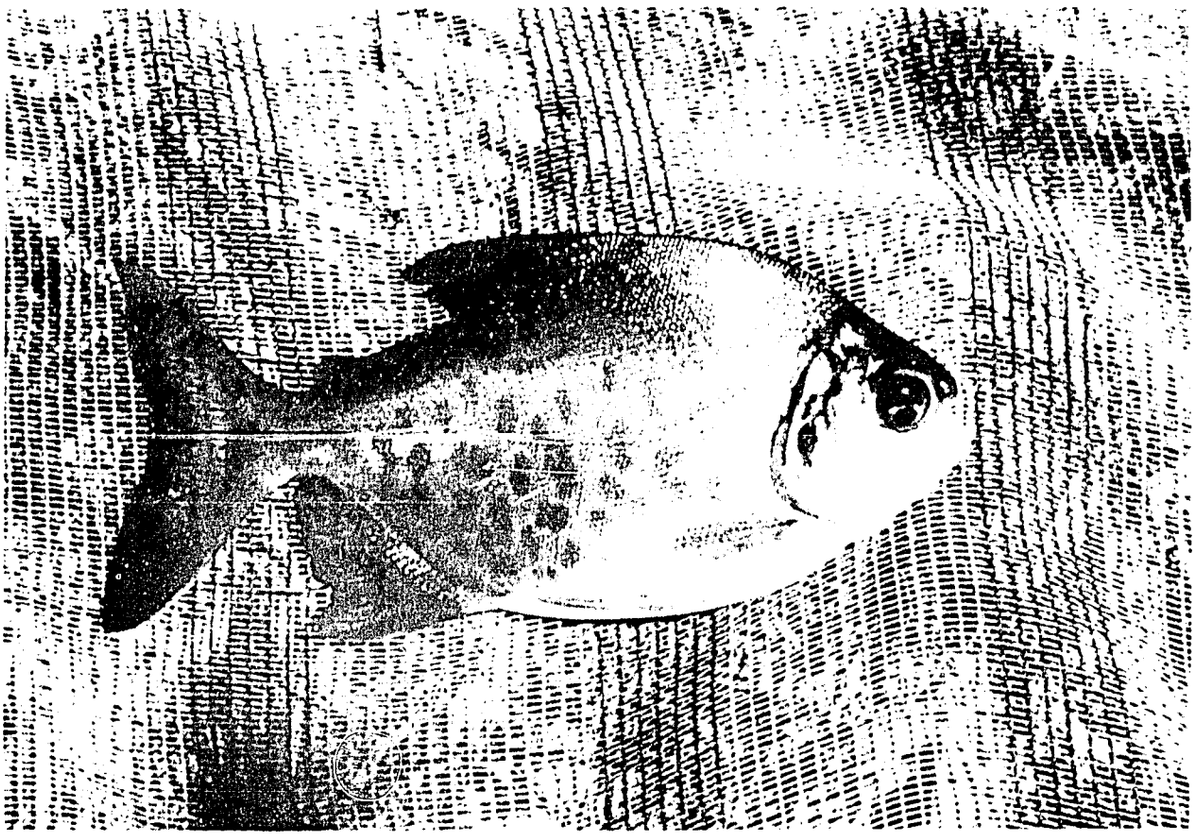
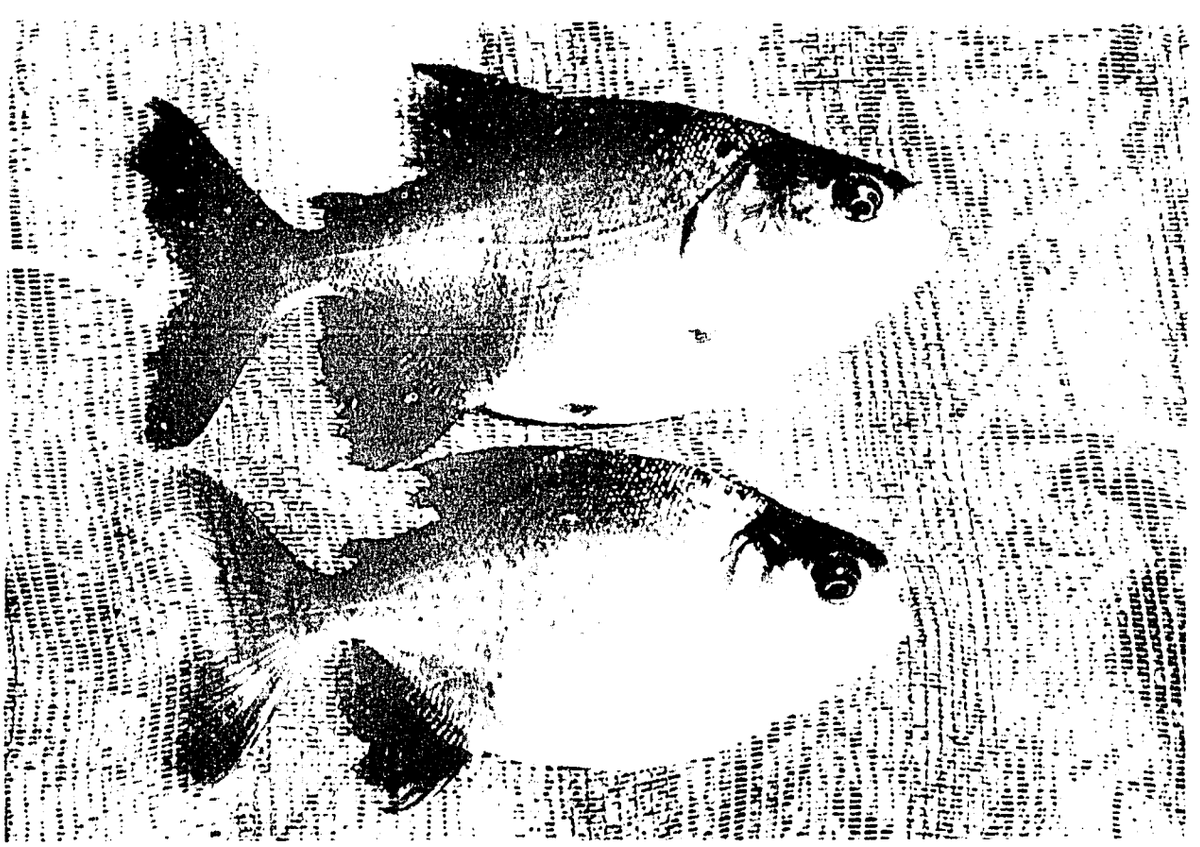


Figure 12. The paco, Colossoma sp., is in culture experiments at the Loreto Fisheries Station.

Figure 13. Gamitana, Myletes bidens, (male above, female below) at the Loreto Fisheries Station.



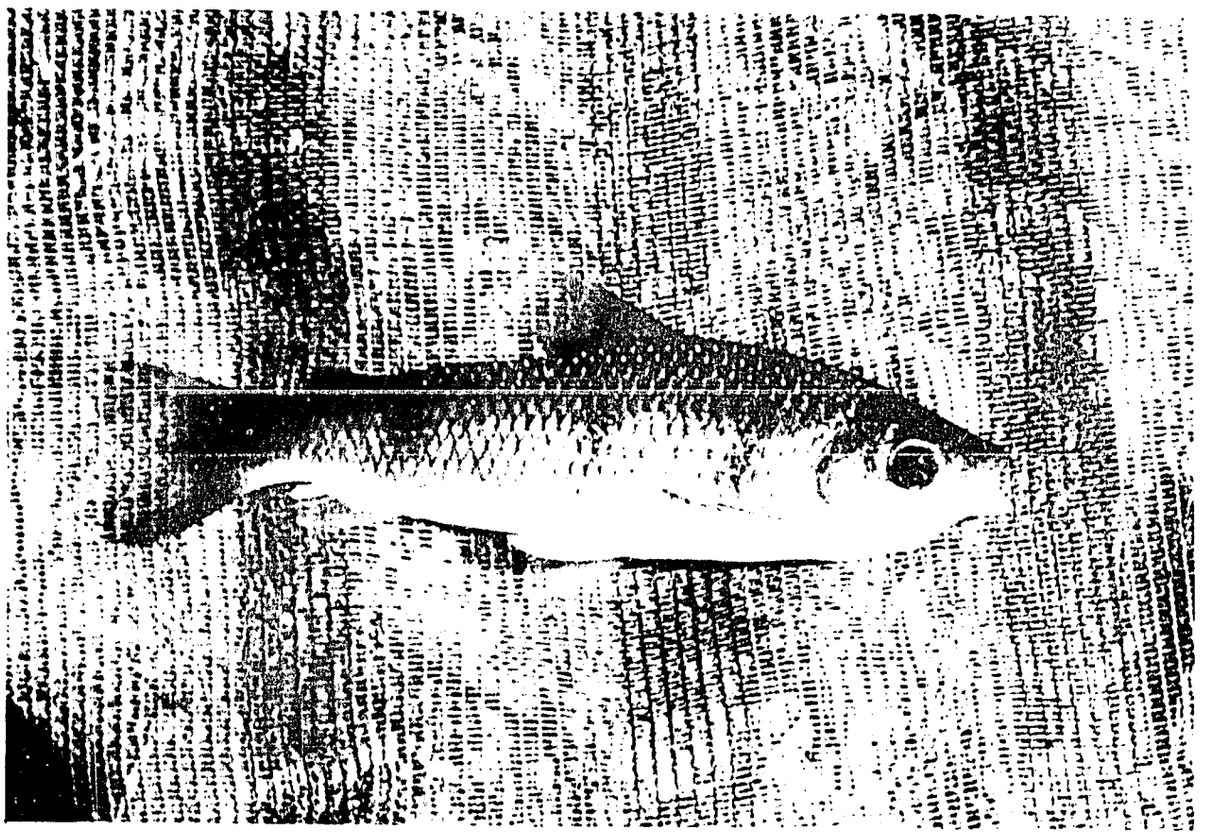
The following table indicates the extent of the controlled fishery in sanctuary zones by the Ministry of Fisheries in 1969.

Common Name	Live Weight (kg)	Fresh Filets (kg)	Salt-Dried Filets (kg)	Salted Filets (kg)
Rio Pacaya Zone				
Paiche	38,721	22,470	10,183	-------
Paiche	3,116	------	------	1,323
Gamitana	12,554	------	3,842	------
Gamitana	1,009	------	------	471
Arahuana	1,752	------	410	------
Boquichico	495	------	306	------
Rio Samiria Zone				
Paiche	16,455	------	4,350	------
Paiche	1,011	------	------	421

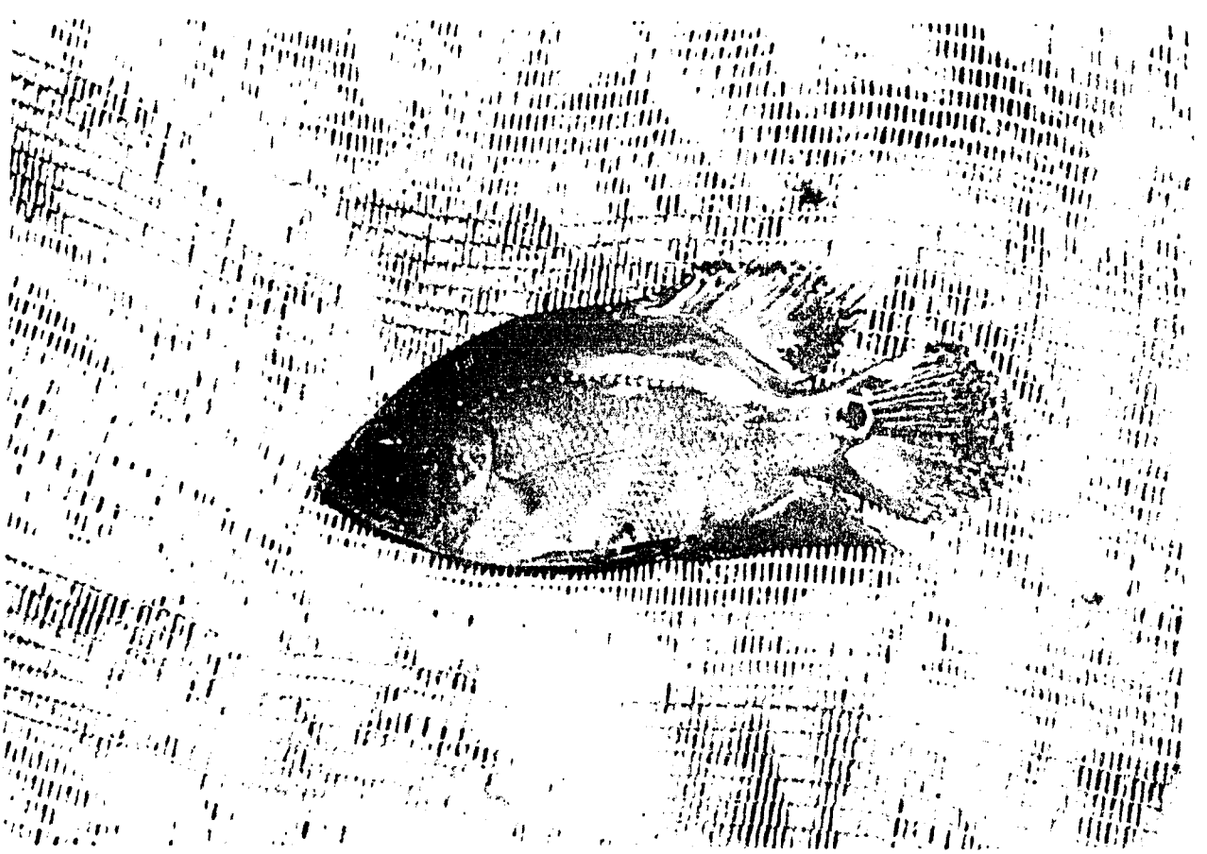
An additional 443 kg of salt-dried paiche filets worth 11,405 soles were confiscated from illegal fishermen. The controlled fishery from the two zones also included 65,100 turtle eggs weighing 1,283 kg. The eggs sold for 20 soles per kg. An additional 17 kg of eggs were confiscated from illegal fishermen.

3.075 Culture of Warmwater Fishes

Promotion of warmwater fishculture is one of the major objectives of the newly established Directorate of Inland Fisheries. Unfortunately, there is not enough local information on culturing either the native Peruvian fishes or introduced species such as Tilapia melanopleura to provide a base for the potential industry.



Figures 14. and 15. Amazon fishes experimentally cultured at the Loreto Fisheries Station. (Above) Liza, Leporinus sp. and (Below) Acarahuazu, Astronotus ocellatus.



An example of the need for research and training in warmwater fisheries is that attempts to spawn the paiche in the Loreto Station hatchery near Iquitos have been unsuccessful for 6 years. Restocking of paiche into certain waters has been accomplished by capturing fingerlings from the Amazon backwaters, and rearing them to a larger size in hatchery ponds before release. On the other hand, paiche are easily spawned in Brazil without the use of hormone injections simply by pairing the adult fish in small hatchery ponds. The young are then easily reared to fingerling size for stocking in new waters. Tilapia melanopleura, introduced into the Loreto Station hatchery from Brazil, is fed only on floating aquatic plants and sweet potato leaves. It is essential that work be done on proper feeding of this and of native species if efficient production methods are to be developed.

Three fishery stations, Loreto, Sauce, and San Martin, have as major functions the culture of paiche and other tropical species. Loreto Station was visited by the Auburn Team on May 30, 1970. Fishes in station ponds were paiche, T. melanopleura, acarahuazu, sabalo, gamitana, paco, palometa, and liza. At the time of the visit, only T. melanopleura and acarahuazu had been spawned in ponds. Young of the other species were seined from the Amazon during the dry season. The fishes, except paiche and T. melanopleura, were fed mixtures of rice bran, vegetables and fruits. Sabalo was reported to eat practically anything offered; also, gamitana, paco, palometa and liza showed promise for intensive culture provided that spawning can be done.

Although inadequate in size as a testing facility, Loreto Station has enough ponds to start collection of pertinent data on food conversion, growth, and survival of important Amazon food fishes. There are 20 small concrete and

earthen ponds totaling 0.14 ha surface area. Fragmentary information is being obtained from 8 species, whereas only 2 or 3 species should be studied at any one time to allow adequate replication in the experiments. At present, each pond contains an experiment in itself, since stocking rates vary. Apparently no records have been kept to date on growth rate or food conversion in the feeding experiments. It is suggested that these records, with those on survival, should be a primary concern if a fishculture program is to be advanced.

On May 31, 1970, the Auburn Team visited a fish farm near Iquitos owned by Sr. Alberto Zamora. The farm had 6 ponds ranging in surface area from 1,500 m^2 to 4,000 m^2. All ponds had been recently stocked with T. melanopleura and acarahuazu, but the four older ponds had previously been stocked with sabalo or gamitana. The following summarizes the previous fish crop production.

Pond	Area (m^2)	Species	Number Stocked	Net Production (kg)	Value (soles)
1	3,500	Sabalo	10,000	1,500	45,000
2	1,500	Sabalo	10,000	1,000	30,000
3	2,000	Gamitana	500	700	28,000
4	3,000	Sabalo	15,000	2,500	75,000

The ponds were stocked with sabalo or gamitana fry seined from the river in March or April, and drained in January, when fish were scarce in the market. This is reflected in the excellent prices: 30 soles/kg for sabalo and 40 soles/kg for gamitana.

Feed for the gamitana and sabalo was mixed according to the following

formula: fish meal - 15 per cent; cottonseed meal - 10 per cent; ground rice - 70 per cent; salt - 5 per cent. Feeding was not strictly regular, and no records were kept for the amounts of feed added to the ponds.

One experiment was run by a biologist of the Ministry of Fisheries in a small pond on a private fish farm near Iquitos. The pond was stocked in November, 1969, with 5 sabalo (25 mm total length) per m^2. The fingerlings were treated with acriflavin, trypaflavin and malachite green. Food was added in 2 increments daily, amounting to 5 to 10 per cent of body weight. Food was a mixture as follows: cattle blood - 50 per cent; fish meal - 20 per cent; manioca - 15 per cent; plantain - 13 per cent; salt - 2 per cent. When the pond was drained in February, 1970, the sabalo averaged 16 cm total length and 70 grams. Survival was 75 per cent. Standing crop at draining was 0.28 kg/m^2 or 2,800 kg/ha. To provide an economic basis for potential fish farming operations, additional information on food conversion, growth rates and production costs are needed.

4.0 SUMMARY

A fisheries survey of two regions in Peru was carried out by the Auburn Team at the request of U.S.A.I.D./Peru and the Government of Peru. The principal objectives were: (1) to assess the status of the trout fishery of Lake Titicaca, with recommendations for increasing its trout populations, and (2) to provide technical advice in development of warmwater aquacultures in the Amazonas Region.

Trout are not native to Lake Titicaca, a 2.1-million-acre lake located at an altitude of 3,813 m in southeast Peru. Since 1940, over 19 million alevins, principally rainbow trout, have been stocked in the lake and tributary streams. By 1961, trout were so abundant that the first cannery was opened; additional canneries were in operation in 1963 and 1964. At the peak of the Lake Titicaca fishery, in 1965, approximately 250,000 kg of canned trout were exported. In subsequent years, the fishery declined steadily, and the lake was closed to commercial fishing in 1969. It appears that the decline of the rainbow trout fishery was the result of uncontrolled exploitation.

Commercial fishing in the lake and tributary rivers should remain closed until such time that the trout populations have recovered. Also, a program of restocking should be carried out in the tributary streams in an attempt to establish spawning runs and effect more rapid recovery of the fishery. After trout populations have recovered so that a commercial fishery can be sustained, regulations should be promulgated and enforced to prohibit fishing especially during spawning season. An extension program in trout management with emphasis on training local persons as agents to work closely with fishermen and representatives of the

processing industry also should be initiated.

In the Amazonas Region near Iquitos, capture fisheries for ornamental fishes for the aquarium trade and fishes for human consumption are quite important to the local economy. The value of ornamental fishes shipped from Iquitos in 1969 by 13 tropical fish dealers amounted to approximately $290,000. In the same area the Amazon River and tributaries provided the local population (about 90,000 people) with an estimated 2,350 metric tons of food fish in 1969 - a per capita annual consumption of 26.1 kg. However, a shortage of food fish persists in the region, especially during the flood season when fishing in the rivers is difficult. Fish sold in the market rise in price to approximately $0.70 per pound in the wet season when fishing is difficult and the catch is low. There is interest in aquaculture in the region, as evidenced by development of small fish farms, although there is insufficient local information on culturing fish to provide a base for the potential industry.

An aquacultural facility should be established to serve the Amazonas Region. However, Iquitos is not suitable for such a pond research facility since vast land areas in this region are periodically subjected to severe flooding by the Amazon River. The pond research facility should be located in an upland jungle area, possibly near Pucallpa. The station, in order that aquacultural management methods be developed rapidly, should include approximately 100 experimenta ponds with a total of 10 hectares of water.

Several universities in Peru offer programs in fisheries, including aquacultures. Hence, training of fishery personnel, for the most part, can be accomplished locally. However, upon request of the A.I.D. Mission in Peru,

the International Center for Aquacultures, Auburn University, will provide professional personnel to assist in proper location and design of an aquacultural testing facility.

5.0 CONFERENCES

U. S. Government

Mr. George Greco,	Acting Director, U.S.A.I.D. Mission
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Private Sector

Sr. Alberto Zamora,	Owner, Fish Farm, Iquitos

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7.0 APPENDIX

Table 1. Checklist of ornamental fishes exported from the Peruvian Amazon in 1969 *

Common Name	Family	Scientific Name
	Characidae	
1. Tetra robertis		Hyphessobrycon serpae
2. Punto rojo; tetra perez		H. rubrostigma
3. Rosaceus; banderita		H. rosaceus
4. Piaba; neon tetra		H. innesi
5. Blue tetra		Microbrycon cochui
6. Trompa roja; ruminose		Hemigrammus rhodostomus
7. Buenos aires tetra		H. caudovittatus
8. Tetra lindo		H. pulcher
9. Pez faro		H. ocellifer
10. Tetra loreto		Hyphessobrycon peruvianis
11. Limon tetra		H. pulchripinnis
12. Huacamayo challua; tucan fish		Chalceus macrolepidotus
13. Moenkhausia; glass tetra		Moenkhausia oligolepis
14. Argentino		M. dichroura
15. Oblicua		Thayeria obliqua
16. Pana roja; pirana		Serrasalmo spilopleura
17. Pana blanca		S. rhombeus
18. Pana negra		S. niger
19. Glass blood fin		Prionobrama filigera
20. Blood fin		Aphyocharax rubripinnis
21. Palometa		Mylossoma aureum
	Anostomidae	
22. Liza amarilla		Leporinus affinis
23. Abramites		Abramites microcephalus
24. Anostomus		Anostomus trimaculatus
25. Chilodus		Chilodus punctatus
26. Copeina rociada		Copeina arnoldi
27. Frederici; liza punteada		Leporinus frederici
28. Copeina punto rojo		Copeina guttata
29. Copeina de aguajal		C. eigenmanni
30. Pyrrhulina		Pyrrhulina rachoniana
31. Pyrrhulina		Pyrrhulina sp.
32. Leporinus bimaculata		Leporinus bimaculata
33. Yaraqui		Prochilodus insignis
34. Anostomus		Anostomus fasciatus

*Data supplied by Ministry of Fisheries.

Table 1.--continued

Common Name	Family	Scientific Name
	Callichthyidae	
35. Shirui; porfol corriente		Hoplosternum thoracatum
36. Leopardo catfish		Corydoras julii
37. Elegans		C. elegans
38. Rabauti		C. myersi
39. Agassizi		C. agassizi
40. Blue catfish		C. nattereri
41. Arcuatus		C. arcuatus
42. Aeneus; green cat		C. aeneus
43. Gold cat		C. griseus
44. Punctatus		C. punctatus
45. Melanistus		C. melanistus
46. Hastatus		C. hastatus
47. Undulatus		C. undulatus
	Gasteropelecidae	
48. Marta; pechito		Carnegiella marthae
49. Strigata morada		C. strigata
50. Gasteropelecus		Gasteropelecus maculatus
51. Toracocharax		Toracocharax stellatus
	Hemiodontidae	
52. Characidium		Characidium fasciatum
53. Yulilla; hemiodus		Hemiodus semitaeniatus
54. Torpedo rojo		Nannostomus trifasciatus
55. Cachorro		Acestrorhynchus cachorro
	Cichlidae	
56. Bufurqui; severum		Cichlasoma severum
57. Scalare		Pterophyllum scalare
58. Apistogramma		Apistogramma pertense
59. Apistogramma		A. ramirezi
60. Festivum		Cichlasoma festivum
61. Flag cichlid		Aequidens curviceps
62. Hercules		A. hercules
63. Aequidens		A. mariae
64. Disco		Symphysodon discus

Table 1.--continued

Common Name	Family	Scientific Name
	Gymnotidae	
65. Macana perro		Esternachus albifrons
66. Macana rayada		Gymnotus carapo
67. Macana puntiada		Hypopomus artedi
68. Macana blanca		Eigenmannia virencens
	Pimelodidae	
69. Cunchi moteado		Pimelodus clarias
70. Cunchi rayado		Pimelodella gracilis
71. Shovelnose; chiripira		Sorubim lima
	Bagriidae	
72. Cunchi corriente		Mystus tengara
	Loricaridae	
73. Otocinclus; limpia vidrio		Otocinclus affinis
74. Farlowella		Farlowella acus
75. Shitari		Loricaria parva
76. Plecostomus		Hypostomus plecostomus
	Nandidae	
77. Pez hoja		Monocirrhus polyacanthus
	Bunocephalidae	
78. Banjo cat		Bunocephalus coracoideus
	Doradidae	
79. Reco reco		Acanthodoras spinosissimus
	Achiridae	
80. Panga raya		Achirus errans

Table 1.--continued

Common Name	Family	Scientific Name
	Cyprinodontidae	
81. Rivulus		Rivulus urophthalmus
82. Rivulus		R. compressus
	Electrophoridae	
83. Anguila electrica		Electrophorus electricus
	Belonidae	
84. Pez aguja		Potorrhaphis guianensis

Table 2. List of some fishes from the Peruvian Amazon Region in the vicinity of Iquitos*

	Common Name	Family	Scientific Name
		Arapaimidae	
1.	Paiche		Arapaima gigas
		Osteoglossidae	
2.	Arahuana		Osteoglossum bicirrhosum
		Characidae	
3.	Gamitana		Myletes bidens
4.	Paco		Colossoma bidens
5.	Sabalo		Brycon sp.
6.	Boquichico		Prochilodus amazonensis
7.	Yaraqui		P. insignis
8.	Puca huicsa (barriga roja)		Tetragonopterus sp.
9.	Ractacara		T. argenteus
10.	Yulilla		Anodas latior
11.	Denton		Rhomboides gibbosus
12.	Sardina		Troportheus angulatus
13.	Sardina		Chalcinus elongatus
14.	Chambira challua		Rhoamphiodon vulpinus
15.	Shuyo		Hoplias malabaricus
16.	Fasacuy		H. macrophthalmus
17.	Quiruchallua		Acestrorhynchus microlepi
18.	San Pedro		Abramites microcephalus
19.	Liza		Leporinus bimaculata
20.	Liza		L. fasciatus
21.	Palometa		Mylossoma maculatus
22.	Palometa		Metynnis sp.
23.	Palometa		Mylossoma aureum
24.	Mojarra plateada		Ctenobrycon spilurus
25.	Mojarra		Hemigrammus ocellifer
26.	Mojarra		H. pulcher
27.	Mojarra trompa roja		H. rhodostomus
28.	Mojarra		Amphyocharax sp.
29.	Mojarra oligolepis		Moenkhausia oligolepis
30.	Pez banderita		Hyphessobrycon sp.
31.	Mojarra		H. heterorhabdus
32.	Mojarra rosada		H. rosaceus
33.	Piaba; neon tetra		H. innesi
34.	Pechito		Gasteropelecus levis

*Data supplied by Ministry of Fisheries.

Table 2.--continued

	Common Name	Family	Scientific Name
		Characidae	
35.	Martas		Carnegiella marthae
36.	Zapatero		C. strigata
37.	Pana roja		Serrasalmo spilopleura
38.	Pana blanca		S. rhombeus
39.	Pana negra		Pugocentrus scapulares
40.	Torpedo negro		Poecilobrycon auratus
41.	Torpedo rojo		Nannostomus trifasciatus
42.	Oblicuas		Thayeria oblicua
43.	Hemiadus		Hemiadus semitaeniatus
44.	Copeina		Copeina arnoldi
45.	Copeina		C. guttata
46.	Pez vidrio		Prionobrama filigera
47.	Yahuarachi		Curimatus sp.
		Cichlidae	
48.	Tucunare		Cichla ocellaris
49.	Acarahuazu		Astronotus ocellatus
50.	Anashua		Crenicichla lacustris
51.	Bufurqui		Cichlasoma festivum
52.	Bufurqui		C. severum
53.	Bufurqui		Aequidens portalegrensis
54.	Escalar o pez angel		Pterophyllum scalare
55.	Apistograma		Apistogramma sp.
		Callichthyidae	
56.	Shiruy		Corydoras aeneus
57.	Shiruy		C. arcuatus
58.	Shiruy		C. hastatus
59.	Shiruy		C. elegans
60.	Shiruy		C. julii
61.	Shiruy		C. rabauti
62.	Shiruy		C. melanistius
63.	Porjol		Callichthys callichthys
64.	Porjol		Hoplosternum thoracatum
65.	Maparatre		Hypophthalmus edentatus
		Pimelodidae	
66.	Challacagllu		Sorubim sp.

Table 2.--continued

	Common Name	Family	Scientific Name
		Pimelodidae--continued	
67.	Zungaro dorado		Pseudopimelodus sp.
68.	Hacha cubo		Sorubimichthys sp.
69.	Potolomocunchi		Pimelodus sp.
70.	Novia cunchi		Trachicorystes sp.
71.	Bagre		Mystus tangara
72.	Cunchi		Pimelodella gracilis
73.	Doncella		Pseudoplatystoma sp.
		Loricaridae	
74.	Carachama		Plecostomus plecostomus
75.	Lagarto carachama		Hemiancistrus arenarius
76.	Carachama amarilla		Chaetostoma lineopunctata
77.	Shitari		Loricaria parva
78.	Farlowella		Farlowella sp.
79.	Limpia vidrio		Otociclus affinis
		Gymnotidae	
80.	Angila electrica		Electrophorus multivalvulus
81.	Macana		Gymnotus carapo
82.	Macana		Hypopomus artedi
83.	Macana		Eigenmannia virescens
		Synbranchidae	
84.	Atinga		Synbranchus marmoratus
		Dasyatidae	
85.	Raya		Potamotrigan histrix
		Sciaenidae	
86.	Corvina		Plagioscion sp.