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**FISHCULTURE SURVEY REPORT  
FOR PARAGUAY**

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## 1.0 ITTNERARY OF AUBURN TEAM IN PARAGUAY, JUNE 6 - JUNE 18, 1970

- June 6** Arrived Asuncion, Paraguay
- June 8** Initial meeting with U.S.A.I.D. ; Sport Fishing Federation; Division of Game, Fish and Fishculture, Ministry of Agriculture and Livestock; Institute of Agrarian Reform.
- June 9** General Directorate of Tourism; Institute of Sciences, National University of Asuncion.
- June 10** Lake Ypacarai and demonstration tilapia ponds near Caacupe.
- June 11** Dorado fishery on Rio Tebicuary approximately 25 km north of San Juan Bautista.
- June 12** Dorado fishery on Rio Tebicuary; Private tilapia ponds near Paraguari.
- June 13-14** Asuncion
- June 15** Mision de Amistad (World Neighbors Friendship Mission) in Asuncion; Lago de la Republica, Puerto Presidente Stroessner.
- June 16** Puerto Presidente Stroessner; Office of the Delegate of the Government; Lake Acaray and Acaray Hydroelectric Dam; Salto Monday and Salto Acaray.
- June 17** Fish hatchery at Experiment Station of the Ministry of Agriculture near Caacupe; Faculties of Agronomy and Veterinary Medicine, and Museum of Natural History, National University of Asuncion.
- June 18** Final conferences with officials of U.S.A.I.D. and Ministry of Agriculture and Livestock, Republic of Paraguay.  
Departed Paraguay.

## 2.0 RECOMMENDATIONS

- 2.01 It is recommended that an advisor in fisheries from Auburn University be provided for 2 years to assess the potential of the dorado fishery as a means of increasing tourism in Paraguay. Particular emphasis should be on biology and population dynamics, including distribution and standing crops in various river systems.
- 2.02 The advisor also will assist in the establishment of a reference collection of Paraguayan fishes, and the training of personnel of the Fisheries Division.
- 2.03 Training in fisheries also should be provided at Auburn University for a university graduate with a background in biology. The participant, upon return to Paraguay, should be added to the staff of the Division of Game, Fish and Fishculture, Ministry of Agriculture and Livestock, as a specialist in aquaculture and inland fisheries management.
- 2.04 Short-term training (3-months) in fishculture at the A. I. D. sponsored fishculture project\* in Northeast Brazil should be provided for the Chief of the Division of Game, Fish and Fishculture. This practical training includes spawning of fish with hormones, production of fingerlings, handling and stocking of fish, fertilizing and feeding, and other fish production methods.

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\*Cooperators are DNOCS (National Department of Works Against Drought); SUDENE (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 PARAGUAY

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#### 3.01 Introduction

The Auburn Team made a survey of fisheries in Paraguay during June 6 - 18, 1970. The visit, under the sponsorship of U.S.A.I.D./Paraguay and the Ministry of Agriculture and Livestock, Republic of Paraguay, had as a primary objective the assessment of the potential of sport fishing for creating tourism in Paraguay. A secondary objective was determination of the status of the fisheries in general.

#### 3.02 Geography, Topography and Climate

Paraguay, with an area of 406,752 km<sup>2</sup>, is an inland country bordered by Bolivia, Brazil and Argentina (Figure 1). The Paraguay River, running roughly north-south, cuts the country in two parts which are considerably different topographically. The land area west of the river, the sparsely populated Chaco, is a flat alluvial plain subject to considerable flooding in the wet season and water shortage in the dry summer season. On the eastern side of the Paraguay River, the land is well watered, the plains fertile and there are heavily wooded areas. Most of the population live in the eastern section.



In general, the climate of Paraguay is characterized by a non-stable balance between the cold masses of air from the south and the very hot masses of tropical air from the north. Sharp changes of temperature often occur and may fluctuate as much as 18 C in 24 hours. With exception of these extreme temperature fluctuations, the climate is similar to that of southern Florida, with monthly average temperatures ranging from 17 to 27 C. The mean annual temperature varies from about 21 C near the southern border to about 26 C near the northern border (Figure 2). Frosts occur annually but are more frequent in the southeast. Highest mean temperatures occur in December and January and vary from 23 C in the northeast, to 29 C in the western Chaco. The coldest months are June, July and August. The lowest mean temperatures are in July and vary from 16 C to 21 C at various locations within the country. The lowest temperature is usually associated with the higher elevation (460 m) of the northeast, compared to 90 m elevation in southern Paraguay.

Rainfall is abundant, though not excessive, and is distributed fairly well throughout the year. This is especially so for the eastern half of the country, which receives an average of 1,575 mm annually (Figure 3).

The Paraguay and Parana Rivers produce certain local effects in climate by the high temperature of the waters which they bring from tropical regions as they flow toward the south. A strip 1 km or more wide, adjacent to the rivers, is characterized by fogs during the mornings and the general absence of freezing.

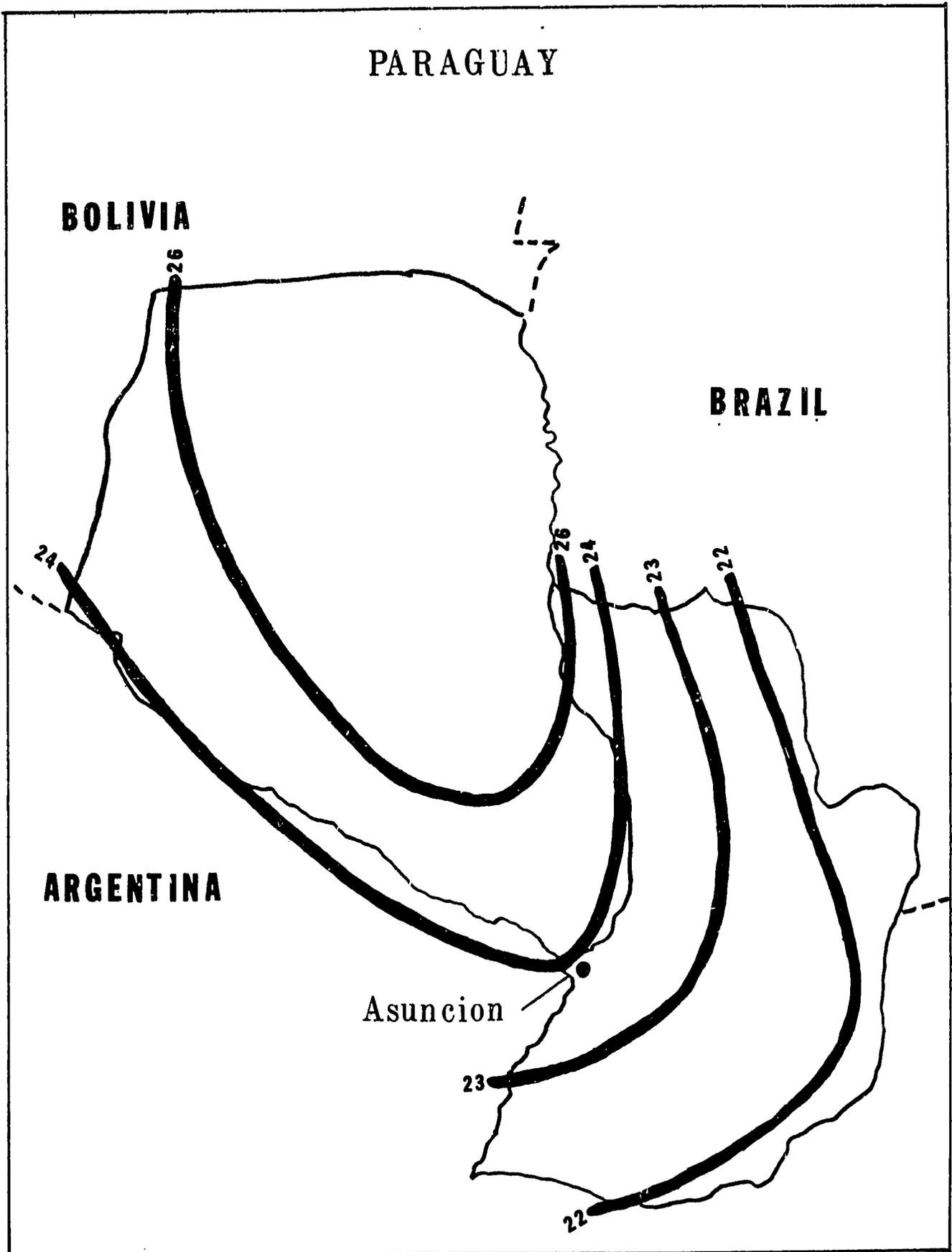


Figure 2. Map of Paraguay, indicating mean annual temperature in degrees centigrade.

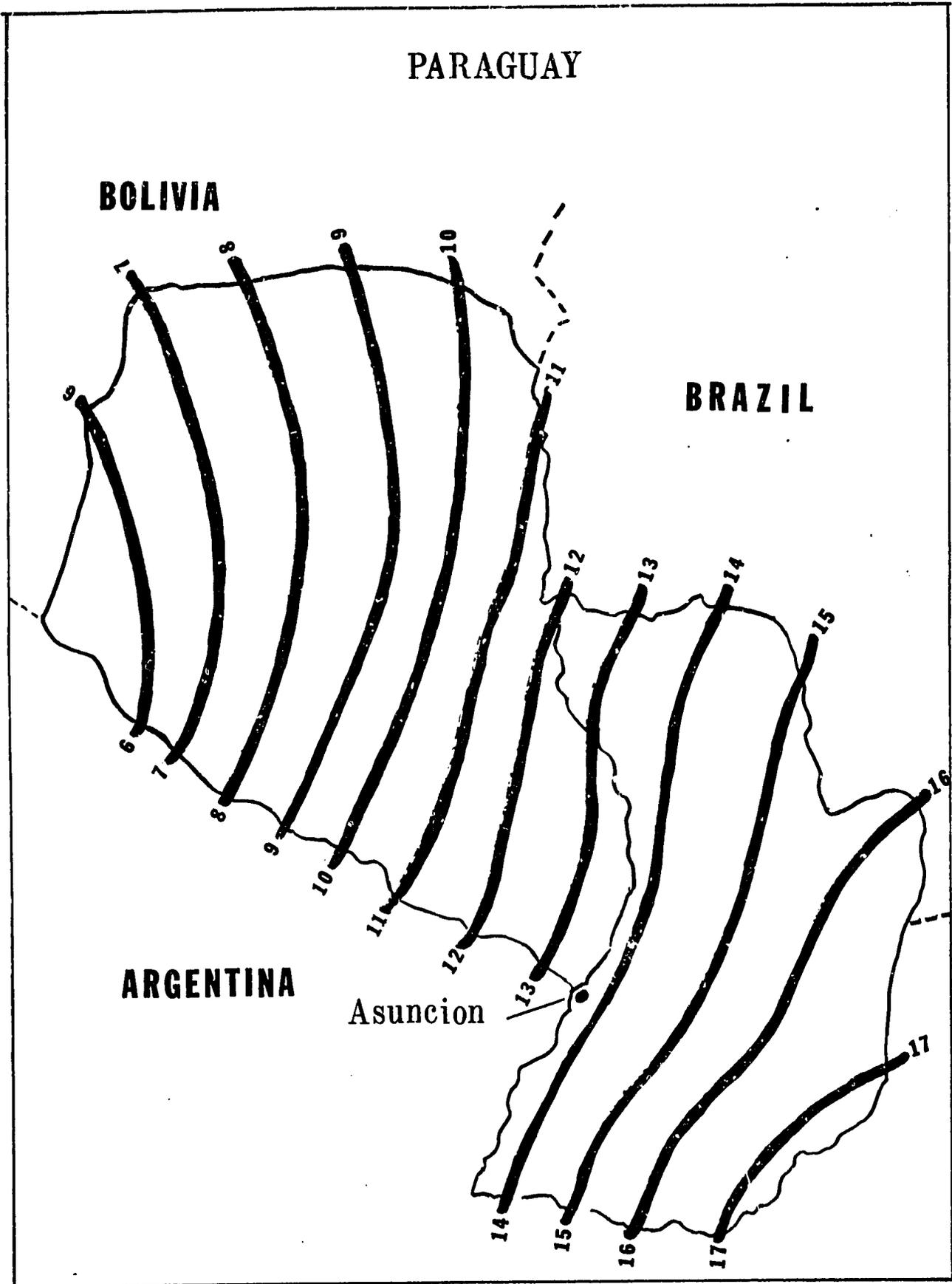


Figure 3. Map of Paraguay, indicating mean annual rainfall in hundreds of millimeters.

### 3.03 Nutritional and Economic Aspects

The population of Paraguay is 2.4 million with an annual growth of 3.1 per cent. At the present rate, the population will double in approximately 20 years.

Adequacy of the food supply for a population is indicated by the amounts 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 following table indicates the amounts of protein per capita available in Paraguay from various sources for the years 1959 - 1961 (U.S. Department of Agriculture, 1964a).

Product	Grams of Protein per Capita per Day
Cereals	21.8
Sugar, fruits, vegetables	16.0
Meat	20.6
Fish	0.1
Fats	0.2
Milk and cheese	6.2
Eggs	<u>1.7</u>
Total	66.6

The total average available protein was 66.6 grams per capita per day, with that from animal sources totaling 28.8 grams per capita per day. Only 0.1 gram of the protein was from fish. The average available protein in 1956 - 1958

was 72.5 grams per capita per day, so a decrease in food supply occurred between 1956 and 1961. Projections for 1970 (U.S. Department of Agriculture, 1964b) indicate that average protein available will be 69.5 grams per capita per day, a slight increase over the 1959 - 1961 period. Food supply in Paraguay, assuming equal distribution, is certainly more favorable than in many other developing countries. Paraguay is self-sufficient in most foodstuffs, but is required to import wheat and wheat flour.

Paraguay is almost completely dependent on agriculture, its known natural resources being its farmlands, grazing ranges, forests and some hydroelectric potential (U.S.A.I.D., 1970). Lumber, quebracho, cotton and meats are chief exports, while most vehicles, machinery, textiles and other manufactured goods must be imported.

### 3.04 Water Resources

#### 3.041 Rivers and Streams

There is an abundance of rivers and streams in Paraguay, the major ones being the Rio Paraguay and Rio Parana. From these river systems, which constitute routes to the Atlantic Ocean, come the bulk of the fishes caught for sport and for food.

#### 3.042 Lakes

Two permanent natural lakes, Lago Ypacarai and Lago Ypoa, are potentially valuable for their fishery resources. Lago Ypacarai, located 25 km east of Asuncion, is 5,400 ha in surface area and has a maximum depth of 3 meters.

Lago Ypoa is approximately two-thirds the size of Lago Ypacarai, and is located in a remote area 75 km south of Asuncion.

### 3.043 Reservoirs

A hydroelectric reservoir was built in 1967 on the Rio Acaray 8 km north of Puerto Presidente Stroessner. The Lago Acaray, with a maximum depth of 20 meters, is approximately 0.3 km wide and 30 km long.

Lago de la Republica is a 40-ha water storage reservoir in the city limits of Puerto Presidente Stroessner. Built 10 years ago, it has a maximum depth of 12 m, and average temperature is 18 C.

### 3.044 Ponds

In eastern Paraguay, the soils, topography, and water supplies appeared quite suitable for pond construction. A program of the World Neighbors Friendship Mission, and the Ministry of Agriculture and Livestock has resulted in the construction of approximately 70 small ponds for fishculture. Dimensions of the ponds averaged approximately 6 m x 15 m x 1.2 m. It was reported that several hundred ponds existed in eastern Paraguay.

## 3.05 Status of the Fisheries

### 3.051 Fish Species

Bertoni (1939) lists 298 species of fishes occurring in waters of Paraguay. Table 1 presents the principal species exploited commercially, and Table 2 (Appendix) is an enumeration of known fishes of Paraguay, most of which belong

Table 1. Principal fishes exploited commercially in Paraguay\*

Species	Common Name	Average and Maximum Wt. Marketed (kg)	Rank According to Volume Marketed
<b>Family Pimelodidae</b>			
<u>Pseudoplatystoma coruscans</u>	surubi	20.0-60.0	2
<u>P. fasciatum</u>	surubi	20.0-60.0	2
<u>Luciopimelodus pati</u>	pati	8.0-20.0	4
<u>L. platanus</u>	pati	7.0-15.0	4
<u>Hemisorubim platyrhynchos</u>	mandove	2.0- 6.0	6
<u>Iheringichthys megalops</u>	mandii saihyu	0.5- 1.0	7
<u>Pimelodus albicans</u>	mandii guasu	0.3- 1.0	8
<u>Sorumbim lima</u>	mandove	3.0- 5.0	9
<u>Pimelodus clarias</u>	mandii	0.3- 1.0	10
<u>P. ornatus</u>	mandii saihyu	0.3- 1.0	10
<u>Rhamdia sebae</u>	yurundia	0.5- 1.0	10
<u>Zungaro mangurus</u>	manguruyu	30.0-80.0	11
<u>Doras armatus</u>	itagwa		14
<u>D. costatus</u>	itagwa		14
<u>D. maculatus</u>	itagwa		14
<u>D. nebulosus</u>	itagwa		14
<u>D. veddellii</u>	itagwa		14
<b>Family Characidae</b>			
<u>Prochilodus argenteus</u>	kihrihmbata	2.0- 4.0	1
<u>P. nigricans</u>	kihrihmbata	2.0- 4.0	1
<u>P. scrofa</u>	kihrihmbata	2.0- 4.0	1
<u>P. reticulatus</u>	kurimata	2.0- 4.0	1
<u>Salminus brevidens</u>	dorado		3
<u>S. hilarii</u>	dorado		3
<u>S. maxillosus</u>	dorado		3
<u>Piaractus brachypomus</u>	paku	6.0-12.0	5
<u>Curimata sp.</u>			12
<u>Curimatella sp.</u>			12
<u>Psectrogaster sp.</u>			12
<u>Serrasalmo gymnogenys</u>	pirana		13

\*Data provided by Sr. Juan Rivaldi Blanco, Chief, Division of Game, Fish and Fishculture Ministry of Agriculture and Livestock.

Table 1. --continued

Species	Common Name	Average and Maximum Wt. Marketed (kg)	Rank According to Volume Marketed
<b>Family Characidae--continued</b>			
<u>Serrasalmo humeralis</u>	pirana		13
<u>S. marginatus</u>	pirana	0.3- 1.0	13
<u>S. rhombeus</u>	pirana		13
<u>S. spilopleura</u>	pirana	0.2- 0.6	13
<u>Leporinus affinis</u>			15
<u>L. conirostris</u>			15
<u>L. fasciatus</u>			15
<u>L. frederici</u>	pira-pihta	1.0- 2.0	15
<u>L. hypselonotus</u>			15
<u>L. striatus</u>			15
<u>Chalcinus angulatus</u>	pihtia-bise	0.3- 1.0	15
<u>Hydrolycus scomberoides</u>	pira-yagua	2.0- 4.0	15
<u>Pygopristis serrulatus</u>	paku-chi	0.3- 0.5	15
<b>Family Synbranchidae</b>			
<u>Synbranchus marmoratus</u>	mbusu	0.5- 0.8	16
<b>Family Sciaenidae</b>			
<u>Pachyurus schomburgki</u>	corbina	1.0- 1.5	17
<u>Plagioscion ternetzi</u>	corbina	1.0- 1.5	17
<b>Family Soleidae</b>			
<u>Achirus jenynsii</u>	pira-kihgiva	0.2- 0.5	18
<u>A. errans</u>	pira-kihgiva	0.2- 0.5	18

to the families Siluridae (Pimelodidae) and Characidae. The most important fishes for food and sport are members of these two families.

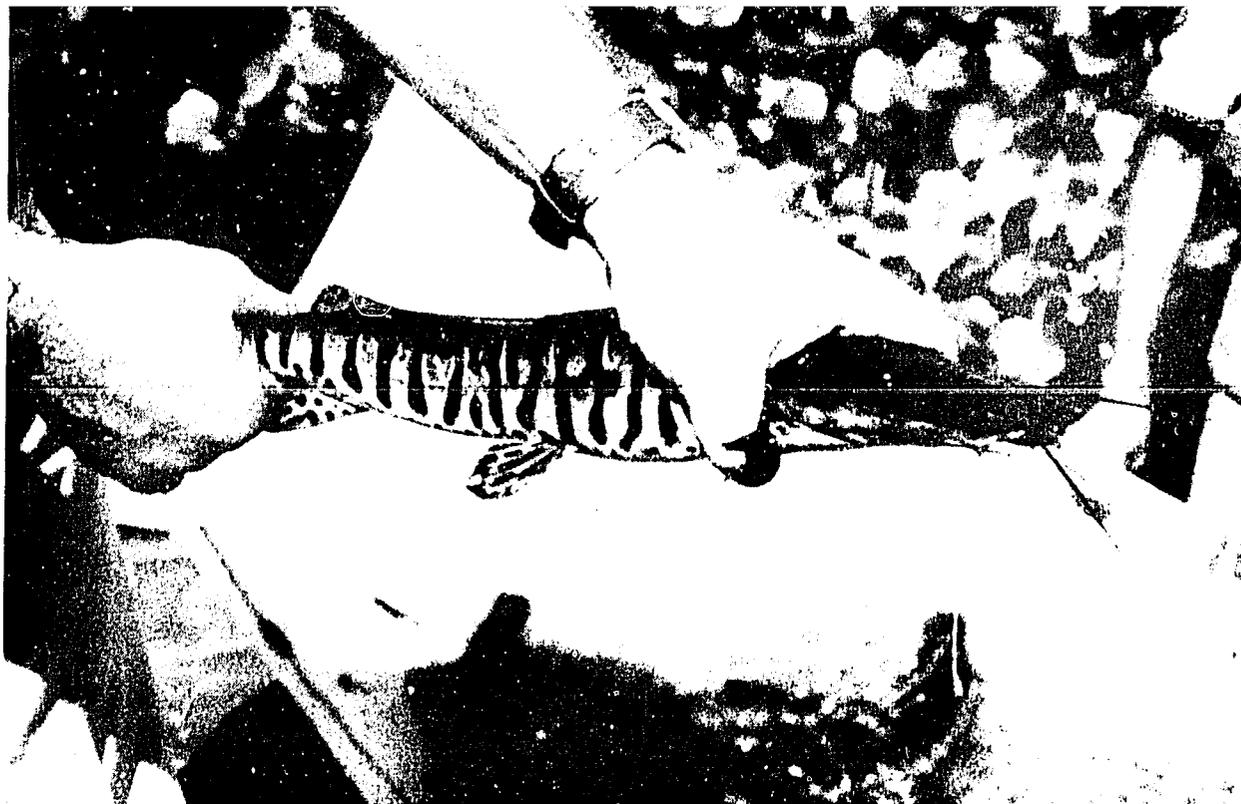
### 3.052 Commercial Fisheries

Most of the commercial fishing in Paraguay is with hand line, trot line, metal can float lines and gill nets. The artisan fisherman brings his catch daily into town in the morning and sells fish on the streets or in the central markets. The major fish market is in Asuncion, the capital city.

It is estimated (FAO, 1967) that the average per capita consumption of fish in Asuncion is approximately 2 kg annually. Government officials estimate that 50,000 kg of fish are marketed annually in Asuncion, which accounts for perhaps 10 per cent of the total fish marketed in the country. No studies have been made of the marketing of fish throughout the country, but it is generally agreed that there is seldom enough fish to meet the demand. All fish are sold fresh daily.

Prices for fish in the market at Asuncion ranged from 100 guaranies/kg for surubi (Pseudoplatystoma coruscans and P. fasciatum) to 25 guaranies/kg for pirana (Serrasalmo sp.).

Approximately equal numbers of catfish and characin species are represented in the catch, with more individual fish and probably more total weight of characins. The more highly prized fish flesh apparently is that of the catfishes, principally surubi. The fish which is utilized most widely throughout the country, however, is probably the kihrihbata or carimbata, Prochilodus sp.



Figures 4 and 5. Catfishes, commonly called surubi, which are the most highly valued commercial species in Paraguay: Pseudoplatystoma fasciatum (above) and Pseudoplatystoma coruscans (below).



Below is a listing of some representative fishes in the market with their prices (127 guaranies = \$1.00).

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Scientific Name	Common Name	Guaranies/kg
Family Siluridae (Pimelodidae)		
<u>Doras costatus</u>	itagwa	33
<u>Luciopimelodus pati</u>	pati	80
<u>Pseudoplatystoma coruscans</u>	surubi	100
<u>P. fasciatum</u>	surubi	100
<u>Zungaro mangurus</u>	manguruyu	100
Family Characidae		
<u>Prochilodus scrofa</u>	kihrihmbata	25
<u>Serrasalmo marginatus</u>	pirana	25
<u>Pygopristis serrulatus</u>	paku-chi	60
<u>Piaractus brachypomus</u>	paku	80
<u>Salminus maxillosus</u>	dorado	100

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The price for surubi and dorado is equivalent to that of first quality beef tenderloin.

### 3.053 Fishculture

Tilapia melanopleura, Tilapia nilotica, and common carp, Cyprinus carpio, have been introduced into Paraguay for culture in ponds. Tilapia stocked into small ponds sometimes die in winter when the temperature occasionally drops to 4 C; however, emphasis in culture is upon these species.

Approximately 70 ponds near Asuncion averaging 6 m x 15 m x 1.2 m have been stocked in 1967 to 1970 as follows:

Species	Ponds
<u>Tilapia melanopleura</u>	56
<u>Tilapia nilotica</u>	4
<u>Cyprinus carpio</u>	<u>10</u>
Total	70

The fishculture program in Paraguay was apparently begun in 1967 at the suggestion of a field representative of the World Neighbors Friendship Mission which is headquartered in Oklahoma. Financing for construction of ponds is done by the Mission and private owners, and technical advice is supplied by the Division of Game, Fish and Fishculture, Ministry of Agriculture and Livestock. Impetus to the program was given by M. Bard during his visits of 1 month each in 1967 and 1968 under the French foreign aid program (Centre Technique Forestier Tropical, 1968).

A small hatchery for producing fingerlings of T. melanopleura and T. nilotica (introduced by M. Bard) is maintained by the Ministry of Agriculture and Livestock at the experiment station near Caacupe. The hatchery consists of 2 concrete-lined ponds 4 m x 5 m x 1.5 m, 2 concrete-lined ponds 4 m x 8 m x 1.5 m, 2 earthen ponds 0.75 ha and 0.1 ha, and a 2 m x 1.5 m concrete pool. Brood tilapia are fed bread, lettuce and Ipomea sp.

At present, the two larger ponds are not being used to produce fingerlings. These could be placed into service by simply poisoning out the wild fish. There is also an area of approximately 2 hectares of land adjacent to the hatchery ponds

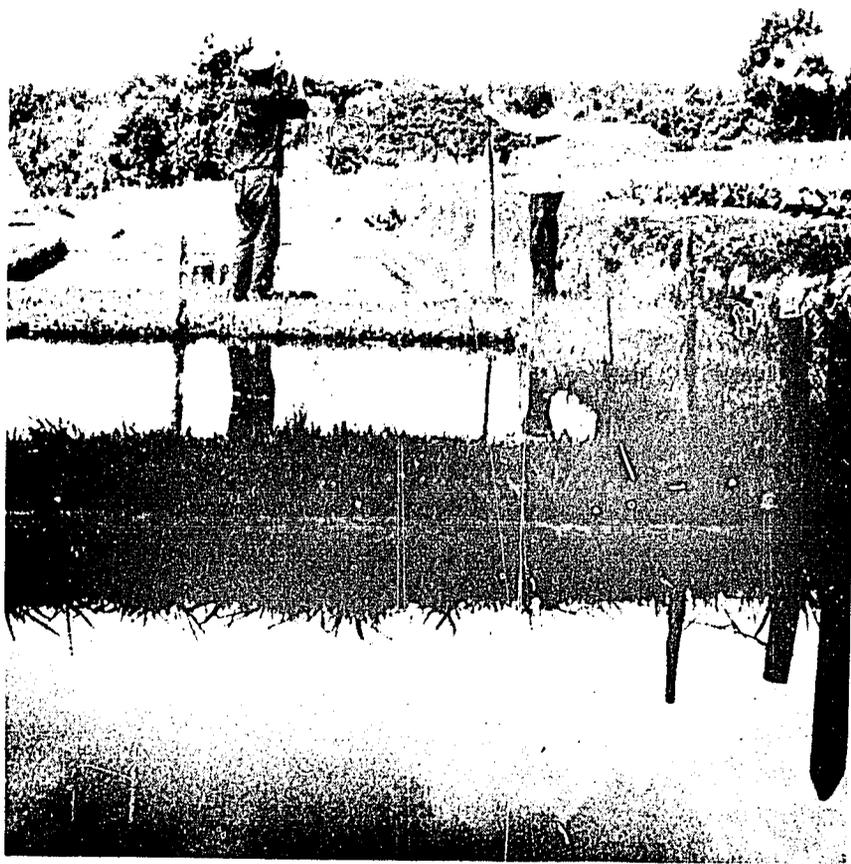


Figure 6. Hatchery ponds for producing fingerlings of Tilapia melanopleura and Tilapia nilotica, located at the Experiment Station of the Ministry of Agriculture and Livestock near Caacupe.

where additional ponds could be constructed.

Personnel of the Institute of Sciences, National University of Asuncion, are studying certain of the tilapia culture ponds cooperating with the Division of Game, Fish and Fishculture (Romero and Blanco, 1968).

Major problems with the fishculture program seemed to be lack of record keeping by the cooperating pond owners, and inadequate use of fertilizers and feeds in order to achieve high fish production.

### 3.054 Recreational Fishing

Interest in sport fishing seemed greater among people of Paraguay than in most other Latin American countries. Modern fishing tackle including spinning and fly fishing equipment, was readily available in stores of Asuncion. However, the most popular gear among native fishermen was the hand line.

Several strings of fish taken by sportsmen with spinning tackle and hand lines were observed. Species included were catfishes, eels, corbina, paku and dorado.

According to officials of the Sport Fishing Federation of Paraguay, best sport fishes are the dorado, paku, manguruyu and surubi.

In attempts to conserve the sport fishery, the Ministry of Agriculture and Livestock has decreed a closed season for net fishing on all species during the summer months of October to February. Sport fishing is allowed year round. Whatever the validity of such closed seasons, however, no enforcement of the decree is practiced since there are no enforcement personnel for fish and wildlife.

### 3.06 Government Divisions Responsible for Fisheries

The Division of Game, Fish and Fishculture within the Ministry of Agriculture and Livestock is responsible for the fish and wildlife resources of Paraguay. Unfortunately, there is only one man, the chief, in the entire Division to perform all the necessary functions. It is essential that the staff of the Division be expanded to include biologists with training in inland fisheries management and aquacultures.

### 3.07 Fisheries Training

There is no training in fisheries available in Paraguay. A course in natural sciences is available through the Department of Natural Sciences, Institute of Sciences, National University of Asuncion. A research project on experimental fishculture which may yield information for inclusion in a course is being conducted by the Director of the Department of Natural Sciences. Some information on the phytoplankton and zooplankton of Paraguay waters has been obtained (Romero, 1967; Romero and Arriola, 1969) which may be helpful in the event of the establishment of a training program in fisheries.

A collection of fishes for reference and teaching was made by Dr. C. J. D. Brown in 1956 - 1957 (Brown, 1959). The fish collection, consisting originally of 76 species identified by Brown and confirmed by the U.S. National Museum, has deteriorated badly. Only approximately 20 specimens remain as dry, mounted exhibits in the Museum of Natural History at the Faculty of Veterinary

Medicine, National University of Asuncion. Replacement and expansion of the collection will be necessary for use in effective teaching, research and management program on fishes of Paraguay.

#### 4.0 SPORT FISHERY AND ITS POTENTIAL FOR INCREASING TOURISM

##### 4.01 Dorado Fishery

The dorado, Salminus maxillosus, is the preferred sport fish of the Republic of Paraguay. This fish, superficially resembling the salmonids of North America, belongs to the Family Characidae, which also includes the pirana, paku and carimbata. It inhabits the major river systems of Paraguay, apparently preferring swift water. Highly piscivorous, and feeding largely on small carimbata, it reaches approximately 30 kg in weight. The dorado takes spinners, spoons and live bait, and leaps spectacularly when hooked. They have excellent flavor, relatively few bones, and rank high as food fish.

Argentina has recognized the value of the dorado and is now limiting the commercial catch, which in the lower Parana River has averaged approximately 675,000 kg annually (Ringuelet, et al, 1967). The sport fishery is so widely known that an international dorado tournament is held each summer on the Parana River, bringing a substantial amount of foreign currency to Argentina. The Director of Tourism in Paraguay is interested in capitalizing on the appeal of the dorado to sport fishermen.

Statistics on the size of the dorado fishery, or on standing crops of this



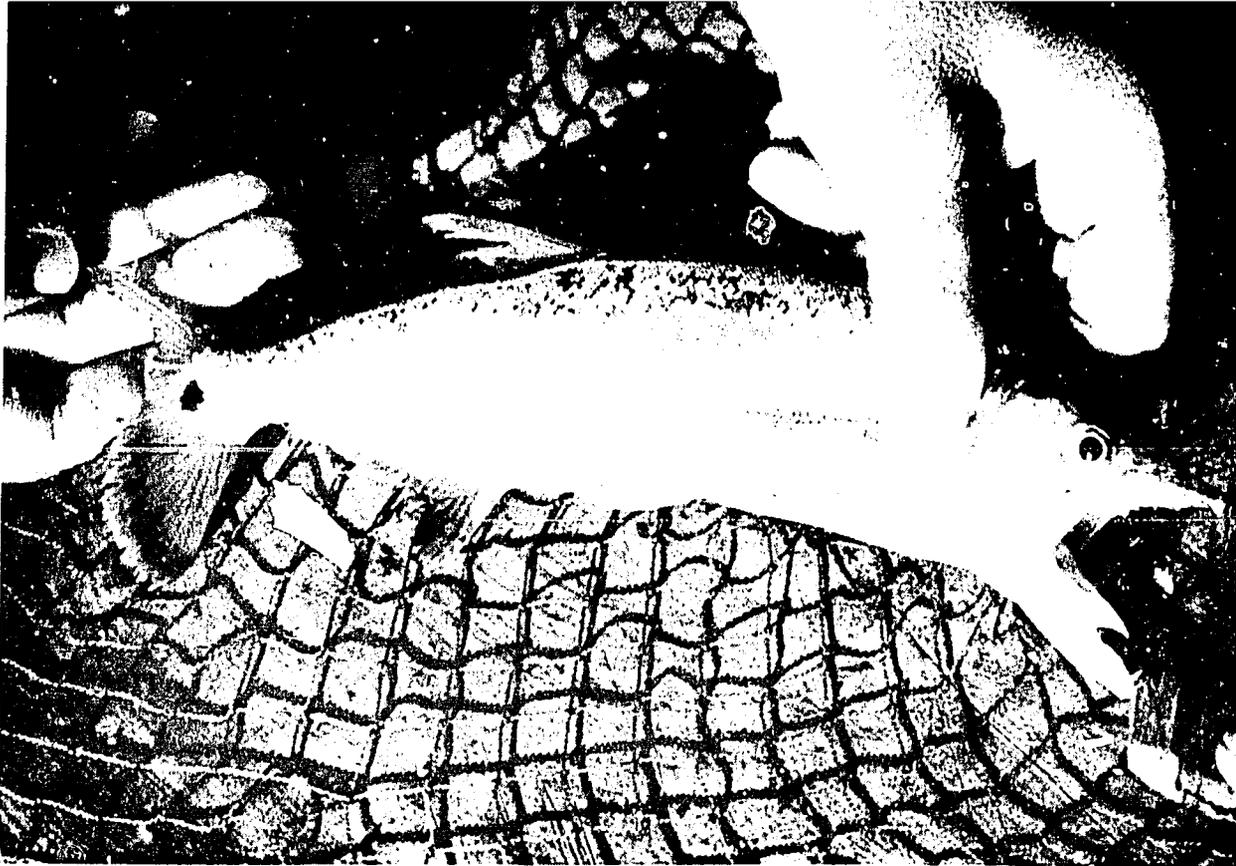
Figure 7. Sport fisherman with dorado, Salminus maxillosus, taken from the Rio Tebicuary, June 11, 1970.

fish in the waters of Paraguay are not known. Until information is available on the standing crop of dorado, its migratory habits, and spawning locations, wise exploitation of the resource cannot be planned. On June 11-12, 1970, the Auburn Team, upon visiting a site on the Tebicuary River near Centu-Cue that was considered to be among the best fishing places in Paraguay, observed the catch of only 1 dorado weighing approximately 2 kg. A local fishing guide indicated that this was the wrong time to fish, the best fishing for dorado was in the summer during October to January. At this time apparently much larger dorado, up to 38 kg, are commonly caught in the Tebicuary River. Smaller dorado, up to approximately 3 kg, may be occasionally caught throughout the year. It appears that the dorado fishery, especially in smaller streams and river tributaries of the Parana and Paraguay Rivers, is seasonal and may be related to spawning runs of mature fish up stream from the lower Parana.

Further, it was reported by members of the Sport Fishing Federation that dorado fishing was declining in the Paraguay River, presumably due to heavy fishing pressure. It is very important that the biology and population dynamics of this fish be studied in Paraguay to provide facts on which regulations may be based if necessary. A recently established regulation is that dorado may still be taken with nets as well as with hook and line, but should not be sold commercially. Enforcement of the law will likely not be effective with the present shortage of fishery personnel.

#### 4.02 Lago Ypacarai

With an area of 5,400 ha which presently supports neither a commercial



Figures 8. and 9. Two piscivorous characins widely distributed in waters of Paraguay: (above) unidentified species taken from Rio Tebicuary; (below) Hoplias malabaricus, the biology of which is under study at the Institute of Sciences, National University of Asuncion.



fishery nor a sport fishery, Lago Ypacarai is a greatly underutilized resource. The shallow lake apparently becomes turbid following heavy rains, apparently because of poor watershed cover. The temperature of the lake water has extremes of 7 C and 36 C, with an annual mean temperature of 26 C.

The Institute of Sciences, National University of Asuncion, has been studying ways to make the lake more productive. A stocking of 50 Tilapia melanopleura fingerlings was made in 1968, but no recoveries of the fish, or their offspring have been verified. Corbina were reportedly added to the lake approximately 40 years ago, but the stocking was apparently not evaluated. The lake is connected to the Paraguay River by the Rio Salada, a small stream. Apparently, river fish have no barriers to entry. The Department of Natural Sciences, Institute of Sciences, has begun a collection of fishes from the lake. The list of 15 species identified by personnel of the Department is given below. Some 10 additional species have been collected but not identified.

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List of Fishes Collected from Lago Ypacarai

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Family Pimelodidae

Luciopimelodus sp.  
Pimelodus albicans  
P. argenteus  
Rhamdia sapo

Family Loricariidae

Ancistrus hoplogenyis  
Loricaria labialis  
L. nudiventris

Family Characidae

Hoplias malabaricus  
Mylossoma aequidens  
M. astranax  
Roeboides boneriensis  
Serrasalmus nattereri  
Triportheus angulatus curtus

Family Cichlidae

Aequidens paraguayensis  
A. portalagrensis

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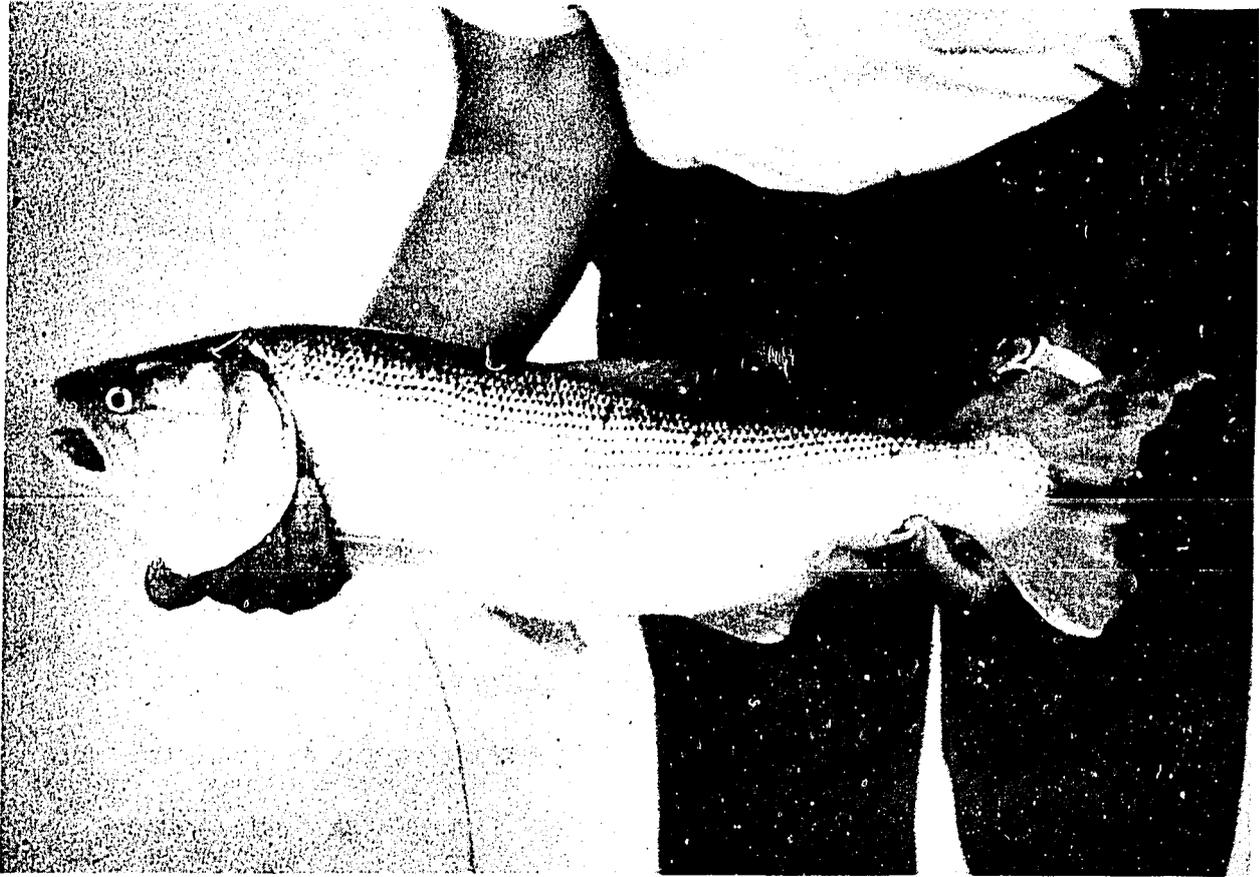
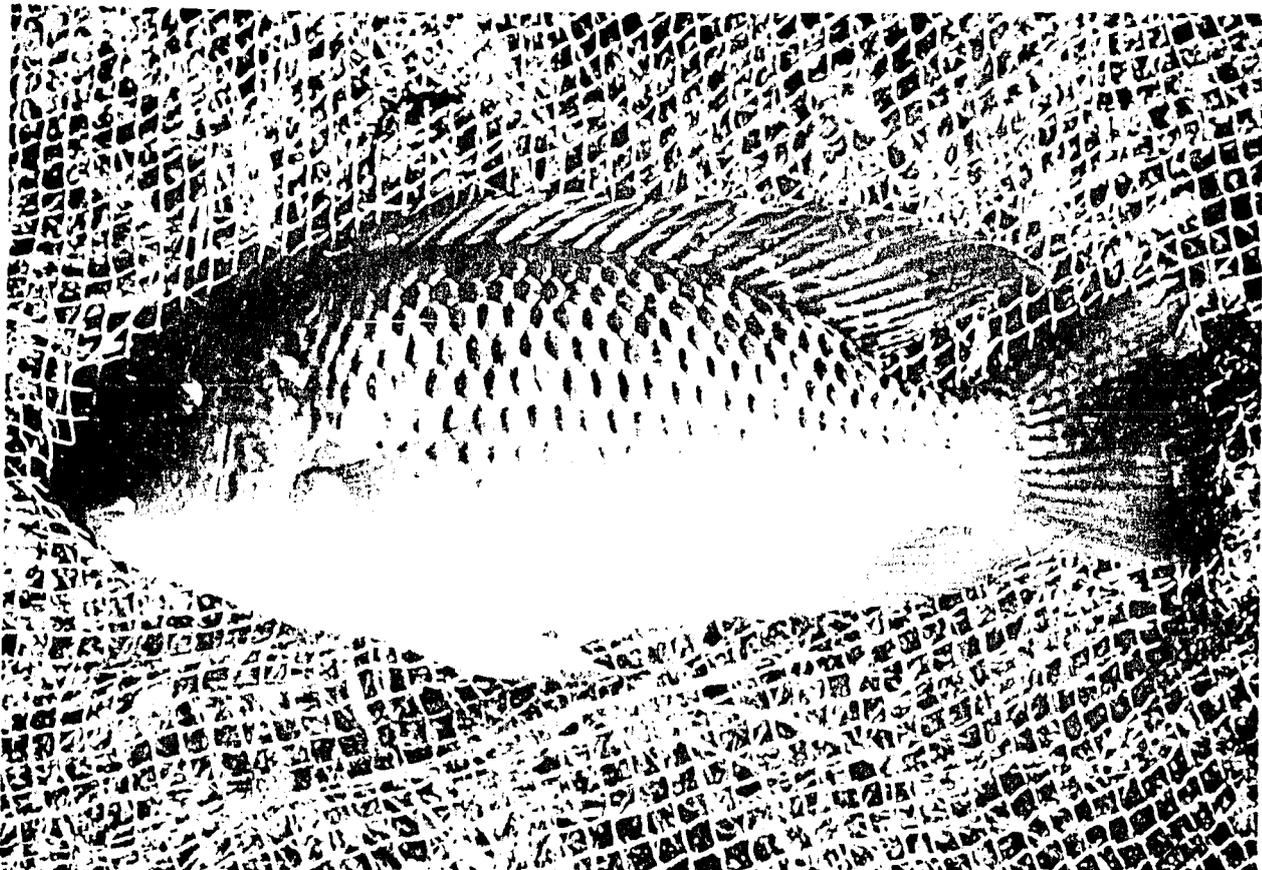


Figure 10. Dorado, excellent for food as well as for sport, attains weight of approximately 30 kg.

Figure 11. Tilapia melanopleura, an exotic species introduced for fishculture.



It appears that the majority of species present in the lake are small forage fishes of the catfish, characin and cichlid groups. Conspicuously absent is a large piscivorous fish to convert the smaller fishes into a more acceptable fish for food or sport. The fish population of this lake should be studied in more detail to determine if introduction of a piscivorous fish species, which would provide a sport fishery, should be recommended.

#### 4.03 Lago de la Republica

This 40-ha lake was built 10 years ago inside the city limits of Puerto Presidente Stroessner. The purpose was for beautification and for auxiliary water supply. Temperature in the headwaters of the impounded stream was 17 C on June 15, 1970, and lake temperature was 21 C. Reportedly, the lake temperature averages 18 C year round with maximum of 26 C, and the stream temperature never exceeds 17 C.

Fishing has never been permitted in the lake. Fishes known to inhabit the stream prior to impoundment were several small catfishes, piranas and other small characins. To evaluate trout for fishculture in Paraguay, the Institute of Agrarian Reform (IBR) arranged through a private trout hatchery in Mendoza, Argentina, for stocking of Lago de la Republica. Existing fish populations were not removed, and 65,000 rainbow trout fingerlings 2.5 to 5.0 cm in length were stocked on November 21, 1969. The effects of the stocking have not been evaluated, but it is doubtful that the fingerling trout survived either the predation by existing fish species, or the high temperatures. It was suggested that a regular program of test fishing with lines and nets be initiated to determine survival of the trout.

Assuming that the trout did not survive, studies should be made of the fishes in the lake and other fishes in Paraguay which might be more suitable for the warm water.

#### 4.04 Lago Acaray

This impoundment, created by the closing of the Acaray hydroelectric dam in 1967, is approximately 10 km<sup>2</sup> in area. The dam, near Puerto Presidente Stroessner, attracts numerous tourists from Brazil and within Paraguay. A good sport fishery certainly should enhance this attraction.

Species present in the lake, built on the Acaray River, were small catfishes, cichlids, and characins, including the doradillo. No surubi, manguruyu or paku were reported. The doradillo is present in small numbers in the lake where they have reached 2 kg. The fish, seen in the tailrace waters by the Auburn Team, appears identical to the dorado except for the silvery color substituted for gold. There was considerable debate among native fishermen as to whether the doradillo is a juvenile dorado or a separate species.

It would be very worthwhile to study the dorado and doradillo for introduction into the lake from the tailrace waters where the doradillo is abundant, or the nearby Parana River, which is famed for dorado.

#### 5.0 SUMMARY

A fisheries survey of Paraguay was conducted by the Auburn Team at the request of U.S.A.I.D./Paraguay and the government of Paraguay. The principal objective was to assess the potential of sport fishing as a means for

increasing tourism in Paraguay.

It was concluded that several fish species could contribute to a substantial sport fishery, with the dorado (Salminus maxillosus) possessing characteristics resulting in this species being considered the preferred sport fish for local sportsmen. The dorado takes both artificial lures and live bait and is a strong fighter; it attains a size of up to 30 kg; it is highly regarded as a food fish because of its excellent flavor; and it appears to inhabit many of the river systems within the country.

Specific information on the standing crop of dorado, spawning habits and locations, growth rate, and distribution throughout the year is required before wise exploitation of the resource can be achieved.

Since no studies of this nature have been carried out in Paraguay, it is recommended that an advisor in fisheries from the International Center of Aquacultures at Auburn University be contracted to investigate the population dynamics and biology of this and other important sport fishes in Paraguay.

The biologist from Auburn, with adequate counterpart assistance from the government of Paraguay and logistical support from the U. S. A. I. D. Mission could complete the studies and submit a detailed report with specific recommendations for most effect utilization of the sportfishery resource. It is anticipated that two years would be required to complete this project.

The work plan would include establishment of creel stations at selected locations in order that greatest amount of biological information could be secured during the peak fishing period. The biologist would train personnel of the

Division of Game, Fish and Fishculture, Ministry of Agriculture and Livestock, in techniques and methods of accurately securing appropriate biological data through collection of the required number of fish specimens with selected fishing gear including gill and trammel nets and other techniques.

It is proposed that the fisheries advisor also assist in the establishment of a reference collection of fishes of Paraguay, including identification and preservation for use in training personnel of the government Fisheries Division. Also, the Auburn Team feels strongly that the U. S. A. I. D. Mission should support study abroad at both the university level and special, non-degree, short-term training for selected participants from Paraguay.

The fisheries advisor also would assist the Division of Game, Fish and Fishculture in organizing an improved testing procedure for intensive pond fish-culture for those regions where the government is encouraging production of fish for food.

## 6.0 CONFERENCES

### United States Government

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### Private Sector

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Sr. Narciso Corrales,	Owner, Hosterio Centu-Cue, Villa Florida, Misiones

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## 8.0 APPENDIX

Table 2. Checklist of fishes from Paraguay\*

<u>Dasyatidae</u>	<u>Siluridae--continued</u>
1. <u>Ellipsurus motoro</u>	28. <u>Luciopimelodus pati</u>
2. <u>E. hystrix</u>	29. <u>L. platanus</u>
3. <u>E. brachyurus</u>	30. <u>Oxydoras kneri</u>
4. <u>E. reticulatus</u>	31. <u>O. eigenmanni</u>
	32. <u>Paulisea lutkeni</u>
<u>Lepidosirenidae</u>	33. <u>Pimelodina sp.</u>
5. <u>Lepidosiren paradoxa</u>	34. <u>Pimelodella gracilis</u>
	35. <u>P. lateristriga</u>
<u>Cetopsidae</u>	36. <u>P. mucosa</u>
6. <u>Pseudocetopsis gobioides</u>	37. <u>P. taeniophora</u>
	38. <u>Pimelodus albicans</u>
<u>Aspredinidae</u>	39. <u>P. argenteus</u>
7. <u>Bunocephalus doriae</u>	40. <u>P. clarias</u>
8. <u>B. iheringi</u>	41. <u>P. fur</u>
9. <u>B. rugosus</u>	42. <u>P. ornatus</u>
10. <u>Dasychthys australis</u>	43. <u>P. valenciensi</u>
	44. <u>Pinirampus pinirampus</u>
<u>Siluridae</u>	45. <u>Pseudopimelodus cottoides</u>
11. <u>Ageneiosus brevifilis</u>	46. <u>Pseudoplatystoma coruscans</u>
12. <u>A. valenciensi</u>	47. <u>P. fasciatum</u>
13. <u>A. ucayalensis</u>	48. <u>Rhamdia brasiliensis</u>
14. <u>A. nuchalis</u>	49. <u>R. hilarii</u>
15. <u>Auchenipterus nigripinnis</u>	50. <u>R. sapo</u>
16. <u>Bergiaria platana</u>	51. <u>R. kneri</u>
17. <u>Doras armatus</u>	52. <u>R. quelen</u>
18. <u>D. costatus</u>	53. <u>R. sebae</u>
19. <u>D. veddellii</u>	54. <u>Sciades pictus</u>
20. <u>D. maculatus</u>	55. <u>Sorubim lima</u>
21. <u>D. nebulosus</u>	56. <u>Sorubimichthys planiceps</u>
22. <u>Hemidoras paraguayensis</u>	57. <u>Trachelyopterus coriaceus</u>
23. <u>Hemisorubim platyrhynchus</u>	58. <u>Trachycorystes galeatus</u>
24. <u>Heptapterus mustelinus</u>	59. <u>T. striatus</u>
25. <u>Hypophthalmus edentatus</u>	60. <u>Zungaro magurus</u>
26. <u>Iheringichthys labrosus</u>	
27. <u>I. megalops</u>	<u>Pygidiidae</u>
	61. <u>Branchioica bertonii</u>
	62. <u>Homodiaetus anisitsi</u>
	63. <u>Pygidium brasiliense</u>

\*Bertoni, A. de W. 1939. Summario catalogos sistematicos de los vertebrados del Paraguay. Clase quinta - peces. Rev. Soc. Cientifica 4(4):28-34. Original data for this list was apparently taken from Eigenmann, C. H. 1891. Catalogue and bibliography of the fresh water fishes of the Americas.

Table 2. --continued

<u>Callichthyidae</u>	<u>Loricariidae--continued</u>
64. <u>Callichthys callichthys</u>	102. <u>P. juvenis</u>
65. <u>Corydoras aurofrenatus</u>	103. <u>P. multiradiatus</u>
66. <u>C. australis</u>	104. <u>Rhinilepis aspera</u>
67. <u>C. microps</u>	105. <u>Sturisoma robustum</u>
68. <u>C. paleatus</u>	106. <u>Xenocara gymnorhynchus</u>
69. <u>Hoplosternum littorale</u>	
70. <u>H. thoracatum</u>	<u>Characidae</u>
71. <u>H. melanopterum</u>	
	107. <u>Curimatella a. alburna</u>
<u>Loricariidae</u>	108. <u>C. a. australis</u>
72. <u>Chaetostoma cirrhosum</u>	109. <u>Curimata bimaculata</u>
73. <u>C. hoplonys</u>	110. <u>C. conspersa</u>
74. <u>Cochlodon cochlodon</u>	111. <u>C. e. elegans</u>
75. <u>Farlowella sp.</u>	112. <u>C. e. nitens</u>
76. <u>Hemiancistrus vittatus</u>	113. <u>C. g. gilberti</u>
77. <u>Hemiodontichthys acipenserinus</u>	114. <u>C. g. brevipinnis</u>
78. <u>Loricaria anus</u>	115. <u>C. latior</u>
79. <u>L. apeltogaster</u>	116. <u>C. gilli</u>
80. <u>L. cataphracta</u>	117. <u>C. nasus</u>
81. <u>L. carinata</u>	118. <u>C. rutiloides</u>
82. <u>L. labialis</u>	119. <u>C. spilura</u>
83. <u>L. vetula</u>	120. <u>C. spiluropsis</u>
84. <u>L. macrodon</u>	121. <u>Psectrogaster ciliatus</u>
85. <u>L. konopickii</u>	122. <u>P. curviventris</u>
86. <u>L. typus</u>	123. <u>Semitapicis laticeps</u>
87. <u>L. laticeps</u>	124. <u>Parodon affinis</u>
88. <u>L. maculata</u>	125. <u>P. paraguayensis</u>
89. <u>L. parva</u>	126. <u>P. tortuosus</u>
90. <u>L. phoxocephala</u>	127. <u>Anastomus vittatus</u>
91. <u>Otocinclus vittatus</u>	128. <u>Anisitsia othonops</u>
92. <u>Oxyropsis inexpectatus</u>	129. <u>Hemiodus microlepis</u>
93. <u>Plecostomus brevicauda</u>	130. <u>H. unimaculatus</u>
94. <u>P. commersoni</u>	131. <u>Prochilodus argenteus</u>
95. <u>P. plecostomus</u>	132. <u>P. nigricans</u>
96. <u>P. ternetzi</u>	133. <u>P. reticulatus</u>
97. <u>P. unae</u>	134. <u>P. scrofa</u>
98. <u>P. vaillanti</u>	135. <u>Lahilliella nasuta</u>
99. <u>Pseudancistrus barbatus</u>	136. <u>Leporinus affinis</u>
100. <u>Pterygoplichthys anisitsi</u>	137. <u>L. conirostris</u>
101. <u>P. gigas</u>	138. <u>L. fasciatus</u>
	139. <u>L. frederici</u>

Table 2. --continued

<u>Characidae--continued</u>	<u>Characidae--continued</u>
140. <u>Leporinus hypselonotus</u>	182. <u>K. moenkhausii</u>
141. <u>L. striatus</u>	183. <u>Ctenobrycon hauxwellianus</u>
142. <u>L. trifasciatus</u>	184. <u>Gymnocorymbus ternetzi</u>
143. <u>Schizodon borellii</u>	185. <u>Hemigrammus tridens</u>
144. <u>S. dissimilis</u>	186. <u>H. ulreyi</u>
145. <u>S. fasciatus</u>	187. <u>Hyphessobrycon anisitsi</u>
146. <u>S. vittatus</u>	188. <u>H. gracilis</u>
147. <u>Characidium fasciatum</u>	189. <u>H. lutkeni</u>
148. <u>Nannostomus</u> sp.	190. <u>H. callistus</u>
149. <u>Microcharax lateralis</u>	191. <u>H. santae</u>
150. <u>Pyrrhulina australis</u>	192. <u>Moenkhausia intermedia</u>
151. <u>P. brevis</u>	193. <u>M. sanctae filomenae</u>
152. <u>Aphyocharax anisitsi</u>	194. <u>M. dichroua</u>
153. <u>A. rathbuni</u>	195. <u>Psellogrammus kennedyi</u>
154. <u>A. stramineus</u>	196. <u>Tetragonopterus argenteus</u>
155. <u>Cheirodon insignis</u>	197. <u>Markiana nigripinnis</u>
156. <u>C. nattereri</u>	198. <u>Mimagoniates barberoi</u>
157. <u>C. ribeiroi</u>	199. <u>Chalcinus angulatus angulatus</u>
158. <u>Holoshethes pequirá</u>	200. <u>C. a. curtus</u>
159. <u>H. heterodon</u>	201. <u>C. paranensis</u>
160. <u>Odontostilbe microcephala</u>	202. <u>Thoracocharax stellatus</u>
161. <u>O. paraguayensis</u>	203. <u>Brachychalcinus</u> sp.
162. <u>O. trementinae</u>	204. <u>Fowleria paraguayensis</u>
163. <u>Astyanax allem</u>	205. <u>Pygocentrus piraya</u>
164. <u>A. abramis</u>	206. <u>P. ternetzi</u>
165. <u>A. multidentis</u>	207. <u>Pygopristis serrulatus</u>
166. <u>A. fasciatus</u>	208. <u>Serrasalmo gymnogenys</u>
167. <u>A. rutilus</u>	209. <u>S. humeralis</u>
168. <u>A. eigenmanniorum</u>	210. <u>S. marginatus</u>
169. <u>Astyanacinus moorii</u>	211. <u>S. rhombeus</u>
170. <u>Astyanax bimaculatus paraguayensis</u>	212. <u>S. spilopleura</u>
171. <u>A. correntinus</u>	213. <u>Colossoma mitrei</u>
172. <u>A. erythropterus</u>	214. <u>C. orbignyanus</u>
173. <u>A. lineatus</u>	215. <u>Metynnis hypsauchen</u>
174. <u>A. pellegrini</u>	216. <u>M. maculatus</u>
175. <u>Brycon hilarii</u>	217. <u>M. mola</u>
176. <u>B. microlepis</u>	218. <u>Myleus asterias</u>
177. <u>B. nattereri</u>	219. <u>M. levis</u>
178. <u>B. orbignyanus</u>	220. <u>Mylossoma aureum</u>
179. <u>Bryconops melanurus</u>	221. <u>Myletes orbignyanus</u>
180. <u>Knodus chapadae</u>	222. <u>M. duriventris</u>
181. <u>K. exodon</u>	223. <u>Piaractus brachypomus</u>

Table 2. --continued

Characidae--continued

- 224. Hydrolycus scomberoides
- 225. Raphiodon vulpinus
- 226. Charax argentea
- 227. C. caliura
- 228. C. gibbosa
- 229. C. squamosa
- 230. Cynopotamus gulo
- 231. Eucynopotamus humeralis
- 232. E. knerii
- 233. E. magdalenae
- 234. Roeboides microlepis
- 235. R. prognathus
- 236. Roestes molossus
- 237. Salminus brevidens
- 238. S. hilarii
- 239. S. maxillosus
- 240. Acestrorhynchus falcatus
- 241. Hoplerythrinus unitaeniatus
- 242. Hoplias malabaricus

Gymnotidae

- 243. Eigenmannia virescens
- 244. Gymnotus carapo
- 245. Hypopomus brevirostris
- 246. Rhamphichthys marmoratus
- 247. R. reinhardtii
- 248. Stenopygus macrurus
- 249. Sternarchus albifrons
- 250. S. brasiliensis
- 251. Gymnorhamphichthys hypostomus

Synbranchidae

- 252. Synbranchus marmoratus

Poeciliidae

- 253. Fundulus balzanii
- 254. F. paraguayensis
- 255. Ylyodon paraguayensis
- 256. Phalloceros caudomaculatus
- 257. Poecilia vivipara

Poeciliidae--continued

- 258. Rivulus punctatus
- 259. Rivulichthys rondoni

Sciaenidae

- 260. Pachyurus schomburgki
- 261. Plagioscion ternetzi

Cichlidae

- 262. Aequidens dorsigerus
- 263. A. paraguayensis
- 264. A. portalegrensis
- 265. A. tetramerus
- 266. A. vittatus
- 267. Astronotus ocellatus
- 268. Chaetobranchopsis australis
- 269. Cichla chacoensis
- 270. C. niederleini
- 271. Cichlasoma facetum
- 272. C. bimaculatum
- 273. C. festivum
- 274. Batrachops ocellatus
- 275. B. semifasciatus
- 276. Crenicichla lepidota
- 277. C. saxatilis
- \* 278. C. vittata
- 290. Geophagus balzanii
- 291. G. jurupari
- 292. Heterogramma corumbae
- 293. H. taeniatum
- 294. H. trifasciatum
- 295. Satanoperca balzanii

Soleidae

- 296. Achirus jenynsii
- 297. A. errans

Belonidae

- 298. Potamorhaphis guianensis eigenmanni

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\*Enumeration of species is exactly as shown in Bertoni (1939).

Table 3. Some materials available for formulating fish feeds in Paraguay

Material	Per Cent Protein	Guaranies per Kilogram
Soybean cake	47	12.0
Cottonseed cake	43	10.0
Peanut cake	43	9.5
Sunflower cake		8.0
Wheat bran		
Rice bran		32.0
Whole rice		18.0
Broken rice		9.0
Meat meal	73	19.0
Bone meal	18	7.0
Blood meal		18.3
Alfalfa meal		7.5
Corn meal		5.5
Palm nut pulp	7	4.7
Manioca flour		9.0
Fish meal*		35.0

\*Fish meal cannot be legally imported; however, it is occasionally available.

Table 4. Temperature data collected from waters of Paraguay by the Auburn Team, June 9 - 16, 1970

Temperature		Date	Time	Body of Water	Location
Water	Air				
19 C	21 C	June 9	10:00 AM	Concrete pool, 4 m x 3 m x 0.5 m	Institute of Sciences
21 C	24 C	June 9	3:30 PM	Rio Paraguay	5 km N. Asuncion
21 C	22 C	June 9	4:30 PM	Asuncion Harbor	Bay off Rio Paraguay
20 C	21 C	June 10	11:00 AM	Lago Ypacarai	25 km E. Asuncion
23 C	21 C	June 10	2:00 PM	Spring, 1 m x 1 m	Near Lago Ypacarai
22 C	21 C	June 10	2:00 PM	Pond, 9 m x 15 m x 1.5 m	Near Lago Ypacarai
21 C	22 C	June 11	12:00 noon	Rio Tebicuary	Centu-Cue
23 C	24 C	June 12	2:30 PM	Pond, 9 m x 15 m x 1.5 m	Near Caacupe
17 C	19 C	June 15	4:30 PM	Stream, 2 m x 0.3 m	Puerto Presidente Stroessner
21 C	19 C	June 15	5:00 PM	Lago de la Republica	Puerto Presidente Stroessner
20 C	19 C	June 16	8:15 AM	Lago Acaray	Near Puerto Presidente Strocser
18 C	19 C	June 16	3:30 PM	Salto Monday	Rio Monday