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THE FISHES OF LAKE VALENCIA,
VENEZUELA

BY

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CONTENTS

Introduction.....	5
Lake Valencia.....	7
List of Fishes with Remarks on Geographical and Eco- logical Relationships.....	11
Food of Fishes.....	18
General Remarks on Food.....	26
Parasites of Valencian Fishes.....	28
List of Fishes with Remarks on Parasites.....	42
General Remarks on Parasites.....	47
Conclusions.....	50
Bibliography.....	51

THE FISHES OF LAKE VALENCIA, VENEZUELA

INTRODUCTION

Though the fishes of tropical lakes have often been studied by systematists, morphologists, and those interested in geographic distribution, they have received scant attention from ecologists. There are indeed few situations where ecological investigations can be made in tropical fresh-water lakes. Most of the lakes in Central Africa are brackish or salty. In South America, the large lakes in the Amazon basin all fuse with the rivers during the rainy season; those on the west coast are at great altitudes and have a very scanty fish fauna. Lake Valencia was selected from among those in northern South America and Central America because it seemed to present typically lacustrine conditions and to promise a reasonably varied and abundant fish fauna.

The writer carried on investigations in Lake Valencia and the rivers draining into it from July 4 to July 31, 1918; then studied the rivers between the lake and the coast to August 5, fishing in the Rio Tuy and its tributaries at El Concejo and Caracas.

The University of Wisconsin granted a special fund for travelling expenses; Dean C. H. Eigenmann induced the University of Indiana to furnish a complete outfit of nets and fishing tackle; and the Zoological Laboratory at the University of Wisconsin generously provided the remainder of the outfit, except a deep sea thermometer and apparatus for gas analysis which were loaned by Mr. C. Juday of the Wisconsin Geological and Natural History Survey.

In Venezuela the government officials and many private citizens showed the greatest interest and courtesy. The writer is particularly indebted to two Americans, Dr. H. Pittier and Mr. Carl Magnus; an Englishman, Mr. Charles Lazzari; and

to many Venezuelans, chief among whom are Coronel Ali Gomez, Don Carlos Delfino, Dr. Juan Iturbe, and a most admirable guide and *compadre*, Agapito Blanchar. It is a pleasure also to acknowledge the great help received from the writings and general advice of Dr. C. H. Eigenmann, whose stores of wisdom relating to South America and its fishes were freely placed at my disposal. Dr. Eigenmann also identified all the fishes collected. The following persons were kind enough to work up other groups of animals: Dr. J. B. Malloch, insects; Dr. H. J. Van Cleave, acanthocephalans; Dr. N. A. Cobb, nematodes; Mr. Bryant Walker, molluscs; Dr. Ruth Marshall, mites; Miss M. J. Rathbun, decapod crustaceans.

The equipment used for fishing was as follows: 1 9-inch dip net with 6 ft. handle; 1 seine 50×4 ft., $\frac{1}{4}$ in. mesh,* with 4×4 bag in middle; 1 seine, 30×4 ft., $\frac{3}{4}$ in. mesh; 2 common sense minnow seines, 4×10 ft. and 4×25 ft.; 2 gill nets, 4×75 ft., $\frac{3}{4}$ in. mesh; 2 gill nets, 4×75 ft., 1 in. mesh; 2 gill nets, 4×75 ft., $1\frac{1}{2}$ in. mesh; 2 gill nets, 4×75 ft., 2 in. mesh; 2 gill nets, 4×75 ft., 3 in. mesh. Besides these nets a square dip net 4×4 ft., a cast net, a trammel net, and equipment for trot lines were taken along, but never used. There were no fishes large enough for the trammel net. The cast net purchased in the United States was found to be much inferior to those in use by the Venezuelans; the latter were of great value, especially in the swift streams.

*All references to meshes of nets indicate "bar mesh.

LAKE VALENCIA

Lake Valencia lies between two mountain ranges about thirty miles south of Porto Cabello, Venezuela. It is surrounded by a basin of considerable size and the level of the lake has apparently been falling for some time. The shores, except around the islands, are everywhere composed of soft mud which supports a thick growth of rushes (Fig. 1). A mile or more from the shores the soil consists of soft black bottom deposits containing numerous weathering snail shells and the

FIG. 1. Rush-grown shore of Lake Valencia near Maracay.

remains of other aquatic organisms. According to Dr. A. Jahn, a topographic engineer residing in Caracas, Lake Valencia drains through the Rio Pao, a tributary of the Orinoco, in the rainy season, but during the long dry season water often flows from the river into the lake. Dr. Jahn stated that the surface of the lake has varied from 412 M. to 415 M. above sea level during the past twenty years. He said that he had made extensive soundings and found the greatest depth to be about fifty meters. The lake is about fifty kilometers long.

Lake Valencia contains twenty-two islands, the shores of which are for the most part rocky, pebbly, or sandy (Fig. 2). The largest, Isla del Buro, is about five kilometers long. The

importance of means for dispersal and isolation are shown by the fact that there are no frogs or snakes on Isla del Buro while another island (Culebra) in the lake is so heavily infested with poisonous snakes that the natives avoid it.

In order to gain some idea of general conditions in Lake Valencia a few limnological observations were made. Table I

FIG. 2. Shore of Isla del Buro and fishing crew.

TABLE I

Temperature and gases (determined by the Winkler method) at various depths in Lake Valencia July 17, 1918. Gases are given in c.c. per liter at 0° — indicates that the water was alkaline as judged by phenapthaline titration with $\frac{N}{50}$ sulphuric acid solution. The depth of the water where samples were taken was 26 m.

Depth	Temperature	Oxygen, c.c. per liter	Carbon dio _x ., c.c. per liter
0.5	27.6	4.897	.....
1	27.5	.....	.....
2	27.25	.....	.....
3	27.25	.....	.....
4	27.2	.....	.....
5	27.2	4.792	-14.2
7.5	27.16	.....	.....
10	27.15	4.735	.....
12.5	27.15	.....	.....
15	27.15	4.872	-14.2
20	27.01	4.755	-9.77
25	26.85	4.435	-9.77

TABLE II

Catches with mud dredge at various depths in Lake Valencia, July 18, 1918. Under "number" the figure in parentheses indicates the individuals (n) actually caught in two hauls of the dredge; the figure following indicates the number per square meter ($n \times \frac{44.44}{2}$). Figures under "volume" indicate percentage by volume of total catch after mud had been washed out through bolting cloth having 10 meshes per c.m.

Depth	Organism	Number		Volume
4.7 m	Fish scales.....	(123)	2733	2
	<i>Chironomus</i> larva.....	(78)	1733	2
	<i>Perithemis?</i> nymph.....	(2)	45	3
	Insect larva.....	(1)	22	.1
	<i>Corixa</i> nymph.....	(1)	22	1
	<i>Arrhenurus</i>	(1)	22	.2
	Leech.....	(1)	22	.1
	<i>Planorbis pronus</i> Mts., <i>Ancylus moricaudi</i> Orb., <i>A. sp.?</i> <i>Amnicola valenciae</i> Prest.*			
	<i>Potamopyrgus crystallinus</i> Pfr., and <i>Amnicola ernesti</i> Mts.....	(3895)	86547	52.6
	Plant remains.....			40
9.6 m	Fish scales.....	(80)	1778	1
	<i>Physa venezuelensis</i> Mts.....	(3)	67	12
	<i>Amnicola valenciae</i> Prest., <i>Potamopyrgus crystallinus</i> Pfr., and <i>Amnicola ernesti</i> Mts.....	(25700)	571054	85
	Filamentous algae.....			2
15 m	<i>Symbranchus marmoratus</i>	(1)	22	8
	Fish scales.....	(2)	45	.2
	<i>Planorbis pronus</i> Mts.....	(4)	89	.3
	<i>Amnicola valenciae</i> Prest., <i>Potamopyrgus crystallinus</i> Pfr., and <i>Amnicola ernesti</i> Mts.....	(6304)	140075	91.5
20 m	Fish scales.....	(3)	67	.3
	<i>Tanytus</i> larva.....	(1)	22	.2
	<i>Planorbis pronus</i> Mts., shells.....	(671)	14909	60
	<i>Planorbis pronus</i> Mts., alive.....	(4)	89	.2
	<i>Amnicola valenciae</i> Prest. and <i>Potamopyrgus coronatus</i> Pfr., alive.....	(235)	5221	15
	<i>Amnicola valenciae</i> Prest., <i>Potamopyrgus crystallinus</i> Pfr., and <i>Amnicola ernesti</i> Mts., shells.....	(3800)	84436	24.2
	<i>Ancylus moricaudi</i> Orb., shell.....	(1)	22	.1
26 m	<i>Hoplias malabaricus</i> scales.....	(3)	67	.3
	<i>Planorbis pronus</i> Mts., shells.....	(107)	2378	3
	<i>Planorbis pronus</i> Mts., alive.....	(5)	111	1
	<i>Amnicola valenciae</i> Prest. and <i>Potamopyrgus crystallinus</i> Pfr., alive.....	(22)	489	1
	<i>Amnicola valenciae</i> Prest., <i>Potamopyrgus crystallinus</i> Pfr. and <i>Amnicola ernesti</i> Mts., shells.....	(5400)	119988	93.4
	<i>Ancylus moricaudi</i> Orb., shells.....	(2)	44	.3
	Plant remains.....			1

* According to Mr. Bryant Walker this species was described as an *Amnicola*, but is more likely a *Potamopyrgus*.

shows the temperatures and the gaseous contents of the water at various depths. The lower temperature of the deeper water, with the decrease in oxygen and increase in carbon-dioxide, indicates a stratified condition. However, there was an abundance of oxygen for fishes at all depths. A Secchi disc 20 cm. in diameter at 10:45 A.M. in bright sunlight disappeared at 3.5 meters, July 18.

Catches with fine (18 mesh per cm.) and coarse (10 mesh) tow nets in deep and in shallow water indicated that plankton was not very abundant. Practically nothing was caught in the coarse net; the fine one yielded some *Diaptomus*, *Cyclops*, considerable numbers of *Moinodaphnia*, and a few algae.

Hauls with Juday's (1916) improved Ekman mud dredge were more productive of results. The dredge used was of brass and cubical in form. It took samples of the bottom to a depth of 15 cm. over an area 15×15 cm. Table II gives the results of ten hauls made at various depths on July 18. It will be seen that the midge larvae, so characteristic in temperate regions of deep lakes with muddy bottoms, are largely replaced by snails. Most of the snails were of small size and the catches after they had been freed from mud consisted largely of "dead" snail shells. A young eel (*Symbranchus marmoratus*) caught at a depth of fifteen meters was placed in a bottle with bottom mud and water. It at once burrowed into the mud but in a few minutes protruded its head and kept it out. On July 25 thirty hauls were made with the dredge where the water was 14.2 M. deep and another small eel was thus secured. A thorough study of the bottom of Lake Valencia would doubtless add to the known fauna, but the data presented in Table II is indicative of the general conditions. It will be noticed that snails are very abundant in deep water. Systematic and extensive use of a mud dredge in the lake would doubtless give interesting results relating to the ecological distribution of the different species.

Reviewing the conditions afforded by Lake Valencia as an environment for fishes it may be said to be a tropical lake with muddy bottom and receding shore line. The water is of average turbidity and hardness. Distinctive habitats are the muddy bottom in deep water; the sandy, pebbly, and rocky shores of the islands; the rush-grown shores about the margin of the lake, and the mouths of rivers where emergent plants other than rushes are found.

LIST OF FISHES WITH REMARKS ON GEOGRAPHICAL
AND ECOLOGICAL RELATIONSHIPS

Professor C. H. Eigenmann (1920) lists twenty-three species of fishes from the Valencia basin. These fall into four groups according to their geographic distribution. In the following list colloquial names follow scientific names when they are known:

(1) Species widely distributed in South America:

Rhamdia quelen Quoy & Gaimard—bagre.

Plecostomus plecostomus Linnaeus—panaque.

Hoplias malabaricus (Bloch)—guabina.

Astyanax bimaculatus (Linnaeus)—sardina.

Gymnotus carapo Linnaeus—lamprea.

Symbranchus marmoratus Bloch—anguila.

(2) Species found in Trinidad:

Chorydoras aeneus Gill—plated nematognath.

Curimatus argenteus Gill—cula.

Odontostilbe pulcher (Gill)—sardina.

Lebistes reticulatus (Peters)—sardina.

Aquidens pulcher (Gill)—chusco.

(3) Species ranging through Venezuela, Rio Meta, and probably elsewhere.

Pimelodella metae Eigenmann—bagre.

Pimelodella tapatotoe Eigenmann—bagre.

Cochliodon plecostomoides Eigenmann—panaque.

Chaetostomus pearsei Eigenmann—coroncho.

Chaetostomus guarensis Steind.—coroncho.

Chaetostomus nudirostris Lütken.

Moenkhausia pittieri Eigenmann—sardina.

Astyanax metae Eigenmann—rabo de candela.

Gephyrocharax valenciae Eigenmann—sardina.

Menidia venezulae Eigenmann.

Crenicichla geayi Pellegrin—mataguaro.

(4) Species found in the lake itself. All but two species are also found in Classes 1 and 3. *Hemigrammus marginatus*

is also found in Southern Brazil; *Creagrutus beni* ranges along the base of the Cordilleras from Bolivia to Caracas.

Plecostomus plecostomus Linnaeus—panaque.

Hoplias malabaricus (Bloch)—guabina.

Hemigrammus marginatus Ellis—sardina.

Astyanax bimaculatus (Linnaeus)—sardina.

Gephyrocharax valenciae Eigenmann—sardina.

Creagrutus beni Eigenmann—sardina.

Lebistes reticulatus (Peters)—sardina (top minnow).

Symbranchus marmoratus Bloch—anguila.

Crenicichla geayi Pellegrin—mataguaro.

Aquidens pulcher (Gill)—chusco.

Of the twenty-three species listed, seventeen are widely distributed or indigenous. Five other species are also found in Trinidad. The geographical relationship of the fish fauna of Lake Valencia and its tributaries is largely with the territory toward the east.

Fifteen of the species were collected in rivers, and five of these were found in no other habitat. Thirteen species were taken at the mouths of rivers and two of these were not found elsewhere except in rivers. Ten species were found along the shores of the islands in Lake Valencia; seven in and near the rushes about the margin of the lake; four species in the deeper parts of the lake. Three species found in rivers were found nowhere else except on the shores of the islands. Four of the species present in the lake were not collected in rivers; eleven of those from rivers were not found in lakes. The three species found in all habitats (*Hoplias malabaricus*, *Astyanax bimaculatus*, *Symbranchus marmoratus*) are widely distributed geographically. *Aquidens pulcher*, another widely distributed species, was found in all habitats except rivers.

The facts described in the last paragraph may be taken to mean that the river is the oldest habitat and the lake the newest for the fishes in this region, because the former contains the larger number of species. This view is supported by the fact that toward the east, where the geographical affinities of these fishes lie, there are practically no lake habitats and many rivers.

The same facts may be interpreted as indicating that, because a river contains a greater variety of conditions (habitats),

there is opportunity for more species to live in it. The lake, being more uniform as to conditions, contains fewer species. This view is supported by the ecological distribution of the fishes in the lake. The habitats have species in direct ratio to the variety of conditions they possess—ten species frequent the shores of the islands; seven occur on the rush covered mud bottom about the margin of the lake; only four are found on the soft ooze in deep water.

Fishes unquestionably choose particular habitats which in general suit their particular needs. The mataguaro, panaque, and a sardina (*Hemigrammus marginatus*) were found in turbulent water formations (on the sandy and pebbly shores of islands, in the swift flowing streams), never on muddy bottoms or in quiet water. The chusco (*Aquidens pulcher*) occurred wherever there were muddy bottoms and quiet water and, as both these conditions were lacking in the swift flowing streams draining into Lake Valencia, the species is confined to the lake itself. Two sardinas, *Gephyrocharax valenciae* and *Creagrutus beni*, and a top minnow, *Lebistes reticulatus*, were found only at the mouths of or in streams. The sardina, *Gephyrocharax valenciae*, was abundant along the shores of islands and along the rushes on the lake's margin, but was never found in streams or in deep water. Another sardina, *Creagrutus beni*, was common along the shores of Isla del Buro, but was not found on muddy rush-grown shores.

The fishes invading all habitats are those in general having a wide range geographically. Among the three examined intensively at Lake Valencia, the guabina is a fish-eater (90 per cent); the sardina, *Astyanax bimaculatus*, feeds on plants (51), insects (30), and fish (15); the anguila eats insects (63), bottom deposits (22), and fish; the chusco, common in all lake habitats, partook largely of snails (49), insects (22), and fish (16). Although these four species are more or less specialized in their food habits, they feed on common ubiquitous foods. The two other species (*Rhamdia quelen* and *Plecostomus plecostomus*) of wide geographic range which occur in the Valencia region are largely associated with rivers, but feed on ubiquitous mud and insects. Ecologically the ability of a species to extend over a wide range depends upon an abundant food supply and the ability to invade a variety of habitats.

TABLE III
Distribution of Fishes at Various Depths in Lake Valencia. The figures under each species refer to catches in gill nets and give total catch followed by the catch per hour.

Mesh of nets in inches	Depth in meters	No. hrs. & min. nets were set	<i>Hoplias malabaricus</i>	<i>Crenicichla geayi</i>	<i>Aquidens pulcher</i>	<i>Plecotomus</i>	<i>Astyanax bimaculatus</i>	<i>Curimatus argenteus</i>	<i>Caiman sclerops</i>	Habitat
$\frac{3}{4}$	1-5	28-40	38-1.33	13-45	5-18		25-.87	1-.04	++	Shore of island
	5-10	2-52	1-.36	4-1.43	7-2.5	.....	3-1.1	.....		
	10-18	2-17	1-.44	2-.87	14-6.52	.....	13-5.75	.....		
1	1-5	26-25	6-.23		11-46		26-.86			
	5-10	30-32	17-.56	11-.36	71-2.34	.....	.....	.....		
	10-18	8-30	1-.12	.....	2-.23	.....	.....	.....		
2	1-5	0				1-.02				
	5-10	52-13	2-.04	.....	.....	.....	.....	.....		
	10-18	12-52	2-.16	.....	.....	.....	.....	.....		
3	1-5	2-28								
	5-10	25-50	.....	.....	.....	.....	.....	.....		
	10-18	34-30	.....	.....	.....	.....	.....	.....		
$\frac{3}{4}$	1-5	15-32	9-.59		5-.33		4-.26	11-.82	++	Muddy shore, rushes
	5-10	24-30	1-.04	.....	7-.25	.....	1-.04	.....		
	10-16	13-50	1-.02	.....	5-.11	.....	3-.07	.....		
1	1-5	22-45	36-1.57		13-.57					
	5-10	24-30	9-.37	.....	21-.86	.....	.....	.....		
	10-16	87-40	1-.02	.....	5-.11	.....	3-.07	.....		

TABLE III (Concluded)

Mesh of nets in inches	Depth in meters	No. hrs. & min. nets were set	<i>Hoplias malabaricus</i>	<i>Cremicichla geayi</i>	<i>Aquidens pulcher</i>	<i>Plecostomus</i>	<i>Asiyanax bimaculatus</i>	<i>Curimatus argenteus</i>	<i>Catman sclerops</i>	Habitat
2	1-5 5-10 10-16	8 24-30 43-50	8-1 10-48 4-09	.....	.....	.....	.....	.....	.....	.....
3	1-5 5-10 10-16	14-45 24-30 43-50	.....	.....	.....	.....	.....	.....	.....	.....
$\frac{3}{4}$	1-5	23	4-17	.....	.....	.....	1-04	1-04	+	.....
1	1-5	48-45	9-19	1-02	13-27	.....	.....	.....	.....	.....
2	1-5	25-45	1-04	.....	.....	.....	.....	.....	.....	.....
3	1-5	23	.....	.....	.....	.....	.....	.....	.....	.....
Total.....	1-5	239-5	111-46	14-06	47-19	0-0	56-23	13-05	+	.....
Total.....	5-10	209-27	40-19	15-07	106-51	1-005	4-02	0-0	0-0	.....
Total.....	10-18	245-19	10-04	2-01	26-11	0-0	19-07	0-0	0-0	.....

The latter conclusion is clearly indicated by the fact that two-thirds of all the species with wide geographic ranges invade every habitat in the lake, while none of the species with limited geographic ranges are found in all habitats. The species confined to rivers are not restricted in habitat, except that they are confined more or less to turbulent water formations. The cula is a mud eater and hence has an ubiquitous food but is limited in range and in ecological distribution, ranging geographically through Trinidad and the Valencia basin and being limited ecologically to the rushes along the lake shore and to the streams. The coroncho is still more limited in geographic range and is restricted ecologically to swift streams which contain large boulders. It clings to the under side of rocks and subsists entirely on the fine muddy deposits which collect in the eddies.

Perhaps enough has been said to bring out the point the writer wishes to make; a wide-ranging species usually feeds upon an ubiquitous food and is often able to invade a number of habitats; species with a limited geographic range are limited ecologically in food, habitat, or both. The fishes discussed in this paper illustrate this principle very well. Shelford (1911) relates the activities of fishes to the law of minimum and says, "the activity which determines the range of conditions under which a species will be successful is the activity which takes place within the narrowest limits." He also points out that "centers of origin" are sometimes only places where optimum conditions for a number of species exist. The writer would emphasize the view that, without other evidence, the fact that a species had a wide range would not necessarily be taken as indication that it was older than an associated species with a restricted range, as geographers have sometimes asserted. The ecology of each species would have to be considered with its range before making generalizations.

Tables III and IV show the catches made in gill nets. These are arranged so as to compare the four chief habitats in the lake: (1) the shores of the islands, which were rocky, pebbly, or sandy, and at the heads of bays sometimes a little marshy; (2) the marshy, rush grown shores around the margin of the lake; (3) the mouths of streams; (4) the deep water. The catch per hour in gill nets is a good means of determining

TABLE IV

Total catches at all depths and localities with nets of different sized meshes. The figures give the total catch and the catch per hour.

Mesh of nets in inches	No. hrs. and minutes nets were set	<i>Hoplias malarabicus</i>	<i>Crenicichla geayi</i>	<i>Aquidens pulcher</i>	<i>Plecostomus plecostomus</i>	<i>Astyanax bimaculatus</i>	<i>Curimatus argenteus</i>
$\frac{3}{4}$	110-41	45-.41	19-.17	43-.39	0-0	50-.45	4-.04
1	249-7	79-.32	3-.01	136-.55	0-0	29-.12	0-0
2	167-10	27-.16	0-0	0-0	1-.006	0-0	0-0
3	167-33	0-0	0-0	0-0	0-0	0-0	0-0

the abundance, size, and variety of fishes present at different localities. The method has some apparent defects—the most active species are most often caught, species too small to become entangled in the finest meshes are not caught at all, and some fishes (catfishes, eels) without hard exoskeletal parts are seldom caught. The results tabulated lead to the following conclusions: There are few or no large fishes in the lake, because nothing was ever caught in the 3-inch mesh nets. The guabina (*Hoplias malarabicus*) is the largest and most active fish in the lake. It has a close rival numerically in the chusco (*Aquidens pulcher*). The mataguaro (*Crenicichla geayi*) is rare in the lake or moves about very little, probably the former is true for it was seldom caught in seines. The total catch of fishes per hour is far below those sometimes made in some lakes in the United States. In Lake Mendota, for example, the average number of perch caught was sometimes over a hundred in twenty-four hours for a 1 in. mesh set in deep water during the summer.

The gaubina and a sardina, *Astyanax bimaculatus*, are found in all habitats. There are more fishes and species along the shores than in deep water, but one species, the chusco, appears to be more abundant at greater depths. The chusco is a mud-bottom species, is least abundant on the shores of islands, and is not found in rivers. The mataguaro, on the other hand, is typically a river fish and is found in the lake only in the turbulent water formations along the shores of the islands.

There is perhaps a migration of the smaller fishes into deeper water during the day. This is indicated by the fact that seining along shore was much more productive at night.

FOOD OF FISHES

It was the plan to study the food of ten individuals of each species from each habitat in the lake. The following review does not include food notes on all the fishes collected in the Valencia basin but gives a good idea of all the common species in the lake itself. Table V summarizes the results. In the table and in the following notes lengths are given in millimeters and do not include the tail fin. Numbers relating to foods mean percentage by volume. In making examinations for food the contents of the stomach and intestine were stripped on a glass plate, the entire alimentary canal was then slit open and any remaining materials taken. The food mass was teased with needles under a binocular microscope, any small objects being examined under a compound microscope.

Aquidens pulcher (Gill), Chusco

Isla del Buro; July 9, 10; number examined, 10; lengths, 105-62, ave. 97. Food: undetermined insect larvae 3.5; chironomid larvae .9; chironomid pupae .1; fly 2; ostracods 9.5; snails 83.5.

Off rush-grown shore, 2.5 m., Maracay; July 22; no. ex., 5; lengths 106-73, ave. 97. Food: fish 20; undetermined insect larvae 19; chironomid larvae 9; ostracods .6; snails 45.4; plants 6.

Off rush-grown shore, Maracay, July 28, 12 m.; no. ex., 3; lengths 90, 74, 77; ave. 80. Food: fish 42; chironomid larvae 28; ostracods 10; snails 20.

Off rush-grown shore, Maracay, July 26; no. ex., 3; lengths 80, 80, 103, ave. 88. Food: fish 10; *Tanypus* larvae 35; *Tanytarsus* larvae 5; *Orthocladus* larvae 1.7; snails 18.3; plants 8.3; bottom 21.7.

Mouth of Rio Bue, July 19, no. ex., 4 (2 empty); lengths 128-112, ave. 120. Food: fish 50; insects 50.

Summary—No. ex. 24; ave. length 92. Food: fish 16.3; undetermined insect larvae 10.4; chironomid larvae 12; chirono-

mid pupae +; fly .9; ostracods 5.8; snails 49; plants 2.5; bottom mud 3.

The chusco feeds on muddy bottoms upon the most abundant foods—snails constituting the chief item in its dietary.

Astyanax bimaculatus (Linnaeus), Sardina

This large sardina was found in all parts of the lake, but was most abundant near the islands.

Isla del Buro, 2 m., July 9; number examined, 1; length 95. Food: midge pupae 30; cladocerans 30; plants 20; plankton algae 20.

Isla del Buro, 11 m.; July 10; no. ex., 3; lengths: 120, 105, 109, ave. 108. Food: fish 33.3; midge pupae 12; plants 8; plankton algae 46.7.

Isla del Buro, 7 m., July 10; no. ex., 3; lengths 106, 92, 89, ave. 96. Food: fish 15; *Sialis* nymph 3; insects 13; snail eggs 1; plants 20; *Wolffia* 7; algae 10.

Isla del Buro, 11 m., July 10; no. ex., 1; length 96. Food: fish 35; fly 25; plants 35.

Isla del Buro, 1.5 m., July 10; no. ex. 2; length 96, 90. Food: plants 40; plankton algae 60.

Mouth of Rio Bue, July 19, no. ex., 2; lengths 28, 32. Food: insect remains 100.

Mouth of Rio Bue, July 20; no. ex., 2; length 78, 85. Food: unknown 50; insects 35; algae 15.

Off rush-grown shore, 12 m., July 28; no. ex., 3, length 95. Food (2 empty): insect nymph 2; plants 60, algae 38.

This is the largest "sardina" found in Lake Valencia and more than half of its food consists of vegetation, including plankton. It therefore goes back to the fundamental sources of food in the lake for its energy and in turn serves as food for caimans, cormorants, herons, and predacious fishes.

Astyanax metae Eigenmann, Sardina

Rio Castaño, July 27; number examined, 4; length 116–79, ave. 97. Food: may fly nymphs 45; plant remains 49; seeds 6.

These four specimens were examined in order to compare another species in the same genus with the last. Although this species was confined to rivers, its food was much the same as that of its relative in the lake—more than half vegetation.

Chaetostomus pearsei Eigenmann, Coroncho

Rio Castaño, July 16; number examined, 10; lengths 111–86, ave. 93. Food: bottom mud and sand, 100.

This sucker-like catfish lives in the swift boulder-filled streams with sandy bottoms. It clings to the under side of rocks by means of its mouth and feeds largely on bottom mud.

Creagrutus beni Eigenmann, Sardina

Isla del Buro, July 12; number examined, 10; lengths 32–25, ave. 28. Food: midge pupae 3.8; snails 96.2.

This little sardina, caught on the same beach as the *Astyanax bimaculatus* taken in this locality, had eaten quite different foods.

Crenicichla geayi Pellegrin, Mataguaro

Isla del Buro, 2 m., July 9; number examined, 5; lengths: 146–130, ave. 139. Food: fish 10.5; snails 52; Planorbis 37.5.

Isla del Buro, 11 m., July 10; no. ex., 2; lengths: 126, 135. Food: (1 empty) fish 100.

Isla del Buro, 7 m., July 10; no. ex., 2; lengths: 147, 148. Food: snails 100.

Rio Castaño, July 27; no. ex., 2; lengths 159, 56. Food: unidentified insect larvae 90; chironomid larvae 10.

This fish feeds largely on snails, fishes, and insect larvae.

FIG. 3. The cula, *curimatus argenteus*

Curimatus argenteus Gill, Cula

Mouth of Rio Bue, July 19; number examined, 5; lengths 107–88, ave. 98. Food: fine organic sediment and mud 100.

Rush-grown shore, Maracay, July 22, no. ex., 2; lengths 102, 93. Food: algae, some filamentous blue greens, 99.5; ostracod .5.

This species has a very long coiled intestine (Figs. 3, 4) and a gizzard at the posterior end of the stomach. It apparently subsists mostly on mud and algae.

FIG. 4. A cula opened to show the coiled intestine.

Gephyrocharax valenciae Eigenmann, Sardina

Mouth of Rio Bue, July 20; number examined, 10; lengths 40–30, ave. 37. Food: undetermined insect larvae 10; chironomid larvae 1; chironomid pupae 6; cladocerans 5.5; cyclops 5.5; ostracods 1.1; mites 1.5; plants 14; algae 21.4; fine sediment 12.5; unknown 21.5.

Rush-grown shore, Maracay, July 24; no. ex., 10; lengths 39–30, ave. 33. Food: undetermined insects 12.5; water bug 5.5; beetle 8; ants 29.5; mites .5; eggs (snail or amphibian?) 40; plants 7.2; unknown 4.

This sardina is versatile in its food habits. It is probably the most abundant fish in Lake Valencia. It occurs in enormous numbers along all shores but is most common over muddy bottoms. It serves as food for many other animals—such as herons, cormorants, gulls, caimans, and predacious fishes.

Hoplias malabaricus Bloch, Guabina

Isla del Buro, 3 m., July 9; number examined, 2; lengths: 155, 160. Food: fish 95, eggs 5.

Isla del Buro, 9 m., July 10; no. ex., 2; lengths: 205, 200. Food: fish 100.

Isla del Buro, 7 m., July 10; no. ex., 1; length 153. Food: fish 100.

Isla del Buro, 15 m., July 10; no. ex., 1; length 90. Food: plankton algae 100.

Isla del Buro, 5 m., rocky shore, July 10; no. ex., 5; lengths 305–186, ave. 233. Food: fish 48.3; 8 sardinas (40–55 mm. long) 33.3; dragon-fly nymphs (close to *Perithemis*) 18.3.

Reed-grown shore, Maracay, 2 m., July 22; no. ex., 2; lengths 263, 212. Food: fish 32.5; eel (*Symbranchus*, 60 mm. long) 50; 2 damsel-fly larvae 12.5; gelatinous algae 5.

Reed-grown shore, Maracay, 1.5 m., July 23; no. ex., 8; lengths 370–189, ave. 222. Food: fish 90, Sialis-like insect 10.

Off rush-grown shore, mud bottom, Maracay, 12 m., July 28; no. ex., 8; lengths 399 (1.37 kilos)—139, ave. 251. Food: none.

This was the largest species of fish found in Lake Valencia. The guabina is a fierce, predacious creature with sharp, strong teeth. It ranges through all available habitats for its chief foods—fishes (90) and insects. When gill nets were pulled once every twenty-four hours the guabina were often empty of food, indicating that digestion is rapid.

Lebistes reticulatus Peters, Sardina

Isla del Buro, 1 m., July 11; number examined 10; lengths 21–14, ave. 16.4. Food: algae 96.1; Diptera 3.9.

Rush-grown shore, Maracay, 5 m., no. ex., 10; lengths 30–13.5, ave. 21. Food: Cyclops 11.1; cladocerans 2.2; ostracods 6.1; rotifers 2.6; algae 78.

This little top-minnow feeds mostly on algae and plankton animals. It is very hardy and lived for hours in collecting pails after other fishes were dead.

Pimelodella metae Eigenmann, Bagre

Mouth of Rio Bue, July 29; number examined 10; lengths 79–37, ave. 61. Food: fish 8.3; insect larvae 7.3; chironomid larvae 8; may-fly nymphs 23; damsel-fly nymphs 8.5; caddis-fly larvae 1.5; beetle larvae 6.5; chironomid pupae 7.5; ostracods .7; earthworm 14.5; plant .2; mud and debris 13.

Like many catfishes, this little bagre is versatile in its food habits.

Plecostomus plecostomus Linnaeus, Panaque

Isla del Buro, 9 m., off sandy shore; number examined 1; length 283. Food: ostracods 5; sponge spicules 20; remains of "old" plants 10; diatoms 10; filamentous algae 1; fine bottom sediment 54.

This fish usually lives in rivers and the Venezuelans were greatly surprised to see it in the lake. It apparently feeds largely on fine bottom mud.

Rhamdia quelen Quoy & Gaimard, Bagre

Rio Castaño, under rocks, July 27; number examined 3; lengths 155, 150, 62. Food: chironomid larvae 46.6; grasshopper 20; Sphaeridae 3.3; fine bottom debris 30.

Symbranchus marmoratus Bloch, Anguila

Isla del Buro, among rocks, July 9; number examined 3; lengths 320, 240, 172. Food: Sialis larva 98; sand 2.

Isla del Buro, among rocks, July 11; no. ex. 3; lengths 301, 150, 138. Food: fish 12; chironomid larvae 5; caddis-fly larvae 72; insects 11.

Isla del Buro, among rocks, July 12; no. ex., 5, lengths 272–150; ave. 233. Food: caddis-fly larvae 33.3; undetermined insect larvae 43.3; sand and pebbles 23.3.

Caught in mud dredge, off Maracay, 14.5 m.; July 25; no. ex. 1; length 130. Food: the top layer of the bottom ooze 100.

Young eels apparently live buried in the bottom mud in both deep and shallow water. The adults subsist largely on insects.

TABLE V (Concluded)

GENERAL REMARKS ON FOOD

Table V shows that the foods eaten by the fourteen important species of fishes in Lake Valencia rank as follows, the figures indicating the average percentage by volume for all species: mud 27, snails 12.4, algae 11.8, fish 10.3, plants 6.6, unidentified insect larvae 5.3, chironomid larvae 5.1, may-fly nymphs 4.9, unidentified insects 2.8, caddis-fly larvae 2.4, chironomid pupae 2, ostracods 1.7, unidentified eggs 1.5, sponges 1.4, grasshopper 1.4, Diptera 1.3, sand 1.3, unidentified food 1.2, earthworm 1.1, ants 1, damsel-fly nymphs .7, copepods .6, beetle larvae .5, cladocerans .4, seeds .4, dragon-fly nymphs .3, pebbles .3, Sphaeridae .3, beetles .3, bugs .2, *Sialis* larvae .1, mites .1, rotifers .1.

If the foods are collected into larger groups the order is as follows: mud, sand, and pebbles, 28.6; immature insects, 19.3; plants, 18.8; molluscs, 12.7; fish, 10.3; adult insects, 7; entomostracans, 2.7; chironomid pupae, 2; unidentified eggs, 1.5; sponges, 1.4; unidentified food, 1.2; earthworm, 1.1; mites, .1; rotifers, .1.

The fishes feeding on particular foods are as follows:

FISHES: *Hoplias malabaricus* 90, *Aquidens pulcher* 16, *Crenicichla geayi* 15, *Astyanax bimaculatus* 11, *Pimelodella metae* 8.3, *Symbranchus marmoratus* 4.5.

INSECTS AND LARVAE: *Symbranchus marmoratus* 72.9, *Rhamdia quelen* 67; *Pimelodella metae* 62.3, *Astyanax metae* 45, *Gephyrocharax valenciae* 35.1, *Astyanax bimaculatus* 24.2, *Aquidens pulcher* 23, *Lebistes reticulatus* 18, *Crenicichla geayi* 17.7; *Creagrutus beni* 14, *Hoplias malabaricus* 8.4.

ENTOMOSTRACA: *Lebistes reticulatus* 9.1, *Creagrutus beni* 7.8, *Aquidens pulcher* 6, *Astyanax bimaculatus* .7, *Plecostomus plecostomus* .5, *Curimatus argenteus* .1.

MOLLUSCS: *Creagrutus beni* 78, *Aquidens pulcher* 49, *Crenicichla geayi* 47, *Rhamdia quelen* 3.3, *Astyanax bimaculatus* 2.

PLANTS: *Lebistes reticulatus* 87, *Astyanax metae* 55, *Astyanax bimaculatus* 52, *Curimatus argenteus* .28, *Plecostomus plecostomus* 21, *Gephyrocharax valenciae* 15.3, *Aquidens pulcher* 2.5, *Hoplias malabaricus* .8, *Pimelodella metae* .2.

MUD: *Chaetostomus pearsei* 100, (young *Symbranchus marmoratus* from bottom of lake 100), *Curimatus argenteus* 71, *Plecostomus plecostomus* 54, *Rhamdia quelen* 30, *Symbranchus marmoratus* 22, *Pimelodella metae* 13, *Gephyrocharax valenciae* 6.3, *Aquidens pulcher* 3.

These lists and the data presented in Table V indicate clearly that bottom sediment, insects, plants, molluscs, and fishes are the most important foods for the fishes of Lake Valencia. Plankton, plant or animal, is not important, but the bottom fauna is a valuable source of food for several species. The fishes feeding on plants are small, abundant species which often themselves serve as food for fish eating animals. The snails and a portion of the immature insects also pass on organic food acquired from plants to predacious animals when they are eaten. The great reservoirs of food available for fishes are the bottom mud (where the organic compounds are derived from plants and to some extent from animals), the aquatic vegetation, and the abundant small animals (snails, insect larvae, etc.) feeding directly or indirectly on plants, mud, and to a less extent on other animals.

It is probable that this condition is not unusual in lakes, tropical and otherwise. The aquatic vegetation and bottom deposits are usually more important sources of fish food than the plankton. Petersen (1918) has come to the same conclusions in regard to the ocean.

PARASITES OF VALENCIAN FISHES

The following list gives the names of all parasites identified and also mentions a few of uncertain relationships. The latter are necessarily included in the statistical comparisons. The Acanthocephala have already been described by Dr. H. J. Van Cleave and the nematodes are to be worked up by Dr. N. A. Cobb. Drs. M. J. Rathbun and B. H. Ransom read the portions of the manuscript relating to the new species of parasites and made many helpful suggestions.

BACTERIA

The liver of a sardina, *Astyanax bimaculatus* (L.), collected in Lake Valencia near Maracay, July 22, 1918 was one mass of cysts. It was sent to Professor H. S. Davis who said:

"The cysts from sardina 116 are very interesting. I have been unable to find any trace of Sporozoa but sections show the presence of exceptionally large rod-shaped bacteria which are probably the cause of the cysts. It is apparently an undescribed disease."

Cysts, probably caused by the same organisms, were found on the stomach of a gaubina, *Hoplias malabaricus* Bloch, caught by the Isla del Buro, July 11.

TREMATODA

Genus *Parspina*, new

Body broad, flat; with twenty spines of equal size symmetrically arranged about the mouth. Uterus long, coiled in anterior end of posterior half of body; testes on either side at posterior third of body, elongate, slightly lobate; ovary spherical, anterior to uterus near median line; vitelline glands on either side of body, anterior to uterus. Intestinal rami smooth, extending from posterior end of anterior quarter to beginning of posterior seventh of body; oral sucker deep but mouth small; a slender prepharynx present; pharynx spherical.

The general plan of structure resembles that of the genus *Pneumatophilus* Odhner but the spines about the mouth are different. Type species—*Parspina bagre*.

Parspina bagre, new species

Length of body, .63 mm.; width, .37 mm.; widest a little behind middle. Cuticula without spines. Oral sucker, deep; length, nearly one-fifth that of body; surrounded by twenty symmetrically arranged blunt, straight hooks of equal size. Prepharynx short and slender. Pharynx globular; nearly half as long as oral sucker. Intestinal rami branching directly from pharynx; smooth; extending to the posterior seventh of the body. Diameter of acetabulum a little less than that of oral sucker.

The genital field, without the vitellaria, occupies the posterior half of the body. The two testes lie side by side, the left slightly anterior to the right, about one-third of the body length from the posterior end. They are ovate, slightly lobate, and the left is somewhat smaller than the right. The ovary is spherical. It lies a little posterior to the acetabulum and slightly toward the right of the median line. Its diameter is one-fourteenth the length of the body. Cirrus pouch almost as wide as the acetabulum, from which it extends posteriorly and to the left. Vitellaria grouped around the intestinal rami, in the second fourth of the body, extending from the uterus to the pharynx. Uterus, slender, coiled in posterior half of the body, containing many eggs. Size of eggs, .016 by .008 mm. Excretory system Y-shaped, without large terminal bladder.

Host: bagre (catfish), *Pimelodella metae* Eigenmann, in intestine.

Type: Cat. No. 7575 (Helminthological Collection, U. S. National Museum). Collected at the mouth of the Rio Bue, near Maracay, Lake Valencia, Venezuela, July 29, 1918. Two specimens were found in a single catfish.

Cysts which contain a larva, apparently of this species, were often found in the fins of small fishes. Figure 5 (Cat. No. 7577; Helm. Coll. U. S. N. M.) shows a cyst from the pectoral fin of a mataguaro, *Crenicichla geayi* Pellegrin, collected by the Isla del Buro, July 9, 1918. The wall of this cyst is thin and its entire length is .22 mm. There is some space

FIG. 5. *Paraspina bagre*. The upper figure shows an adult; the lower figure, an encysted larva.

between the wall of the cyst and the larva within. The larva is elliptical. Its anterior end is truncated and armed with twenty spines. The interior of its body shows no differentiation into organs but is filled with coarse granules. Larvae like those represented in Figure 5 were also found in the fins of the following fishes: cula, *Curimatus argenteus* Eigenmann; the sardinas, *Astyanax bimaculatus* (L.), *Creagrutus beni* Eigenmann, and *Gephyrocharax valenciae* Eigenmann; the top-minnow, *Lebistes reticulatus* (Peters).

The distribution of cysts in the fins is characteristic. Ten *Creagrutus beni* collected near the Isla del Buro, July 12, had cysts distributed on the fins as follows: dorsal 37, caudal 31, anal 20, pelvic 17, pectoral 15, skin 1. Ten *Gephyrocharax valenciae* collected at the mouth of the Rio Bue, July 20, gave the following results: caudal 41, anal 32, dorsal 17, pelvic 5,

pectoral 3. The cysts are more abundant toward the posterior end of the body.

Genus *Wallinia*, new

Plagiorchiidae with the genital pore median and immediately anterior to acetabulum; vitellaria small and largely confined to the lateral regions of the second quarter of the body; acetabulum one-fourth to one-third greater in diameter than the oral sucker, situated close behind the bifurcation of the intestinal rami; ovary globular, small, on the left side behind the acetabulum; testes rounded, arranged one behind the other in the third quarter of the body, the posterior one somewhat to the left of the median line. Named for Dr. Ivan E. Wallin.

This genus differs from *Pneumonoeces* in the position of the genital opening, the size and position of the acetabulum, and from *Plagiorchis* in the arrangement of vitellaria, acetabulum, testes, and other features. Type species—*Wallinia valenciae*.

Wallinia valenciae, new species

Length, 1.34 mm. (contracted); width, .38; body widest in region of acetabulum, constricted behind the oral sucker (Fig. 6). Diameter of acetabulum about one-fifth the length of the body; diameter oral sucker about two thirds that of

FIG. 6. *Wallinia valenciae*,

acetabulum. Genital field occupies the posterior three-fourths of the body. The small spherical ovary lies somewhat behind the acetabulum on the left side. The testes are rounded; the anterior one lies slightly behind the ovary near the median line; the posterior testis is on the left side of the body, extending to the middle of the intestinal ramus on that side. The uterus is coiled in the posterior three-fourths of the body; the loops are slender and filled with eggs. Size of eggs, .041 by .02 mm.

The vitellaria are small and lie outside the intestinal rami in the second quarter of the body. The genital pore is crowded into the triangular space between the anterior margin of the acetabulum and the intestinal rami.

Host: *Gephyrocharax valenciae* Eigenmann, in intestine.

Type, Cat. No. 7569 (Helm. Coll. U. S. N. M); collected from a fish taken in Lake Valencia at Maracay, in shallow water among rushes, July 24, 1918.

The following species is placed in the genus *Allocreadium* Looss, although it appears to differ from other members of that genus in possessing a shorter esophagus and in the position of the genital aperture immediately anterior to the acetabulum.

Allocreadium wallini, new species

Length, 1.55 mm.; width, .74 mm.; body widest behind middle (Fig. 7). Oral sucker and acetabulum approximately equal in diameter. Ratio of diameter of oral sucker to that of pharynx about 7:3. A short prepharynx is present. Intestinal rami smooth, branching directly from pharynx, extending to posterior fifth of body. Cuticula is without spines.

FIG. 7. *Allocreadium wallini*. A, a young individual; B, a mature individual with eggs in the uterus.

The genital field, without vitellaria, occupies nearly half the length of the body and the posterior testis is one-fifth the body length from the posterior end. The spherical ovary lies on the right side of the body at the posterior margin of the acetabulum; diameter about one-fifteenth the length of the body. The lobate testes are about twice the diameter of the ovary. They are usually close together between the intestinal rami, are usually elongated across the body, and one lies anterior to the other. Vitellaria, small, rounded, filling the body posterior to the testes and distributed anteriorly along the sides to points just anterior to the acetabulum. The folds of the uterus are very large. It is coiled on the left side of the body in the region of the acetabulum, and usually contains a few (0-29; average 5) eggs (.15 mm. long). Cirrus sac elongated, pear shaped, nearly as long as the diameter of the acetabulum. Genital pore anterior to margin of acetabulum and slightly to the right of the median line.

Host: Mataguaro, *Crenicichla geayi*, in intestine.

Type: Cat. No. 7579 (Helm. Coll. U. S. N. M.); collected at Isla del Buro, Lake Valencia, Venezuela, July 9, 1918.

Allocreadium chuscoi, new species

Length, .56 mm., width, .29 mm.; body widest behind middle (Fig. 8). Acetabulum and oral sucker nearly equal in size; ratio of diameter of oral sucker to that of pharynx about 11 to 4. Diameter of acetabulum, .084mm.

FIG. 8. *Allocreadium chuscoi*.

Genital field, exclusive of vitellaria, occupying the middle half of the body. Ovary somewhat angular, at the right

posterior margin of the acetabulum. Uterus short, coiled somewhat posterior to acetabulum. None of the specimens examined contained eggs. Genital pore in the median line immediately anterior to the acetabulum. Cirrus sac elongated, pear shaped, eleven-fourteenths as long as diameter of acetabulum.

Testes lobate, the anterior one somewhat on the left of the median line, the posterior one somewhat on the right. Vitellaria small, ellipsoidal, arranged in a V-shaped area outside the intestinal rami and across the posterior end of the body. Intestinal rami smooth, slender (diam. .02 mm.) extending to within one-seventh of posterior end of body.

Host: Chusco, *Aquidens pulcher* Gill, in intestine.

Type: Cat. No. 7562 (Helm. Coll. U. S. N. M.); collected in mouth of Rio Bue, near Maracay, Lake Valencia, July 19, 1918.

TREMATODE No. 2

Forty trematodes of this species were found in the intestine of a cula, *Curimatus argenteus* Eigenmann, caught at the mouth of the Rio Bue, July 20, 1918. The specimens were

FIG. 9. Trematode No. 2.

not in good enough condition for complete study. Figure 9 shows the general form of the body; the length of which was .35 mm. The suckers are nearly equal in size. The genital pore is close to the anterior border of the acetabulum.

Clinostomum intermedialis Lamont

The adult of this species lives in the esophagus of the cormorant, *Phalacrocorax vigua* Viellot. On July 27, 1918, a bagre (*Rhamdia quelen* Quoy and Gaimard) collected under a rock in the Rio Castaño contained twelve encysted forms distributed as follows: 5 in muscles at base of tail, 1 back of head under skin, 3 under operculum, 3 under membrane covering floor of mouth. Two other bagres collected at the same time were not infected with this parasite. The length of the encysted forms was 6 to 7.5 mm. Similar encysted forms were also found in an eel (*Symbranchus marmoratus* Bloch) caught in the rocks along the shore of Isla del Buro, July 12, and in a sardina, *Astyanax bimaculatus* (L.), collected July 20 at the mouth of the Rio Bue.

Clinostomum Cyst No. 1

A large larval *Clinostomum* (Fig. 10) was taken from a cyst in the muscles at the base of the tail of a gaubina, *Hoplias malabaricus* (Bloch), captured along the shore of Isla del Buro,

FIG. 10. *Clinostomum* Cyst No. 1.

July 11, 1918. (Cat. No. 7588; Helm. Coll. U. S. N. M.) It measures 16 mm. in length. Probably the adult stage is found in some fish-eating bird.

Diplostomum mataguaroi, new species

Larval forms of this species (Fig. 11) were found in cysts in the peritoneum, particularly over the swim bladder, and in the liver of the mataguaró, *Crenicichla geayi* Pellegrin. The adult perhaps will be found to belong to the genus *Strigea*.

Length of entire cyst, 1.54 mm.; length of larva, .92 mm.; width, .48 mm. The cyst has a thin wall and there is a considerable fluid-filled space between it and the larva.

The body is very flat and clearly divided into two regions by a constriction a little posterior to the middle. The muscular oral sucker is followed by a more slender pharyngeal bulb.

FIG. 11. *Diplostomum mataguaroi*.

The slender intestinal rami extend nearly to the posterior end of the body and the middle half of each is more or less sacculate.

The posterior sucker is larger than the anterior and there is a lobate adhesive organ just behind it.

Type, Cat. No. 7586 (Helm. Coll. U. S. N. M.); collected from liver of *Crenicichla geayi* Pellegrin, at Isla del Buro, Lake Valencia, Venezuela, July 10, 1918.

FIG. 12. Trematode Cyst No. 3.

TREMATODE CYST NO. 3

On July 27, 1918, a mataguaro, *Crenicichla geayi* Pellegrin, which had several trematode cysts in its fins and beneath its skin, was caught in the Rio Castaño. The cysts all had the form shown in Figure 12. The cyst wall was thick but had no definite outer boundary—the fibers composing it blending gradually into the surrounding tissues. There was much more pigment about the cysts in the fins than about those beneath the skin. The larva within the cyst measured .28 by .16 mm.; the cyst about .6 by .5 mm. The diameter of the oral sucker is about one-eighth and the acetabulum somewhat more than one-fourth the length of the body.

This cyst was not found in mataguaros from Lake Valencia. It was abundant in two mataguaros caught in the Rio Castaño, July 27. One specimen had the cysts distributed about as follows: dorsal 60, caudal 30, anal 60, pelvic 90, pectoral 60. The other had none in the fins but carried about forty in its skin.

CESTODA

No adult tapeworms were found in the fishes of Lake Valencia. The larvae collected probably have their adult stages in birds or in other fish-eating animals.

FIG. 13. Tapeworm cysts found in Valencian fishes.

TAPEWORM CYST NO. 4

Two small cysts, .3 mm. long (Fig. 13A) were taken from the peritoneum of an eel (*Symbranchus marmoratus* Bloch) 130 mm. in length, caught in the soft bottom of Lake Valencia with a mud dredge at a depth of 14.5 m. There are four suckers in the cyst and the wall is thin.

TAPEWORM CYST NO. 5

Groups of small cysts were found in the peritoneum of sardinas, *Astyanax bimaculatus* (L.), caught by Isla del Buro, July 10; also in the same situation in top-minnows, *Lebistes reticulatus* (Peters), taken by Isla del Buro July 11 and in Lake Valencia near Maracay July 24.

The cysts are nearly globular (Fig. 13B) and contain a larval tapeworm, folded once. They measure .36 mm. in diameter.

CYSTS OF UNKNOWN PARASITES

Cyst No. 6

An elongated cyst (Fig. 13C) was found in the peritoneum of a Chusco, *Aquidens pulcher* (Gill), caught at the mouth of the Rio Bue, July 19, 1918. It measures .29 mm. in length.

Cyst No. 7

Globular cysts occurred in the fins of two sardinas, *Astyanax bimaculatus* (L.), caught in the mouth of the Rio Bue, July 20, 1919. These dried up on account of a crack in the vial in which they were preserved. They measured about .42 mm. in diameter and are perhaps very young cysts of *Paraspina bagre*.

Cyst No. 8

Globular cysts, .1-.17 mm. in diameter, were found in the peritoneum of chuscos, *Aquidens pulcher* (Gill), by Isla del Buro, July 9; and near Maracay in Lake Valencia at a depth of 16 m., July 26.

Cyst No. 9

A chusco, *Aquidens pulcher* (Gill), caught in Lake Valencia, July 9, at a depth of 16 m., had the liver filled with minute cysts .017 to .009 mm. in diameter.

ACANTHOCEPHALA

Dr. H. J. Van Cleave has kindly described the acanthocephalans, reporting two species.

Pandosentis iracundus Van Cleave

This minute parasite was found in the chusco, *Aquidens pulcher* (Gill), and in the mataguaro, *Crenicichla geayi* Pellegrin.

Quadrigyus torquatus Van Cleave

This worm was found in five species of fishes: the guabina, *Hoplias malabaricus* (Bloch); anguilla, *Symbranchus marmoratus* Bloch; mataguaro, *Crenicichla geayi* Pellegrin; and the sardinas, *Gephyrocharax valenciae* Eigenmann and *Astyanax bimaculatus* (L.).

NEMATODA

The nematode parasites were sent to Dr. N. A. Cobb of the Bureau of Plant Industry and as it will probably be some time before he is ready to report, these worms are listed as "intestinal" when they occurred in the lumen of the intestine and "visceral" when they were found encysted among the visceral organs.

CRUSTACEA

Aegathoa lazzari Pearse

Found twice on fishes from Lake Valencia on the sardinas *Astyanax bimaculatus* (L.) and *Gephyrocharax valenciae* Eigenmann.

Dolops geayi Bouvier

This argulid was found on fishes, attached to the body at bases of the fins, and in the branchial and buccal cavities. The following fishes served as hosts: chusco, *Aquidens pulcher* (Gill); mataguaro, *Crenicichla geayi* Pellegrin; and the guabina, *Hoplias malabaricus* (Bloch).

FIG. 14. *Porocephalus gracilis*.

ARACHNIDA

Porocephalus gracilis Diesing

This peculiar parasite (Fig. 14) was reported by Diesing (Shipley, 1898) from Brazil where it occurs in a number of species of fishes and reptiles. In Lake Valencia it was found only in the chusco, *Aquidens pulcher* (Gill), occurring in cysts in the peritoneum and liver. It was found in chuscos collected in Lake Valencia at Isla del Buro, July 9, and in others collected near Maracay, July 22, 26. By the Isla del Buro, July 9, six chuscos contained cysts as follows: liver: 6, 8, 8, 1, 5; peritoneum: 7, 1. Near Maracay July 22 and 26 the results from four specimens were liver: 2; peritoneum: 12, 4, 1.

Beauchamp (1918) has recorded another porocephalid parasitic in fishes from the Belgian Congo.

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LIST OF FISHES WITH REMARKS ON PARASITES

Aquidens pulcher, Chusco

Table VI A shows that this fish carries eight species of parasites, four of which were not found in other fishes. It also (Table VI A) has a very large number of parasites per individual.

TABLE VI*
A. AQUIDENS PULCHER

Locality	Date, July	No. examined	<i>Allocreadium chusoi</i>	Cyst No. 6	Cyst No. 8	Cyst No. 9	Visceral nematodes	<i>Pandocentis iracundus</i>	<i>Dolops† geayi</i>	<i>Poroccephalus gracilis</i>
Isla del Buro.	9	6	4-11	0	3-5	0	0	3-.8	0	6-1.3
Isla del Buro.	10	4	3-55	0	0	0	0	1-2	0	0
Rio Bue.....	19	4	3-10	1-.3	0	0	0	0	0	0
Maracay.....	22	4	2-6	0	0	0	3-2	1-.3	1-.3	3-4
Maracay.....	23	1	1-5	0	0	0	0	0	0	0
Maracay.....	26	3	1-.7	0	1-.3	1-50	0	2-2.4	0	1-1.6
Total.....	.....	22	14-20	1-+	4-.7	-71	3-.2	7-3	1-+	10-2

* All divisions of this table are arranged on the same plan. Numbers occurring under columns headed by the name of a parasite refer to number of fishes infected; the second number being the average for the total catch of fishes.

† This species is very transparent. It may have occurred before July 9 and been overlooked. It also leaves its host readily and swims in the water. Such behavior makes statistical records even more unreliable.

Astyanax bimaculatus, Sardina

This fish (Table VI B) has nine species of parasites, the largest number of any fish examined in Lake Valencia. Its number of parasites per individual is not large (Table VII). It is commonly eaten for food by predacious fishes and other animals and, as would be expected, carries several immature parasites.

Astyanax metae, Sardina

Four fishes of this species were caught in the Rio Castaño, July 27. Three carried no parasites; one had fourteen nematodes encysted among its viscera.

TABLE VI. B. ASTYANAX BIMACULATUS

Locality	Date, July	No. examined	Bacterial cysts	Trematodes	<i>Vigintispinis</i> bagre cysts	<i>Clinostomum</i> inter-medialis cysts	Tapeworm cyst No. 5	<i>Quadrigrus tor-quatus</i>	Intestinal nematode	Visceral nematode	<i>Agathoa lazzari</i>
Isla del Buro...	9	1	0	0	0	1-1	1-2	0	1-2	1-2	0
Isla del Buro...	10	9	0	1-1	0	3-4	2-27	3-9	7-3	7-6	0
Rio Bue...	19	2	0	1-1.5	2-2	0	1-5	0	0	0	0
Rio Bue...	20	2	0	0	0	1-2.5	0	0	0	1-1	1-.5
Maracay.	22	1	1-1	0	0	0	0	0	0	0	0
Total..	.....	15	1-.1	2-.3	2-.3	5-.7	4-4	3-.6	8-2	9-3	1-.1

Chaetomus pearsei, Coroncho

Ten specimens were caught in the Rio Castaño July 16. Five of these were free from parasites; the other five carried a total of twenty-seven intestinal nematodes.

Creagrutus beni, Sardina

Ten specimens, caught by the Isla del Buro, July 12, carried two species of parasites. Nine of the specimens had a total of 108 *Parapsina bagre* cysts in the fins. Two each had a single intestinal nematode.

Crenicichla geayi, Mataguaro

This fish carried eight species of parasites, (Table VI C)

TABLE VI. C. CRENICICHLA GEAYI

Locality	Date, July	No. examined	<i>Parapsina bagre</i> larvae	<i>Allocreadium wallini</i>	<i>Diplostomum mataguarei</i>	Trematode Cyst No. 3	Intestinal nematodes	Visceral nematodes	<i>Pandosentis iracundus</i>	<i>Dolops geayi</i> †
Isla del Buro...	9	6	3-17	5-19	6-3	0	2-4	3-3	0	†-†
Isla del Buro...	10	4	1-1	3-99	2-6	0	0	2-3	2-3	2-2†
Rio Castano...	27	2	0	0	0	2-370	0	0	0	0
Total.....	.....	12	4-9	8-43	8-3	2-62	2-2	5-1	2-.5	†-†

†This species is very transparent. It may have occurred before July 9 and been overlooked. It also leaves its host readily and swims in the water. Such behavior makes statistical records even more unreliable.

and had the largest number of parasites per individual (Table VII). The latter is probably due in part to opportunities for infection through its food, but is also due to the large number of cysts (Trematode No. 3) present in the fins and skins of two fishes captured in the Rio Castaño, July 27. These two fishes were without any of the seven parasites found in fishes from the lake and the parasites they carried were not found in any other locality.

Curimatus argenteus, Cula

This beautiful fish was not often caught and only seven specimens were examined. Four were without parasites; one carried a *Paraspina bagre* cyst on its dorsal fin; another had forty trematodes in its intestine; and the other had a trematode cyst (No. 2) dorsal to the swim bladder.

Gephyrocharax valenciae, Sardina

Table VI D summarizes the parasites found in this fish. Although it is commonly eaten by other animals, it does not contain an unusual number of immature parasites.

TABLE VI. D. GEPHYROCHARAX VALENCIAE

Locality	Date, July	No. examined	<i>Wallinia valenciae</i>	<i>Paraspina bagre</i> cysts	Cyst No. 7	Intestinal nematodes	<i>Aegathoa lazzari</i>
Rio Bue.....	20	10	0	6-9.8	1-.3	1-.1	0
Maracay.....	24	10	1-.1	0	0	0	1-.1
Total.....	.....	20	1+	6-5	1+	1+	1+

Hoplias malabaricus, Guabina

This is the largest and fiercest predacious fish in Lake Valencia. As one would expect it bears a very large number of parasites per individual and is infected with eight different species. (Table VI E). Every individual examined was infested with encysted nematodes.

TABLE VI. E. HOPLIAS MALABARICUS

Locality	Date, July	No. examined	<i>Clinostomum</i> cyst No. 1	Tapeworm cysts	<i>Quadrigrus torquatus</i>	Intestinal nematodes	Visceral nematodes	Small cysts on caeca	Small cysts on liver	<i>Dolops geayi</i>
Isla del Buro.	9	2	0	0	1-1	0	2-11	2-15	0	1-.5
Isla del Buro.	10	5	0	0	4-2.5	2-.8	5-23	2-5	0	0
Isla del Buro.	11	3	1-.3	0	2-18	1-.7	3-19	0	0	0
Maracay....	22	2	0	0	0	1-.5	2-41	1-1.5	0	1-1
Maracay....	23	8	0	0	1-.3	1-.1	8-26	0	0	8-6
Maracay....	28	3	0	2-4	3-12	1-.7	3-40	1-1.7	2-31	2-6
Total.....	.....	23	1+	2-.3	11-4.3	6-.5	23-29	6-2.7	2-3	12-27

Lebistes reticulatus, Sardina

These little top minnows do not carry many parasites per individual and are infected by only three species (Table VI F).

TABLE VI. F. LEBISTES RETICULATUS

Locality	Date July	No. examined	Trematodes	<i>Clinostomum</i> cysts	Tapeworm cyst No. 5
Isla del Buro..	11	10	1-.1	2-.4	8-4.1
Maracay.....	24	11	0	1-.5	8-4.4
Total.....	.....	21	1+	3-.4	16-4.2

Pimelodella metae, Bagre

Ten of these little catfishes, caught at the mouth of the Rio Bue, July 29, were not heavily parasitized. Two individuals had three adult *Parspina bagre* in their intestines; two others carried three intestinal nematodes.

Rhamdia quelen, Bagre

Three of these catfishes, caught in the Rio Castaño, July 27, carried three species of parasites among the viscera. One had twelve *Clinostomum intermedialis* cysts; two each had two "Cyst No. 8"; one had a nematode cyst.

Symbranchus marmoratus, Anguila

This eel (Table VI G) had few parasites—two encysted among the viscera; an acanthocephalan and a nematode in the intestine.

TABLE VI. G. SYMBRANCHUS MARMORATUS

Locality	Date July	No. examined	<i>Clinostomum intermedialis</i> larvae	Tapeworm cyst No. 4	Intestinal nematodes	<i>Quadrigyus torquatus</i>
Isla del Buro.	9	3	0	0	1-1	1-.3
Isla del Buro.	11	3	0	0	1-.3	1-.7
Isla del Buro.	12	5	1-8	0	0	0
Maracay . . .	25	1	0	1-2	0	0
Total . . . . .	.....	12	1-3.5	1-.1	2-.4	2-2.5

Phalacrocorax vigua, Cortua (Cormorant)

A single cormorant was examined near Maracay, July 20. There were fifty-seven trematodes (*Clinostomum intermedialis*) in its esophagus, and fifty nematodes in its stomach.

Caiman sclerops, Bava

Four caimans were shot near Maracay and examined for parasites, July 22, 23. Two were infected with a total of thirty-four nematodes in the base of the aorta; three had a total of four nematodes in the wall of the trachea.

GENERAL REMARKS ON PARASITES

Fourteen of the twenty-five parasites found in fishes were confined to a single host. This may be taken to indicate that the fish fauna of the lake is rather recent or that the parasites have a high degree of host specificity, but the knowledge is too limited to generalize in this connection.

The fishes with the greatest infection by parasites are as follows:

1. According to total number of fishes infected: *Creagrutus beni*, *Chaetostomus pearsei*, *Rhamdia quelen*, *Hoplias malabaricus*, *Crenicichla geayi*.

2. According to average number of parasites per individual: *Crenicichla geayi*, *Hoplias malabaricus*, *Aquidens pulcher*, *Creagrutus beni*, *Astyanax bimaculatus*.

3. According to number of species of parasites: *Astyanax bimaculatus*, *Aquidens pulcher*, *Hoplias malabaricus*, *Crenicichla geayi*, *Gephyrocharax valenciae*.

Fishes having the fewest parasites were as follows:

1. According to total number of fishes infected: *Gephyrocharax valenciae*, *Symbranchus marmoratus*, *Curimatus argenteus*, *Pimelodella metae*, *Aquidens pulcher*.

2. According to average number of parasites per individual: *Pimelodella metae*, *Astyanax metae*, *Lebistes reticulatus*, *Gephyrocharax valenciae*, *Chaetostomus pearsei*.

3. According to number of species of parasites: *Astyanax metae*, *Chaetostomus pearsei*, *Pimelodella metae*, *Creagrutus beni*, *Rhamdia quelen*, *Lebistes reticulatus*, *Curimatus argenteus*.

In general the fishes with the most restricted habitat have a high number of individuals infected, but carry few species of parasites and have a small average number of parasites per individual. The most abundant fishes, which have a variety of food, including other fishes, and a wide range in habitats, generally have the most parasites in all respects. There are three

exceptions in one class to the last statement: *Gephyrocharax valenciae*, *Symbranchus marmoratus*, and *Aquidens pulcher* all have a large number of parasites per individual and are infected with a large number of species of parasites, but few individual fishes are infected.

All things considered the fishes showing the highest parasitic infection rank in the following order: (1) *Aquidens pulcher*; (2) *Astyanax bimaculatus* and *Crenicichla geayi*; (4) *Symbranchus marmoratus*, *Curimatus argenteus*, *Hoplias malabaricus*, *Gephyrocharax valenciae*. It will be noted that those toward the end of the list generally have the diet restricted to fewer items (Table V) than those at the beginning. This, with the results presented in the last paragraph, may indicate that a restricted diet is associated with a smaller percentage of infected fishes. In other words, the fewer kinds of food a fish eats, the less likely it is to be infected with parasites.

TABLE VII

Parasitic infection of fishes of Lake Valencia. The figures refer to number of fishes infected and where there are two, the second is per cent.

Species of fish	No. examined	No. species parasites*	No. possible infections	No. fishes infected	Skin and fins	Viscera	Enteron	Total of average infections per individual
<i>Aquidens pulcher</i> ..	22	8	176	41(23)	1(.6)	19(11)	21(12)	32.9
<i>Astyanax bimaculatus</i>	15	9	135	35(26)	3(2)	19(14)	13(9)	11.1
<i>Astyanax metae</i> ...	4	1	4	1(25)	0	1(25)	0	3.5
<i>Chaetostomus pearsei</i>	10	1	10	5(50)	0	0	5(50)	5.8
<i>Creagrutus beni</i> ...	10	2	20	11(55)	9(45)	0	2(10)	12.2
<i>Crenicichla geayi</i> ..	12	8	96	31(32)	6(6)	15(16)	12(13)	111.5
<i>Curimatus argenteus</i>	7	3	21	3(14)	1(5)	1(5)	1(5)	6.2
<i>Gephyrocharax valenciae</i>	20	5	100	10(10)	7(7)	1(1)	2(2)	5
<i>Hoplias malabaricus</i>	23	8	184	63(34)	12(6)	34(19)	17(9)	42.5
<i>Lebistes reticulatus</i> ..	21	3	63	20(30)	0	19(29)	1(2)	4.6
<i>Pimelodella metae</i> ..	10	2	20	4(20)	2(10)	0	2(10)	.6
<i>Rhamdia quelen</i> ...	3	3	9	4(47)	0	4(47)	0	9.3
<i>Symbranchus marmoratus</i>	12	4	48	6(12)	0	2(4)	4(8)	6.5
Total.....	169	57	886	234(29)	39(6)	115(13)	80(10)	.....

* Numbers in this column mean number of species of parasites occurring in each species of fish.

Tables VII and VIII show infection of various parts of the body in relation to habitats. Intestinal parasites appear to enter most often fishes frequenting the mouths and courses of rivers. Visceral parasites are most common in fishes from rivers and muddy lake bottoms.

TABLE VIII

Infection of fishes of all species by habitats. Isla del Buro has rocky pebbly and sandy shores; the lake shore at Maracay is very muddy and grown up with rushes and other water plants; the river mouth is like the shore at Maracay; the Rio Castaño has sandy and rocky bottoms. The second number in a column is per cent. Figures represent actual, not computed, totals for each habitat.

Locality	No. exam-ined	No. species para-sites*	No. possible infec-tions	No. infec-tions	Skin and fins	Viscera	Enteron
Isla del Buro.	71	31	313	130(45)	16(5)	64(22)	50(16)
Maracay....	46	20	191	66(36)	13(7)	38(20)	15(8)
River mouth.	33	16	97	26(27)	10(10)	6(6)	10(10)
Rio Castaño.	19	6	25	12(48)	0	7(28)	5(20)
Total.....	169	73	626	234(38)	39(6)	115(19)	80(12)

*Numbers in this column obtained by adding kinds of parasites occurring for each species of fish in each locality.

The fins and skin are not often infected in river fishes; in fact, such parasites are infrequent in other habitats. The visceral parasites are more common than those in the intestine—probably because they are usually more or less permanent residents of a fish, whereas the enteric parasites usually pass out after a time.

CONCLUSIONS

Lake Valencia is a large lake which presents typical conditions for the tropics. It becomes stratified during the summer in relation to temperature and gaseous content. However, the deep water contains sufficient oxygen for fishes and there is considerable food present there. Its plankton is not abundant.

The most fishes occur in shallow, littoral habitats. There are no very large fishes in the lake and the number of fishes present, as judged by the catch per hour in gill nets, is not as great as in certain lakes in Wisconsin, which the writer has investigated by methods like those used in studying this lake. There is some evidence that the majority of the fishes were originally inhabitants of rivers. In general the wide ranging species feed on ubiquitous foods and are able to invade a number of habitats. The foods eaten by the fishes in Lake Valencia are, in the order of their importance: mud, immature insects, plants, molluscs, fishes, adult insects, entomostracans, oligochaetes, mites, and rotifers. The bottom and the aquatic vegetation furnish most of the food and plankton is of little importance.

About twenty-three species of parasites occur in Valencian fishes. In general the species of fishes which have the greatest variety of habitats and foods are most infected. River fishes have fewer parasites than those in the lake.

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