

## ABSTRACT

Susan Becht Greene. A STUDY OF THE LIFE HISTORY OF THE PIRATE PERCH APHREDODERUS SAYANUS (GILLIAMS).

(Under the direction of Joseph G. Boyette) Department of Biology, 1970.

The purpose of this study was to determine several factors in the life history of pirate perch, Aphredoderus sayanus, primarily the habitat and local distribution, food habits, and interspecific and intraspecific interactions such as territoriality and predation. The threefold approach consisted of field collections, laboratory analyses, and observations under semi-natural conditions.

Records of physical and chemical characteristics of each site and of species collected were completed for each site sampled on 130 collection trips in Pitt County, North Carolina. Although pirate perch were collected in almost all habitats sampled, the largest populations were found in swamps and swamp-drainage streams. Young juveniles were found in shallow, heavily vegetated water with abundant bottom fauna. Older juveniles and adults were usually collected under banks in shallow water with little current.

Data compiled from gut analyses indicated that young juveniles fed mostly on small Crustacea and were active throughout the day. Older juveniles fed mostly on larger Crustacea, insect larvae, and small fish and tended to

concentrate feeding activity in early morning and late afternoon. Adults fed mostly in early morning on small fish and insect larvae.

Field data indicated a spawning period of March to June.

Aquaria were arranged to simulate natural conditions by the addition of sand, mud, native vegetation, and debris. Pirate perch, along with other species usually caught with them, were placed in the aquaria for behavioral observation. Except for predation, very little reaction toward other species was demonstrated by pirate perch in aquaria. However, the fact that the fish failed to regain their natural irridescence in aquaria indicated that natural conditions were not closely enough approximated. This failure could have affected all behaviors observed in aquaria.

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A STUDY OF THE LIFE HISTORY OF THE  
PIRATE PERCH  
APHREDODERUS SAYANUS (GILLIAMS)

A Thesis  
Presented to  
the Faculty of the Department of Biology  
East Carolina University

In Partial Fulfillment  
of the Requirements for the Degree  
Master of Arts in Biology

by  
Susan Becht Greene

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## INTRODUCTION

The purpose of this study was to determine several factors in the life history of pirate perch, Aphredoderus sayanus (Gilliams), primarily the habitat and local distribution, food habits, and interspecific and intraspecific interactions such as territoriality and predation. The threefold approach consisted of field collections, laboratory analyses, and observations under semi-natural conditions.

General ecological studies are valuable because they provide bases for preliminary hypotheses for more specific study as well as contributing to the general fund of scientific knowledge. In ichthyology, knowledge of the habits of any but some commercial and game species is practically nonexistent.

The pirate perch was the subject of this study. The family Aphredoderidae is monotypic, represented only by the species, Aphredoderus sayanus. Although it is one of the most common species in eastern North Carolina and widespread in the United States, particularly east of the Mississippi River, little scientific research had been done on its life history and ecology.

During this year of study, approximately 500 pirate perch were captured in eastern North Carolina. Many of these were immediately released, but approximately 200 were preserved or placed in aquaria for further observation, the

number of individuals in aquaria averaging 25 to 30 throughout the study.

## REVIEW OF LITERATURE

There has been little scientific research published on pirate perch. Except for taxonomic descriptions, primarily by Eddy (1957), the only previous behavioral observations of this species were published in a short note by Abbott (1861) and in a paragraph by Sterba (1963). Abbott observed that pirate perch schooled in spring, generally paired in summer and autumn, and buried themselves in sand during winter. He also noted that they were carnivorous and nocturnal. Although he did not observe spawning, he hypothesized that pirate perch guarded the ova and young. Sterba described requirements for pirate perch as well-aerated, cool water and living food.

## MATERIALS AND METHODS

The 130 separate collections of pirate perch and other fish were made using seines, dip nets and plankton tow nets. Collecting was done in Pitt County at sites selected to represent available types of aquatic habitat--large coastal river, creeks, brooks, swamps, and ponds. Collection trips were made into nine other eastern North Carolina counties: Jones, Onslow, Pamlico, Craven, Lenior, Greene, Wilson, Beaufort, and Edgecombe. Detailed data sheets were completed for each site, noting temperatures, water depth, current flow, pH, dissolved oxygen concentration, vegetation, and bottom composition (Fig. 1). These observations yielded information concerning local distribution of the species and habitat.

Over 1000 pirate perch were taken in the study. Approximately 100 of these fish, representative of sizes collected, were preserved in 10% formalin (with note of time and place of capture) and another 100 were placed in aquaria for behavioral observation.

Gut analysis was performed by a combined frequency of occurrence and volumetric method on 100 fish of various sizes, yielding data on items eaten by each size of pirate perch and on the time of day of feeding activity.

Certain behaviors were observed under semi-natural conditions. To simulate natural conditions, aquaria from 10

## COLLECTION DATA

No \_\_\_\_\_

Location \_\_\_\_\_

Drainage \_\_\_\_\_ Water Color \_\_\_\_\_ Turbidity \_\_\_\_\_

Depth \_\_\_\_\_ Width \_\_\_\_\_ Current \_\_\_\_\_

pH \_\_\_\_\_ Dissolved O<sub>2</sub> \_\_\_\_\_ Bottom \_\_\_\_\_ Vegetation \_\_\_\_\_

\_\_\_\_\_

Temperature: Water \_\_\_\_\_ °C Air \_\_\_\_\_ °C Date \_\_\_\_\_ Time \_\_\_\_\_

Method of Collection \_\_\_\_\_

\_\_\_\_\_

Figure 1. Sample Collection Data Form

to 55 gallons were filled to a depth of one to four inches with sand and mud, planted with native aquatic vegetation, and arranged with selected debris (Fig. 2). These aquaria were arranged in a cabinet equipped with light timing devices and were supplied with pumps, filters, and air stones as diagramed in Fig. 3. Usually lights were set on a twelve-hour-on and twelve-hour-off cycle; incandescent and fluorescent sources were used in clear, frosted, red or blue, and varying in wattage from 15 to 150. This observation center was constructed and maintained in my home.

Pirate perch of various sizes were placed in aquaria along with other species commonly found with them in collections. Aquatic invertebrates were added to the aquaria, and this food supplemented with earthworms, ants, tadpoles, frog eggs, and canned fish roe.

Careful notes were made of feeding habits, evidence of territoriality, aggressive behavior, times of activity, and intra- and interspecific interactions. The number of pirate perch under observation in aquaria averaged 25 to 30 during the study.

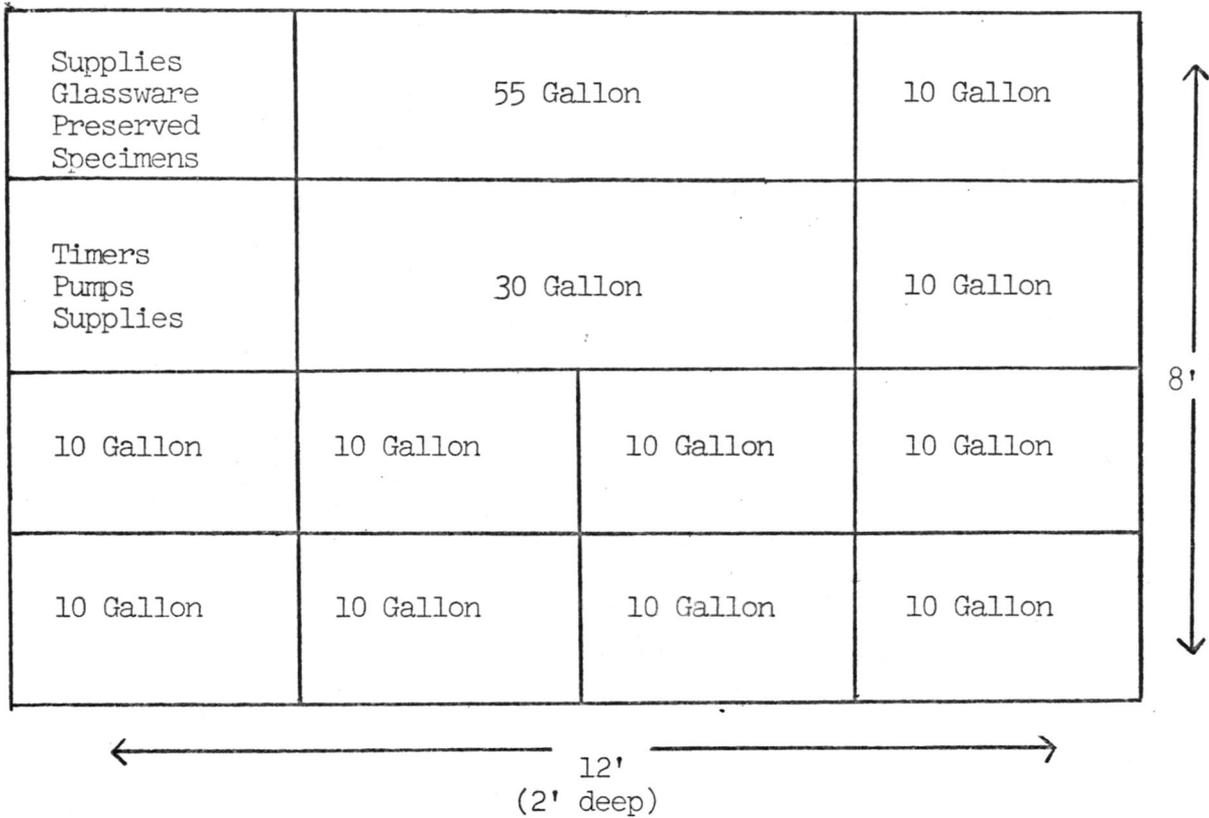


Figure 2. Observation Center (front view)

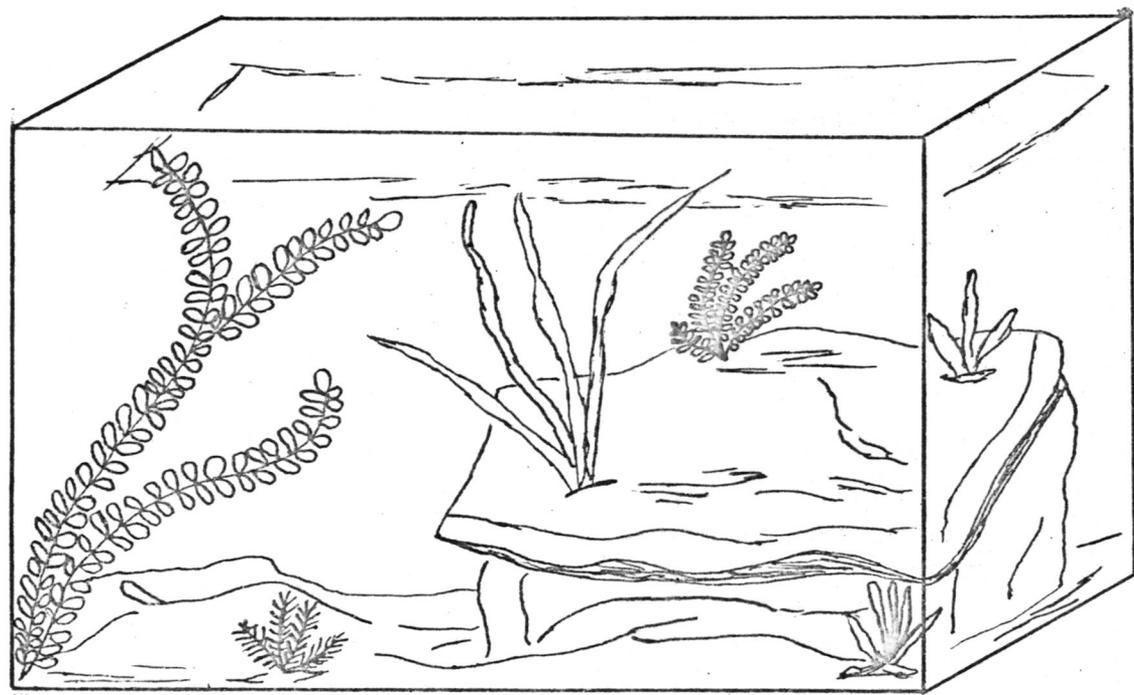


Figure 3. Typical Aquarium Set-Up

## RESULTS

### Growth

Although no yolk-sac larvae were collected, a single specimen appearing to be an older larval form was secured with a plankton net (Fig. 4). The eye was quite large and the depth of body in proportion to length was greater than in other juvenile forms observed. The coloration of the larva was light tan with distinct microscopic melanophores dark brown to black. It lacked the irridescence and dark tail bar seen in older juveniles and adults. However, fin rays were formed. There is a graduation from larval to juvenile form, and the decision to consider this specimen larval was based on comments by Mansueti and Hardy (1967) on development of fin rays and chromatophores, and general body form.

In contrast, the early juvenile form showed brilliant blue and violet irridescence on the lateral and ventral body and dark brown or black dorsal body, tail, and fins. The eye was less prominent, and the tail bar just anterior to the caudal fin was distinct (Fig. 5).

Coloration described for juveniles persisted in adults, being especially brilliant in spring and summer.

One unusual characteristic of pirate perch growth was anal migration. The anus migrated from a nearly mid-ventral position in the juvenile to a jugular position



Figure 4. Larva of Aphredoderus sayanus

Drawn from a specimen measuring 0.8 cm standard length and 0.9 cm total length, under 40X magnification

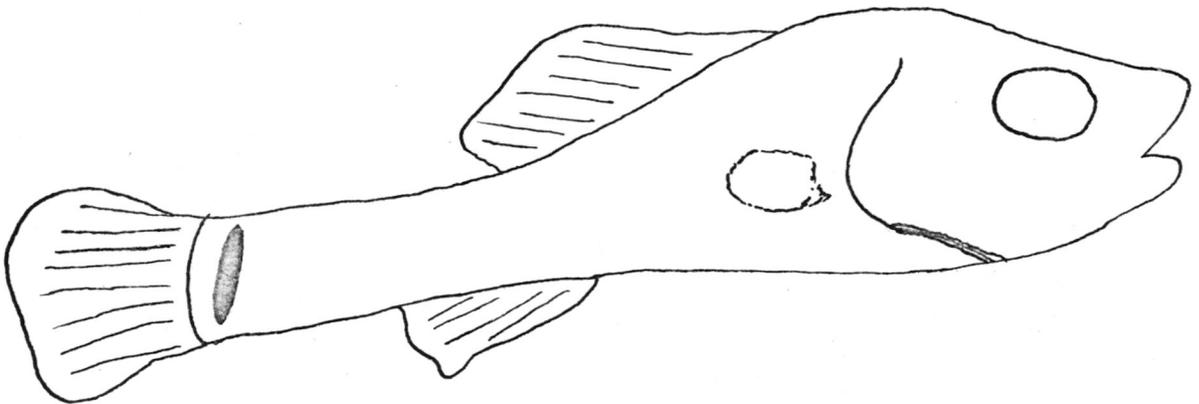


Figure 5. Early Juvenile of Aphredoderus sayanus

Drawn from a specimen measuring 1.0 cm standard length and 1.1 cm total length, under 10X magnification

in the adult (Table I). This migration was accompanied by looping of the intestine over and in front of the stomach.

Sexual maturity as indicated by gonadal development coincides with the attainment of a total length of approximately seven centimeters. Unless a fish is obviously gravid, it is extremely difficult to distinguish the sex without dissection. The male of a pair is usually somewhat larger than the female.

#### Habitat

Table II summarizes data obtained from eight major collection sites in Pitt County. Although pirate perch were taken in almost all habitats except in extremely brackish coastal waters, the largest populations were found in swamps and swamp-drainage streams. Young juveniles were always found in shallow (less than six inch) water in thick vegetation. Almost invariably, older juveniles and adults were collected near the bank, usually under it, and in or behind overhanging vegetation. Water was less than three feet deep with very slow current, if any. Pirate perch never were collected in the main current flow.

#### Food and Feeding

Data presented in Table III summarize results of gut analyses of 90 fish collected in late spring and summer of 1968.

TABLE I.

Percent Length from Nose to Anus in Aphredoderus sayanus

Stage	Length From Nose to Anus in Cm	Mean %	Sample Size
early juvenile	0.4 - 1.2	37	35
late juvenile	1.1 - 1.8	33	40
adult	1.8 - 2.0	23	25

TABLE II.

## Summary of Collection Data of Eight Major Sites

Location	Description	Species Commonly Collected
Creek crossing N.C. Hwy 43 at a bridge at the Pitt-Craven Co. line 5 miles west of Vanceboro; part of Creeping Swamp	In dry weather, area under bridge consisted of pool 100 x 20 yds more or less isolated from rest of swamp. During rainy seasons there was an overflow primarily southwest into swamp which ended in a large pool 1/2 mile away. There was also an influx of water from swamp to the north. Deepest water was in channel under bridge, being 4' in dry seasons and 6' to 8' after a rain. Water was stained brown and had average pH of 5.0. Emergent and bank vegetation was heavy.	<u>Aphredoderus sayanus</u> <u>Anguilla rostrata</u> <u>Umbra pygmaea</u> <u>Gambusia affinis</u> <u>Esox niger</u> <u>Esox americanus</u> <u>Chologaster cornuta</u> <u>Ictalurus nebulosus</u>
Creek crossing N.C. Hwy 43 3 miles west of Vanceboro, Craven Co., N.C.	Swamp creek, brown water color slow current, deep at bridge but shallow up and down stream, light vegetation concentrated on edges and banks	<u>Aphredoderus sayanus</u> <u>Anguilla rostrata</u> <u>Gambusia affinis</u> <u>Esox niger</u> <u>Esox americanus</u> <u>Chologaster cornuta</u>

Table II. Cont.

Location	Description	Species Commonly Collected
Johnson's Mill Run at bridge on Pitt Co. road #1401, east of Sally Branch Community and adjacent to J.L. Stokes' store	Fast-moving, clear water stream with sandy bottom, undercut banks, many pools and eddys which supported many fish; average pH 6.5; heavy vegetation on overhanging banks. Current rate 1 1/2 to 2 mph; depth under 2' but reached 4' in channel	<u>Lepomis</u> sp. <u>Aphredoderus sayanus</u> <u>Ictalurus nebulosus</u> <u>Gambusia affinis</u> <u>Noturus insignis</u> <u>Moxostoma conus</u> <u>Etheostoma nigrum</u>
Tar River at the Wildlife Access Area, Pitt Co., adjacent to Greenville airport	Large coastal plain river, moderate current, depth varied with rainfall, undercut banks and sandbars, water generally muddy, pH 7.0	<u>Notropis</u> sp. <u>Esox americanus</u>
Stream crossing Pitt Co. road #1120 2 miles west of Winterville, N.C.	Clear water, sandy bottom with many sand bars, heavy vegetation emergent and on banks, depth to 1 1/2' and moderate current	<u>Notropis altipinnis</u> <u>Notropis hypselopterus</u> <u>Aphredoderus sayanus</u>
Stream crossing Pitt Co. road #1403 135 yds. east of W.R. Stokes residence, Rt. 4, Greenville, N.C.	Farm irrigation stream with silt and sand bottom and average depth of 1' with deeper pools, average pH 6.5, heavily shaded, moderate current, undercut banks	<u>Aphredoderus sayanus</u> <u>Gambusia affinis</u> <u>Lepomis</u> sp. <u>Noturus insignis</u>

Table II. Cont.

Location	Description	Species Commonly Collected
Sand Pits pond behind Greenville airport and adjacent to Tar River Wildlife Access Area	Pond which resulted from sand dredging operations, depth average 2' with some pools to 7', no current, water stagnant, heavy layer of silt and mud on bottom with some sand bars, heavy floating and emergent vegetation	<u>Gambusia affinis</u> <u>Fundulus notti</u> <u>Lepomis</u> sp. <u>Esox</u> sp. <u>Aphrododerus sayanus</u>
Short Bridge over Tyson Creek 1.5 miles northwest of Falkland on Pitt Co. road #1250.	Water level and stream flow varied greatly, water color light amber, depth 2' to 5', bottom of sand and silt, vegetation heavy along edges, pH 6.5	<u>Aphredoderus sayanus</u> <u>Centrarchus macropterus</u> <u>Esox</u> sp. <u>Notemigonus crysoleucas</u>

TABLE III.

Food and Feeding Habits of Aphredoderus sayanus

	Larva	Early Juvenile	Late Juvenile	Adult			
Total Length	to 1 cm	1 - 3 cm	3 - 7 cm	over 7 cm			
Food	unknown	<u>Item</u>	<u>% by No.</u>	<u>Item</u>	<u>% by No.</u>	<u>Item</u>	<u>% by No.</u>
		Isopods	10	Decapods	15	Fish	45
		Cladocerans	52	Amphipods	21	Insect larvae	38
		Copepods	18	Isopods	5	Amphipods	7
		Insect larvae	14	Insect larvae	39	Decapods	5
		Other	6	Fish	13	Other	5
				Other	7		
Time of Feeding	unknown	<u>Time Captured</u>	<u>%*</u>	<u>Time Captured</u>	<u>%</u>	<u>Time Captured</u>	<u>%</u>
		Before 9 AM	60	Before 9 AM	65	Before 9 AM	75
		9 - 5 PM	31	9 - 5 PM	12	9 - 5 PM	15
		After 5 PM	70	After 5 PM	45	After 5 PM	32

\*% = percent of fish of each size classification caught during each period having whole or mostly whole food item in stomach.

Feeding was observed over 150 times in aquaria. The principal foods eaten were amphipods, freshwater shrimp, earthworms, mayfly and dragonfly larvae, Gambusia affinis, and smaller pirate perch.

#### Population Dynamics

Exact data on population density were not obtained due to the method of sampling. However, certain generalizations may be made from the collection data obtained.

Gravid females were caught from late February to June, but most often in March and April. Larvae and young juveniles were taken from May 15 to July 15, indicating a spawning period from March to June. The young juveniles were found in shoals in loose schools of 100 to 200 fish. Older juveniles were found singly or sometimes near a younger juvenile school in slightly deeper water. Adult fish were not caught in association with schooling juveniles, although older juveniles and adults were often caught together.

#### Intraspecific Interactions

Some aspects of intraspecific behavior were mentioned above. Each age was distinct with respect to times of activity. The young juveniles were not nocturnal in habit, but moved about aquaria freely in light periods, keeping near the surface except when feeding at the bottom. Older juveniles and adults were mostly nocturnal; during light

periods they generally aggregated in corners or under stones or branches in the postures represented (Fig. 6).

The pirate perch showed no evidence of territoriality in aquaria. However, it is possible that in nature territory was established during the mating season, since pairing was evident in the field. When pairs were placed in aquaria they did not show sexual activity, but behaved as the adults described above. This behavior indicated a failure to simulate natural conditions in aquaria.

Aggressive behavior was demonstrated only at feeding, when pursuit and occasional tail-nipping occurred, although no serious injury was observed.

#### Interspecific Interactions

In the field, certain species were often caught with pirate perch in the same net sweep, with swampfish, Chologaster cornuta, being most common (Table II.). Juvenile swampfish were very often caught with pirate perch of the same size, and swampfish were commonly eaten by adult pirate perch. Other prey species were mudminnow, Umbra pygmaea, small eels, Anguilla rostrata, several cyprinids (minnows), and numerous invertebrates (Table III.). There was no direct evidence that pirate perch were preyed upon by other species, but pickerel (Esox niger and E. americanus) and other carnivorous species were usually abundant in the same waters that harbored pirate perch.

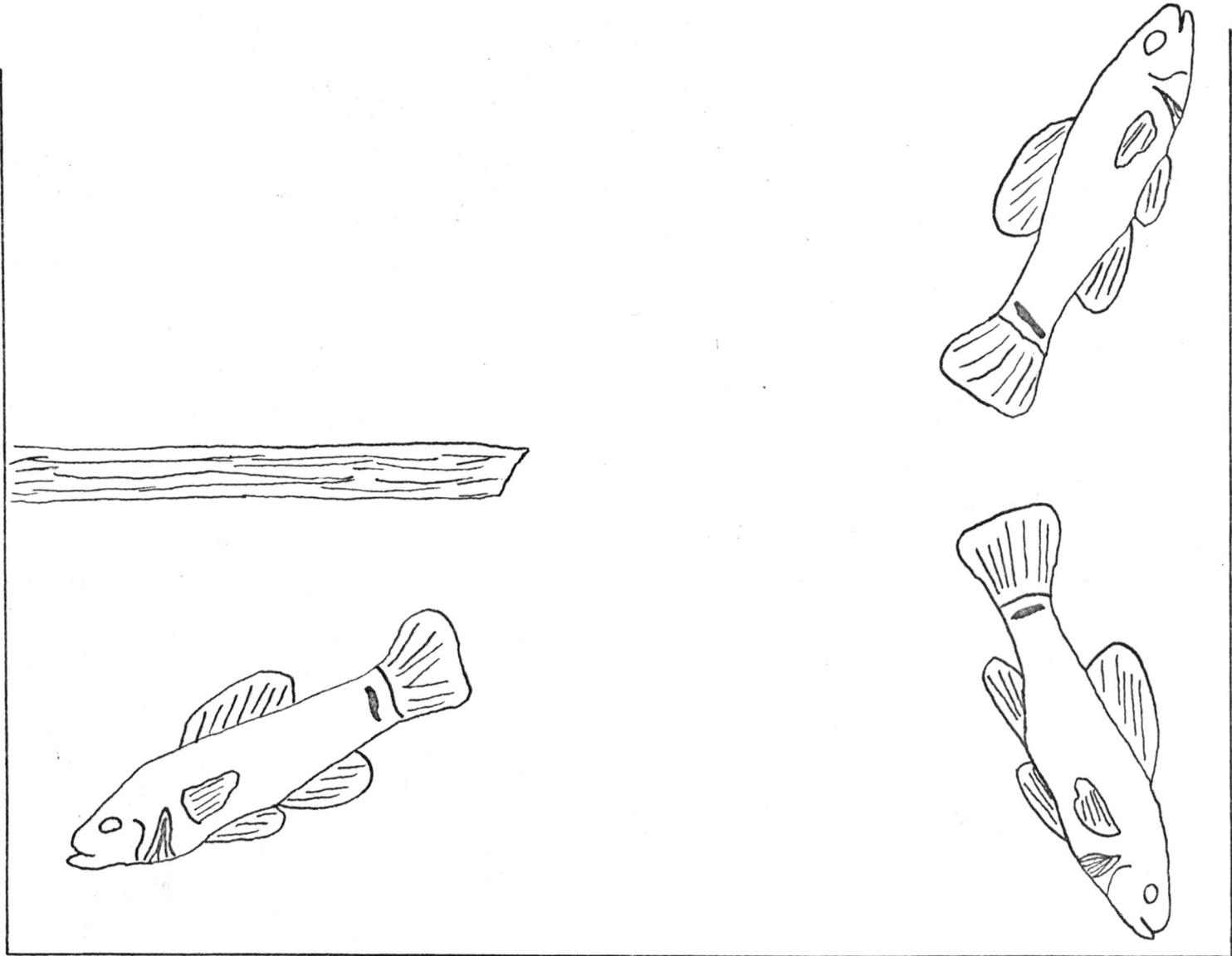


Figure 6. Orientation Postures of Aphredoderus sayanus

## DISCUSSION

### Growth

Evidence suggested change in coloration from the larval to juvenile stage, with a brilliant blue and violet irridescence developing along with a darkening of the whole body. The tail bar anterior to the caudal fin became distinct in this transition.

Of the species collected in this study, anal migration was unique to pirate perch and swampfish, two species with similar habitats. However, the adaptive value of the jugular anus was not clear.

Sexual maturity was probably reached during the second or third year of age, at an approximate total length of seven centimeters. However, there were no external sex-distinguishing characteristics. During spring and summer, the irridescence of the adults was brilliant in the wild, although they did not retain this coloration after being placed in aquaria, where they became muddy black or brown. This coloring indicated a failure to simulate natural conditions in aquaria although native vegetation, debris, bottom material, and water were used.

### Habitat

The largest populations of pirate perch were found in swamps and swamp-drainage systems, although the fish were

almost ubiquitous in eastern North Carolina. Pirate perch were collected in all natural waters which were sampled in Pitt County with the exception of the Tar River. However, its tributaries generally supported large numbers. According to stream survey reports of the North Carolina Wildlife Resources Commission, pirate perch do live in the Tar, although not in large numbers (Smith and Bayless, 1964).

Swamps and swamp-drainage streams generally had an acid pH of approximately 5.0, stained and shallow water, and mucky bottoms heavily littered with leaves and other debris. In these places there was abundant bottom fauna--amphipods, insect larvae, freshwater shrimp, crayfish--as well as the young of other fish species, particularly swampfish, Chologaster cornuta. These swamp streams supported many pirate perch, most of which were caught near and under the banks in shallow water. Some fish, particularly adults, seemed to be buried in the mud, especially in the extreme temperatures of midsummer and winter.

In May, 1969, a larva was collected in a plankton sample in a rain-swollen creek. Although it was taken in the upper waters and in rather strong current, it was doubtful that this was the usual location. More probably, it was swept from shallow, quiet water by the current. The youngest juveniles were always taken in quiet, shallow, heavily vegetated water.

Clear water streams with sandy bottoms and slightly

acid pH were also characteristic of Pitt County. They were generally shallow with heavy bank vegetation and slow to moderate current. Many of these streams were used in farm irrigation and were tributaries of the Tar River. These streams supported many pirate perch, commonly under banks behind overhanging vegetation.

Ponds in Pitt County did not support large pirate perch populations, as far as could be determined, although a few fish were secured near the banks of almost every pond sampled.

Although pirate perch had a wide local distribution, certain common factors of habitat seemed apparent. Young juveniles were always collected in shallow, heavily vegetated water where abundant bottom fauna was present. Older juveniles were caught under banks in shallow water with little current. The pH range as found in Pitt County did not appear to be a limiting factor, but the combination of abundant small food and shelter of overhanging banks in sluggish, shallow waters seemed important habitat factors.

#### Food and Feeding

Food and feeding habits of larvae could not be determined from the small number collected. Young juveniles fed mostly on small Crustacea and were not nocturnal, often feeding in the middle of the day. Older juveniles tended to feed more often in early morning and late afternoon and

generally fed on larger animals--larger Crustacea, insect larvae, and small fish. Adults fed mostly in early morning and probably through the night. Small fish and insect larvae were their major food items.

In aquaria pirate perch most often ate amphipods, freshwater shrimp, insect larvae, earthworms, and small fish, especially topminnows, swamp fish, and pirate perch.

When food items were introduced into aquaria, differences in individual aggressiveness were observed. Some fish would pursue a worm held in submerged forceps; others would attack only while it floated down or gyrated on the bottom; and others would feed only after other fish were feeding. Larger fish often took food away from smaller fish. Several times two fish of equal size consumed one worm, working from opposite ends. When lunging at a fast-moving object, the fish often missed, bumping the bottom or sides of aquaria.

After the prey was captured, fish sank to the bottom and consumed it. A half-hour or longer was required for a large worm to be totally ingested. If the food item was small, several might be consumed in quick succession. Small fish were usually eaten head-first and captured in a quick rush from concealment. Some apparent disoriented feeding was observed in which fish seemed to have difficulty capturing prey in quick rushes, often missing the prey entirely. This difficulty may have been due to reflections on aquaria glass.

### Population Dynamics

The spawning period extended from March to June, with most gravid females caught in March and April. Although spawning was not observed, it was not likely that the ova and young were guarded, as Abbott (1861) suggested. Young juveniles schooled in very shallow water, and adults were never caught in association with them. Adults did predate on the younger fish, however.

In winter, pirate perch were usually caught singly, not aggregated. In spring, beginning in late March and April, adults were often found in pairs. Five pairs were caught in a fifty-foot section of one narrow stream. Later, beginning in June, the fish aggregated in deeper water, especially when low water conditions prevailed. Twenty-five large adults were collected in one swamp pool in July, 1968.

### Intraspecific Interactions

Pirate perch in aquaria showed no evidence of territoriality, and, although pairing was evident in the field during the mating season, it was not duplicated in aquaria.

Young juveniles in aquaria moved about freely in the light, while older fish generally aggregated under debris or in corners. However, all ages and sizes would feed during light periods when food was offered. The only basic intraspecific interaction noted in aquaria was predation.

### Interspecific Interactions

Common prey species of larger pirate perch included swampfish, mudminnow, eel, and several species of minnows, in addition to numerous invertebrates (see Table III.). Pirate perch were probably prey to other larger carnivorous species, such as pickerel and large eels.

In aquaria, large mudminnows often assumed a tilted orientation like that described for pirate perch, and the two species often crowded together in corners with no apparent antagonism. In aquaria swampfish usually buried themselves in the bottom sand and mud. Except for predation, very little reaction toward other species was demonstrated by pirate perch in aquaria.

## SUMMARY

1. Field studies were concentrated in Pitt County, in eastern North Carolina. Laboratory analyses and observations under semi-natural conditions were also used in this study.

2. The larval form showed light tan coloration which developed into the dark body with blue and violet irridescence characteristic of juveniles and adults.

3. The anus migrates from a nearly mid-ventral position in juveniles to a jugular position in adults.

4. Although pirate perch were collected in almost all habitats sampled, largest populations were found in swamps and swamp-drainage streams. Young juveniles were found in shallow, heavily vegetated water with abundant bottom fauna. Older juveniles and adults were usually collected under banks in shallow water with little current.

5. Young juveniles fed mostly on small Crustacea and were active throughout the day. Older juveniles fed mostly on larger Crustacea, insect larvae, and small fish and tended to concentrate feeding activity in early morning and late afternoon. Adults fed mostly in early morning on small fish and insect larvae.

6. March to June was the spawning period. Young juveniles schooled in shallow water and were preyed upon by adults.

7. In spring adults were often collected in pairs. In summer and autumn they tended to aggregate, but in winter they were usually collected singly.

8. Failure to simulate natural conditions in aquaria was indicated by the lack of reproductive activity and by failure to regain natural iridescence.

9. Pairing was evident in the field during mating season, but no territoriality was shown in aquaria.

10. Except for predation, very little interaction with other species was demonstrated by pirate perch in aquaria.

#### LITERATURE CITED

- Abbott, C. C. 1861. Notes on the habitats of Aphredoderus sayanus. Proc. Acad. Nat. Sci. Phil., 1861: 95-96.
- Eddy, Samuel. 1957. How to know the freshwater fishes. W. C. Brown Co., Dubuque, Iowa.
- Mansuetti, Alice J. and Jerry D. Hardy, Jr. 1967. Development of fishes of the Chesapeake Bay Region; an atlas of egg, larval, and juvenile stages. Pt. I. Earl E. Deubler, Jr. (ed.) Port City Press, Baltimore.
- Smith, William B. and Jack Bayless. 1964. Survey and Classification of the Tar River and Tributaries, North Carolina. North Carolina Wildlife Resources Commission, Raleigh, N. C.
- Sterba, Gunther. 1963. Freshwater fishes of the world. (Transl. from German) The Viking Press, New York.