

BEHAVIOR OF THE LONGEAR SUNFISH, *LEPOMIS MEGALOTIS* (RAFINESQUE)

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and

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ABSTRACT

Longear sunfish, *Lepomis megalotis* (Rafinesque) consistently exhibit aggressive behavior when placed in small aquaria in the laboratory. Apparently there is less aggressive behavior in wild populations in their natural Louisiana stream environments. Of the many longear sunfish collected from their natural habitat, few had any fin damage and none had extensive fin damage or body scars. A comparison of field observations with laboratory experiments showed that aggressive behavior in the longear sunfish increases markedly due to laboratory conditions, especially when the fish are confined to smaller areas, or volumes, than they normally occupy in nature.

Field experiments and observations are included for year-to-year occupancy of home range, spawning in the home range, reproductive behavior, feeding behavior, and aggressive behavior, as well as laboratory work on aggressive behavior.

INTRODUCTION

The longear sunfish (*Lepomis megalotis*) is a member of the exclusively North American freshwater family Centrarchidae. The species ranges from Minnesota east to Ontario, Ohio, and western Pennsylvania southward through the Mississippi Basin to the Gulf states and Mexico (Blair *et al.*,

1957) and east to the Apalachicola River (Dr. R. D. Suttkus, personal communication). The longear sunfish treated here is the southern subspecies (*Lepomis megalotis megalotis*).

Data on the behavior of the longear sunfish are limited. Kirsch (1895) reported longear sunfish on spawning beds in northern Indiana during July. Hankinson (1919) stated that the breeding season for the longear sunfish in Illinois dates from May 25 to June 17 in streams and from July to as late as August 23 in ponds. He also reported that longear sunfish appear to nest in small colonies. The nest of the longear sunfish has been described by Hubbs and Cooper (1935). They also give data on age and growth and report that male longear sunfish grow faster than females. Witt and Marzolf (1954) described one incident of spawning of the longear sunfish. The home range of the longear sunfish and the phenomenon of homing have been defined and discussed by Gerking (1950, 1953), Gunning (1959), and Gunning and Shoop (1963).

Miller (1963) investigated the behavior of the pumpkinseed and the orangespotted sunfish kept in aquaria. She found the behavior of the two species to be similar and compared their behavior with that of other species of *Lepomis*. In comparing the pumpkinseed (*L. gibbosus*) to other *Lepomis*, Miller found that paired pumpkinseeds were not aggressive in a 50-gallon tank but that it was not possible to maintain more than one individual *L. megalotis* or *L. auritus* in

¹ Part of a dissertation submitted in partial fulfillment of the requirements for the Ph.D. degree in Zoology at Tulane University, April, 1965.

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the same size tank because one individual would become dominant and attack the others until they died.

Tinbergen (1953) stated that most inter-specific fighting is done in the breeding season and appears as a consequence of gonadal growth, which in its turn, through the pituitary gland, depends on rhythmic factors such as day-lengthening in the case of many animals of the north temperate zone. Some fighting is related to the dominance relationship in the group and is not linked with the breeding season. Greenberg (1947) studied social hierarchy in the green sunfish and found that immature green sunfish maintain hierarchies, territories, or both in small aquaria. Considering that Greenberg did not make field observations, we propose that it is possible that his observations were merely artifacts resulting from laboratory conditions.

METHODS

The field experiments and observations were conducted on Warner Creek, a gravel-bottomed creek near Enon in Washington Parish, Louisiana. The water was clear except after rains; therefore, the creek was excellent for field observations. The width of the stream in the area studied ranged from 1.8 to 4.8 meters. The study area was divided as follows: Section A (upstream), 23.5 m; Section B (middle), 35.4 m; and Section C (downstream), 49.1 m.

The stream was checked once a week from April 11, 1964, to May 25, 1964, and every other day from May 25, 1964, until June 19, 1964, to observe reproductive behavior when it first commenced. The study area was visited daily from June 19, 1964, to June 24, 1964, at which time reproductive activity was at its peak. Spawning was observed on four occasions. Thereafter, the stream was checked every other day until August 18, 1964, at which time there was no further spawning activity.

Observations were made from the bank with the aid of 7 x 50 binoculars and notes were recorded on a portable tape recorder. Observations were made at numerous intervals during the day for 10-minute periods during which time all of the activities of the fish were recorded. Temperature readings in °C were taken at intervals during the day. All nests were measured after they were deserted by the male longear sunfish.

Single pairs of fish were placed in a battery of ten to twelve five-gallon tanks in the laboratory and observations were made for 10-minute periods recording: (1) time for dominance to become established, (2) number of chases per 10-minute period, (3) number of nips per 10-minute period and area nipped, and (4) length of time required to kill the subordinate fish. The tanks were bare except for gravel on the bottom; they were aerated and the temperature was maintained at 25°C. The fish were fed daily with mealworm larvae (*Tenebrio*). After the subordinate fish was killed, both fish were removed, measured for standard length and body depth, and cut open and sex determined.

OBSERVATIONS AND RESULTS

Year-to-Year Occupancy of Home Range

During July of 1963, a total of 80 longear sunfish in Section B was marked by removing a pelvic fin from each fish; all fish were returned to this section following fin-clipping. The entire study area was sampled by electrical shocking on four occasions during June and July, 1964. A total of 24 longear sunfish bearing pelvic fin-clips was taken. No multiple recaptures were involved since all fish lacking a pelvic fin were re-marked by clipping another fin. The 24 recaptures were distributed as follows: 2 in Section A, 20 in Section B, and 2 in Section C. Twenty of the 24 recaptures were thus found in their respective home ranges after one year had elapsed. The recapture rate one year subsequent to marking was 25 percent. The number of recaptures diminishes with the passage of time due to several factors (Gunning and Shoop, 1963): (1) natural mortality, (2) fishing mortality, (3) mortality resulting from electrical shock, and (4) emigration of fishes to other parts of the stream. A 25 percent recapture rate is excellent under these conditions. Ricker (1945) studied the mortality of the bluegill in two Indiana lakes and reported an annual rate of natural mortality of 46 percent for one lake and 56 percent for the other. Natural mortality rates are not known for the longear sunfish, but they are probably equally as high. On the basis of these data, it is concluded that a stable population was studied.

Spawning in the Home Range

Twelve fish were observed on nests during this study. Four occupied nests before fish were marked for future recognition on June 26, 1964 by the fin-clipping method. Of the eight fish occupying nests after June 26, 1964, five were marked; therefore, 62.5 percent of the fish observed bore marks. This is good evidence that the longear sunfish spawn in their home range since only 41 fish were marked and this was probably less than half of the total population of the section.

Territoriality

In the upstream portion of Section C, there was a cluster of 7 nests, ranging from 12.7 to 45.7 cm apart. The defended area was practically restricted to the nest and 5 to 7 cm beyond in all directions. In the downstream portion of Section C, one nest was 1.2 to 1.5 m from the surrounding nests and consequently the territory consisted of an area described by a 1-meter radius from the center of the nest.

The inter-specific territoriality relationships varied. Males guarding their territory were seen to chase away small and large (17-22 cm total length) *Hypentelium nigricans* and *Moxostoma poecilurum* (up to 30 cm total length). Witt and Marzolf (1954) reported that the behavior of the longear sunfish toward *Fundulus notatus* was quite different from that toward other fishes; at no time did the sunfish attempt to chase them even though they passed over the nest. They concluded that *Lepomis megalotis* does not defend against surface-feeding fishes but rather against those that may feed from the bottom. Nesting longear sunfish in Warner Creek were observed chasing *Fundulus olivaceus*, which is a surface-feeding fish. Therefore, our findings are in conflict with their hypothesis.

Longear sunfish were never seen to chase largemouth bass (*Micropterus salmoides*) in this study even though the latter passed across their nests. Witt and Marzolf (1954) hypothesized that the longear sunfish may be able to recognize differences in form between predacious and non-predacious fishes in the same manner as birds are presumably able to differentiate between silhouettes of predacious and non-predacious birds (Tinbergen, 1951).

Intra-specific territorial relationships were consistent. All longear sunfish, regardless of size, were chased away from the nests except females ready to spawn. Occasionally there was chasing between holders of adjacent territories, or more often two males of adjacent territories would meet at the territory line, face each other and back off.

There was no actual physical contact in any of these defensive attacks and no threatening posture was observed. Defense in the natural environment consisted of a sudden rush on the part of the defender and retreat by the intruder.

Nest Construction

The males alone constructed the nests. Nests were built on a gravel-bottom area in shallow water ranging from 20.3 to 59.7 cm deep. The nests are circular excavations and the depression is made by vigorous action of the tail. The diameter of the nest is usually about equal to twice the length of the fish. At the onset of occupying a territory and constructing a nest, the male swims into shallow water and remains over an area, circles the area, chases away other fish, tail-wags, and circles back out to the deep water and remains there for a short time. The male assumes a position at a 45° angle with the bottom and moves the whole caudal peduncle area vigorously from side to side, thus hollowing out a depression in the gravel; this activity is called "tail-wagging." For example, on June 20, 1964, the construction of nest 5 was observed. In nine observation periods of 10 minutes each there were 145 tail-wags in the center of the nest, 128 tail-wags along the edge, and 22 tail-wags across the nest. In addition the male circled the nest 14 times, circled back to the deep pool 39 times, chased off other longear sunfish 36 times, and chased off other species of fishes 3 times.

There were twelve nests in the study area. The dimensions of the nests are given in Table 1.

On five occasions a male was observed to occupy a deserted nest. The fish were differentiated from each other by markings, such as the presence of clipped fins or dark pigmented spots. In these cases the new male would simply clear the debris from the bottom of the old nest by tail-wagging.

Sex Recognition and Courtship

The sex of a longear sunfish is somewhat difficult to determine on the basis of external features. During the spawning season the males usually are more brightly colored. The female may also be brightly colored but upon entering a male's territory, she usually shows a number of dusky, vertical bars on the body. The pattern of the female is similar to that of a longear sunfish that has been badly frightened or like the "fear pattern" of the subordinate fish in the laboratory experiments.

Noble (1934) believed that sex recognition on the part of male *Lepomis gibbosus* is based on the differential behavior of males and females. He stunned adult males and females and pulled them slowly toward a male guarding a nest and both were welcomed in the same manner. Noble concluded that males are unable to distinguish sex of quiescent adults of their own species by appearance alone. Males recognize males by their rapid movement and displays. Similar experiments were conducted by Breder (1936) for *Lepomis gibbosus* and *Lepomis auritus*. From our field observations the same conclusions were drawn about sex recognition in the longear sunfish. The male longear sunfish guarding a nest leaves the nest to chase off approaching longear sunfish of either sex. Approaching male longear sunfish will turn and flee and are chased by the guarding male; female longear sunfish ready to spawn will remain in the territory. The male longear sunfish then displays violently, dashing to the surface of the water and back to the bottom of the

nest, turning on his side and displaying his bright orange ventral surface to the female. The female then enters the nest and circles with the male.

Spawning

In the process of spawning, the male and the female circled the nest side by side. The female was always between the male and the center of the nest. Both circled in an upright position and every 50 to 60 seconds the female turned over on her side at a 20 to 30 degree angle with the bottom and brought her vent close to the male's. This spawning posture lasted from 2 to 20 seconds while both fish circled slowly and quivered rapidly, thus releasing their gonadal products.

If another fish came near the nest while the male was spawning, he immediately left to chase the intruder away and then returned to circle with the female either in the same or opposite direction. After spawning was completed the male chased the female from the nest and then returned to fan the eggs and guard the nest.

Spawning was first observed on June 21, 1964, at 11:00 A.M. in nest 8. A 17 cm male guarded the nest and a 12 cm female, with vertical bars and a slightly orange ventral surface, entered the nest. The male circled the nest with the female and they spawned five times in five minutes. The male left the nest to chase off another male longear sunfish and the female left also. The temperature at the time of spawning was 29°C.

At 11:35 A.M., a 12 cm longear sunfish

TABLE 1
Nest data for *Lepomis megalotis* of Warner Creek, Louisiana.

Nest	Diameter of Nest Floor in cm	Width of Nest Rim in cm	Depth of Nest in cm	Water Depth in cm
1	45.7	10.2	7.0	21.1
2	45.7	10.2	3.8	35.6
3	45.7	12.7	4.4	39.4
4	35.6	7.6	3.8	21.6
5	38.1	7.6	5.7	59.7
6	40.6	7.6	4.4	38.4
7	40.6	10.2	2.9	36.8
8	33.0	10.2	2.8	26.0
9	35.6	12.7	6.4	22.9
10	40.6	7.6	3.8	20.3
11	45.7	7.6	5.1	25.4
12	35.6	12.7	4.4	35.6
Mean	40.2	9.0	4.5	31.9

female entered nest 8. It was not possible to determine if it was the same female that spawned in the nest previously. This female remained in the nest for twenty minutes. The male and the female circled in the nest and spawned 20 times in 20 minutes; the male left the nest 15 times during this period to chase off other longear sunfish. The male chased the female from the nest after 20 minutes and returned to guard it. The following day the nest was full of small longear sunfish, 5 to 10 cm in length. These fish had invaded the nest and were feeding on the eggs deposited the previous day. The male which had been guarding the nest moved into the area, chased a few fish from the nest, and left. The small longear sunfish returned and ate the bulk of the eggs.

Spawning was observed in nest 5 on June 21, 1964, at 1:30 P.M. The water temperature was 31°C. A 10 cm female entered nest 3, which was 1.2 meters from nest 5. The male guarding nest 5 became very excited when the female moved into nest 3 and dashed back and forth to the surface of the water, turned over on his side, and displayed the bright orange on his ventral side. The female only circled with the male in nest 3 and then left to enter nest 5 where she spawned seven times in 5 minutes with the 22 cm male there. During this time, the male from nest 5 left the nest once to chase away the male from nest 3. After five minutes the male from nest 5 chased the female away.

At 1:40 P.M., a 12 cm female entered nest 5 and spawned five times in five minutes, during which time the male left twice to chase off another longear sunfish. The water temperature was 31°C when spawning took place in nest 5. The nest was guarded by the male until three days later when it was left unguarded and was invaded by 15 small longear sunfish. The male returned, made an attempt to chase a few of the fish away,

and then left the nest unguarded again. The small longear sunfish returned and ate the bulk of the eggs.

The following conclusions can be drawn relevant to the spawning acts observed: (1) the female was smaller than the male, usually 5 cm or more; (2) the female had vertical bars while in the male's territory; (3) the female circled and spawned toward the center of the nest with regard to the male's position; (4) the female spawned while slanting horizontally at a 20 to 30 degree angle to the bottom and with her vent next to that of the male's; (5) the male remained in an upright position while spawning; (6) there was an average of one spawning act per minute; (7) a spawning act lasted from two to 20 seconds; and (8) the males did not always guard the nest sufficiently and allowed small longear sunfish to enter and feed on the eggs.

Guarding the Nest

After spawning, the males chased the females from the nests and fanned the eggs by moving the pectoral fins and the caudal peduncle rapidly. This behavior is similar to the tail-wagging activity associated with nest construction. The aggressiveness of the males increased after the eggs and young were present in the nest and decreased subsequent to the departure of the young fish. (Table 2).

Behavior of the Young

Eggs were present in nest 6 on July 20, 1964. The actual spawning in this instance was not observed. Some of the rocks, with the eggs adhering to them, were removed from the nest and placed in an aquarium in the laboratory. Acriflavin was added to the tank to prevent fungus growth and the temperature was maintained at 25°C. The eggs hatched on July 22, 1964, both in the laboratory and in the stream. When the young hatched out they remained hidden

TABLE 2
Aggressiveness of male longear sunfish on nests under various conditions.

	Nest 5		Nest 6	
	No. of observation periods	Chases per 10 minutes	No. of observation periods	Chases per 10 minutes
Prior to egg laying	9	5.5	7	3.0
Eggs present in nest	9	6.2	6	11.0
Young present in nest	—	—	22	12.0
After young left nest	—	—	12	1.0

among the rocks in the bottom of the nest. They had large yolk sacs and remained stationary on their sides in the bottom of the nest. On July 23, 1964, eyespots were noticeable and the fishes exhibited more movement. On July 24, 1964, the young could not swim, but were propelled by quick flexing actions in the bottom of the nest. The behavior and development of laboratory-hatched young corresponded closely with that of those in the stream. The male guarding the nest would remain within 60 cm of the observer while the nest was being checked for young. The young were present in the nest on July 27, 1964. Due to rain and muddy water, the nest could not be checked again until July 31, 1964, at which time the young were no longer present in the nest. The young probably left the nest between the 29th and the 31st of July, 1964, since the young in the laboratory did not lose their yolk sacs and become free-swimming until July 29, 1964.

The young in the laboratory swam around jerkily at a 45-degree angle with the bottom before the yolk sac was completely absorbed. They could swim only a distance of approximately 2.5 cm before they would start to sink, frequently resting on the bottom. After the young were free-swimming, they were placed in a 20-gallon tank. The fish dispersed over the entire tank and showed no sign of schooling.

Length of Time the Male Defends the Nest

In nest 6, the only one in which the eggs hatched successfully in this study out of 12 nests, the male remained on the nest from the time the young left (between July 29, 1964, and July 31, 1964) until August 13, 1964, or 15 to 16 days after the young had left. Occasionally he chased fish from the nest and left periodically to spend more and more time in an adjacent deep pool.

Feeding Behavior

Longear sunfish in pools were observed eating dragonflies and other insects which touched the surface of the water. Those fish defending their territory, nest, or young were never observed to feed.

An interesting form of commensalism with the sucker, *Hypentelium nigricans*, was noted on two different days. On July 12,

1964, from 9:30 A.M. to 9:50 A.M., two 17 cm and three 12 cm longear sunfish were seen following a 30 cm *Hypentelium nigricans*. The sucker was moving along the bottom shoving gravels around and picking them up with its mouth. The longear sunfish moved along beside the sucker, picking around and feeding in the gravel after it had been stirred up. From 12:25 P.M. to 1:00 P.M. on the same day, one 17 cm, three 10 cm, and a group of 5 cm longear sunfish followed a 30 cm and a 22 cm *Hypentelium*, feeding beside them in the gravel. On July 22, 1964, two 17 cm longear sunfish were seen following a 25 cm *Hypentelium* and feeding beside it.

Inter-Specific Relationships

Inter-specific relationships were studied in longear sunfish which were not occupying territories. They were not disturbed by the presence of any of the large suckers (Catostomidae) or by any of the other sunfish or minnows (Cyprinidae). They were frightened by the largemouth bass and occasionally were chased by them. On one occasion a large largemouth bass swam by a group of about twenty-five small longear sunfish which were resting quietly in the open water of a pool, and they immediately formed a small, compact group. A school of large sharpfin chubsuckers (*Erimyzon tenuis*) moved into the same group of sunfish without disturbing them.

Intra-Specific Relations

Observations were made on behavioral reactions between longear sunfish which were not guarding territories. A total of 16 hours of observations were made in 10-minute periods from April 16, 1964, through August 18, 1964. No nipping or chasing was observed during this time, and on only five occasions were fish seen to even dash a short distance toward each other. Frequently as many as 20 fish were seen swimming together in pools and grouped together near the surface as close together as two cm, and yet no aggressive action was observed. Absence of damaged fins in 245 longear sunfish collected for laboratory experiments suggested that there was not the type of aggressive behavior noted in small tanks.

TABLE 3
Aggressive experiments on the longear sunfish during the period
April 10, 1964 to May 5, 1964.

Sex	Dominant		Sex	Subordinate		Time to Establish Dominance*	Average Number/ 10 Min. Interval	
	S.L. in cm	B.D. in cm		S.L. in cm	B.D. in cm		Chases	Nips
Male	3.8	1.8	Male	4.0	1.5	3 hrs. 10 min.	9.8	1.3
Male	4.4	1.6	Male	3.2	1.1	5 hrs. 10 min.	17.8	1.1
Male	4.6	2.2	Male	4.5	1.9	4 hrs. 20 min.	9.1	2.3
Male	5.4	2.0	Male	5.3	2.0	2 hrs. 15 min.	6.1	7.3
Male	5.9	2.8	Male	5.2	2.1	4 hrs. 15 min.	3.1	2.4
Male	6.6	2.6	Male	5.7	2.5	30 min.	20.2	21.2
Male	6.6	2.6	Male	6.3	2.4	5 hrs. 30 min.	17.0	5.8
Male	7.0	2.8	Male	6.6	2.6	20 min.	35.3	2.3
Male	7.9	3.3	Male	6.6	2.6	5 min.	23.3	7.9
Male	10.3	4.4	Male	10.0	4.4	2 hrs. 45 min.	15.8	3.3
Male	5.9	2.8	Female	5.6	2.2	13 hrs. 30 min.	0.3	0.1
Male	5.0	2.0	Female	4.6	1.9	3 hrs. 50 min.	22.4	3.1
Female	10.5	4.5	Male	10.0	4.4	7 hrs. 45 min.	3.2	1.4
Female	10.5	4.5	Male	7.0	2.8	1 hr. 35 min.	2.0	0.3

* Time elapsed from the time of placing the pair in the tank until the subordinate fish assumed the striped "fear pattern".
S.L. = standard length B.D. = body depth

TABLE 4
Aggressive experiments on the longear sunfish during the period
July 16, 1964 to August 5, 1964.

Sex	Dominant		Sex	Subordinate		Time to Establish Dominance	Average Number/ 10 Min. Interval	
	S.L. in cm	B.D. in cm		S.L. in cm	B.D. in cm		Chases	Nips
Male	5.6	2.3	Male	5.2	2.1	85 hrs. 35 min.	2.5	3.6
Male	7.6	3.2	Male	6.7	2.6	18 hrs. 25 min.	15.5	1.8
Male	13.5	6.7	Male	12.4	5.5	1 hr. 15 min.	0	0.6
Female	9.4	3.8	Female	9.1	3.6	13 hrs. 20 min.	13.6	15.3
Female	9.4	3.8	Female	7.9	3.1	11 hrs. 25 min.	2.2	2.3
Male	6.7	2.5	Female	5.4	2.3	34 hrs. 20 min.	12.0	1.1
Male	12.4	5.5	Female	9.7	3.9	24 hrs.	1.6	1.2
Female	6.0	2.4	Male	5.1	2.1	14 hrs. 45 min.	22.8	5.0
Female	9.3	4.3	Male	8.2	3.6	17 hrs. 50 min.	17.9	1.3
Female	9.1	3.6	Male	8.9	3.9	10 hrs. 45 min.	5.6	3.6

S.L. = standard length B.D. = body depth

Results of Laboratory Investigations

A. General Experiments on Aggressive Behavior

When two longear sunfish were placed in a five-gallon tank (Tables 3-6), they remained side by side in one of the bottom corners for a period of time, usually one hour or longer. They then began to move around and investigate the tank. Suddenly one fish chased the other but no fighting occurred. Soon the subordinate fish became barred or assumed the so-called "fear pattern" and remained near the top of the tank. When this happened dominance had definitely been established.

The eye of the subordinate fish turned dark. The iris is normally lightly pigmented with a variable amount of red around the pupil. If a fish lost in an encounter, black pigment spread to the rest of the iris and the red was obscured.

After dominance was established, the dominant fish began to nip the fins, caudal peduncle area, and sides of the subordinate fish and did not cease the aggressive behavior until the subordinate fish turned ventral side up and died.

From 55 experiments (Tables 3-6), the following data were obtained with regard to the role of sex: (1) 10 females were dominant over 10 males, (2) 10 males were dominant over 10 females, (3) 25 males were dominant over 25 males, and (4) 10 females were dominant over 10 females. As many females were dominant over males as there were males dominant over females; therefore, sex plays no role in the determination of dominance. By way of confirmation, Hale (1956) noted no sex difference in levels of aggression in *Lepomis cyanellus*.

In 48 out of 50 experiments in which there was a size difference, the dominant fish was the largest. The results of these experiments indicate that dominance is influenced by the size of the fish, the larger usually establishing dominance. Hale (1956) found that size was an important factor in dominance relations in the green sunfish, the larger fish usually dominating the smaller fish.

The size of the fish used in the experiments ranged from 3.8 to 13.5 cm in standard length. All fish were equally aggressive,

but it took longer for the smaller-sized fish to kill the subordinate fish.

The average length of time for dominance to be established was 5 hours and 18 minutes with a range from 5 minutes (Table 3) to 85 hours and 35 minutes (Table 4).

Observations were made in the laboratory during April, May, July, and August (Tables 3-4), as well as during October, November, and December (Tables 5-6), to compare aggressive behavior during the spawning period with that during other months of the year. There was no significant difference between intensity of aggression during the winter months and the spawning season.

There was no preference in the order of which fins were nipped first, but some fins and parts of the body were nipped more than other parts. The areas nipped the most are listed in descending order of frequency: pectorals, caudal, side, anal, caudal peduncle, head, dorsal, pelvics, and opercle.

B. Experiments on Tank Size as a Factor Affecting Aggressive Behavior

Eighteen pairs of fish ranging in standard length from 4.0 cm to 10.3 cm were placed in 50-gallon tanks (120 x 41 x 41 cm) and observed for aggressive behavior. If dominance was not established after a period of 4 to 5 days, the pairs were moved to 20-gallon tanks (76 x 32 x 32 cm).

Nine fish ranging in standard length from 6.3 cm to 10.3 cm established dominance over the other member of the pair in the 50-gallon tanks.

Nine pairs of fish ranging in size from 4.0 cm to 6.1 cm did not exhibit aggressive behavior in 50-gallon tanks; instead each fish maintained a separate territory at opposite ends of the tank. Upon placing these pairs in 20-gallon tanks, the larger one immediately established dominance over the smaller.

It was not necessary to move the fish to smaller tanks since even the smallest pair showed aggressive behavior in 20-gallon tanks. The 50-gallon tanks were not large enough for fish over 6.3 cm (standard length) to maintain separate territories. Fish under 6.3 cm (standard length) were able to maintain separate territories in 50-gallon tanks, but when they were confined to a smaller area they immediately displayed aggressive behavior. These experiments

TABLE 5
Aggressive experiments on the longear sunfish during the period
October 24, 1964 to November 29, 1964.

Sex	Dominant		Sex	Subordinate		Time to Establish Dominance	Average Number/ 10 Min. Interval	
	S.L. in cm	B.D. in cm		S.L. in cm	B.D. in cm		Chases	Nips
Male	6.5	2.7	Male	6.4	3.0	5 hrs. 40 min.	12.6	3.7
Male	6.7	2.7	Male	5.7	2.7	1 hr.	23.4	2.8
Male	6.9	3.2	Male	6.6	3.1	1 hr. 10 min.	32.5	4.6
Male	7.3	3.1	Male	5.9	2.6	11 hrs. 20 min.	27.0	8.7
Male	9.3	4.4	Male	9.3	3.8	9 hrs. 30 min.	16.0	1.6
Male	9.3	4.4	Male	9.3	4.4	30 min.	13.6	4.1
Male	12.5	5.9	Male	12.3	4.6	7 hrs. 40 min.	0.3	0.9
Male	8.1	3.5	Male	7.7	3.4	71 hrs.	2.7	3.7
Male	11.0	4.6	Male	9.1	3.7	8 hrs. 45 min.	7.9	0.5
Male	12.2	5.9	Male	11.0	4.6	19 hrs. 20 min.	3.8	0.1
Female	5.5	2.4	Female	4.9	2.2	6 hrs.	15.3	3.4
Female	6.9	3.1	Female	6.3	2.6	21 hrs. 50 min.	7.7	1.6
Female	7.5	3.2	Female	8.1	3.5	5 hrs. 30 min.	13.9	4.6
Female	9.1	3.9	Female	8.7	3.9	1 hr. 10 min.	15.4	1.4
Male	4.9	2.0	Female	4.5	1.8	27 hrs. 30 min.	26.0	3.8
Male	7.5	3.2	Female	7.4	3.1	22 hrs. 10 min.	8.1	2.2
Male	8.5	3.4	Female	8.5	3.4	3 hrs. 20 min.	16.3	2.8
Male	9.7	4.1	Female	9.1	3.9	10 hrs. 30 min.	17.2	5.9
Male	10.2	4.1	Female	10.0	3.9	4 hrs. 10 min.	1.8	2.6
Female	6.0	2.7	Male	5.9	2.4	3 hrs. 30 min.	28.0	1.0
Female	6.0	2.7	Male	5.7	2.4	1 hr. 10 min.	13.1	4.3
Female	7.5	3.2	Male	7.5	3.2	1 hr. 40 min.	7.7	5.0
Female	6.8	3.0	Male	6.4	2.4	4 hrs. 10 min.	13.4	8.9

S.L. = standard length B.D. = body depth

TABLE 6
Aggressive experiments on the longear sunfish during the period
November 13, 1964 to December 14, 1964.

Sex	Dominant		Sex	Subordinate		Time to Establish Dominance	Average Number/ 10 Min. Interval	
	S.L. in cm	B.D. in cm		S.L. in cm	B.D. in cm		Chases	Nips
Male	5.8	2.5	Male	5.3	2.5	2 hrs.	14.0	5.4
Male	5.8	2.5	Male	5.3	2.4	2 hrs.	25.3	7.1
Female	4.6	1.8	Female	4.3	1.8	5 hrs. 10 min.	5.1	6.8
Female	6.8	3.0	Female	6.6	2.7	1 hr. 50 min.	11.8	11.0
Female	7.0	3.2	Female	7.0	3.2	2 hrs.	1.6	0.9
Male	6.9	3.0	Female	6.1	2.5	1 hr. 30 min.	33.3	6.2
Female	5.0	2.0	Male	4.7	1.9	1 hr. 10 min.	42.8	4.2
Female	5.6	2.4	Male	5.0	2.3	1 hr. 10 min.	27.0	5.2

S.L. = standard length B.D. = body depth

show that the consistent aggressive behavior of pairs of fish in 5-gallon tanks is due to fish being confined to such a small area or volume. Investigators studying sunfish behavior in the laboratory should do preliminary work in order to determine the importance of tank size in determining the extent of aggressiveness in each species studied.

DISCUSSION

The stated purpose of this study was to observe the behavior of the longear sunfish, with primary emphasis on the reproductive and aggressive behavior of the species.

The reproductive behavior of the longear sunfish is characteristic of the Family Centrarchidae. Our observations are generally in agreement with those in the literature summarized by Breder (1936) for *Lepomis*. However, there was a marked difference with regard to the effect of sunshine on nesting fish. Breder (1936) reported that the pumpkinseed sunfish was so sensitive to changes in illumination that the male left the nest during the passage of a cloud over the sun and retreated to deep water. Breder (1936) also reported the same observation for the redbreast sunfish. Longear sunfish were never observed to leave their nests during the passage of a cloud over the sun and even remained over their nests during heavy rains.

Aggressive intensity in the laboratory, that is intolerance to confined aquarium conditions, was the same during the winter months as it was during the spawning season. One can collect longear sunfish from the natural environment at any time of the year and observe aggressiveness in aquaria after the fish have been in the laboratory aquaria for a short time.

Aggressive behavior in the natural environment is intensified after the male longear sunfish builds a nest and establishes his territory. In fact, aggressive behavior in the form of chasing was not observed in nature except for those males guarding nests.

In the laboratory, sex appears to play no role in the determination of dominance relationships. In the natural environment the male dominates the female to the extent that he chases her from the nest after spawning is completed.

It appears that confining longear sunfish to small aquaria causes more serious dam-

age to the fish as a result of aggressiveness than occurs in nature. As stated previously, of the 245 longear sunfish collected in the natural environment and returned to the laboratory, none had damaged fins. In laboratory aquaria, the typical result of placing two large longear sunfish together is damage to the fins from nipping and ultimately death of the subordinate member as a result of aggressiveness by the dominant member of the pair. An artifact situation is created in the laboratory that would not ordinarily obtain in nature. The physical contact between fishes that was observed during laboratory investigations on aggressiveness was not seen in the natural environment.

ACKNOWLEDGEMENTS

We would like to thank Dr. Royal D. Suttkus for his helpful suggestions and the following people who assisted during the field work: Dr. Jerome Shireman, Mr. Joseph Zieman, Dr. James Reed, Mr. Glenn Clemmer, Dr. John Ramsey, and Dr. Jamie Thomerson. We are also grateful to the late Mr. Lionel Ruckstuhl and Mrs. Ruckstuhl of Talisheek, Louisiana, who extended their hospitality to the senior author in the form of room and board during periods of intensive field work. Finally, we wish to acknowledge the encouragement and assistance of Miss George Ann Huck.

This study was supported by a National Institutes of Health Predoctoral Fellowship Grant No. 20310 for the period from September, 1963 to May, 1965 (Huck) and National Science Foundation Grants GB-2420 and GB-6037 (Gunning).

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September 8, 1967