ENVIRONMENTAL CONDITIONS IN BURROWS AND PONDS OF THE RED SWAMP CRAWFISH, Procambarus clarki (Girard), NEAR BATON ROUGE, LOUISIANA

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ABSTRACT

Biological and chemical-physical data were obtained from burrows of the red swamp crawfish, *Procambarus clarki,* and the adjacent ponds and ditch during the burrowing period.

Burrows constructed by mature and immature crawfish were of the same general pattern. Burrows usually consisted of an undulating downward channel, varying in depth, devoid of a connection with the adjacent pond or ditch. The tunnel was covered by a chimney or mud plug at the top and was enlarged at its deepest part into a chamber. Variance in the diameter of the channel seemed correlated with the total body-length of the inhabiting crawfish.

Fauna present in burrow water consisted mainly of planktonic crustaceans. In general, the animal groups in burrows were similar to those present in the adjacent pond or ditch but fewer species and numbers occurred in the burrows. The benthic fauna in the burrows was dominated by oligochaetes whereas aquatic insect larvae, mainly diptera, dominated in the ponds and ditch.

Air, water, and soil temperatures fluctuated during the observation period but were closely related in the burrows and the adjacent pond or ditch. The turbidity was very high in the burrows and exceeded that of the ponds and ditch at all times. No apparent seasonal trend in the chemical water properties could be established. Very low oxygen, high free carbon dioxide and slightly acid water characterized the burrow habitat. Chemical soil properties in burrows and in the adjacent ponds or ditch were similar.

INTRODUCTION

Crawfish are a commercial food in Louisiana and their recreational value is well established. The annual crawfish production is valued at approximately $4 million, 90 per cent of which is comprised by the red swamp crawfish, *Procambarus clarki* (Smitherman et al., 1967). The present natural and cultural supplies cannot meet the steadily increasing demands. Therefore one of the prime objectives of the Louisiana Crawfish Industry Development Association is to expand the crawfish culture and thus increase the market value to $40 million annually (Anonymous, 1966).

Expansion of crawfish culture requires effective management techniques. Development of these techniques will rely upon basic research of the natural ecology of crawfish. The success of pioneer crawfish farming heretofore has varied greatly due to the lack of basic knowledge concerning the ecology of the crawfish (Viosca, 1961). Basic research on some aspects of crawfish ecology and culture has been completed at Louisiana State University and will hopefully improve management procedures (Walker et al., 1966; Smitherman et al., 1967; Loyacano, 1967; de la Bretonne, 1969).

Little has been done to establish the conditions necessary for survival of crawfish in their burrows. The red swamp crawfish is known as a burrowing species and spends several months inside a burrow

(Viosca, 1939; Penn, 1941, 1943, 1956). More basic research on the water quality and soil properties in crawfish burrows is needed to help in developing efficient management techniques.

The objectives of this study were to obtain data on:
(1) physical, chemical and biological properties of water and soil in burrows of red swamp crawfish and in adjacent ponds or ditch during the burrowing period.
(2) the construction of burrows.

When possible, the chemical-physical data obtained in the burrows were correlated with the crawfish requirements or the effects on the crawfish.

MATERIALS AND METHODS

Burrows selected for the study were located on the banks of two ponds and on the shore of a drainage ditch, all situated at the Ben Hur Farm, Louisiana State University.

Sampling and examination of burrows commenced August 1968 and continued until the end of February 1969 when burrowing of crawfish virtually ceased. A total of 158 burrows were examined during this project.

Chemical and Physical Analysis of Water

Immediately prior to taking a water sample from burrows, ponds or ditch, the air, water and soil temperatures were recorded to the nearest 0.1 C with a telethermistor.

A total of 106 water samples were taken for chemical and physical analysis between 12 noon and 3 p. m. Water was siphoned out of the burrows with a polyethylene tube and transferred into BOD bottles. The water samples were analyzed for: dissolved oxygen (Winkler method, Alsterberg modification), pH (Beckman glass electrode), total hardness (EDTA), turbidity (Hach colorimeter), carbonate, bicarbonate and total alkalinity. The analyses were done according to the methods and procedures described by Swingle (1964) and Anonymous (1965). Determination of free carbon dioxide by titration was impossible due to the high turbidity of the water samples; therefore it was calculated from the pH and the bicarbonate alkalinity (Langelier, 1936; Moore, 1939; Larson, 1942).

A total of six water samples from burrows and six from ponds and ditch were analyzed for; nitrogen, phosphorus, potassium, calcium and magnesium (Anonymous, 1965).

Biological Analysis of Water

At the end of February 1969, water was siphoned out of two burrows at each pond and out of two burrows at the ditch by the described method, to determine the fauna present. Each sample was flushed through a number 12 plankton net. Tows for two meters each were made with the same plankton net in three different spots in each of the ponds and in the ditch.

The residues were collected separately for each burrow, pond or ditch and preserved in 5 per cent isopropyl alcohol and adjusted to a total volume of 100 ml. For each original sample two aliquot subsamples of one ml each were taken with a Hensen-Stempel pipet (Welch, 1948).

A differential count of the subsamples was carried out under a microscope. From the average number of organisms the number of each kind was computed per 1,000 ml burrow, pond, or ditch water. The organisms were identified using the following keys: Pratt (1935), Pennak (1953), Edmondson (1959) and Usinger (1959).

Physical and Chemical Analyses of Soil

At the end of the burrowing period, a total of six soil samples were collected from burrows and six from ponds and ditch. The 12 soil samples were analyzed for: pH, phosphorus, potassium, calcium and magnesium using the methods described by Brupbacher et al., (1968). Total nitrogen was determined by the Kjeldahl method (Anonymous, 1965.

Biological Analysis of Soil

Nine soil samples from burrows, ponds and ditch were separately washed through a number 18 mesh sieve, followed by a number 50 mesh. The residue was collected from the sieve and preserved in 10 per cent formalin for seven days. The organisms and debris were then transferred into 90 per cent isopropyl alcohol.

Identification and counting of the organisms present in each sample was done under a binocular dissecting microscope. From these counts, the number of organisms of each kind was computed per 1,000 cc of soil. The organisms were identified using the following keys: Pratt (1935), Pennak (1953), Edmondson (1959) and Usinger (1959).

Burrow Construction and Crawfish

At the end of the burrowing period and occasionally during the period August 1968-December 1969, 118 burrows were dug out to collect information on their shape and dimensions. The following measurements were taken whenever possible: chimney height, tunnel diameter, chimney elevation above water level in pond or ditch, depth to water in burrow, water depth in burrow, and burrow depth.

Observations were made on: number of tunnels and chambers, their location and dimensions, condition of the chimney or mud plug, and the presence of crawfish. If the latter could be captured without destroying the burrow, sex, sexual maturity, and total body length were recorded.

RESULTS AND DISCUSSION

Physical and Chemical Water Properties in Burrows, Ponds and Ditch

Throughout the period from August 1968 to January 1969 no apparent seasonal trend in the chemical water properties was noted. Since the physical factors and water chemistry were very similar for both ponds, the data were compiled together and are summarized in Table 1. In the burrows adjacent to the ponds the physical and chemical water characteristics were alike and were summarized together in Table 1. Results of the analysis of ditch water and water from burrows at this location are shown in Table 2.

Air, water and soil temperatures in burrows, ponds and ditch were closely related (Tables 1, 2). Crawfish tolerated a wide temperature range without apparent detrimental effects.

The turbidity of burrow water greatly exceeded that of the ponds or ditch at all times. Wallen (1955) reported that crawfish withstood over 150,000 ppm turbidity without lethal effects under laboratory conditions. In this study, crawfish apparently were not adversely affected by very high turbidities occurring in the burrows and could survive if surrounded by moist clay instead of water.

The amount of dissolved oxygen (D.O.) was very low and free carbon dioxide (CO_2) high in the burrows. These conditions were probably the result of several interactions. In burrows few algae were found and photosynthetic activity was kept at a minimum due to lack of sunlight. The water surface in contact with the air was greatly reduced because of the small diameter of the tunnel. Simple diffusion of oxygen into the water was therefore minimal. The high amount of organic matter in the soil of burrows could be assumed responsible for a relevant chemical oxygen demand. The inflow of ground water low in oxygen and high in free carbon dioxide concentrations into the burrow was possibly another factor. Continued respiration by crawfish and other organisms occupying the burrow as well as decomposition of organic matter by bacteria were other factors which most probably accounted in part for the low dissolved oxygen and relatively high free carbon dioxide. Moore and Burn (1968) collected four young crawfish from a pond with D.O. ranging from depletion to 0.4 ppm at the bottom. In laboratory experiments, *Cambarus fodiens*, a species typical of lentic environment, was resistant to 0.5 ppm D.O. for 22 hours, whereas *Orconectes propinquus*, a representative of lotic waters, was less tolerant (Bovbjerg, 1952). In this study the lowest D.O was 0.2 ppm and crawfish seemed to tolerate this condition without any detrimental effects.

Water from all burrows except one had high free carbon dioxide values up to 372 ppm. This resulted in a lowering of pH in the burrows to an average of 6.8, whereas the ponds averaged 8.6 and water from the ditch 7.4 respectively. Free CO_2 only occurred in two samples from the ponds and in very small amounts (6 ppm and 1 ppm). In the ditch where the pH was usually lower, free carbon dioxide was determined in all the samples. According to Lagler (1956) free CO_2 in excess of 20 ppm could be harmful to fish especially at low oxygen concentrations. In most burrows and twice in the ditch the carbon dioxide exceeded this value but crawfish were not distressed.

Swingle (1964) stated that bicarbonates occurred within the pH range of 4.5 to 10.5, above pH 10.5 a mixture of carbonates and bicarbonates could be present, while carbonates practically did not occur below pH 8.4. Since water in burrow varied in pH from 6.0 to 8.2, bicarbonates were well represented and carbonates were practically absent. In ponds where the pH varied from 7.9 to 9.6 carbonates were present in 20 samples out of 25. Ditch water having a pH ranging from 7.0 to 8.2 had no carbonates present.

The total hardness (EDTA) in burrows exceeded that of pond and ditch water. This could be expected since the ponds were supplied by soft artesian well water. de la Bretonne (1969) reported that increase in water hardness up to 100 ppm resulted in increased production and higher survival of red swamp crawfish.

Higher amounts of calcium and magnesium were found in burrow water compared to the respective adjacent pond or ditch, with one exception for Mg (Table 3). This was probably a result of the turbidity in the burrows. Filtration and centrifugation could only remove a certain amount of the clay particles. The high readings for N, P, K, Ca and Mg were probably caused by the remaining clay which was relatively rich in these elements.

Diurnal Cycle in Burrows and Pond M 10

On November 1, 1968 a 24-hour test was started in one pond. The air, water and soil temperatures, dissolved oxygen, and pH data recorded in the burrows and the pond each four hours were as follows:

	Pond				Burrow			
Factor	Max.	Time	Min.	Time	Max.	Time	Min.	Time
Air temp. (C)	23.5	4PM	14.0	4AM	22.0	12N	16.0	12MN 4AM
Water temp. (C)	27.0	4PM	15.0	4AM	24.5	4PM	16.0	4AM
Soil temp. (C)	25.0	4PM 8PM	17.0	8AM	20.0	4PM 12MN	17.5	4AM
Dissolved oxygen (ppm)	11.6	4PM	2.7	4AM	1.3	8PM	0.2	8AM
pH	9.6	4PM 12N	8.5	4AM	7.0	12N	6.5	4AM

Aquatic Fauna in Burrows, Ponds and Ditch

In general the fauna present in burrows consisted of the same groups as those in the ponds and ditch but with fewer species and numbers (Table 4). Isopoda, Amphipoda and Tardigrada were the only groups found in burrows and not found in ponds or ditch. Diptera larvae occurred in the ponds only. Planktonic crustaceae made up 85 per cent of the aquatic fauna in burrows and 88 per cent in ponds and ditch. The different sampling technique in the burrows versus ponds and ditch should be considered in interpreting the quantitative data of Table 4.

Chemical Soil Properties in Burrows, Ponds and Ditch

Chemical analyses of soil from burrows, ponds and ditch for N, P, K, Ca, Mg, and pH are shown in Table 5. Generally the soil of burrows adjacent to the ponds had higher mineral content than the pond bottoms, whereas this situation was reversed in the ditch/burrow area. This fact was probably due to discharge in the ditch of waste material from a nearby laboratory and deer pens. The data obtained were not conclusive in showing distinct differences in chemical soil properties between burrows and ponds or ditch, and more investigation on the mineral requirements of *P. clarki* is therefore necessary.

Benthic Fauna in Burrows, Ponds and Ditch

The relative numbers of benthic organisms found in burrows, ponds and ditch are given in Table 6. Oligochaeta dominated by number and species in the burrows, whereas aquatic insect larvae dominated by species in the ponds. Fishes, some of which probably feed upon bottom organisms, were more abundant in the ditch compared to the ponds, which might explain the smaller species variety of the benthic fauna in the ditch. The different sampling techniques used in burrows and open aquatic habitats respectively should be considered in interpreting the value of the quantitative data in Table 6.

Burrow Construction

Data on burrow construction are given in Table 7. All burrows were built in the same general pattern with only slight modifications in the number of tunnels and chambers.

Tunnels and Chambers

The burrows generally consisted of an undulating downward nearly circular tunnel, covered by a chimney or mud plug and enlarged at the bottom into a chamber of about 15 cm in diameter. Usually a connection between the burrow in the bank and the adjacent pond was lacking. In the ditch, however, a few burrows had a side tunnel about 15 cm beneath the ground level of the bank and leading under the water level in the ditch. A mud plug in these tunnels avoided flushing of the burrow.

Under the chimney or mud plug, the tunnel was usually open and filled with water further down, with fine mucky clay at the bottom. The water level in the burrows varied with the ground water table and the intensity of the rainfall. Only six burrows out of the 118 studied had an aeration chamber in the upper part.

The depth of the burrows varied considerably (Table 7). Girard (1852), Tarr (1884), Hobbs (1942) and Pennak (1953) stated that the varying depth of the burrows was mainly a result of the fluctuating water table, and that crawfish burrowed until the water was encountered. This was also observed in this study and the depth of the burrows varied considerably.

Chimneys and Mud Plugs

Chimneys were of hollow cylindrical shape with a diameter of about 10 cm at the base and slightly tapered toward the top. They were built with moist clay lumps of approximately 1 cm in diameter. The soft clay balls brought up by the crawfish naturally cemented together by their drainage and subsequent solidification on contact with the air and exposure to the sun.

When the chimney was partially destroyed by heavy rain, it was reconstructed overnight by the inhabiting crawfish. Rebuilding of chimneys took place until mid-November 1968; crawfish then became less active and either installed a mud plug or left the tunnel open. After completion of the burrow the crawfish sometimes isolated it from the external environment by sealing the opening on top of the chimney.

Observations on Crawfish

During the period from early September 1968 through February 1969, a total of 56 red swamp crawfish were obtained from burrows. Data were taken on body length of mature and immature crawfish and construction properties of their burrows (Table 8). Until the end of November 1968, all but one individual were mature males and females. Later only mature females and immature crawfish were extracted from the burrows.

On pond banks immature crawfish built burrows similar to those of adults, but in the dry pond bottom they did not construct a terminal chamber.

Viosca (1937) stated that young red swamp crawfish were entirely aquatic which is in contradiction with the findings in this study. Burrowing by immature crawfish confirmed that burrows are not built and occupied for the mere purpose of copulation, and protection of the females in berry.

A positive relationship existed between the total body length of crawfish and the diameter of their burrows (Table 8).

Usually each burrow was inhabited by one crawfish only, except early in the burrowing season, when the mature male guarded the entrance from potential invaders and the female in berry or carrying young, occupied the deeper part.

From December 1968 until the end of February 1969 no adult male was found inside the burrows. Penn (1943) stated that the majority of the males which attained sexual maturity during the summer or fall did not survive through the winter. In two burrows, each one occupied by an adult female, carapace remnants were found. Since red swamp crawfish can be cannibalistic, these remnants could have belonged to an adult male devoured by the female.

From August 1968 until about the end of October 1968, crawfish occasionally came up to the surface and were very aggressive. Later in the season they were sluggish, probably because of the low temperature and reduced metabolism. After extraction from the burrow and exposure to the sun, they remained lethargic for about 10 minutes before regaining their natural vigor.

During January and February 1969, most red swamp crawfish were found in either the terminal chamber or were packed so tightly in the clay that it was difficult to separate them without injury. Water as such seemed not to be required as long as the gills could be kept moist.

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TABLE 1. Physical and chemical water properties in burrows and ponds (August 1968 - January 1969)

Physical or chemical factor	Location	Average	Mode(s)	Median	Range	Number of observations
Air Temperature (C)	Ponds	20.0	6.0 9.0 21.5 22.0 25.0	21.5	2.0-36.5	27
	Burrows	21.4	31.0	23.0	3.0-34.0	55
Water temperature (C)	Ponds	20.5	15.5	20.0	9.0-34.0	27
	Burrows	17.7	9.0 14.0 15.0	16.0	9.0-34.0	51
Soil temperature (C)	Ponds	19.8	15.0	17.0	10.0-30.5	27
	Burrows	18.8	26.0	17.0	10.0-29.0	61
Turbidity (ppm)	Ponds	755	1000 1200	650	160-1600	25
	Burrows	2538	2000 3000	1800	320-13,500	42
pH	Ponds	8.6	8.2	8.5	7.5-9.6	25
	Burrows	6.8	6.8	6.8	6.2-8.2	45

Physical or chemical factor	Location	Average	Mode(s)	Median	Range	Number of observations
Dissolved oxygen (ppm)	Ponds	7.5	8.0	7.6	4.0-12.6	25
	Burrows	1.2	0.8 1.0	1.0	0.2-2.8	43
Bicarbonate alkalinity (ppm $CaCO_3$)	Ponds	192	147 182 183	192	114-266	25
	Burrows	221	261	224	65-286	42
Carbonate alkalinity (ppm $CaCO_3$)	Ponds	44	0	32	0-172	25
	Burrows	0.2	0	0	0-8.0	42
Total alkalinity	Ponds	236	236 319	248	125-322	25
	Burrows	221	261	224	65-286	42
Total hardness (EDTA) (ppm)	Ponds	39	40	40	12-64	25
	Burrows	143	114	136	40-296	42
Carbon dioxide (ppm)	Ponds	0.6	0	0	0-6.0	25
	Burrows	67	66	51	0-208	42

TABLE 2. Physical and chemical water properties in burrows and ditch (August 1968 - January 1969)

Physical or chemical factor	Location	Average	Mode(s)	Median	Range	Number of observations
Air temperature (C)	Ditch	22.7	26.0	26.0	11.0-33.5	5
	Burrows	17.8	17.0	17.0	10.0-27.5	8
Water temperature (C)	Ditch	22.8	...	24.5	13.0-33.5	5
	Burrows	20.2	14.0	18.0	13.0-29.0	11
Soil temperature (C)	Ditch	19.2	...	19.0	13.0-27.0	5
	Burrows	19.4	14.0	17.0	12.0-29.0	11
Turbidity (ppm)	Ditch	211	...	215	115-300	4
	Burrows	537	290	300	150-3100	13
pH	Ditch	7.4	...	7.2	7.0-8.2	4
	Burrows	6.8	6.0 6.8 7.3	6.8	6.0-8.0	13
Dissolved oxygen (ppm)	Ditch	6.3	...	6.8	3.8-9.6	5
	Burrows	1.0	0.2 1.0	1.0	0.2-2.8	11

Physical or chemical factor	Location	Average	Mode(s)	Median	Range	Number of observations
Bicarbonate alkalinity (ppm $CaCO_3$)	Ditch	213	...	232	109-277	4
	Burrows	197	...	244	111-398	12
Carbonate alkalinity (ppm $CaCO_3$)	Ditch	0	0	0	......	4
	Burrows	0	0	0	......	12
Total alkalinity (ppm $CaCO_3$)	Ditch	213	...	232	109-277	4
	Burrows	197	...	244	111-398	12
Total hardness (EDTA) ppm	Ditch	154	...	162	50-242	4
	Burrows	348	140 550	210	140-632	13
Carbon dioxide (ppm)	Ditch	18	...	21	3-28	4
	Burrows	95	...	63	24-372	12

TABLE 3. Amounts of N, P, K, Ca and Mg in water from burrows, ponds and ditch *

Location	N per cent	P	K	ppm Ca	Mg
Pond M 10	0.13	3.27	27.90	10.80	23.85
Pond M 11	0.06	1.28	8.40	7.35	8.35
Ditch	0.06	0.67	6.40	50.00	18.90
Burrows M 10	0.00	1.60	18.10	13.50	12.60
Burrows M 11	0.33	16.45	160.00	81.00	177.50
Burrows ditch	0.06	0.60	3.50	82.50	28.30

* All values are averages of two samples.

TABLE 4. Number of organisms per 1,000 ml water in burrows, ponds and ditch

	Burrows *			Ponds		
Organism	M 10	M 11	Ditch	M 10	M 11	Ditch
Copepoda	500	389	14	286	65	71
Nauplius larvae	..	..	32	165	237	193
Cladocera—Water Fleas						
Daphnia sp.	..	111	..	113	218	14
Daphnia eggs	..	..	..	33	161	..
Macrothrix sp.	..	..	..	..	..	27
Isopoda—Sow Bugs						
Asellus sp.	..	1	..	..	..	..
Other	2	..	..	..	..	..
Amphipoda— Scuds, Sideswimmers						
Gammaridae	..	..	2	..	..	..
Ostracoda—Seed Shrimp	..	105	80	<1	4	222
Tardigrada—Water Bears	..	104	..	..	..	..
Rotifera—Rotifers						
Keratella sp.	..	..	..	..	199	31
Rotaria sp.	..	..	..	..	..	37
Other	..	111	..	..	107	78
Gastrotricha	..	..	..	..	..	<1
Nematoda—Roundworms	..	2805	417	<1	6	17
Oligochaeta—Earthworms						
Aeolosoma sp.	..	326	..	..	<1	..
Tubificidae	..	..	3	..	..	..
Other	..	668	1	..	..	..
Diptera— Flies, Mosquitoes, Midges						
Culicidae— Flies, Phantom Midges						
Chaoborus astictopus						
(larvae)	..	..	..	<1	<1	..
(pupae)	..	..	..	<1	..	..
Chironomidae—Midges						
Chironomus sp. (larvae)	..	..	..	..	<1	..
Coryneura sp. (larvae)	..	..	..	<1	..	..
Total	502	4620	548	597	997	690

* Average of two samples.

TABLE 5. Amounts of N, P, K, Ca, Mg and pH in soil from burrows, ponds and ditch *

Location	N per cent	P	K	Ca	Mg	pH
		ppm				
Pond M 10	0.15	132	230	2220	589	6.8
Pond M 11	0.16	176	253	2975	748	6.8
Ditch	0.28	376	500	6800	1538	6.9
Burrows M 10	0.06	195	178	2220	624	7.0
Burrows M 11	0.11	112	240	3065	975	6.9
Burrows ditch	0.12	144	322	4500	1405	7.2

* All values are averages of two samples.

TABLE 6. Number of benthic organisms per 1,000 cc soil in burrows, ponds and ditch

Organism	Burrows *			Ponds		
	M 10	M 11	Ditch	M 10	M 11	Ditch
Oligochaeta—Earthworms						
Tubificidae	..	24	3	2	1	77
Other	2	3	1	..	..	..
Gastropoda—Snails	<1	..	13	..	..	2
Pelecypoda—Clams, Mussels	..	..	1	..	..	..
Hymenoptera						
Formicidae—Ants	..	..	..	..	<1	..
Coleoptera larvae—Beetles						
Hydrophilidae—Water Scavenger Beetles						
Berosus sp.	..	..	..	..	1	..
Diptera larvae—Flies, Mosquitoes, Midges						
Culicidae—Mosquitoes, Phantom Midges						
Chaoborus astictopus	..	..	..	7	2	15
Chironomidae—Midges						
Clinotanypus habitus	..	..	..	8	..	..
Chironomus sp.	..	..	..	2	<1	..
Chironomus plumosis	..	..	..	..	9	..
Pentaneura sp.	..	..	..	..	..	5
Ceratopogonidae—Biting Midges						
Culicoides unicolor	..	..	..	7	5	..
Probezzia glabra	..	..	1	..	..	..
Tabanidae—Horseflies						
Chrysops vittatus	..	..	<1	..	..	..
Dolichopodidae						
Argyra albicans	2	..	..	..	..	..
Total	4	27	19	25	18	99

* Average of two samples.

Table 7. Construction characteristics of burrows
(All measurements are in cm)

	Chimney height	Tunnel diameter	Chimney elevation above water level pond	Depth to water in burrow	Water depth in burrow	Burrow depth
Burrows M 10						
Average	6.1	5.2	9.5	16.7	18.4	41.6
Mode(s)	7.0	4.0 5.0	10.0	10.0	3.0, 10.0, 13.0, 25.0	63.0
Median	4.5	5.0	10.0	15.0	16.0	37.5
Range	1.5-20.0	1.5-14.0	4.0-21.0	2.5-77.0	2.0-51.0	10.0-120.0
Number of observations	10	69	31	49	39	38
Burrows M 11						
Average	5.0	4.9	10.2	10.4	21.2	50.6
Mode(s)	5.0	3.0	5.0	3.0-4.0	20.0	42.0, 47.0, 70.0
Median	5.0	4.0	9.5	6.0	20.0	47.0
Range	2.0-9.0	1.5-10.0	2.0-25.0	2.0-55.0	2.0-97.0	18.0-97.0
Number of observations	11	33	20	25	26	21
Burrows ditch						
Average	9.8	5.7	13.7	10.9	33.7	70.3
Mode(s)	8.0, 9.0	5.0	14.0, 15.0, 16.0	8.0	20.0, 23.0, 40.0, 60.0	100.0
Median	9.0	5.0	15.0	9.5	30.5	74.0
Range	8.0-15.0	3.0-15.0	6.0-20.0	9.0-20.0	3.0-65.0	14.0-109.0
Number of observations	6	29	21	16	16	21

TABLE 8. Total body length of mature and immature crawfish and construction properties of their respective burrows
(All measurements are in cm)

	Total body length	Burrow diameter	Depth crawfish captured	Burrow depth
Immature crawfish				
Average	4.9	2.9	26	39
Mode(s)	4.0	2.0	10	10, 15, 25, 83
Median	5.0	3.0	22	34
Range	3.0–6.0	1.5–9.0	10–70	10–109
Number of observatoins	25	25	25	25
Mature crawfish				
Average	7.7	5.8	39	56
Mode(s)	8.0	4.0	0	18, 40, 53, 63
Median	8.0	6.0	42	53
Range	5.0–9.5	3.0–14.0	0–105	10–120
Number of observations	31	31	31	31

FLORIDA WALLEYE?

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Florida has comparatively few species of large predatory freshwater fishes. Many lakes of the state have an abundance of forage fishes. Therefore, niches may be available for additional desirable predatory species.

As far as I know, there is no record of walleye *(Stizostedion vitreum)* occurring naturally as far south as peninsular Florida. People not familiar with walleye may have the mistaken impression they require cold, deep water. If this were so, an attempt to introduce them into Florida would be absurd. However, there is a strong superficial resem-

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