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NOTES ON HABITATS, SYSTEMATIC CHARACTERS AND
LIFE HISTORIES OF TEXAS SALT WATER
CYPRINODONTES

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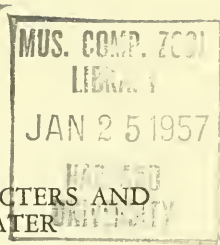
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NOTES ON HABITATS, SYSTEMATIC CHARACTERS AND
LIFE HISTORIES OF TEXAS SALT WATER
CYPRINODONTES

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and

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In September 1950 the first author, following the suggestion of the second, began a study of the Cyprinodontes living in the salt waters of Texas. Sixty stations were set up from the Rio Grande to the Sabine River, a distance of about 400 miles. It was planned to visit these localities once every three months for at least one year. The whole area was covered about one and a half times, when the first author was called into the United States Air Force. The data were then turned over to the second author who is responsible for the writing.

The Cyprinodontes in Texas salt waters are an abundant, vigorous group of fishes living in the shallows next to the shores of the bays, and in the adjacent sloughs, bayous and ponds, which are often isolated from the open waters. Here they are exposed to great diurnal and seasonal extremes of temperature and abnormally high salinities. They also withstand sudden freshets and can tolerate wide and rapid salinity changes. They seem to be the most resistant of all fishes in these waters to variations of the physical environment. Evidence for these statements has been given before by Gunter (1945, 1950). When cold waves strike and millions of pounds of fishes are killed on the Texas coast (Gunter, 1952) dead cyprinodonts are not seen on the bay shores. Instead they are found at this time, and at this time only, out from the shores in water three feet deep or more. Since they are found in waters of abnormally high salinities but are extremely rare on the Gulf beach, only being found occasionally near the mouths of the passes (Gunter, 1945; Kramer and Gunter, *in press*), it seems that they are restricted to the bay areas by the presence of cover, which may be shells, plant debris or merely a rugose or muddy bottom. When disturbed these fishes do not rush headlong into flight; instead they go to the bottom leaving a cloud trail of stirred mud for a few feet, which stops abruptly as they hide in a depression, under a shell or in the mud itself. Kilby (1955) found that *Cyprinodon variegatus* will bury itself in mud or plant debris when the tide falls.

The cyprinodonts are ecological dominants in their environment and they have some commercial value as bait, for which their general

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TABLE 1.
NUMBERS OF SPECIMENS CAUGHT AT THE VARIOUS LOCATIONS, WITH TEMPERATURE AND SALINITY.

Date	Location	Temperature (°C)	Salinity (per mille)	Cyprinodon variegatus	<i>Fundulus stमित्त</i>	<i>Fundulus grandis</i>	<i>Fundulus pulchreus</i>	<i>Fundulus jenningsi</i>	<i>Aldina multifasciata</i>	<i>Lucania parva</i>	<i>(Gambusia affinis</i>	<i>Mollinnesia latipinna</i>
IX:21	Redfish Point; #1; Copano Bay	35.0	33.2									
" "	Redfish Point; #2; tidal ponds	35.0	38.1	20	33	3						
IX:22	Port Bay; #1; N of road, W of bait house, Copano	35.0	36.0	4	5	3						
" "	Port Bay; #2; NE of bait house on shore, Copano	35.0	35.3		1					35		
" "	Port Bay; tidal ponds on ranch SE of causeway, Copano	34.5	47.6	376		1	1		1			1
IX:26	South Bay near Boca Chica, Laguna Madre	27.0	32.0									
" "	Creek by Yacht Club, road to Boca Chica, Laguna Madre	27.5	10.0			3						13
IX:27	Port Isabel; Laguna Madre; 3 mi. from Lighthouse	33.0	35.6	56								
" "	Port Isabel; Laguna Madre; 3 mi. from Lighthouse	33.0	37.5	12		1						1
" "	Port Mansfield; Redfish Bay	27.5	54.4	132	32	4						
IX:28	Riviera Beach; Baffin Bay	34.0	64.9	354								
IX:29	Nueces Bay; midway White Point and causeway	30.0	39.8									
X:2	Hynes Bay at Austwell	29.0	22.1	2								
" "	Cavasso Creek at Hwy. #35.	30.0	35.2									
" "	Aransas Bay, mainland of Goose Island, near cafe	31.5	32.3	223	14	1	2		1			
X:5	Oso Creek, Yorktown Road near Rodd Field	27.5	60.9	703	4							
" "	Laguna Madre, across from Pita Island	30.0	42.4	361	39	37						
X:6	St. Charles Bay; 1 mi. NE of Goose Island bridge	31.5	31.5	69		17			3	1		
X:9	Small pond N of Fulton near Oakshore Apts.	27.0	34.1	347		5				1		41

[illegible]

TABLE 1.—Continued
NUMBERS OF SPECIMENS CAUGHT AT THE VARIOUS LOCATIONS, WITH TEMPERATURE AND SALINITY.

Date	Location	Temperature (°C)	Salinity (per mille)	<i>Cyprinodon variegatus</i>	<i>Fundulus sinus</i>	<i>Fundulus grandis</i>	<i>Fundulus pulvereus</i>	<i>Fundulus jenkinsi</i>	<i>Adinia multifasciata</i>	<i>Lucania parva</i>	<i>Gambusia affinis</i>	<i>Mollinestia lathripina</i>
1950												
" "	Scott Bay Near Baytown	26.5	11.6	7		161	1					12
" "	Trinity Bay at mouth of Double Bayou	24.5	7.0	37						7		
X:26	West Bay at N end of causeway on Galveston Hwy. #75	29.5	21.0		1							2
" "	Slough on N side of Dickinson Bay	27.0	15.4	1	1	8	3	6	1		2	
" "	Galveston Bay at Seabrook	24.0	13.1	57	56	15		2	6			
X:27	Snip Channel near Dow Chemical Plant at Freeport	25.0	27.7	28		3						
" "	Ship Channel at Velasco	24.0	27.9									
XI:3	Two mi. S of Magnolia Beach, tidal pond	18.0	18.4	23	1	14	2			14		
" "	Slough N of Powderhorn Lake at Indianola	18.5	26.6	17	4	25			4			141
" "	Carancahua Bay along NE shore	19.0	23.9	15	6	115	5		6			
" "	Mud puddle in dry creek, NW side of Lavaca Bay	17.0	44.8	11		29	10		8	4		9
XI:8	Ingleside Cove; SE shore	25.5	44.4	17	12	4						
" "	Tidal pond (2 mi. inland from Redfish Bay); 3 mi. S of Aransas Pass	28.0	88.8	795								
" "	Bill's Point; Port Bay (Copano)	28.0	38.2	21						7		
" "	Slough on farm Hwy. to Bill's Point near Port Bay Club	28.0	142.4	2009								
" "	Tidal pond E of Aransas Pass shipyard on causeway	27.0	48.5	171	2	1						
XI:27	Rattlesnake Point (Port Bay) Copano	18.0	35.2	14	1	2	1		3	1		
" "	Bill's Point (Copano)	20.0	37.4	20					1	9		
XII:22	Bill's Point (" ")	17.0	38.3	98	1	1				7		

hardiness fits them well. However, the monetary measure of this use is unknown for no statistics are kept.

A few life history notes have been given in the papers cited above. Kilby (1955) gave considerable information including length frequency curves for four species, but the life cycles are still known incompletely.

METHOD

Stations were visited in a jeep with four-wheel drive, which permitted approach to almost any selected point on the bay shore. A fifty-foot minnow seine, with mesh of one-quarter of an inch stretched, was the collecting gear. One haul was made at each station, but length of haul was not standardized. All cyprinodonts taken were counted and the presence of commercial shrimp of the family Penaeidae was noted. A general physical description of each station was recorded. The stations were always in the same general area, but some changed with stages of the tide and drying of the ponds. Water temperatures were taken with a thermometer reading to tenths of a degree centigrade. A water sample was taken and the salinity was determined later in the laboratory by sea water hydrometers. Samples in which salinity was extremely high or low were checked by titration. Many samples of the fishes were preserved and are now in the Institute of Marine Science collections.

The authors made a few hauls together, but most of the time the first author had the assistance of Mr. C. A. Schultz. Others who occasionally helped haul the seine were H. H. Hildebrand and W. D. Simpson. The slope of the bottom, its type, depth and other factors varied not only from place to place but from time to time. Therefore, it was impossible to set up a standard drag and this matter was perforce ignored, except that at each station attempts were made to haul the seine in such a way that samples of what was present were obtained.

THE DATA

General Habitat Relationships

Table 1 gives the localities, temperatures, salinities, and shows the numbers of the various species caught at each station. Eighty-four stations were made from September 1950 to March 1951.

Examination of this table shows that the cyprinodonts are predominantly fishes of tidal ponds, sloughs, salt water creeks and bayous, rather than bays or open waters. *Gambusia affinis* (Baird and Girard) were not taken at all in open waters; *Fundulus jenkinsi* (Evermann) was taken once out of six times on a bay shore; *F. pulverens* (Evermann) was taken four out of 16 times on a bay shore; and *Mollienesia latipinna* (Lesuer) was taken once in 19 times. Gunter (1945) and Kilby (1955) found the same distribution of the last species. *Lucania parva* (Baird and Girard) is slightly more of an open water fish than the above species and was taken one-third of the time on the open shores. *Fundulus grandis* (Baird and Girard), *F. similis* (Baird and

Girard) and *Cyprinodon variegatus* (Lacépède) are quite common along the bay shores, but even these species were found more often in protected waters. *Adinia multifasciata* (Girard) belongs in the same group, but its distribution is more spotty and it is less abundant.

Table 2 lists the species in order of numbers caught and gives the number of times they were caught. The numbers caught in three other studies, two in Texas and one in Florida, are also given.

TABLE 2.
NUMBERS OF CYPRINODONTES CAUGHT IN THE COURSE OF THIS WORK
WITH SIMILAR FIGURES FROM THREE OTHER STUDIES.

	Times taken *	No.	Gunter (1945)	Gunter (1950)	Kilby (1955)
<i>Cyprinodon variegatus</i>	63	8,859	6,673	924	6,191
<i>Fundulus grandis</i>	49	1,099	454	74	1,979
<i>Mollienesia latipinna</i>	19	780	1	67	10,846
<i>Fundulus similis</i>	32	505	1,362	252	1,954
<i>Adinia multifasciata</i>	21	323	44	37	5,303
<i>Gambusia affinis</i>	8	173	—	421	2,026
<i>Lucania parva</i>	21	160	476	1,522	4,205
<i>Fundulus pulvereus</i>	16	60	—	8	—
<i>Fundulus jenkinsi</i>	6	24	—	—	—
TOTALS		11,845	9,010	3,297	32,504

* number of stations out of 84 total.

The figures given in the first column probably show a truer picture of the relative abundance of the Cyprinodontes in Texas coastal waters than the other two reports by the second author, because hauls were made in every type of environment in which these fishes live from one end of the Texas coast to the other. The hauls made by Gunter (1945) were all on the open shores of Copano and Aransas bays in south Texas, and are typical of the bay shores only. Thus, he did not take *Gambusia affinis* and *Mollienesia* was taken only once, although salinities were often quite low. The cyprinodonts reported by Gunter (1950) were taken in the sloughs and ponds (some of them fresh water) of Blackjack Peninsula on the Aransas Refuge in south Texas. This accounts for the larger numbers of *Gambusia*. The case of *Lucania parva* is less easily explained and will be discussed under salinity relations. The figures given by Kilby (1955) relate to two brackish marsh areas in Florida, where, in both species (several of which are not present in Texas waters and are therefore not listed) and numbers, the predominance of the Cyprinodontes is certainly overwhelming. Of 54,687 fishes he caught, over 40,000 were cyprinodonts.

The chief conclusion to be drawn from this table is that *Cyprinodon variegatus* is very abundant in most places where killifishes live. Two species of *Fundulus*, *grandis* and *similis*, are also widely distributed and abundant, the first more on open shores and the second more in protected waters. It may be significant that *grandis*, the more open

water species, grows to a larger size. *Mollienesia latipinna*, especially, and also *Adinia multifasciata* and *Lucania parva* are more abundant in protected waters.

Salinity Relationships

The catches of the various species as related to salinity of the water are set forth in Tables 3 and 4. The ranges and averages are given in Table 3; the numbers caught at certain arbitrary salinity groupings are given in Table 4. Over 30 per cent of the salinities encountered were well above that of normal sea water, and no such salinities were found during the previous work. It should be noted that all of these high salinities were found in south Texas, with several records from the Laguna Madre which is a notoriously hypersaline body of water. The south Texas region is semi-arid and it was subjected to a severe drouth before and during the time of this study. The previous work by the second author was carried out during wetter years.

Gambusia affinis is, of course, a fresh water fish which ventures into waters of moderate salinity. Eleven fish, or 7.2 per cent of the catch, were taken in water ranging from 11.3 to 20.6 parts per thousand saline. The remainder were caught at salinities of 3.5 or below.

Fundulus jenkinsi is reported only from a restricted area of the Texas coast. Our records indicate that it is found in waters of rather low salinity. Two specimens, 8.3 per cent of the catch, were taken at a salinity of 3.4, the remainder being caught at salinities ranging from 11.3 to 20.6.

Gunter (1945) found *Lucania parva* most abundant at salinities between 10.0 to 15.0 *per mille*. On the other hand Gunter (1950) found that 99.9 per cent of the catch on the Aransas Refuge was at salinities between 0.9 and 2.5. In the Florida west coast marshes Kilby (1955) found that 81 per cent of this species was taken at salinities of 10.0 or less. In this work, however, only 39.4 per cent of the catch was taken at salinities below 10.0 and the larger part was taken at salinities from 18.4 to 48.2, over 17 per cent being found in waters saltier than normal sea water. Certainly the fish tolerates a very wide salinity range and possibly its distribution is determined by factors other than salinity, which cause it to be found at low salinities in normal years.

It has been shown previously by both Gunter (1945) and Kilby (*op. cit.*) that *Adinia multifasciata* is found most often at medium salinities. The same thing was found in the present work, except that the salinities were toward the higher ranges, and over nine per cent of the fish were taken at hypersalinities. This fish is truly a brackish water species and is not found ordinarily at either the lowest or the highest salinities of coastal waters.

Fundulus similis was abundant only at medium and high salinities. *F. grandis* occurred over a wider range.

Mollienesia latipinna was found widely scattered over a broad sa-

TABLE 3.
SALINITY RANGES AND AVERAGE SALINITY AT ALL LOCALITIES WHERE EACH SPECIES WAS CAUGHT. RANGES AT WHICH THE SPECIES WERE TAKEN IN THREE OTHER STUDIES ARE GIVEN FOR COMPARISON.

	Salinity ‰/‰		Salinity Range		Kilby
	Range	Avg.	Gunter (1945)	Gunter (1950)	(1955)
<i>Gambusia affinis</i>	1-20.6	8.5	not taken	0.4-3.1	1.2-25.2
<i>Fundulus jenkinsi</i>	3.4-20.6	14.0	not taken	not taken	not taken
<i>Lucania parva</i>	1-48.2	24.9	2.1-24.2	0.7-16.3	0.1-28.2
<i>Fundulus pulvereus</i>	11.6-47.6	28.9	not taken	0.4-16.0	not taken
<i>Mollienesia latipinna</i>	1-53.9	24.1	10.0	0.4-16.3	1.2-37.6
<i>Adinia multifasciata</i>	13.1-53.9	30.4	8.4-35.7	3.1-16.3	0.8-37.6
<i>Fundulus grandis</i>	1.8-76.1	30.1	2.0-37.1	0.4-18.6	0.8-35.6
<i>Fundulus similis</i>	13.1-76.1	33.5	2.0-37.1	1.4-18.6	0.8-37.6
<i>Cyprinodon variegatus</i>	1.8-142.4	34.5	2.0-35.7	0.4-18.6	0.0-35.6

TABLE 4.
NUMBERS OF FISHES CAUGHT AT CERTAIN ARBITRARY SALINITY CLASSES.

	1	1-9.9	10.0-19.9	20-29.9	30-36.9	37-49.9	50-79.9	above 80.0
<i>Gambusia affinis</i>	95	46	10	1	—	—	—	—
<i>Fundulus jenkinsi</i>	—	2	10	12	—	—	—	—
<i>Lucania parva</i>	1	62	14	1	54	27	—	—
<i>Fundulus pulvereus</i>	—	—	8	7	24	19	—	—
<i>Mollienesia latipinna</i>	7	65	31	143	514	1	19	—
<i>Adinia multifasciata</i>	—	—	8	126	100	3	9	—
<i>Fundulus grandis</i>	—	19	439	249	181	200	17	4
<i>Fundulus similis</i>	—	—	28	130	140	99	48	56
<i>Cyprinodon variegatus</i>	—	130	165	569	2,226	1,318	922	2,804

linity range, but was taken only once at a hypersalinity.

Cyprinodon variegatus tolerates a very wide range of salinity, especially towards the higher ranges.

It is clear that except for *Gambusia affinis* all species had their greatest abundance between 20 and 36.9 parts per thousand salt. With regard to *Cyprinodon variegatus* the tendency was for the abundance to be greatest at an even higher salinity. However, the great abundance at salinities above 80 parts per thousand should not be taken as the normal distribution or preference of this species, because in such cases both the fishes and the salts were concentrated in drying ponds. They were withstanding the salinity but they probably had not selected it. This was certainly the case where the salinity was 142.4 parts per thousand, calculated as if it were sea water. It should be understood, however, that water at such salinities is not sea water, for some salts are precipitated before sea water attains such concentrations and the complex is changed. This determination was made with hydrometers. Titration gave a salinity of 130.0 *per mille*, but it was not certain that all the chloride was precipitated and at this concentration. So far as we know this is the highest salinity at which living fish have been reported. This salinity must be very close to the toleration limit, for one haul in the Laguna Madre where the salinity was 147.0 showed only dead *C. variegatus*.

Tables 3 and 4 show that *Fundulus grandis*, *F. similis* and *Cyprinodon variegatus* have very high salinity preferences and tolerances, and these three species should in our opinion be classed as fully marine.

Species Characteristics

The Cyprinodontes in this area are not easy to separate on the basis of external meristic characters and for some species it is virtually impossible. However, the field worker quickly learns to distinguish them all by color and subtle differences of shape, some of which are difficult to describe.

Table 5 gives a series of body measurements and scale counts for both sexes of the various species over a fairly wide length range. The species with lower scale counts are *Cyprinodon variegatus*, *Adinia multifasciata*, *Lucania parva* and *Mollienesis latipinna*; the species with higher counts are *Fundulus grandis*, *F. similis* and *F. pulvereus*.

It is also clear from Table 5 that the deeper-bodied species are *Cyprinodon variegatus*, *Adinia multifasciata* and *Mollienesis latipinna*. The slimmer species are *Fundulus jenkinsi*, *F. similis* and *F. pulvereus*.

The fishes with the smallest eyes, proportionally, are *Fundulus grandis* and *F. similis*. Those with the largest eyes are *Gambusia affinis* and *Lucania parva*. The latter two are also the smallest species.

The so-called longnose killifish, *Fundulus similis*, was found to have a slightly longer snout than the other fishes at lengths of 25 to 100 mm, but the difference was not great.

Table 6 gives the dorsal and anal ray counts of the various species,

TABLE 5.
PROPORTIONAL MEASUREMENTS AND SCALE COUNTS OF BOTH SEXES OF A NUMBER OF SPECIES.
(Length Readings in Millimeters)

Number	Total Length		Standard Length		Depth in S. L.		Head in S. L.		Snout in Head		Eye in head		Scales	
	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.
<i>Gambusia affinis</i>	♂ 4 ♀ 22	23-31 20-32	26.0 26.9	19-23 16-26	20.8 21.6	4.0-4.5 3.8-4.5	4.25 4.16	3.7-4.0 3.3-4.0	3.93 3.60	3.1-3.5 3.0-4.0	3.35 3.47	2.5-3.1 2.8-3.5	32-34 30-33	32.5 31.7
<i>Mollienesia latipinna</i>	♂ 30 ♀ 44	24-52 17-57	35.4 38.3	18-40 13-46	27.9 30.1	2.7-3.3 2.8-3.5	2.98 3.13	3.0-3.7 2.9-3.7	3.40 3.36	2.9-4.0 3.0-4.0	3.32 3.42	2.8-3.5 2.7-4.0	27-31 26-31	28.8 28.8
<i>Fundulus jenkinsi</i>	♂ 9 ♀ 15	26-45 26-60	37.8 37.5	21-37 20-49	30.6 28.9	4.4-5.3 4.6-5.8	4.79 4.69	3.2-3.5 3.2-3.5	3.29 3.39	3.0-4.0 3.0-4.0	3.38 3.49	2.9-3.8 2.8-3.8	34-37 33-37	34.8 34.9
<i>Fundulus pubereus</i>	♂ 17 ♀ 41	30-51 16-50	38.4 31.4	24-47 12-47	31.9 25.1	3.5-5.0 4.0-5.5	4.32 4.51	2.8-3.5 3.0-3.5	3.25 3.20	3.4-4.0 3.3-4.5	3.75 3.79	3.0-4.0 3.0-4.0	36-40 35-42	38.1 38.2
<i>Fundulus similis</i>	♂ 11 ♀ 5	21-80 25-100	48.7 75.6	17-64 20-80	38.5 60.2	4.0-5.2 3.9-5.5	4.52 4.50	2.9-3.3 3.0-3.2	3.05 3.08	2.8-3.5 2.7-3.3	3.12 2.84	3.0-4.5 3.3-5.9	35-40 37-38	37.5 37.6
<i>Fundulus grandis</i>	♂ 17 ♀ 21	37-112 29-115	67.5 64.5	30-92 23-96	57.7 52.9	3.2-4.5 3.5-5.0	3.83 3.94	3.0-3.6 3.0-3.6	3.32 3.36	3.0-3.7 3.0-3.8	3.39 3.45	3.4-5.0 3.0-4.8	36-42 35-41	38.8 38.5
<i>Lucania parva</i>	♂ 19 ♀ 34	23-38 19-36	29.2 28.3	19-31 16-32	24.2 23.4	3.5-4.3 3.5-4.5	3.81 3.94	3.0-3.7 3.0-4.0	3.34 3.37	3.6-4.5 3.5-5.0	3.96 3.78	2.5-3.3 2.5-3.5	26-30 26-31	28.3 28.8
<i>Adinia multifasciata</i>	♂ 39 ♀ 48	16-36 16-37	27.5 27.6	13-28 12-28	22.1 21.9	2.5-3.5 2.6-3.6	2.96 3.13	2.8-3.3 2.7-3.4	2.98 3.04	3.0-4.0 2.8-4.0	3.53 3.45	2.5-3.5 2.5-3.5	25-28 24-28	26.8 26.9
<i>Cyprinodon variegatus</i>	♂ 5 ♀ 15	35-52 20-51	43.8 34.8	27-42 16-40	34.0 27.1	2.2-2.7 2.3-3.0	2.38 2.58	2.8-3.2 2.8-3.3	3.06 3.01	3.5-4.0 3.4-4.1	3.62 3.69	3.5-4.0 2.9-3.6	27-29 25-29	28.2 27.3

TABLE 6.
DORSAL AND ANAL RAY COUNTS FOR BOTH SEXES OF THE VARIOUS SPECIES. NUMBERS ARE THE NUMBER OF SPECIMENS WITH THE RAY COUNT LISTED AT THE TOP OF THE COLUMN.

	Number of Rays															Dorsal insertion relative to anal				
	Dorsal																			
	6	7	8	9	10	11	12	13	14	15	9	10	11	12	13	Anal				
<i>Gambusia affinis</i>	♂	4									4									
	♀	1	21								20	2				Behind				
<i>Mollinnesia latipinna</i> *	♂						7	27	4	1	34	2				Distinctly Before				
	♀					3	3	19	52	6	4	50	2			Before				
<i>Fundulus jenkinsi</i>	♂		1	8								4	3	2		Distinctly Behind				
	♀		2	13								2	11	2		Behind				
<i>Fundulus pulvereus</i>	♂		1	4	12							17				Slightly in front to slightly behind				
	♀		1	2	24	12	1				11	27	2			Slightly in front to slightly behind				
<i>Fundulus grandis</i>	♂				10	3	4				4	12	1			Over to Slightly before				
	♀				1	7	12	1			5	12	4			Slightly before				
<i>Fundulus similis</i>	♂				2	2	4	3			3	6	2			Slightly before				
	♀				1	1	2				1	3				Slightly before				
<i>Lucania parva</i>	♂				1	3	10	4			4	8	6			Before				
	♀			1	2	6	21	4			1	10	18	5		Before				
<i>Adinia multifasciata</i>	♂			31	8							2	32	5		Before				
	♀			41	5							2	36	8		Before				
<i>Cyprinodon variegatus</i>	♂					4	1				1	3	1			Before				
	♀				1	4	10				4	10	1			Before				

* Fewer anals than dorsals counted, hence numbers do not correspond.

with remarks on the insertion of the dorsal relative to the anal.

Examinations of color markings were made on live specimens and these are given under the individual species accounts in the next section.

It should be noted at this point that the "Amazon molly" females, *Mollienesia formosa* Girard, which have their northern limit on the Texas side of the Rio Grande, were not found during this investigation. However, specimens were collected later by other workers in resacas near the Rio Grande. They are not included in this account because we saw no specimens and we are not certain that they belong with the salt water fauna.

Life History Notes

Gambusia affinis

Forty-four fish taken along the eastern part of the coast between October 23 and 25, 1950 ranged from 20 to 32 mm in total length. Twenty-three specimens caught on January 28, 1951 in the Galveston Bay ranged from 22 to 48 mm in length. Ninety-five caught in a resaca near the Rio Grande on March 3, 1951 ranged from 23 to 40 mm in length. Only two females had attained a length of 40 mm.

In this account we have not used subspecific names, since the measurements, locality records and presumably the specimens themselves will serve the purposes of taxonomists who wish to relate these fishes to other populations. However, all indications are that this fish corresponds to *G. a. affinis* of most authors (cf. Knapp, 1953).

Specimens from the Galveston region had a rather prominent, but fine cross-hatching of gray and black on the back and sides. The fins were colorless, except that the dorsal was black-edged with two vertical rows of black dots. In some males there were three rows of these dots on the dorsal. A row of these dots formed an indistinct vertical stripe on the mid-caudal. The gonopodia on four males, 23 to 31 mm long, ranged from 6 to 8 mm in length.

The stomachs of two specimens contained only animal food, consisting of small fish, small crustaceans and annelids.

Mollienesia latipinna

Seventeen specimens taken in September, 1950 were 12 to 43 mm long; 533 fish caught in October were 13 to 56 mm long; 141 fish caught in November were 31 to 53 mm in length; 12 taken in January 1951 were 12 to 41 mm, and 71 taken in March 1951 were 24 to 71 mm long. Among these, thirty were males. A group of 260 fish caught in the Galveston area in September 1950 showed a ratio of 64 males to 196 females; another group of 141 taken in November, 1950 near Indianola had a ratio of 30 males to 111 females. The largest male caught was 53 mm long, the largest female 71 mm.

Both males and females had seven or eight horizontal bluish stripes along the body. There were also three to six vertical stripes under what could be called the shoulder region. There were small yellow

spots on the sides of some females. In some females the dorsal, anal and caudal were black-edged. In others the anal was pale and the caudal was dusky; in still others the caudal was pale or faintly black-edged. There were three or four rows of horizontal spots on the dorsal. The males differed from the females chiefly in more vivid coloration and the fact that the caudal was yellow and more heavily black-edged.

All specimens examined had a purely black peritoneum.

Two females taken on August 26, 1950 had bright yellow eggs, 1.5 to 2 mm in diameter. A fish with young presumably nearing birth was taken on September 23, 1950.

One male, 31 mm long, had a gonopodium 6.5 mm in length.

Fundulus jenkinsi

Of the 24 specimens caught, nine were males from 26 to 45 mm long. The 15 females were 25 to 60 mm long.

Both males and females are cross-hatched on the back and sides and spotted on the sides. The spots may be round or sometimes elongated into little vertical bars. The cross-hatching may be very faint or a prominent gray-green. In some the spots are above the midline and in a few the spots form an almost continuous midline along the side. In some females there is a faint midline with no spots. Every fish collected had an almost horizontal bar on the opercle at about the eye level.

A female with eggs less than 0.25 mm in diameter was taken on September 26, 1950. On January 28 1951 a female was taken with clear eggs, 0.25 mm in diameter; another taken at the same time had clear eggs 0.5 mm in diameter.

This fish has not been mentioned often in the literature since it was described by Evermann from Dickinson Bayou, where it was found again during this investigation and at that location only. However, it is known to extend over most of the northern Gulf coast, although its distribution is scattered and spotty and is doubtless determined by some special ecological requirement which is unknown. Garman (as cited by Hubbs, 1926) recorded it from Alabama in 1895 and Hubbs (1926) reported a specimen from Prevost Island, St. Tammany Parish, Louisiana, Fowler (1945) listed five specimens from Moss Lake, Louisiana and, in a table (p. 34), listed it from the Rio Grande drainage of Texas. Bailey, Winn and Smith (1954) recorded 80 specimens from the Escambia River, Florida, where the salinity ranged from 4.5 to 24.4 *per mille*. Miller (1955) gave the known range as from the Escambia River to Houston. Galveston would have been a little more specific. He also states that Fowler (*op. cit.*) listed the species from the Rio Grande. However, Fowler's table refers only to river basins or drainages, and the record is very indefinite and doubtful, especially since he did not mention the fish in his account of Texas species. Since our own rather extensive col-

lections did not reveal *F. jenkinsi* west of Dickinson Bayou, it seems best to consider the range limits set by Miller (*op. cit.*) as correct until more information is available.

Fundulus pulvereus

Of the fifty specimens sexed 15 were males from 30 to 46 mm long. The females were 16 to 45 mm long. No fish under 20 mm long was caught except at one haul in Lavaca Bay on November 3, 1950, where eight of ten specimens were from 15 to 17 mm long.

The base color of the females ranged from olive to dark gray-blue above, shading to gold on the sides and to silvery or cream on the belly; large discrete dark dots are scattered over the body, but are chiefly confined to the area above the midline or slightly below. However, this dotting is quite variable. Five females had the dots only above the midline; in one fish they formed a row. Six females had dots only along the midline and ten of them had the dots both above and below, although they were most numerous above. A few females had faint, broken horizontal stripes. The fins were pale to dusky and pectorals were yellowish at the base. The suborbital was sometimes rather golden.

The males had 12 to 17 bluish vertical stripes, with silvery interspaces of the same width. There were some fainter horizontal stripes. They were olive on the back and silvery on the belly. There were black and white horizontal stripes on the posterior part of the dorsal. The anals and dorsals were dusky or the anal was yellowish dusky. The caudal was also dusky yellowish. A dorsal ocellus was clear, faint or absent.

A fish with a developing ovary was seen on October 3, 1950. Ovaries with very small eggs were seen on October 23. Ovaries with egg 0.2 mm in diameter were also seen on that date, on October 25, and October 2. Clear eggs 0.33 mm in diameter were seen on November 3. A fish, apparently ripe, with yellowish eggs 1.0 mm across, was taken on October 2. Fish with clear eggs, 0.5 mm in diameter were taken on January 19 and 28, 1951. It appears that this species spawns in the fall and winter, if not other seasons as well.

Aquatic insects were found in one stomach and two isopods, about 1.0 mm long, were found in another.

Miller (1955) gives the range as Bay Minette, Alabama to Corpus Christi, Texas.

Fundulus similis

It has been previously stated that ripe males and females are present in the Aransas Bay area from April to August (Gunter, 1945). The second author has observed this fish spawning in July on the shores of Copano Bay. They get as close to shore as possible and seek small depressions and cups of water similar to those of a horse track, connected to the bay by the merest fingerlet of water through which the fish skitter adeptly. In the little potholes they wriggle excitedly and

convulsively with the usual motions of spawning fish, sometimes standing almost upright on their tails. Eggs were not recovered.

In the present work the smallest specimens caught for each month from September to March respectively were 20, 23, 25, 31, 32, 38 and 43 mm long. The larger fish ranged from 83 to 114 mm long, but not in sequential order by months. The largest was taken in February. Five large males ranged from 77 to 92 mm in length and averaged 81.6 mm; eight large females were 86 to 114 mm long and averaged 99.7 mm. These were not taken in the breeding season and the sizes are somewhat larger than those given by Gunter (*op. cit.*).

This species has from 8 to 17 vertical black stripes on the sides. The posterior one or two may end dorsally in a round spot. There is sometimes a more faded spot ventral to these posterior stripes. The dorsal, anal and caudal fins are pale or dusky and black-edged.

Fundulus grandis

The numbers of fish caught by months and the size ranges are shown in Table 7.

TABLE 7.
NUMBER OF *Fundulus grandis* CAUGHT EACH MONTH AND THE
LENGTH RANGES.

Month	Number caught	Length ranges (in mm)
September	15	22-93
October	832	22-111
November	186	18-88
December	1	42
January	37	29-91
February	23	30-86
March	14	28-131

Gunter (1945) found the smallest fish from June to August and the greatest catches in midsummer and midwinter. These data are somewhat different, possibly because the total area where the fish lives was sampled. The winter of 1950-51 was rather severe, which probably accounts for the low winter catch, the fish having moved out of the shallows. In shallow ponds, which froze over at the time of the severe freeze and fish kill of January 28-February 1, (*cf.* Gunter, 1952) the fish may have been wiped out, as was particularly noted for *Cyprinodon variegatus*. Kilby (*op. cit.*) found small fishes at all periods of the year and small abundance increases in certain months in winter, spring and fall.

Nine males ranged from 62 to 131 mm long and averaged 93.5. Seven females were 82 to 114 mm long with an average of 105.4.

The fish is predaceous and three specimens were found with partially swallowed mollies sticking out of their mouths. Two stomachs contained aquatic insects and vegetable matter.

The base color is a dull greenish above shading to lemon yellow

below. There are 12 to 19 faint stripes on the sides. The anal and lower half of the caudal may be yellow or the anal, dorsal and caudal may be dark with white splotches at the base. The first two may be edged with yellow, and the caudal may be edged with white. The ventrals are yellow and the pectorals are pale. In some males the dorsal and caudal are flecked with silver and the anal is pale. In the males coloration is much more vivid with the silver flecking and striping noticeable, while the larger females may appear olive to dull olive yellow below.

Yellow eggs, 2.0 mm in diameter, were stripped from females on October 10, 24 and 25, 1950.

Lucania parva

The length range of this species was 17 to 48 mm. Only three specimens below 20 mm were caught, in October and November.

The upper part of the body is pale green or olivaceous shading to pearly on the belly. The scales are black-edged, making a dark cross-hatching on the back and sides. The anal is black-edged, and there is a dark blotch on the leading edge of the dorsal in the male. The males also have some yellow or yellowish orange on the base of the dorsal, anal and caudal and the subopercle is faintly washed with gold; in the female this area is more silvery. The caudal may or may not be black-edged in the male. There is a faint midline stripe.

None of the above color differences hold invariably for the males and females and it may be that the colors are enhanced during the breeding season. Only one thing seemed to hold and that was concentrations of the melanophores at about one-third the height of the dorsal of the males, between the first and second and second and third rays, which appear with the naked eye to be two darkly drawn lines. In the females these melanophores are not so closely associated as to look like a black streak.

Eggs 0.33 to 0.5 mm across were taken in the latter part of November. They were clear. A fish with yellow eggs, 1.0 mm in diameter was taken on January 28, 1951.

Larval crustaceans and small annelids were taken from one stomach; another contained small white mollusc shells and crustaceans.

Adinia multifasciata

The size range of 360 fish was 16 to 38 mm. Eleven fish under 20 mm long were taken in October, November and January, seven being taken in one haul on the Lavaca Bay shore in November.

All fins except the pectorals may be yellow or more rarely they are all pale; or there may be combinations of yellow and pale fins, in which case the anal is always yellow, or the anal and ventrals are yellow.

The body base color is greenish on the back, with a yellowish tinge on the side shading into white on the belly. There are many narrow vertical stripes of dark blue gray separated by silvery areas. The

stripes are not straight but are somewhat irregular, giving a variegated appearance.

Four ripe females with yellow eggs, 0.75 to 1.0 mm in diameter, were taken on October 18, 1951.

One stomach contained algal detritus and one contained pieces of a dragonfly.

Cyprinodon variegatus

Gunter (*op. cit.*) found that small fish were added to the population from June to December. The present data are not greatly at variance with that statement, although some quite small fish were taken in January. Gunter also found the greatest abundance in winter, but in the present study it was found in the fall. Kilby (1955) found fish 15 mm in length or less in every month except January, February and March. He took the greatest numbers of fish in August and October.

Forty-two males taken during this investigation ranged from 35 to 58 mm long and averaged 45.0 mm. Thirty-six females were from 31 to 55 mm long and averaged 46.5 mm. The distributions are shown in Table 8.

TABLE 8.
NUMBER OF SPECIMENS OF *Cyprinodon variegatus* CAUGHT EACH
MONTH AND THE LENGTH RANGES.

	Number	Length Range (in mm)
1950		
September	875	9-43
October	3,215	13-64
November	3,093	13-47
December	98	17-42
1951		
January	329	16-45
February	419	21-58
March	299	21-50

Although this fish is resistant to cold, and no dead cyprinodontid has ever been found on the open shores following the fish-killing freezes which strike the Texas coast, many in the shallow isolated ponds were wiped out by the hard cold wave which struck on January 28, 1951.

This is a pugnacious little fish and it puts all other cyprinodonts to flight. In aquaria it finally kills the larger species by chasing them incessantly and nipping off their fins.

The color of this common little fish is too well known to deserve comment.

The stomachs of five females contained vegetable matter.

Raney, *et al.* (1953) described the breeding habits of this fish in Florida, in which the males set up certain territories and hold them against all comers except for the females, with which they breed or

attempt to breed. The second author observed the same behavior of the species in a roadside ditch connecting with Redfish Bay at Aransas Pass, Texas.

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ABSTRACT

Sixty stations were set up between the Rio Grande and the Sabine River, covering the habitats of the salt water Cyprinodontes along the bay shores, sloughs and tidal ponds. These were visited eighty-four times, about one and a half rounds of all stations, between September 1950 and March 1951. Drags were made at each station with a fifty foot minnow seine with mesh one quarter of an inch stretched. Water temperatures were taken and salinities were determined later by hydrometer. Some samples were checked by titration. All cyprinodonts captured were counted and measured. Sexual condition and coloration were noted and some stomach contents were noted. External meristic counts were made.

In order of abundance the nine species taken were: *Cypri-*

nodon variegatus, *Fundulus grandis*, *Mollienesia latipinna*, *Fundulus similis*, *Adinia multifasciata*, *Gambusia affinis*, *Lucania parva*, *Fundulus pulvereus* and *F. jenkinsi*. There were 8,859 of the first taken and only 24 of the last. *C. variegatus* was almost three times as abundant as all other species together. *C. variegatus*, *F. grandis* and *F. similis* are fairly abundant on open shores, while the others are found mostly in protected waters. As a whole, the cyprinodonts are more inhabitants of sloughs and ponds than bay shores and they are extremely rare on the Gulf beach. Due to a severe drouth the salinities at many stations were quite high and in drying ponds they were about 80 ‰. Only *Gambusia affinis* and *F. jenkinsi* were not taken at salinities higher than 30 ‰; *F. grandis*, *F. similis* and *C. variegatus* were sometimes caught, the latter quite abundantly, at salinities above 80 ‰ and on one occasion this fish was taken where the density measurement was equivalent to 142.4 ‰ saline, calculated as sea water. It is assumed that the fishes taken at extremely high salinities did not select them, but were merely withstanding them after having been caught in drying ponds and sloughs.

Species with lower scale counts were: *C. variegatus*, *Adinia multifasciata*, *Lucania parva* and *Mollienesia latipinna*; species with higher counts were *F. grandis*, *F. similis* and *F. pulvereus*. The deeper bodied species were *C. variegatus*, *A. multifasciata* and *M. latipinna*; the slimmer species were *F. jenkinsi*, *F. similis* and *F. pulvereus*. The fishes with smallest eyes proportionally were *F. grandis* and *F. similis*; the two smallest species, *G. affinis* and *Lucania parva*, had the largest eyes. Detailed color markings were given for all species except for the well known *C. variegatus*. The smallest *Mollienesia* were taken in September and January and a fish with young nearing full term was taken in late September. Female *F. jenkinsi* averaged several mm longer than males. They were found with developing eggs in September and January. The species was taken only at the type locality, Dickinson Bayou. Male and female *F. pulvereus* were found to be about the same size. The smallest fish were taken in early November. Ripe fish were taken in November, but females with developing eggs were also found in January. *F. similis* were observed spawning in minute pot-holes or depressions on the bay shores in July. The smallest fish taken increased from 20 mm in total length in September to 43 mm in March. Females were slightly larger than males. Ripe female *F. grandis* were taken in October and the smallest fish were taken in November. Ripe *Adinia* were taken in October. The smallest *C. variegatus* were found in September, October and November. The territorial defense of males during the breeding season, as previously described by other workers, was observed. Stomachs of two *Gambusia* contained fish, crustaceans and annelids. Aquatic insects were found in one *F. pulvereus* stomach and two isopods were found in another. Two *F. grandis* contained aquatic insects and vegetable matter, and three had incompletely swallowed small *Mollienesia*. One stomach of *Adinia multifasciata* contained algal detritus and another contained pieces of a dragonfly. The stomachs of five female *C. variegatus* contained vegetable matter.

