Lamar State College of Technology Research Series

Paper No. 17

Reprinted from COPEIA, 1958, No. 1, pp. 16-22, February 21
Printed in U. S. A.

Life History of the Pigmy Seahorse, *Hippocampus zosterae* Jordan and Gilbert, at Cedar Key, Florida[1]

KIRK STRAWN

Reprinted from Copeia, No. 1, February 21, 1958

Lamar State College of Technology
Beaumont, Texas

Reprinted from COPEIA, 1958, No. 1, pp. 16-22, February 21
Printed in U. S. A.

Life History of the Pigmy Seahorse, *Hippocampus zosterae* Jordan and Gilbert, at Cedar Key, Florida[1]

KIRK STRAWN

LITTLE is known of the life history of the pigmy seahorse, *Hippocampus zosterae*.[2] From June, 1948 to June, 1957, large samples were taken at Cedar Key, Levy Co., Florida. From February, 1950 to February, 1951, bilunar monthly collections were made at 28 stations on three grass flats during spring tide periods. Further data were obtained from seahorses collected in other parts of the Gulf of Mexico, including some from Harbor Island, Texas, which were kept alive at The University of Texas. Pushnets (Strawn, 1954a), beam trawls, and minnow seines were used to collect seahorses. Seining was discontinued when it was discovered that one person could collect more seahorses with a pushnet than two could with a seine. Three-eights-inch stretched mesh netting was used in both the pushnets and trawls because only small seahorses could go through it.

Cedar Key specimens, except for a few found on vegetation floating in the channels, were taken on the grass flats bordering the islands or between these keys and the mainland. The grass flats in this area are restricted to above the extreme low water mark except for limited fringes. Deeper grass flats in clearer offshore water were not investigated. The angiosperms growing on the grass flats at Cedar Key are: *Diplanthera wrightii* (Ashers); widgeon grass, *Ruppia maritima* L.; *Halophila engelmanni* Ashers; turtle grass, *Thalassia testudinum* König; and manatee grass, *Syringodium filiforme* Kütz.[3] Of the three most conspicuous plants, *Diplanthera* occurs in the shallowest water, *Syringodium* is predominant in the deepest water, and *Thalassia* is mixed in at intermediate depths. In the spring, summer, and fall the seahorses live wherever these plants occur. In the winter, when leaves exposed to the air during low tide are killed back by desiccation, seahorses tend to concentrate in deeper water and in tide pools where the vegetation is the heaviest. In addition to the seed plants, year-round residents, numerous algae flourish and become extremely abundant on parts of the grass flats in the spring.

A report of size, sex, location caught, and type of net used is given by Strawn (1953). Nearly all sea horses collected from February, 1950 through February, 1951, are plotted in Figure 1 by sex, length in mm., and the time of year taken. The variation in the number of seahorses plotted in this figure for different collecting periods is as much the result of variation in the excellence of collecting conditions and of collecting intensity as of changes in population size. The length was measured, following Ginsburg (1937), from the tip of the cornet, the knob on top of the head, to the tip of the tail. This measurement was made by placing a fish on a millimeter rule with the tip of the coronet at the 0 mm. mark and with the axis of the head held perpendicular to the tail. Forceps were used to uncoil the tail. Every attempt was made to exert as little pressure as possible in straightening the tail because stretching would add as much as a millimeter to the length measured. Many of these specimens were remeasured three years later, and while many measured a millimeter longer, none varied by more than one millimeter from the original measurements. Ginsburg used calipers while holding the tail straight with a glass slide. He held the lower profile of the head at right angles to the tail which gives essentially the same measurement on these small seahorses as the method used in this study. Measurements, taken to the closest millimeter, ranged from 7 to 38 mm.

SEX RATIO

The sex of seahorses 16 mm. long collected in the summer could be determined by the presence or absence of a brood pouch. In specimens of this size the brood pouch was represented ventrally on the first few caudal segments by an elevated ridge surrounding the area of the future pouch. At the end of the breeding season, the last of October, the ridges were not present in individuals under 18 mm., and in the middle of December, a 20 mm. male had the stage of development characteristic of the 16 mm. males of summer.

[1] An enlargement of part of a master's thesis prepared at The University of Florida, 1953. The last phases of this study were supported by a Duke University Marine Laboratory National Science Foundation Grant, 1957.

[2] *Hippocampus regulus* Ginsburg is here considered a synonym of *H. zosterae*. Populations with a mode of 11 dorsal rays range from Mexico to Cedar Key, and populations with a mode of 12 dorsal rays occur from Tampa Bay to Key West and Biscayne Bay, Florida.

[3] See Thorne (1954) for a discussion of flowering plants of the Gulf of Mexico. Dandy and Tandy (1939) found *Cymodocea manatorum* Ashers to be a synonym of *Syringodium filiforme* Kütz.

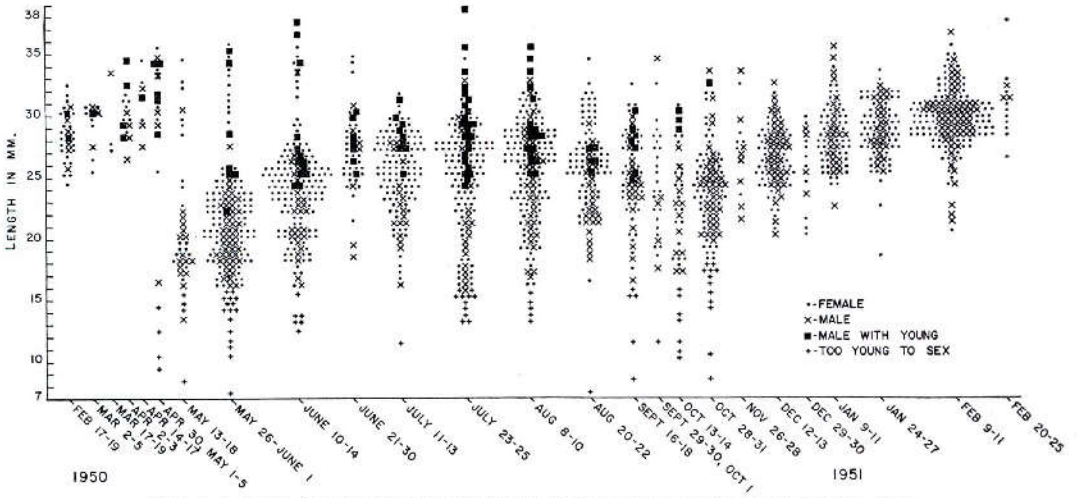

Fig. 1. Length frequency distributions of the pigmy seahorse at Cedar Key.

Males below these seasonal lengths rarely had recognizable ridges.

In collections made at Cedar Key, females outnumbered males throughout the 12-month period (Table I). Collections made February 17 and 18, 1951, south of the west end of Gandy Bridge, Old Tampa Bay, Pinellas Co., Florida, contained 394 fish of which 47.71 percent were males. Gudger (1906) stated that female pipefish, *Syngnathus floridae* Jordan and Gilbert, at Beaufort, North Carolina, outnumbered males seven to three. This is similar to the summer ratio found in *H. zosterae* at Cedar Key.

Data presented in Table II indicate that the sex ratio obtained can be influenced by the collecting site. Group 1 stations had plants with longer living leaves than Group 2 stations during the winter when exposure to air is the greatest and the plants are killed back by desiccation. On the Group 2 stations there were about two females to one male during all seasons. On the Group 1 stations there were two females to one male only during the period from May 27 to August 22, 1950; all the rest of the year there was approximately one female to one male. When sex ratio of seahorses collected on the Group 1 stations in the summer is compared to the ratio of those collected on the Group 1 stations in the fall a X^2 value of 9.2 is obtained. A difference in sex ratios as great as or greater than that observed could be expected on a chance basis less than once in two hundred investigations. The sex ratio of the fall Group 1 sample compared to that of the fall Group 2 sample gives a X^2 value of 3.7 and a probability of .06. The difference between the sex ratios of these two samples, therefore, is not of conventional statistical significance but is suggestive. Thus, the sex ratio of a sample of pigmy seahorses is definitely correlated with the season and, probably, with the types of environmental vegetation.

TABLE I

PER CENT OF MALE TO FEMALE PIGMY SEAHORSES AT CEDAR KEY FROM FEBRUARY 17, 1950 TO FEBRUARY 11, 1951

	Number	Per cent	
		♀♀	♂♂
Feb. 17–May 18	115	57	43
May 26–Aug. 22	854	69	31
Sept. 16–Oct. 31	211	57	43
Nov. 26–Feb. 11	407	57	43
Total for year	1587	63	37

TABLE II

SEX DISTRIBUTION OF THE PIGMY SEAHORSE ON GROUPED STATIONS AT CEDAR KEY FROM FEBRUARY 17, 1950 TO FEBRUARY 11, 1951

	Group 1 Stations			Group 2 Stations		
	Total	Per Cent		Total	Per Cent	
		♀♀	♂♂		♀♀	♂♂
Feb. 17–May 18	41	51	49	32	66	34
May 27–Aug. 22	325	67	33	178	71	29
Sept. 16–Oct. 31	91	49	51	53	66	34
Nov. 26–Feb. 11	101	52	48	9	67	33

Breeding Season

Males with young were found during the period extending from late February, 1950 to the end of October, 1950 (Fig. 1). Other indications of breeding are a flabby pouch on males without young and females with full bodies and large eggs in the ovaries. A courting male pumps his pouch full of water until it looks like a balloon ready to burst. In contrast, the pouch of a male out of breeding season is a shriveled structure that requires modification before it can be distended. Data indicate that breeding commences in early or mid-February and ends by late October or early November. During September and October of 1948, extensive collections were made in search of males with young in their pouches. Few were found after late September, and no males with young were caught after the middle of October. In the falls of 1949 and 1950, a similar decrease in breeding was observed though one gravid male was collected the last of October in 1950. By late October, 1950, most males had shriveled pouches, and the few females with eggs contained exceptionally small numbers. None of the males collected in November and December of 1948 and December, 1949, had young in their pouches. From November 26, 1950 to February 11, 1951 (Table III), none of 158 males, 25 mm. or longer, were gravid. A collecting trip in early March, 1949, produced gravid males. On February 19, 1950, two males containing advanced embryos and several females with large eggs were taken. One of these males had almost fully developed young that by warm water Harbor Island, Texas standards (Strawn, 1954b) must have been in the pouch for about 9 days and probably longer since the developmental rate should be slower at winter temperatures. Thus males with young and females with ripe eggs most certainly were present by the tenth of February, 1950. Large series of seahorses were collected with a trawl on February 9–11, 1951, to ascertain whether breeding had started as early as it had the preceding year. Some of the females had partially developed eggs whereas no macroscopic eggs had been apparent in December, but all of the males still had shriveled brood pouches. Two of five females collected February 23, 1951, had large ovarian eggs and the one male had a flabby brood pouch. Farther south the breeding season starts earlier and ends later. On February 17 and 18, 1951, 74 of 188 males taken south of the west end of Gandy Bridge, Pinellas Co., Florida, were gravid. These are considered to be the first broods of the year since only one male had fully developed young. Breder (1940) observed a Palmetto Key fish (Lee Co., Florida, almost due west of Fort Myers) give birth to a brood on February 9, 1939. Two of four breeding size males and two of three adult females collected by Royal D. Suttkus and Edwin B. Joseph at Key Largo, Monroe Co., Florida, on November 17, 1953, were gravid.

Table III

Number of Male Pigmy Seahorses at Cedar Key with and Without Young in Pouch from February 17, 1950 to February 11, 1951

	22–24 mm.			25 mm. and larger		
	With	Without	Per Cent With	With	Without	Per Cent With
Feb. 17–March 19 Vernal to Autumnal Equinox	0	0	0	3	10	23
(April 1–Sept. 18)	7	55	11	100	57	64
Sept. 29–Oct. 31	0	25	0	4	15	21
Nov. 26–Feb. 11	0	14	0	0	158	0

The breeding season appears to correlate closely with seasonal changes in the length of day. This is inferred from the proportion of 25 mm. or longer males which had young in the brood pouch during different seasons. Although males with young in the pouch ranged from 22 to 38 mm., those under 25 mm. are of little use for this purpose since only seven of these contained young. The number and per cent of males 22–24 mm. and 25–38 mm. with and without young are given in Table III. It may be seen that during the period between the vernal and the autumnal equinox about two-thirds of the 25 mm. or longer males had young in the pouch, while in the 36 days following the autumnal equinox and the 30 days preceding the vernal equinox, less than one-fourth had young. During the period from November 26, 1950 through February 12, 1951, none had young out of a total of 158. In terms of hours of sunshine per day (Marvin, 1944) this means that no breeding was found during less than 11.1 hours light, fewer than one-fourth of the males were breeding with 11.1 to 12.1 hours light, and about two-thirds of the males were breeding with over 12 hours light.

Channel temperatures (Fig. 2) are not closely correlated with the breeding season of *H. zosterae* at Cedar Key. Breeding stopped in the fall when the channel temperatures were still much higher than when breeding was first observed in the late winter and spring. Breeding continued during March and April at temperatures lower than those found when breeding ceased in the fall. Although temperature does not correlate closely with the beginning and end of the breeding season, it may be important as a wide limit. The earlier start of the breeding season in 1950 than in 1951 may be the result of the warmer January and early February temperatures of 1950 (Fig. 2).

Salinity appeared to have had little effect on the breeding season in 1950. Heavy breeding occurred following the periods of highest (33.8 0/00) and lowest (9.7 0/00) salinities in June, 1950, and in the middle of September, 1950, respectively, as well as at intermediate salinities.

Seasonal changes in the percent of time the flats were exposed to the air at low tide did not delimit the breeding season. Breeding occurred in late winter and early spring during periods of extreme exposure and in August when exposure was the least. Possible peaks in breeding caused by changes in tide level or amount of moonlight during the lunar month (Korringa, 1947) were not obvious from the data and were not investigated.

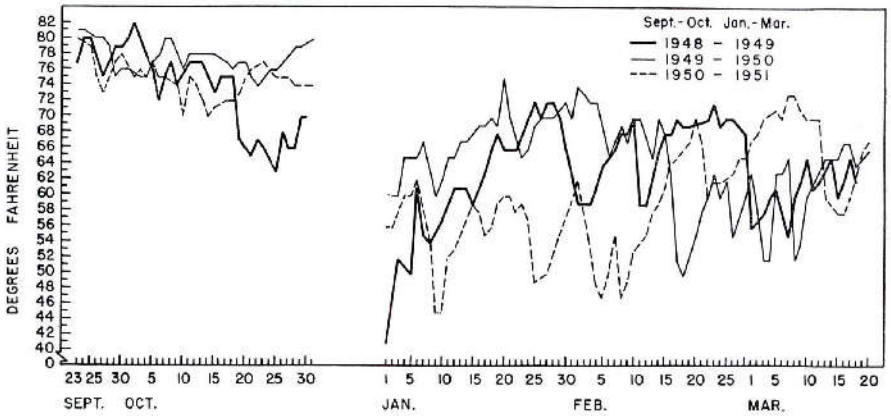

Fig. 2. Cedar Key Tide Station water temperatures following the autumnal equinox and preceding the vernal equinox.

Contents of Ovaries and Brood Pouches and Frequency of Broods

Under the magnification used (12.5×) a ripe ovary contains large eggs ready to be injected into the pouch of the male and minute, yolked eggs of the following batch. This sharp contrast in size between immature and ripe eggs differs strongly from that found in the northern greenside darter, *Etheostoma blennioides* Rafinesque, by Fahy (1954). His plots of egg size show a bimodal curve consisting of a large peak representing numerous future batches and a smaller peak formed by the large, maturing eggs of the next batch. The eggs of the second batch are not included in the counts. With few exceptions only females with large mature or nearly mature eggs were used for egg counts. The largest batch found in the ovaries of a female (34 mm.) was 69, and the most young taken from the pouch of a male (31 mm.) were 55. The numbers of eggs though similar are rarely evenly divided between the two ovaries. Large eggs are of similar size, except for an occasional undersized one which will produce an inviable runt in the pouch of the male, and are easily counted while small eggs are variable in size and are difficult to count. Fully mature eggs are rounded and tend to be loose in the ovary while less mature eggs are tightly packed and angular. Egg-like structures containing yolk were counted as eggs whereas pieces of a translucent material that sometimes are present in an ovary and may even completely surround some of the eggs were not counted. The female evidently dumps the whole contents of the ovary into the pouch of the male, and in some cases this includes what appears to be all the large eggs in the ovary still tightly joined together, angular in shape, and covered by maternal membranes. Even under these seemingly abnormal conditions most of the eggs have a developing embryo. For purposes of compari-

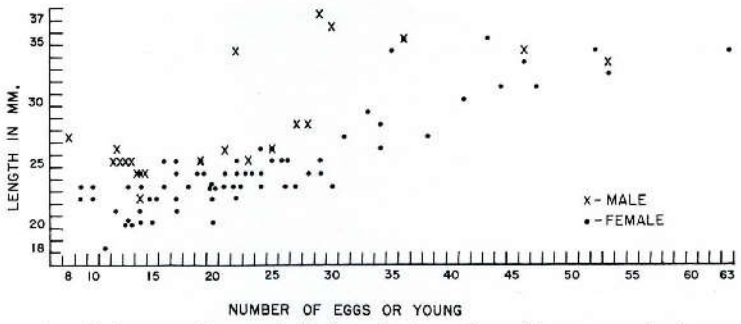

Fig. 3. Lengths of pigmy seahorses plotted against number of large eggs in the ovaries of the females and eggs or young in the pouches of males collected on May 27–30 and June 10–14, 1950, at Cedar Key.

son, all living and dead eggs and egg-like structures in the pouches of males were counted the same as they were counted in the ovaries of the females. During the main part of the breeding season less than 1 percent of the eggs in the pouches were inviable. Non-egg ovarian material and unseparated eggs were also rare in the summer of 1950. Many of the 74 gravid males collected at the start of the breeding season near Gandy Bridge, February 17 and 18, 1951, contained a few inviable eggs, non-egg ovarian material and unseparated angular eggs. Only one gravid Cedar Key male (30 mm., collected February 19, 1950) of 96 examined contained more than one age group in his pouch. Five were well developed with little yolk sac and 12 were less fully developed with larger yolk sacs. This is another example of atypical contents in the brood pouch at the start of the breeding season. From the fact that the young in all but one of the males examined appeared to be of the same age and from the general similarity in numbers of eggs in the females and males shown in Figure 3, it is concluded that one female usually furnishes all the eggs found in the pouch of a male. Data on seasonal changes in fecundity and mate selection in relation to size will be published elsewhere.

Between mid-June and late August, 68 percent of the males 25 mm. or longer had young in their pouches. Harbor Island males at about 85°F. (a temperature believed to be comparable to the average summertime temperature on the grass flats at Cedar Key) carried their young for approximately 10 days, and one male gave birth to two broods within 12 days (Strawn, 1954b). Presuming Cedar Key males carry their broods for 10 days and that these 10 days represent 68 percent of the time for the average male, then the 32 percent of the time they are without young would be 4.7 days. Thus broods are about 14.7 days apart, and a male produces two broods per month. Data on the greenthroat darter, *Etheostoma lepidum* (Girard), indicate that more frequent broods are to be expected at higher temperatures and the reverse at lower temperatures (Strawn, 1957).

Growth, Sexual Maturity, and Number of Generations a Year

Newborn young in two broods of Cedar Key *H. zosterae* ranged from 7 to 9 mm. so the fish of this size in Figure 1 are either newborn or are certainly less than a week old, judging by the growth rates of aquarium raised specimens from Harbor Island, Texas, plotted in Figure 4. The latter were raised, under constant light, in a two gallon glass

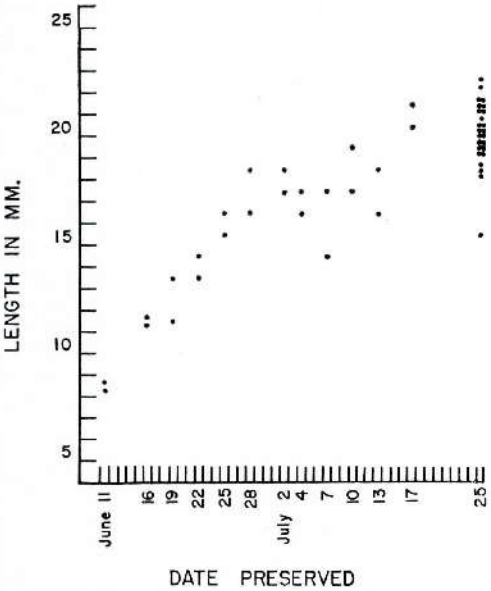

Fig. 4. Growth rate of a brood of pigmy seahorses from Harbor Island, Texas, born June 11, 1951.

goldfish drum at about 85°F. and were fed all the newly hatched San Francisco Aquarium Society brine shrimp they could eat. During the 17 days following birth they grew from about 8 mm. to as long as 18 mm. Another brood raised to maturity under similar conditions at the same time grew even faster. During most of the year the long breeding season coupled with the production of at least three generations a year make the determination of the growth rates of wild Cedar Key seahorses difficult. The break in the breeding season from November to January, when no young are added to the population, enables one to observe the slow average growth rate of the overwintering fish and the rapid April through June growth of their young (Fig. 1). The apparent slow growth of young of the year prior to May may be the result of cold water temperatures.

Males born in the cold water of late winter and early spring evidently take about three months to mature. Small males with young were collected as early as mid-May, 1949. In 1950, the first small gravid males were taken in late May (Fig. 1), but it is likely that intensive collecting would have yielded them earlier. If these males were born in the last half of February, early in the breeding season, they would be a little over three months old. The rapid growth rate at higher temperatures during May and June, evidenced in Figure 1, suggests attainment of breeding size during warm weather in less than three months. Two-month-old laboratory raised fish of Harbor Island parentage were of breeding size, and 19 of the 22 males had fully developed brood pouches. Fish from Pinellas Co., Florida, kept in running sea water at Duke University Marine Laboratory during the summer of 1957, bred at a little less than two months. Cecil Boyd, who bred Florida pigmy seahorses in Ocean Beach, California, had aquarium born males gravid at the age of two months. Three months between the birth of a seahorse and the birth of its young is more than sufficient time for the production of three generations between late February and the end of the breeding season in October. Two and a half months between generations, a possible figure judging by laboratory data, during the warm period from the last of May to late October would permit four generations a year.

Longevity

The pigmy seahorse at Cedar Key has a high rate of reproduction combined with a relatively stable population size and must be an important link in the food chains on the grass flats. Few would be expected to die of old age. Though I know of no reference to predation on the pigmy seahorse, there are several references to seahorses as fish food. Jordan and Gilbert (1882) named a large seahorse, *Hippocampus stylifer,* taken from a red snapper stomach. Longley and Hildebrand (1941) mention 20 specimens of *Hippocampus punctulatus* Guichenot taken from the stomach of a remora, and Herald (1949) discusses a seahorse that appeared among the stomach contents of a yellowfin tuna. *H. zosterae* maintains a relatively stable non-breeding population during the winter when many of the possible predators are scarce or absent from the shallow water of the grass flats. One of these, the blue crab, *Callinectes sapidus,* is extremely abundant on the flats in the summer and it frequently captures and devours the pipefishes, *Syngnathus floridae* and *S. scovelli* Jordan and Gilbert, caught with it in the pushnet.

The overwintering Cedar Key pigmy seahorses disappear from the flats by early August and do not become members of the next year's overwintering population (Fig. 1). A collection of 394 overwintering pigmy seahorses, made south of the west end of Gandy Bridge on February 17 and 18, 1951, had no individuals of a size that would indicate that they had previously overwintered. Cedar Key fish would be up to 8½ months old at the end of the breeding season in early November, and the 38 mm. male taken July 24, 1950, (Fig. 1) would be between 9 and 17½ months old. Judging by late spring and early summer growth rates the bulk of the fish present at the end of October are not over three months old, and thus it is a rare seahorse that survives over a year. Overwintering pigmy seahorses can survive past August. A male, collected at Harbor Island, Texas, the last of January, lived in The University of Texas aquarium room until the following November, and it might have survived longer with better care. Blair (1948) states that the calculated life span of small mammals living in the bluegrass field and meadow associations in Southern Michigan is only a fraction of the age attained by the same or similar forms in captivity, and he attributes this almost entirely to predation. Another possible reason for the disappearance of fish from the flats could be dispersal. During the late summer children at Cedar Key find pigmy seahorses clinging to drift along the beaches away from

grass beds, and following storms these fish can be found on vegetation floating in the channels. Many Tampa Bay pigmy seahorse fishermen believe that pigmy seahorses move with the tidal currents from one area to another.

Summary and Acknowledgments

Females outnumbered males throughout the year. Season and environment can influence the observed sex ratio. The breeding season extends from mid-February to late October and is associated in time with days having over 11 hours of sunshine. A maximum of 69 large eggs was found in the ovaries of a female, and up to 55 young were counted in the pouch of a male. At about 85°F. the average male probably has two broods per month. The young grow rapidly and mature within two to three months. At least three generations are produced a year. Few individuals attain the age of a year, and no evidence of two-year-old fish was found.

Many people aided in this study. In particular, I wish to thank Dr. Howard T. Odum for his encouragement and assistance, Dr. E. Lowe Pierce for the use of much of his personal equipment, Dr. Clark Hubbs for providing space in The University of Texas aquarium room, and Charlene Strawn who helped with all stages of the study and prepared the figures. Drs. W. Frank Blair, Archie F. Carr, Arnold B. Grobman, and B. B. Leavitt have offered valued suggestions.

Literature Cited

Blair, W. Frank. 1948. Population density, life span, and mortality rates of small mammals in the blue-grass meadow and blue-grass field associations of southern Michigan. *Amer. Midland Nat., 40(2): 395–419.*

Breder, C. M., Jr. 1940. The expulsion of young by the male of *Hippocampus zosterae*. Copeia, *1940(2): 137–38.*

Dandy, J. E. and Geoffrey Tandy. 1939. On the identity of *Syringodium* Kütz. *Jour. Botany 77: 114–16.*

Fahy, William E. 1954. The life history of the northern greenside darter, *Etheostoma blennioides blennioides* Rafinesque. *Jour. of Elisha Mitchell Sci. Soc., 70(2): 139–205.*

Ginsburg, Isaac. 1937. Review of the seahorses (*Hippocampus*) found on the coasts of the American continents and of Europe. *Proc. U. S. Nat. Mus., 83(2997): 497–594.*

Gudger, Eugene Willis. 1906. The breeding habits and the segmentation of the egg of the pipefish, *Siphostoma floridae. Proc. U.S. Nat. Mus., 29(1431): 447–500.*

Herald, Earl S. 1949. Pipefishes and seahorses as food for tuna. *Calif. Fish and Game, 35(4): 329.*

Jordan, David Starr and Charles H. Gilbert. 1882. Notes on fishes observed about Pensacola, Florida, and Galveston, Texas, with description of new species. *Proc. U.S. Nat. Mus., 5: 241–307.*

Korringa, P. 1947. Relations between the moon and periodicity in the breeding of marine animals. *Ecol. Monogr., 7: 347–381.*

Longley, William H. and Samuel F. Hildebrand. 1941. Systematic catalogue of the fishes of Tortugas, Florida. *Papers Tortugas Lab., 34, Carnegie Inst. Wash. Publ. 535: 331 pp., 34 pls.*

Marvin, C. F. 1944. Sunshine tables. Pt. I. Latitudes 20° to 30° North. *U. S. Dept. Commerce, W. B. 805 (edition 1905, reprinted 1944): 1–23.*

Strawn, Kirk. 1953. A study of the dwarf seahorse, *Hippocampus regulus* Ginsburg, at Cedar Key, Florida. Master's thesis presented to the Graduate Council, University of Florida, January, 1953. 1–114.

———. 1954a. The pushnet, a one-man net for collecting in attached vegetation. Copeia, 1954 *(3): 195–197.*

———. 1954b. Keeping and breeding the dwarf seahorse. *Aquarium Jour., 25(10): 215–218 & 227–228.*

———. 1957. The influence of environment on the meristic counts of the fishes, *Etheostoma grahami* and *E. lepidum. University Microfilms. pp. i–iv and 1–58. 6 Tables, 9 figs.*

Thorne, Robert F. 1954. Flowering plants of the waters and shores of the Gulf of Mexico. *Fish. Bull. of Fish and Wildlife Serv., 55(89): 193–202.*

Department of Biological Sciences, Lamar State College of Technology, Beaumont, Texas.