# SPAWNING SEASONS AND GROWTH OF THE CODE GOBY, *GOBIOSOMA ROBUSTUM* (PISCES: GOBIIDAE), IN THE TAMPA BAY AREA

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# SPAWNING SEASONS AND GROWTH OF THE CODE GOBY, *GOBIOSOMA ROBUSTUM* (PISCES: GOBIIDAE), IN THE TAMPA BAY AREA[1]

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## INTRODUCTION

Ginsburg (1933A) described the code goby from Corpus Christi, Texas, and (1933B) recorded its distribution from Corpus Christi across the northern Gulf of Mexico and around southern Florida to the Indian River area on the middle Florida east coast. He also reported a single specimen from Bahia, Brazil. This range has been increased only by a record from Yucatan, Mexico (Hubbs, 1936), and an unpublished record from Brownsville, Texas (USNM 176203). Ginsburg (1933B) gave meristic data and discussed relationships (closest to *G. bosci*). He concluded on the basis of museum specimens that in the genus *Gobiosoma* males average larger and are more numerous than females, and that males and females may be differentiated externally by the nature of their genital papillae (triangular, compressed, pointed flap in males; short thick, truncated cone with lateral terminal fimbriae in females). Hildebrand and Cable (1938) were, however, unable to sex *G. bosci* and *G. ginsburgi* by external characters. One of us (V. G. S.) has found the genital papilla a reliable index of sex in both species.

Fowler (1940) illustrated color pattern variations of the code goby from Lee County, Florida.

At Cedar Key, Florida (ca. Lat. 29°10′ N., Reid, 1954) *G. robustum* was commonest on flats covered with vegetation and occurred at temperatures and salinities ranging from 10.5-30.5°C. and 17.5-31.5 ‰ respectively. The breeding season in this area as inferred from young fish 11-20 mm S.L. extended from spring to fall (June, September, December). Ripe females occurred in June; males with developing gonads were observed in April and August. Winter-caught individuals were pale while summer-caught ones were darker.

In Tampa Bay (ca. Lat. 27°45′ N., Springer and Woodburn, 1960), *G. robustum* was common all year on grass flats, but absent from sandy bottoms. Maturing females were found during November and December, 1957, and February through May, 1958. Maximum average size, 26.9 mm S.L., was attained in May followed by a gradual decrease in average size. The species was most abundant at moderately high salinities, usually between 22 and 32 ‰. Water temperatures during collections ranged from 10.0-32.5°C.

At Palmetto Key (Florida west coast, ca. Lat. 26°50′ N.) Breder (1942) found *G. robustum* abundant among mangrove roots and on sandy beaches (two habitats from which we have procured no specimens in collections from both coasts of Florida and the Florida Keys). He obtained specimens from depths as great as 20 feet, which was as deep as he collected, and from over a variety of bottoms: grass, sponge beds, scallop beds, sand bars and soft spots of flocculent mud. Males guarded eggs in nests of shells and sponges at least from March to June. The largest male was 24 mm S.L. and the smallest ripe one 16.5 mm. Males were generally larger than females. Ripe females were 16.5-21.5 mm S.L. Breder described incubation of naturally spawned eggs (of unknown age at collection) through 117.25 hours at temperatures ranging from 15.5-18.5°C. All eggs died before hatching. He reported that fertilized eggs varied from 1.30-1.79 mm along their longest axes and from .50-.70 along their shortest axes, and mentioned that March eggs were larger than June eggs. Considerably more data than the ten measurements he made will be necessary to establish a seasonal difference in egg size.

Shropshire (1932) described four Florida specimens as *G. molestum* (= *G. bosci*);

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however, the fin-ray counts (second dorsal-10, anal- 11) and general appearance of his figures leave little doubt that the species was *G. robustum,* undescribed at the time of his writing. The four specimens included two larvae, 2.54 and 6.37 mm (total length?) and a postlarva and juvenile, both 8.78 mm. The specimens were collected in plankton hauls during May and June, 1931.

## Station Description

Material for the present study, unless otherwise indicated, was collected from the "B" portion of the Tampa Bay station, St. Petersburg (see Springer and Woodburn, 1960, p. 5). Considerable environmental data for this station are available (Springer and Woodburn, 1960; Phillips, 1960A, 1960B). Salinities and temperatures for the present study are included in Table 1. These are similar to the ranges over the past few years (excluding the exceedingly cold winter of 1957-58). During most of the study, vegetation extended from 25 yards below the highest high tide level to a distance of 300 yards out from this point. From November, 1959, through June, 1960, grasses (*Diplanthera, Thalassia*) were dense over the area. In June much of the station was heavily blanketed by *Ulva.* By July the *Ulva* had died and decayed leaving a large area in which any disturbance of the bottom caused decomposition gases to be released. In July and August, gobies were taken only along the periphery of this area. From September through the close of the study the bottom was clear of decaying debris, and the grasses that remained were sparse. *Gobiosoma robustum* was collected only from the grassy areas.

Depths over the grassy portions ranged from a few inches to about four and one-half feet. During the October collection the greatest depth in the sampling area was about one foot. This was shallower than for any other collection.

## Methods

Specimens were collected in a pushnet (Strawn, 1954) with a mesh diameter of under one mm, or less than that of a fertilized egg of *G. robustum* (Breder, 1942). All specimens collected were preserved in 10 percent formalin. To insure that all fishes were removed from the pushnet, a plastic scraper with holes less than a millimeter in diameter was used to scape the net. After preservation in formalin for a few days specimens were leached in fresh water and preserved in 40 percent isopropyl alcohol.

Surface temperatures of the water at the collection locality were taken at least 100 feet from the shore line and at a point where the depth was at least one foot; tenths of a degree centigrade were estimated. Densities of water samples taken at the same site as the temperatures were measured using a densimeter. Readings were corrected for temperatures and converted to salinities using a table supplied with the density kit.

To determine comparative monthly relative abundances of *G. robustum,* collections were made in as uniform a manner as possible. A collection of the same single transect of the station area was made each month, but it was soon realized that the varying depths of water and amounts of algae present each month affected collections and made comparisons of abundance impossible. However, each collection almost certainly reflects the relative frequencies of occurrence of the sexes and size groups for its particular month.

Standard lengths (S.L.) were taken with a pair of needlepoint dividers and stepped off on a millimeter ruler. Measurements were recorded to the nearest millimeter; where fractions of a millimeter are given they were estimated.

Specimens were sorted in the laboratory and measured within a few days after collection. They were sexed externally using the genital papilla and supporting color features.

In males the genital papilla is compressed and has the shape of a slender triangle. It is longer in the breeding season and usually there are melanophores covering it. In almost all males examined the prepelvic region is sprinkled with melanophores, increasingly so with size. This area rarely shows more than a faint yellow color in freshly preserved specimens. The pelvic fins and body are generally more heavily pigmented than in females and the number of melanophores reaches its maximum during the breeding season (accounting for Reid's observation that summer-caught individuals were darker than winter-caught ones).

TABLE 1.

*Egg diameter frequencies for Gobiosoma robustum* *

| | 1959 | | 1960 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. |
| Day | 23 | 21 | 22 | 17 | 21 | 25 | 19 | 24 | 25 | 22 | 23 | 26 | 22 |
| Salinity $^0/_{00}$ | 23.0 | 24.7 | 25.6 | 25.6 | 23.0 | 19.2 | 23.8 | 27.1 | 27.7 | 19.0 | 15.5 | 21.6 | 23.8 |
| Temperature °C. | 25.5 | 18.0 | 15.5 | 18.5 | 19.5 | 28.2 | 26.4 | 28.2 | 30.8 | 31.0 | 28.5 | 29.4 | 25.0 |
| Micrometer Divisions | | | | | | | | | | | | | |
| 1 | III | XI | | | | | | | | | | | |
| 2 | XI | IV | VII | V | I | | | | | | | XIII | IV |
| 3 | | | VI | VIII 10 | II | | | 1 | 6 | | | II | XIII |
| 4 | | | IV | 35 | VI 16 | | | I 20 | 32 | I 33 | 7 | I 3 | III |
| 5 | 1 | | | 5 | 9 | 6 | | 31 | 34 | 34 | 16 | 20 | |
| 6 | 1 | | | 1 | 7 | 32 | 2 | 24 | 23 | 47 | 25 | 2 | |
| 7 | | | | 9 | 17 | 54 | 14 | 7 | 5 | 54 | 9 | | |
| 8 | | | | 12 | 25 | 34 | 11 | 18 | 5 | 29 | 19 | | |
| 9 | | | | 4 | 15 | 16 | 7 | 22 | 26 | 20 | 34 | | |
| 10 | | | | 4 | 21 | 32 | 36 | 52 | 35 | 35 | 47 | | |
| 11 | | | | 15 | 27 | 24 | 48 | 38 | 42 | 33 | 76 | | |
| 12 | 2 | | | 26 | 27 | 26 | 68 | 36 | 68 | 45 | 68 | 11 | |
| 13 | 6 | | | 16 | 36 | 34 | 47 | 38 | 91 | 39 | 56 | 9 | |
| 14 | 7 | | | 9 | 23 | 45 | 72 | 48 | 66 | 52 | 62 | 19 | |
| 15 | 7 | | | 3 | 19 | 52 | 65 | 60 | 44 | 35 | 35 | 11 | |
| 16 | 1 | | | 1 | 8 | 66 | 52 | 35 | 13 | 13 | 19 | 7 | |
| 17 | 2 | | | | 11 | 34 | 39 | 19 | 8 | 6 | 8 | 6 | |
| 18 | | | | | 8 | 14 | 20 | 11 | | | 10 | 2 | |
| 19 | | | | | 3 | 5 | 9 | 6 | | | 6 | 3 | |
| 20 | | | | | 1 | | 7 | 7 | | | 1 | 4 | |
| 21 | | | | | 2 | 1 | 1 | 1 | | | 1 | | |
| 22 | | | | | | | 2 | 1 | | | 1 | 1 | |
| 23 | | | | | | | | | | | | 2 | |
| No. Females | 16 | 15 | 17 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |

* Roman numerals in a particular micrometer division class represent the total number of females in which diameter of largest egg fitted into a particular class (see also Methods section).

In females the genital papilla is a broad, thick, flap-like organ with a shallowly indented tip. The organ is best developed in large females and reaches its greatest elaboration during the breeding season. On each side of the indented tip of well developed papillae there is frequently found a single mélanophore; the remainder of the organ is unpigmented. The prepelvic region is usually without melanophores to a point beneath the posterior level of the head. On rare occasions there is a sprinkling of melanophores in this area, but never so much as in comparably sized males. In freshly preserved females the prepelvic area is bright yellow.

Frequent gonadal checks were made to test ability to distinguish the sexes externally. Although specimens as small as 12 mm S.L. can be sexed externally, error-free sexing was possible only in specimens 16 mm (= 15.5-16.5 mm) or greater. Graph 1 records all specimens less than 16 mm S.L. as sex indeterminate and allocates their length measurements to the two sexes on a 50-50 basis. A chi-square test for a 1:1 sex ratio (one degree of freedom) was made for each month using the sex ratios of specimens 16 mm and larger (Table 2). The 1:1 ratio was found to be statistically feasible for all but one month, September, considering a *P* value of .05 as the critical level of significance. We have no explanation for the variation in sex ratios encountered during that month. (Richard Rosenblatt, personal communication, has suggested that on the basis of chance alone one of the 13 samples would be expected to have a significant *P* value.)

Our smallest gobies were postlarvae (Hubbs, 1943), 5.6-8.5 mm S.L. At this size the fins have developed their full complements of elements. Of the six species of gobies, other than *G. robustum*, found inshore in the Tampa Bay area, *Gobisoma bosci*, *G. longipala*, *Gobionellus boleosoma*, *G. hastatus*, *Microgobius gulosus* and *M. thalassinus*, only *G. longipala* could be confused with small individuals of *G. robustum*. The rest have consistently higher counts for either the second dorsal or anal fins, or for both. Adults of *G. longipala* are easily distinguished from those of *G. robustum* by the presence of a pair of ctenoid scales on each side of the base of the caudal fin, but the very young of *G. longipala* are unknown. We have collected only one *G. longipala* (14.9 mm) in the Tampa Bay area, but many thousands of *G. robustum*, and thus feel confident that our material is *G. robustum*.

TABLE 2.
*Chi-square and P values (one degree of freedom) for the assumption that the monthly sex ratios of specimens of Gobiosoma robustum 16 mm. and larger are 1:1*

| Month | Observed sex ratio | Chi-square value | *P* value (Between) |
|---|---|---|---|
| 1959 | | | |
| Nov. | 12 males<br>16 females | .572 | .30 & .50 |
| Dec. | 14 males<br>15 females | .034 | .80 & .90 |
| 1960 | | | |
| Jan. | 18 males<br>17 females | .028 | .80 & .90 |
| Feb. | 119 males<br>130 females | .484 | .30 & .50 |
| Mar. | 44 males<br>64 females | 3.70 | .05 & .10 |
| Apr. | 215 males<br>224 females | .184 | .50 & .70 |
| May | 81 males<br>85 females | .096 | .70 & .80 |
| Jun. | 64 males<br>71 females | .362 | .50 & .70 |
| Jul. | 39 males<br>50 females | 1.36 | .20 & .30 |
| Aug. | 23 males<br>33 females | 1.79 | .10 & .20 |
| Sep. | 39 males<br>66 females | 6.94 | .01 & .005 |
| Oct. | 121 males<br>122 females | .004 | .95 & 1.0 |
| Nov. | 104 males<br>104 females | .000 | 1.0 |

Egg diameters were measured at a magnification of 27X using an ocular micrometer (one micrometer division equal .034 mm). Ovaries were removed from specimens after they had been in alcohol for one to several months. Eggs were teased from the ovaries and all adherent tissue removed. Random egg diameter measurements (for justification see Clark, 1925) were made on 25 eggs of the largest egg class (see below) in each right ovary. Measurements on groups of eggs from various sections of ovaries disclosed no obvious local segregation of large eggs; nevertheless eggs were measured routinely from both ends and the middle of each ovary. Because of the small gradation in egg diameters in ovaries with no egg diameter greater than about four micrometer divisions, only the diameter of the obviously largest egg in such an ovary was measured. Roman numerals in Table 1 indicate the numbers of such measurements. In one ovary there were only two obviously large eggs (November, 1959) separated by two micrometer divisions from the next largest eggs. In this particular instance only the diameters of the two large eggs were listed.

The oöcyte stages (Harrington, 1959) correlating with the egg diameters were not determined, but it is a generally established fact that in maturing ovaries the egg diameter varies directly with the maturity of the egg, and, therefore, ovaries with the highest average egg diameters are the ripest.

## Description of Eggs and Ovaries

In preserved ovaries the developing eggs are transparent until a maximum diameter of (.102-.136 mm) is attained, at which time the eggs become increasingly opaque. They remain opaque, and with no obvious perivitelline space, until the chorion (?) is separated from the vitelline membrane. After this separation there is an opaque area (germinal) comprising about one-third of the vitellus and a translucent area (yolk) comprising the remaining two-thirds. A widely variable number of oil droplets is present in the egg. Random diameters of these eggs, which we consider ripe, range from .476-.782 mm with differences of as much as .238 mm between the longest and shortest axes of a single egg. A comparison with Breder's (1942) diagrams of spawned eggs indicates that the chorion elongates considerably after spawning. This, as well as shrinkage from preservation, would account for differences between our measurements and his.

Table 3.
*Total counts of the largest egg class in single ovaries of individual females of Gobiosoma robustum*

| Month | Standard Length mm. | Number of Large Eggs |
|---|---|---|
| Sep. | 15 (14.6) | 56 |
| Aug. | 16 | 105 |
| Apr. | 21 | 193 |
| Feb. | 24 | 200 |
| Feb. | 26 | 269 (Lee Co., Fla.) |
| Apr. | 26 | 402 |
| Feb. | 27 | 266 |
| May | 27 | 349 |
| Apr. | 28 | 397 |

As also noted by Breder for spawned eggs, a large group of filaments is found attached to the chorion of ripe eggs. The presence of these filaments in goby eggs has frequently been noted in the literature; they serve to attach the eggs. Our observations indicated that the filaments were always present at the germinal end of the egg.

In ripe females the ovaries extend the entire length of the coelom and occupy over half its volume. Both ovaries ripen equally and contain approximately equal numbers of eggs of the largest egg class (see below). A 27 mm female taken in May had 349 eggs of the largest egg class in its right ovary and 346 in its left. A few total counts of eggs of the largest egg class of individual females were made (Table 3). These indicate that the number of eggs increases with size, but may vary as much as 50 percent in females of the same size. None of these females had spawned recently as the ovaries in each instance were tightly packed and filled the coelom; and the February females would not have spawned (see below).

The plotting of random diameters of all eggs three micrometer divisions and greater in an ovary sample (Table 4) indicates at least two well-developed groups (classes) of eggs in ovaries in which the smallest diameter of any of the obviously larger eggs is about 9 or 10 micrometer divisions. Part of the spread of measurements is the result of the eggs having both long and short axes, and random, instead of longest or shortest, diameters were measured. The second egg class occurs primarily at from four through six micrometer divisions. Below three divisions our frequencies are neither absolute nor roughly relative to the others.

Since they mature synchronously, the eggs of the largest egg class are apparently spawned in toto during one short time interval. Further evidence for this is supplied by our finding only what appear to be total complements of the largest eggs in either ripe or ripening ovaries. Only once did we find a partial complement of ripe eggs (June, 26 mm, 59 eggs). Pos-

TABLE 4.
*Frequency distributions of random egg diameter measurements of all eggs over 2 micrometer divisions in ovary samples of Gobiosoma robustum*

| Micrometer Divisions | Month Size mm. | Feb. 24* | Feb. 27 | Feb. 26† | Apr. 28 | Apr. 26 | Apr. 21 |
|---|---|---|---|---|---|---|---|
| 1 | | | 1 | 3 | 2 | 2 | 4 |
| 2 | | 3 | 2 | 8 | 6 | 3 | 4 |
| 3 | | 7 | 7 | 4 | 2 | 3 | 11 |
| 4 | | 13 | 21 | 12 | 6 | 4 | 32 |
| 5 | | 10 | 16 | 38 | 7 | | 15 |
| 6 | | 13 | 2 | 24 | | 1 | |
| 7 | | 2 | 3 | 9 | | | |
| 8 | | 1 | 3 | | | | |
| 9 | | | 5 | 1 | | 1 | |
| 10 | | 5 | 17 | 1 | | 9 | |
| 11 | | 30 | 46 | | | 21 | |
| 12 | | 63 | 53 | | | 11 | |
| 13 | | 63 | 22 | 1 | | 4 | 1 |
| 14 | | 29 | 8 | 5 | 2 | 1 | 8 |
| 15 | | 9 | | 26 | 7 | | 13 |
| 16 | | | | 33 | 15 | | 17 |
| 17 | | 1 | | 36 | 10 | | 9 |
| 18 | | | | 31 | 6 | | 6 |
| 19 | | | | 14 | 5 | | |
| 20 | | | | 7 | 1 | | |
| 21 | | | | 2 | 1 | | |
| 22 | | | | | 1 | | |

* Total ovarian egg complement with diameters over 2 divisions measured.
† Lee County, Florida, approximately 100 miles south of Tampa Bay.

sibly, the female was in the act of spawning when collected, or was the only one from which we had squeezed eggs while checking ripeness in the field.

After the largest egg class has reached maturity and been spawned it is possible that sufficient time will remain during the breeding season for the second largest egg class to mature and be spawned. We have no evidence for a third spawning by any female.

## SPAWNING SEASON AND LENGTH CLASSES

Table 1 gives the egg diameter distributions for each month from November, 1959, through November, 1960. In November, 1959, a few females (one in 16) were approaching ripeness; it is questionable that they spawned after the collection date as the standard length-frequency distributions (Graph 1) give no indication of the entrance of a group of young into the population until the following spring. During December the ovaries reached their maximum regression, and there was only a slight advance from this state during January. In February there was a rapid advance in maturity of about one-third of the females. During March about one-half of the females were advanced and there was spawning by some of these (females from Lee County, Florida, approximately 100 miles south of Tampa Bay, were possibly spawning in February, Table 4). By April, the entire population had advanced to functional maturity and spawning continued through April, May and June. During July and August, the warmest months of the year, spawning appears to have been suppressed, or at least repressed. In September there was a resurgence of maturation followed by

TABLE 5.
*Monthly average standard length of males and females of Gobiosoma robustum 16 mm and larger*

| Month | Males | Females |
|---|---|---|
| 1959 | mm. | mm. |
| Nov. | 21.8 | 19.5 |
| Dec. | 21.4 | 18.7 |
| 1960 | | |
| Jan. | 19.8 | 20.4 |
| Feb. | 19.1 | 19.5 |
| Mar. | 21.4 | 20.3 |
| Apr. | 23.2 | 22.2 |
| May | 26.6 | 24.5 |
| Jun. | 22.0 | 22.6 |
| Jul. | 20.3 | 19.0 |
| Aug. | 18.5 | 18.8 |
| Sep. | 17.5 | 17.0 |
| Oct. | 18.0 | 17.7 |
| Nov. | 19.2 | 18.7 |

a marked decline in October, with only 20 percent of the females with maturing eggs. This probably represents the last spawning of the year. In November, 1960, all the females had either regressed or unregenerate ovaries.

The overlap of temperatures (Table 1) during spawning and non-spawning periods suggests that some factor other than temperature may be involved in the regulation of the breeding season.

Monthly length - frequency histograms (Graph 1) provide further evidence of the spawning cycle as inferred from egg diameter measurements. The first young of the year, taken in May, were moderately advanced. The absence of young in the March and April collections when, according to egg diameters, breeding probably occurred may have resulted from incubation periods protracted by low temperature. Water temperature at the time of the May collection was lower than during the April collection. However, the air temperatures in St. Petersburg, to which the shallow bay waters are highly responsive, averaged 62.8°F. in March, 81.8° F. in April and 84.5° F. in May (U. S. Weather Bureau Climatological Data, 1960), indicating that the low water temperature at the time of the May collection was a temporary depression.

Batches of young including post-larvae were taken in June, July, September, October and November, 1960. The absence of a new batch of young in August is evident from the progression of the modal class and the absence of strong peaks to the left of it. On the basis of the length-frequency histograms spawning would have been suspended from sometime after the July collection to some point before the date of the September collection.

Gunter (1945) surmised that *Harengula pensacolae* (reported as *H. macrophthalma*) and *Menidia beryllina* on the Texas coast spawned twice, or had two spawning peaks, a year (spring and late summer, or early fall). Springer and Woodburn (1960) found supporting evidence for Gunter's beliefs for both these species in the Tampa Bay area. In Texas ripe females of *Etheostoma lepidum* (Hubbs and Strawn, 1957) were fewest in July and young fish were absent only in August in populations living near springs and subject to temperatures ranging from 14-24°C. Ripe fish were absent from May through October in downstream populations where temperatures ranged from 7-35°C. Harrington (1959), on the basis of experimental evidence, postulated a slackening of spawning for *Fundulus confluentus* on the middle Florida east coast during the warmer, long-day middle portion of its spawning period.

## Growth, Size at Maturity and Maximum Size

The growth pattern of *G. robustum* is apparent from Graph 1. Maximum average size of the population, exclusive of the new year class, was reached during May, 1960. This was also noted by Springer and Woodburn (1960) for May, 1958. Thereafter the average size undergoes a decrease for several months. The cause of this appears to be a mortality of the older and larger individuals. After July growth of the various batches of young of the year and average decrease in size of the old population due to mortality fuse and obscure the average growth picture. Not until the fall spawning had ceased do the frequency histograms indicate consistent average increase in size (assuming spawning ceases by November).

The graph indicates that *G. robustum* is an annual fish with few individuals, if any, ever attaining an age of much over one year. On the basis of size, some males may live two years. The largest females obtained in several years collecting did not exceed 29 mm S.L., and specimens of this size are uncommon. The progression of the frequency histograms indicate a maximum growth of 29 mm is quite feasible during the first year of life. The largest males we have obtained are 42 mm (April 28, 1958) and the largest found after examining many museum collections are 44 mm (Pensacola and Corpus Christi).

From the regression in size of both males and females indicated on the graph it would appear that after July the adults, representing the previous year's spawning, comprised only a small part, or no part at all, of the population. The smallest specimens (exclusive of the new year class) obtained in May were 21 mm. By August the largest specimens present were only 23 mm. This probably means that almost the entire population, spawners included, from August on, was comprised of specimens spawned no earlier than the previous March.

On the basis of museum specimens Ginsburg (1933B) concluded that males of the genus *Gobiosoma* not only attained a larger size than females, but averaged larger. Breder (1942) believed this of *G. robustum.* In Table 5 we have listed the monthly average sizes of males and females 16 mm and larger. We find that during some months females were, on the average, larger than males. The females never averaged more than .6 mm larger than males, whereas males may average as much as 2.7 mm larger than females.

Only females were examined for sexual maturity. From the beginning of breeding through June, no females of less than 17 mm S.L. were seen with maturing eggs. Advanced eggs were almost entirely restricted to females of about 19 mm or greater. After June, females as small as 16 mm were commonly found with maturing eggs and by September specimens as small as 14.6 mm (15 mm class) had advanced eggs. Obviously these small females were only a few months old, and on the basis of the size of the May young of the year could have been only two months old. Orton (1920) referring to his invertebrate studies made the following germane statement: "There are indications, however, that in all animals born into suitable breeding conditions gonad development occurs very early during the period of growth and at the expense of increased size." Females born early in the spawning season spawn before the season is over while those born later must await the following spring.

## SUMMARY

The spawning cycle and growth of *Gobiosoma robustum* was studied in the Tampa Bay area (ca. Lat. 27°45′ N.). Monthly collections were made from November, 1959, through November, 1960. Diameters of 25 eggs of the largest egg class of from 15 to 20 females were measured each month. These showed that the species has two spawning periods a year: early spring to early summer and late summer to fall. Spawning was not evident during the middle of the summer when water temperatures were highest. Monthly length frequencies give additional support for conclusions derived from egg diameters.

The sex ratios are usually about 1:1. Males achieve a considerably larger maximum size (44 mm S.L.) than do females (29 mm) and usually average larger. Females of the new year class may be ripe when only a few months old and at a size as small as 14.6 mm S.L. After July almost the entire, if not the entire, population, including spawners, is comprised of the new year class. Few, if any, individuals achieve an age of more than one year.

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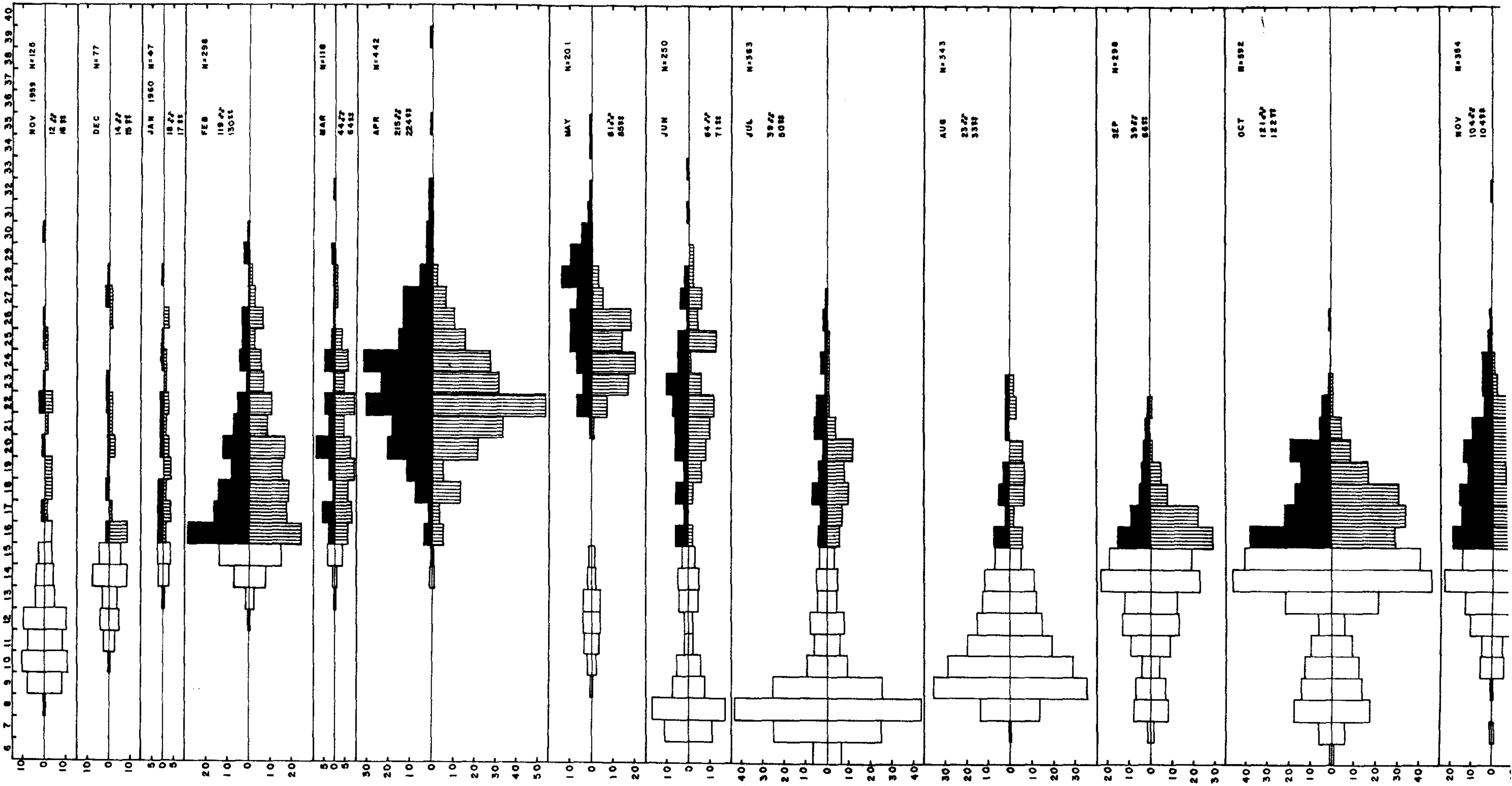
## ABSTRACT

Egg diameter measurements indicate that *Gobiosoma robustum* spawned from early spring to early summer and from late summer to fall during 1960 in the Tampa Bay area. The middle non-spawning period occurred during highest temperatures. Standard length frequency progressions support egg diameter data and also indicate that *G. robustum* is an annual species.

Sex ratios are usually about 1:1. Males achieve a larger size than females. Females may mature at 14.6 mm. standard length when only a few months old.



Graph 1. Monthly standard length frequency histograms for specimens of *Gobiosoma robustum*. The solid areas above each base line represent males, the vertically lined areas represent females and the open areas represent sex-indeterminate specimens. The ordinate denotes frequency of occurrence and the abscissa standard lengths in millimeters.