

# AN ECOLOGICAL STUDY OF *GOBIOSOMA BOSCI* AND *G. GINSBURGI* (PISCES, GOBIIDAE) ON THE GEORGIA COAST<sup>1</sup>

MICHAEL D. DAHLBERG<sup>2</sup> AND JAMES C. CONYERS<sup>3</sup>

## ABSTRACT

The ecology of two species of "scaleless" gobies, *Gobiosoma bosci* and *G. ginsburgi*, from estuarine and beach waters around Sapelo Island, Ga., is compared. Small patches of oysters, in addition to oyster reefs, are important nesting areas for both species. Numerous invertebrates and five other fishes are characteristic of the oyster patches. Habitats common to both species include reefs and patches of oysters, bottoms of estuarine rivers of moderate to high salinity, and burrows in an eroding clay deposit off Sapelo Beach. In contrast to *G. bosci*, *G. ginsburgi* ranges offshore, is thought to spawn in deep water, and is not found in fouling communities, marsh pools, and low salinities.

These gobies are sexually dimorphic in genital papilla, body size, and color. They nest in oyster shell. Males incubating and guarding their own eggs are cannibalistic on eggs of other individuals, apparently having the ability to distinguish their own nests or eggs from those of other individuals. Higher egg counts in nests than in ovaries prove that *G. bosci* is polygamous.

The spawning seasons of *G. bosci* and *G. ginsburgi* are apparently similar. The season of *G. bosci* is protracted to the south and correlates with water temperature.

Our study of the reproduction and ecology of the two species of "scaleless" gobies, the naked goby (*Gobiosoma bosci*) and seaboard goby (*G. ginsburgi*), was initiated when they were discovered incubating eggs in oyster shells at Sapelo Island, Ga. This provided the opportunity to compare certain aspects of the life history of these two secretive species and analyze their ecological relationship to oyster communities. There are some published ecological information on these two species (Dawson, 1966, 1969, and references therein) and some scattered reports on reproduction that are partially summarized by Breder and Rosen (1966).

Since most species of *Gobiosoma* are tropical (Böhlke and Robins, 1968), the genus probably

originated in the tropics. However, the low spawning threshold of *G. bosci*, about 20°C (Nelson, 1928), suggests a temperate-water origin for this species. *G. bosci* ranges from Connecticut (Pearcy and Richards, 1962) and Long Island Sound to Campeche, Mexico (Dawson, 1969). *G. ginsburgi* ranges from the Wareham River and Woods Hole, Mass. (Ginsburg, 1933; Lux and Nichy, 1971), to Jekyll Island, Ga. (Dawson, 1966). *G. robustum* ranges from the Gulf of Mexico to the St. Johns River, Fla. (Tagatz, 1968), and has been found in Maryland (Schwartz, 1971). *G. longipala*, the Gulf cognate of *G. ginsburgi*, is considered a distinct species (Dawson, 1966). The similarity of these two species, however, leaves little doubt that they are derived from a common ancestor whose distribution was split by the emerged Florida plateau, which now functions as an ecological and/or physical barrier. In contrast, Atlantic and Gulf populations of *G. bosci* have not diverged recognizably.

*G. bosci* and *G. ginsburgi* are easily distinguished. *G. ginsburgi* has two ctenoid scales

<sup>1</sup> This work was done at the University of Georgia Marine Institute, Sapelo Island, Ga.

<sup>2</sup> Virginia Institute for Scientific Research, 6300 River Road, Richmond, VA 23229; present address: Cyrus Wm. Rice Division, NUS Corporation, Manor Oak Two, 1910 Cochran Road, Pittsburgh, PA 15220.

<sup>3</sup> Virginia Institute for Scientific Research, 6300 River Road, Richmond, VA 23229.

## HABITATS

on each side of the caudal fin base and *G. bosci* is entirely scaleless. The best field characteristic for differentiating the two species is the color pattern on the sides of the body. In *G. bosci*, the sides are dark with eight or nine narrow, light bars that are of uniform width, and there are no dark spots along the lateral midline. During the breeding season the light bars of some males are obscured by increased pigmentation. In *G. ginsburgi*, the light bars broaden below the lateral midline, and there are dark spots or lines where the midline crosses the dark bars.

*G. bosci* and *G. ginsburgi* occur in large oyster reefs and small isolated patches of oysters that are partially exposed at low tide. The total area occupied by the small patches is relatively great since they border the maze of tidal creeks and occupy shallow mud flats in the lower reaches of the estuary where salinity is generally above 15‰. Two such sites were selected for detailed study. One is the mouth of Big Hole lagoon that separates Sapelo Island Beach from Cabretta Beach. The bottom is predominantly sand, but ebb tide currents have eroded deposits of hard clay that are derived from Pleistocene salt marshes. The gobies occupy the small reefs in sand and clay bottoms and often nest in isolated hinged shells that are stabilized in the clay. The second study site is a creek that runs under the boat house of the University of Georgia Marine Institute and that winds through the salt marsh. This is a typical salt marsh creek with a mud and shell bottom and mud banks that are bordered with cord grass (*Spartina alterniflora*). Small reefs along the bank and bottom are exposed when the approximately 2.1-m tide is low.

Some specimens were obtained by seining at Sapelo Island and other specimens by sampling with a bucket dredge and otter trawl in the estuary that ranges from the oligohaline Riceboro Creek to Sapelo and St. Catherines Sounds. The 30-ft (9.1 m) seine had 1/4-inch (6.35-mm) mesh. The 20-ft (6 m) wide trawl had 1 1/4-inch (32-mm) mesh. A June collection is from Chatham County. Dip net collections were taken beneath floating docks at Halfmoon Landing and Carrs Neck Creek. Macroinvertebrates observed in reefs were collected by hand or dip net.

In the Sapelo Island region most collections of *G. bosci* and *G. ginsburgi* were made in patches of oyster shells or in isolated hinged shells. *G. bosci* occurs where shells are not available in Texas (Hoese, 1966) and in grassy areas in Chesapeake Bay (Hildebrand and Schroeder, 1928). Some *G. bosci* were collected in marsh pools, as they were by Kilby (1955), and some among fouling communities (including sea squirts, hydroids, barnacles, and small oysters) on pilings, and on the underside of floating docks in summer and winter, a habitat reported by Joseph and Yerger (1956).

Extensive trawling and dredging in a Georgia estuary for 3 years produced four collections of *G. bosci* at stations where water depth ranged from approximately 4.5 to 12.0 m. Two were from part of the lower estuary where shells are abundant on the bottom, and two were from the middle part of the estuary where the bottom has various amounts of sand, gravel, mud, and debris. A few were seined in sandy areas along Sapelo Beach where cover was scarce. On 4 March 1969, 9 *G. bosci* were found along with 114 *G. ginsburgi* and 7 *Hypsoblennius hentzi* in tubular burrows in an eroding clay outcrop on Sapelo Beach. Burrows such as these, apparently made by false angel wings (*Petricola pholadiformis*), may be overwintering sites for large portions of the goby populations. Gobies and other fishes become scarce on the reefs in fall and winter. Some *G. bosci* were found in mud and debris at the edge of oyster reefs at near-freezing water temperatures (Hoese).<sup>4</sup> At temperatures below 20°C many *G. bosci* were found in mud-bottom marsh pools, where they apparently burrow in the mud during the coldest part of the winter, as speculated by Hildebrand and Cable (1938). A mass migration of *G. bosci* to deeper waters of the sounds in the winter is unlikely, as they were trawled in shallows (generally less than 1.2 m) throughout the year (Dawson, 1966).

<sup>4</sup> Hoese, H. D. Studies on fishes associated with American oysters (*Crassostrea virginica*). Unpublished manuscript filed at University of Southwestern Louisiana.

We collected *G. bosci* at temperatures of 12.7° to 31.3°C. It is known to occur at temperatures of 1.5° (Hoese, see footnote 3) to 33.2°C (Gunter, 1945).

*G. bosci* is euryhaline and is common in low to moderate salinities. Dawson (1966) suggested that *G. bosci* apparently departs from the size-salinity relationship described by Gunter (1945) wherein the youngest individuals predominate in the low salinities. Our data generally support Gunter's observations as our three low-salinity (0-1.9‰) collections contained only 14- to 22-mm specimens. However, Dawson (1966) found most 9.5 to 11.0-mm *G. bosci* to occur at 14.8 to 24.7‰ salinities. *G. bosci* spawns in moderate to high-salinity waters and the 4- to 15-mm pelagic larvae move upriver by an unknown mechanism (Massmann, Norcross, and Joseph, 1963). Since the smallest specimens reported by Dawson (1966) apparently were recently spawned, his observation does not disprove the size-salinity hypothesis.

Habitats of *G. ginsburgi* and *G. bosci* overlap to some degree. *G. ginsburgi* was commonly found in oyster shells at Big Hole. It was rare in the marsh creek; here only a single 16-mm *G. ginsburgi* was collected, along with 44 *G. bosci*, on 12 February 1968. *G. ginsburgi* was more abundant than *G. bosci* in burrows in the eroding clay banks on the beach as noted above and in deepwater stations in the estuary. There

TABLE 1.—List of fishes and common macroinvertebrates that were associated with the subtidal patches of oyster shells in Georgia.

Polychaete worm <i>Nereis succinea</i>	Shrimps <i>Palaemonetes vulgaris</i> <i>Palaemonetes pugio</i>
Snails <i>Urosalpinx cinerea</i> <i>Terebra dislocata</i> <i>Odostomia</i> sp.	Crabs <i>Callinectes sapidus</i> <i>Menippe mercenaria</i> <i>Rhithropanopeus harrisi</i> <i>Neopanope texana sayi</i> <i>Eurypanopeus depressus</i> <i>Panopeus herbstii</i> <i>Pagurus longicarpus</i>
Bivalves <i>Petricola phaladiformis</i> <i>Brachidontes exustus</i>	Fishes <i>Gobiosoma bosci</i> <i>Gobiosoma ginsburgi</i> <i>Gobiesox strumosus</i> <i>Opsanus tau</i> <i>Hypsoblennius hentzi</i> <i>Chasmodes bosquianus</i> <i>Hypleurochilus geminatus</i>
Isopods <i>Sphaeroma quadridentatum</i> <i>Cassinidea lunifrons</i>	
Amphipods <i>Gammarus</i> sp. <i>Melita nitida</i>	

were nine dredge and trawl collections of *G. ginsburgi* (13 specimens) in the estuary compared with four of *G. bosci* (4 specimens). In contrast to *G. bosci*, these collections of *G. ginsburgi* were all taken in shell areas. *G. ginsburgi* ranges offshore to a depth of 45 m (Dawson, 1966). Apparently it spawns in deep water, and its young do not migrate into low-salinity water. *G. ginsburgi* occurred in three dredge collections from 1.6 to 12.9 km (about 10 m depth) off the Georgia coast. *G. ginsburgi* was not found in shallow marsh pools, fouling communities, or in low salinities. We collected it at salinities of 24.9 to 34.1‰ in the estuary, and de Sylva, Kalber, and Shuster (1962) collected it at 22 to 30‰.

### ASSOCIATED SPECIES IN OYSTER PATCHES

Other fishes and conspicuous invertebrates were collected with the gobies for the purpose of characterizing the small oyster shell patches and to allow comparison with the larger, typical oyster reefs. The larger reefs are primarily intertidal in sounds and high-salinity rivers. The small reef patches are mostly subtidal and are subjected to a stronger ebb tide current and probably more erosion than the larger reefs in the mud flats.

Most of the invertebrates and all the fishes collected (Table 1) were reported for North Carolina oyster reefs by Wells (1961). The only records we add are the amphipod *Melita nitida* and the auger *Terebra dislocata*. Some species that we consider to be common in the subtidal reef patches were considered to occur in less than 20% of the collections in North Carolina (Wells, 1961). These include *Palaemonetes pugio*, *P. vulgaris*, *Callinectes sapidus*, *Menippe mercenaria*, *Rhithropanopeus harrisi*, *Pagurus longicarpus*, and *Cassinidea lunifrons*.

The seven species of fishes (Table 1) are characteristic oyster reef species. They are intimately associated with the reefs. They remain within the interstices of the reef throughout the tidal cycle during the warmest months and all nest there to some degree. However, they become scarce or absent on the reefs in winter. Other fishes collected with oysters (Wells, 1961)

are temporary visitors, do not lay adhesive eggs in the shells, and are rarely found in the interstices of the reef.

The oyster association offers advantages to the gobies and other fishes. The reef provides nesting sites, food, and added protection from predators. A great diversity of reef invertebrates is available for food (Wells, 1961). *G. bosci* eat *Gammarus* and other crustaceans, annelids, small fish, ova (Hildebrand and Schroeder, 1928), and dying oysters (Hoese, 1964). They eat brine shrimp in aquariums and probably feed on other zooplankton in nature. *Gobiosoma* species may be significant predators in the food chain of an oyster community, but are probably unimportant as prey species unless their eggs are eaten. Hildebrand and Cable (1938) reported that eggs of *Chasmodes* attached in oyster shells were preyed on by the crab *Eurypanopeus depressus*. We found three *G. ginsburgi* in the stomach of *Urophycis floridanus*. *Gobiosoma* species are reported in the food of predaceous fishes, including several sciaenids (de Sylva et al., 1962; Darnell, 1958; Hoese, see footnote 3), but their secretive habits would protect them from predation when they occupy reefs.

### SEXUAL DIMORPHISM

*G. bosci* and *G. ginsburgi* are sexually dimorphic in their color, body size, and genital papilla.

Male *G. bosci* tend to be darker (Breder and Rosen, 1966), and males were observed to turn darker when they were actively defending their nests. Males reach a larger size than females and are generally larger (Tables 2 and 3) as in *G. robustum* (Springer and McErlean, 1961). For *G. bosci*, the largest male and female were 50 mm and 37 mm SL (standard length), respectively. Corresponding lengths of *G. ginsburgi* were 41 and 32 mm. Maximum recorded length of *G. bosci* is 58 mm (Schwartz, 1961). Male *G. ginsburgi* reach 53 mm total length (42 mm SL) (de Sylva et al., 1962).

The sexes are easily separable by the structure of the genital papilla (Ginsburg, 1933). The papilla of males is triangular and compressed, whereas the papilla of females is conical, fleshy, with a larger opening than in males, and with fingerlike projections around the tip. The papilla is poorly developed in juveniles, accounting for most of the unsexed specimens in Tables 2 and 3. The papilla is most developed during the breeding season in *G. robustum* (Springer and McErlean, 1961).

Ginsburg (1933) found a predominance of males in collections of *G. bosci*, *G. ginsburgi*, and *G. robustum* and considered this to be possibly due to gear selectivity for the larger gobies. With the exception of collections of guarded nests, there is a relatively even sex ratio in our collections of *G. bosci* and *G. ginsburgi*. For example, *G. bosci* was represented by 20 males

TABLE 2.—Monthly length frequencies of *Gobiosoma bosci* from the Georgia coast, April 1967-June 1970. M - male, F - female, U - sex unknown (including juveniles), I - incubation of eggs or larvae, G - gravid female. None were collected in September.

Length (mm)	Jan.		Feb.		Mar.		Apr.			May			June		July			Aug.		Oct.	Nov.		Dec.		Total		
	F	M	F	M	F	M	MI	F	U	MI	FG	U	MI	F	U	MI	FG	U	M	U	M	M	F	M		U	
13-15			2											4			3		2							1	12
16-18		2	3											4			4		1								14
19-21		2	8											3								1					14
22-24		5	5		1							1				3			1				2				18
25-27	1	4	4	1	1						1					2											14
28-30	1	4	3						2	2	1		2	1			2		1	1					1		21
31-33		3			1						2		2	1			2	2	2						2		17
34-36		1	1	2		1					3		4				3	1				1					17
37-39		1		1			1				4		2	3			4	1				3					20
40-42		3		2							5		2	7			5										24
43-45					1						3		3				3										10
46-48				1		1							1														3
49-51										1																	1
Total	2	25	26	7	3	3	1	2	18	4	4	23	2	11	22	6	7	3	4	1	5	2	3	1		185	

TABLE 3.—Monthly length frequencies of *Gobiosoma ginsburgi*, from the Georgia coast, April 1967-June 1970. M - male, F - female, U - unidentifiable sex (including juveniles), I - incubation of eggs or larvae, G - gravid female.

Length (mm)	Jan.			Feb.		Mar.			Apr.		May			June	Aug.	Oct.	Nov.			Dec.	Total	
	M	F	U	M	M	F	U	MI	U	MI	FG	U	MI	U	U	U	M	F	U	U		
8-10																					2	
11-13			2													1	1				1	4
14-16				1	2			1		1											1	5
17-19					9	8												1	1			19
20-22	1	1		1	5	10						1	1	1								21
23-25		1			8	10			1	2	1											23
26-28	1				9	17				5	1		1									34
29-31					6	8			5	2												21
32-34					4	1			1	3												9
35-37					11					1												12
38-40					4																	4
41					1																	1
Total	2	2	2	2	59	54	1	6	2	13	3	1	2	1	1	1	1	1	1	1	1	155

and 25 females in February collections from the tidal creek. March collections of *G. ginsburgi* from burrows in an eroding clay outcrop at Sapelo Beach included 59 males and 54 females. This even sex ratio also occurs in *G. robustum* (Springer and McErlean, 1961).

### NESTING BEHAVIOR

*G. bosci* and *G. ginsburgi* apparently have evolved an instinctive ability to select nesting sites that will allow successful reproduction. They lay adhesive eggs inside dead, gaping, hinged oyster shells, which provide a clean stable substrate and protection from predators. The size of the aperture of the oyster shell, its submergence throughout the tidal cycle, and the amount of water circulation provided by tidal currents seem to be important criteria for selection of nesting sites in reef areas. Though nests were most commonly found in oyster shells, we collected one male *G. bosci* with eggs from a hinged quahog (*Mercenaria mercenaria*) shell. Nelson (1928) also reported *G. bosci* nesting in "clam" shells, and Breder (1942) found nests of the reproductively similar *G. robustum* in sponges and scallop shells.

We noted during our collection of nesting shells that all nests were below mean low tide, and none were found emerged during the extremely low spring tides. The gape of each nesting shell was just large enough to allow the goby to enter. This characteristic gape facilitated our recognition and collection of nests. Closing

the shells before extracting them from the reef prevented escape of the parent gobies.

Nests seemed to be located where the tidal current restricted siltation and stagnation at low tide. Masses of developing eggs and larvae probably require a continuous flow of water to provide oxygen and remove metabolic waste products. In aquarium observations, male gobies provided additional circulation by fanning the egg masses with slow undulations of the caudal fin. They apparently display this behavior in nature because all egg masses examined were free of silt.

Male *G. bosci* and *G. ginsburgi* guard and aggressively defend the nest until the eggs hatch and larvae become free-swimming. In laboratory observations males even attacked inanimate objects such as pipettes which were inserted into the nest. In defensive display, the dorsal fin and pelvic disc were erected, the mouth was opened broadly, and the body color was darkened. The erected pelvic disc elevated the body and may function to make the goby appear larger.

Male *G. bosci* were observed to successfully defend their nests against other male *G. bosci* introduced in the vicinity of the nest. Attached eggs of *G. ginsburgi* placed with male *G. bosci* were promptly eaten, even when the males were guarding their own eggs. Furthermore, male *G. bosci* were cannibalistic when presented with unfamiliar unhatched eggs while guarding their own nests. Both species may be important predators on eggs of their own species and other species nesting in oyster reefs. Since we saw

no evidence that males ever eat their own eggs, they apparently are able to distinguish their own progeny or nest from those of other individuals. Male gobies do not fast while incubating eggs. In fact, they temporarily left their nests to feed on brine shrimp (*Artemia*) introduced into aquariums.

### SPAWNING SEASON OF *GOBIOSOMA BOSCI*

The spawning season of many marine fishes becomes longer to the south along the U.S. Atlantic coast in relation to warmer waters. Naked gobies spawn in the warmer months and both ends of their spawning season become protracted to the south. In New York waters *G. bosci* probably spawns from June through August (Greeley, 1939; Perlmutter, 1939). Nests of *G. bosci* were found in late May and June in New Jersey (Nelson, 1928). Small *G. bosci* (4-7 mm) occur from June through October in Delaware (de Sylva et al., 1962). Spawning apparently occurs from May through October in Virginia (Massmann et al., 1963; Schwartz, 1961; Hildebrand and Schroeder, 1928). On the Carolina coast spawning is from June to October (Kuntz, 1916; Breder and Rosen, 1966) and possibly beginning in late April or early May (Hildebrand and Cable, 1938). We found *G. bosci* nesting in oyster patches only during the peak of its spawning season in Georgia, from April 24 through July (Table 2). Its spawning season commences in early April in Mississippi and extends to October in Mississippi (Dawson, 1966) and Tampa Bay (Springer and Woodburn, 1960).

The spawning season of *G. bosci* probably ranges from a 3-month period, June-August, in New York to a 6- or 7-month period on the Gulf coast. Mean monthly water temperatures can be used as a rough indication of the relationship of temperature and spawning season; however, these may be somewhat extreme for the months at the beginning and ending of the breeding season. Temperature data are from U.S. Coast and Geodetic Survey (1961) stations at Montauk, Long Island, N.Y.; Breakwater Harbor, Del.; Gloucester, Va.; Southport, N.C.; and Eugene Island, La. Mean temperatures at the

beginning and ending of spawning were 16° and 21°C in New York, 20° and 17°C in Delaware, 20° and 19°C in Virginia, 18° (April) or 23° (May) and 26°C in North Carolina, and 20° and 23°C on the central Gulf coast. Spawning commenced at 20°C in New Jersey (Nelson, 1928). Pending more thorough studies of spawning seasons, it can be concluded that spawning of *G. bosci* commences in the spring when water temperatures are 16° to 20°C and terminates in the fall or late summer.

The peak of spawning activity is in the warmest months, May through August, from New York to the Gulf coast. Therefore, this peak is related to temperature seasonally, but it does not change geographically in relation to temperature as Dahlberg (1970) demonstrated for the Atlantic menhaden, although summer maximums (mean monthly temperatures) range from 21°C in New York to 30°C in Louisiana. Higher summer maximums of 30° to 31°C in Tampa Bay apparently suppressed the spawning of a congener, *G. robustum* (Springer and McErlean, 1961).

### SPAWNING SEASON OF *GOBIOSOMA GINSBURGI*

Available data indicate that the spawning season of *G. ginsburgi* is very similar to that of *G. bosci*. *G. ginsburgi* probably spawned from July to October in Delaware as 2 to 6-mm larvae were found in these months (de Sylva et al., 1962). One *G. ginsburgi* was ripe in May in Virginia (Hildebrand and Schroeder, 1928). In oyster patches males were incubating nests on April 24 when the shallowwater temperature was 26°C in May and June. An 8-mm specimen dredged in Sapelo Sound on August 28 was probably spawned in August. If spawning continued into the fall as in Delaware, it may be restricted to deep waters since no nests were found after June. The stomach of a *Urophycis floridanus* contained three female *G. ginsburgi* (22-30 mm) that were gravid and appeared to be ready to spawn. The *U. floridanus* was trawled on 1 May 1969 in water depth over 7.6 m in the North Newport River, Liberty

County, Georgia. An abundance of shell on bottom probably would provide a suitable spawning site.

## EGG SIZE AND FECUNDITY

To analyze fecundity, eggs were counted in nests and ovaries. Eggs from ovaries of three *G. bosci* and one *G. ginsburgi* were counted and measured (Table 4). Thirty-five to 50 randomly selected eggs from both ovaries were measured with a filar micrometer eyepiece adapted to a 20× dissecting scope. Random egg diameter measurements were made as in Springer and McErlean (1961).

TABLE 4.—Sizes and numbers of eggs from ovaries of *Gobiosoma bosci* and *G. ginsburgi* in Georgia. Two size classes were found in *G. ginsburgi*.

Standard length	Date caught	Diameter of eggs		Number of eggs
		Average	Range	
mm		mm	mm	
<i>G. bosci</i>				
27	19 May 1970	0.195	0.112 - 0.247	701
28	19 May 1970	0.170	0.112 - 0.242	966
35	11 July 1967	0.599	0.526 - 0.720	1,382
<i>G. ginsburgi</i>				
25	1 May 1969	0.154	0.112 - 0.211	434
		0.602	0.549 - 0.684	

In one ripe *G. ginsburgi*, ova of two size classes were equally distributed throughout the ovary. Large ova were 0.55 to 0.68 mm, and small ova were 0.11 to 0.21 in diameter. In *G. robustum* the size range was somewhat greater and ripe ova were 0.476 to 0.782 mm (Springer and McErlean, 1961). The immature eggs may be spawned the following year or not at all. Springer and McErlean concluded that it is possible that sufficient time remains in the fall for the small egg class to be spawned; however, they also observed that the late spawners (mostly in fall) were entirely or mostly of a different year class than the early spawners (mostly in spring). In the fall, females matured at small sizes, 14.6 mm in *G. robustum* and 12.9 in *G. longipala* (Dawson, 1966). In three gravid *G. bosci* we found none of the small size class of eggs in the ovaries.

Springer and McErlean (1961) reported up to 402 eggs in a single ovary and approximately the same number in left and right ovaries of *G. robustum*. Our counts are based on both ovaries. Four nests of *G. ginsburgi* contained 354, 400, 790, and 1,884 eggs. Distinctly different stages of development were apparent in the largest nest. One female *G. ginsburgi* (25 mm) had 435 ripe eggs plus a similar number of immature ova. Fourteen *G. bosci* nests contained 332 to 2,000 eggs and three others had 3,933, 8,000, and over 9,000 eggs. The fact that three gravid females contained only 701 to 1,382 eggs points to a polygamous nature of the males. Further evidence of polygamy is the difference in developmental stages of adjacent egg masses in nests of *G. bosci* and *G. ginsburgi*. This polygamous behavior occurs in a closely related group, *Gobius*, and in an oyster associate, the oyster toadfish, *Opsanus tau* (Breder and Rosen, 1966). However, Runyan (1961) concluded that variation of developmental stages within *Gobiosox* egg clusters probably resulted from deposition on successive days, and she found no evidence for polygamy.

Fishes characteristic of oyster reefs have evolved parallel patterns of reproductive behavior. Adhesive eggs are incubated and guarded by the males. There are various degrees of reliance on oyster shells for nests. The extent of polygamy is not known. Low fecundity is characteristic of fishes that exhibit parental care. We found that egg counts in oyster shells were 319, 1,001, and 2,302 for *Gobiosox* and 1,058, 1,502, and 3,856 for *Chasmodes*. Runyan (1961) found 1,600 eggs in an average-sized female *Gobiosox* and 300 to 2,500 eggs in shells.

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