ASPECTS OF THE LIFE HISTORY OF THE SEABORD GOBY, GOBIOSOMA GINSBURGI, IN ESTUARINE AND INNER CONTINENTAL SHELF WATERS

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ABSTRACT. The seabord goby, Gobiosoma ginsburgi, is abundant in the polyhaline portion of estuaries and on the inner continental shelf in New Jersey waters. Based on extensive collections using a variety of sampling techniques, benthic individuals in both estuarine and inner shelf areas (depths from 0.5–20 m) occurred primarily in structured habitats such as mud/silt shells, worm tubes, and hydroids. Spawning occurred from June through September, as evidenced by the presence of mature and maturing females (15.0–55.7 mm SL) with developed and developing ovaries as well as planktonic larvae in the estuaries and on the inner shelf. Settlement in estuaries and the inner shelf occurred from July through September at sizes of approximately 3–12 mm SL. Following settlement, they grew slowly and reached sizes of up to 35 mm SL by the fall. The similarities in settlement and growth between the estuary and the inner continental shelf indicate that both areas serve as nurseries for this species. Little growth is evident during the winter so that by the following spring this year-class ranged from 21–39 mm SL and was of reproductive size. This spawning of this species in New Jersey waters occurs at one year of age. Results of this investigation indicate that this species uses both the estuary and the inner shelf to complete its life history.

KEY WORDS. Estuary, ocean, life history, nursery, Gobiosoma ginsburgi

INTRODUCTION

The seabord goby, Gobiosoma ginsburgi, is reported primarily in estuarine waters from Massachusetts (Ginsburg, 1933; Lux and Nichy, 1971) to Georgia (Dawson, 1966). Two studies noted its occurrence in oceanic waters (Dawson, 1966; Dahlberg and Conyers, 1973). Over this range, it is common but seldom abundant (Schwartz, 1961; Peary and Richards, 1962; Richards and Castagna, 1970), although the larvae are abundant in Virginia waters (Olney, 1983; Cowan and Birdsong, 1985; Olney and Boehlert, 1988). Dahlberg and Conyers (1973), Hoff (1976) and Munroe and Lofspiech (1979) examined aspects of the entire life history and ecology of this species. The objective of this study is to investigate aspects of the seasonal abundance and life history of G. ginsburgi in New Jersey waters. Large collections of this species were available from intensive sampling along an estuary-inner continental shelf corridor, thereby enabling us to address the issue of estuarian dependence for this species.

MATERIALS AND METHODS

Data for these analyses were derived from a variety of estuarine and inner continental shelf collections (Table 1), but the primary study sites were in New Jersey: Great Bay and Little Egg Harbor estuaries and an adjacent portion of the inner continental shelf centered around Beach Haven Ridge (Fig. 1). These estuaries are relatively unimpacted systems with broadly ranging seasonal temperatures and high salinity water that is surrounded by extensive Spartina alterniflora marshes (Able et al., 1992; Psuty et al., 1993). Beach Haven Ridge (Stahl et al., 1974; Twitchell and Able, 1993) is typical of sand ridges along the east coast of the U.S. (McBride and Moslow, 1991). It is located at depths of 10–20 m approximately 5 km from Little Egg Inlet (Fig. 1).

Care was taken to separate individuals of G. ginsburgi from the dominant G. box in estuarine collections (Able and Fahay, 1998). The latter did not occur in inner continental shelf collections. The only other goby reported from Great Bay is Gobionellus holosoma (Witting, 1995; Able and Fahay, 1998). Identification of G. ginsburgi larvae was based on illustrations and descriptions from an unfinished manuscript by D. Ruple and reported pigmentation patterns (Massmann et al., 1953; Wang and Kernehan, 1974). Larger larvae (< 10 mm) and benthic juveniles and adults had two prominent ctenoid scales on either side of the caudal peduncle (Ginsburg, 1933; Hildebrand and Cable, 1938; Dawson, 1966). Standard length (SL) was measured with a dial caliper to the nearest 0.1 mm.

Collections of larvae were made with a 1-m² (0.505 m² mesh) Tucker trawl during day and night tides at Beach Haven Ridge and a 1-m plankton net (4 m, 1.0 mm mesh) extended from a bridge over Little Sheepshead Creek between Little Egg Harbor and Great Bay during high tide tides (Fig. 1). See Witting (1985) for additional details for estuarine larval collections. In the vicinity of Beach Haven Ridge, the primary collections of benthic individuals were made with a 2-m (6 mm mesh) beam trawl, which was towed for 1–2 min per set. In Great Bay-Little Egg Harbor estuaries, most collections came from 1-m (3 mm mesh) beam trawl tows at a variety of locations. Other collections of juveniles and adults came from a variety of sites including the lower estuary of the Hudson River and Delaware Bay (Fig. 1, Table 1).

The identification of reproductively mature females was based on the presence of large diameter ova (> 0.52 mm, as observed by Dahlberg and Conyers, 1973) in the ovaries. All ova measurements were made with an ocular micrometer at 25× magnification. For most collections, water samples were collected with a bucket (surface) or Niskin bottle (bottom). Water temperatures were measured with a stem thermometer and salinities with a refractometer (American Optical). Age was determined by examining length-frequency progressions and by examination of sagittal otoliths for presence of annuli.

RESULTS AND DISCUSSION

Distribution, Abundance, and Habitat

This species was distributed in polyhaline estuarine waters and on the inner continental shelf off New Jersey in depths from 0.5–20 m based on large collections (n=1,172) (Table 1, Fig. 1). The consistent occurrence and abundance of juveniles and adults on the adjacent
Table 1. Sources of study material from New Jersey. (See Fig. 1 for sampling sites.) RUMFS = Rutgers University Marine Field Station.

<table>
<thead>
<tr>
<th>Location</th>
<th>Gear</th>
<th>Sampling Duration</th>
<th>Sampling Frequency</th>
<th>Sampling Depth</th>
<th>Number of Individuals</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beach Haven Ridge</td>
<td>2-m beam trawl (6 mm mesh)</td>
<td>July 1991–1993</td>
<td>Monthly</td>
<td>8–20 m</td>
<td>517</td>
<td>Able and Fahay, unpublished data</td>
</tr>
<tr>
<td>Beach Haven Ridge</td>
<td>Traps</td>
<td>July–September 1993</td>
<td>Weekly</td>
<td>8–15 m</td>
<td>8</td>
<td>RUMFS survey</td>
</tr>
<tr>
<td>Great Bay/Little Egg Harbor estuaries</td>
<td>1-m beam trawl (3 mm mesh)</td>
<td>July 1990–1993</td>
<td>Monthly</td>
<td>0.6–5 m</td>
<td>34</td>
<td>RUMFS survey</td>
</tr>
<tr>
<td>RUMFS boat basin/Great Bay</td>
<td>Traps</td>
<td>July 1990–1993</td>
<td>Daily</td>
<td>3–4 m</td>
<td>22</td>
<td>RUMFS survey</td>
</tr>
<tr>
<td>Great Bay/Little Egg Harbor</td>
<td>Seine</td>
<td>May 1990–May 1991</td>
<td>Semimonthly</td>
<td>0.5–1.5 m</td>
<td>7</td>
<td>RUMFS survey</td>
</tr>
<tr>
<td>Little Sheephead Creek</td>
<td>Plankton net (1 m hoop)</td>
<td>February 1981–1993</td>
<td>Weekly</td>
<td>4.0 m</td>
<td>234</td>
<td>RUMFS survey</td>
</tr>
<tr>
<td>Delaware Bay/Brown Shoals</td>
<td>Bottom grab (0.1 m x 0.1 m)</td>
<td>September 1990–August 1992</td>
<td>Unknown</td>
<td>Unknown</td>
<td>83</td>
<td>Batelle Ocean Sciences survey</td>
</tr>
<tr>
<td>Delaware Bay/southern New Jersey</td>
<td>Otter trawl</td>
<td>1920–1930s</td>
<td>Unknown</td>
<td>Unknown</td>
<td>67</td>
<td>Academy of Natural Sciences of Philadelphia</td>
</tr>
<tr>
<td>Hudson River</td>
<td>Traps</td>
<td>1993</td>
<td>Daily; biweekly</td>
<td>8–20 m</td>
<td>98</td>
<td>RUMFS/National Marine Fisheries Service, Sandy Hook survey</td>
</tr>
</tbody>
</table>

Fig. 1. Primary study area in southern New Jersey with other important localities mentioned in the text. Squares indicate regular collecting localities; closed squares indicate locations of *Gobiosoma hispida* collections.
inner continental shelf represent an extension of its habitat into the ocean. Prior to this report, there was only brief mention of its occurrence in the ocean (Dawson, 1966; Dahlberg and Conyers, 1973). This pattern is quite distinct from *G. bosci*, which is the dominant form throughout the estuary, but did not occur on the inner continental shelf in this or other studies off New Jersey (Able and Fahay, 1998). Planktonic larvae of *G. ginsburgi* were collected over several years (1991–1993) in nighttime sets from a bridge over Little Sheephead Creek between Little Egg Harbor and Great Bay (Fig. 1), where salinities typically ranged from 22–33 ppt (Witting, 1995). For benthic juveniles, the salinities were lowest at the Hudson River (15–22 ppt), higher at Great Bay (24–32 ppt), and highest at Beach Haven Ridge (30–83 ppt). The occurrence of this species in the higher-salinity waters of estuaries was consistent with the findings of other investigators (see Munroe and Lotspeich, 1979). The location of the Hudson River approached the lowest recorded salinities for the larvae of this species (12.3 ppt, Olney, 1983). The planktonic larvae were densest on the inner continental shelf at Beach Haven Ridge, but relatively high densities were also observed in the estuary at Little Sheephead Creek (Fig. 2).

Our observations indicate that benthic juvenile and adult *G. ginsburgi* were associated with physical structure. They were collected in Great Bay habitats ranging from mud to sand with shell, worm tubes, and hydroids over the substrate. At Beach Haven Ridge, where a large number of *in situ* transacts (33 m length, n=76 transacts) were made at depths of 8.8–19.8 m for assessment of juvenile fish abundance, SCUBA divers observed numerous individuals (n = total of approximately 100). Observations of *G. ginsburgi* were easily made because it is typically stationary, and it is the only gobid found on this portion of the inner shelf (K.W. Able and M.F. Fahay, unpublished data). Juveniles and adults occurred exclusively in a common habitat type, the valves of the surf clam, *Spisula solidissima*, and were never found on sand substrate. In some instances, these clam shells consisted of a depression under a single valve lying flat on the substrate. In other instances, fish were observed in large, dense accumulations of these shells. Densities of gobies across all transacts with shells ranged from 0.2–12 ind./m². This species has also been observed associated with structure, including mollusk shells, in estuaries in Massachusetts (Hoff, 1976), Rhode Island (Munroe and Lotspeich, 1979) and Georgia (Dahlberg and Conyers, 1973).

Abundance of all life history stages was distinctly seasonal at both of the primary study sites (Fig. 2). Pelagic larvae were present only from July through September with a peak in density in July in Great Bay, while in the vicinity of Beach Haven Ridge, larvae occurred from July through September with a peak in August. The timing of larval occurrence in New Jersey was consistent with that for Rhode Island (July–August; Munroe and Lotspeich, 1979), Delaware (July–October; de Sylva et al., 1962), but was extended later in Chesapeake Bay (June–December; Dovel, 1971; Olney and Boehlert, 1988). Benthic individuals occurred on the inner shelf from July through October, but were most abundant in September (Fig. 2).

**Reproduction**

Spawning occurred from approximately June through September in New Jersey waters based on the collection of a few mature and immature females and small larvae. Maturing and mature females (n=9, 15.0–38.7 mm SL) were collected in Great Bay from June through late August. These dates overlap with the July period of reproduction in Rhode Island (Munroe and Lotspeich, 1979) and Long Island, New York (Greeley, 1938), but were later than the May period of reproduction in Chesapeake Bay (Hildebrand and Schroeder, 1982) and the April–August period in Georgia (Dahlberg and Conyers, 1973). The smallest larvae (3–8 mm SL) were collected in July and August in Great Bay and as late as October at Beach Haven Ridge (Figs. 3, 4). The collection of smaller larvae at Beach Haven Ridge (Fig. 3) is probably due to the smaller mesh size of sampling gear used there (0.505 mm) than in the estuary (1.0 mm).

It is not clear if this goby spawns in the ocean. No mature or maturing females were collected from the inner continental shelf, but plankton collections there collected small, recently hatched larvae. The latter larvae may have derived from estuarine outwelling on ebb tides from Great Bay - Little Egg Harbor (Charlesworth, 1968) through Little Egg Inlet or from undetected mature individuals in the ocean. More intensive collections for adults are necessary to determine unambiguously if spawning occurs both in estuaries and on the continental shelf. Prior studies have suggested that spawning only occurs in estuaries (Dahlberg and Conyers, 1973; Munroe and Lotspeich, 1979).

**Settlement**

There are distinct morphological changes associated with settlement. This occurs at approximately 9–12 mm SL because both planktonic larvae and the smallest benthic individuals were collected in this size range (Figs. 3, 4). The smallest benthic individuals had the complete fin-ray complement, and pigmentation was similar to that of the adults. The basicaudal ctenoid scales, which are diagnostic for this species, were also present and are known to form in individuals by 10 mm SL (Hildebrand and Cable, 1938). Settlement occurred simultaneously with an abrupt change in the relative proportion of pelvic fin length. At 7–9 mm SL, pelvic fin length averaged 10.3% SL; by 9–11 mm SL and greater, it was 18% of SL. A similar pattern in size at settlement and pelvic fin development is evident for *G. bosci* (Breitburg, 1991).

Settlement, based on the presence of the smallest benthic juveniles, occurred in both the estuary and the ocean during summer.
Age and Growth

Based on analyses of length-frequency modal progressions and examination of sagittal otoliths, all individuals of *G. ginsburgi* collected in the estuary and on the inner shelf were age 0+. On the inner shelf, the size range of larvae, juveniles and adults ranged from 3-45 mm SL (Fig. 3). Age 0+ individuals were approximately 15-45 mm SL by October. In the estuaries, where the most complete monthly collections were available (Fig. 4), the planktonic larvae and benthic juveniles ranged from approximately 6-24 mm SL. By October, they were as large as 36 mm SL as the result of the growth of the juveniles (Fig. 4). The relatively small sizes attained by the fall are slightly less than those of the cooccurring congener, *G. bosca* (Able and Fahay, 1998).

Examination of whole sagittal otoliths from larger individuals (n=18, 15-44 mm SL) collected in both estuarine and inner shelf study areas revealed no evidence of annuli. We suspect that the disappearance of the smaller individuals (9-20 mm SL) during the winter (Fig. 4) is due to size-selective overwinter mortality. This also occurs in age 0+ individuals in four other species (black sea bass, *Centropomus striata*; smallmouth flounder, *Etpopus microstomus*; tautog, *Tautoga onitis*; and conner, *Tautogolabus adspersus*) from the same study area (Hales and Able, in press).

In summary, *G. ginsburgi* mature at one year. Age 0+ individuals captured in April, after the first winter, overlapped in size with those of the gravid females (19-0-38.7 mm SL). Thus, the attainment of reproductive size in the first year and the lack of evidence of older individuals indicate that this species may only live one year. Further, we conclude that *G. ginsburgi* is one of a group of species in the Middle Atlantic Bight, including *Centropomus striata* (Able et al., 1995), *Scophthalmus aquosus* (Morse and Able, 1995), and *Etpopus microstomus* (Able and Fahay, 1998), that uses both the estuary and the inner continental shelf as settlement and nursery areas (Able and Fahay, 1998). This is in contrast to the congener, *G. bosca*, which appears to be restricted to estuarine waters (Able and Fahay, 1998).

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Fig. 4. Length-frequency distribution of larvae and juvenile/adult *Gobiosoma ginsburgi* from Great Bay, Hudson River and Delaware Bay. See Fig. 1 for these locations.
LITERATURE CITED


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