THE LIFE HISTORY OF THE SILVERSIDE

Menidia menidia (Linnaeus)

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INTRODUCTION

This paper is based on an attempt to assemble the existing knowledge of the silverside, *Menidia menidia*, and to contribute to what is known about the life history of this species. A vast amount of work is needed on the ecological relationships between the food fish and the forage fish. One of the most important forage fishes on the Atlantic Coast is the silverside. To understand the inter-relationships between the food fish and the forage fish it is necessary first to understand the life histories of both. For this reason it is important that the life history of this species be studied.

For contributions that made completion of this paper possible, appreciation is expressed to:

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4. Miss Ann O'Rourk, of Western Maryland College, who identified the parasites found on the fish collected.

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MATERIALS AND METHODS

Fish were collected in a number of ways. A hundred foot haul seine with one-quarter inch bar mesh, six foot depth at the brails, and ten foot depth at the center was used with either one or two operators. A fifteen by three and a half foot seine with mesh fine enough to hold eggs or the smallest fry was used by two operators. Part of the hundred foot seine was stretched across the mouth of the Green Holly Creek (described later) with the rest piled on shore. The fifteen foot seine was then taken by two operators about fifty yards upstream and
worked down the narrow creek, driving the fish toward the hundred foot seine. When the fifteen foot seine had nearly reached the hundred foot one, the free end of the latter was quickly brought around in such a way as to enclose the fish and it was hauled in the regular manner. For dipnet collections, which were made at night, a crab net twelve inches in diameter with one-quarter inch bar mesh was used. A small spot light bulb furnished light necessary for the operation. Fish were not attracted to the light but were seen swimming by.

Salinities are expressed in parts per thousand and temperatures in centigrade degrees. Collections were preserved in ten percent formalin and examined forty-eight or more hours after preservation. Lengths are expressed as total length in millimeters after preservation. Scales were taken from preserved specimens, rinsed in water, and pressed to dry between ordinary microscope slides. After drying, they were placed in scale envelopes for later examination.

Collecting stations were:

1. Sandy Point, Solomons Island, Md.—dropoff about three feet in first hundred, sea lettuce present, sandy bottom.

2. Bay side of Drum Point, Calvert County, Md.—dropoff about four feet in first two hundred, eel grass scarce in seining place but abundant farther out and present on either side, bottom sandy or shallow diatomaceous ooze.

3. End of Chesapeake Biological Laboratory pier at Solomons Island—seven hundred feet from shore, depth about eight feet, eel grass abundant, fine sandy bottom.

4. Mouth of Green Holly Creek, St. Mary's County, Md.—about twenty feet wide and two and a half feet deep, eel grass abundant around outside of mouth but no vegetation in creek proper, sandy bottom.

5. Molly's Island, Solomons Harbor—dropoff about four feet in first hundred, no vegetation, sandy bottom.

6. Front of Chesapeake Biological Laboratory, Solomons Island, Md.—dropoff about one foot in first hundred, sea lettuce absent early in season when samples were taken but abundant later on, fine sandy bottom, exposed by very low tides.
DESCRIPTION OF THE SPECIES

The species *Menidia menidia* has been divided into two subspecies, *Menidia menidia menidia* (Linnaeus) and *Menidia menidia notata* (Mitchell), the former being the more southern type. Kendall (1902) discusses the differences saying:

"Beginning with the St. Johns River, *M. dentex* agrees most nearly with the description of *M. menidia* [*Menidia menidia menidia*]; northward the intergradation becomes more and more evident, reaching its height in the Chesapeake region, whence northward the characters approach typical *M. notata* [*Menidia menidia notata*], agreeing perfectly in nearly all specimens north of Cape Cod.

"The differential characters heretofore considered specific were the more backward situation of the first dorsal, fewer scales in longitudinal and cross series, and the deeper body of *M. menidia* . . .

"In Chesapeake Bay the differential characters do not conform to the specific requirements; thus individuals with the backward position of the first dorsal have the slender bodies and more numerous scales of *M. notata* and vice versa. With specimens from Woods Hole agreeing perfectly with *M. notata*, mixed forms as well as perfect *M. menidia* are found, the majority being the *M. menidia* form.

"The range of *Menidia menidia*, as given by Jordan and Evermann in Fishes of North and Middle America, is from Cape Hatteras to Florida. Curiously, the range of *M. notata*, in the same work, is given south to Cape May, leaving an intervening space of many miles—Cape May to Hatteras—seemingly unoccupied by either form, but which is inhabited by intergrading or mixed forms of *M. menidia* and *M. notata* . . .

"The intergradation, however, is not uniform. As has been said . . . specimens have been taken in the Chesapeake which conform respectively to the descriptions of *M. menidia* and *M. notata*; at the same time others do not agree with the description of either, or rather partake of the characters of both forms to such an extent that it is impossible to say to which form it belongs. Specimens have been found at Woods Hole, even, which were essentially the *M. menidia* form. This is hardly an ideal intergradation, rather such as might be expected from the interbreeding of two closely related species and the occurrence of stragglers of either of the two forms or their hybrid offspring north or south of the point of intermingling."
Hildebrand and Schroeder (1927) state that, "The extremes as well as the intermediates sometimes occur in a single lot collected in one locality within a few hours." However, this taxonomic difference, if any, should not mean a difference in the habits of the fish. No attempt was made to differentiate samples by subspecies and literature on both forms has been used. Henceforth the fish in question will be referred to as *Menidia menidia* or the silverside.

![Fish](image)

**Fig. 1. Menidia menidia:** an immature specimen, 56 mm. in length (x 108).

The following description of *Menidia menidia* is given by Hildebrand and Schroeder (*ibid.)*:

"Head, 4.15 to 4.7; depth, 4.3 to 6.95; D. III to VII-I, 7 to 10 (usual formula IV to VI-I, 8 or 9); A. I, 20 to 26 (usual formula I, 22 to 25); scales, 44 to 50 (15 to 18 oblique rows on sides between upper angle of gill opening and origin of spinous dorsal). Body variable, very slender to moderately deep and compressed; caudal peduncle rather long, its depth 2.2 to 3 in head; head depressed above, narrower below; snout moderately long, pointed, its length 2.7 to 3.75 in head; eye, 2.75 to 3.75; interorbital, 3.35 to 3.8; mouth small, moderately oblique, nearly terminal, the lower jaw being slightly included: teeth in jaws pointed, in narrow bands, with the outer series somewhat enlarged; scales firm, with margins entire, extending somewhat on the base of caudal but not on the soft dorsal and anal; origin of spinous dorsal rather variable, sometimes about equidistant from tip of snout and base of caudal, more usually nearer the latter; the predorsal distance 1.75 to 2 in length to base of caudal; second dorsal situated over middle of anal base; caudal fin moderately forked; anal fin long, its base about an eye's diameter longer than head; ventral fins small, inserted equi-
distant from tip of snout and end of anal base, or more usually somewhat nearer the former; pectoral fins moderate, pointed, 1 to 1.3 in head.

Fig. 2. Silverside scales: A. *Menidia menidia*, September 10, 1949, 88 mm.; B. *Membras vagrans*, June 1, 1946, 104 mm.; C. *Menidia menidia*, July 21, 1950, 124 mm.; D. *Menidia menidia*, September 10, 1949, 90 mm. (note double focus).

"Color greenish above; more or less silvery, with metallic luster in life below; sides with a bright silvery, well-defined band, about half diameter of eye, bounded above by a dark line; scales on upper part of sides and back with numerous brownish dots; fins plain translucent; peritoneum black."

The largest specimen found in this study was 140 mm. or five and a half inches in length. There is no external difference between the
sexes, and the young after attaining twenty mm. are practically identical with the adults (see fig. 1).

The genus *Menidia* may be distinguished from the genus *Membras*, the rough silverside, in that it has cycloid scales while the latter has strongly ctenoid scales (see fig. 2, A and B). The species *menidia* may be distinguished from the species *beryllina*, the freshwater silverside, by the following table adapted from figures given by Hildebrand and Schroeder *(ibid.)* and Kendall *(op. cit.)*:

<table>
<thead>
<tr>
<th>Species</th>
<th>Rows of Scales in Lateral Series from Upper Angle of Gill Opening to Base of Caudal FIN</th>
<th>Rows of Scales in Lateral Series from Upper Angle of Gill Opening to Origin of First Dorsal FIN</th>
<th>Soft Anal Rays</th>
<th>Color of Peritoneum</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M. menidia</em></td>
<td>39-50</td>
<td>15-18</td>
<td>20-29</td>
<td>“Silvery, with or without dusky punctuations”</td>
</tr>
<tr>
<td><em>M. beryllina</em></td>
<td>37-41</td>
<td>12-14</td>
<td>14-20</td>
<td>Black</td>
</tr>
</tbody>
</table>

Differentiation of the two species by peritoneum color has proved in practice to be an unreliable method. *Menidia beryllina* rarely attains a length of over three and a half inches.

*Menidia menidia* has been called capelin, smelt, young smelt, green smelt, sand smelt, sardine, anchovy, shiner, small fry, frier, hrit, spearing, spearing, whitebait, and silverside. The first seven names arise from confusion with other species. In New York City, wholesalers and retailers of silversides call *Menidia menidia* “spearing” and *Menidia beryllina* “whitebait,” differentiating the species by the greater size of the former. However, by far the most common name for the genus *Menidia* is “silverside.”

**IMPORTANCE**

is the shiner, or silversides (*Menidia menidia notata*). This is a species which spawns in the spring (Hildebrand, 1922), and the young of each year stay so close to shore and are of such small size that they do not become available to the striped bass as food until August. At this time they reach 2 cm. in length and often stray farther offshore. . . . Stomach content analysis of striped bass 30-50 cm. long . . . in 1936 and 1937 showed that adult *Menidia* and the common prawn (*Palaeomonetes vulgaris*) formed the main food from April to August, but that in August and September the bass fed on juvenile *Menidia* to a large extent. Shortly after this change in diet in 1936 there was a decided increase in the growth rate of the two-year-old striped bass . . . which, despite the drop in water temperature . . . was greatest in October. The presence of what was apparently an unusually great number of juvenile menhaden (*Brevoortia tyrannus*) in 1936 may also have played a part in this increased growth rate, for from August on striped bass commonly fed heavily on this species during this year. However, juvenile menhaden were not as abundant in 1937 in this area, yet the growth rate of striped bass in September and October continued much as it had throughout the summer in spite of the drop in temperature. . . . It therefore appears that the increased food supply of striped bass resulting from availability of juvenile *Menidia* after the middle of August may be correlated with the maintenance or increase of the growth rate in the early fall when the water temperature falls rapidly, and when the normal expectation would be that the growth rate would slow down." The silverside, being restricted to the shore zone more than anchovy, *Anchoviella*, the menhaden, or the Atlantic herring, *Clupea harengus*, is presumably a less important forage fish than these but still valuable in this role.

It is reported that in 1946, 126,300 pounds of silversides were caught commercially in New York State (Anderson and Power, 1950). According to William H. Dumont, Acting Chief, Branch of Commercial Fisheries, U. S. Fish and Wildlife Service, in an unpublished letter, these silversides are *Menidia menidia*, known to wholesalers and retailers as spearing. They are sold in New York City restaurants, particularly those patronized by the Latin races. The fish sold as whitebait in New York City are chiefly *Menidia beryllina* but may contain young of other species, particularly *Menidia menidia*. Anderson and Power (*ibid.*) report that 32,900 pounds of whitebait were landed in New York State in 1946. Silversides are used to some extent as bait but are inferior because they die too quickly for live bait and soften too
soon on a hook (Kendall, *op. cit.*). On Prince Edward Island they are sometimes canned or used for fox food (McKenzie and Day, 1949), and in some localities they are used to bait eel pots.

Reports on the palatability of silversides have been highly favorable and it is quite possible that they could spring quickly to popularity as food for human consumption and be heavily fished by man. A large scale removal of this nature would not necessarily mean depletion of this species. Usually an optimum fishing pressure can be established for a species where an ample brood stock is left. Even if depletion should result it cannot be said to be harmful until the ecological relationships of the silverside with other forage fish, with the young of commercially important species, and with its predators is thoroughly understood.

**SPAWNING, EMBRYOLOGY, AND LARVAL DEVELOPMENT**

Silversides hatched in the spring in the Chesapeake Bay reach their adult size, usually a little over 100 mm., by December of the same year. The females average slightly larger than the males. The gonads develop slowly but steadily throughout the winter and up until spawning takes place. Time of spawning varies with the latitude, the peak in Chesapeake Bay occurring in May. In North Carolina ripe fish are found as early as March and as late as August (Hildebrand, 1922) with the peak occurring in April and May. In New England, the peak occurs in late June but spawning is known to have occurred as early as May (Bigelow and Welsh, *op. cit.*). The data in Table 1 show the development of the gonads, the time of spawning, and the size of the fish at spawning time of five samples of silversides taken in Chesapeake Bay. These data indicate that:

1. The spawning peak occurs in May.

2. There is a positive correlation between greater size and earlier maturity.

3. Females at maturity are larger than males.

4. Though there may be great variation in individual collections, numerically the sexes in ripe fish are approximately equal.

Hildebrand (*op. cit.*) and Hildebrand and Schroeder (*op. cit.*) suggest that silversides spawn more than once during a season, basing
their assumption on the long period of time in which ripe fish are
found and the presence of different sizes of eggs in the gonads at one
time. That phenomenon was observed in this study. However, all
eggs examined were opaque except those of the largest size which
were virtually transparent. Since small translucent eggs were seen in
the late fall, it is to be implied that these smaller opaque eggs seen
in the springtime were either dead or arrested ones that would not
develop further. No one has reported finding ripe fish in large numbers
at any time other than spring and early summer and no larvae have
been reported found after the eighth of August. In fact, when the
spawning peak was passed only a few of the fish of the spawning class
were found in this study, the last being found on July 21. Thus it is
almost certain that this species spawns only once, at least in Chesa-
peake Bay. Figure 3 does suggest, however, that there may be two
spawning beats a few weeks apart by two populations of fish. Gunter
(1945) showed that *Menidia beryllina peninsulce*, a Gulf Coast species
comparable to *Menidia menidia*, spawns twice a season, once in the
spring and once in the late summer. It may be that an individual
fish in this area spawn twice during a season, or that each spawning beat
is accomplished by fish of a different age class.

The fish congregate in shallow water close to shore, when spawning,
and deposit their eggs and milt where in rosy strands the eggs
clung to vegetation and to each other. Fowler (1918) gives the
following description of the spawning act: "May 12 we found bunches
of spawn in the meadow grass, just below high tide, along the shores
of Magothy Bay at Long Point Island [Northampton County, Vir-
ginia]. Also a number of dead fish was found in the trash and debris
washed above the tide-mark. These had all spawned several days
before, as they were all quite fresh. Mr. George Skidmore, who re-
ported seeing a large school spawning in this locality on May 1, was
attracted by the great number of fish congregated, which were appar-
ently to the number of several thousand individuals, all collected at
high water over the grass. At this time the water was but several
inches deep, and the fish occupied an area of a hundred or more square
feet. The water for a still greater area was all white with the expelled
milt of the males, so that it had a conspicuous milky appearance. All
the fish were greatly agitated, tossing and tumbling about. As the tide
went down they all moved off-shore with it, and the eggs were left
attached or screened by the grass on the dampened shore to await the
return of high water. Doubtless the greater part of these eggs perish.
or are devoured by crabs, birds, etc." Bumpus (1898) and Hildebrand (op. cit.) also mention eggs being left on shore by the receding tide. Ryder (1883) suggested that the silverside is a nocturnal spawner but no other observer confirms this theory. Repeated searches were made, in this study, on the beaches of a creek where large numbers of ripe silversides were found but no spawning fish or eggs were seen. A fine meshed seine was dragged through the eel grass on several spring seineing trips without finding either eggs or larvae, and plankton tows close to shore also failed to produce larvae or eggs. Unsuccessful searches for eggs and spawning fish were made along a beach where, later, large numbers of the young fish were found.

During the period when ripe fish were found, eggs were stripped into shallow dishes containing a little sea water, milk was stripped over them, and more water was added. When these eggs were brought to the laboratory none of them hatched or showed evidences of having been fertilized. Ripe male and female fish were placed in 12 gallon aquaria filled with sea water in hope that they would spawn. Eggs were exuded soon afterward by some of the females but this was probably more in the nature of a miscarriage than spawning. Since running salt water was not available the fish died after a few days.

A ripe female contains about 300 mature eggs and many smaller seemingly dead or arrested eggs. The eggs are slightly more than a millimeter in diameter and spherical in shape. They are yellowish in color, semi-transparent, and heavier than sea-water. There is attached at one pole a number of gelatinous threads about five times as long as the diameter of the egg. These threads are rubbery in their ability to stretch and contract, very tough, and capable of adhering with great tenacity to almost any object they encounter, including other eggs. The function of these threads appears to be to cling to the vegetation and prevent the eggs from washing ashore or resting on the bottom where survival chances are probably lower. Several oil globules of varying sizes are found in each egg.

No study of the embryology of the silverside was undertaken in the course of this work but the subject has been well covered by Kuntz and Radcliffe (1917), Hildebrand (op. cit.), and Clark and Moulton (1949).

The incubation period is about ten days at normal temperatures and the newly hatched larvae are about five mm. in length. These
larae have lost virtually all their yolk sac but still have a continuous vertical fin-fold (Hildebrand, op. cit.). By the time the larvae have reached twelve to fifteen mm., the fin-fold is lost and it resembles the adult (Bigelow and Welsh, op. cit.) except that the lateral band is not well differentiated (Kuntz and Radcliffe, op. cit.). Larvae, 4.4 to 9.1 mm. in length, were taken by Perlmutter (1938) from May 12 to August 8 in plankton tows off Long Island, New York.

LIFE CYCLE AND HABITS

After spawning has taken place in the spring, young silversides can be found along the shores of salt and brackish water bodies throughout the summer. They travel in schools and often go above the low water mark. Because of their extended spawning period, there is great variation in size through most of the summer. Size distributional histograms (fig. 3) seem to indicate that more than one population exists as a result of more than one spawning beat. Blocks 14 and 16 each may show two populations, the younger being on the left. In block 17, the younger population has come into predominance while in 18, 19, and 20 the older one predominates. As indicated in table 2, however, 14 and 17 were collected with a 15 foot fine meshed seine in shallow water while 16, 18, 19, and 20 were caught with a 100 foot, one-quarter inch bar seine in water up to four feet deep. The large seine, because of its greater length and because it covered deeper water, was better able to get larger fish, while its coarse mesh undoubtedly caused it to lose many of the small silversides. Conversely the smaller seine, because of its lesser length and because it covered only shallower water did not collect many larger fish, while its fine mesh made it efficient in capturing smaller ones. Hence samples obtained with the large seine are biased in the direction of greater lengths, while those obtained with the smaller seine are biased in the opposite direction. The smaller seine was used earlier in the season and the larger one later because the former was probably less biased when the fish were smaller and later the larger seine was probably capable of getting a better sample. The data are far too inadequate to establish the existence of populations but do suggest their presence. Whether these populations, if any, persist or are erased by compensatory growth is unknown—1949 year class size distributional histograms (fig. 3, blocks 1 to 11) give no indication of more than one population. The erratic length distributional curves obtained by Warril and Merriman (1944) seem to indicate more than one population. To establish the existence
Fig. 3A. Length frequencies in mm. of Menidia menidia collected at Solomons. The total period here is from August 10, 1949 to March 24, 1950, and each numbered block sums up several collections as indicated in Table 2.
Fig. 3B. Length frequencies in mm. of *Menidia menidia* collected at Solomon Islands. The total period here is from April 6, 1950 to July 13, 1950, and each numbered block sums up several collections as indicated in Table 2.
or non-existence of populations and spawning beats will require many large, carefully collected samples and extensive data on spawning.

Fig. 3C. Length frequencies in mm. of *Menidia menidia* collected at Solomons. The total period here is from July 17, 1950 to August 4, 1950, and each numbered block sums up several collections as indicated in Table 2.

Growth of silversides in Chesapeake Bay is rapid throughout the summer so that they have reached adult size by winter (see fig. 4). Merriman (*op. cit.*) sampled silversides from July 17 to September 2, 1937 in Connecticut and got a growth rate far slower than that found in Chesapeake Bay, suggesting that Connecticut silversides take two years to mature. If this is the case, then it is conceivable that Maine silversides require three years to mature and Florida silversides might have habits similar to those of the Gulf Coast form, *Menidia beryllina peninsulariae* (*see page 11*). Bigelow and Welsh (*op. cit.*), in reporting on fishes of the Gulf of Maine say, "Probably the silverside attains maturity at one year of age" and Tracy (1910) is of this opinion in regard to Rhode Island silversides.

As the water temperature dropped in the fall, silversides became scarcer in seineing hauls, while midwinter hauls caught no fish at all.
(see table 2). Wartel and Merriman (op. cit.) were unable to catch silversides by seining in midwinter. The method employed in this study for getting fish in the winter was that of dipping from the end of a seven-hundred-foot pier over eight feet of water with a dipnet and light at night. This method was productive of small numbers of silversides throughout the winter. This evidence would tend to indicate either that most of them have migrated to deeper waters or died by wintertime. Several authors hold that silversides are found along the shores throughout the winter. "Silversides are probably resident throughout the year wherever found." (Bigelow and Welsh, ibid.) "It is the only fish which occurs in large numbers in the shallow waters throughout the winter, large schools may be seen along the shores of Pipers Island [North Carolina] during the coldest days, when practically all other fishes have migrated to deeper water or to a warmer latitude." (Hildebrand, op. cit.) "It probably remains near shore during most of the winter, but part of them at least retire to deeper water during the period of low temperatures. . . . Silversides were caught in many beam-trawl hauls during these winter months, but the aggregate catch was so small in comparison with the known abundance of the fish along shore during most of the year that it is doubtful if the deeper waters of the bay can be considered a wintering ground." (Hildebrand and Schroeder, op. cit.). It is possible that the reason Hildebrand and Schroeder found so few fish in the winter was not because most of them were close to shore but because most of them had died by wintertime. The number of fish found in the course of this investigation in the spring was far less than the number found the preceding fall. Bean (1908) says, "The common silversides . . . lives in Gravesend Bay (New York) almost all the year, hibernating in spring holes in winter." When Green Holly Creek was sampled on March 24, 1950 about 500 fish were found. These fish may have spent the winter there—no previous sampling was done. It is doubtful that the tremendous numbers of silversides found in the summer and fall could spend the winter in this and similar creeks without being noticed, but with a heavy mortality in the fall it is conceivable that this might happen. The question of silversides' wintering grounds is still an open one.

Growth of silversides stops during the winter (see figs. 3 and 4). In the spring of 1950, large numbers of ripe fish were found in the mouth of Green Holly Creek. Seinings at that time along places
Fig. 4. Growth: The circles represent the samples given in Table 2. The curve, which begins on August 10, 1949, and terminates on August 4, 1950, was drawn by inspection.
where they are found during the summer failed to produce fish and it is possible that this creek and similar localities are favorite haunts of ripe silversides. Few silversides of the 1949 year class were found after they had spawned in the spring of 1950. Fowler (op. cit.) mentions silversides dying after spawning (see pages 11,12). The last silverside of the 1949 year class was found on July 21, 1950. Scales showed a winter and/or spawning ring followed by growth (see fig. 2C). If a silverside were to live and grow at the rate shown through its second summer and fall in Chesapeake Bay it would attain a length of eight inches or more. No fish of such sizes have been observed in this study or reported by others, strongly indicating that silversides meet death in one way or other soon after spawning.

Out of 880 fish whose gonads were examined, 356 were males and 524 were females. In 1949, from early August until the end of December, 145 males and 325 females were found, while in 1950 the same year class showed a ratio that was nearly equal, 199 males to 211 females. It is significant that the ratio is so nearly equal near the spawning time after being so far off when the fish were younger. In individual collections the ratios varied highly, for instance: August 16, 31 males and 79 females; April 6, 78 males and 24 females; April 24, 41 males and 39 females; May 11, 1 male and 29 females.

Warfel and Merriman (op. cit.) found that the silverside population of an area in Connecticut had a tendency to increase slowly and steadily in numbers for one to two months in the summer and then to show a sudden dropoff followed by a similar building-up process and another dropoff. This pattern was erased as the fish disappeared from the area with the advent of cold weather.

*Menidia menidia* ranges from Nova Scotia to Florida in salt and brackish waters. The species intergrades with *Menidia beryllina* in waters that are nearly fresh. Large numbers of *Menidia beryllina* were found in front of the Chesapeake Biological Laboratory (station 6) in March, April, and May. *Menidia menidia* is the predominant species of silversides here in the summer when they are small but during those months when only large *Menidia menidia* exist the *Menidia beryllina* are able to take over. Usually at salinities over ten *Menidia menidia* predominates (Mansueti, 1950).
FOOD HABITS

Kendall \textit{(op. cit.)} examined 367 silversides stomachs at frequent intervals from April 1 to December 21, 1900, in a number of localities in the vicinity of Woods Hole, Massachusetts. He does not specify that these fish were \textit{Menidia menidia} but from the accompanying length measurements and the places of capture there is little question but that they were of this species.

Through the months of April, May, and June copepods were found in most of these stomachs and usually made up most or all of the total volume of food in the individual stomachs. \textit{Mysis} was found frequently in April and early May while fish eggs (mostly, if not all, their own) were found in late June. Empty stomachs were rare during these months. During the months of July through November, food was much more varied and few strong trends were noted. Copepods were rare during these months while empty stomachs were more common. Prawns were fairly common in late September and in October and November. In late September and early October a number of insects of the orders \textit{Diptera} and \textit{Hymenoptera} were found. December showed only empty stomachs on the two dates sampled.

Other foods found by Kendall were diatoms and unidentified algae, annelids and unidentified worms, a squid, amphipods, crabs, a cladoceran and unidentified crustaceans, an unidentified insect, small fish, and ooze.

These fish were taken from a number of localities but no change of food habits in different environments is evident. The lengths of the fish were given, ranging from less than three to over five inches. Average length and length range were about the same throughout the sampling period eliminating the possibility of the food changeover being due to a change in the size of the fish. Therefore the changeover from copepods is probably due to a change in the availability of food. April, May, and June seem to be, on the basis of low incidence of empty stomachs, the months of best feeding for the months sampled. These figures cover only a nine month sample in southern Massachusetts. Whether the feeding pattern is similar every year in that locality and whether it is similar to those of other localities is unknown.

The stomachs of a number of silversides taken in June which averaged about 35 mm, in length were examined at the Chesapeake Bio-
logical Laboratory. These stomachs contained mostly sand with a few diatoms and molluscs.

Feeding can be adjusted to changing conditions. For instance, Kendall found diatoms were eaten on three occasions only and the incidences on these occasions were high. Probably the diatoms were available at other times but not eaten by adult fish except when little other food was available. In a sample of 30 adult fish taken in this study on May 11, 1950, every fish was found to be gorged with annelid worms. These probably became available suddenly in large quantities and the fish took advantage of the situation. It is evident from the foods taken in that the silverside is both a top and bottom feeder.

PREDATORS

As may be seen by the figure on page nine, man is only a minor predator of the silverside. Beside the fish mentioned on page eight, the needlefish, Tylosurus, sea robin, Prinonotus, the sculpins, family Cottidae, toadfish, Opsanus tau, and windowpane, Lophosetta aquosa are known to feed on silversides (Bigelow and Welsh, op. cit.). However, it may safely be said that any fish that lives associated with the silverside and feeds on small fish uses the silverside as food. Because of the top-swimming habits of the silverside, gulls, terns, kingfishers, and other birds prey upon it.

PARASITES

No specific study of the parasites of the silverside was made but the following were observed in the course of this work:

Class Trematoda, one unidentified species

Class Hirudinea

Piscicola, two unidentified species

Class Crustacea

Livonea ovalis

Sumner, Osburn, and Cole (1913) give the following parasites found on silversides in the vicinity of Woods Hole, Massachusetts.

Class Trematoda

Distomum tornatum

Distomum valdeinflatum
Distomum sp.
Gasterstomum sp.

Class Cestoda
Rhyynchobothrium bulbifer
Rhyynchobothrium imparispine

Class Nematoda
Filaria sp.

Class Crustacea
Ergasilus manicatus

Martin (1939) stated that Menidia menidia passes on the Trematode, Stephanostomum tenue, to the striped bass. It is probable that the silverside is an intermediate host for other parasites that are found in the food fishes.

SUMMARY

1. The silverside, Menidia menidia, is a small fish of the family Atherinidae, order Mugiliformes.

2. Though it finds limited use as bait and food for human and animal consumption, the principle value of the silverside is that of a forage fish.

3. Spawning takes place in shallow water in the spring and early summer over an extended period of time.

4. The silverside in Chesapeake Bay lives only one year and dies soon after spawning.

5. The sex ratio in young fish in their first summer is about 2 to 1 in favor of females. During spawning season, however, the ratio is about equal.

6. It is a marine and brackish water fish of the Atlantic Coast of the United States and Canada. It intergrades with Menidia beryllina as the water grows fresher.

7. It is fairly adaptable in its food habits, feeding mainly upon algae, larvae, and small animals.

8. The silverside is preyed upon extensively by other fish, including many of the commercially important species, and by birds.
BIBLIOGRAPHY

This bibliography represents, so far as can be ascertained, a complete list of references pertaining to *Menidia menidia* with the exception of work on parasites.


DESCRIPTION OF TABLES

Table 1.

Numbers used to indicate gonad development are to be interpreted as follows:

1. Gonads firm but small and underdeveloped, eggs visible but small.
2. Gonads larger, eggs about two-thirds full size.
3. Gonads ripe, eggs full size, eggs and milt capable of being squeezed from the fish.
4. Gonads all or partly spent, bloodshot in females with few translucent eggs, flabby and watery in males.

Table 2.

The numbers to the left of the dates represent the groups into which the data was divided for length distributional analysis (see fig. 3). A description of stations, gears, methods of measurement, and chemical methods may be found under "Materials and Methods." "Effort" refers to the number of hauls when seines were used or to the number of minutes spent when a dipnet was used. Under "Number of Specimens," when a number is followed by another in parenthesis, the former is an estimate of the total number caught and the latter is the number from which the data was taken.
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