Zoeal Stages of the Stone Crab, *Menippe mercenaria* Say

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ABSTRACT

Larvae of the stone crab, *Menippe mercenaria* Say, were reared from egg to a true crab stage in 27 days on a diet of *Artemia* nauplii. They were successfully cultured in swarms and placed in small compartments where their individual development was studied. Six zoeal stages were found and described, although only five are believed to occur normally in nature. One molt per zoeal stage was noted, and from 3 to 6 days were spent in each stage. Pre-zoeae were observed but these did not molt into a first stage. Such diagnostic characters as size and shape of antennae, and segment and seta numbers of endopodites, maxillules, maxillae and second maxillipeds, were constant in all zoeal stages. Telson appearance and chromatophore occurrence may also be helpful in identification. Comparisons were also made between known xanthid zoeae and *Menippe* zoeae. Experiments on salinity and temperature tolerance of the zoeae indicate that in a temperature range of 23 to 25°C, zoeae may not be able to survive in salinities of 27% or lower.

Introduction

This study begun in 1956, provides descriptions and illustrations of all the zoeal stages of the stone crab, *Menippe mercenaria* Say. This species is the largest member of the family Xanthidae in the Beaufort Inlet area of North Carolina. Its early development has never been described fully. Rathbun (1930:472–7) gave a general description of *M. mercenaria* and cited the geographic range as from North Carolina to Mexico. Hay and Shore (1918:439) stated that young crabs, after attaining a true crab form, are found under shell fragments in deep waters of harbor channels. After reaching a width of about one-half inch, the crabs live among oyster shells and rocks in shallower waters of harbors. At full size they make burrows 6 inches in diameter and 12 to 20 inches deep just below the low-tide mark of shoals. Binford (1912:18) reported that a female produced six egg masses within a period of 69 days, each mass containing between 500,000 and 1,000,000 viable eggs. The pre-zoea and first zoeal stages were first described by Hyman (1925), but a complete description of the larval development of *M. mercenaria* has not been recorded in the literature.

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Methods

Adult female *Menippe mercenaria* were held in indoor tanks supplied with running salt water. They were fed oysters, *Crassostrea virginita*, clams, *Mercenaria mercenaria*, and an occasional live fish. Females which developed a dark egg mass were placed in a large animal jar into which flowed sea water that had passed through a sand-and-shell filter. A siphon connected this container to another jar used as the larval collecting chamber. Another siphon extending to the bottom of the zoeal collecting jar was connected to a lower overflow chamber. This chamber prevented water in the collecting jar from overflowing and losing the more active zoeae which normally swam near the water surface.
Three-gallon, round, animal jars were found to be satisfactory for rearing large numbers of zoeae. Best results were obtained when the jars were blackened, except for the top 2 or 3 inches, and covered with an opaque lid. The positively phototropic zoeae constantly swam in the band of light near the top of the partially darkened jars and thus avoided entanglement in the refuse that accumulated on the jar bottoms.

When it was necessary to observe individual zoea, rearing was done in plastic boxes and Syracuse watch glasses conditioned in sea water.

Small groups of zoeae were separately fed *Chlamydomonas, Nannochloris*, a mixture of the sperm, embryos and larvae of *Mercenaria mercenaria*, Fleischmann’s yeast and nauplii of *Artemia*, in order to determine food preferences. Zoeae that were fed *Chlamydomonas, Nannochloris*, and yeast did not survive, and those that were fed sperm, embryos and larvae of *Mercenaria mercenaria* demonstrated poor survival. Live, newly-hatched nauplii of *Artemia* were found to be the best food and were used throughout the experiment.

Refuse was removed from containers each day just before feeding. Zoeae were placed in clean containers and in freshly filtered sea water every second day. The uncontrolled culture-room temperatures were usually about 28°C but ranged as high as 33°C. Salinities ranged between 32 and 35‰.

Experiments were conducted with zoeae reared in the following salinities: 23, 27, and 33‰, to examine the possible influence of salinity and temperature on larval development. Some were reared in compartmented plastic boxes, six zoeae per compartment (Costlow and Bookhout, 1959). These were placed in a water table where water temperatures, dependent on room and incoming sea water temperatures, ranged between 27 and 29°C. Other zoeae were reared in an air-conditioned room where temperatures varied between 23 and 25°C. They were placed in Syracuse watch glasses, 10 zoeae per glass (Costlow and Bookhout, 1959). The zoeae placed in 23‰ were previously acclimatized for 15 minutes in a salinity of 27‰.

Drawings were made from preserved specimens. The mounting medium, Polyvinyl Lactophenol (Thompson, 1958) and the stain Chlorazol Black E. (Cannon, 1937) were helpful. Appendages were dissected from zoeae with fine insect pins. A Whipple disk used with both a compound and dissecting microscope aided in drawing figures to scale.

**Results**

*Menippe mercenaria* spawned as many as four egg masses in indoor sea-water tanks during summer months with no intervening molts or matings. About two weeks were required for eggs to hatch. Following hatching of a sponge, it was not unusual to find the same female carrying an egg mass one week later. A female whose spawning history before capture was unknown was observed to molt and mate immediately after spawning once in the laboratory.

A female that spawned at least four egg masses in one summer ate 40 clams ranging in length from 40 to 102 mm during a 32 day period. Temperatures during this time ranged between 27 and 31°C.

Large mortalities among zoeae occurred during all experiments. In mass culture, a few individuals were raised to the megalops stage in 19 days and to an early juvenile stage in 27 days. Three to 6 days were required for zoeae to go from one stage to another. Results of salinity and temperature studies indicate that mortalities increase with lower salinities and temperatures (Table 1 and 2). In experiments where development of individual zoeae was followed, only one molt per stage was noted.

**Larval Stages**

**Pre-zoea:**—This stage (Hyman, 1925) was seen but not observed to molt into a first-stage zoea.

**First zoea:**—(Fig. 1) Cephalothorax with slight interorbital bulge; dorsal and rostral spines approximately equal in length, slightly more than twice length of lateral spines (Fig. 1, A and C); dorsal not so straight as rostral spine, directed posteriorly; lateral spines pointed slightly downward; eyes large, non-stalked, outwardly composed of six-sided facets.

Antennule conical (Fig. 1, E); with six blade-like distal sensory flagella, five about as long as protopodite, one shorter and narrower than others.