PROJECT REPORT

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Project Name: Studies on the Larval Life History of the White Shrimp, Penaeus setiferus (Linnaeus).

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Studies on the Larval Life History of the White Shrimp, Penaeus setiferus (Linn.)

This report gives the methods and results of several experiments and observations conducted on the larval life history of the white shrimp, Penaeus setiferus. This must of necessity be a negative recitation because of experimental failures. However, the author hopes that these failures might help other investigators by pointing out some of the blind paths that were encountered in his pursuit of the answer.

Many publications on this subject purport to give a satisfactory description of the larval life history of the white and other penaeid shrimps of commercial importance in the United States. The simple fact remains, however, that there is no one publication or group of publications that gives the means of identifying the larval stages of our penaeid shrimps. For this reason specific studies on any phase of the biology or ecology of these animals that involve the early part of their life history are, of course, impossible. An important corollary of this statement is that no really effective protective measures may be taken by the appropriate civil agencies to give the maximum commercial yield of this sea food. Considering the economic importance of the shrimp fishery to our southern states this is, to say the least, unfortunate.

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During the period from September 1958 until June 1960 several experiments and observations were made on the early life history of the white shrimp. The objective of this work was to provide morphological descriptions of the larval instars of this animal. All work was conducted at Port Aransas, Texas.

Two main avenues of attack were made on the problem. These were: the hatching and rearing of individuals in the laboratory and the capture and rearing of individuals taken from the sea. It is evident that the first of the two is the more desirable, and it received the greater attention.

In attempting to rear individuals from eggs laid in the laboratory four different aquarium arrangements were used. In all cases shrimp used in the study were taken with a twenty foot otter trawl.

The first set-up was a large paraffin lined wooden tank, approximately eight feet long, two feet wide, and two feet deep. This tank was fitted with a one thousand watt immersion heater and sensitive thermostat, a glass wool

filter constructed from an inverted bell jar, and an electric pump for circulation and filtration. Air was supplied through six air stones from piston pumps. This system was constructed so that the water was never in contact with metal of any kind. Sea water was filtered through three inches of compressed glass wool before being placed in the tank.

During the winter and early spring months when large white shrimp were available only in the bays several large (100 mm and up) adults of both sexes were placed in the tank in water of moderate salinity, 20 ppt, taken from Aransas Pass at ebbing tide. This was done in order to start the shrimp off in water of approximately the same salinity as that where they were captured and then simulate their passage to the Gulf by gradually increasing the salt content. This increase was accomplished by adding more sea water to the tank to offset evaporation. The temperature of the water in the tank was held between eighty and ninety degrees Farenheit for the entire time. Food, consisting of fresh fish, various annelids, and sea lettuce, was placed in the tank almost every day. Excess bits of refuse were taken out by the filter and manually before they fouled the water.

Although shrimp were placed in this tank on several occasions, none ever showed signs of ripening sexually. Canibalism of the moulting individuals by hard shrimp made it difficult to keep a large group alive for any length of time. From two to four weeks after a sample of fifteen or more was placed in the tank only two or three individuals would be left alive, and these were always in poor physical shape. Several bruised themselves by striking the walls of the tank while swimming forward and when jumping out of the water upon being started by someone entering the laboratory.

In the next series of experiments the large tank was also used, but it was connected to five twenty gallon aquaria with plastic water lines. The system was arranged so that the same water flowed through all of the tanks and through a common filter, but shrimp could be isolated in any individual tank. The basis for this sytem was the idea of preventing canibalism in the experimental animals and yet retain them in water containing a sizable number of shrimp, a "school" so to speak. Each small tank was fitted with its own immersion heater to keep from having a temperature drop in the water lines leading from the large tank. Water was circulated by two electric pumps from the large tank, through all five of the smaller aquaria, then back through a filter into the large tank.

Again large adult but sexually immature shrimp were taken from the bays and placed in the tanks. Two individuals in the three possible combinations of the sexes were placed in the small tanks, and a "school" of adults of both sexes was placed in the large tank. As the individuals in the large tank died they were replaced so that from fifteen to twenty-five individuals were in the "school" during the tests.

Although this arrangement greatly increased the time that shrimp could be kept alive and in a seemingly good condition, none showed any signs of ripening. The individuals in the large tank still died at the same rate as before, but the pairs kept in the smaller tanks lived for as long as six weeks. After this length of time the experiments were discontinued.

After the two foregoing failures an attempt was made to secure sexually ripe individuals from the Gulf. Pairs of males and females were isolated in small aquaria that had been filled with open gulf water, and ripe females were isolated individually in small aquaria. All of the small aquaria used were

equipped with air stones and thermostatically controlled immersion heaters. Small air operated filters were used in each tank to keep the water clean.

Again the results were negative. The individuals thrived in this aquarium arrangement, but the females declined sexually, that is, the ovaries became smaller rather than increasing in size. After one to two weeks of confinement the ovaries had absorbed the eggs and had shrunk in size so that they resembled those of sexually immature shrimp taken from the bays. The author thinks that these shrimp had not reached a point of no return in sexual development.

In a final attempt to obtain eggs in the laboratory all of the aquaria were removed & small household plastic dish pans were put in their place. This was done so that the number of captive shrimp could be increased, thus improving the chance of success. Each pan was partially filled with about two gallons of filtered Gulf water. The pans were aerated with an airstone and covered with a sheet of clear plastic. One ripe female was placed in each pan and allowed to remain without food for five or six days. If she had not spawned by this time she was removed, the pan was cleaned and refilled, and another female tried. In this manner it was possible to hold about a hundred females for the five to six day period within a month's time. Out of all the females held in this manner about a dozen spawned. Over half of the females that spawned were dead when the eggs were discovered; thus these must be considered abortions and not normal spawnings. The others, which were alive after spawning were extremely weak when found and died within an hour. Since the appearance of the eggs in all cases was the same, all of these layings were considered to be abortions. The eggs were a bright yellow and were all clumped into a ring on the water's edge at the surface and in large clumps on the bottom. Microscopic examination showed the eggs to be undeveloped and clouded. The water in all cases was colored a thin milky white as though there had been a good deal of mucous extruded with the eggs.

In attempting to obtain living larvae from the Gulf several methods were used. Several sizes of plain plankton nets, a Clark-Bumpus sampler, and a Hardy sampler were tried, all without success. Small postlarval penaeids were easily collected from Aransas Pass, several of the bays, and in the surf; but no larval stages were ever taken. Samples taken at all times of the year from Aransas Pass yielded only postlarvae. This means apparently that the larval stages are passed through only in the Gulf. This assumption is also substantiated by the facts that fully ripe females are found only in the Gulf, and no one had ever collected larvae from the bays or passes.

Discussion: It would seem that the rearing of the white shrimp in the laboratory would be a relatively easy task since the animals are hardy, small, and easily kept. The stumbling block in this and other attempts to rear this shrimp is the fact that all of the North American penaeids lay only in the open seas. It is extremely difficult to capture such small animals at the depths they are found in the ripe condition without injuring them seriously in the process. All of the shrimps used in this study were taken with a standard type otter trawl. Although this means is fairly efficient, it is drastic in its treatment of the smaller animals captured. Some other means, possibly traps of some sort, would provide specimens in better physical condition.

Transportation from place of capture to the laboratory is another serious problem. Most boats used for collecting are fitted with a brass pump for circulating fresh water through the live box. Metals of any kind, particularly copper, seems to have a toxic effect on most marine animals. And too, by constantly pumping fresh water into the live box and by moving through a salinity gradient, as from the shore outward, the shrimp are put through a rather

rigorous treatment. Aerating the water in the live box aboard the boat rather than pumping sea water continuously would alleviate the effects of salinity changes as the boat moves through different waters.

It is quite possible that someone will rear the white shrimp in the laboratory. It seems, however, that the next logical means to be tried is pond culture. Aquaria, no matter how elaborately they are equipped, are very artificial environments. It is quite impossible to simulate many of the physical and chemical factors as they are found in the open sea. While ponds also present problems of this sort, many environmental facets, such as, sun, wind, temperature, symbiotic organisms, etc. are provided naturally in an impoundment of water. Many factors such as depth and geographical location will, of course, be of prime importance in this approach to the problem.

Prepared by Charles Goodwin Accepted by Howard T. Lee
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