Proceedings of the National Shellfisheries Association
Volume 57 — June 1967

INFESTATION OF THE HARD CLAM, *MERCENARIA MERCENARIA*, BY THE BORING POLYCHAETE WORM, *POLYDORA CILIATA*

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ABSTRACT

Accidental and experimental infestation of the hard clam, Mercenaria mercenaria, *by the polychaete worm,* Polydora ciliata, *in the laboratory is described. Experimental infestation was obtained by putting free-swimming larvae of* P. ciliata *in pans with hard clams; here the larvae metamorphosed and built tubes on the clams' shells. Perforation of the shells of clams 5-8 mm long appeared within 18 days but took twice as long in clams 30-35 mm long. Calcified mud blisters appeared on the inner surfaces of the shells of all clams within 30 days after the shells were perforated. Despite considerable damage to the shells of the victims, especially small individuals, chi-square analysis of several groups of data did not consistently show statistically significant differences between the mortality of infested clams and controls.*

Clams in a sand substrate were not attacked by the worms. Several clams that became infested before they burrowed into the sand showed no signs of the worms when examined weeks later. It seems that, by burying, clams escape attack by P. ciliata *but exposed clams, especially small ones, can suffer considerable damage to their shells.*

INTRODUCTION

Several species of polychaete worms of the genus *Polydora,* including *P. ciliata,* have a well-deserved reputation as oyster pests (Korringa, 1952). *Polydora ciliata* have also been noted in other mollusks — for example, the sea mussel, *Mytilus edulis* (Field, 1922, from Lebour, 1907), the periwinkle, *Littorina littorea* (Thorson, 1946), and the bay scallop, *Aequipecten irradians* (Turner and Hanks, 1959). To my knowledge, however, this species has never been reported in the hard clam. The following account describes accidental and experimental infestations of the hard clam by *P. ciliata* in the laboratory.

During a recent winter, we found laboratory-reared clams of various sizes, from 3 to 16 mm long, infested with a species of *Polydora,* identified as *P. ciliata* by Dr. Marian Pettibone, Invertebrate Division, U. S. National Museum. The infested clams were being grown in trays of warmed, running sea water without a substrate into which they could burrow. At the time of the discovery, the infestation was well-established and most affected clams contained the U-shaped external burrows typical of *P. ciliata.* Also present, and covered with new shell material, were the mud-laden tubes of the worms which formed raised areas on the internal faces of the shells (Figs. 1 and 2).

All of the dead individuals from the largest size group (average length 13 mm) contained *P. ciliata.* Eighty-five per cent of the dead clams from the next largest size group (average length 10 mm) were also infested. Only 5 per cent of the dead clams from the 8 mm group contained *P. ciliata* and the worm was completely absent from dead clams of the smallest size group (average length 5 mm). These data suggested that the worm larvae were present in the seawater system, that they began to burrow into the clams soon after the clams were placed in running water and that the highest percentage of infestation was in the largest clams because they had been in running water the longest. It was apparent also that,

FIG. 1. *Typical U-shaped burrows of* P. ciliata *in live young clams.*

although the activity of the worms in the clams' shells may have contributed to the death of their hosts, many dead clams, especially of the smaller sizes, contained no *P. ciliata* and must have died from other causes.

These observations proved little, except that *P. ciliata* can attack clams. Left unanswered were several questions. How readily and under what circumstances does *P. ciliata* attack clams? What is the rate of penetration of the shell? How is the degree of infestation and damage to the clam related to size of the clam? Does the presence of *P. ciliata* contribute to the mortality of clams?

EXPERIMENTAL INFESTATION OF HARD CLAMS

Within 6 months after they were discovered in the clams, many of the worms became sexually mature and laid eggs. Development of the eggs and larvae followed Wilson's description (1928) for this species. Eggs were deposited in transparent sacs, each attached to the inner wall of the worm's tube by a stalk. There the eggs developed into ciliated larvae which moved about actively within the sacs. At a length of approximately 250 μ, when three setiferous segments had developed, the larvae left the egg sacs and became free-swimming. Contrary to Wilson's experience (1928), I had no trouble obtaining metamorphosis of the larvae and continued growth of the young worms.

Experiment No. 1

In the first attempt to induce experimental infestation, and thus to learn the sequence and timing of the events involved, I added early free-swimming larvae of *P. ciliata* to an enamel pan containing 6 liters of sea water and 100 clams 5 to 10 mm long. A pan of 100 control clams of similar sizes was also maintained. The water was changed 3 times a week. Mixed algae were added daily as food for the clams; it may also have been consumed by the worm larvae. In approximately 20 days, the larvae metamorphosed, constructed tubes on the outer surfaces of many clams, and began to erode the shell immediately under the tube. Within the next 10 days some worms had perforated the shell, stimulating the clams to deposit new shell material to wall off the intrusion. This group of clams was kept under observation 47 days. Erosion and damage

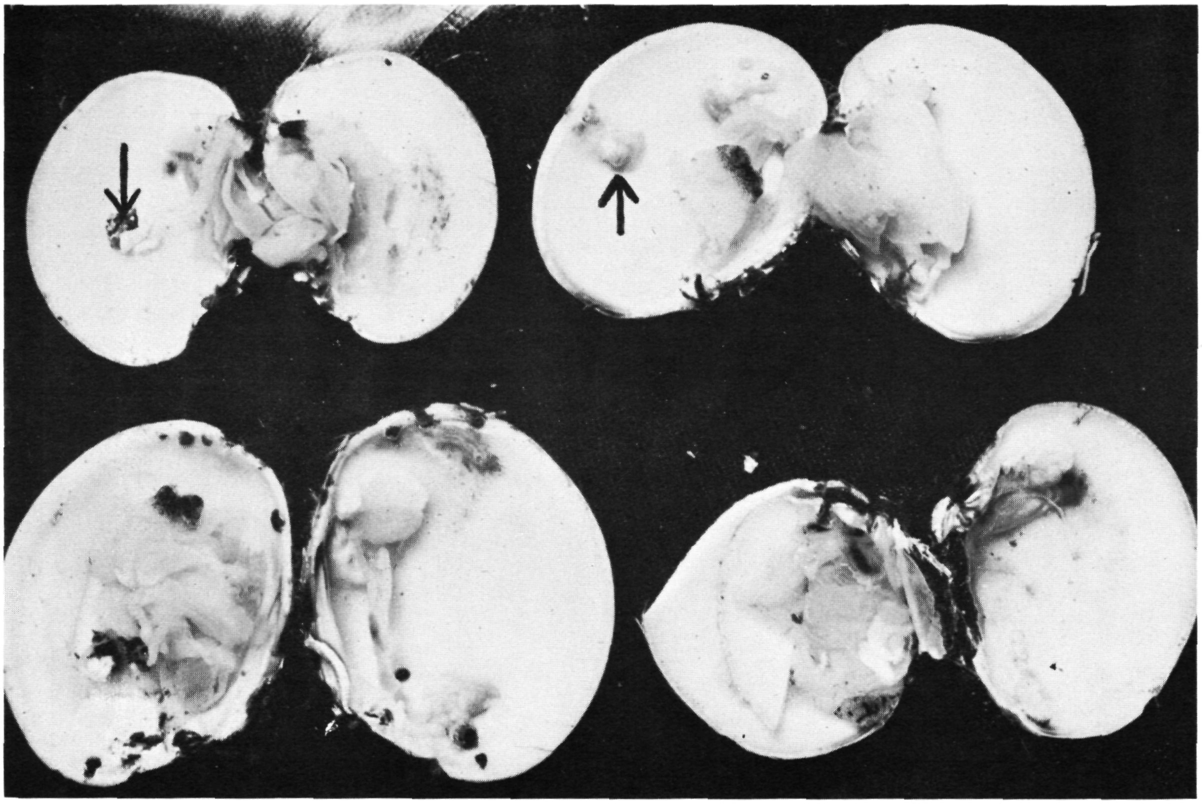

FIG. 2. *Live young clams with shell-covered mud-bubbles caused by* P. ciliata *tubes protruding through the clams' shells.*

to the clams' shells increased steadily; in a few clams the soft parts became visible through the damaged shells. During this period, 17 clams in the pan with *P. ciliata* died; all contained live worms and their muddy, shell-covered tubes. One clam died in the control pan. Chi-square analysis showed the difference in number of dead clams between treated and control groups to be significant at the 95-per cent confidence level.

Experiment No. 2

The second experiment was designed to learn whether *P. ciliata* attacks clams that have dug into the substrate. One hundred clams 5 to 10 mm long were allowed to dig into sand in a 6-liter enamel pan after which early free-swimming larvae of *P. ciliata* were added. A second pan of clams with worm larvae but without sand and a third pan with clams only were included in the experiment. By the fourteenth day worm larvae in the pan without sand had metamorphosed and had built tubes on 30 of the 100 clams. In the pan with sand, worm tubes were present on all of the clams which were still on the surface. Shortly thereafter, these 6 clams dug into the sand.

All of the clams were removed and examined at the end of 2 months. Of those in the pan with worms but no sand, 16 clams had perforated shells and at least one well-calcified mud pocket, each containing a worm. The remaining 84 clams were free of worms. Apparently, some of the worms that had originally set on the 30 clams not only failed to continue their attack but moved away. None of the clams in the pan with sand contained *P. ciliata* at this time and only 5 showed any sign of past infestation. Mortality was negligible in all pans.

Experiment No. 3

This experiment was performed to determine if the rate of infestation by *P. ciliata* or the extent of damage and death was related to the size of the clams. Twenty clams averaging 32 mm long, 100 averaging 8 mm long, and 100 averaging 5 mm long were placed in separate 6-liter pans together with equal numbers of worm larvae. Controls were maintained for each size-group of clams.

Shells of the 5-mm group of clams were perforated within 18 days after the worm tubes appeared; those of the 8-mm group were perforated within 20 days. In the 32-mm group of clams, however, shells were not perforated before the thirty-ninth day. The shell-covered, muddy bulges on the inner faces of the shells were present in all size groups within 30 days after perforation.

Six months later at the end of the experiment all 20 of the clams in the 32-mm group of controls were alive. Seventeen of those exposed to *P. ciliata* were alive and all contained at least 1 live worm, as had the 3 clams which died during this period. Most of the infested clams exhibited both shell perforations and the internal signs of worm activity but the areas of damage were a small part of the total shell area.

Eighty-three clams in the 8-mm control group and 71 clams in the group exposed to worm larvae were still alive at the end of 6 months. Twenty of the exposed clams contained *P. ciliata* or showed signs of former infestation. Those that did contain live worms also contained muddy areas newly-coated with shell material over a considerable part of the inner surface of the shells. The affected clams appeared to be healthy otherwise and siphoned as vigorously as the controls.

Of the smallest clams (5 mm), 84 controls and 71 of the clams exposed to worm larvae were alive when the experiment ended. Thirty-five of the exposed clams contained worms, all of which had internal, recently-calcified, muddy areas occupying more than half of the inner shell surface of the victims. In a few of the affected clams, the soft parts were visible through breaks in the shell caused by the burrowing of the worms. These clams, nevertheless, pumped actively and gave no sign of distress.

In none of the 3 groups of clams was the difference in number of dead clams between exposed and control lots statistically significant at the 95-per cent confidence level, although the chi-square value approaches significance in each group.

ROLE OF *POLYDORA CILIATA* AS AN EPIZOON

Polydora ciliata is known to be a boring species as contrasted to *Polydora websteri*, the common "mud blister worm" in oysters, which apparently is not (Korringa, 1952). Opinions in the literature differ, however, as to whether *P. ciliata* makes mud blisters on the inner surfaces of its hosts' shells. Korringa (1952) stated that *P. ciliata* does not make mud blisters in oysters. It burrows into the shell from the outside and only occasionally perforates it. The oyster seals off the occasional perforations by laying down small amounts of additional shell material which do not form blisters. Turner and Hanks (1959), on the other hand, found "calcified blisters characteristic of *Polydora* along the inner edge of both shells" in the bay scallop, *Aequipecten irradians*. My own observations of *P. ciliata* in clams show that the clams' attempts to seal off the extensive perforations produce large, raised, calcified, soft bubbles immediately over the worms' mud tubes on the inner surfaces of the shells; these structures can accurately be called "blisters".

The experiments reported here show that buried clams are not susceptible to attack by *P. ciliata*. The fact that worms leave infested clams that burrow into the substrate indicates that a subsurface existence is intolerable to *P. ciliata*.

The effect of the burrowing worms in the clams' shells on the well-being of the victims is not entirely clear. Statistical tests of the experimental data are inconclusive as to the significance of the differences between the death rates of clams exposed and those not exposed to *P. ciliata*. It is possible, however, that extensive shell damage, and the energy required to repair it, weakens the victims and may in time make them more susceptible to disease or predation.

ACKNOWLEDGMENTS

Miss Lucretia Reese and Mr. Harry Cook aided in collecting the data for this paper.

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