

SOME NOTES ON AMERICAN SHIPWORMS.

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In a Congress like this, where men meet to discuss the means of protecting and increasing the supply of the toothsome products of our waters, a paper on shipworms may seem in strange company. While we wish to preserve and protect most of the products of our waters, these creatures we would gladly obliterate from the realm of living things. We have been studying and combating them for a century and more, but have found no adequate means of counteracting their depredations.

During the summer of 1893, while engaged in observations on the oyster at Beaufort, N. C., for the U. S. Fish Commission, the writer became interested in the various shipworms found so abundantly in the waters of that region, and having made some observations on their natural history he returned for periods during the two succeeding seasons to continue them. The results have been incorporated in a paper on the "Natural History, Organization, and late Development of the *Teredinidae*," which is almost ready for publication.

Shipworms were favorite objects of study during the eighteenth century, on account of their great damage to the dikes of Holland in 1733 and subsequent years. The contemporaneous observers seem to have been unaware of the observations of Pliny and others in ancient times, and supposed the shipworms were natives of India, whence they had been brought by shipping in modern times. During these times they were considered true worms, and it was not till the time of Cuvier that their molluscan characters were recognized.

Even if shipworms were not recognized to be bivalve-mollusks from their adult organization, it would be easy to determine this fact from a study of the development. They start as eggs which none but a specialist could distinguish from the eggs of most bivalves. In the American forms that seem most abundant, at least in our southern waters, the eggs are cast freely into the water and soon fertilized by the male element. They soon begin to develop, and in our warm southern climate become little free-swimming creatures in three to four hours. As yet these little creatures have none of the distinctive features of the shipworms or even of bivalve-mollusks, but within a day the bivalve shell is acquired. For a few days one can rear the larvæ in aquaria, but after a time the conditions become unfavorable, and they disappear. For perhaps three weeks more, in a state of nature, they lead a free-swimming life, and are gradually transformed into little free-swimming bivalves, almost exactly like the little clam or oyster. But how and where, in nature, this transitional period is passed has not been observed.

The next stage which the writer found were the little bivalves about $\frac{1}{100}$ inch in diameter, crawling over the surface of the wood, in quest of their future homes. Once

they have found appropriate places, they begin to change. One by one the bivalve characters become masked, and the little bivalves are transformed into the very long, worm-like shipworms which are found in wooden structures in salt water the world over.

But along with the transformation the bivalve shell is preserved, though it is much modified as compared with other bivalve shells, and covers only a small part of the head end of the body. With it the shipworm excavates the burrow in the wood in which it lives, and seems equally able to penetrate the hardest or softest kind of wood with equal facility. As the wood is grated away by the shell, the small particles are taken into the digestive canal, and the débris is extruded through the anus; but whether it serves for food in any way is a question in dispute. During its life in the wood at least the larger portion of its nutrition is taken in through the tube which at rest hangs in the water, and consists of small animal, and especially vegetable, organisms. In thinking of shipworms, then, it should be remembered that the wood in which they form their burrows is primarily for their own protection, and that without this protection their long, naked, delicate bodies are defenseless.

At Beaufort all kinds of unprotected wood become literally riddled in a very short time. Two kinds of worms are found there in great and about equal abundance—*Teredo norvegica* and *Xylotrya fimbriata*, whose mode of spawning has been already described. A very small proportion of specimens were of *Teredo navalis*, one of the common European forms, in which the eggs are retained in the gills of the mother during a considerable period of their development, perhaps almost till time for them to set into the wood. It is apparently this last species which the writer has found most abundant in Long Island Sound, though a considerable portion of *Xylotrya fimbriata* were also found.

The breeding season in North Carolina, so far as determined, lasts at least till the middle of August and perhaps throughout the summer. That the latter is true is indicated by two sets of facts. In the first place, individuals were found with ripe sexual products during the early part of August, and the young derived from eggs laid at this time must continue to set till September or later. In the second place, the young were setting in the wood abundantly till the middle of August, a fact which indicates that the same continues to some degree for some time longer. Of course, from an economic standpoint, the period during which the wood is attacked is one of the most vital points to discover.

The number of young produced is amazing—estimated in one case, from a single very large female, at 100,000,000—and while the greater part are lost before the setting stage is reached, yet the number that set is very great, and one of the most discouraging features in dealing with shipworms in a practical way. If the spat were of fairly appreciable size and set in but moderate numbers it might be feasible, by the careful removal of all old piles and other old timbers, to sufficiently reduce the number to a minimum. But when, under favorable conditions, over 100 to a square inch set where there is not room for more than one or two to reach maturity, it is easily seen what an excess is always present and how futile it is to try to combat the larvæ before they enter the wood. The practical way, of course, is to prevent their entrance into the wood by protecting the wood with copper paint and sheeting. With small piles and timbers it would seem to be worth while to try various means of keeping the bark on the wood, which, so far as I know, has not been done; for it is well known that as long as the bark is on timbers they are not attacked by shipworms.

Once the shipworm has set into the wood it grows with amazing rapidity in our southern waters. In twelve days it has grown to be an eighth of an inch long, in twenty days about half an inch, and in thirty-six days 4 inches, when it is thousands of times as large in volume as when it sets. It has become sexually mature, and is ready to produce a new generation. How long shipworms may live has never been observed, though it is probable for several years, and that during this time they keep growing if there be room in the wood for growth, though when crowded the individuals become dwarfed. The writer has found specimens of great size of *T. norvegica*, some 3 to 4 feet long, and it is easily seen how destructive may be a few of these individuals which may be almost an inch in diameter. The age of such specimens I have not been able to determine, but it is estimated to be less than two years.

In the colder waters of Long Island the writer has found specimens of both *T. navalis* (?) and *Xylotrya fimbriata*, the former the more abundant. They seem to set most abundantly after the 1st of July, though observations for one season can not be conclusive. The rate of growth is much slower, and it would seem to take twice as long to attain the same sizes as in the warmer southern waters.

The writer in his studies of shipworms has paid most attention to features purely scientific in their interest. Observations of any considerable economic value must cover a variety of localities under different conditions and extend through a period of years—observations which the writer has not had sufficient opportunity to make, and which for our American forms have unfortunately never been made.

MINNEAPOLIS, MINNESOTA.