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THE CATFISH AS A HOST FOR FRESH-WATER MUSSELS

By A. D. Howard

The rapid growth of the pearl-button industry, with its increasing demand for shells of the fresh-water mussel, has already made it evident that this natural resource is not unlimited and that even a practical extinction is possible. In recognition of this situation the U. S. Bureau of Fisheries has carried on for several years an extensive investigation of methods of artificial propagation.

The interesting relation of parasite to host between the Unionidæ and fishes has long been known. An examination of fishes caught at random plainly indicates that in nature the number of mussels successfully finding a host is comparatively small. Lefevre and Curtis* have demonstrated that in certain cases a single fish may by artificial means be induced to carry several thousand more mussels than it would under ordinary circumstances in nature. Thus large numbers of the young mussels which otherwise would sink to the bottom and die are carried through the most critical period in their life history. The method of infection is as follows:

Young mussels or glochidia produced to the number of many thousands by each female mussel, are taken from the gills of the latter and placed in a receptacle with the fish to be infected. The myriads of glochidia thus distributed in suspension through the water, passing constantly through the gills of the fish, become attached to the filaments of the gills or in some cases fasten externally upon the fins. As soon as they become attached there is a reaction of the tissues of the fish, in the nature of an hypertrophy of the ex-

*Lefevre, G., and Curtis, W. C.: 12 Studies on the Reproduction and Artificial Propagation of the Fresh-water Mussels. Bull. Bureau of Fisheries, Vol. 30, 1910.

ternal epithelium, which produces a cyst enveloping the glochidium. Under normal conditions the young mussel remains encysted long enough to pass through a metamorphosis after which it drops from the fish in a form closely approaching the adult.

A little experimentation shows that, taken a given species of mussel, all fish are not equally susceptible. Some do not readily receive the glochidia, others quickly shed them, while others die from excessive infection. Thus we have in certain instances what has been called an immunity at least to a given mussel species. Lefevre and Curtis find immune to the glochidium of Lampsilis such fishes as the German Carp, certain minnows and darters.

Acting upon the information obtained from such experiments the Bureau has carried on practical work in mussel propagation. Fish in large numbers are infected and released to spread the mussels in whatever waters they may reach. This work, however, has been limited to a few species of the Lampsilis group, chiefly *Lampsilis ligamentina* and *L. anadontoides*. With one possible exception none of the Quadrula group of mussels, including some of the most valuable commercial shells, had up to the time of the present investigation, been carried through the parasitic stage. Many experiments had been made on various species of fish and under varied conditions to determine a suitable method of propagation. The rarity of successful infections and other results would suggest that as in other cases of parasitism in the animal and vegetable kingdom each mussel may have its appropriate host or hosts restricted to a species of fish, a genus or a family as the case may be. Since the number of species of mussel for this locality is forty or more and the number of species of fairly common fish at least sixty, the problem of determining the appropriate host for each mussel is obviously quite complex. To determine the hosts for each species of mussel by artificial infection, a "trial and error" method would be very difficult.

Obviously a more direct solution of the problem would be secured by a study of natural infections, i. e., fish taken at large are examined for glochidia and when present these are determined as to species, condition, etc.

In an investigation of some members of the Quadrula group of mussels which I have carried on this spring and summer the above method was employed. I made examinations of as many species of local fish as were obtainable, identifying as far as possible such glochidia as were found. Some glochidia, because of peculiarities of form or size, were readily determined, while others were less easily identified because of less apparent differences. In this study I found of great assistance the excellent preparations and drawings of glochidia by Messrs. T. Surber and H. W. Clark, of this station, who kindly placed their material at my disposal.

This line of investigation, as well as answering the main question for which it was undertaken, revealed some other interesting points. Among these may be mentioned the predilection of several species of mussel for one kind of fish; for example, "the Sheepshead," *Aplodinotus grunniens*, was found to carry commonly the glochidia of *Lampsilis lævissima*, *L. gracilis*, *L. alata*, *Plagiola donaciformis* and others. This fish feeds upon mussels and so we have an explanation of the presence of these thin shelled species upon its gills.

Another observation for these species, so far as I know previously reported for *L. lævissima* only was the extensive growth beyond the glochidial shell while still on the gills of the host.

Some cases of remarkably full infection have been found, but a small number seems more common for natural infection.

The absence of glochidia uniformly in certain species of fish is quite striking, as in the German carp, *Cyprinus carpio*, Linnæus, mentioned above, as well as the garpike, *Lepis-*

Lepisosteus osseus, Linnæus, and the dogfish, *Amia calva*, Linnæus. In some cases the immunity seems to extend to large groups of fishes as for example the Catostomidæ (suckers). The Catfishes have been regarded as belonging among the immune fishes, this opinion being based largely on the results of artificial infection experiments.

In my examination of catfish the results have been largely negative, especially in the spring catches, but on fish caught during July and August I found natural infection. The first of these on *Ictalurus punctatus*, the channel cat, and the second on ***Leptops olivaris***, the flathead. The species proved to be ***Quadrula pustulosa***, the pimple-back, a common shell of this locality and of considerable importance commercially.

To test for methods of "artificial propagation" I made infections with three species of catfish and two other kinds. The following were employed: ***Ameiurus melas***, bullhead, *Leptops olivaris*, flathead and *Ictalurus punctatus*, fiddler. *Pomoxis annularis*, crappie and *Lepomis pallidus*, sunfish. When exposed to infection in the same tank and thus under the same conditions, the difference in susceptibility between the catfish and the other species was very marked and the difference in implantation still more so. The catfish retained the glochidia; while though abundant on the gills of the crappie and sunfish, they disappeared the second day. Experiments to determine the optimum infection were undertaken and a count of eight hundred made upon one fish. In this experiment the fish showed no discomfort nor any signs whatever of impaired vitality, however at the present time the optimum for the mussel has not been determined.

Later observation on natural infection in *Ictalurus punctatus* has yielded further confirmatory evidence that this species is the natural host for *Quadrula pustulosa*. The glochidia in these cases showed an advanced stage in the metamorphosis of the young mussels in which two adductor muscles are apparent and considerable growth beyond the

glochidial shell. Eight out of eleven fish examined were infected and the maximum infection observed (on one fish) was twenty-one.

The results would seem to demonstrate *Ictalurus punctatus* as a natural host for *Quadrula pustulosa* and the experiments so far as they have gone would indicate that other species of catfish may be also. The possibilities offered by the catfish as a medium for artificial propagation are obviously almost ideal. This fish, valuable for food, is abundant and can be transported and handled with less mortality perhaps than any other species. These conditions make the expense of propagation less and the chances of successful distribution in every case greater.

Summarizing the practical results we find the investigation has provided a species of mussel and a species of fish not hitherto available for artificial propagation.

DISCUSSION

DR. R. E. COKER, Fairport, Iowa: We at Fairport, Iowa, are engaged in the propagation of the freshwater mussels which support the important industry of button manufacture. The fishing has been so extensive as to deplete the more important rivers of the country, until the point is now reached where we have to replenish the beds. The method of doing so is this. We take the young stage of the mussel (the glochidium) and get that infected on the gills of the fishes; then, after a certain period of time, or right away, as the case may be, these fish are released in the streams, and the mussels in due course, after the necessary period of parasitism, fall to the bottom, where they can look after themselves. All fishes are not equally susceptible to the mussels; there are some which we cannot now use at all, but the game fishes can all be used to carry mussels of the *Lampsilis* group, and other species of economic importance. There is another group of mussels generally included under the genus *Quadrula* which yield a fine quality of button. Up to the present time we have not been able to do anything with that group of mussels. We now handle lots of others, but not those. Up to this time, also, we have had no use for the catfish, and a great many other of the coarse fishes. So when we seined out the overflow ponds and sloughs we could use the game fishes but had to discard the catfishes.

This paper by Dr. Howard shows some results of the work which he has been carrying on with reference to the quadrulas, mussels which

we could not handle; and he finds that certain catfishes which we had no use for in mussel propagation are the hosts of one of these quadrula species. The *Ictalurus punctatus* is the natural host apparently of the *Quadrula pustulosa* or "warty back"—a useful shell. He has found young mussels on the gills of those fish and he has artificially infected the fish with these mussels, and they have carried them for a number of days. Just at this time he has not carried the matter far enough to know the optimum number, but he has one catfish now that is carrying 800. Of course the game fishes will carry from 1,000 to 2,000 more of the other species. Undoubtedly this catfish would have carried more if it had been loaded more heavily at the start.

DR. TOWNSEND: I have been greatly interested in the Fish Commission reports touching this subject. The dependence of the mussel upon the fish for its distribution is a very fascinating matter. I shall watch the progress of work out on the Mississippi with a great deal of interest.

I am at present writing a report on the new method of pearl shell cultivation on the west coast of Mexico. Last year I visited the great pearl fisheries at La Paz where a Mexican company has been cultivating pearl shell for two or three years. Entirely aside from the pearls that sometimes turn up in the pearl oysters, pearl shell is a very valuable commodity, being worth $300 or $400 a ton according to grade. There is no doubt that the company has greatly increased the supply of pearl shell in its locality, and while they refused to give me any information as to their methods, I was allowed to go over the place and form my own conclusions. I photographed the clusters of young oysters, the trays, the crates of shells sunk in the bay, the zigzag canal in which the crates are placed for the maturing of young, and altogether made two dozen photographs which will show what the method is. The promoters were harvesting the second crop of shells and appeared to have a great quantity.

The success of this work will be important to the ocean pearl shell fisheries of the entire world.

DEMONSTRATION OF DR. HERRICK'S FREE PEARLS OF FORCED PRODUCTION

INTRODUCED BY R. E. COKER

Dr. W. P. Herrick, of New York, has kindly authorized me to demonstrate to the Society a number of pearls produced as a result of artificial stimulation. These pearls, it should be stated at the outset, are not perfect, valuable jewels, but represent the successful achievement of a step, and that a highly significant one, in the solution of a most interesting problem.

For some years Dr. Herrick has been engaged in experiments with the view to determine if it were not possible to cause the production of free, perfect pearls as the result of artificial stimulation.

This work was begun with local species at Quissett, Cape Cod, and Woods Hole, Mass., where the common marine oyster, the hard clam, and a thin-shelled fresh-water mussel were easily available. At a little later stage, Dr. Herrick obtained some pearly fresh-water mussels of the Mississippi River through our station at Fairport; and, beginning with last year, 1911, a good deal of experimentation with fresh-water mussels has been done by him on the ground at Fairport. It may be added that, while we have not been able to extend him any important facilities, and his work has been conducted entirely with the aid of his own private resources, we have viewed the investigation with a great deal of interest.

There were, as he recognized, two stages to be accomplished: (1) to demonstrate by experimentation a practicable method of forcing the formation of free pearls, (2) to make the method applicable to the production of commercial pearls by the appropriate species. For accomplishment of the first stage (the determination of methods) the most common and easily procurable native species were