THE PEARLY FRESH-WATER MUSSELS OF THE UNITED STATES; THEIR HABITS, ENEMIES, AND DISEASES, WITH SUGGESTIONS FOR THEIR PROTECTION.

By CHARLES T. SIMPSON.

The *Naiades*, or pearly fresh-water mussels, have a distribution throughout the lakes and streams of the globe, not only on the continents, but also on all the larger and some of the smaller islands. They exist in countless numbers, especially in the United States, which seems to be the metropolis of these forms, both as to species and individuals. Probably over 600 valid species are now living in North America, and fully three-fourths of these are found in the Mississippi drainage area and the streams which fall into the Gulf of Mexico from the north. Many of these mussels here attain a great size. Some are covered with knobs or pustules, or have peculiar and striking forms, while others are brilliant with radiating stripes or beautiful and intricate patterns of coloring. The interiors of many of these species are very rich, the colors varying from almost blackish-purple to coppery, glowing red, pink, salmon, straw-color, and silvery white.

Within the past few years a great deal of interest has been aroused in the United States in regard to these mussels. Thousands of persons have given more or less attention to hunting them for their pearls, which often have a high money value, and others have gone quite extensively into the business of manufacturing the shells into buttons and various ornaments. So great has been the drain on them that in many places they have become very scarce, and are even threatened with extinction. Mr. George F. Kunz, the well-known gem and pearl expert, has just published a paper on the fresh-water pearls and pearl fisheries,* containing an immense amount of useful and accurate information. In the present paper the subject of the pearly mussels will be treated more from a biological standpoint.

The species inhabiting the Mississippi drainage area extend their range on the south through all the streams of the United States flowing into the Gulf of Mexico, and to some extent into Mexico; on the north some of them range nearly to the Arctic Ocean, and from the Rocky Mountains, which are a barrier on the west, throughout a considerable part of the St. Lawrence drainage area. On the Atlantic coast from the St. Lawrence to the Gulf of Mexico the streams and lakes are filled with mussels, usually simple in form and dull in color and quite different from those of the Mississippi region. Only a very few species are found in the waters draining into the Pacific.

The shells of the pearly mussels consist of two convex valves, which fit together and inclose the animals. These valves are covered with a coating of somewhat leathery matter called the epidermis, and are joined together at the upper part or back of the animal by a hard, horny, rather tough and elongated C spring, which has a tendency to throw them open. In front of this spring, which is called the ligament, there are found, on uninjured shells, a couple of slightly corrugated eleva-

* "The fresh-water pearls and pearl fisheries of the United States," U. S. Fish Commission Bulletin for 1897, pp. 373–426, pls. I–XXII.

tions, one on each valve, and opposite; these are called the beaks or umboes, and are the oldest part of the shell. The rounded end of the shell is the front or anterior part, as this is always ahead when the animal is moving, and the pointed end opposite is the hinder or posterior part. In most of the heavier species there are developed interlocking or hinge teeth along the upper inner edge of the shell.

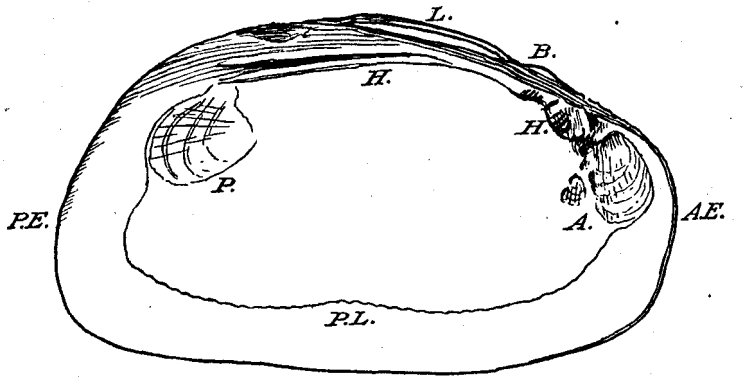

FIG. 1.—Diagram of interior of Unio. B., beak; L., ligament; H. H., hinge; A., anterior adductor scars; P. L., pallial line; A. E., anterior end; P. E., posterior end.

If a living mussel is taken and a thin knife is inserted at the front and hinder ends and a cut made toward the hinge, it will gape and the animal may be examined. A thin veil of soft animal tissue, called the mantle, covers the entire inside of both valves, reaching out to their edges, and joined together at the upper part of the shell. It is fastened to the shell near the border in a slightly indented furrow called the pallial line, and by muscles at the upper part of it. The edge and outside of this mantle throw out a sort of milky liquid, containing carbonate of lime and animal matter, which builds up the shell, thickening it from the inside and adding to it at the edge; the brilliant nacre next to it, a layer of vertical prismatic cells outside this, and over all the protecting epidermis. The mantle is carried between the locking hinge teeth, filling the space between them like a cushion. At each end of the shell inside, near the back, will be found a mass of tough, white, muscular fibers running from valve to valve, which have been cut into by the knife, and these are the powerful adductor muscles by which the animal closes the shell. Some of the *Naiades* have thin shells and no hinge teeth, the *Anodontas*, for example, and these almost invariably live in stagnant or slow-moving water. The *Unios*, the thicker-shelled forms, which have well-developed teeth, live for the most part in

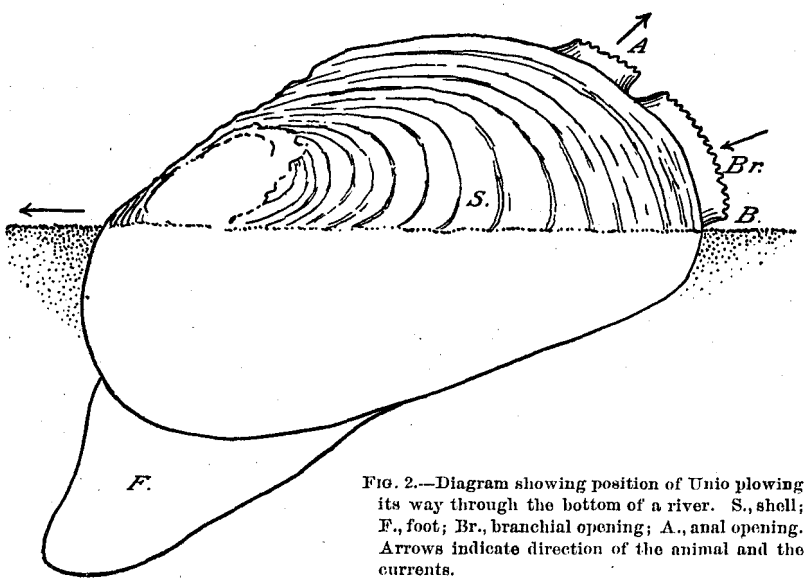

FIG. 2.—Diagram showing position of Unio plowing its way through the bottom of a river. S., shell; F., foot; Br., branchial opening; A., anal opening. Arrows indicate direction of the animal and the currents.

running water. The adductor muscles allow the shell to open but a short distance, so that the teeth always lock, and the mantle cushion swells when they are open and prevents them from slipping. There can be no doubt but that the hinge teeth are developed in the river mussels to prevent the valves of the shell from twisting on each other, which they would be likely to do in swift currents or in time of floods.

The *Anodontas*, living in still water, have thinner shells and do not need any locking teeth. Within the mantle, filling a large part of the shell and hung along the hinge line, is a sort of bag which contains the vital organs and is called the abdominal sac. This extends below and in front into a tough sort of hatchet or tongue shaped organ that is pushed out of the shell when the animal moves, and by expanding and contracting and moving forward and backward the whole is plowed along in the sandy or muddy bottom, leaving a little furrow. This is called the foot. Up under the forward adductor muscle is an opening into the abdominal sac called the mouth. It is carried through, as a tube, much folded and bent back on itself, the intestinal canal, and finally empties near the posterior adductor. Surrounding this canal, as it passes along the back of the animal, is a sort of heart, which beats regularly. Fastened to the mantle and the top of the abdominal sac in some cases, hanging down between the two, and reaching from the hinder end of the shell well toward the front, are, on each side of this sac, two curtains or flaps of the most daintily beautiful and delicate texture, and these are organs of vital importance to the mussels. They are the gills or branchiæ, and answer to the gills of the fishes or the lungs of land animals. Just in front of them and near the mouth, on either side of the abdominal sac and under the mantle, is another pair of smaller flaps, somewhat triangular in our species, and extending behind, which are called the palpi, and when the animal is feeding these are constantly in motion. At the hinder part of the animal the mantle, which is not fastened together here in our species, shows two small openings, one above the other, by having its edges pressed close together between and below these openings. One or both of these is fringed, and when the animal is feeding these fringes may be seen beautifully expanded between the hinder parts of the shell. The upper is the anal and the lower the branchial opening.

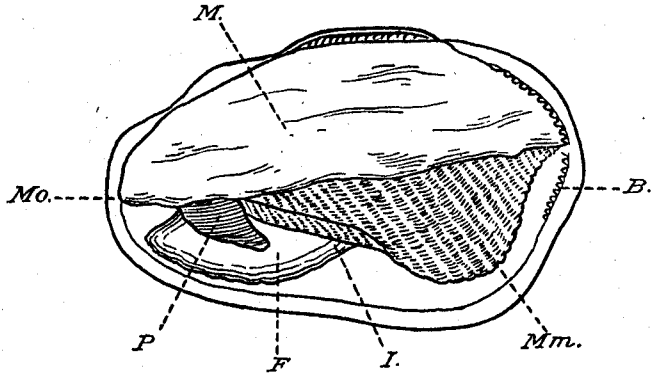

FIG. 3.—Anatomy of female *Lampsilis luteolus*. M., mantle folded back showing below; P., labial palpi; F., foot; I., inner gill; Mm., outer gill with the hinder part transformed into a marsupium; B., branchial opening; Mo., position of mouth.

When the animal feeds, the front part of the shell is usually buried in the mud or sand, leaving the hinder part to project free into the water; the shell is opened, the branchial and anal openings are spread, the palpi forward begin a rapid flapping, which draws in a current of pure water through the branchial opening. This passes through the gills, aerating the blood, then into the mouth and along through the intestinal canal, carrying in confervæ and microscopic forms of life which serve as food for the animal, and on out at the anal opening.

The sexual system consists of racemose glands within the abdominal sac, the male and female organs being so much alike that only a very clever expert can tell them apart. The sexes are generally, though not always, separate. Usually one animal is a male and another a female, and this is always the case among the more highly organized *Naiades*, but it has been pretty well proved that in some cases individuals are provided with both sets of organs. It is held by some students that certain of these mussels may change from one sex to the other, but this has not been proved. It is not certainly known yet how impregnation takes place, but it is supposed that the male ejects the spermatozoa into the water, where it is taken up by the female and passed into the ovaries. Within the ovaries the eggs are developed, and when they reach a certain stage they pass down through an opening into the gills. Here they undergo still further changes, developing a small bivalve shell, but very different in form from what it is when mature. Later on they are thrown out of the ovisacs of the transformed gill and fall to the bottom of the stream or pond.

Each little mussel is usually provided with one or more pairs of spines or hooks on its base, and when thrown out it lays on its back with the valves opened very wide. A long filament floats up from the minute clam, which in some way can attach itself to the fins, gills, or scales of fishes which come in contact with it. When such a connection is made, the little mussel rapidly draws itself up and snaps the valves on to the gill, scale, or fin, burying the hooks in it. This irritates the fish, causing it to throw out a fleshy substance, which incloses the embryo naiad just as an oak leaf covers up the egg of the gall insect that is laid in it. This cyst is air and water tight, and in it the little prisoner remains for a period of some seventy days, growing but little, though developing its organs. It is easy to see that during the time of its encystment it may be carried many miles away from the spot in which it left its mother's gills, and when it finally works out and drops to the bottom it is ready to found a new naiad colony.

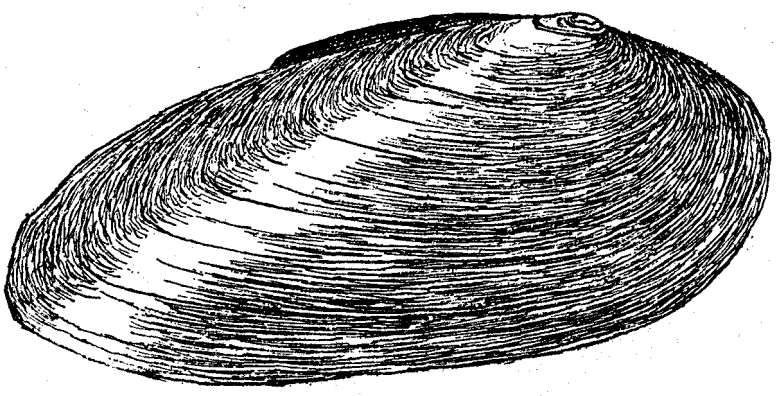

FIG. 4.—*Unio gibbosus* Barnes. A species in which the male and female shells are alike. This has young filling the outer gills only.

It has often been a source of wonder to naturalists how a given species of fresh-water mussel can inhabit a number of independent streams flowing into the sea, for it is a well-known fact that the *Naiades* can not live in salt water or even that which is more than very slightly brackish. Yet such is often the case. *Unio complanatus* inhabits every stream emptying into the Atlantic from Labrador to Savannah. And *Anodonta californiensis* is met with in a great number of rivers flowing into the Pacific. Now, I conceive that it would be easily possible for these embryos to attach themselves to the marine fishes which go up the rivers that empty into the sea and into the fresh water to spawn; that in some cases—rarely perhaps—these fish, not finding conditions favorable for spawning in the first stream entered, might return to the sea

and ascend a near-by stream, carrying with them the encysted mussels, which might be dropped in the second stream entered. Of course, when thus inclosed in the protecting cyst they could be carried through the sea without injury.

The pearly mussels live in a great variety of conditions. Most of them are found in shallow water, but certain forms live at considerable depths. Arnould Locard is authority for the statement that *Unio prosacrus* lives down to 50, 100, or even 200 metres in Lake Tiberias.* Others live at great depths in the African Lake Tanganyika. In Florida I have seen myriads of *Unio tortivus* buried among the fibrous roots of trees, and in the muddy, sandy banks just below the surface of the water, *Lampsilis anodontoides* of our western rivers sometimes burrows to the depth of a foot or more, and the curious *Anodonta angulata* of California and Oregon buries itself in hard clay in rapid water, with the wide posterior end down stream, allowing the sharp angle along this part of the shell to just come to the surface of the clay, so that it presents little resistance to the current. Our curious *Margaritana dehiscens* has a greatly elongated foot, and burrows deeply in the mud at the bottom of the streams, and the same is true of the South American *Mycetopoda* and the Chinese *Solenaia*. These forms probably do not migrate under any ordinary circumstances. I have reason to believe that the species which plow furrows on the bottoms of ponds and streams often migrate.

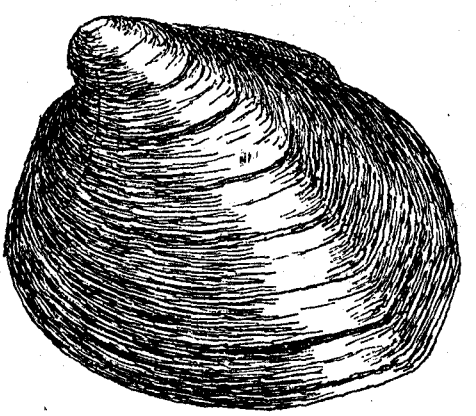

FIG. 5.—*Quadrula ebena* Lea. Niggerhead of the button manufacturers. Young shell taken in its tenth year. This has young in all four leaves of the branchiæ.

Ordinarily, the pearly fresh-water mussels die in a short time if taken out of the water—in 24 to 48 hours, as a rule. I have had thousands of specimens taken alive, packed tightly in boxes, and sent to me at Washington by mail or express from various parts of the country, from as far as Texas, Dakota, Florida, or Maine. Perhaps half of these reached me in a living condition when they came through promptly. Generally they die when exposed a few hours in the sun. Once when collecting in Indian Territory I came upon an artificial pond at McAlester which had been drained only a few days, and all over the soft bottom the water stood in puddles. Thousands of *Unio subrostratus* and *tetralasmus* were lying dead in the mud, and the odor was so sickening that I could scarcely collect them. Yet, under certain circumstances, both species will live buried in dried mud for a long time. Hon. J. D. Mitchell, of Victoria, Tex., kept specimens of *tetralasmus* alive in a dry room for many months.

In June, 1850, a living pond mussel was sent to Mr. Gray in London, from Australia, which had been out of water more than a year.† In a small stream near Braidentown, Fla., a great colony of *Unio obesus* is established. This stream or drain is in the piney woods, and only runs during some three months in the summer—the rainy season. The rest of the year it is dry, and thousands of these mussels may be found just buried in the sandy banks, or among the flags and rushes of the bottom where there is very little moisture; yet all are healthy. I have laid these mussels out in the sun for months, after which nearly all of them were found to be alive. There can be but little doubt that the specimens which live in perennial water soon

* Arch. d'Hist. Nat. de Lyon, 1883, p. 197. † Woodward's Manual of the Mollusca, 1856, p. 18.

die if removed from it, while those which inhabit streams or ponds that often dry up will live a long time out of water. It is well known that the streams of Australia often go dry, and the smaller ones of the Western States are quite liable to do so.

Some species in rocky streams remain in the crevices of the rocks. In the Big Vermilion River, in Lasalle County, Illinois, a swift rocky stream, I have found living mussels which had been so washed about that nearly all the epidermis was destroyed. The shells in such streams are usually heavier than those from more quiet water.

There are two great and very distinct groups of pearly mussels in the fresh waters of the United States, and several smaller somewhat intermediate ones. In the first the shells of the male and female are essentially alike, and the embryos, before being thrown into the water, fill either the entire outer gills, or, in some cases, all four of them. At this time the marsupium, as the transformed gills may be called, is smooth and pad like. In the second great group the shell of the female shows a decided swelling on the base just behind the middle, and this is absent in the male shell. In the species of this group the embryos are only found in the hinder part of the outer gill, and this part is rounded below, and the ovisacs containing them are separated from each other by a furrow and rounded on the lower end. The latter group contains the more highly organized of our fresh-water mussels.

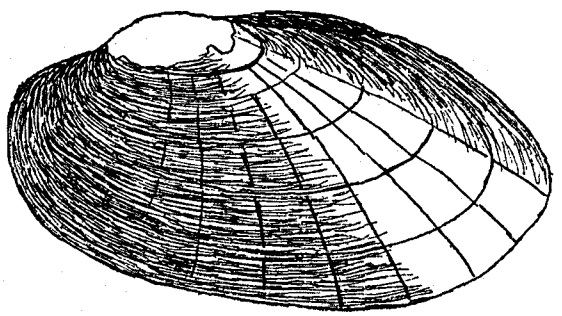

FIG. 6.—*Lampsilis luteolus* Lam. Male. Shell not produced at posterior base.

From all the observations that have been made, it seems that in a majority of cases the species of the first group become impregnated in the fall, carrying the eggs in the ovaries through the winter. In the late winter or early spring they pass into the gills, develop a shell, and are thrown out into the water along up to June. Those of the second group, where the males and females are so different, probably become gravid in the spring or early summer, and have the hinder part of the outer gill full of eggs in the summer or early fall. These rules do not hold absolutely, and some of the species, or even many of them, especially of the more highly organized groups, may breed oftener than once a year under favorable circumstances.

Little is known as to the winter habits of these mussels. It is quite certain that they sometimes burrow into the mud and become almost if not quite dormant, while at other times they are active during the winter. Certain species may be found gravid at different periods of the year; others seem rarely so. I have never seen or heard of a gravid *Unio plicatus* (a common, thick, plicate form of the Mississippi Valley), and I have examined many specimens of *Margaritana margaritifera* taken all through the year, and have never seen any with embryos either in the ovaries or gills.

The number of young contained in the female at a single time is often very great. In the species which carry them only in the hinder part of the outer gills they are far less numerous than in those of the other group. Most of these probably contain from 500 to 1,000 at a time, if fully adult. The species which have the whole outer gills transformed into a marsupium have a far greater number, while those which have all four gills filled contain the most. The common swan mussel of Europe, *Anodonta cygnea*, has been estimated to carry 200,000. A *Glabaris* from Lake Nicaragua, which

I examined, must have had at least a million eggs in its inner gills, and Dr. Isaac Lea made a calculation that a single *Unio multiplicatus*, our largest species, and one which carries the young in all four of the gills, had no less than 6,000,000.

There is ample need for all these young, for from the time of their birth until they die of old age they are constantly beset by enemies and forces that cause their destruction. Even nature herself seems bent on destroying them. Many of them will survive after being frozen, and an instance is on record where an *Anodonta* that was frozen solid while gravid hatched out its young all right on being thawed out; yet millions of them are undoubtedly destroyed by very severe weather. I have seen tens of thousands of empty shells in spring in the Potomac, after a very severe winter, clinging together by the ligament, and in many cases having shreds of flesh still attached to them. These probably did not bury deeply enough or the water might have been unusually low during hard freezing. No doubt those that live in shallow water suffer most from frost, but on two or three occasions I have seen the *Unionidæ* of a region almost exterminated after an uncommonly hard and unfavorable winter.

Dr. James Lewis, an exceedingly able and careful student of North American mollusks, believed that many of our pearly mussels are almost absolutely dormant during the winter. He held that in the summer they make their growth, adding a wide concentric layer to the shell. In winter the growth practically ceases, but the mantle still deposits a slight amount of shelly material and epidermis; but as the shell does not increase in size in winter, these deposits of epidermis form a narrow, dark, concentric line or band around its border. Others have held to the same idea, which is probably a correct one. In many cases these dark resting lines are marked as plainly on the outside of the shell as are those in a section of a tree, and if the theory of Dr. Lewis is correct, we may thus count the age of the clams by the rest periods, as we do that of the forest trees by the annual rings. In some cases these marks are not plain or even visible, and this is especially so with many tropical *Naiades*, which may continue to grow more or less throughout the year. It is possible that those of our northern species which do not show these rest rings or only have faint indications of them may be more or less active through the winter.

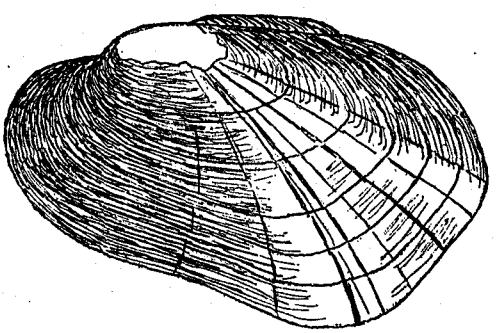

FIG. 7.—*Lampsilis luteolus* Lam. Female. Shell produced at posterior base.

It is hard to tell just at what age these mussels begin to breed, because this no doubt varies with the species, the amount of food, and favorable or unfavorable conditions; but I think it may be stated that it is generally at from three to five years from the embryo in those species which carry the young in the hinder part of the outer gills. Those which have both outer gills filled with young do not begin quite so early, and in the forms where all four gills are filled I do not think they often begin to produce young until they are seven or eight years old. The number of young produced by these young mussels is quite small compared with those of fully adult or old specimens. But if these younger mussels, say from five to nine years of age, could be always thrown promptly back into the water they could at least furnish one, possibly two crops of young, which would go a long way toward keeping up the supply, and really prove little or no loss to anyone. After reaching maturity but little is added to

the size of the shell, though it increases in thickness; hence it is difficult to say how old mussels become, but it is reasonable to believe that many live to be from 15 to 25 years old.

Floods no doubt cause considerable havoc among the *Naiades* on the one hand and unusual droughts on the other. In the former, millions are washed from their beds and often buried deep under mud, sand, or gravel, and destroyed, or are swept out into places where at ordinary times there is no water. River beds are changed, and wide areas densely populated with these forms are transformed into dry land. A letter received from a correspondent a few days ago told of his being in Honduras and seeing a multitude of buzzards congregated together in the valley of a small river. On investigating he found that the stream had changed its course over a long distance during a recent flood, leaving its old bed dry, and in it were vast numbers of decaying Unios. Where droughts dry up streams that are ordinarily perennial myriads of mussels perish.

In many parts of the world, and especially in certain localities of the United States, a large amount of carbonic acid in the water works great damage to the pearly mussels. This is especially true in the Southern States, while the waters of the Upper Mississippi Valley are generally comparatively free from it. No doubt the epidermis is developed in part to protect the shell from the effects of acid, but that upon the beaks, being rather thin and wearing away or becoming broken on account of being older there and more prominent than elsewhere, gives the acid a chance to begin to erode the shell. In many cases it eats down into the heaviest shells until they are seriously injured. The animal attempts to counteract this by adding on layers to the inside of its shell, but any great erosion always produces disease. I have seen some of the heaviest shells of Holston River so eroded that they were shapeless and it was impossible to tell what they were, and in Florida many Unios are destroyed by having holes actually eaten through to the animal.

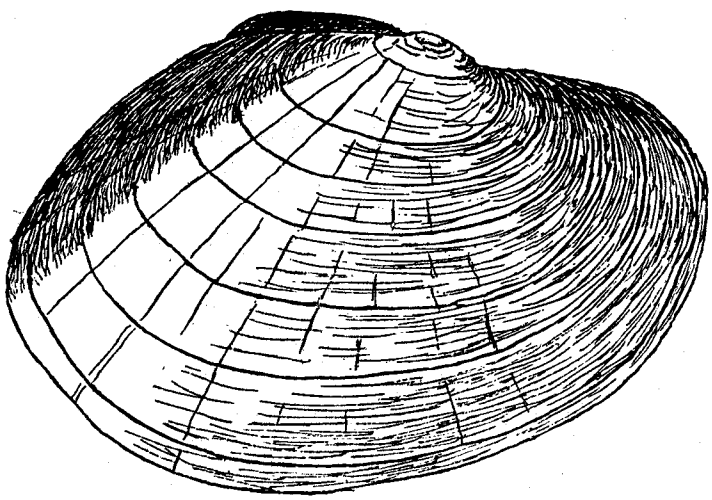

FIG. 8 —*Unio ventricosus* Barnes. Showing rest periods. This specimen was collected in its eighth year.

We do not know anything of the enemies of the *Naiades* when they are first born, but it is quite likely that such do exist. Experiments seem to show that fish avoid the embryos when aware of their presence, but devour the mussels eagerly after they have passed through the encysted state. Raccoons and muskrats prey on them, the latter carrying the shells out in great numbers along the banks of lakes and streams. Many rare shells that are eagerly sought by the collector are thus brought out of deep water, but they are generally weathered or broken when found. Mr. J. B. Upson,

of Rockford, Ill., states that crows carry some of the large species from Rock River to a considerable height in the air and drop them on the rocks, where they are broken, and thus they can feast on the animals.

Many years ago Dr. Isaac Lea bestowed the specific name *salmonia* on an *Anodonta*, which had peculiarly roughened, orange-colored nacre, and which was quite abundant in some parts of New York. Since then a number of other species have been found to occasionally exhibit this peculiar, roughened, blistered nacre, sometimes yellow, salmon, orange, or even a dirty white, and Prof. H. L. Osborn has recently shown in the Zoological Bulletin (vol. I, No. 6, pp. 301–310) that this is the work of a Trematode. The so-called *Anodonta salmonia*, when free from this parasite, is the *Anodonta grandis* of Say. I have seen quantities of mussel shells greatly injured by this pest, and though it may not actually destroy the animals, it unquestionably does great damage.

The question, "Can anything be done to save these mussels?" is a most important one. It is not difficult to enact statutes to protect timber, fish, or wild game; but it is one thing to make laws and another to enforce them. Whatever is furnished by the bounty of nature seems to be the property of the first one getting hold of it. In wanton wastefulness, man has destroyed many millions of acres of our original forest, until now we are forced to go without timber, or plant and raise it; he has swept out of existence much of our wild game, and made the most serious inroads on the fishes. And now it seems as though he must exterminate the *Naiades*. No doubt the settling up of the country, breaking the land, fencing and pasturing every foot of ground, draining out the ponds and marshes, and cutting down the timber indirectly proves destructive to the clams. The water which falls as rain or snow rapidly runs off as disastrous floods at times, and in a short time after the heaviest rains the ground is dry and, consequently, in the summer months many of the streams cease to flow. I remember forty years ago when the larger streams and smaller rivers of northern Illinois were perennial and meandered through thick woods, with here and there deep, quiet pools, and they were filled with fresh-water mussels. To-day they go dry during severe droughts; they are wide-bedded and shallow; their banks are shadeless; the pools have disappeared, and so have the mussels.

Hogs are a great enemy of the *Naiades*, and they not only destroy such as are found on the surface, but root them out from almost any depth. They should be kept away from streams and lakes, especially during low water. I have seen hundreds of acres of river bed during the time of low water completely dug over by hogs, and nothing left of the mussels but broken shells.

The dumpings of manufactories and the sewage of cities turned into rivers are destroying not only the fish but the *Naiades*. In many places below factories or cities the water of the streams is offensively foul and wholly changed in color, so that practically no kind of organic life can exist in it. Along the Potomac and Shenandoah rivers, in the vicinity of Harpers Ferry and above it, are a number of mills which grind wood into a pulp for the manufacture of paper. These throw their sawdust and waste into the streams, and down below, where the water is comparatively quiet, it settles to the bottom, forming great masses of slushy, putrid matter, which is, no doubt, destructive to fish and mussels. The city of Chicago is about to turn its sewage into the Des Plaines River, from which it will be carried into the Illinois River, a stream abounding with the very finest of fresh-water mussels. There can be but little doubt that this great volume of filth and poison will destroy every mussel in both of these streams, and may exert its deleterious influence even on the Mississippi River

below. It is not likely that pearl-hunters or button-makers will ever completely exterminate any of the species. There will always be some individuals left (especially where they are not abundant enough to make it pay to collect) to propagate the race. Fishes also can be depended on to carry the young about and plant them, thus forming new colonies and helping to restock the old ones. But sewage and much of the refuse from manufactories will kill everything downstream. It is to be hoped that some plan may be devised to utilize this waste, otherwise it will be difficult to compel cities and mill-owners to dispose of it in any other way than by turning it into the water-courses.

The immense number of mussels taken by pearl-hunters and the manufacturers of buttons and ornaments, generally in the most wanton and wasteful way, is undoubtedly diminishing the supply with great rapidity. In cases where individuals are collecting independently, either for pearls or to sell to manufacturers, it would probably be very difficult to get them to even throw the small mussels back into the water. But manufacturers, who ought to be intelligent enough to understand how rapidly the supply is becoming exhausted, and how much it is to their interest to preserve it, might at least use their influence to have those in their employ attend to this matter, and where corporations or individuals have control of water from which collecting is done they could compel attention to this. No mussel less than four or five years old should be taken by a pearl-hunter or anyone engaged in collecting for a manufacturer. Such young specimens would not furnish pearls of any value, and, as a rule, they are too small to be used with profit for buttons.

Certain regulations might be made in regard to dredging, raking up, and otherwise disturbing the beds of mussels. Mr. J. F. Boepple, president of the principal button factory at Muscatine, Iowa, who has given this subject much attention, believes that the disturbing of the beds at the time when the animals are loaded down with young is a cause of much injury, and he is no doubt right. When the gills are filled with embryos they often protrude when the shell is open, and if disturbed they suddenly close the shell, sometimes cutting off large portions of the ovisacs.

It is doubtful whether any part of the year could be selected for a closed season that would be much better than another part. There is not enough yet known about this matter to give complete data to work upon, but from what I have seen in the examination of many thousands of animals taken throughout a wide range of country, and during the greater part of the year, and the statements of others, it would seem that the process of breeding is going on with some of the *Naiades* all the time.

Something, no doubt, might be done in the way of mussel farming, just as oyster-growing is made profitable. The great mussel shoals on the Tennessee River, reaching from Florence, Ala., for 20 miles up the stream, are literally blocked with mussel shells. I have seen ripples in rivers where one could not step for a mile without treading on a living mussel. Such places, if kept under control and properly worked, ought to prove immensely profitable, and they need never be exhausted or even reduced.