Contributions from the Biological Laboratory of the U. S. Fish Commission, Woods Hole, Massachusetts.

OBSERVATIONS ON THE LIFE-HISTORY OF THE COMMON CLAM, MYA ARENARIA.

By JAMES L. KELLOGG.

For some years, numbers of small bivalves, attached by a byssus to stones and eelgrass, were noticed along the beaches at Woods Hole, Massachusetts. The outline of the shell was such as to suggest the long-necked or soft clam (*Mya arenaria*), and yet the differences were considerable so far as form was concerned. The whole outline was rounded, and the umbones prominent and widely separated, while in the adult clam the shell is elongated from before backward, the inconspicuous umbones approaching each other closely near the median line. The character of the hinge might have determined the matter, but it was so small and fragile, in the few specimens picked up in the search for other material, that examination was difficult and uncertain. I have long suspected, however, that a study of these forms would show them to be the young of our common clam.

Among the numerous notes and papers by the late Prof. John A. Ryder is a short description of the young *Mya* attached by a byssus.* These small individuals were found in New Bedford Harbor by Mr. V. N. Edwards, of the U. S. Fish Commission. They were attached to floating timbers, together with masses of ascidians (*Molgula*). Professor Ryder, in his study of them, discovered in a few specimens a single byssus-thread arising from a byssus gland in the foot.

Being invited by Dr. H. C. Bumpus, who represented the Rhode Island State Fish Commission, to make some investigations as to the life-history of the clam, during the summer of 1898, I proceeded to Woods Hole, in order to consult with him in regard to the work. Soon after my arrival, it was learned that Dr. A. D. Mead, who had just returned from the Kickemuit River, in Rhode Island, had observed many small bivalves in the seaweed in which were also to be found the small star-fish, which he was engaged in studying. On proceeding to this place, these creatures, which I had previously seen at Woods Hole, were found in countless numbers attached by a byssus-thread to the matted filaments of the marine alga *Enteromorpha*, and rarely to *Ulva* and eelgrass. The *Enteromorpha* was attached to the long blades of eelgrass, and to stones on the bottom, and was found only near the beach, which contained a great many clams. The small lamellibranchs were soon determined to be the young of *Mya*, and the following is an account of their development and habits from the period of their fixation by the byssus-thread to the adult condition.

*American Naturalist for January, 1889, Embryological notes.

Many of the attached forms were extremely small. Several were obtained which were but 0.4 mm. in length, and these the unaided eye could with great difficulty distinguish from fine grains of sand. A glance at fig. 2, which represents an individual of this length, shows a creature with little resemblance to the adult *Mya*. The outline is rounded, and the umbones are very prominent, and project out so as to be widely separated from each other. The foot (*f*) is of the plowshare-shaped variety found in *Venus*, *Unio*, and other clams, and, though not so represented in the figure, may be seen through the delicate semi-transparent shell to extend over the entire ventral surface of the visceral mass. In this it is very unlike the hatchet-shaped foot of the adult *Mya*, which is relatively small, and projects forward from the anterior surface of the visceral mass. The siphons (*s*), however, are similar to those in the adult form, but are excessively delicate and filmy, occupying so little space when retracted that the shell does not gape posteriorly to accommodate them. They are protracted and retracted with the utmost facility and rapidity.

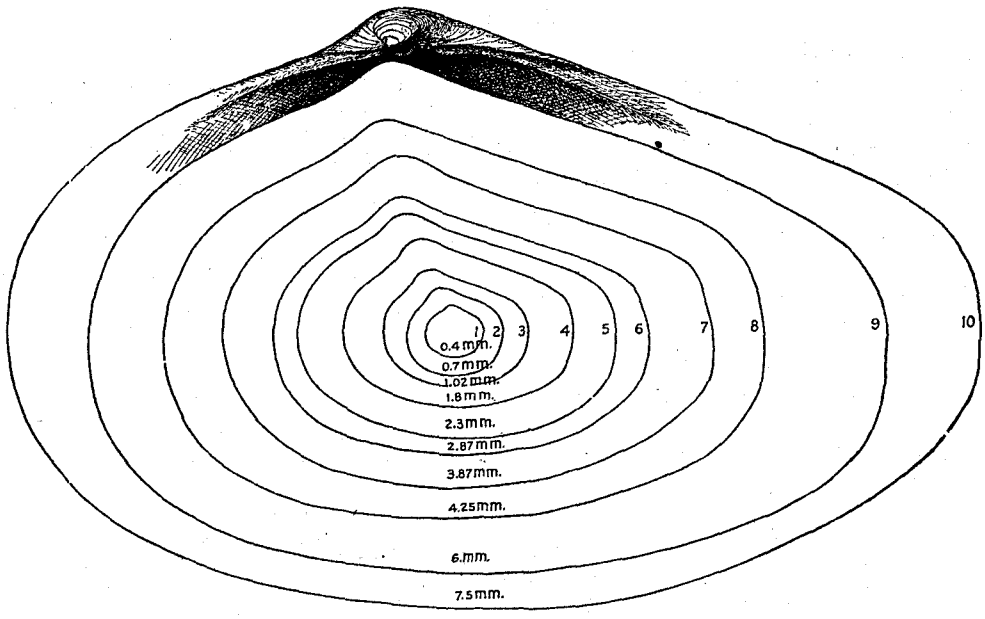

FIG. 1. *Mya arenaria*. Ten camera outlines of shells varying in length from 0.4 mm. to 7.5 mm. They are intended to illustrate the change from a rounded outline in smaller individuals to the elongated condition of older forms. There is at first a more rapid posterior, and subsequently a more rapid anterior, growth of shell, which causes the relative position of the umbo to shift forward, and then back to a position midway between the two extremities of the shell.

It was not difficult to determine that these individuals were young long-necked clams. When arranged in a series from smaller to larger forms, very slight differences between contiguous individuals, as regards the outline of the shell, lead from the rounded form with prominent umbones to the elongated shell of the adult, in which the umbones are inconspicuous. This comparison is illustrated in fig. 1, in which the outlines of the shells of a few individuals have been selected from a large series. They represent forms from 0.4 to 7.5 mm. (less than $\frac{5}{16}$ of an inch) in length. The largest shell differs from that in the adult in having the still conspicuous umbones placed anterior to the middle of the shell, but the general appearance is much the same, and the changes in outline from one to the other are easily followed in intermediate sizes.

In drawing a great many outlines with a camera, two individuals of the same length very frequently presented differences in outline which were considerable. Everyone has probably noticed how great are these variations in form in the shells of the adult clams, even where the shells have not become distorted in growth by coming in contact with unyielding bodies, such as embedded stones. The outlines selected and here reproduced are, of course, representative, and show one or two curious facts which would appear in any similar series. The first of these is that the small rounded shell, as already described, becomes relatively much elongated. Again, in the shell 0.4 mm. in length, the umbo appears near the middle of the shell, and then rapidly shifts its position anteriorly, as the creature becomes older. In outlines 9 and 10 in the series (in individuals 6 and 7.5 mm. in length), the umbones are being gradually moved back toward the middle of the shell, and this is continued in older shells until, as in the adult, they have again assumed a position about equally distant from the anterior and posterior extremities. This shifting in the position of the umbones is of course due to the fact that the shell for a time grows more rapidly posteriorly, and at a later period the anterior part has a more rapid growth.

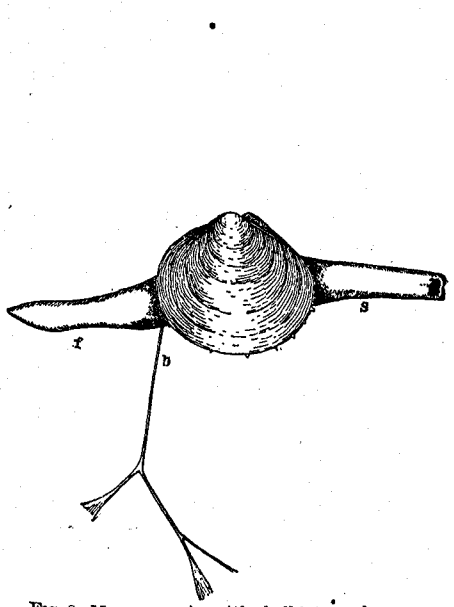

FIG. 2. *Mya arenaria*, with shell 0.4 mm. long, removed from attachment to seaweed (*Enteromorpha*) and showing the single, branched byssus-thread (*b*) arising from a byssus gland at base of foot (*f*). The filmy siphons (*s*) are shown protracted.

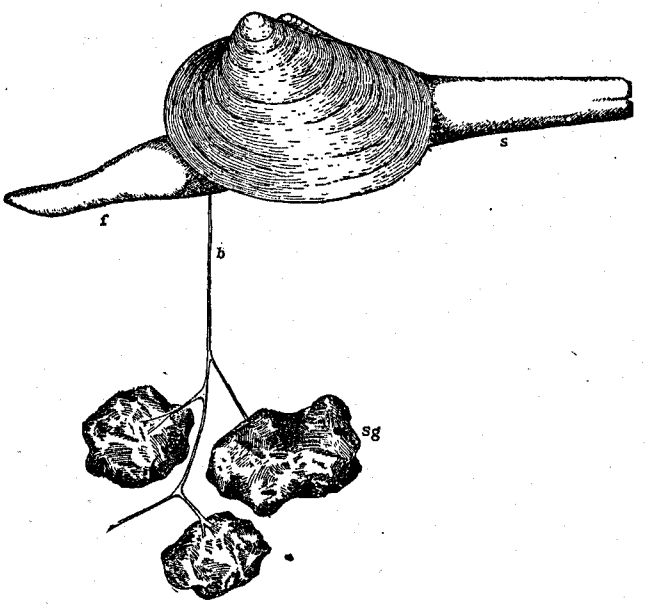

FIG. 3. *Mya arenaria*. Form 2.3 mm. long (drawn on smaller scale than fig. 2), removed from burrow in sand, and showing attachment of byssus (*b*) to numerous sand grains (*s. g.*).

In shells not longer than 2 mm., it is not difficult to detect the usual tooth in the left valve (as well as the excavation in the right), which Gould & Binney describe in the adult as erect, "rounded at its summit, of about equal breadth and height; its inner face is smooth and rounded; its outer face is divided into two portions, the largest of which is spoon-shaped, the other flat, and traversed across the middle by a grooved ridge, which projects beyond the margin of the tooth like a smaller tooth." This description may be easily applied to the small shell. In the smallest forms examined there was a concrescence of the mantle folds similar to the condition in the adult.

ATTACHMENT.

One of the most interesting features of the life-history of the long-necked clam—interesting from an economical as well as from a scientific point of view—is the fact that it is attached by a byssus to foreign objects during a considerable period of its early life. The smaller forms in the seaweed above the bottom were minute in size, some being but 0.4 mm. long. In each there was a well-developed byssus, which afforded a rather firm hold to the filaments of the weed. All the clams in the weed of course maintained their position by the same means, and the largest found, when the first examination was made early in July, was 7 mm. in length (a little more than 0.25 inch). A search early in August revealed several somewhat larger than this, each attached by a byssus, and in the mud of the bottom also many were obtained, some from 10 to 13 mm. long, which still possessed a well-developed byssus-thread.

In the note by Professor Ryder, before cited, a statement in regard to the size of attached individuals is not quite clear. He says:

> As they grew larger it was further supposed that they were held fast in their unusual position by the fibers and cement substances secreted by the mantles of their ascidian neighbors, and thus were suffered to attain a considerable size (from 2 to 15 mm.). * * * However, further investigation showed that in this I was in error, for after a careful search a few individuals were found from which a single byssal thread was found to proceed.

From this statement it does not appear positively that any individual 15 mm. long was seen to have a byssus thread attaching it to a floating body, though such possibly may have been the case.

Beginning work early in July, I was able to find few sexually mature adults in Narragansett Bay or at Woods Hole, the breeding season evidently coming earlier in these localities, probably in May and June; but that some still continue to discharge sexual cells late in July is shown by the fact that even in August there appear on the seaweed a few very small forms, which must be comparatively young.

We are led to the conclusion, therefore, that the free-swimming embryos attach themselves to foreign objects, such as the seaweeds (*Enteromorpha* and *Ulva*), eelgrass, stones, and other bodies, and that these attachments by the minute clam take place in the months of June, July, and August—the great majority of them in Narragansett and Buzzards bays in the latter part of June and in early July. Having become fixed in this way by a byssus thread, the clams remain for some time, many of them attaining a length of at least 6 or 7 mm., and perhaps more.

FREEING FROM ATTACHMENT.

It may be well to notice at this point the fact that the attachment of the clams may be broken at any time, apparently at the will of the animal, by a casting off of the byssus-thread. This is a very usual phenomenon among lamellibranchs with a byssus, and may be well observed in the black mussel, *Mytilus edulis*, where the byssus is very greatly developed. Here, as well as in the young clam, all the threads may be cast off from the gland in the foot, and new threads may be produced at will. Apparently young clams of all sizes in the weed very often perform this act. When they have in this way made themselves free in a glass dish, they at once begin to move about by means of the well-developed foot. Slowly crawling about for a time, they finally reattach themselves, and even after this has been accomplished, they move about in various directions to the length of their tether. In this process of freeing and reattachment, however, it very often happens that the little clams fall from the supporting weed altogether, and reach the bottom. In order to determine, if possible, how fre-

quently this happened, I kept a large mat of *Enteromorpha*, covered with clams, floating in running sea-water. Under the mass was spread some fine cloth. In the course of a week, great numbers—perhaps a fourth of all those attached—were found to have fallen from their support to the cloth, and these were of all sizes. Here they attach themselves, wander about, and again attach, until, apparently tired of the effort to find congenial surroundings, they remain inert, most of them without byssus threads, for long periods of time.

MIGRATION TO THE MUD.

As one would naturally suppose, this period is a critical one for the clam, as much so, probably, as any in its history, though it has to contend with other great dangers which threaten its existence both before and after it enters the mud. The eelgrass on which the *Enteromorpha* filaments grow most abundantly, in the localities examined, is to be found in shallow water, near the clam beds. In falling from their support, most of the clams would probably find a resting-place on the bottom, below the lowest low-tide mark. That this actually happens may be easily demonstrated by taking a little of the mud in these localities and washing it through a fine sieve. When this is done the small clams are often found. But the clams do not depend entirely upon *Enteromorpha* for fixation. As before indicated, they may also attach to stones and other bodies in the water. In the early summer, in certain localities, the floating weed may bear no attached individuals, which are, however, to be found fastened to near-by stones on the bottom. Wherever they may be, they probably free themselves from time to time, and, being below the low-water mark, fewer may reach maturity than if they had been between the tide marks. This is a matter of inference. *Mya* undoubtedly may live in bottoms which are never exposed. I know this to be true, for example, at the salt pond at Wakefield, Rhode Island, and in the river at Essex, Massachusetts, and probably many other such regions are known; but it is difficult to believe that regions below clam flats usually, or perhaps often, bear clams. Clam-diggers very generally seem to know nothing of their existence.

It may be concluded, then, that of the great numbers of small clams which fall to the bottom below low-tide mark, few are able to reach a favorable position higher up on the beach, and the great majority are destroyed. In such localities individuals over 6 or 7 mm. in length are seldom found. While the majority may thus perish, we may well believe that a few, on falling at certain times, are borne by tidal currents above the low-tide mark. They are to be found here burrowed into the sand, or attached to the sides of stones, close to the line where the stone touches the mud. This occurs most frequently on stones covered by rockweed (*Fucus*), and perhaps for the reason that here the little clams find better protection from their most destructive enemies, the young star fish. It is probable that many of these small clams between the tide marks originally attached themselves in this position, never having been fastened to objects in the water below low-tide mark.

This wholesale destruction of individuals below low-water mark is but another example of the tremendous struggle for life to which so many species of organisms are subjected in nature. Of the millions of swimming larvæ that probably arise from one female during a breeding season, few become attached to suitable objects, the water currents carrying most of them away. Those which succeed in fastening themselves are killed in vast numbers by very small star-fish; and even after attaining a position in the sand and mud of a favorable locality, the shifting of the sand, the crowding of individuals, the decay of organic material in the water, or the isolation of salt water

in shallow arms of the sea, lead to the destruction of many. Considering the phases of the life-history of the soft clam thus far described, it seems that artificial methods might be developed which should remove some of the dangers to be found in nature, and hence lead to a greater proportionate increase in the number of adults.

BURROWING INTO THE MUD.

The migration from the point of attachment having been accomplished, we are next concerned with the habit of burrowing into the mud. In the adult clam the foot is reduced to a laterally compressed, fin-like projection from the anterior side of the visceral mass, not extending to its ventral surface. It is with great difficulty that the mature clam buries itself in the sand after having been dug from its burrow. Clams 1 to 2 inches in length will cover themselves gradually in the course of 30 to 45 minutes, but they reach the usual depth of several inches only after a much longer period. Very large clams out of their burrows are still less active. In the young the foot is relatively very much larger than in the adult, and extends from the anterior side of the visceral mass, just under the mouth, far back on its ventral side. This condition of the foot is almost exactly like that to be found in such a clam as the quahog (*Venus mercenaria*) in its mature state. *Mya* has probably descended from an ancestral form which possessed this plowshare-shaped foot, the organ being reduced to its present form because it became less and less an organ of locomotion and was used simply for digging downward into the sand. We have a confirmation of this view in the structural peculiarities of the foot in the very small *Mya*, as described above.

In the young *Mya* the foot is capable of great extension, and is used not only in crawling over objects, but also in digging into sand and mud. It is extremely interesting to notice that individuals but 1.5 mm. long, when placed upon sand, at once attempt to cover themselves by thrusting and worming the sharp anterior end of the foot into it. Unless the sand be extremely fine, clams of this size are not able to thrust aside the grains sufficiently to obtain a lodgment. Those measuring 2 or 3 mm. in length are sometimes able to cover themselves partially or wholly; while one 6 mm. long can usually work its way beneath the surface of any clam bed, and thus rest in comparative security. All clams which I have observed, under 6 or 8 mm. in length, work their way downward only far enough to cover the shell. None of them seem to be very energetic, and often after working long enough to raise the posterior end of the shell to a vertical position, they give up the attempt to bury themselves and remain in that attitude until toppled over by the water currents. After having become completely covered, they exhibit a great deal of restlessness, apparently often push to the surface again, as if dissatisfied with the surroundings, and after wandering about for a short distance once more go down. This process has been seen to be repeated, in an individual 6 mm. long, half a dozen times in the course of three days. They seem to wander short distances—1 or 2 inches only—between the periods of descent, but perhaps the wanderings on the bottom may at times be more extensive.

How large the clam becomes before it digs into the bottom to remain permanently has not been determined. I have frequently found lying on the surface empty shells at least 2 cm. long which had been perforated by the oyster-drill (*Urosalpinx*), and this creature could only have made its attack when the living clam was out of its burrow. Clams of this length, then, apparently have periods of wandering, and it would be interesting to determine, if it were possible, whether or not they would be able to move up between the tide marks from some position below low tide. When

dug out of the beds, clams measuring 2 or 3 cm. in length are generally found to have gone down 12 or 15 cm. (5 or 6 inches) from the surface, the extremely delicate and filmy siphons of the small individual becoming relatively larger and more muscular. There undoubtedly comes a period—probably not far from this time—when the clam ceases to come to the surface, and, except for some accident, remains forever buried, reaching up to the water only by means of the siphon tubes. Evidence of this is the fact that clams are frequently to be found between rocks in such a position that it would be impossible for them to move, having reached such a location when smaller. Then, too, shells, especially the larger ones, are frequently distorted and rendered asymmetrical by coming in contact, in growth, with an unyielding object, such as a stone. The shape in such cases conforms to the space in which movement is possible. This same distortion of the shell may be noticed in other burrowing lamellibranchs, like *Petricola pholadiformis*. In case of this latter form, and also in *Pholas truncata*, which are to be found buried along the edges of salt marshes, the burrow is seen to be surrounded by so dense a feltwork of roots from the marsh vegetation that it would seem entirely impossible that the adult animal could remove itself. It is a mystery how the young could ever force its way into such material.

FIXATION IN THE BURROW.

A peculiar habit, the utility of which is very evident, is the spinning of the byssus by the small clam as soon as it has succeeded in covering itself in the sand. As has just been stated, the small individuals bury themselves, and again appear upon the surface, and this is repeated several times. But whenever the creature goes into the sand, it apparently at once proceeds to pour out the secretion which forms the byssus thread, and attaches itself more or less firmly by this means. Fig. 3 represents a clam with a shell 2.3 mm. long, which has been removed from its burrow. The single byssus thread (*b*) is seen to branch, the ends of the branches being attached to three sand grains (*s. g.*). Actually the number of sand grains and pebbles to which attachment is made is usually much greater than represented. The extremity of the thread which is fastened to the foreign body is considerably widened, as shown in figure. The character of the thread is the same, whether the creature is attached to several sand grains, to a single filament of *Enteromorpha*, or to other bodies. Fig. 2 represents a very small individual, 0.4 mm. in length (drawn on a larger scale than fig. 3), which was attached by several branches of the byssus to one short seaweed filament.

In coming out of the burrow and moving to a new locality, the byssus is cast off at the gland in the foot and left behind, and a new one is constructed at the next descent. This is done within a few minutes. Clams, from the smallest which are able to cover themselves in the sand to those at least 13 mm. long, exhibit this peculiar habit of forming a byssus in the burrow. How much longer the byssus organ remains in functional activity and when it begins to atrophy have not been determined.

The utility of this habit is well illustrated in a circumstance which recently came under observation at the house-boat laboratory, in the Kickemuit Narrows, belonging to the Rhode Island Fish Commission. Suspended in the water was a box filled with sand taken from a neighboring clam-bed. In the sand had been sunken some glass dishes, about 3 inches in depth, which had also been filled with sand. Here a number of small clams were allowed to burrow. On August 5 the region was visited by a terrific windstorm, and everything connected with the house-boat was pitched about furiously for more than an hour. Upon examining the glass dishes afterwards, it was found that all the finer sand had been washed out of them, and but a few small pebbles

remained. On these, however, several clams remained firmly attached, and this had prevented their being washed away. Where the waves were breaking on the beach the same thing was probably taking place. Small clams near the surface in their shallow burrows were probably washed out in great numbers. Many of them were then undoubtedly thrown up and left to perish. I have been informed by clam-diggers that during violent storms, when the tide is high, vast numbers of small clams are sometimes thrown up on the beach and left high and dry to perish by the retreating tide. Thus the possession of a byssus, which is attached to pebbles and sand grains many times heavier than the clam itself, must be of immense advantage in tending to keep the animal from floating off from the bottom.

THE BYSSUS THREAD.

Reference has been made to the relatively large, plowshare-shaped foot which extends backward over the ventral side of the visceral mass. The byssus organ, in which the secretion for the thread is produced, is located in the usual position on the ventral side of the foot, and far toward its posterior extremity. Its position is indicated in figs. 2 and 3, in which, however, the foot is represented as being projected forward to a considerable extent, carrying the byssus organ outside the shell. The byssus itself appears to be made of a single delicate transparent thread (*b*) sometimes bearing a number of side branches, the end of each branch forming a point of attachment. The precise manner of attachment has not been ascertained, but it does not seem probable that it is effected exactly as in *Mytilus* (mussel) and the young *Pecten* (scallop), in which forms a groove on the ventral side of the foot leads from the opening of the byssus organ out nearly to the tip. This groove is converted into a closed tube, and the fluid secretion of the gland is poured out into it. At the tip of the foot it is allowed to come in contact with the body to which attachment is to be made, and adheres tightly. The groove of the foot is now slowly opened, and the secretion, upon coming in contact with the water, is converted into a tough fiber. In this way *Mytilus* forms a number of threads, which extend out in various directions, all uniting near the opening of the byssus gland.

In the clam, an attachment having been made at a few points, the thread may be greatly elongated by pouring the secretion out directly into the water, where it at once hardens, much as the secretion from the spinning gland of a spider hardens, after its extension, by coming in contact with the air. By fastening a byssus thread from a clam 6 mm. (nearly 0.25 inch) in length to the point of a needle, one is able, by exerting a gentle pull on the thread, to draw it out to a length of 5 cm. (about 2 inches) in the space of about 15 minutes. The secretion is poured out at intervals, but not at any time with much rapidity. The thread thus obtained appears to be single, is very elastic, and is possessed of some degree of toughness.

POINTS BEARING ON THE DEVELOPMENT OF METHODS OF CLAM-CULTURE.

The rapidly diminishing supply of clams in Rhode Island has for some time been regarded with serious concern. Clam-diggers everywhere on Narragansett Bay, whom I have met during the present summer (1898), have given the most discouraging reports. In some localities, where clams were abundant four or five years ago, very few can now be obtained. The culture of oysters, as carried on in Narragansett Bay, Long Island Sound, and elsewhere on the New England coast, has been attended by many great and serious difficulties, and yet it has become, in the hands of enterprising

men, a very profitable business. In localities where it has been impossible to obtain a set of "spat," where the beaches between tide marks may not be used, where an annual rental of $10 an acre must be paid, where the deadly star-fish abounds, and where oysters are purchased abroad and shipped great distances simply to be spread upon the bottom and allowed to grow to a marketable size, the business pays and is thriving. One or two attempts have been made to develop methods of clam-culture in this country, but for various reasons—principally because of a lack of protection by law from the depredations of clam-diggers—they have been discontinued.

From the account of the life-history of the long-necked clam here given, it would appear that it may be possible to develop culture methods which should be productive of much greater results than those obtained by oyster culture. Two or three points elucidated, as well as some facts not yet mentioned, may well be noticed as bearing on the solution of this economic problem.

The habit of attachment.—Probably in many localities it would be possible, as it is in the Kickemuit River, to obtain great numbers of young clams in the early summer by simply gathering floating seaweed to which they are attached and transporting them to localities where conditions should be most favorable for further development.

Though no facts bearing on this point are at hand, it may be possible to bring about an artificial fertilization of the ova of the clam in such a way that the swimming larvæ might be induced to attach to some suitable object which should be convenient to handle when it is suspended in the water containing the embryos. This has been accomplished with some degree of success in the case of the oyster, where artificial fertilization may be brought about with very great ease; but with some lamellibranchs it seems absolutely impossible to induce this union of the sexual cells, and this may be the case with the clam. Even if it were so, sexually mature individuals might be placed in inclosed localities, where large numbers of the young could be collected.

Tenacity of life.—While the adult *Mya* dies quickly in aquaria, the small clams are very tenacious of life. Early in July, 1898, a bucket full of *Enteromorpha*, covered with clams, was taken from the water at the Kickemuit Narrows at 11 a. m. of a hot day, and was carried to Woods Hole, arriving at 4 p. m., the water in the bucket having become very warm. The clams were transferred directly to the much colder sea water in the hatching-house of the U. S. Fish Commission station. None of them seemed to be in the least injured by their rough treatment, and they lived in very slowly running water for over a month, when they were removed. In this case, no care having been taken to make the conditions favorable, they did not seem to thrive, and certain individuals measured from time to time showed little or, in some cases, no growth. Others, after remaining a month in the hatching-house, were placed in small glass dishes, which were allowed to stand until the water had nearly evaporated and a zooglea mass had formed on top of it, and they remained alive under these conditions for many days. These facts seemed to indicate that the small clams are very hardy and that, if desirable in culture work, they could easily be transported without injury.

Effect of waters of differing degrees of salinity.—In the transfer of clams just mentioned, it may be noticed that the salinity of water in the two localities is somewhat different. In the Kickemuit the average salinity is about 1.019; at Woods Hole, about 1.024. As is the case with oysters, clams will live in water which is brackish. At the salt pond near Wakefield, Rhode Island, for instance, the salinity is from 1.0049 to 1.0058 on the surface, and quite a number of clams are found along its shores. The density at the bottom may be much greater than at the surface, however.

Enemies.—One important fact which must be considered in developing any method of clam-culture is that the clam in its attached condition, and when exposed on the surface of a bed, is destroyed in vast numbers in many localities by one or two natural enemies. The worst of these is that curse of the oyster-culturist in northern waters—the star-fish. Many extremely interesting and important observations in regard to this creature's habits of destroying clams and other forms have been made during the past summer by Dr. A. D. Mead. These observations show that the star-fish, even when minute in size, is terribly destructive to the young clams.

Another enemy of the young clam is the oyster-drill (*Urosalpinx*). Many clam shells have been taken from the surface sand of the bottoms which exhibited the clean perforation filed by this creature. Shells so pierced were from 3 mm. to 2 cm. or more in length. As I have never found drilled shells in any great numbers in one locality, it would appear that the clam is not seriously menaced by this foe. The adult clam, deep below the surface, is probably not disturbed by other enemies than man.

SUMMARY.

To recapitulate the principal points established in the foregoing description of the life-history of the clam, beginning after the swimming larval condition, we notice that the breeding season in Narragansett and Buzzards bays probably extends through May and June into July. Beginning my observations late in June, I have not been able to determine its limits with any certainty. After the free-swimming larval period, the young clams attach themselves by means of a byssus, which is produced from a byssus gland in the foot. Attachment is made to various bodies in the water. Clams may be found so attached from the latter part of June to the 1st of August. They are to be found in certain localities in immense numbers. The attached individuals measured varied in length from 0.4 to 7 mm. The shape of the smaller individuals differs greatly from that of the adult in being much more rounded, with umbones widely separated laterally. As they become older, they gradually assume the outline which characterizes the adult, but in so doing the umbones come to be situated relatively far forward, and then again move back toward the middle of the shell on the dorsal side. This shifting in the relative position of the umbo is due to a more rapid growth of the posterior, and subsequently of the anterior ends of the shell.

In the smallest forms examined, the mantle folds were in concrescence ventrally. The foot is relatively greatly developed, extending over the entire ventral side of the visceral mass. The siphons have the general characters of those in the adult, but are filmy and may be retracted within the shell with very great quickness.

Clams of all sizes apparently free themselves from their attachment. The byssus is cast off and the creature climbs from one point to another by means of the foot, sometimes reattaching, sometimes falling free to the bottom. In the sand, unless it be excessively fine, individuals less than 2 mm. in length are rarely able to cover themselves, though they always make the attempt. Those 5 or 6 mm. long are apparently able to burrow beneath the surface of any clam shore.

Having attained a lodgment in the sand, all clams observed proceed immediately to form a byssus thread, which is attached to sand grains and pebbles. This tends to secure the creature, so that, even if water currents or the action of the waves should dislodge it from its burrow, it would not be carried so far from its original position as would otherwise occur. Of their own accord, these clams frequently leave the first burrow, wander about, and form another, some individuals repeating the process many times. A time finally comes when they dig into the sand to remain permanently.