14.—REARING OYSTERS FROM ARTIFICIALLY FERTILIZED EGGS, TOGETHER WITH NOTES ON POND-CULTURE, &c.

By JOHN A. RYDER.

The desirability of testing the breeding of oysters in ponds in the United States, as practiced for many years past in France, has long been a desideratum.

In order to test the feasibility of such a method on a scale large enough to give us practical results, an arrangement to carry out such a scheme was finally effected with the Eastern Shore Oyster Company in June of the present year. The beds near where the work was undertaken are owned by Messrs. Pierce & Shepard, who afforded the writer every opportunity to carry on his investigations, and also aided him very materially in the work of experiment. A pond was excavated in the salt marsh on the shore of Chincoteague Bay, on a farm situated at a distance of about 2 miles from the village of Stockton, Worcester County, Maryland. This pond covered an area of about 50 square yards, and was connected with the bay by a trench or canal about 10 feet in length, 2 feet in width, and 3½ feet in depth, which last was the same as that of the pond itself.

The water which supplies this pond was filtered through a permeable, porous gate, or diaphragm, which was placed in the trench connecting the pond with the bay, and no water was allowed to enter the pond which had not been first filtered through this diaphragm.

The diaphragm itself was constructed of boards perforated with auger holes, and lined on the inside with gunny-cloth or sacking; and the space between the perforated boards filled with sharp, clean sand. The space between the boards was about 2 inches; through this the tide ebbed and flowed, giving a rise and fall of from 4 to 6 inches during the interval between successive tides.

This apparatus, if it may be called such, constituted the receptacle into which the artificially fertilized eggs of a number of oysters were introduced every two or three days.

It was supposed, when the experiment was commenced, that some difficulty would be experienced with a rise of temperature in the pond in excess of that found in the bay, because the water was kept confined and still, and constantly exposed to the direct rays of the mid-day sun. But to our surprise and gratification it was learned that the temperature in the pond and in the bay was precisely the same at every observation which was made in order to test this question.

Another question also arose in our minds as to whether it might not be that the water in the pond might become less salt than that in the open bay; in other words, that its specific gravity would be less than that of the water in the bay, owing to leeching from the banks of the pond in addition to that precipitated during rains.

To our great satisfaction we were also agreeably disappointed to find that the specific gravity of the water in the pond remained steadily about the same as that found to prevail in the bay. The specific gravity in the pond was 1.018, and 1.020 at times in the bay, to as low as 1.0175, and the fluctuation of the specific gravity of the water in the pond was found to be about the same as in the bay.

At the head of the creek the specific gravity of the water was about 1.010. In this situation a good many oysters were living and growing; but even this density is not so low as that prevalent in the waters of Saint Jerome's Creek, where it fluctuates between 1.007 and 1.010, and where excellent oysters are grown.

From numerous observations and considerations based upon the facts of distribution, it is believed that the oyster in all cases thrives best in waters of a specific gravity about such as has been indicated above, or from 1.007 to 1.020.

Another equally important point to settle was whether a sufficient amount of food would be generated in the pond to supply any young or old oysters with nourishment. To our satisfaction we found immediately after the diaphragm had been placed in the trench that the confined waters of the pond acquired a distinctly brownish-green tint, which we at first supposed was due to particles of dead, brown organic matter. A microscopical investigation of the water showed that in this we were in error, and that the brown color of the water was largely due to the presence of innumerable microscopical plants, consisting largely of diatoms, having brownish contents. It was also found that immense multitudes of very small monads, with long flagella, would collect upon floating chips and light objects at the surface of the water during the warm mid-day hours. It seems, therefore, evident that food was generated in abundance here, and greatly in excess of what may be found in the open bay, and that one of the most important conditions for the success of our experiment had been established.

The final results fully confirmed this conclusion, inasmuch as we found that spat grew just as rapidly in the pond as in the waters of the open bay. There is, moreover, no reason to suppose that it would not grow to a marketable size just as certainly as spat collected in the natural way.

COLLECTORS.

The collectors used in our experiment were of the simplest possible character, the object being to make the experiment as practical in character as possible. To this end stakes were driven into the bottom of the pond, extending above the surface some distance, to which oyster shells, with holes punched through, were attached after being strung upon galvanized iron wire. A number of these simple collectors were placed in the pond, each set being marked with the date on which they were placed in position, in order to afford data for a more detailed study of the results of the experiment.

The first collectors of the kind described were placed in position upon the same day when the first spawn was poured into the pond. This occurred on the 7th of July last.

Other collectors were then put down at odd dates during the remainder of the month of July. The care of this portion of the experiment, together with the spawning of the oysters themselves, was mostly in the hands of Mr. H. H. Pierce, whose share in the work was, to say the least, as important as my own.

METHODS OF TAKING AND INTRODUCING THE SPAWN INTO THE POND.

The oysters used for the purpose of spawning were taken from the vicinity of the oyster-house, which stood only about twenty yards from the pond, besides others which were obtained from the deeper waters of the adjacent bay. It was found that the eggs of those from the shallow water near the pond were as readily fertilized as those from the deeper water, and no difficulty was experienced at any time until towards the latter part of July in obtaining an abundance of good spawn for our experiments.

The oysters from which spawn was obtained were carefully opened by removing the right valve and allowing the soft parts of the animal to remain attached by the muscle to the left one. The spawn itself was then pressed out of the generative organs by means of a pipette gently stroked over the gland and out along the course of the efferent ducts, so as to force the spawn out into the upper gill chamber, as described in previous publications by the writer.

The sexes were distinguished apart very easily by what the writer has described as the "drop test," which consists simply in dropping the spawn from a pipette into a dish of clean sea-water and watching the kind of cloud which it forms after it strikes the water. Invariably, if the specimen was a female, the eggs would break up into a granular cloud which could be very readily seen to be composed of very minute whitish bodies if the transparent vessel was held up so as to look down through it upon a dark ground below.

In case the specimen was a male the drop of milt would not so readily break up, but would exhibit a somewhat glairy consistency; and if the drop was stirred in the water it would break up into wisps and streaks, so as to appear, on a small scale, like a series of minute mare's tail clouds such as are seen in the sky at times. This test was found so practicable that we were able to readily teach a novice how to distinguish the sexes apart in one lesson.

The method of taking the spawn was just as easily learned by Mr. Pierce and Mr. Shepard, both of whom soon became as expert as the writer in the practice of the art of taking oyster spawn. The spawn so taken was mixed together in a small dish. The milt and eggs placed in contact at once were thoroughly stirred together and poured from time to time, as the water became milky in the small glass collecting

vessel, into a wooden pail. This was repeated until it was believed that a sufficient amount of spawn was mixed with the water in the pail, which was then taken and poured into the pond at different points, in order to distribute it over as great an area as possible.

Before the spawn was poured into the pond, however, it was allowed to stand in the pail from three to five hours, in order to give it a chance to develop to the swimming stage of the embryo. Fresh supplies of water were also added once or twice during this time to that in the pail in which the spawn was originally taken.

This briefly describes the processes used in conducting our experiment; and while it bears a strong resemblance to the method used by Mr. Brandely, it is really very different in that he had a second pond at a higher level from which supplies of fresh water were drawn through a sponge filter. In our case nothing of the kind was used; we depended absolutely upon nothing else than the rise and fall of the tide for the renewal of the water in the pond. We did, however, use a diaphragm through which the water could pass and repass somewhat similar to that used by the French experimenter. The method used at Stockton was, however, essentially the same as the apparatus devised by the writer in 1880 and 1881, but which was designed and made on such a small scale and under such unfavorable conditions that no practical results were achieved.

RESULTS OF THE EXPERIMENT.

On the 22d day of August, or 46 days after the beginning of our experiment, Mr. Pierce sent me by mail a series of shells taken from the collectors, which had been placed in the pond at various dates during the month of July, and which showed young oysters or spat attached, ranging from one-fourth to three-fourths of an inch in diameter; demonstrating conclusively that the young would grow just as rapidly in our pond as in the waters of the open bay. Of this last fact I am positively assured on the ground of previous observations made during the three preceding seasons.

We are therefore prepared to assert that it is perfectly feasible to rear oysters from artificially fertilized eggs, and, so far as I can judge, quite as successfully as by the method of sowing shells on the bottom, now largely practiced on the coast of Connecticut in the waters of Long Island Sound. While our experiment has not shown that we could get a greater set of spat than that ordinarily obtained under natural conditions on planted shells, the experiment has settled several questions which are of the greatest importance in the practical work of oyster culture.

One of the difficulties encountered was the same as that met with in shell-planting in the open waters, namely, the accumulation of slime and ooze on the surface of the collectors, which is so deadly to the infant oyster when it is from one five-hundredth to one-ninetieth of an inch in diameter, a very slight quantity of sediment serving at this

time to smother the infant mollusk and arrest the flow of water through its tiny gills. thus producing death by asphyxia.

THE FOOD OF YOUNG OYSTERS.

This slime I have determined, during the previous seasons, to be largely composed of the very lowest vegetable organisms, namely, *bacteria*, or those plants constantly associated with putrefactive processes, and even accused of being the proximate or remote causes of contagious and infectious diseases in man and the lower animals.

Any one, however, who has carefully studied the feeding habits of the young oyster is soon convinced that it is upon these very low and minute forms that the animal largely depends for food. In fact, it is possible to frequently find young oysters in the stomachs of which multitudes of these minute plants are rotating under the impulse of the vibratile cilia with which the stomach is lined, the stomach itself being a cavity not over the one four-thousandth of an inch in diameter, which will give some idea of the minuteness of the food required to nourish so tiny a creature.

It appears that in practice it will be impossible for us ever to provide against the generation of minute organisms which form the slimy coating of fixed objects used as collectors in the water. But from the foregoing considerations it would appear that the removal of the slime, or the prevention of its deposit, is not altogether desirable, in view of the fact that the minute plants comprising a large part of it form an important element in the development of the young, serving, as we have seen, to nourish it during its infant life.

UTILITY OF THE EXPERIMENT.

The practical utility of the experiment, in the writer's estimation, consists in this, that it proves that ponds or inclosed areas of water may be readily utilized on the eastern coast of the United States for cultivating oysters in the same way as is practiced in France and other foreign countries. In fact there are many thousands of acres of salt marsh all along the eastern coasts of the States of Virginia, Maryland, Delaware, New Jersey, and perhaps New York, and Chesapeake, Delaware, and Chincoteague Bays, which could be readily converted into permanent and profitable planting grounds for the cultivation of oysters.

The great advantage of this method would be that the persons, constructing the inclosures or digging out ponds on their own territory, would be absolutely protected by law from the incursions of the lawless tongers whose rights and privileges are not yet as clearly defined in some of the States as they should be. The method would also be of advantage from the fact that inclosed areas properly constructed are more accessible—in fact, could be so arranged as to be worked without the use of boats. It would also be found that oysters would fatten and come into condition for market at a relatively much earlier time in the

season than those planted in open, unconfined waters where cold currents interfere with the abundant development of food.

This view is borne out by the fact that green-gilled oysters are invariably fat, and are usually found at the end of summer in more or less confined waters, or under such conditions as would obtain in inclosed areas in some degree similar to the one used in our experiment at Stockton. In truth, the writer is now confirmed in the belief that the green-gilled condition is due to an abundance of green microscopic food, which is absorbed in large quantities so as to tint the juices and finally the blood-cells of the animal, and that these green organisms are multiplied under just the conditions afforded by more or less completely inclosed ponds or areas of brackish water.

THE BEST COLLECTORS FOR MUDDY WATER.

The collectors best adapted for waters which contain a large amount of organic matter in suspension are evidently brush or stakes supporting strings of oyster shells strung on wire, because the tide will constantly tend to sweep the accumulated sediment off the surfaces of the twigs and shells. Such collectors should of course be put into the water upright, so as to cause the collecting surfaces to be far above the bottom, which is usually covered to a depth of from a few inches to several feet with black ooze or mud in such situations. The brush should be thrust with the main stem down into the mud far enough to support the branched top against the tide, and also be so placed as to bring the top below low water. The stakes, with their load of shells, should be arranged in a similar way.

These two forms of collectors seem to me to be the cheapest and most available in the practical work of spat collecting where the water contains much sediment and the bottom is too deeply covered with ooze to make shell planting profitable. Where the ooze is too deep shells will rapidly sink into it so as to be entirely covered, and afford no surface to which young spat can attach itself and grow.

By means of some such method a large area can be rendered profitable as planting ground which is now utterly barren and useless for such purposes.

These are mere suggestions, but I am fully convinced from the facts which have come under my observation during the last three years that they are very important ones, because in many cases it is evident that all that is needed to get spat is to afford surfaces upon which it may attach itself in those situations where the bottom is deeply covered with mud and where the fixation of spat and the establishment of oyster-beds is often, without such provision, a sheer impossibility. The importance of placing collectors in such places must, therefore, be evident to the intelligence of the most ordinary person.

OBSERVATIONS UPON OYSTER SPAT AT WOODS HOLL, MASS.

In the early part of the month of August my attention was called to a number of wooden buoys lying on the beach near the light-house establishment at Woods Holl, and which had been taken from the upper end of Buzzard's Bay, near Cohasset. These wooden buoys were replaced by others during the early part of July. Upon examining the surfaces of a number of those which had been removed from their former position, it was found that they were covered with a remarkable "set" of young oysters ranging in size from one-ninetieth to one-eighth of an inch. In some cases as many as twenty-five young oysters might have been counted on a surface of one square inch. Every available clean surface was covered more thickly than I had ever observed anywhere in either the Chesapeake or Chincoteague Bays. It was evident that the attachment of spat in this case would have been very great in that vicinity had there been an abundance of collectors placed in position in the early part of the month of July or the latter end of June, the time which seems to be the most important period at which to place collecting apparatus in position, as shown by my observations in Chincoteague Bay, where I am satisfied that little or no spat caught on any sort of collecting apparatus previous to the 1st of July, although oysters in the vicinity may have been spawning much earlier.

This point was determined by the following method: Upon examining the shells and old oysters in Chincoteague Bay, about the end of June, I soon became convinced that all the young oysters then visible belonged to the set of last season. Two facts served to prove this; the first was that the larval shell was eroded or eaten off of the beaks of the spat shells by the carbonic acid in solution in the water. It was also evident that these young oysters had made a second growth which belonged to this year, because a distinct offset or line indicating as much could be detected on the outside of the upper valve of every specimen which was examined. These data serve to finally fix the approximate time at which the set of spat occurs in the latitude of Chincoteague Bay. But it is evident that this time is somewhat later in Buzzard's Bay, on the coast of Massachusetts, from the fact that the spat observed in that neighborhood averaged much smaller than that from the more southern waters alluded to above.

THE SET OF SPAT IN BUZZARD'S BAY.

During the second week of August, in company with Vinal N. Edwards, I made a trip on the steam-launch from Woods Holl to the head of Buzzard's Bay to examine the set of spat in that region, having been encouraged to do so by what I had witnessed on the buoys brought in from the neighborhood some weeks before. Going to a point of land covered largely by coarse gravel, we found that a planter had sown a considerable area with clam and oyster shells. It was ascertained that

immense numbers of spat had been caught, ranging from about one sixteenth to three-eighths of an inch in diameter; the average size was probably about three-sixteenths of an inch. In some cases a single shell was found to give attachment to more than 100 young oysters of the sizes mentioned.

It is evident, of course, that a large proportion of these, owing to their being so crowded, could not possibly survive much beyond the time when they would grow large enough to crowd each other and come in contact at their edges. Many would necessarily be killed in the course of growth from this cause, so that it follows that it is not desirable that spat should catch so thickly as in this case. Indeed it is probable that a set of three to five young oysters on one shell has a better chance to survive than a much larger number. But the question here raised can only be settled by future observations made by competent persons, though it is true that the author has made some observations which afford almost positive proof that young oysters are sometimes killed by overcrowding while still quite small.

THE SET OF SPAT IN 1883 IN DIFFERENT OTHER LOCALITIES.

The set of spat on planted shells, and on all kinds of objects in the water, seems to have been unusually large during the past summer. Reports from various sources indicate as much; since it is a fact that shells planted in Buzzard's Bay, as noted above, have had in some places an unusual crop of young oysters fixed to them.

In Long Island Sound the planted oyster shells have had an enormous number of spat attached, as is shown by a report in the *Hartford Times*.

The shells in the vicinity of New Haven, according to this report, cost seven cents per bushel. The firm of the Smith Brothers, who, by the way, sold $30,000 worth of oysters last year, have sown 130,000 bushels of shells on their 350 acres of oyster farm land this year, at a cost of about $17,000. The set upon their shells is an unusually large one, and has caused considerable excitement amongst the oyster-men in the vicinity.

The Smith Brothers tried only four of their beds. One of these was sown with shells by a younger brother last spring, who put his mite of $500 into the work. His lot seemed to be the most thickly covered with spat; and one of the firm offered him $3,000 in hard cash for it, but he declined the proffer with thanks.

In Chincoteague Bay Messrs. Pierce & Shepard have also sown some ground with shells this season. The result has been most gratifying, in that a very good set has been found on them.

In the southern waters, especially in Chesapeake Bay, the sowing of shells has not been practiced to the extent that it probably will be in the course of the next few years, when the method is more favorably known.

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One advantage of oyster culture in the Chesapeake over that practiced in Long Island Sound and the more northern waters is, I believe, to be noted in the fact that star-fishes are not as abundant; nor have I ever heard that they were as destructive as they are farther north. The experience of Messrs. Pierce & Shepard proves conclusively that what applies to the practice of shell-planting in Long Island Sound is equally applicable in the waters of Chincoteague Bay, and, inferentially, in those of the Chesapeake.

ENEMIES.

There are some "drills," or boring whelks, which are found in Chincoteague Bay, that bore into the shells of living oysters and cause some destruction, but not, so far as I could learn, to a serious extent.

These molluscan enemies of the oyster are found more or less abundantly in all waters in which oyster culture is practiced; and are probably one of the necessary evils to be encountered in the business, together with the boring sponge, which eats into the shells and which seems to be found in greater or less abundance wherever oysters grow.

PROPER CONDITIONS.

The idea that a rough, ragged surface is necessary upon which oyster fry may readily catch, is a fallacy. The prime condition that is necessary in order that the fry may adhere, and live, to any surface put down for collecting purposes, is that that surface shall be clean and remain so long enough for the young oyster to get large enough to take care of itself in some measure.

It is doubtless true that where oyster shells are pretty thickly sown, the interstices between the shells serve to some extent to retain the fry whilst they are still in the swimming stage; but rough surfaces are not at all essential, in that we find spat sets as thickly on the smooth inner surface of oyster shells as upon the rough outer one.

METAMORPHOSIS OF THE FRY.

When the young oyster ceases to swim, and attaches itself, it undoubtedly grows considerably after the time of attachment before its valves lose the perfect symmetry of the larval stage. This has been proved by the examinations which I have made of the spat caught on the buoys brought to Wood's Holl. This is also evidence that the writer is probably correct in his statement that the young oyster attaches very soon, or within 24 to 48 hours after the eggs have been fertilized, as announced in his paper on the "Fixation of the fry of the oyster," published in Bulletin United States Fish Commission, vol. 2, 1882, pp. 383 to 387. Another fact confirming this opinion is the circumstance that it

is impossible to start the larval shell of the oyster from its surface of attachment, after it has acquired the umbones and before it begins to develop the spat shell, without breaking it. This is proof that the shell of the fry has been glued to its surface of attachment at a very early stage; and it is also a fact that it is invariably the left valve which is undermost with its beaks directed towards the left side.

COMPARATIVE FREEDOM OF THE WATER FROM SUSPENDED MATTER.

The northern waters where oysters are grown seem to be clearer and less full of suspended particles, at least in Buzzard's Bay, than in the Chesapeake. This may be one reason why the spat catches in such abundance in certain places, sticking to gravel, dead shells, bowlders, stones, buoys, and all kinds of fixed objects having clean surfaces. It may be that the water of the Chesapeake, holding more sediment in suspension, is less favorable for the attachment of spat than that of the clearer northern oyster regions. At any rate, the deposition of sediment at some places in the Chesapeake proceeds at an unusually rapid rate, which would naturally, as explained above, interfere with the attachment of the fry. This has suggested to the writer the practicability of transporting small spat from the northern waters to the more southern, inasmuch as it seems that a greater proportion of spat will catch and grow on the same area there than in the south. Certain it is that quite young spat may be transported, say from the Chesapeake to Chincoteague Bay, and survive the journey and grow very rapidly, as I had opportunity to learn during the past summer on the grounds of Messrs. Pierce & Shepard. Whether it would be profitable to transport small spat for long distances, and whether it would survive such a journey could, of course, only be learned by actual experiment; but it is possible that the experiment would be worth a trial.

ABSORPTION OF BRACKISH WATER BY SALT-WATER OYSTERS.

The growers who carry on the cultivation of the oyster practice in many places what is called "plumping" or puffing up oysters for market by exposing them for a short time to the effects of water fresher than that in which they grew. One party at Franklin City has actually used steam heat in order to warm fresh water to 65° or 70° Fahr. in winter, so as to get the oysters to open their valves and take in enough fresh water to puff up their flesh and give them a better appearance in the market. By this process the animal does not acquire any additional matter except the water, which is taken up in great amount, but it loses a part of its saltness, and, in flavor, becomes more like an oyster from brackish waters.

EFFECT OF SEA WATER ON BRACKISH-WATER OYSTERS.

It is a remarkable fact that just the reverse effect will be produced on the flesh of oysters which are carried from brackish into water which is more salt. This was shown by taking some oysters from Buzzard's

Bay and bringing them to Wood's Holl, where they were kept supplied with water running from a faucet for several days. At the end of that time the soft parts had shrunken to a remarkable degree and acquired a toughness and leathery consistency in marked contrast with that observed in the animals before the experiment was tried. These effects are produced, as is well known, by osmotic action.

STORAGE FLOATS.

An ingenious system of floats, which are raised and lowered by means of windlasses, are used in this work by Mr. Conger, of Franklin City, Md. This apparatus is a great convenience in storing oysters temporarily near the oyster houses, where they are packed for market. The floats are 20 to 25 feet long and 7 or 8 feet wide, with a bottom made of strong slats. The windlasses are supported on the tops of four piles driven into the mud in two pairs, one at either end of the float.

ECONOMICAL SIGNIFICANCE OF THE STOCKTON EXPERIMENT.

The success in rearing oysters from the eggs, as practiced at Stockton the past summer, admits of no doubt whatever; inasmuch as there could be no question as to the identity of the eggs from which the spat which caught on the collectors was derived. No other ova could by any means have gained access to the inclosure, so as to vitiate our results. But this success I do not esteem of as much value as the facts of collateral importance which it has substantiated. These are the following:

First. It has proved that oysters may be grown in inclosed ponds.

Secondly. It has proved that an abundance of food will generate in such inclosures.

Thirdly. It has proved that we can depend upon the tide to renew the waters of such ponds.

Fourthly. It has been shown that the cost of digging out ponds on an extensive scale would be a comparatively inexpensive undertaking, because no digging is required except such as can be done with a spade. The nature of the salt marsh is such that it can be cut into any shape desired; the black muck of the marsh being interpenetrated with great numbers of roots and decayed fibers of vegetable matter which render it tough, so that it can be cut out in solid blocks. About the depth of what would be taken by three superimposed spadesfull is a sufficient excavation for the purposes of pond culture in many places. There are thousands of acres along the eastern coast of the United States of salt marsh lands which are available for pond culture, besides the ground already occupied off-shore; so that the development of the industry seems to be practically unlimited. Wherever the water is fresh enough to grow oysters, and where such marsh lands also exist, the construction of ponds for oyster culture is feasible on just as grand a scale as is now practiced on some parts of the coast of France.

The writer does not think that the rearing of oysters from artificially impregnated eggs will ever be a profitable business, in that it is likely that collecting spat by simple and inexpensive methods, such as the use of brush, shells, gravel, and other cheap, clean materials, will always yield as good results on a large scale as any artificial method could possibly give. But it is possible that we greatly underestimate the value of wholly artificial methods.

NOTICE OF A PARASITE OR COMMENSAL OF THE OYSTER, WITH REMARKS ON ITS DISTRIBUTION.

About a year since, M. Adrien Certes, of 21 Rue de Jouy, Paris, announced, through the pages of the Bulletin of the Zoological Society of France, that he had met with an organism inhabiting the stomach and intestines of the oyster, which presented some remarkable characteristics, and which was allied to a parasite found in the blood of the frog, and to another species found in the intestines of birds.

The writer first noticed this creature in the stomach and intestines of the American oyster during the summer of 1880, and then supposed it to be nothing more than a small vegetable organism allied to *Vibrio*, and has made some allusion to it under that name in his report to the Maryland Commissioner for that year.

M. Certes has since shown that this identification is an error, as well as a later name which the writer had proposed, namely, *Spirillum ostrearum*. A more critical examination has shown that it is often found in great numbers in the stomach, especially at its hinder extremity, in which a singularly transparent rod is embedded. In this place they are sometimes found in vast numbers. They do not seem to be a true parasite, but are rather to be regarded as a messmate inhabiting the alimentary tract of the oyster. They are very minute, thread-like organisms, which are provided with an extremely delicate, narrow frill or membrane, which is wound spirally around the body of the animal. The living creature moves rapidly across the field of the microscope, looking very much like a minute animated spiral spring, rotating with a screw-like motion through the liquids taken from the stomach and gut of the oyster. This creature has been encountered by the author in the contents of the stomachs of oysters in Washington and Philadelphia; also at different places on the shores of the Chesapeake and Chincoteague Bays, and even as far north as Buzzard's Bay. It therefore seems to be a constant inhabitant of the oyster. It has also been found in other portions of Europe besides the place where it was originally found by M. Certes, who first noticed it in oysters taken from the vicinity of Marennes. This gentleman, in a letter to the writer, dated August 7, says that Professor Möbius has also found it in the oysters of the North Sea. The animal found in the American oyster is apparently very similar if not identical with that found in the flat oyster (*Ostrea edulis*) of Europe.

Professor Möbius has published an account of his discovery in No. 134 of the Zoölogischer Anzeiger, of the 19th of March, 1883.

The discovery of this parasite and its subsequent study was made in precisely the same way as by the writer. The contents of the stomach of the oyster were removed by thrusting a pipette or medicine-dropper into the mouth of the animal, and drawing out by that means the juices and the microscopic food which the stomach contained. Almost every other oyster examined, and sometimes every one, will be found to be inhabited by this creature; but no ill effects, so far as the writer is aware, are traceable to its presence when infested oysters are consumed by man as food. It seems to be a perfectly harmless commensal or pensioner upon the oyster whose stomach it inhabits.

THE FOOD OF THE OYSTER.

The method of removing the contents of the stomach of the oyster with a pipette is valuable for another very important purpose, namely, to learn the nature of the food which the animal had taken shortly before. This season, while examining oysters in Chincoteague Bay, with this object in view, I found that the adults were guilty of swallowing sometimes as many as 200 of their own young at one meal. These young oysters ranged in size from one five-hundredth to one two-hundredth of an inch in diameter, and already had the shell developed; and the larger ones were found to be themselves feeding, inasmuch as food could be seen in their stomachs.

Besides these young oysters a good many oyster eggs were also found amongst the contents of the stomach, together with spermatozoa, diatoms, the very youngest stages of barnacles, and the shells or external coverings of a singular infusorian, which was identified as a species of *Tintinnus*. Of this last organism, several thousands of their shells were sometimes met with in the contents of the stomach of a single oyster.

The fact that adult oysters swallow their own young and eggs shows that they may be, in this way, to some extent, destructive of their own species.

The investigation of the contents of the stomach and intestines of the oyster by the method already described on an extensive scale in different localities along the eastern coast of the United States is important; because it is a well-known fact that the flavor of oysters varies or is affected by local causes which are probably mainly the food and the saline condition of the water in which they grow.

The contents of the stomachs of a great number of individuals could be very readily removed and preserved for investigation by the means which the writer has used. The identification of the minute vegetable and animal remains in such material preserved for study could readily be carried on by specialists versed in the characters presented by the various forms.

Possibly the most important of the food elements of the oyster are diatoms. These free-swimming, minute plants are found in vast num-

bers wherever oysters grow, and are numerous in species; so that the subject would be worthy of the attention of some one who had devoted extensive study to them. By such a course it would be possible to determine whether the diatomaceous flora of a given district where oysters are grown differed essentially from the diatomaceous flora of another; and it might in this way be possible to get at the reason why oysters from different localities differ in flavor.

THE POPULAR DELUSION REGARDING GREEN-GILLED OYSTERS.

For many years green-gilled oysters in England and France have been more highly esteemed by the epicure than the white-fleshed ones; in consequence of which fact the growers have made every effort to cater to this singular taste. They have also found it a profitable taste to cater to; because the green-gilled oysters are higher in price in the markets of Europe than the white-fleshed ones. The only place in the United States, so far as the writer is aware, where this taste has been developed is in the city of Norfolk, Va.; where it is said that green-gilled oysters are worth five cents per quart more than white-fleshed ones. The prevalence of this peculiarity in a large proportion of the oysters from the Chesapeake Bay and Rappahannock River last winter was the cause of a serious decrease in the value of the affected product. Every test, chemical, physical, and gastronomical, which has been tried at the instance of various investigators, has shown that the consumption of green-gilled oysters is never attended with evil effects. In fact, it has been proved that the green color is in no way due to copper, as has been asserted by ignorant or prejudiced persons. In truth, the color is due to a harmless vegetable coloring matter absorbed from the food upon which the animal feeds, and is very nearly identical in composition with the green coloring material found in the leaves of trees.

It is to be hoped that the public mind may be educated up to the point where they will fully comprehend the fallacy of the belief that the green of oysters is due to copper; because it may be said that any such quantity of a copper salt which would produce the green color of oysters would necessarily be fatal to the animal itself.

To sum up, it may be said that the doctrine that the green color of oysters is due to copper is utterly fallacious, and without a shadow of foundation in fact.

It was formerly believed that the acquisition of the green color was confined to the oyster, but I have recently learned that the soft and hard clam are both affected under certain conditions and at certain times by a similar alteration in the tint of the gills, which is doubtless due to precisely the same cause as the same condition in the oyster. This is all the more likely, because the food consumed by these two animals is very similar to that consumed by the oyster; but that they should be in any way deteriorated in quality by the acquisition of this green color is in the highest degree improbable.

WOODS HOLL, *September* 4, 1883.