24.—ON EXPERIMENTS, BEGUN IN 1880, TO PLANT AMERICAN OYSTERS IN THE WESTERN BALTIC, AND THE USEFULNESS OF CONTINUING THESE EXPERIMENTS, WITH THE AID OF THE GERMAN FISHERY ASSOCIATION.*

By K. MÖBIUS.

At several points on the Baltic Sea, the Greifswald Oie (southeast of the island of Rügen), Warnemünde, and Kiel, various attempts have been made during the last forty years to cultivate the European edible oyster (*Ostrea edulis*, L.), but all without success. The oysters which had been planted did not propagate, but pined away and finally died.

Thousands of years ago, when the inhabitants of the Cimbrian peninsula had no other weapons and implements but those made of stone and bone, oysters must have been frequent in the Little Belt, for at a place on its western coast, near the village of Süderballig, between Hadersleben and Apenrade, there is a kitchen-midden from the stone age, which, besides many common edible mussels and heart-mussels, contains numerous oyster shells. It is evident that the oysters once contained in these shells were not brought from a distance, but had been caught in that neighborhood. The circumstance that at one time there were oyster beds in the Little Belt proves that in those times the water of the Western Baltic must have been salter than it is now. In still earlier times, when the Baltic was not confined within its present limits, but covered a considerable portion of its shore-regions, oysters were found still farther from the two belts, east and south of Kiel, in places which are now 300 to 600 meters above the water-level. The bottom of the Baltic, therefore, has risen in course of time, and so the straits connecting it with the North Sea, the Sound, and the two Belts have become shallower and narrower, in consequence of which the amount of salt water received by the Baltic from the North Sea has decreased, and no longer counterbalances the fresh water which continually pours into it from its tributary rivers. It is certain that the change of the water of the Baltic was a very slow process, which possibly is still going on. Our descendants will be able to determine this question, as by the investigations of Dr. H. A. Meyer, and the German commission for the scientific exploration of the German seas, the present degree of saltness of the water of the Baltic has been accurately ascertained. The oysters of the Süderballig kitchen-midden are smaller than those of the same age from the oyster beds on the west coast of Schleswig (as the specimens placed on exhibition show). They proba-

* *Über den im Jahre* 1880 *begonnenen Versuch, nordamerikanische Austern in der westlichen Ostsee anzusiedeln und die zweckmässige Fortführung desselben unter etwaiger Beihülfe des Deutschen Fischerei-Vereins.* Translated from the German by HERMAN JACOBSON. From Circular No. 2, 1883, of the Deutsche Fischerie-Verein, Berlin, April 30, 1883.

bly had, therefore, reached a stage of deterioration, when they were eaten by the ancient inhabitants of the regions of the Little Belt.

If the European oyster could live in the present water of the Baltic, it would not have set the limit of its domain near the island of Anhalt, in the Kattegat. That the oysters have been driven from the Baltic by its waters gradually losing their saltness, may be seen from the fact that on the eastern, the Swedish coast of the Baltic, where the water is less salty than in the middle and the western (Jutland) coasts of the Kattegat, they have retired farthest towards the Skagerack.

The most recent attempt to cultivate oysters in the Baltic is principally distinguished from the former failures by the fact that it has been made, not with our European species, which, as experience has shown, cannot live in the Baltic, but with another kind, the North American oyster, *Ostrea virginiana* Lester.

The North American oyster is longer than the European in the direction from the ligament toward the edge of the stomach. In the same direction the impressions of the adductors is, when compared with its breadth, of larger extent, and its fore part is blunter than in our *Ostrea edulis*, and has a more or less of a dark, violet color. The indentation in the left or hollow valve is narrower and deeper than with our oyster; nor does it have the low, wart-shaped teeth, which in the *Ostrea edulis* are found on the anterior and posterior edges below the ligament. The *Ostrea virginiana* grows to the length of one foot (more than 30 centimeters). Like *Ostrea edulis*, it spawns during the warm months. On the coast of Virginia and Maryland, on shallow beds which are more exposed to the rays of the sun, they spawn as early as May, according to W. K. Brooks, and on beds at a depth of 9–11 meters in July. Brooks estimates the number of eggs of a full-grown American oyster at nine millions.* As the eggs do not develop in the beard of the mother oyster, and are therefore not protected by her, as is the case with the embryos of the European oyster, the American oyster needs a greater fecundity than the European, if it is to increase in spite of the manifold destruction of the eggs and young.

The idea of cultivating North American oysters in the Little Belt was conceived by the late engineer, Mr. C. C. P. Meyer, of Hadersleben, who had spent some time in America. When Meyer came to Kiel to communicate to me his plan and ask my advice, I advised him to place oysters on the east coast of Schleswig only in such locations where they could not be covered with mud and sand or by masses of living or dead plants; for the American, like the European, oyster, after it has once adhered to some portion of the bottom of the sea, can no longer move about, and must perish if it is covered with mud, sand, or plants.

Meyer found some persons to join him in his enterprise. A company was formed which obtained permission from the provincial govern-

* W. K. Brooks: Development of the American oyster (*Ostrea virginiana*), in report of the Commission of Fisheries of Maryland for 1880. Baltimore, 1880.

ment at Schleswig to start oyster beds on its east coast. By a special agreement made in March, 1882, the provincial government, with the consent of the minister of agriculture, granted this company the privilege of establishing and using oyster-beds for forty years, within certain limits. During the winter of 1879–'80, Meyer went to America, and brought thence 1,250,000 spat and 5,000 large oysters, which, in quantities of 5,000 to 150,000, he placed at ten different points in the Little Belt, from Knudshoved, near the Danish frontier, as far south as the island of Barso, in the Bay of Gjenner.

Through the kindness of the managers of this enterprise I have twice been enabled to participate in the examination of these artificial oyster-beds—in August, 1880, and September, 1882. In some places nothing was found but empty oyster-shells, and in others, besides empty shells, also living oysters. In those places where the result was most unfavorable, the bottom was either covered with quicksand or with dense masses of dead sea-grass. The best result was obtained south and southeast of the island of Aarò, on firm, sandy, or stony bottom, free from plants. According to a communication from Hadersleben, dated some time in March (1883), many of the oysters placed in the Little Belt are still alive. They have, therefore, lived in the Baltic through three winters, which, however, does not imply that the experiment of acclimatizing the American oyster in the Baltic has been a complete success, for this would require that they also propagate in the Baltic from one generation to the other.

The first time I examined the beds, in August, 1880, I found in the shell of one of the older American oysters a very small live young oyster, which had probably been born in Europe. In September, 1882, I could not discover any signs of propagation. Although this does not show conclusively that the American oyster is not able to propagate in the Baltic, there is, on the other hand, nothing whatever to prove that the American oysters placed in the Baltic will propagate and ultimately form regular oyster-beds. These circumstances induced me to inquire for the causes of their probable barrenness. The shells of the oysters had increased considerably in size as early as August, 1880; they must, therefore, have taken and assimilated a certain quantity of food, sufficient to form new matter for the shell. But none of the oysters which I opened in August, 1880, and September, 1882, had that healthy appearance, which in the Schleswig oysters is termed fatness, and which is caused by the well-developed sexual glands. On the contrary, they were all thin and watery, like old and barren European oysters.

I thought that possibly the saltness and temperature of the Little Belt were not suitable for the healthy development of all the organs of the American oyster, and especially not for the growth of mature eggs.

Unfortunately we know but little regarding the saltness and temperature of the American oyster-beds. The only data which we possess we received from Prof. G. Brown Goode, in Washington, in answer to

a request made by the president of our association. Prof. G. Brown Goode informed us that in the Chesapeake Bay oysters perish, when the saltness, for some time, is less than 1.3 per cent. According to observations made by Dr. H. A. Meyer,* the saltness of the sea-water on the east coast of Schleswig-Holstein only goes below 1.3 per cent. in spring and summer, when large quantities of fresh water are emptied into the Baltic from the rivers and streams. In autumn and winter the percentage of saltness is higher, as much as 2 per cent. and more, in deep places. On the 15th September, 1882, I found a saltness of 1.8 per cent. in the surface-water near the island of Aarò, where the American oysters have been placed.

Wherever the European oysters form natural beds, and also in basins where they are cultivated or kept for the market, the average saltness of the water is greater.

	Per cent.
The average saltness on the Schleswig oyster-beds is	3 to 3.3
Near Whitstable and Herne Bay, mouth of the Thames....	3.1 to 3.2
In the river Roach, southeast coast of England	3.1
In the Bay of Arcachon†	3
In the Ostend oyster-basins	2.9
In the basins of Tremblade, mouth of the Sendre, Western France	2.5

As the North American oyster is found as far south as the coast of Texas and as far north as New Brunswick, it evidently possesses the faculty of accommodating itself to different temperatures. According to Ingersoll,‡ the oyster-beds near New Brunswick are during winter covered with ice. This great adaptability of the North American oyster to sea-water of different temperatures suggests the question whether there are not varieties of it which cannot only stand a low temperature, but also water possessing but a small degree of saltness, qualities which are peculiar to all the marine animals living in the Baltic. The oysters set out near the island of Aarò were selected without any special regard to these qualities. They belong to the variety which is found in the latitude of New York, especially near Long Island. They

* H. A. Meyer: *Untersuchungen über physikalische Verhältnisse der westlichen Theiles der Ostsee.* Kiel, 1871.

† In the *Deutsche Fischerei-Zeitung* for August 1, 1882, J. Boeck says: "In France oysters are cultivated in the mouths of rivers; in Southwestern France, in inlets having brackish water. * * * There is reason to hope that by means of naturalized and acclimatized oysters, oyster-culture may be successfully introduced in our many inlets having brackish waters."

In this connection I would say that the saltness of the water of the Baltic, between Rügen and the Greifswalder Oie, is only .72 per cent.; in the Greifswalder Bodden, .65 per cent.; and in the haffs still less. It appears from this that it is not safe to draw a conclusion, as to the saltness of sea-water from a similarity in the configuration of the coast.

‡ E. Ingersoll: "The oyster industry," in The History and Present Condition of the Fishery Industries, prepared under the direction of Prof. S. F. Baird, by G. Brown Goode. Washington, 1881.

therefore came from portions of the sea having a higher temperature and a greater saltness than the Little Belt, near Aarò. If we wish to continue our experiments, we should select the most northerly variety of the American oyster, and take them from beds where the water has the least degree of saltness which they can stand. Unfortunately, Ingersoll's work on the American-oyster industry contains no data relative to this subject. Here is an opportunity for the German Fishery Association to make some practical use of its connection with North America, by causing more exhaustive investigations to be made in that country.

With this view, the following questions would have to be answered:

1. Are there any oyster-beds on the coasts of New Brunswick, where the water is much less salty than in the open sea, and near what towns are these oyster-beds located?

2. What is the maximum and what the minimum degree of saltness in the water near these oyster-beds?

3. Are these oyster-beds covered with ice every winter, and how long?

4. Could healthy oysters, capable of propagating, well packed, be quickly sent from New Brunswick to Germany in spring, when frosts have ceased?

In the above-mentioned work of Mr. Ingersoll a Mr. Venning* is mentioned as inspector of fisheries in New Brunswick. Ingersoll has also received information relative to the New Brunswick oyster-beds from Professor Whiteaves.† Both these gentlemen, whose residence Ingersoll unfortunately does not give, might possibly aid us in answering the above questions.

For answering the second question, What is the maximum and minimum degree of saltness of the water near these oyster-beds? Observations would have to be made. For these the following instruments would be needed: An aerometer, a thermometer, and a glass cylinder in a solid box which can be easily handled, accompanied by plain and intelligible directions. A set of the instruments, manufactured under the supervision of the commission of scientific investigation of the German seas, can be obtained from Mr. Steeger, of Kiel, for about 25 marks ($5.95).

If these investigations should lead to favorable results, I would recommend to get oysters from New Brunswick in the spring of 1884 and set them out in suitable places on the east coast of Schleswig-Holstein; but a layer of oyster-shells should first be placed on the bottom, as experience has shown that these form the most favorable habitat for young oysters.

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*The reference is doubtless to Mr. W. H. Venning, inspector of fisheries, Saint John, New Brunswick.—C. W. S.

†Probably Professor J. F. Whiteaves, Assistant Director of the Geological Survey of Canada, Ottawa, Ontario.—C. W. S.