

## XXXIV.—RESULTS OF THE INVESTIGATIONS RELATIVE TO THE OYSTER AND ITS CULTIVATION AT THE END OF THE FIRST YEAR OF THESE INVESTIGATIONS.\*

[Appendix to the Sixth Annual Report of the Zoological Station of the Netherlands Zoological Association.]†

LEIDEN, 1881.

The review (*catalogue raisonné*) of the *literature of the oyster*, referred to in our report, was completed during the month of June. It is intended to form the first part of the final report on the investigations relative to the oyster, but on account of its size (104 pp. 8vo, close print) it has been thought best not to embody it in this appendix. The table of contents of this review, which has not been given to the book-trade, is as follows:

### *Introduction.*

The "Ancients" on the oyster.

Conrad Gesner (1516–1565) on the oyster.

### A. *Works of a purely scientific character :*

I. Systematic study of the oyster, and its geographical distribution.

II. General anatomy and physiology of the oyster.

III. Anatomy and physiology of the generative organs of the oyster.

IV. History of the growth and development of the oyster.

### B. *Works relating to the general natural history, fishing, cultivation, &c., of the oyster :*

I. Works which do not exclusively relate to *one* country or locality.

II. Works relating to the oyster-fisheries and the cultivation of the oyster in *the Netherlands*.

III. Works relating to the oyster-fisheries and the cultivation of the oyster in *Belgium*.

IV. Works relating to the oyster-fisheries and the cultivation of the oyster in *France*.

V. Works relating to the oyster-fisheries and the cultivation of the oyster in *Great Britain and Ireland*.

VI. Works relating to the oyster-fisheries and the cultivation of the oyster on *the German coasts of the North Sea*.

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\*"Overzicht van den stand van het onderzoek de oester en haar cultuur betreffende aan het einde van het eerste onderzoeksjaar."—Translated from Dutch by HERMAN JACOBSON.

† *Zesde Jaarverslag | omtrent het | zoölogisch station | der | Nederlandsche | Dierkundige Vereeniging, | uitgebracht door de Commissie voor het zoölogisch station, | op de Vergadering van 10 December, 1881. |*

- VII. Works relating to the oyster-fisheries and the cultivation of the oyster on the coasts of *Denmark, Sweden, and Norway*.
- VIII. Works relating to the attempts to establish oyster-beds on the coasts of *the Baltic*.
- IX. Works relating to the oyster-fisheries and the cultivation of the oyster on the coasts of *the Mediterranean and Adriatic*.
- X. Works relating to the oyster-fisheries and the cultivation of the oyster on *the east coast of North America*.
- XI. Works relating to the oyster-fisheries and the cultivation of the oyster on the coast of *China*.

*Alphabetical index.*

The investigations relative to the ANATOMY OF THE OYSTER were in charge of Messrs. *Hoek, Vosmaer and Waalewijn*.

Dr. *Hoek* writes that, as far as the generative organs are concerned, the more important questions are those relating to physiology, at least in viewing the matter from the point of view of an oyster cultivator. These questions—to mention some of them—are as follows: *At what age does the oyster begin to propagate? What percentage of the oysters on a bed take part in the propagating process? Does the propagating oyster exercise the functions of one sex or of both sexes? Does one and the same oyster propagate once or more than once a year? &c.* All former investigators, who have occupied themselves with this subject, have attempted to answer these and other similar questions. The reason why they did not succeed—for even the investigations made by the most prominent among them (*Davaine, Lacaze-Duthiers, Möbius, &c.*), have not led to any certain results, but only to more or less doubtful suppositions—must be found in the circumstance, that an attempt was made to answer these questions, without any satisfactory knowledge of the anatomical (both macroscopic and microscopic) construction of the oyster.

What is the construction of the generative organs? Where are they located? How are the generative products emitted? These three questions seem so simple that it is difficult to imagine that they could not be satisfactorily answered by the aid of the experience of former investigators. The oyster is not such a rare shell-fish, nor can it be classed among those animals which, on account of their small size, are difficult to examine. The fact that its anatomy is particularly little known is doubtless owing to the circumstance that the oyster—more than other mollusks—presents great difficulties to the use of the dissecting needle, scalpel, and magnifying glass, to such a degree as to make such experiments appear futile and bring them to an abrupt close. Our more modern methods of investigation cannot yet be said to be entirely suited to the nature of the oyster; it will nevertheless be to these methods that we will have to look for a speedy and deeper insight into the construction of the generative organs.

These methods consist principally in hardening the oyster and in ob-

taining their sections for microscopic observations. Oysters can be hardened by means of different liquids; as far as our experience goes, we are inclined to give preference to pure alcohol or combinations of chromium.

The results which have so far been reached, and which, from their nature, must be considered as preliminary, are given below. Although it would perhaps be preferable not to publish some of these supposed results, as yet, we shall give them, so that they may serve as guides in future investigations:

(1.) The generative organ of the oyster is not, as in other lamellibranchiates, a strictly localized organ, but extends equally on both sides of the body. The organ on the right side is connected with that on the left, both on the abdomen and on the back, and besides this by a portion which bounds the pericardial cavity in front. It is therefore a continuous organ which does not extend into the mantle.

(2.) The generative organ is located near the surface of the body, but is separated from the skin by a thin layer of tissue.

(3.) The generative organ consists of a system of vessels which, throughout, have an anastomotic character, and which run parallel with the surface of the oyster, and from their internal sides or faces there arise blind tubular prolongations which extend inwards into the tissue of the body. In these tubes the generative products are developed.

(4.) The generative products are developed from the epithelial cells, which cover the inner sides of these blind tubes or follicles. During this process both male and female generative products are developed close to each other in one and the same follicle, and can gradually be distinguished from each other by their structure and the manner in which they color.

(5.) It must be considered as a rule, that one of the two generative products in one and the same oyster will, in its development, by far exceed the other. Those generative organs which furnish principally *male* products, contain but few eggs, and these in a very backward state; whilst in those organs which furnish principally *female* products, the male products appear to be still less developed than the female products in the first mentioned case.

(6.) The generative organs of an oyster, having young spat in its gills, appear in sections as large vacant spaces. Whilst in such oysters nearly all the eggs had disappeared from the follicles, the male products were much more developed than had been observed in some principally female oysters, during the period that the eggs were still in the follicles. This observation seems to favor the opinion that the same follicles develop first eggs and then spermatozoa. This, however, does not prove that the reverse cannot also be the case.

(7.) The opinion advanced by *Lacaze-Duthiers*, that all the blind tubular acini or follicles of the generative organ, on both sides of the body, pour their contents into a main channel, having an opening on each side

near the surface of the body, located under the mantle on the ventral side of the large muscle, rests on a mistake.

(8.) *Rolleston's* and *Robertson's* opinion, that lymphatic vessels occur in Lamellibranchiates, deserves to be carefully examined. There are, in the oyster, vessels, the inside of which is coated with a layer of cells with small cilia. These may be observed especially in both sides of the pericardial cavity. Occasionally specimens are obtained in which they can only be distinguished from the anastomosing vessels, on the internal aspect of which the generative follicles are found, by the greater length of the hairs. In some specimens such a supposed lymphatic vessel, according to the view of *Rolleston* and *Robertson*, may be observed, one side of which is coated with young eggs.

(9.) It is improbable that the organ of *Bojanus* has anything to do with the emission of the generative products. Nothing is known concerning such an organ in the oyster; but everything which relates to the determination of the anatomy of the generative organs of the oyster, should be carefully observed. It is found on the ventral side of the pericardial cavity and communicates with it through a narrow slit, almost a distinct papilla. In sections of this organ cæcal tubes may be observed, the yellow and peculiarly formed cells of which are highly characteristic.

(10.) It may be considered as *absolutely* certain that the eggs are impregnated by spermatozoids from another oyster; but it cannot as yet be said with certainty whether these spermatozoids reach the eggs at the very moment they are emitted, or whether this takes place in the generative follicles or in some of the vessels. Whenever an oyster has eggs between her gills, all that can be said with absolute certainty is this, that *these* eggs have been produced by *that* oyster.

Dr. *Vasmaer* offered the following report of his observations relative to the natural history of the oyster:

Owing to the nature of the case the following observations can only be regarded as implied by their title, as *a report of my activity*. It would be unjust to look at present for important results.

After having microscopically examined a number of large oysters, in order to get a general idea, I soon became convinced that success could only be looked for from microscopic observations. The method now so much in vogue of making a series of sections or slices, in order to obtain a clearer insight into the structure of the animal, will doubtless throw light on many dark points. Although I am sorry to say that I am not yet able to state where the generative vessels empty, I feel convinced that a series of sections will lead to some certainty in this matter. It is certain, however, that the opinions of *Lacaze-Duthiers* and those who have followed him are not correct.

Firmly convinced that the method referred to is preferable to all others, I have not only made numerous sections of small oysters, which, therefore, in their entirety, could be subjected to microscopic observa-

tions, but also of large oysters, cutting thick slices in different directions; and by sketches which I have made of all these cuts, I have been enabled to compare these observations with those made in other specimens and in the usual way. In the first place, as regards the shape and location of the gut, or rather of the entire digestive canal, I found that it is not nearly as uniform as is generally supposed. I, for my part at least, have not seen mention made, in any work, of a different location of this duct. It also seems to me an important circumstance that, as a general rule, the anus is located on the side and not at the end of the duct. A small bag is, therefore, formed at the end of the duct which, in one case observed by me, showed a sort of worm-like appendage.

A series of sections is extremely well suited to give some idea of the relation between the generative organ and the liver. Whilst the generative organ appears to thin out round the liver dorsally, it gradually increases in thickness towards the bottom ventral side; the liver, however, runs, though much narrower, through to the place where the great cavity begins, which contains the heart and the so-called organ of Bojanus. [The liver does not extend to the pericardiac space; this is the case in *Ostrea Virginiana* as well as in *O. edulis*, as may be shown in longitudinal sections.—J. A. Ryder.]

More than once I have had to make injections of the heart and the vessels originating in it, but I cannot say that these attempts have been particularly successful. Of larger blood vessels I could, on the large cuts, only distinguish one (probably the aorta). In view of the fact that there are still strange and conflicting opinions as to the course of the blood vessels, further experiments with injections cannot be too highly recommended. Important conclusions may possibly be drawn from the contraction of the heart, which continues for a long time after the oyster has been opened; at least various questions are thereby suggested, such as whether the motion of the so-called Bojanus organ is voluntary or involuntary? I think I have noticed that the diastole and systole did not take place simultaneously in both portions of the heart, but alternately. I must repeat, however, what I said above, that all these observations bear more or less the character of *suppositions*, which stand in need of further proof.

As regards the method of making preparations, several of those commonly in use have been tried. The hardening by means of Müller's liquid, which in the beginning seemed to promise well, cannot be recommended for fine microscopic cuts.

It will be best to use alcohol of 70 per cent. or of 90 per cent., or pure alcohol, and then to embed the hardened oyster in paraffine in the well-known way; or also picric acid, which takes the lime out of the shell. In this manner small, one-year old (and younger) oysters can be preserved whole.

I need hardly say that it is very important to examine oysters of

*various* ages. Special attention should, however, be paid to *young* oysters, and to the development of the generative organs in these. As far as my observations go, exclusively male or exclusively female oysters do not occur. In full-grown, healthy oysters an oval lump of spermatozoa may be observed, surrounded by free eggs placed radially and with great regularity. In comparing perpendicular and other cuts, these eggs appear in close elliptically-shaped groups or lumps, each in a tissue pouch, or several together in one and the same pouch. The eggs are generally attached by a wide base; are granular, and provided with a large, round nucleus and nucleoli. In specimens stained with fine picrocarmine the difference between the nucleus, with its appurtenances—*sit venia verbo*—and the egg-cell itself can be very distinctly observed. The egg-cell has a brownish-yellow color, and is granular, whilst the nucleus is reddish, and appears to be a homogeneous body. In oysters which have already lost some of their young spat, the empty pouches or hulls may be seen in considerable number. As far as my observations go, I am inclined to think that eggs and spermatozoa do not mature simultaneously. It seems that new generative products may at a later period be developed in the empty pouches. It would be worth the trouble to examine into this matter carefully.

My preliminary observations have convinced me that it is absolutely indispensable to the success of these investigations to make a *series* of sections of oysters of *different* ages and examine these carefully. If during the coming year I am privileged to continue my investigations, I shall principally follow this method.

The investigations relative to *the history of the development of the oyster* are perhaps farther advanced than any other portion of our investigations. They were in charge of Dr. *Horst* and Professor *Hoffmann*. Mr. *Horst* made use of the booth of the zoological station at *Wemeldinge*, described in the first part of our report; and his observations were so successful that he was enabled to prepare a brief review of the embryology of the oyster, accompanied by the necessary illustrations. This review is too extensive, however, to be embodied in this report, as a whole, and we shall therefore give its principal features in brief outline.

It is particularly difficult to obtain the necessary facts relative to the first stages of the development of the oyster; and it is hoped that next year's observations will supplement those of the present year. The principal difficulty lies in the circumstance that, as a general rule, more female (mother) oysters are found with old than with quite young brood. There is no doubt that, in their general features, the first stages of the development of the oyster-egg resemble those of other bivalves. The result of the first stage in the process of development is, that the lower (*vegetative*) pole of the egg is formed of a large granular cell from which the *entoderm*\* (and *mesoderm*?) develop, whilst on the upper (*animal*) pole numerous smaller cells may be observed which furnish the material for

\* I have retained two terms, which are not found either in Webster's Dictionary or in Dunglison's Medical Dictionary, and which—not being Dutch, but Greek—will be

the *ectoderm*. The last-mentioned cells gradually grow all round the vegetative cell or sphere without however inclosing it entirely. Afterwards these cells also begin to segment, and a layer of cylindrical cells is formed, which is slightly invaginated or pushed inward at one point and which forms the *entoderm*.

About the same time a crescent-shaped groove is formed at the other pole of the egg by an invagination or pushing inwards of the entodermal cells (erroneously called the gastrula mouth by former investigators), from which the shell-gland is developed. Soon after this we see the formation of the primary intestinal channel by a further invagination of the entodermal surface. Back of the opening of the mouth a few large cells make their appearance, which must probably be considered as the first mesodermal cells. The shell-gland has now assumed the shape of a deep little bag, the wall of which is composed of large cylindrical cells. The portion of the ventral side located below the mouth projects considerably during the succeeding stage, so as to form a sort of foot, as in the embryo of the snail.

During the further growth of the embryo the entoderm develops into a spacious stomach cavity, with a sac-like appendage, which later forms the end of the intestine, but which is still closed; the gastrula mouth becomes the permanent mouth. The ectoderm is now lifted up from close contact with the entoderm and in this way the body cavity is developed. The invagination of the shell-gland has meanwhile disappeared almost entirely by an inflection of its margin. Its place is now occupied by a thickening of the ectoderm, consisting of long conical cells. These cells develop a thin membrane, which is the first trace of the shell, from which it appears that the bivalvular shell does not originally appear as such, but that the shell begins to form as one piece. Above the mouth a cirlet of vibratory filaments begins to make its appearance, which later forms the *velum*, the organ of motion of the larva.

During the succeeding stage the shell rapidly increases in size, and almost entirely envelops the larva; the *velum* becomes more clearly defined, and in the center of the velar area, encircled by its ciliary ring or crown, a thickening of the ectoderm (velar plate) begins to make its appearance. A funnel-shaped gullet forms the entrance to the pear-shaped stomach, whilst the hinder portion of the intestine develops an opening communicating with the outside.

By the appearance of pigment at different points of the body of the larva (velar plate, gullet, stomach) the *white spat* assumes a dark gray color and becomes *black spat*. On both sides of the intestine muscles begin to develop, running downward from the hinge, by means of which the head part, which protrudes from the shell, can be drawn in; and like the abductor muscle, which connects the left and the right valves of the shell and closes them, the former are also developed from mesodermal

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easier understood, if given in the original, than if a translation had been attempted: "*entoderm*," "*mesoderm*." The similar term "*ectoderm*" is found in Webster, but not in Dunglison.—TRANSLATOR.

cells. The *velum* now appears as a double row of long threads, which surround a vaulted surface, and in the center of which lies the velar plate or thickening, which projects outwardly, and consists of several layers of cells; from this the pharynx\* (mouth) arises at a later period. The intestinal channel has meanwhile increased considerably both in length and width; the stomach has been divided by a constriction into a lower and upper portion, and the intestine arises from the line of junction of the two. The anterior portion of the stomach develops on the upper side a large round sac, the rudiment of the liver; the whole intestinal channel is coated internally with fine ciliary filaments, with the exception probably of the hepatic protuberance. On the ventral side of the larva, in nearly the same place where formerly the so-called "foot" was located, a knob-shaped enlargement of the ectoderm begins to make its appearance, which is probably the rudiment of the pedal (parieto-splanchnic) *ganglion*.

Older stages than those on which the above observations were made have not been examined. In order to recognize very young oysters which have just adhered to an object, a glazed tile covered with pure lime has been successfully substituted for the usual collector (stone tiles covered with a mixture of lime and sand); on such a collector an oyster measuring only 0.57 millimeter could be distinctly recognized with the naked eye.

In conclusion Dr. *Horst* gives some information relative to a presumed enemy of the oyster spat. He says that in his aquarium, which contained a female (mother) oyster, which every now and then emitted large quantities of spat, there were also a number of actinia (sea-anemones). The quantity of oyster spat decreased visibly without his being able to discover the cause, until one day he saw bluish-gray pellets, measuring but a few millimeters, come out of the mouth of an actinia. These pellets appeared to consist exclusively of empty oyster shells of the most diminutive size, and therefore showed that the actinia had been feeding on oyster spat.

Professor *Hoffmann* makes the following report on his investigations: During the second half of July he occupied himself with some investigations relative to the development of the oyster. The great heat during July, by which the temperature in the wooden shed rose to 94°, made it impossible to steadily continue the observations.

The first stages of segmentation were not observed, whilst full observations, both on optic and actual sections, were taken during the gastrula stage. The *gastrula*† does not belong to the hollow, but rather to the

\* The Dutch word "*bovenslokdarmknoep*" is not found in any Dutch dictionary. Mr. Ryder has rendered it as the rudiment of the mouth or pharynx.—TRANSLATOR.

† This word is not found in Webster's English nor Dunglison's Medical Dictionary. The words *coelogastrula* and *sterrogastrula* are translated hollow and solid type by Mr. Ryder. These are words of little consequence, except as descriptive of different conditions of development of the body cavity. All mollusca nova appear to pass at first through a *sterrogastrula* stage, followed by a *coelogastrula* condition.—TRANSLATOR.

solid type. The cells of the mesoderm, whose origin I cannot state with absolute certainty, but which appeared to me to be a product of the entoderm, do not form a continuous sheet or leaf, but begin to be differentiated at a very early period into embryonic muscle and connective tissue. The præconchial invagination begins to make its appearance at a very early stage, the cells of the ectoderm being distinguished by their high cylinder-shaped appearance; the shell therefore belongs to a very early embryonic formation; in young oysters the post-larval shell of which has already formed, the embryonic shell can still be very distinctly observed. Full information as to the results of my observations of oyster embryos, made principally on cross-section, are at the disposal of the Commission, in case they should desire it for their final report.

As regards the investigations relative to *the young oyster, after it has settled*, Dr. *Hubrecht* writes: "The time which I spent at the station in June was almost wholly devoted to the regulation of the physico-meteorological observations, the preliminary results of which will be published in full at some future time. On my return, in August, we made a distribution of the work assigned to us, and I was commissioned to occupy myself with the oyster larvæ and their settling on the tiles, but was much delayed in my work by the long-continued unfavorable and cold weather. Regular observations were out of the question during this month, the season of the settling of the oyster spat having been brought on prematurely by the hot weather in July. I was therefore obliged to abandon the task which I had set myself for this year, and devoted all the time I could spare from the physico-meteorological observations, to the study of the anatomy of the oyster, more especially of those points on which the opinions of scientists differ very much, and where there are still important gaps in our knowledge, viz, the heart with the pericardium, the organ of *Bojanus*, and the channels through which the generative products are emitted. I made numerous microscopic sections of one to three year old oysters; but these results of these observations I shall reserve for our final report, because it will require the uninterrupted observations of another summer, to bring this investigation to a satisfactory close."

Dr. *Van Rees* writes regarding his observations on the radius of distribution of the oyster spat and the conditions under which they settle, as follows: "Whilst at the zoological station during the second half of June I noticed the forerunners of the oyster spat. To my great regret I was not able to be in *Bergen op Zoom* during July and continue my observations at that place. When I returned during the last days of July, I noticed that a great deal of spat had settled. By fishing in different places I found, however, numerous oyster larvæ swimming about in the water, which could be kept alive for several days in sea-water contained in wide, open glass jars. In fishing I used the tow net in the manner in which I had seen Professor *Weismann* use it in the Lake of Constance. The tinned iron hoop of the net is furnished with a long, free bag of very

fine gauze, weighted with a stone or a piece of lead, the net is let down to a limited depth, and left under water a shorter or longer time—say 5 to 10 minutes—according to the force of the current and the swiftness of the boat. Even at a moderate rate of speed the net tightens, and everything which floats into it is retained by the fine meshes. A piece of wire-grating closes the opening of the net to larger objects. Drawing it carefully out of the water it is turned inside out into a wide glass jar with fresh sea-water. After having, by microscopic observations, obtained a general idea of the various animal forms contained in the water, it is not difficult to distinguish them from each other, with the naked eye or with a magnifying glass, particularly by their different motions.

“During my first experiments with the above described net I found it to be extremely well suited to my purpose. This was, in the first place, to find the proportion of oyster larvæ floating near the surface, in deeper water, and immediately above the bottom, at different times, and in as many places as possible. It seemed important to me to get an idea of this proportion, especially in connection with the following considerations.

“The swiftness with which the oyster larva moves about by means of the thread-like apparatus, is very insignificant as compared with the swiftness of the current of the tide when coming in or going out. As regards the radius of distribution of the oyster spat, it is entirely dependent on the varying swiftness of the current. In the river *Scheldt*, where natural and artificial oyster beds are scattered all over the river, oyster spat is probably floating about everywhere as soon as the time has arrived for the spat to become detached from the mother oyster. Whether oyster spat will settle more freely in one place than in another will, therefore, depend not so much on the radius of distribution of the oyster larvæ of this or that oyster bed as on the peculiar conditions of the current. It is, therefore, in the first place, necessary to learn to know the swiftness and direction of the currents in the principal portions of the river *Scheldt*, and it is consequently a matter for which we are very thankful that the minister of public works has given his support so freely to this part of our observations. A thorough knowledge of the currents, combined with practical experience, will give us a better insight into the reason why certain localities are better adapted to the settling of the oyster spat than others. In studying this subject, special attention should be paid to the manner in which the oyster larvæ are distributed over the different depths of water, as unfortunately but little is known at present concerning this important matter. Although their organs of motion do not enable them to go any great distance—which, moreover, is not essential to their distribution—these organs, nevertheless, furnish them with an entirely satisfactory power of rising and sinking, and of keeping themselves afloat in the water when it is not violently agitated. In connection with the conditions of current

and temperature, the distribution of the larvæ in the water is a question of primary importance.

"It was a grievous disappointment to me that I had to let the greater portion of the month of July go by without making any observations in this direction; and as the weather during August was exceptionally unfavorable, I could not make up for time lost in July. Spat fell during all of this month, but regular observations at favorable points had become absolutely impossible. During the coming summer I hope to be able to devote my undivided attention to the distribution of the oyster larvæ."

On the PHYSICO-METEOROLOGICAL OBSERVATIONS in the Eastern *Scheldt* during 1881, the following report was offered by Mr. *Hubrecht*, who had been assisted in his work by Mr. *van Kervel*:

As soon as possible after the Commission of the Zoological Station had, at their meeting of March 10, resolved that the observations of the oyster cultivation (and subjects connected therewith) in the Eastern *Scheldt*, should also be extended to the condition of the water, its temperature and density, as well as the nature of the currents in the *Scheldt*, which might exercise an influence on oyster cultivation, the commission opened negotiations with Prof. *C. H. D. Buys Ballot*, of *Utrecht*, Director of the Meteorological Institute. To his kind aid and the friendly assistance of Dr. *Maurits Snellen* we owe the knowledge of various important facts as to the best manner and time of taking observations, and of a peculiarly arranged areometer, which was manufactured under the supervision of Dr. *Maurits Snellen*, and which deserves the preference over other areometers which we tried. To these gentlemen we herewith express our best thanks.

From the very beginning we felt convinced that, on entering a field in which none of our number felt at home, we ran great risk of making mistakes and of drawing erroneous conclusions, if we did not call in the aid of competent persons at the right time. It soon became evident that the observations on the current would not only require theoretical knowledge and technical experience which we did not possess, but would also involve considerable expense, which our treasury was not able to bear. These difficulties, however, would only deter us from making the desired observations if it should appear that we could not have the help of competent persons. Our hope that the minister of public works would allow the expenses of these observations to be borne by his department was not put to shame, and by a letter from him, under date of August 26, 1881, we were authorized to enter into an arrangement with the chief engineer of Zealand. Thanks to the kind assistance of this officer and of the district engineers stationed at *Goes* and *Zierikzee*, we had a preliminary conference on the subject, where we had an opportunity to state the ideas which led us to the supposition that there must be some connection between the settling of the oyster

spat in certain localities and the local currents in such places, and to submit them to the greater experience of these gentlemen who were better acquainted with the Eastern *Scheldt*. After we had consulted with these gentlemen as to the best way of making the desired observations, and had visited various points on the Eastern *Scheldt*, on the 16th of August, with them, we felt that we must no longer trespass on their time, when (as mentioned above) we were gladdened by the letter from the minister, during the latter part of August. We intend to embody the results of these investigations in our final report as soon as they have been communicated to us. It is hardly necessary to say that, as long as we are not in possession of these results (we hope to receive them during the first months of the year 1882), no connection can be traced between them and the facts mentioned in this report, and that we cannot attempt to draw up a plan for the observations to be taken on the oyster beds during the following years, but that nevertheless we may entertain the hope that we may come to know *some* of those general laws which govern the distribution of the oyster in this and other localities.

We have still to report our observations on the temperature and density of the sea water. Prof. *Buys Ballot*, Director of the Meteorological Institute, told us that, if such observations taken at different points of the *Scheldt* were to be really valuable, they must be taken three times a day, at high water, low water, and at 2 p. m., by the sun-dial, when the heat of the sun is supposed to have exercised its most powerful influence. In reporting such observations it should also be mentioned what the state of the weather was at the time, as rain and wind may have a considerable influence on the temperature and density of the sea-water.

As regards the areometer above referred to, and manufactured at *Utrecht* by Mr. *Olland*, Prof. *Buys Ballot* advised us to get in addition one of the large areometers which are used by the German "Commission for the investigation of the German waters" in the German Ocean, and which are fully described and highly praised in their official report. The relative value of these different instruments could, however, only be ascertained by practically testing them in the observations which we had before us. Mr. *Steger*, of *Kiel* (Germany), furnished us this instrument as well as a set of areometers, which had also been recommended by the German commission. In using these instruments it has been found desirable to make some slight modifications, which were made by the engineer of the torpedo service No. I.

Prof. *Buys Ballot* also advised us to use the maximum and minimum thermometers according to the *Negretti* and *Zambra* system. As the water in the Eastern *Scheldt* is, comparatively speaking, not very deep, he thought it would be sufficient to observe the temperature of the water in the areometer, provided it is sufficiently thick and is drawn up quick

enough not to allow any considerable quantity of sea water from higher layers to flow into it.

In conclusion, we must mention that through Mr. *W. Leemans*, engineer, we obtained from the ministry of public works the loan of an iron areometer, which was subjected to a comparison with the above-mentioned instruments, and which was used in the observations made at *Tholeu*, of which we shall speak later.

We also employed a number of thermometers and areometers from the firm of *Kipp*, at *Delft*, likewise with the view of obtaining a knowledge of the instruments most suitable for our purpose.

This will suffice to give an idea of the *instruments* with which we operated, and we will only briefly refer to the *method* pursued in our operations during the past summer.

Thanks to the friendly assistance of the minister of marine, we got the promise of co-operating with us from Mr. *J. F. van Kervel*, retired lieutenant, 1st class, Netherlands Navy, and during the course of the summer we had ample opportunity to experience the great value of his services. From his former occupation, more familiar than any of our number with the use of physical and meteorological instruments, he was ever ready not only to give his advice regarding the most profitable way of making observations and the conclusions which might be drawn from such observations, but also to give his personal aid whenever he thought that his presence at any of our stations of observation might be of use in furthering our object. Also in August, when, through the kindness of the minister of war, we obtained the use of one of the steamers of the torpedo service at *Brielle* for two weeks for the purpose of making observations on the Eastern *Scheldt* (see the private report on the subject), it was Mr. *van Kervel* who, in spite of the extremely unfavorable weather, gave his personal aid and attention to these observations. We herewith express to him our warmest thanks, and the hope that in the future we may count on his co-operation, without which our progress on this (to us) strange field would be considerably delayed, if not entirely stopped.

The method and object of the last-mentioned observations were as follows:

(1.) To ascertain to what modifications the temperature and saltness of the sea water in the Eastern *Scheldt* is subject:

a. At different times.

b. At different depths.

(2.) To ascertain if these modifications are everywhere apparent to the same degree, and also if there is a noticeable difference in this respect between banks which are deep under the water and those which are occasionally dry.

(3.) To ascertain whether there is any connection between these modifications and the phenomena of the current, as far as they have been observed by the engineers of the Department of Public Works.

(4.) To find whether there is any connection between the settling of a greater and smaller quantity of oyster spat and the following:

- a. The nature of the bottom.
- b. Phenomena of the current.
- c. Changes in the temperature of the water; and,
- d. Changes in the density of the water.

These four points, which are here given in the order in which the difficulty of their explanation increases, give an outline of the problem, the solution of which we are seeking. The fourth point at the same time indicates what results long-continued and carefully made comparative observations may possibly lead to. These results, however, will, in our opinion, not be reached in the near future, although we feel convinced that any positive results in this direction will not only be of importance to oyster culture in its present state, but will also serve as a guide in exploring other localities, where in former years profitable oyster fisheries were carried on, which at present have entirely disappeared.

From the causes already referred to we are still less able to return an answer to the question mentioned under No. 3. Our observations of the temperature and density of the water are as yet not numerous enough, and in some respects not reliable enough, to justify us in basing upon them comparisons such as are there indicated. The observations with which we have been occupied during the past summer are principally those mentioned under Nos. 1 and 2. As has been said before, we were obliged not only to determine the respective value of our different instruments, but also to endeavor to arrive at some definite result as to the manner in which *long-continued* observations of this kind should be regulated—who should take such observations, and how they should be taken. Knowing that we could only spend a few short summer months in the localities where the observations must be taken, and fully aware of the great importance of obtaining full data also from other seasons of the year (especially autumn and spring), we made inquiries of a number of oyster cultivators, whether among their employés suitable persons could be found who would permanently take charge of these observations, and thus furnish us with the desired data. From different parties we obtained highly valuable aid in this respect. In the first place we must here mention Mr. *Wagtho*, of *Tholen*, who took observations during the whole summer, and still continues to do so; furthermore Messrs. *F. Leo de Leeuw*, of *Wemeldinge*, *C. L. de Meulemeester*, of *Bergen op Zoom*, and the watchmen of the firms of *Hagan & Brand* and *Bolier & de Groot*. All of their observations, taken during the past year, have been tabulated, and will be appended to our first report in that shape. We shall, as a matter of course, in continuing these observations, have to rely on the active co-operation of the oyster cultivators. The importance of their aid cannot be overestimated, and the results of such observations will undoubtedly gain in value, if based on a broad basis of facts, carefully and patiently gathered during a long period of

time. We hardly need say, that the establishment of such stations of observation goes beyond the financial means of the Zoological Station. Private enterprise should therefore share this burden with us.

The daily observations, which, as has been mentioned, are taken three times a day, are transmitted to us, and entered on specially-prepared forms. From these forms it will appear that the observations were not only taken at certain regular hours, but also at a uniform depth, which, at low water, was still 3 meters under the surface of the water. We thought that thereby we should increase the value of these observations for drawing comparisons.

Besides this series of observations, which were in part at least entrusted to subordinates, Mr. *van Kervel*, during August, took a number of observations, with a view to obtaining the greatest possible degree of accuracy, by thus controlling the observations taken at *Tholen*, *Wemeldinge*, &c. These observations were unfortunately somewhat limited by the exceedingly unfavorable condition of the weather. We deem it important to give the results of these observations in their entirety, as, in our opinion, furnishing important hints as to the method to be followed in future observations on the Eastern *Scheldt*.\*

Mr. *van Kervel* adds the following remarks to this table:

"It is somewhat surprising that out of more than 30 careful observations from which the table has been prepared, the difference of temperature between the bottom and surface water is so small, compared with the difference, observable in this respect, in the observations taken at *Tholen* and *Wemeldinge*."

We shall have to ascertain, by further observations, whether these differences are caused partly by the presence of a larger quantity of marsh water, and partly by the main current of the Eastern *Scheldt* which at *Wemeldinge* flows close to the bank.

The figures given in said table furnish ample food for thought; they prove that, at the time when these observations were taken by means of excellent instruments and with the greatest care, the differences of temperature at various points of the Eastern *Scheldt*, between the bottom and the surface, were very small and in some cases hardly noticeable.

*The water in the deep places and that in the shallow places does not show any considerable difference of temperature, whilst there was a great difference in the depth at which the observations were taken, this difference ranging from 2 to 21 meters.*

This important result will, during the coming year, be made the subject of new and careful observations, taken as frequently and in as many places as possible. If this preliminary result seems to be confirmed, this will prove that there is no need of so many stations of observation on the *Scheldt* as we had imagined in the beginning, and that, if only a good point of observation has once been selected, additional observa-

\*See table at the end of this paper.

tions of the bottom temperature may not be needed for drawing up an exact table of the changes of temperature to which the water on the oyster beds is subject.

The observations relative to the saltness of the water will, during the coming year, be brought into a more definite relation to the results of the observations on the current taken by the engineers.

The two series of observations, both those on the temperature and those on the saltness of the water, should go on simultaneously with investigations as to the quantity of oyster spat, not which settles on this or that oyster bed, but which is found in given portions of the water of the *Scheldt*. We do not conceal from ourselves the great difficulty of investigating this latter point, but we feel convinced that this will be the most certain way of obtaining really reliable results. During the course of the winter we propose to study out a method by which such investigations could be made. The experiments in that direction made in 1881 have not yet led to results definite enough in their character to enable us to make a final decision as to the best method of carrying on these observations. Simultaneously with these investigations careful observations should be taken of the quantity of oyster spat found on the different beds during the year, not only on the so-called "tile beds" (where tiles are employed as collectors), but also in different parts of the eastern *Scheldt*.

We have been informed by many persons of experience in these matters that circumstances of a local character (still water near the main current, the emptying of two currents, as at the *Eendracht*, deep holes in the bottom, &c.) are considered to have great influence on the settling of the spat; and this also formed the starting point of some of our consultations with the engineers in regard to observations on the current. We shall refer to this matter more fully in our final report; here we will only mention what has been communicated to Mr. *van Kervel* relative to the settling of spat on those portions of oyster beds where his observations were taken. (See the *table*.)

(1.) The portion of lot 324, near the pit or hole, is considered to be very favorable to the settling of oyster spat, especially near the edge (more particularly the northern edge), and also along the upper portion of the steep walls of the hole.

In the deep portion of the hole very few oysters are found. (See *table*, column of observations, relative to the nature of the bottom). On the portion of lot 324, referred to, no oysters are planted.

(2.) Oyster spat settles very freely south of the "*Laagte*."

(3.) Oyster spat settles in considerable quantities in the northeastern portion of lot 267, and seems to flourish better there than in the north-western portion of lot 266.

(4.) Also in lot 231 and in its vicinity oyster spat is said to settle very freely.

(5.) It is well known that large quantities of oyster spat settle in the

"*Eendracht*," from some distance north of the *Vosmeer Ferry* to the so-called "*Nachtegaal*"; this applies especially to the whole of lot 38 in the "*Nachtegaal*."

In the above we have endeavored to give a brief sketch of our past and our future activity; and the reader will thereby get an idea of the slow progress of our investigations, chiefly owing to the circumstance that so far no definite way whatever has been marked out for us. An investigation like the present requires time and patience, especially in the beginning; it is certain, however, that as we begin more and more to reach the firm basis of reliable observations we shall be able to report more rapid progress. Once more, briefly put, the questions which we must have steadily in view are these: What influence do the temperature and saltness of the water have during the period when the larvæ are passed from the mother oyster? Which way does the spat travel when passed from the mother oyster, and in what manner is this way determined by circumstances directly connected with current, temperature, and saltness, and how can it be controlled by means of these data? What influence do these same circumstances exercise on the full-grown oyster.

As regards the study of those animals which live on the same beds as the oysters, as their enemies, parasites, friends, or messmates, we have to present the following reports:

#### I. INFUSORIA.—(Report by Dr. J. van Rees.)

With regard to those infusoria ciliata, which I observed near the oysters, I shall for the present confine myself to the following short notice. The fauna of the brackish water of the *Scheldt*, in general, differs but little from the fauna of the North Sea, as far as I have learned to know it at the *Helder*, *Flushing*, and *Nieuwediep*.

Besides some few forms described by *Olaparède*, *Lachmann* and *Stein*, a few of those varieties were found which *Cohn* has observed in the water of the Baltic, and a description of which he has published;\* but his description is far from systematic, and leaves much to be desired, especially as regards the illustrations.

Among the forms of infusoria which I observed, there were the following:

Of the group of the HALOTRICHÆ: a few small varieties of *Lacrymaria*, *Amphileptus* and *Leionotus*; (*Amphileptus meleagris* *Cl. Lachm.*, which I had found in the *Helder* as a parasite on *Carchesium polipinum*, did not occur here) also *Glaucoma scintillans*, *Cyclidium glaucoma*, and *Cyclidium elongatum* *Cl. Lachm.*, erroneously called by *Cohn* with a new name, *Limbus velifer*. Concerning this last-mentioned kind I must say that they do not have one but two pseudo-membranes consisting of very fine cilia, which extend from the front part of the animal to the outer side of the little oval mouth.

\* "Zeitschrift für Wissenschaftliche Zoologie," Vol. XVI, 1866.

Of HYPOTRICHÆ I found *Chilodon cucullulus* a few varieties of *Ervilia* and *Dysteria* (not quite the same forms which I observed on the coast). Related to these there is another form, also new in our fauna, and which is principally distinguished by dark grains of pigment scattered irregularly all through the body, and found in unusually large masses in a certain place close under the surface, and only covered with a strongly convex somewhat broad elevation of the *ectosarc*\* entirely free from grains, which doubtless answers the purpose of a lens. This variety is moreover distinguished by an unusually wide and perfectly straight esophagus.

Among the few ASPIDISCÆ I noticed *Aspidisca limbifera* which I had also observed in the *Helder*, and which is distinguished by a fine wavy hem running along the right side and round the edge of the back part.

Of the EUPLOTES I found here, as well as near the coast, a variety closely related to Stein's *Euplotes harpa* (from the Baltic), and distinguished from this one principally by a more regular inner edge of the peristome ("Stirnrand" of Stein). Just as in the coast-waters I again found two sizes of this variety closely resembling each other, and but few intermediary stages. Of *Euplotes longipes* Cl. Lachm., recently described by me in an article, "*Zur Kenntniss der Bewimperung der Hypotrichen Infusoriën*," I found large numbers. I likewise found Stein's *Uronychia transfuga* resembling the *Campylopus paradoxus* of Claparède and Lachmann. On account of its restlessness this variety presents unusual difficulties to the observer. It is my opinion, however, that all three varieties belong to the same genus (*Uronychia*).

Of the genus STYLOPLOTES, which is related to the EUPLOTES and URONYCHIÆ, I found, besides *Styloplotes grandis miki* (also described in the above-mentioned article), and a small variety which I had noticed in *Nieuwediep*, a third kind, but only in small numbers.

Besides some small OXYTRICHINÆ I also found the beautiful *Oxytricha saltans* (*Actinotricha saltans*, Cohn), which immediately strikes the eye by its four strong adoral ciliary plates. I also noticed some varieties of the group STICHOTRICHIA and UROLEPTUS, amongst the rest the *Oxytricha auricularis* Cl. Lachm., but, as on the coast, in very small number. Cohn's *Oxytricha flava*, which does not belong to that group, but rather to that of UROSTYLA, of a beautiful orange, red, or brown color, was also found here, but not in as large numbers as in the sea. Cohn, in his illustrations, does not show the proper distribution of color on this animal; the color is exclusively found in small but very distinct little balls or bags, which refract the light, and are arranged in rows. The very rapid changes of form to which this animal is subject, make it very difficult to make accurate observations of it.

Of the group of PERITRICHIA I found only a few forms, a few varieties of the genus *Vorticella* and *Zoëthamnium*, the same as on the coast.

\* Cf. foot-note on p. 6. The same remark applies here as to *entoderm* and *mesoderm*.—  
TRANSLATOR.

*Vaginicola crystallina* Ehbr., and *Cothurnia nodosa* Cl. Lachm., besides a large number of intermediate forms, were also very common. Besides these I noticed a *Strombidium* and the elegant *Halteria pulex* Cl. Lachm. (without any good reason called *Acurella siro* by Cohn).

Of HETEROTRICHÆ no trace could be discovered.

As my knowledge of a number of important varieties is still very defective, I hope that another prolonged visit to the *Scheldt* will enable me to fill many gaps.

## II. SPONGES.—(Report by Dr. G. C. J. Vosmaer.)

In the beginning of July, when I had not yet begun my work at the station, Dr. R. Horst wrote me, that at *Yerseke* he had found on the so-called collectors a large number of calcareous sponges. Thanks to his forethought I am now in possession of a large number of them. When later in the season I searched for sponges at *Bergen op Zoom*, I found in Mr. de Meulemeester's pits the same kind which I recognized as *Sycandra ciliata* (trans. var. *coronata*), according to *Haeckel's* terminology. In examining a large number of specimens, among them some very large ones (up to 80 millimeters) I became doubtful whether *Sycandra ciliata* H. and *coronata* H. can be considered as two different species, and whether they should not, as in former times, be looked upon as two varieties of one and the same species. The circumstance that I had to class all the specimens which I examined, under the "transitory variety," seems to speak strongly in favor of the last-mentioned opinion. I hope to continue my observations with the view of forming a definite opinion on this subject. To whatever kind these sponges may belong, the fact that calcareous sponges occur on our coast is entirely new. It is also peculiar that all such objects are found on the lower side of the collectors, and that they therefore hang with their oscule downward.

Another important discovery was that of another sponge belonging to the family of the *Chalinaea*, which is probably identical with *Chalinula fertibis*, Kell., 1880. This sponge, which is likewise new in our fauna, appears as a light brownish-red crust on the oyster shells, especially on the large oysters called "*paardepooten*"—"horse-feet." Most of them seemed to come from Lot 250, near *Yerseke*, and some were also found by me in the "*Eendracht*" (Lot 18) near *Tholen*. I hope that I shall be able at some future time to give a fuller account of these sponges.

A kind of sponge, found in many places on our coast, and called by Johnston *Halichondria panicea*—a name which is no longer employed—is also found amongst oysters.

In how far either of these kinds of sponges is healthful or hurtful to the oyster, cannot be determined at the present time.

## III. WORMS.—(Report by Dr. R. Horst.)

The varieties of worms mentioned below were found on the oyster-beds during the past summer. This list does not, however, pretend to

give all the species of *Annelida* living on the oyster-beds; for no one had specially occupied himself in gathering specimens of this group.

The most frequent kind was *Nereis pelagica* L., which is very common on our coasts; some specimens wore their remarkable wedding garment (*Epithoken*). But few specimens were found of *Nereis longissima* Johnst., and *Nereis Dumerilii* Aud. & Edw.; two of the latter kind were found in one oyster. The *Phyllodoce* family was represented by *Phyllodoce maculata* Johnst. and *Eulalia virides* Oersted, also found in other portions of our waters. Of the *Polynoë* family I found *Lepidonotus squamatus* L. almost as frequently as *Nereis pelagica*, also *Polynoë impar* Johnst. (*Evarne impar* Malmgr.) less frequent than the preceding, and *Polynoë cirrata* Aud. & Edw. (*Harmothoë imbricata* Malmgr.) I also found a number of very small specimens (only measuring 3 millimeters) of *Pholoë minuta* Oersted, also belonging to this group. *Capitella capitata*, van Ben. repeatedly observed on our coasts, was also found here.

#### IV. ARTICULATES.—(Report by Dr. P. P. C. Hoek.)

The number of articulates which have been observed is very small, and it is certain that it is only a small portion of those which occur here. We will mention the following:

##### (1.) *Cirripeds.*

*Balanus crenatus* Brug., very common on oyster shells.

*Sacculina carcini* Thomps. Only found on the lower portion of *Carcinus moenas* L.

##### (2.) *Arthrostracans.*

###### a. *Læmodipods:*

*Caprella linearis* Lin. A few specimens of the small variety were found near *Kattendijke* and in the *Eendracht*.

###### b. *Amphipods:*

*Microdeuteropus* Spéc.—Probably a new variety; chiefly remarkable on account of its being generally found in the slits of the folds of the oyster shell, between the beard of the oyster, &c.

*Gammarus marinus*, Leach. Very common near *Bergen op Zoom* found on different kinds of fucus, &c.\*

*Allorchestes imbricatus* sp., Bate. Found near *Wieren*, together with *Gammarus marinus*.

*Talitrus locusta* Latr. Everywhere between and under the stones in the oyster pits.

###### . *Isopods:*

*Ligia oceanica* Lin. Very common with *Talitrus* along the stones.

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\*Prof. W. F. R. Suringar, of Leiden, was kind enough to determine for me three kinds of fucus which are very common near *Bergen op Zoom*, viz, *Fucus vesiculosus*, L., *Fucus platycarpus*, Thuret, and *Ozothallia vulgaris*, Dene (= *Fucus nodosus*, L.).

3. *Thoracostracans.*a. *Macrourans:*

*Homarus vulgaris* Bel. One specimen was found on the *Yersche* oyster bed.

*Crangon vulgaris* Fabr. Below *Wemeldinge*, in the Eastern *Scheldt*.

b. *Anomurans:*

*Pagurus bernhardus* Lin. Found here and there in the Eastern *Scheldt*.

c. *Brachyurans:*

*Carcinus maenas* L. Very common on the oyster grounds.

*Hyas coarctatus* Leach, var. A dark-red variety with a peculiarly felt-like body was found once.

APPENDIX: *Pycnogonida.*

*Pycnogonum litorale*, Ström. Some specimens were found near *Katendijke*, below *Wemeldinge*, and in some other places.

## V.—MOLLUSKS.

As has already been said at the end of our private report, only the most common kinds of mollusks are observed here. As relating to this part of our investigation, we give below a letter from the secretary of the commission, dated November 9, 1881, and addressed to the superintendent of the *Scheldt and Zeeuw-stream* fisheries:

LEIDEN, November 9, 1881.

To the Superintendent of Fisheries in the *Scheldt and the Zeeuw-stream*, at *Tholen*:

In reply to your letter No. 6402, of June 7, 1881, and the one further explaining it, of 12th July, 1881, No. 6482, the Commission of the Zoological Station has the honor to report as follows:

The inquiry addressed by you to the Commission relates to the occurrence of the "Drill"\* on oysters imported from *Arcachon* and planted on *Herkingsche* Banks. As you are of opinion that the "Drill" has not been found in our waters till now, you have requested us to make an investigation of the subject, with the view to ascertain whether this animal has been introduced with the oysters referred to, and if so, has of course remained alive during the transportation.

On the 14th July, 1881, I personally visited the *Herkingsche* Banks, in company with one of your officers. Thanks to the kind aid of Messrs. *van den Berg*, who rent several lots on these banks, we were enabled to examine on some of these lots everything which, by means of a scraper, had been brought up from the bottom in our presence. I examined on

\*The French word "*Perceur*" is given in the original, no Dutch translation of it having been attempted. Mr. Ryder translates it by this word "Drill."—TRANSLATOR.

this occasion a very large number of oysters, and on none of them did I find the peculiarly-shaped egg-shells of the "Drill"; neither did I find either young or old, living or dead specimens of the animal itself.

We did not continue this investigation, principally because we felt that it would be fruitless. Considering that, even in the most unfavorable case, the quantity of "Drills" is very small, we doubt whether a continuation of this investigation would be of any use. The chance was very slender that by dredging we would find either the animal itself or its young; and, on the other hand, as long as a single oyster and a single foot of ground remained unexamined the circumstance of our not finding any "Drills" would not justify us in drawing any conclusions as to their non-occurrence in these waters.

Such theoretical considerations would, however, not have prevented us from seeking greater certainty on this point by a second investigation, if it had not been for the fact that an accurate investigation of the entire mollusk fauna of our country might involve questions which should be approached with the utmost caution. Supposing we had obtained the absolute certainty that a "Drill" was living or had lived among the oysters planted on the *Herlingsche* Banks, this would by no means prove incontrovertibly that this "Drill" had been recently introduced from the coast of France among Arcachon oysters.

The "Drill" which is referred to in the above is the *Murex erinaceus*, L. The *Murex tarentinus*, Lamarck, is, according to some writers, a variety of the same genus, found in more southern seas, the Mediterranean, &c., whilst according to others (among them *Gwyn Jeffreys*, an authority of the first rank), *Murex tarentinus* is nothing more nor less than a full-grown *Murex erinaceus*. This animal is quite common on the coast of France, from the south as far as *Boulogne*; on the coast of Great Britain it is found on rocky bottoms, from the tide line as far as the region of the Laminarians, both on the southern and western coasts of England and Scotland, and on the coasts of Ireland and Wales. This animal has also been repeatedly observed on the eastern coast of England and Scotland, in the mouth of the Thames, near Yarmouth, Scarborough, Northumberland, Durham, in the Bay of Berwick, near Aberdeen, and in the Moray Firth (*Gwyn Jeffreys*). It is also found near Ostend and Blankenberg, on the coast of Belgium, although not as frequently. (*F. de Malsine* observed a live specimen on a ray near Ostend.) As far as the coast of the Netherlands is concerned, *Herklots* says this animal belongs to its fauna, without telling us, unfortunately, where he has observed it. The museum of the Zeeuw Association, at *Middelburg*, possesses a specimen which came from the North Sea. I must also mention, in conclusion, that, according to *Lovén*, this animal is found in the Kattegat, but not farther north, either on the coast of Scandinavia or in the open North Sea. The fact of its having been found near Yarmouth is only given on the authority of the "*Commission zur Untersuchung der deutschen Meere*"—Commission for investigating the German Seas.

As this animal is found in all these different localities, it will not astonish us that it occasionally occurs on the coast of the Netherlands, and, in fact, it is rather surprising that this animal is so rare in our coast fauna. We shall find an explanation of this circumstance by examining the nature of the bottom; the *Murex erinaceus* does not live on a sandy or clay bottom, but shows a decided preference for rocky bottoms. That our oyster grounds have so far been free from this animal, which is so hurtful to the oyster, must in the first place be ascribed to the bottom, and in the second place to their shallowness. We are all the more inclined to embrace this opinion when we remember that the Zeeuw oyster grounds for more than a century (*Job Baster*) have been stocked not only with oysters imported from Arcachon (as the oyster cultivators at *Bruinisse* assured me they have worked with Arcachon oysters for several years), but also with young oysters from Great Britain, and that the "Drill" could easily have been introduced from the last-mentioned country. The scattered cases where the *Murex* referred to have been observed on the coast of the Netherlands may possibly have been caused by its having been introduced with other shell fish; if this could be ascertained beyond a doubt, we would possess a proof (although only a negative one) of the correctness of our supposition that the non-occurrence or rare occurrence of the "Drill" must principally be ascribed to conditions existing on our oyster-grounds which are not favorable to the development of this animal.

If we are to have a more thorough examination of the oysters imported from Arcachon (and other points on the coasts of France and Great Britain), and planted on the Zeeuw oyster grounds, with the view to ascertain whether or not the "Drill" is found there, we deem it necessary to answer the following question: "Must the *Murex erinaceus* L., even now be considered as a representative—though a very scarce one at that—of the fauna of the Eastern *Scheldt* and the neighboring waters?" Both for this investigation and for an accurate determination of the localities where natural oyster and muscle grounds are found, an exhaustive examination, from a zoological point of view, of the Eastern *Scheldt* seems absolutely necessary. The matter of undertaking such an investigation will form the subject of serious consideration by the commission.

Very respectfully,

DR. P. P. O. HOEK,

*Secretary of the Commission of the Zoological Station."*

The above appendix will, in the opinion of the commission, give an idea of the present condition of the investigation. In said appendix it has been mentioned repeatedly that in our final report, which will be published when the entire investigation has been brought to a close, all the results will be given in full, if necessary, accompanied by illustrations and maps.

Tabular statement of observations relative to the density and temperature of the water in the Eastern Scheldt and in the "Eendracht" in the neighborhood of the oyster grounds, August, 1881.

		AUGUST 22, 1881.—Wind SW., cool; light showers; clearing weather; temperature of the atmosphere at 12 m. 19.8°C.; low water at Bergen op Zoom about 8 a. m.								
Place of observation.	Hour of observation.	Depth of water in meters.	Ebb tide.				Flood tide.			
			Bottom.		Surface.		Bottom.		Surface.	
			Areometer.	Ther. C.	Areometer.	Ther. C.	Areometer.	Ther. C.	Areometer.	Ther. C.
<i>Bergsche Diep</i> , near the black buoy outside the harbor.....	11.00 a. m.	2.3		o		o	1021.1			16
	12.00 m.	3.1					1021.6	15.8		15.8
	12.30 p. m.	2.4					1021.9	16		16
<i>Bergsche Diep</i> (Lot No. 336).....										
<i>Northern portion of Lot No. 339</i> .....										
<i>In the pit or hole of Lot No. 324<sup>1</sup></i> .....	12.00 m.	12					1022.1	16.8	1022.1	16.6
<i>Northern edge of the pit of Lot No. 324<sup>2</sup></i> .....	12.30 p. m.	5					1022.1	16.9	1022.1	16.9
<i>Zilverput</i> (Silver-pit) south of Lot No. 324.....										
<i>Bergsche Diep</i> (Lot 307).....										
<i>In the "Laagte,"</i> on muscle lots between Lots No. 306 and 307 <sup>3</sup> .....	10.00 a. m.	1.6					1021.9	16.2	1021.9	16.2
<i>Lot 310, between the "Laagte" and "Diep van de Kraaijer"</i> <sup>4</sup> .....	11.00 a. m.	3					1022.1	16.5	1022.1	16.5
<i>Lot 267, close to the dike</i> <sup>5</sup> .....										
<i>Lot 267, farther out in the stream</i> .....										
<i>Diep van de Kraaijer</i> (Lot 285).....										
<i>Lot 231, near Pietermanskreek</i> .....										
<i>Pietermanskreek</i> (Lot 248).....										
<i>Lodijkache gat</i> (Lot 274).....	1.45 p. m.	17					1022.3	17.1	1022.3	17.1
<i>Yercke Bank</i> (Lot 226).....	2.00 p. m.	4.5	1022.3	17.1	1022.3	17				
<i>Wemeldings</i> (Lot 470).....										
<i>Eendracht, near Tholen</i> (Lot 22).....										
<i>Eendracht</i> (Lot 38), the "Nachtgaal" <sup>6</sup> .....										
<i>Near the Voormer Ferry</i> (Lot 445) <sup>7</sup> .....										

<sup>1</sup> The bottom of the hole clayey and sandy. <sup>2</sup> The edge of the pit covered with shell sand and shell gravel. <sup>3</sup> During the preceding days much rain fell. Whenever the sluices on the south coast of Tholen show marsh water, it flows at the beginning of the flood tide along and over the "Laagte." <sup>4</sup> Flood tide currents coming from the "Lodijkache gat," and others, coming from the stream north of "Vogelaar," meet each other probably near or a little to the south of the "Laagte." <sup>5</sup> At low water this place is dry. When the sun shines the flood tide, therefore flows over a considerably heated bottom. <sup>6</sup> At 4.30, when the water had fallen considerably, a three-fourth mile's northerly current flowed with the "Nachtgaal." At 5 o'clock this northerly current was still more perceptible. <sup>7</sup> On the 23d and on the morning of the 24th much marsh water flowed into the "Eendracht," especially through the first sluice south of the Voormer Ferry. At 10 o'clock a weak northerly current could be noticed at Voormer. At 2.30 it was much stronger; and at 4, when the water was falling, there was a strong northerly current, flowing at the rate of 2 miles.

Tabular statement of observations relative to the density and temperature of the water in the Eastern Scheldt, &c.—Continued.

S. M. S. 29—65

[25]

OYSTER CULTIVATION IN THE NETHERLANDS.

1025

Place of observation.		August 24, 1881.—Wind SW., quite cool; showery; every now and then rain; temperature of the atmosphere at 12 m., 18° C.; low-water at Tholen about 9.15 a. m.									
		Hour of observa- tion.	Depth of water in meters.	Ebb tide.				Flood tide.			
				Bottom.		Surface.		Bottom.		Surface.	
Areome- ter.	Ther. C.	Areome- ter.	Ther. C.	Areome- ter.	Ther. C.	Areome- ter.	Ther. C.				
Bergsche Diep, near the black buoy outside the harbor.....				0	0			0	0		
Bergsche Diep (Lot No. 338).....											
Northern portion of Lot No. 329.....											
In the pit or hole of Lot No. 324.....											
Northern edge of the pit of Lot No. 324.....											
Zilverput (Silver pit) south of Lot No. 324.....											
Bergsche Diep (Lot 307).....											
In the "Laagje," on muscel lots between Lots No. 306 and 307.....											
Lot 310, between the "Laagje" and "Diep van de Kraaijer".....											
Lot 287, close to the dike.....											
Lot 267, farther out in the stream.....											
Diep van de Kraaijer (Lot 285).....											
Lot 231, near Pietermanskreek.....											
Pietermanskreek (Lot 248).....											
Lodijkache gat (Lot 274).....											
Yerache Bank (Lot 228).....											
Wemeldinge (Lot 470).....											
Eendracht, near Tholen (Lot 22).....		10.45 a. m.	12				1121.8	17.4	1021.7	17.3	
		5.30 p. m.	14	1021.9	18.8	1021.8	18.9				
Eendracht (Lot 38), the "Nachtegaal".....		3.10 p. m.	5				1021.7	17.2	1021.6	17.2	
		4.30 p. m.	4.5	1021.7	17	1021.7	17.1				
		5.00 p. m.	3.5	1021.7	18.9	1021.7	17				
Near the Vosmeer Ferry (Lot 445).....		1.00 p. m.	5				1021.5	17.6	1021	17.5	
		4.00 p. m.	6.5	1021.7	17.2	1021.6	17.2				

Tabular statement of observations relative to the density and temperature of the water in the Eastern Scheldt, &c.—Continued.

AUGUST 28, 1881.—Wind WNW., cool toward noon; clearing weather; temperature of the atmosphere at 12 m., 17.5° C.; high water at Bergen op Zoom about 5.30 a. m.

Place of observation.	Hour of observation.	Depth of water in meters.	Ebb tide.				Flood tide.				
			Bottom.		Surface.		Bottom.		Surface.		
			Areometer.	Therm. C.	Areometer.	Therm. C.	Areometer.	Therm. C.	Areometer.	Therm. C.	
<i>Bergsche Diep</i> , near the black buoy outside the harbor.....				0		0		0		0	
<i>Bergsche Diep</i> (Lot No. 336).....	7.30 a. m. 12.44 p. m.	7 17	1022.1	16.6	1022.1	16.6		1022.2	16.7	1022.1	16.9
<i>Northern portion of Lot No. 339</i> .....											
<i>In the pit or hole of Lot No. 324</i> .....											
<i>Northern edge of the pit of Lot No. 324</i> .....	11.00 a. m.	4.5	1022.2	16.9	1022.2	16.9					
<i>Zilverput</i> (silver pit), south of Lot No. 324.....	10.30 a. m.	8	1022.2	16.8	1022.2	16.9					
<i>Bergsche Diep</i> (Lot 307).....	8.00 a. m. <sup>1</sup> 1.00 p. m.	21 9	1022.3	16.6	1022.1	16.6		1022.1	16.8	1022.1	17
<i>In the "Laagle,"</i> on muscle lots between lots No. 306 and 307.....											
<i>Lot 310</i> , between the "Laagle" and "Diep van de Kraaijer".....											
<i>Lot 267</i> , close to the dike.....	8.15 a. m. 12.15 p. m. 12.20 p. m.	2 0.5 16	1022.3	16.6	1022.3	16.6		1022.1	17.8	1022.2	16.7
<i>Lot 267</i> ; farther out in the stream.....											
<i>Diep van de Kraaijer</i> (Lot 285).....											
<i>Lot 231</i> , near Pietermanskreek.....											
<i>Pietermanskreek</i> (Lot 248).....											
<i>Lodijkse gat</i> (Lot 274).....	9.15 a. m.	18	1022.3	16.6	1022.3	16.8					
<i>Yersche Bank</i> (Lot 226).....											
<i>Wemeldinge</i> (Lot 470).....											
<i>Eendracht</i> , near Tholen (Lot 22).....											
<i>Eendracht</i> (Lot 38), the "Nachtegaal".....											
<i>Near the Vosmeer Ferry</i> (Lot 445).....											

<sup>1</sup>The observation taken in the ebb-tide current coming from the "Eendracht."

Tabular statement of observations relative to the density and temperature of the water in the Eastern Scheldt, &c.—Continued.

[27]

OSTER CULTIVATION IN THE NETHERLANDS.

1027

August 29, 1881.—Wind SW, cool about noon; clear during the forenoon, later cloudy; temperature of the atmosphere at 12 m., 17° C.; high water at Bergen op Zoom about 6 a. m.

Place of observation.	Hour of observation.	Depth of water in meters.	Ebb tide.		Flood tide.					
			Bottom.		Surface.		Bottom.		Surface.	
			Areometer.	Ther. C.	Areometer.	Ther. C.	Areometer.	Ther. C.	Areometer.	Ther. C.
<i>Bergsche Diep</i> , near the black buoy outside the harbor.....				0		0		0		0
<i>Bergsche Diep</i> (Lot No. 336).....										
Northern portion of Lot No. 339.....	5.00 p. m.	6				1022.2	16.9	1022.1		16.8
In the pit or hole of Lot No. 324.....	4.30 p. m.	12				1022.2	16.8	1022.2		16.8
Northern edge of pit of Lot No. 324.....										
<i>Zilverput</i> (Silver pit), south of Lot 324.....										
<i>Bergsche Diep</i> (Lot 307).....	9.45 a. m. <sup>1</sup>	18	1022.3	16.5	1022.2	16.5				
In the "Laagte," on muscle lots between Lots No. 306 and 307.....										
Lot 310, between the "Laagte" and "Diep van de Kranter".....										
Lot 267, close to the dike.....										
Lot 267, farther out in the stream.....										
<i>Diep van de Kraaijer</i> (Lot 285).....	3.45 p. m.	11				1022.3	16.8	1022.3		16.8
Lot 231, near <i>Pietermanskreek</i> .....	11.00 a. m.	1	1022.3	17						
<i>Pietermanskreek</i> (Lot 248).....	11.15 a. m.	3	1022.3	16.8	1022.3	16.9				
<i>Lodijkache gat</i> (Lot 274).....	10.15 a. m.	21	1022.5	16.6	1022.4	16.8				
<i>Yersche Bank</i> (Lot 226).....										
<i>Wemeldinge</i> (Lot 470).....	2.15 p. m.	16				1022.5	16.9	1022.5		17
<i>Eendracht</i> , near Tholen (Lot 22).....										
<i>Eendracht</i> (Lot 38), the "Nachtgaal".....										
Near the <i>Voormeer Ferry</i> (Lot 445).....										

<sup>1</sup>The observation taken in the ebb-tide current coming from the "Eendracht."