

III.—THE PROPAGATION OF THE EEL

By Dr. OTTO HERMES.*

[From Circular No. 6, Berlin, November 25, 1880, of the "Deutsche Fischerei-Verein"—German Fishery Association.]

Since the beginning of last spring, when the eel fisheries in our part of the country commenced, I have given my undivided attention to the eel question (see Circular No. 1, p. 23; No. 2, p. 55; No. 4, p. 72, 1880), to dispel, if possible, the darkness which still hides the life of this mysterious fish. I do not hesitate to communicate, at the present time, the results of my investigations to the readers of the Circular, with the hope of stimulating others to make observations of this problem.

It was natural to extend these investigations to the formation and development of the sexual organs of the sea eel (*Conger vulgaris*), which so closely resembles the fresh-water eel, all the more as its sexual organs and the manner in which it reproduces its species are likewise but little known. If positive facts could be ascertained with regard to this eel, it would be tolerably safe to conclude, from the similarity of the two kinds of fish, that the same would apply to our common river eel (*Anguilla fluviatilis*).

The sea eel grows twice as long as our river eel (specimens measuring 6 feet in length are by no means uncommon), and outwardly differs from the latter by the different formation of the jaws and the dorsal fin. In the sea eel the latter begins immediately back of the pectoral fins, whilst in the river eel it is placed farther back. In the sea eel the upper jaw protrudes over the lower jaw; in the river eel the reverse is the case. The position and formation of the internal, especially the sexual, organs is very similar in both. But whilst the river eel grows up in rivers and only goes into the sea to spawn, the sea eel never leaves the sea. The sea eel stands imprisonment very well, and grows rapidly. I have had a considerable number in the Berlin Aquarium, and have examined several large ones which died. These were invariably female fish, whose ovaria had developed to an extraordinary degree. From lack of the natural conditions they could probably not spawn, and I believe that they died from this cause. I have been informed that a sea eel in the aquarium in Frankfort-on-the-Main actually burst in consequence of the unnatural development of the ovaria.

* Zur Fortpflanzung des Aales, von Dr. Otto Hermes.—Translated by Herman Jacobson.

In the autumn of 1879 I received a number of sea eels which had been caught near Havre, measuring 60 to 70 centimeters in length. They ate voraciously and grew rapidly. Only one did not develop so fast, and could easily be distinguished from the others by its smaller size. This, the smallest of all the sea eels in the aquarium, died on the 20th of June, 1879, and was examined by me the same day. I was very much surprised when I discovered that its sexual organs were entirely different from those hitherto observed in eels. When an incision was made in these organs a milky fluid oozed out. I had before me a mature male eel. A drop of this fluid, when placed under the microscope and magnified 450 times, showed a large number of live spermatozooids, whose head and tail could easily be distinguished. They moved about in a very lively manner, thus fully establishing the fact that the organs examined by me were male organs. As to my knowledge no mature male of the *Conger vulgaris* had ever been found or described, I requested Dr. Rabl-Bückhard to examine this fish with me, and had correct drawings of the organs made by a painter, Mr. Müttzel, and, for the sake of comparison, placed by the side of these drawings a sketch of the ovaria of a female *Conger* measuring 84 centimeters in length. Both these drawings, reduced to half of their natural size, accompany this article.

The male sexual organs lie on both sides of the swimming-bladder, resembling long, compressed, ribbon-like channels extending the whole length of the abdominal cavity, commencing at the liver and extending beyond the anus. By a number of lateral notches each testicle is divided in several parts of different size. The right testicle has four such notches, and therefore five parts, the first section, counting from the head, measuring 45 millimeters; the second, 70; the third, separated from the second by a notch extending only half the breadth of the organ, 8; the fourth, 43, and the fifth, 38. The left testicle consists of an upper part measuring 103 millimeters, followed by a second part of 18 millimeters, and by one of 80, which by three notches, extending only one-third of the breadth of the organ, is subdivided into three parts measuring 15, 27, and 33 millimeters, respectively. The thickness of the most strongly developed upper part of the left testicle is 9 millimeters, and its breadth from the root to the free edge 18 millimeters. The attachment of the right testicle commences 11 millimeters farther forward than that of the left. The free edge of both testicles gradually grows narrower, and thus forms a border consisting of several folds measuring at most 4 millimeters in breadth and overlapping the parenchyma. If we compare these organs of *Conger* with the so-called *Syrski* organs of *Anguilla*—described in circular No. 2, 1880—the similarity of the two is very striking. In *Anguilla* we see a large number of small subdivisions or parts, and in *Conger* a small number of large parts. But if we consider that owing to the difference in the size of these two species, the parts of *Conger* must be simpler and larger, and that we examined a fully grown mature male *Conger* measuring 74 centimeters, whilst the sexual organs of the *Anguilla*—measuring 43 centimeters—were not fully developed,

we may conclude with a probability bordering on certainty that the *Syrski* organs are really the male sexual organs of *Anguilla*. The male, both of *Conger* and *Anguilla*, is therefore considerably smaller than the female.

In order to ascertain the proportion of male to female river eels in our part of the country, and likewise in order to find how far up the rivers the male eels ascend, I have made a series of investigations, which, though interesting in themselves, are by no means sufficient to throw all the light we desire on the life of the eel. This requires further and more exhaustive investigations, for which I would ask the hearty co-operation of the members of the German Fishery Association.

Syrski's work,* which marks an era in the history of this investigation, throws some light on the relations between the male and female eels of the Adriatic, which has been further increased by *Jacoby's* investigations at Comacchio. The sexual relations of our North Sea and Baltic eels have hitherto been but little investigated. Mr. Cattie, teacher at the Real school at Arnheim (Holland), found among a large number of eels, measuring 30 to 45 centimeters, 25 per cent. of males. We could not learn, however, where these eels were caught.

I have examined:

- (1) 72 eels caught in the Baltic, near Wismar.
- (2) 72 eels from the Great Belt.
- (3) 250 eels from the Elbe, near Cumlosen.
- (4) 40 eels from the Havel, near Wendendorf.
- (5) 137 eels caught near Neuenkirchen in the island of Rügen.
- (6) 40 eels caught on the coast of Schleswig.

The length of these fish varied from 28 to 42 centimeters.

I found among those mentioned under:

- (1) 8 males, or 11 per cent.
- (2) 8 males, or 11 per cent.
- (3) 13 males, or 5.2 per cent.
- (4) No males.
- (5) 61 males, or 44.52 per cent.
- (6) 1 male, or 2.5 per cent.

From these figures it is apparent that Siebold's assertion that the male eels do not ascend the rivers, but remain in the sea or near the mouth of the rivers, cannot be taken in a literal sense. Cumlosen is near Wittenberge, or at least 20 (German) miles from Cuxhafen, at the mouth of the Elbe, and still we here find 5 per cent. males. How large a percentage of males there may be near the mouth of the Elbe and farther up the river I could unfortunately not ascertain, because the necessary data were wanting. From the Havel, near Havelberg, I unfortunately got only 40 eels, among which there was not a single male; but we are not justified in concluding from this that there are no male eels in the Havel.

*"Ueber die Reproductionsorgane der Aale." Vol. LXIX of the "Abhandlungen der k. k. Akademie der Wissenschaften zu Wien." Part 1. April, 1874.

In order to solve this question satisfactorily a larger number of eels would have to be examined. It would be wrong, however, to conclude, from the fact that male eels are found in rivers, that eels can propagate their species in rivers. Both male and female eels do not fully develop in fresh water, and only reach their full maturity in the sea.

The difference in the percentage of males in different parts of the Baltic is a strange phenomenon, 11 in one and 44.52 in the other. It is possible that we have to look for the spawning places of the eels in those waters where males are found in such large numbers; and here investigations should be carried on all through autumn.

The catching of such small eels as are required for these investigations is, however, attended with considerable difficulty. The fishery law prohibits the catching of eels measuring less than 35 centimeters, and even those measuring 35 to 40 centimeters are rarely seen in the market. As a general rule the fishing apparatus is not at all adapted to the catching of such small eels. In Cumlosen I had special eel baskets or traps constructed of fine wicker-work. A similar apparatus will be required in other places, if we wish to obtain light on the many dark points in the life of the eel.

The spawning places of the eels, towards which their migrations doubtless tend, will be the places where fully matured eels can be found, and from the direction in which the eels migrate the location of the spawning places can probably be ascertained.

Mr. Dallmer, superintendent of fisheries in Schleswig, who has regularly supplied me with eels from the Schleswig coast, writes me that he intends to make a thorough investigation of this coast with special reference to the eel question.

Mr. Dallmer writes: "In October and November many eels are caught in wicker baskets in the Little Belt and near Flensburg and the Island of Alsen. As these baskets are of course placed with the opening in the direction from which the eels come, this opening must indicate the direction in which the eels migrate, and if the position of the baskets in the different localities were marked on a map the course of these migrations could easily be ascertained. With this view I have drawn a map of the German side of the Little Belt and the Flensburg-Alsen waters, and have transmitted it to Mr. Hinkelmann, superintendent of fisheries at Flensburg."

If this attempt is followed by good results, Mr. Dallmer thinks the German Fishery Association should publish maps of all the German coasts where eels are caught, and have them filled out in the manner above indicated by competent persons. This proposition is thoroughly practical and promises success.

Both in the North Sea and in the Baltic eels are only caught near the coast, but never in the open sea. A man thoroughly acquainted with our western coasts, who at the same time is a very close observer—Mr. Decker, superintendent of fisheries at Blankenese—says in a letter to

Mr. Dallmer regarding the occurrence of eels in the sea, more especially in the North Sea: "Eels are found in the North Sea wherever there are islands and banks, even if these are left dry at low tide, but in the open sea they are never found. On the west coast of the island of Sylt, which is not obstructed by banks, no eels have, to my knowledge, ever been caught, whilst a great many are caught on the west coast of the island of Amrum (only a few miles distant), which is protected by a number of banks. Near Heligoland eels are frequently caught, a line and hook to which a stone is tied being thrown into the sea from the shore. Beyond the turbid yellowish water surrounding the island no eels are caught. Near Nemverk, on the Watt, I have caught many eels, but I feel convinced that beyond a line drawn from Gross-Vogelsand to Scharhörn no eels can be found. I am therefore of opinion that it may be considered absolutely certain that the Watten Sea, and the mouths or the lower parts of rivers, and not the open North Sea, are the spawning places of eels." Such observations of practical fishermen, based on accurate knowledge and experience, are exceedingly valuable, and it is to be desired that a larger number of similar observations could be made and published.

Among the outward signs by which a male eel may be recognized is a very striking metallic or bronze color, by which it can easily be distinguished from the female. Mr. Hinkelmann could thereby always beforehand inform me how many males I would find among the fish which he sent me. Among these there were several which measured 45 centimeters in length.

For a further study of the eel question it will be necessary to continue these investigations in as many rivers, bays, and coast waters as possible. Every one interested in this matter is herewith requested to send me eels. They are best packed in wicker baskets in moist sea-weeds or aquatic plants. I presume that in view of the general interest felt in this matter the German Fishery Association will gladly bear the expenses.

EXPLANATION OF THE ILLUSTRATIONS.

- A. Fully-matured male sexual organs—one-half the natural size—of a sea eel (*Conger vulgaris*) measuring 74 centimeters in length.
a, stomach; *a'*, upper; *a''*, middle; *a'''*, lower part of the liver folded back; *f*, swimming-bladder; *g*, gall-bladder; *h*, anus; *i*1, *i*2, *i*3, *i*4, the different parts of the left testicle; *k*1, *k*2, *k*3, *k*4, *k*5, the five parts of the right testicle; *l*, *Bursa seminalis*; *m*, urinary bladder; *p*, skinny border of the testicles.
- B. Spermatozoids.
- C. Undeveloped sexual organs (ovaria)—one-half the natural size—of a female sea eel (*Conger vulgaris*) measuring 84 centimeters in length.
a, stomach; *b*, cœcum; *c*, spleen; *d*, liver; *e*, right ovarium; *e'*, left ovarium; *f*, swimming-bladder; *g*, gall-bladder; *h*, anus; *m*, urinary-bladder; *p*, base of the left ovarium.

