

## VIII.—CONTRIBUTIONS TOWARDS A MORE CORRECT KNOWLEDGE OF THE HERRING'S MODE OF LIFE.

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The following may be considered as a continuation of my former treatise "On the propagation and growth of the herring and small-herring,"<sup>1</sup> and will comprise a résumé of all we know so far regarding the general condition and mode of life of the herring, and its bearing on the herring fisheries on the daily life and the yearly and secular migrations of the herring.<sup>2</sup>

In compiling this treatise I have consulted my own experience and all the old literature on the subject which was accessible, and likewise the information which I have gathered from many a conversation with fishermen. In going over all the literature on the subject I have met with many difficulties, as the peculiarities in the herring's mode of life are often described in provincial terms which are sometimes unintelligible. By publishing this résumé I hope to have in some measure obviated this difficulty.

For comparison's sake, I shall also give a few observations on the small-herring (*Clupea sprattus* L.), concerning which much less is known, but whose mode of life in many respects agrees with that of the herring.

The food of the herring belongs exclusively to the animal kingdom, but varies a great deal in different seas and during different seasons. It chiefly consists of small crustaceans, especially of the copepod species, but also includes worms, young fish, roe, &c., and in some places the larvæ of gnats, &c. In fact, the herring devours any small aquatic animals which it can get, and does not even spare its own offspring. Boeck and L. Agassiz have said that the character of the herring's teeth proves that it is not confined to any special kind of food.

As in many places herrings are principally caught during the spawning-season, when, as is well known, they do not eat much, the idea has, especially in former times, been quite prevalent among fishermen that the herring lived on nothing else but water,<sup>3</sup> an idea which is found in

\* AXEL LJUNGMAN, *Bidrag till Kännedommen om sillens lefnadsförhållanden*. Copenhagen, 1880. [Translated by HERMAN JACOBSON.]

<sup>1</sup> *Nordick Tidsskrift för Fiskeri*, V., pp. 193-194.

<sup>2</sup> Compare my treatise: "*Kortfattad framställning af den nutida Kännedomen om sillens gång och flyttningars samt dessas beroende af fysikaliska och biologiska förhållanden*," in "*Bohus läns hafsfisken och de vetenskapliga hafsfiskeundersökningarna*," II Göteborg, 1878.

<sup>3</sup> "*Ex puro aquæ elemento vivit, sicut salamandra ex igne*."—Another explanation of the origin of this idea has been given by Neucrantz (*De harengo*, p. 28).

several of our older authors, *e. g.*, Rondelet, although Albertus magnus has already pointed out the impossibility of this statement.

In the Skagerak, where I have made many observations, the favorite food of the herring consists of small copepods, which are often found in enormous quantities. During the warm season these little animals are very numerous, and herrings during this time are much less valuable. The same is the case in Norway, where three kinds of herring food are known, viz, the "red food," which according to H. Ström, Rathke and others consists of small crustaceans; the "yellow food," which according to Axel Boeck consists of annelida larvæ; and the "black food," which, according to Rathke, consists of larvæ of mollusks. In olden times laws were given in Scotland and other parts where herring fisheries are carried on to counteract the influence of this food on the herring. In Norway herrings which have gorged themselves with such food are called "aated," and in Scotland "gutpoke."

Professor Möbius has published some data regarding the quantity of food which a herring can devour. These data are based on exact observations. Thus, there were found no less than 60,000 tails of copepods in the stomach of a single herring which had been caught in the Bay of Kiel.

As regards the food of the young herring but little can be said, as we do not as yet possess a sufficient number of observations from different localities. Prof. C. J. Sundevall says that on the Stockholm coast the young herring when measuring little above an inch feed on small copepods; and Prof. G. Lindström states that even in a smaller herring caught on the same coast he has found larvæ of a *tergites*. Axel Boeck maintains that the young herring immediately after it has lost the umbilical bag begins to snap after small crustaceans. Quite recently Dr. H. A. Meyer has communicated the result of his extensive observations, according to which the food of young herrings in the Bay of Kiel consists of larvæ of *Rissoa*, *Ulva*, *Lacuna*, *Tellina*, *Cardium*, &c., and occasionally of larvæ of *Nauplius*, whilst when they grow somewhat larger they will eagerly devour full-grown copepods.<sup>4</sup>

The herring only in exceptional cases bites a baited hook and line, but may be caught with floating hooks. Whenever we find it mentioned that herrings were caught with hooks, this doubtless refers to floating hooks.

The herring often consumes small and generally very oily aquatic animals in such enormous quantities that its whole inside is filled with a putrefying stinking mass of animal matter, so that it is not fit to become an article of human food. And this condition of the herring has by some authors been considered as a sickness; as such even that certain faintness has been explained which sometimes overcomes the herring after spawning to such a degree that it is helplessly tossed about

<sup>4</sup> *Nordisk Tidsskrift for Fiskeri*, V., p. 154, 200.

by the waves.<sup>5</sup> This very circumstance was mentioned in the dispute regarding our fishery laws, when it was used as proof of the assertion that the sea-herring had been driven away from the coast of Bohus län. This faintness has doubtless been much exaggerated, but cannot be denied entirely, although it has not been observed in all places where herrings are found. It may possibly be ascribed to the diminution of vital strength produced by spawning or by a long period of scanty food, or (according to Gisler), by long and violent storms and otherwise unfavorable weather. It is likewise supposed that the herrings, like other fish, occasionally suffer from destructive epidemics.

Both the herring and the small-herring are troubled with several kinds of parasites, among which, doubtless, those are the most dangerous which attack the floating roe or the young fry.

In connection with the sicknesses of the herring, we must here mention its tenacity of life even when outside of its native element and its power of endurance, which has been viewed and described so differently from time immemorial. It has been said that the herring breathed its last immediately when taken out of the water, and as the cause of this its wide gill-openings were assigned. Neucrantz already opposed this view, and more recent authors have proved conclusively that the herring can live out of the water for several hours, if it is not exposed to the heat, pressure, or any violence. Herrings caught in nets are generally dead when the net is hauled in, and this circumstance has probably given rise to the opinion that the herring dies as soon as taken out of the water. Herrings caught in large seines live longer, and those caught in bottom-nets or fish-pots live longest. The herring cannot stand any strong pressure, and in seine-fishing care should be taken to avoid it, as it may cause the death of many herrings and by increasing the weight may make the hauling in of the seine difficult or impossible. On the whole the herring must be counted among the least hardy fish, and this applies in a still higher degree to the small herring. Under favorable circumstances, however, even the small herring may live for half an hour after it is taken out of the water. Other fish of the herring species seem to be still more tender.

There are few animals which are more defenseless and more persecuted by numerous and dangerous enemies than the herring; and if it was not so extraordinarily prolific it would surely have died out, or would, at any rate, have ceased to appear in such large numbers as to form the object of fisheries of a vast economical importance. The principal enemies of the herring are, among fish, the cuttle-fish, the cod, the salmon, and the shark; among birds, the puffin, the sea-gull; finally the whale, the seal, and above everything man, who, on account of the great variety of means by which he can pursue the herring, is by many considered its most dangerous enemy. Great dangers, however, threaten not only the grown herring, but also the roe and young fish. Among the

<sup>5</sup> F. BUCKLAND., *familiar history of British fishes*. London, 1873, p. 102.

enemies to the roe must be mentioned parasitic algæ, infusoria, star-fish, large crustaceans, the cod, the whiting, the flounder, and other fish. The young fish are also violently persecuted by the cod, the whiting, and other fish.

As an enemy of the herring we must finally mention the so-called "sea-blossoms," a kind of lover of salt water algæ (*Oscillatoria*), which are quite frequent in the Baltic, and which often force the herring to seek deeper water.<sup>6</sup>

The herring and the small herring, although closely related, cannot well live together, but must rather be considered as mutual enemies. They keep in separate schools, and if both kinds are caught in one and the same seine, as will sometimes happen, this is doubtless caused by the seine's enveloping two different schools, either whole or in part.<sup>7</sup> When these two fish meet the small herring has invariably to give way to the stronger herring; and when large herrings begin to appear in the seines this is considered an unfavorable sign for the small herring fisheries. The large migratory herring is considered dangerous to the young herring, and when occurring in large numbers it is said to chase the small herring away; the fishermen on the northern coast of Bohus län, therefore, do not like to see this herring make its appearance.

After having thus briefly given an account of the food, the sicknesses, and the enemies of the herring, we must make a few remarks regarding its general mode of life.

As regards its life during the tenderest age C. J. Sundevall says: "As long as the fish still have the umbilical bag they move about in a very peculiar way. By violent contortions of the body, which occur every second, and even oftener, they work themselves up to the surface of the water (at least when inclosed in vessels 1 to 2 feet deep); as soon as they touch the surface they keep still for a little while, and then again sink to the bottom. This movement is constantly repeated." "As soon as the umbilical bag has been consumed, which takes place in a week's time, the young herrings begin to swim about in dense schools and with a worm-like movement."<sup>8</sup>

When the herrings are not disturbed, they generally move in a straight line or in more or less curved lines, and like most other fish, do not turn round abruptly. On this peculiarity fishing with bottom-nets and fish-pots is based.

The herring is a lively fish and prefers a strong current. It has often been observed to go straight against the current, which, however, may

<sup>6</sup>C. J. SUNDEVALL, *Stockholms läns Kgl. Hushållnings-Sällskaps Handlingar*, VI, Stockholm, 1855, pp. 152, 153. V. SKRYDSTRUP, *Nordisk Tidskrift for Fiskeri*, II, p. 40.

<sup>7</sup>Violent storms, however, may occasionally cause the small herring to mingle with the larger herring.

<sup>8</sup>*Stockholms läns Kgl. Hushållnings-Sällskaps Handlingar*, VI, Stockholm, 1855, pp. 195, 196. *Kgl. Svenska Vetenskaps-Akademiens Handlingar*, I, Stockholm, 1858, pp. 17, 18. Compare also A. BOECK, *Om Silden og Sildefiskerierne*, Christiania, 1871, p. 14, 15.

be caused by its desire to catch the small crustaceans which are carried along by the current.

The herring is easily scared, and at any sudden noise quickly changes its course, no matter whether it is going with or against the current, but generally returns very soon to its old place. Fishermen, therefore, are not afraid that noise could entirely scare the herrings away from a coast.

In seine-fishing the herrings generally exhibit great terror of the seine, and it is often very difficult to catch them in this manner. By saying this we do not wish to convey the impression as if seines did drive the herrings away from the coast; for one seine after the other may often be hauled in successfully in one and the same place. The more or less transparent character of the water has a great deal of influence on seine-fishing. This mode of fishing can, on the coast of Bohus län, be only carried on by daytime on the southern part of the coast, where the many rivers and streams make the water muddy, so the herring cannot see the seine until escape becomes impossible. During the last great Bohus län herring fisheries in the eighteenth century, fishing was generally carried on by daytime, but already during the second half of that fishing period the fishermen were obliged to fish by night. The rich herring-fisheries of the last two winters have, however, shown a tendency to return to more favorable conditions. The herring, which is a much less daring fish than the small herring, does not make any vigorous attempt to fly from the seine<sup>9</sup>; the small herring, on the other hand, boldly rushes against the sides of the seine, especially whilst it is being hauled in, endeavoring to push through the meshes, and in this respect it resembles the pilchard. If in seine-fishing small herrings are caught among the larger ones, they are generally found sticking in the meshes of the seine. The small herring does not, like the herring, try to escape the seine by going into deeper water, except during day-fishing in very clear water. If, however, there is the least chance of escape, they will all rush out as fast as possible. Gislér, from reports received by fishermen, relates that it is possible for the herring to disentangle itself from the seine; and G. C. Oederström maintains, also, according to fishermen's reports, that the herring possesses the faculty of swimming about and above the seine, especially when coming in towards the coast or when rising from the deep, so that it can only be caught when going out. All such reports, however, lack confirmation from scientific authorities. This also applies to the report common among the fishermen, that the herring could lift up portions of the seine and go underneath. This explanation probably has had to serve as an excuse for mistakes made during fishing.

The herring often changes its depth very suddenly; and especially during calm weather it has been observed to come to the surface and suddenly head foremost to rush to the deep, whilst the small herring,

<sup>9</sup> When a codfish accidentally gets into a seine with the herrings it creates such a terror among them that they rush against the sides of the seine with the fury of despair and often burst it.

according to the observations of old and experienced fishermen, never does this.

The herring generally goes deeper than the small herring, which is more of a surface fish. During the rich fisheries in the Norwegian boundary-waters, fishermen have reported that large herring and small herring were caught alternately by lowering and raising the seine.

It has been observed during seine-fishing that the larger herrings keep nearer the bottom than the small ones, which always love to keep near the surface. It has also been observed that after spawning the herring goes deeper than previous to it, so that in drag-net fishing most fish are caught in the lower part of the net. In some cases this may be explained by the fact that the herring after spawning seeks to devour the floating roe. According to other reports, however, the herring goes to the surface after spawning and to the deep previous to it.<sup>10</sup>

Several authors, one of them living in the latter half of the last century<sup>11</sup>, relate that "fishermen have observed in different places," that the herring at times hides near the bottom ("in the mud, among the algæ and other aquatic plants, as also in holes made by itself both in bays and sounds and farther out at sea"), and it is in this respect compared to the lance, the eel, and the stickleback.<sup>12</sup> Although the herring has certainly been observed occasionally "to bore with its snout among the sand and stones of the bottom," as old authors already have observed, we are scarcely justified in the supposition that the herring, like the eel, hides on the bottom for any length of time. It is not probable that the herring has a regular period of winter sleep, as some old authors have maintained.

It is well known that the herring emits air-bubbles, and Gisler has given a description of this phenomenon which we will quote in his own words: "When the herrings are closely huddled together, they breathe heavily, and gape after every breath like a person in a close room; from the anus a string of small air-bubbles is emitted, whilst water spurts from the mouth.

The herring is even said to possess the faculty of producing sounds, as the Scotch fishermen say, "squeak," and without sufficient reason, however, it has been said that it breathed its last with an audible sigh or sound.<sup>13</sup>

<sup>10</sup> Compare "*Bohus läns hafsfisken och de vetenskapliga hafsfiske-undersökningarna*, II, p. 34; *Nordisk Tidsskrift for Fiskeri*, V, p. 209.—Report on the herring fisheries of Scotland, London, 1878, p. 76.

<sup>11</sup> DURAMEL DU MONCEAU, "*Traité général des pêches*, II, Paris, 1772, section 3, p. 339.

<sup>12</sup> G. C. CEDESTRÖM, *Svenska Österjö sill-och strömmings-fiskerierna naturhistorisk betraktelse*. Stockholm, 1873. Prospectus, p. 7; appendix, pp. 4, 12; supplement, p. 1.

<sup>13</sup> Compare F. BUCKLAND, Report on the herring fisheries of Scotland, London, 1876, p. 167. HUGH MILLER according to W. BRABAZON. The deep-sea and coast fisheries of Ireland, Dublin, 1848, p. 32. P. NEUCRANTZ, "*De harengo exercitatio medica*," Lubeca, 1654, p. 23. VALENCIENNES, "*Histoire naturelle du hareng*," Paris, 1847, pp. 65, 89.

The mode of life of the herrings when gathered in schools finally deserves some remarks.

The herring is one of the most gregarious fish; from its tenderest age it gathers into schools, and only in very exceptional cases lives in solitude.

Between the spawning seasons the herrings certainly scatter a little more, and generally go farther away from the coast to seek their food, but it is an erroneous idea that during this period the schools are entirely broken up. When the spawning season approaches, the smaller schools gather into larger ones, which finally assume such enormous dimensions as to deserve the name of "herring mountains." When such an enormous mass of herrings approaches the coast, it gives a peculiar color to the water, and when near the surface creates a considerable commotion in the water.

When a large mass of herrings are gathered in one place, many air-bubbles rise to the surface, which circumstance doubtless contributes its share towards coloring the water. The Norrland fishermen say that the herring "is milling," and from the size of the air bubbles draw their conclusions as to the depth at which the herrings are. The smaller the bubbles the deeper the herrings are supposed to be. Also on the coast of Bohuslän these so-called "herring bubbles" form an important mark for the fishermen, who thereby judge not only of the approach of the herrings, but also of the depth at which they will be found. If the bubbles burst when reaching the surface, the herrings are in deep water; if they float for some time on the surface, the herrings are nearer the surface. These air bubbles can best be observed during day fishing with large seines, and they will then by their greater or smaller number indicate in how far the haul will be successful or not.

French and English authors say that according to the observations of many fishermen the location and size of a school of herrings are indicated by an oily substance ("*grassin*" "*smelt*") floating near the surface, which is considered a favorable sign for the fisheries. The French Channel fishermen say when they see this that the water is "*pouilleuse*." Some authors explain this phenomenon as being caused by herrings which have been torn to pieces by sharks (*Squalus acanthias* L.), and say that it is a sure indication that sharks are near. Bartlett's explanation, however, seems better, according to which this oily substance is formed from the numerous excrements of the herrings.<sup>14</sup> Strange to say, this phenomenon has both in old and modern times been by some confounded with the whitish substance floating about near the surface during the spawning season of the herring.

It is also said that the large and dense schools of herrings when spawning, or when swimming near the surface in large schools, produce a peculiar odor, which has often been observed by the Norrland fishermen.

<sup>14</sup> Report on the herring fisheries of Scotland. London, 1878, p. 169.

Schools of herrings when swimming near the surface are said by their movement to produce a rushing sound, which ceases immediately when, scared by some sudden noise, the herrings go into deeper water. In this connection we will also mention the old fable that the herrings when gathered in large schools produce a sharp cracking noise, whereupon they disappear.<sup>15</sup>

When a large number of herrings move about rapidly, a peculiar glitter is produced on the surface, which our fishermen call "herring light." Some old authors have maintained that the herrings themselves are phosphorescent, and that the "herring light" is therefore not produced by the numberless small crustaceans floating near the surface; but this is probably an erroneous idea. In olden times these herring lights were thought to be the cause of the frequent sheet lightning occurring late in summer and in the beginning of autumn, and such lightning was termed "herring lightning." When the herrings turn about in the water their sides, which shine like metal, reflect the light, and produce a very pretty effect, but much fainter than the "herring light."

Herrings of different age and size do not generally go together in one and the same school, although there are exceptions to this rule (thus the so-called "May-herring," which towards the end of spring are caught, especially on the southern coast of Bohus län, are often found in company of two- and even one-year-old herrings). Cases are also said to have been observed where the two sexes went in separate schools.

In every school the larger and stronger fish precede the smaller and weaker ones. This circumstance may possibly have given rise to the well-known fable, that the herring schools are led by a so-called "herring-king," who always swims at the head of the school and whose death by violence was thought to injure the fisheries. The herrings often swim in the same order as the old northern heroes used to march, viz, in the form of a wedge whose point forms the head of the column.<sup>16</sup> A similar order has been observed among other fish and likewise among birds.

The herrings always follow their leaders, and when these change their course the whole school changes. If through some violent cause a school of herrings is scattered and broken up into smaller schools, each one of these swims in the same order as the large school used to do. Like the single herring, the schools move either in a straight line or in slightly-curved lines, and unless disturbed they do not change their course. Like some of our small fresh-water fish, the smaller herring schools, principally composed of young herring often move about in a circle, gliding gently along. Occasionally a school of herrings will describe circular movements with extreme rapidity; those in the center will then remain almost stationary, while those on the outside will move round with great velocity, such velocity increasing from the center to-

<sup>15</sup> VALENCIENNES, "*Histoire naturelle du hareng.*" Paris, 1847, p. 88.

<sup>16</sup> A. BOECK, "*Om Silden og Sildefiskerierne,*" pp. 53, 54.



wards the circumference. The Bohuslän fishermen say that the herrings are "milling," and the Dutch fishermen say they are "grinding."

Gisler says that the herrings, especially during the spawning season, push against each other with such violence that many of their scales come off and float about near the surface. This phenomenon has also been observed by the Bohus län fishermen.

Owing to outward causes the herring schools swim at very different depths under the surface, and at times even rise to the surface, which they do more frequently when out at sea than when near the coast. The herrings have thus been observed immediately after the close of the spawning process to rise to the surface and remain there for some time, quietly floating about with a scarcely perceptible movement; in clear weather the herrings may often be observed sporting about near the surface and beating the water with their dorsal fins, producing quite a shower of spray. British fishermen call this "the play of the herrings," and French fishermen, "*le jeu des harengs*," and the same name is given to it by our Bohus län fishermen,<sup>17</sup> although the word "*lek*" (play) is used by them in a different sense from the one employed by Swedish naturalists. When the herrings are thus joyfully sporting about in the water it is considered as a favorable sign for the fisheries.

The small herrings may also at times be seen moving about quickly near the surface and beating the water with their dorsal fins.

On the Stockholm coast<sup>18</sup> the herrings are said to "bathe" in the still water, which expression is probably intended to describe a gentle movement of the herring when hunting for small crustaceans. C. J. Sundevall describes this peculiarity of the herring and some other fish as follows: "*Bathing fish* so called are schools of fish which in summer keep near the surface to enjoy the warmth of the sun. This term is very expressive, and we recommend its adoption."

<sup>17</sup> See *Nordisk Tidskrift for Fiskeri*, v, p. 211.

<sup>18</sup> C. J. SUNDEVALL, *Stockholms läns Kgl. Hushållnings-Sällskaps Handlingar*, vi, pp. 84, 86, 126. H. WIDEGREN, *Några ord om sillfiske*, Stockholm, 1871, p. 3; *Tidskrift for Fiskeri*, vi, p. 66.

