

VII.—CONTRIBUTION TOWARDS SOLVING THE QUESTION OF THE SECULAR PERIODICITY OF THE GREAT HERRING FISHERIES.

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There is doubtless no phase in the history of our Scandinavian sea-fisheries which has attracted more general attention and has been of such far-reaching consequences as the periodical stoppage and return of our great herring fisheries; but, at the same time, there is scarcely a question whose solution has offered greater difficulties. For six years I have been engaged in scientific investigations of the herrings and herring fisheries on the west coast of Sweden, chiefly with a view of improving the fishery laws. During these investigations I have necessarily been confronted with the above-mentioned difficult problem, and after having given it some attention I have from time to time published the results of my investigations.¹

The old, and doubtless erroneous opinion that the last great Bohuslän herring fisheries came to an end on account of the reckless manner in which they were carried on, formed the leading scientific thought in the old fishery law, which has not yet been completely abolished, and one of whose principal features is the prohibition to catch herrings with large seines. When this whole question was subjected to a more thorough investigation, it became clear that a scientific tribunal would condemn this law. But even from a purely economical standpoint this question is of such importance to the fisheries that no trouble should be considered too great in solving it. All the works which have so far been published on the subject will show clearly that the problem is so vast, that it will require a long time and the labor of more than one person to reach a satisfactory conclusion. The following little treatise will fully show the truth of my remarks:

As an introduction to this new attempt to solve the problem in question, I shall give a brief and systematic review of all the attempts at solving it which have hitherto been made.

In reviewing all the causes, which from time to time have been assigned,

* *Axel Ljungman*, "*Bidrag till lösningen af frågan om de stora sillfiskernas sekulära periodicitet.*" Copenhagen, 1880. [Translated by HERMAN JACOBSON.]

¹ *Preliminär berättelse för 1873-74 öfver de beträffande sillen och sillfisket vid Sveriges västkust anställda undersökningarna*, Upsala, 1874, p. 23-29.—United States Commission of Fish and Fisheries, III. Report of the Commissioner for 1873-74, and '74-75, Washington, 1876, p. 137-141. Northern Ensign, Wick, October 18, 1877, No. 1429, p. 4. *Några ord om vårt stora bohuslänska sillfiskes upphörande och återvändande in Götoborgs Handels och Sjöfarts-Tidning*, January 26, 1878. *Bohusläns hafsfisken och de vetenskapliga hafsfiskeundersökningarna*, II, Göteborg, 1878, p. 24, 65-99.

of the disappearance of the herrings from our coasts, we shall soon find that they may be divided into three groups: the *first* embracing explanations of a mythical or purely accidental nature; the *second*, human agencies; and the *third*, natural causes.

A. Under the first head there would come:

1. The wrath of God manifested on account of the abuse of his gifts, or on account of the wickedness or indifference of men, Sunday fishing, denying the priests their tithes, dissatisfaction with the laws made, or the taxes imposed by the government.
2. Sorcery.
3. Shedding of blood.
4. Cruelty towards the herring.
5. Using herring as manure.
6. Occurrences which by mere accident were simultaneous with the disappearance of the herrings, *e. g.*, the burning of sea weeds, the establishment of new light houses, &c.
7. The failure of the whales and other so-called herring-hunters to drive the herrings toward the coast.
8. Caprice of the herrings, or their natural instinct.

All these causes, which doubtless were very popular among the common people, imply the going away of the herrings to another place which proved itself worthier of such a blessing.

B. Under the *second* head come all those causes which may be assigned to human agencies:

1. The herrings have been gradually destroyed, their schools becoming smaller and smaller towards the end of the fishing period. This result has been brought about—
 - a. By excessive fishing, and more especially by catching the young herrings with seines having narrow meshes.
 - b. By preventing the herrings from reaching their favorite spawning-places.
 - c. By destroying the roe.
 - d. By disturbing those places where the young herrings were in the habit of seeking food and shelter.
2. The herrings have slowly but surely been driven away by—
 - a. Noise.
 - b. By unsuitable fishing-apparatus, by fishing with seines during daytime, or by using drag-nets too early in the season.
 - c. By disturbing the spawning-process.
 - d. By disturbing the spawning-places by seine-fishing or by throwing refuse in the water.
 - e. By leaving dead herrings at the bottom of the sea, or by throwing guts and gills into the water.
 - f. By throwing fish-oil refuse in the water.
 - g. By preventing the schools of herrings from reaching their accustomed spawning-places.

- h. By reckless fishing, thus depriving the herring of his necessary food.
- C. Under the *third* head would come all natural causes :
1. The herrings have been destroyed by the unfavorable condition of the weather, by an unusual number of fish of prey and birds of prey, by lack of food, &c., by various natural causes hurtful to the roe, the young fish and the fully-grown fish.
 2. The herrings were obliged to leave the coast in consequence of—
 - a. Changes in its physical condition both meteorological and hydrological (accidental or periodical), as likewise changes in the nature of the bottom, principally at the spawning places.
 - b. Changes of a biological nature, *e. g.*, an increase in the number of fish of prey or birds of prey; lack of food; or changes in the character of the local fauna and flora, occasioned by overwhelming masses of herrings flocking towards one point.
 - c. A secular periodicity in the natural condition of the whole region where herrings occur, thus obliging the large schools of herrings to change their spawning-places and their places of sojourn during the early part of their life.

Of all these explanations only the last mentioned shall form the subject of further remarks, and it will be our object to find out whether there is really any secular periodicity in nature sufficiently strong to cause the disappearance of the herrings from certain coasts.

In the year 1843 the well known astronomer, Mr. S. H. Schwabe, at Dessau, succeeded in proving that the solar spots known since the second decade of the seventeenth century were periodical in their occurrence; and in 1852 it was found that "the daily variation of the magnetic needle lasted exactly as long as the period of the solar spots, and that this variation reached its utmost limit at the time when the solar spots were most numerous, and was scarcely noticeable when the solar spots were fewest in number." The average length of the solar-spots period was by Wolff found to be 11.11 years; Schwabe had previously put it at 10 years, and Lamont, in Munich, at 10.48; whilst Wolff, Fritz, and others proved conclusively that there were longer solar-spots periods, comprising about fifty-five and one-half years. Other scientists, however, put the length of the longer periods at a different figure, *e. g.*, Köppen at forty-five years, Lemström fifty-eight, Klein sixty-seven, and Hornstein seventy. In 1862 Fritz, and in 1873 Köppen showed a correspondence in the occurrence of northern lights and the changes in the solar-spots periods.* Thus evidence was constantly accumulating to prove the great influence which the solar spots exercise on our earth. Among the evidence bearing more directly on our question the most important is doubtless the correspondence between the occurrence of the northern lights and the solar spots discovered by Fritz, and the fact

* The periodicity of the northern lights had already been spoken of during the last century by Mairan, Wargentin, Th. Bergman, and others.

of there being periods in these phenomena embracing twenty periods of the lower order, and extending over two hundred and twenty-two years.

We will now endeavor in the same way as the changes in the weather, the harvests, the migrations of the grasshoppers, &c., have been compared with the solar spots periods, to compare these latter with our Bohus län herring-fishery periods, and we shall find that there is such a remarkable correspondence between the two that it can scarcely be considered accidental. Starting from the last of the above-mentioned fifty-five and one-half years' periods, viz., the one extending between the minima of solar spots, 1810-1867, we will give a series of fifty-five and one-half years' periods, and with each of these we will mention briefly whatever is known regarding the "genuine sea-herrings" periodical occurrence on the coast of Bohuslän, and when we have no data whatever we will mention such occurrences as can possibly be supposed to have some connection with the herrings' periodical occurrence; for from the time previous to the year 1300 we have scarcely any information regarding our Bohuslän herring fisheries.

1867-1922. (Rich fisheries began in 1877.)

1811-1866. (No good fisheries.)

1755-1810. (Rich fisheries 1748-1808, which, especially during the last quarter of the eighteenth century, assume enormous dimensions.)

1699-1754. (No specially good fisheries till near the end of the period from 1747 or 1748.)

1643-1698. (Good fisheries, at least between 1660-1680.)

1587-1642. (No good fisheries.)

1531-1586. (Particularly good fisheries, at least between 1556 and 1587.)

1475-1530. (No good fisheries.)

1419-1474. (Good fisheries, at least about the middle of the century.)

1363-1418. (No good fisheries.)

1307-1362. (Particularly good fisheries, at least during the first thirty years of the century, which probably already commenced towards the end of the preceding century.)

1251-1306. (At the beginning and about the middle of the period no good herring fisheries, although probably the fisheries were good towards the end.)

1195-1250. (Probably there were good fisheries, judging from the fact during this period Gullholmen, Öckerö, and other desert islands were colonized, and the convents of Marstrand and Dragsmark were founded.)

1139-1194.

1083-1138. (Probably there were good fisheries, during which Konungahella became the most important commercial city of the north.)

1027-1082.

971-1026. (Good fisheries, at least during the reign of Olaf the Saint.)

915-970. (No good fisheries, at least during the beginning of the reign of Gunhild's sons.)

859-914.

From this series of fifty-five-and-a-half-years' periods, it will be seen, first, that large numbers of sea-herrings came to the coast of Bohus län during every other one of these periods, producing good fisheries and consequent wealth; second, that unusually good fishery periods changed about with less good ones. Thus, the herring fisheries during the fifteenth and seventeenth centuries were far less important, and probably did not last as long as those of the fourteenth, sixteenth, and eighteenth centuries. In the above series this change has been indicated by putting some of the figures in heavy-faced type. The Bohus län herring-fishery cycles seem therefore to correspond exactly with Professor Fritz's great Northern lights' periods of about two hundred and twenty-five years each, and to include one very good and one less good fishery period, as well as two intermediate periods when the sea-herrings staid away from the coast. From what we know concerning our periodical herring fisheries, it appears that the interval between the good fisheries of the fourteenth century and those of the sixteenth century was longer than the interval between those of the sixteenth and eighteenth centuries, and that the interval between the good fisheries of the thirteenth and fourteenth centuries, and between those of the seventeenth and eighteenth centuries was probably shorter than might be supposed, for between the two last mentioned it is said to have been only fifty years.³ Such differences in the length of the periods are also known in the periods of the solar spots, those whose average length is 11.11 years often being only eight to fifteen years long. It is probable, however, that these differences indicate still longer periods, during which they recur with a certain regularity. Thus, in the series given above, the differences following each other make it probable that there is a larger period of four hundred and forty-four and one-half years, with which the former rich herring fisheries on the coast of Skåne and Zealand may correspond.

It is also a strange phenomenon that the most flourishing fisheries of a herring fishery period coincide with or occur about the same time with the liveliest formation of solar spots, and the most numerous northern lights during a fifty-five-and-a-half-years' period,⁴ and that a peculiar

³ O. LUNDBECK., *Antekningar rörande Bohuslänska Fiskerierna i synnerhet Sillfisket*. Göteborg, 1832, p. 36.

The fact that the interval between two Bohus län herring-fishery periods is as high as seventy years may be explained by the small alternating fishery periods having only occupied a part of the fifty-five-and-a-half-years' period; even the unusually rich herring-fishery periods do not seem to have always occupied the whole of that period, although in some cases, *e. g.*, during the eighteenth century they may have been even a few years longer.

⁴ By comparing the different statistical data regarding the revenue derived by the government from the herring fisheries during the present and the last century with Wolf's relative figures, I have not been able to find any very striking coincidence between the occurrence of solar spots and good fisheries; but it seems that, *e. g.*, in the Scotch herring fisheries the best fisheries occur generally two to five years after the maximum number of solar spots, and the smallest, one to three years after their minimum number. A more striking coincidence may possibly be shown between the

change took place in the relation between the solar spots and the temperature during the last decade of the eighteenth century, when Bohuslän, as is well known, had the richest herring fisheries which have ever occurred. As there are also traces of such a change during the latter part of the seventeenth century, it is not improbable that such a change always coincides with the frequent occurrence of the sea-herrings on the coast of Bohuslän.

It is self-evident that this little treatise can by no means claim to have answered satisfactorily the question regarding the causes of the secular periodicity of the great herring fisheries, and more especially of the Bohuslän fisheries, but it may serve to direct attention to a hitherto not yet attempted way of explaining this dark problem, and to decrease the belief in the old explanation of the periodicity of the herring fisheries of mans disturbing the household of nature by the fisheries. In order to show more fully the coincidence between the herring fisheries and the solar-spots periods, scientists and historians should work hand in hand. It cannot be expected of scientists that for the sake of a few data they should go through the immense collections of documents in our archives or through the whole range of historical literature, and thus gather all the necessary facts from former times; but these facts should be obtained by persons who have made a life work of the study of history. By such work done by the officers of the Royal Norwegian Archive, it became possible for Axel Boeck to furnish quite a number of new and interesting contributions to the history of the Bohuslän fisheries.

As regards the manner in which a coincidence between such vastly different phenomena as the solar spots and northern lights and the herring fisheries is brought about, we can only point to the influence of the solar spots on the weather and thereby on the currents of the sea. Here we therefore find a rich field for long-continued observations by which the necessary hydrological material should be gathered for proving the actual occurrence of such regular periodical and secular changes in the direction and intensity of the currents of the sea, by which a change in the occurrence of herring food and the consequent migrations of the large schools of herrings could be explained. It is probable, however, that ere long science will have obtained all the necessary data, so that the greater portion of what is still wanting can be supplied by careful calculations.

In looking at the advantages which our new method of explanation affords we shall, by comparison with the other attempts in this direction mentioned above, find very soon that it is the only way of explaining both the temporary and local regularity in the secular periodicity of the

solar spots and the mackerel fisheries, as the mackerel are, according to the observations of many fishermen, most frequent when the sky is full of cirro-cumuli, or so-called "mackerel clouds," which are known to be in some way connected with the solar spots. As soon as I have gathered more material I hope to be able to give fuller information on this interesting subject.

great herring fisheries, and their varying length and importance. It not only explains the varying occurrence of the herrings during the period and their final disappearance, but also their regular return; and it does this in a manner which offers far less difficulty than the older explanations, not even excepting my own explanation of these phenomena by changes in the cenobitic condition of the spawning-places produced by the disproportionately large size of the schools of herrings.

The theory which I have advanced throws new light on the herring fisheries and on the nature of the herring which at some future time may be the subject of another treatise.

