

XVIII.—SPECIAL RESULTS OF THE INVESTIGATIONS RELATING TO THE HERRING AND HERRING FISHERIES ON THE WEST COAST OF SWEDEN MADE DURING THE YEARS 1873-1883.*

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1. NATURAL HISTORY OF THE HERRING.

As regards the preparation of a natural history of the herring, I have found it necessary, in view of the principal aim of my investigations, and my limited time and means, to confine my work to the preparation of what was of special importance for this aim, and what could be obtained in the unfavorable circumstances under which I had to work. Here, as the Royal Academy of Sciences stated in its memorial of March 12, 1873, a larger force of men and an ample supply of apparatus was needed; and as this requirement was not met, I felt compelled to abandon the special investigations of such matters as formed the subjects of exclusive observations by other naturalists, and to concentrate my activity upon those subjects which were essential towards answering the questions in law and general administration, which I had met with; such as, the "spawning of the different races of herring;" the cause of the periodicity of the Bohuslän herring fisheries; and the gathering of general data relative to the races of the herring and the sprat, their propagation, growth, mode of life, their migrations, and their physical and biological causes.

As regards the different races of herring and their spawning, the investigations have shown that the herring which forms the object of the famous Bohuslän herring fisheries is a sea herring, belonging to the North Sea, which spawns partly during the first part of autumn and partly towards the end of winter or in the beginning of spring, and which only at secular periods visits the eastern part of the Skagerack; whilst the herring which permanently lives in these waters is a coast herring and spawns in spring. The younger among these coast herring seem to spawn later in spring than the older ones; according to G. Winther's observations this is also the case with the herring in the sound, which spawn in autumn. Professor Nilsson, however, supposes that the very reverse is the case with the herring in the Kattegat, which spawn in

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autumn, and thinks that the younger herring spawn before the older ones. This whole question deserves to be further investigated both as regards the herring fisheries in the Kattegat, and in the North Sea. The information relative to the permanent occurrence in the eastern part of the Skagerack of herring which in autumn spawn on the coast of Bohuslän has not been fully verified. The two principal kinds of herring referred to above; viz, the coast herring, which spawns in spring, and the sea-herring, which spawns in autumn, are even at the present time caught in considerable quantities on the coast of Bohuslän. As they are principally half-grown fish of medium size, they must come mostly from some other place than the eastern Skagerack. Although it has so far been impossible to obtain absolute certainty as to the proper home of these herring, it is nevertheless highly probable that such herring from the Kattegat, or perhaps from the North Sea, pay occasional visits to the coast of Bohuslän. In that case we would perhaps be justified in speaking of an identity of race between this half-grown herring and the so-called "old" sea herring. The question of difference of race and local origin of the herring visiting the coast of Bohuslän is, however, so complicated and difficult, that it will hardly ever be satisfactorily answered; even in the best view the time for such a solution is very far distant. The external differences of shape between the different races are very small, and, moreover, individuals of one and the same race frequently differ from each other. People have gone too far, however, when on account of such differences and connecting links between the various races of herring, they have concluded that there is no difference of race at all, but only a difference of individuals. By arguing in this way, the existence of any race of animals might be denied, which would mean nothing more nor less than cutting the knot instead of solving it. If no such variations or connecting links could be proved, we would be confronted by different species, and not by varieties of one and the same species. To prove the existence of varieties presupposes always that we should find some variations from the same, which in reality are nothing but exceptions from the common rule.

Relative to the spawning season of the sea herring which, during the winter of 1877-'78, returned to the coast of Bohuslän, there has been a difference of opinion between me and Mr. von Yhlen and Prof. T. A. Smitt, who declared that these herring visited the coast of Bohuslän for the purpose of spawning, and that they spawned there during the first part of winter; whilst I maintained that they did not visit the coast for the sake of spawning, and, moreover, that they were partly herring belonging to a variety which spawns in autumn, and partly such as spawned towards the end of winter and beginning of spring; the same occurs on the east coast of Scotland, where two different kinds of herring are found, which spawn at different times. The correctness of my view has been proved by the experience of later years, and by other naturalists. Professor Smitt, in his report to the minister, of

October 25, 1880, gave the spawning season of the sea herring in accordance with my view, but Mr. von Yhlen not only held to his erroneous and fully refuted opinion, but even gave more opinions of a similar character, showing that even in his published reports he does not blush to deliberately make statements which he knows not to be true. As regards the common opinion—also defended by my opponents—that the principal characteristic of the great Bohuslän coast herring fisheries was that they related to spawning fish, I stated emphatically that this had not been the case during the greater portion of the preceding herring period, and that probably there would be no difference in this respect during the period recently begun. I also advanced a theory that, as a general rule, fisheries for spawning fish occurred about the middle of a Bohuslän herring period—changing my views in accordance with actual facts—whilst my opponents endeavored to change these facts and to make them agree with their preconceived opinion. The undoubtedly correct statement made by me in the beginning of 1879 that the herring fisheries which commenced on the northern part of the Bohuslän coast during the winter 1877-'78 were not fisheries for spawning herring, has, strange to say, been interpreted by Professor Smitt (who in 1880 took my opinion to be correct) in such a manner that I seem to have denied that a new fishing period had commenced during that winter.

As regards the herring which spawn towards the end of winter and generally in the beginning of spring, and which in comparatively small quantities are caught among the other herring, several opinions have been advanced. Some believe that these are the older and stronger individuals of the coast race of herring (spawning in spring)—Prof. S. Nilsson and others—whilst others think that they are a separate and more pelagian form of herring (*H. tridegren*), belonging to the fauna of the eastern Skagerack. Others again suppose that, like the sea herring spawning in autumn, they are herring which, during the fishing period, have immigrated from the North Sea, in which latter case they may either form a separate race of herring (my own view) or be simply the older among the sea herring (*F. Trybom*) which spawn in autumn. The opinion advanced by Professor Nilsson at one time (in the beginning of 1879) seems to me to offer a simple explanation of the case, and therefore is admissible; I consequently endeavored to make it agree with the circumstances of the Bohuslän herring fisheries, both between and during the herring periods. On the coast of Bohuslän, and on some other coasts, rich herring fisheries generally commence with small and inferior herring, which seem to have their home near the coast; and only after the fisheries have been continued for some time are herring caught, which come from a greater distance. This fact may be explained either by the herring living near the coast having to give way to the great masses of herring coming from the sea, or by supposing that both these kinds of herring are enticed or driven towards the coast by one and the same cause, in which case those nearer to the coast are, of

course, caught first. If the race of great herring in question had its permanent home in the eastern Skagerak, it ought to approach our coast only a little before (or almost at the same time with) the herring which come from a greater distance; whilst on the contrary, like all large and full herring, they remain in greater depths, and never go as high up the fiords as the smaller or the spent herring. Dr. Trybom's objection seems to have been caused by his overlooking the common circumstance that rich herring fisheries are preceded by small and inferior herring, and that the herring in question need not be found any nearer the coast than the spent herring, even if they should have entered a large fiord somewhat earlier than the latter. Last year's experience, however, seems, in my opinion, to point to the fact that these herring are a separate race, which possibly may in some way be connected with the Norwegian spring herring, which they resemble in several important points. Dr. Trybom, who, during the winters of 1880-'81 and 1881-'82, visited the coast of Bohuslän to study the herring and the herring fisheries, considers it probable that the larger among the herring spawning in autumn which visit the coast of Bohuslän, finish their spawning process so late in the season, that instead of its going on during the coldest season, it goes on towards its close, which is towards the end of winter or beginning of spring. As an objection to this view it may be said that a delay of from three to four, and even five months in the spawning season of part of a race of herring, although on the east coast of Scotland and some other places, assumed as an explanation of entirely different circumstances, is hardly credible, and has, as a fact, not been observed either in the North Sea or the Kattegat. No such autumnal spawning is known on the west coast of Norway. The herring which spawn in spring in the southern Kattegat and the Sound and Belt are smaller than the herring of the same waters which spawn in autumn; and are, moreover, distinguished from the latter by external differences of form. The herring of the southern part of the North Sea, which spawn towards the end of winter, also seem to be smaller than the herring of the same waters which spawn in autumn. This whole question can hardly be answered satisfactorily before the present Bohuslän herring period has come to a close, and proper observations have been made relative to the interval between the periods. It is not, however, of any great practical importance, at least as far as the choice between Dr. Trybom's opinion and mine is concerned. If we desire to enter the unlimited domain of suppositions, we shall here find a promising field for numerous new hypotheses.

As regards the question of the origin of the different races of herring, it will be sufficient to say that as a general rule it is treated in too one-sided a manner as an isolated fact, or, at best, but few of the circumstances which have something to do with it are taken as a sufficient explanation. The same remark also applies to the question as to what races of herring are actually found in the Skagerack. This as a

general rule has been treated far too lightly. If it is desired that this question should be answered in a more satisfactory manner than it has been thus far (which is amply sufficient as far as the aim of my investigations is concerned), a person should be commissioned to make observations, who can give his whole time and undivided attention to the subject.

The spawning-places which are the immediate occasion of the great Bohuslän herring fisheries during the intervals when the herring do not enter the eastern Skagerack, and during the herring periods when they do not spawn near the coast, are not known; and owing to lack of time and means I have not been able to make a search for them, although from information furnished by fishermen and from other circumstances known to me, I have been enabled to form a tolerably correct idea as to their location. It is certain, however, that Mr. von Yhlen's and Professor Smitt's supposition that the herring spawn in the open sea, off the coast of Bohuslän, in the great depths, and on the soft clay bottom which is found there, is incorrect; for nothing of the kind is known from any other sea; but, on the contrary, wherever the spawning of the herring has been observed it invariably was found to take place on a hard bottom, or on one covered with rich vegetation. It should be remembered that the spawn of the herring adheres to the object over which the spawning process goes on, and that therefore the clay bottom of the great depths cannot be a suitable place.

Another question of great importance relative to the object I had in view was the one as to the cause of the close of the last Bohuslän herring period, and of its return. With the view to explain this periodicity from physical or biological circumstances, I have endeavored to ascertain, as accurately as possible, the influence of these circumstances on the movements of the herring, and have at the same time studied as carefully as possible all the historical data relative to the different herring periods and the great herring fisheries in the North Sea. I have done this in order to find out whether a secular periodicity was a general characteristic of these fisheries, and whether this very periodicity formed a sort of connecting link between the different fisheries. My observations have finally led me to the conclusion that the great Bohuslän herring fisheries for nine centuries have formed a regular series of periods, which, in spite of what Axel Boeck thinks he has proved, alternated with the great spring herring periods on the west coast of Norway; and that, owing to the great depth of the sea and the lack of great connected banks, suitable for spawning places, off the coasts of Norway and Bohuslän, the coast fisheries in these regions could not be carried on with seines at all times with the same favorable results. On the other hand, near the coasts of Great Britain there is found an extensive plateau of such banks, whose location is such that the fishermen can reach the herring when they move towards these banks, or when they occupy them, without being obliged to go away from the

coast far enough to take from their fisheries the character of coast fisheries. Owing to the distance, it is almost impossible, at least with sailboats, to carry on any coast fisheries on the coast of Bohuslän during the period when the sea herring do not enter but pass by the Skagerack on their way to the spawning grounds in the North Sea, as is the case during the intervals between the Bohuslän fishing periods. I have also succeeded in explaining in two new ways the secular periodicity of the Bohuslän herring fisheries; and so far all attempts to disprove my arguments have proved unsuccessful. In the first place I have endeavored to explain this periodicity by changes in the prevailing biological conditions, consisting in a gradual change of the local fauna and flora of the sea through the great masses of herring visiting these regions for many years in succession; and in the second place, by assuming a secular periodicity in all the outward conditions of nature prevailing throughout the entire region inhabited by herring. This last-mentioned periodicity is supposed to compel the great schools of herring to move from one place to the other in search of food, and also of spawning places. It is very probable, however, in my opinion, that these two causes work together. In giving this explanation I have also been able to explain the regular changes of time and place where the sea herring, during the fishing period, approach the coast of Bohuslän. By continuing my observations I arrived at the conclusion that the second way of explaining the periodicity is probably the one which reveals its most important cause, since I succeeded in showing that the Bohuslän herring periods agreed with corresponding and well-known periods in the change of weather, the occurrence of northern lights, the number of solar spots, &c.; and that the richest fisheries during a period correspond with a peculiar disturbance of or change in the relation between the solar spots and the temperature, which only takes place during the periods when there are herring fisheries on the coast of Bohuslän, but not during the intervals between the periods. These periods on an average last fifty-six years; and as several scientists, with good reason, have sought to explain these periods in the occurrence of solar spots from the varying position of the principal planets towards the sun, it seems to me that we may look in the future for so complete an explanation of all these circumstances that we shall be enabled to tell beforehand with some degree of certainty when these periods will occur, and in what respects they will differ from each other. From what is so far known relative to the Bohuslän fishing periods, I have considered myself justified in drawing the conclusion that as regards the extent of the fisheries, very extensive and less extensive periods alternate. The reason why the intervals between the fishing periods are not equally long must be sought in the fact that the herring come near the coast at a time which varies with every period, which of course also causes the fishing period on the inner coast to vary in length. It may also be supposed that the different fishing periods differ in another important point. Thus, the

present period does not seem to show a regular tendency to rapidly develop into decided autumnal fisheries, most productive on the southern part of the coast, which so strongly characterized the preceding period, so far as known the longest of all Bohuslän herring periods; the present period also began some years after the beginning of the fifty-six years' period, whilst the preceding period commenced some years before that time. My explanation of the cause of the secular periodicity of the great Bohuslän fisheries is also of great practical importance to the fisheries, as it enables us to tell with a considerable degree of certainty when the fishing period will come to a close. It is not known that any of the preceding fishing periods continued after the corresponding period of solar spots and northern lights.

In accordance with my view of the causes of the secular periodicity of the great Bohuslän herring fisheries, I was enabled to predict as early as 1875 and 1876 that a new herring period was near at hand, which prediction I based partly on the historical experience relative to the return of these herring fisheries after a certain time, and partly on the considerable changes in the great North Sea herring fisheries, observed since the winter of 1860-1870, and the occurrence of sea-herring in the western part of the Skagerack during the autumn of 1875. Since the beginning of the present fishing period, Professor Smitt stated in his report to the minister, dated April, 1878, that as early as 1876 he had mentioned in the Royal Academy of Sciences a change in the migrations of the schools of herring, caused by the circumstance that several large fish of the mackerel kind, especially those known as "herring-hunters," had come near the coast of Bohuslän; and later he refers to this statement in such manner as if he intended to say that he had predicted the near approach of a new herring period. This highly improbable supposition was proved by me to be incorrect, and nothing more has been heard regarding such "herring-hunters" from more southerly seas, where no herring are found. Nothing of the kind is known relative to the Norwegian, Scotch, Iceland, and American herring fisheries, and the first fish of the kind (herring-hunters) was caught on the coast of Bohuslän, as early as 1863, therefore many years before the changes in the North Sea herring fisheries referred to above took place. As fish belonging to southern seas are every now and then observed on the west coast of Sweden, the occurrence of these mackerel does not justify us in assuming a change in the currents of the sea; there are, moreover, circumstances which speak more for an increased access of northern than of southern water to the waters of the Skagerack.

2. HISTORY AND STATISTICS OF THE HERRING FISHERIES.

As regards the history and statistics of the Bohuslän herring fisheries, the result of my investigations has, so far, principally consisted in the publication of brief reviews on the history of these fisheries. But I have made extensive studies for a comparative history not only of

these, but also of the great North Sea herring fisheries, with the view to throw more light on many a fact in natural history and political economy, which is of importance in the definite solution of the great herring problem. These studies should, however, be continued in foreign libraries and archives, before it is possible to obtain sufficient material for producing a work which will materially benefit science and the public. I shall, however, give a brief review of the more important points in my observations, so far as they have been published.

As I have already stated above, I have succeeded in showing the probability that the Bohuslän herring periods form an entirely regular series, which can be traced, though not in all cases with absolute certainty, for nine centuries. Formerly all this was a matter of mere supposition, but I succeeded in furnishing undoubted proof of the herring period during the fifteenth century by the old document of June 22, 1496, relative to the Vinga coast and its allegiance to Sweden and Nesterötland. The proof which Asel Boeck produces for herring fisheries on the coast of Bohuslän during the fifteenth century is a bull of Pope Nicholas V, dated July 15, 1453, relative to the nobility's refusing to pay the tithes of fish; but this bull may refer to the Norwegian coast as well as to the Swedish coast. Still less importance can be attached to Boeck's supposition, that a legend mentioned by Peder Claussön Früs of herring fisheries which had been disturbed by sorcery refers, to the herring period of the fifteenth century.

I have also shown that the herring period mentioned by Boeck, as having taken place between 1260 and 1340, and given by him as a proof that the Bohuslän herring fisheries and the Norwegian spring herring fisheries took place about the same time, did not take place at that time. It is hardly credible that fisheries which commenced in 1260 should within a few years have developed to such a degree as to cause the islands on the coast of Bohuslän to be cultivated. King Hakon the Old died during an expedition to Scotland in 1263, and the improvements on the coast of Bohuslän for which he is praised in the Sagas, and which seem to point to rich herring fisheries, could hardly have been made during the last years of the old king's life, which were greatly disturbed by wars. There is, therefore, no reason to suppose that there were rich herring fisheries on the coast of Bohuslän during the thirteenth century, but it is certain that such fisheries took place on the Bohuslän coast in the beginning of the fourteenth century, at the same time when it appears that but few herring came to the coast of Norway. The fisheries during the reign of King Hakon the Old, referred to by Boeck, probably took place during the first half of the thirteenth century, so that we would get two herring periods instead of one. For the same reasons that Früs, Holmberg, Boeck and others have supposed that herring fisheries took place during the reign of Hakon the Old, we may suppose that such fisheries took place during the reign of Sigurd Jorsalafar. Taking the herring periods, which are well established,

during the eleventh, sixteenth, seventeenth, and eighteenth centuries, we get a regular series of herring periods, alternating with intervals when no herring came near the coast; and we are justified in explaining this secular periodicity from natural causes.

I have gathered many important data relative to the herring periods during the seventeenth and eighteenth centuries, thus, *e. g.*, that during the seventeenth century the fisheries first came to a close in the southern part of the coast, and that during the eighteenth century the fisheries commenced in the northern part of the coast, &c.

I have studied all the old authors on the subject, and have arrived at the conclusion that as early as the first half of the seventeenth century people knew that these fisheries were secular and periodical. I think I have also succeeded in showing, in opposition to Boeck's views, that the Bohuslän herring fisheries alternate with the spring herring fisheries on the west coast of Norway, so that these two fisheries never flourished at one and the same time, but that they commenced on one coast when they came to a close on the other, and *vice versa*; and I have finally been able, guided by historic data, to predict the near approach of rich herring fisheries at a time when Mr. von Yhlen proclaimed in the newspapers that no such fisheries could be possibly looked for. I have also by my study of the comparative history of the herring fisheries been enabled to furnish important contributions towards a more correct view of the actual importance of the old Scania and Dutch herring fisheries, and have pointed towards a possible secular periodicity in the Dutch herring fisheries in the Zuider Zee and the Scotch herring fisheries in the Firth of Forth and the Moray Firth.

As regards the statistical part of my work, its very nature confined it to the gathering of the data which are absolutely necessary for judging of the value of the present Bohuslän herring fisheries, and to the study of such statistics relative to foreign fisheries as might aid in throwing more light on the subject in hand.

3. VARIOUS METHODS PURSUED IN THE HERRING FISHERIES.

Of far greater interest to the general public, and much better known, have been my labors relative to the methods of carrying on the herring fisheries on the coast of Bohuslän. The different views as regard the best method of carrying on these fisheries have led to a lively interchange of opinions, in which my views have met with most favor, although they could not afford the fishermen any pecuniary assistance from the public fund. All I have aimed at was to influence public opinion and thus to exercise a good influence on the development of the fisheries, which unfortunately cannot be said of the endeavors of my opponents.

As I had no means of introducing by way of experiment new fishing apparatus and methods, I had to confine myself to point out, principally

by statistical data, the different economic advantages of the various methods and apparatus. The same formed the object of Prof. S. Nilsson's and other prominent scientists' studies half a century ago. They started, however, from the supposition that, as regards the method employed, the herring fisheries on the south coast of Sweden could hardly be excelled. Their ideas were very correct, however, as to the desirability of the Bohuslän people retaining their method of seine-fishing, unless they were forbidden to do so; the consequence was the prohibition of such seines for the herring fisheries by paragraph 22 of the fishery law of 1852. Their opinion that nets are absolutely preferable for the herring fisheries has been refuted by me, when I showed that different economical and physical conditions may necessitate the use of different apparatus and methods of fishing, and that because a certain apparatus or method is the best in one locality one is not justified in supposing that it should apply to every other locality. I have furthermore called attention to the enormous difference between fisheries on a large and a comparatively small scale, and have shown that even fisheries of the latter kind may pay in those parts of the coast of Bohuslän where, owing to the small quantity of fish, the prices are very high. In the very beginning of my labors I was enabled, guided by statistics from Scotland, to show the absolute necessity of equipping large and more powerful boats and furnishing them with superior apparatus, if the seine fisheries in the Skagerrack were to yield good results, and have pointed out this necessity in my memorial to the minister dated in February, 1878. Seine fisheries carried on during autumn and winter in the open sea require strong boats and numerous seines, so that the quantity of fish in the various hauls may make up for the naturally smaller number of chances to make hauls, and that the number of these chances may be increased by the use of strong boats and superior apparatus as is done by the Yarmouth fishermen and others. All this, however, requires more capital than our fishermen can command at the present time; great herring fisheries with seines cannot be developed all at once, not only because they require much capital, but also competent men to lead the fishing expeditions, and experienced sailors and fishermen. The German experiments at Emden show how much time it takes to develop such fisheries to any considerable degree of importance.

I have never, as Professor Smitt seems to intimate, worked against the introduction of seine fisheries, but all I have done was to publish reports, for the benefit of the public, on the relative advantages of the different kinds of apparatus, and in this connection I have pointed out the facts that seine fisheries on a large scale required, not only much capital, but also so large a number of fishermen, that on the coast of Bohuslän we would have to take them away from other trades; that the development of the Bohuslän fisheries, starting from the present method and aiming at such fisheries as are carried on on the northeastern coast of America, would be most desirable under the existing circum-

stances. The American method of carrying on the fisheries, with large and fast vessels and seines, promises to us profitable fisheries, and to especially develop the herring fisheries in such a manner that, instead of drawing the fishermen away from the great sea fisheries, and thus hurting them, they will, on the contrary, be furthered and increased to a degree of prosperity hitherto unknown with us.

Professor Smitt has several times reproached me that by my experiments I had endeavored to introduce large seine fisheries for herring in the Skagerack, and declared that our population would thereby suffer considerable losses, to which I could boldly reply that I did not have a single cent at my disposal for making such experiments.

As the terms "great fisheries," "great sea fisheries," and "fisheries at a distance from the coast" (*utomskärsfiske*) refer to very different kinds of fisheries, and should not be confounded with each other, I shall give a brief explanation of their meaning. As the "fisheries off the coast" are carried on under such circumstances that the fish cannot be taken home every day, but must be either kept or prepared on board the vessels, or delivered to other vessels out at sea, they are called "great sea fisheries." "Great fisheries" are those sea fisheries which are carried on on a large scale in the service of private capital, as is the case with the seal and whale fisheries. "Great fisheries" can be carried on both at a distance from the coast and near it. As "great fisheries" at a distance from the coast, we may mention the great Dutch herring fisheries in the North Sea, the beam trawl net fisheries in the North Sea, the French and English cod fisheries near Iceland, &c. As "great fisheries" near the coast, we may mention the former herring fisheries of the Dutch and Germans near the west coast of Scandinavia, the former Dutch herring fisheries on the west coast of Scotland, the herring fisheries of the Northmen near Iceland, &c. Coast fisheries can be carried on both near the coast and at some distance from it, as the natural conditions will allow.* The most important coast fisheries in Europe are the Scotch herring fisheries, and the Norwegian cod fisheries near the Loffoden.

I have endeavored to benefit the herring industry, as regards the catching and salting of the fish, and as regards the results of the fisheries, by publishing a review of the influence, on the migrations of the herring, of physical conditions.

As regards the preparation of herring and the herring trade, my activity has, likewise, from want of funds, been limited to the publication of several pamphlets, by which I have endeavored to create a public opinion in favor of the introduction of suitable improvements in the methods of preparing fish, and of proper laws for aiding and encouraging this trade.

Thus, at the very beginning of the present fishing period, I made translations of Th. D. Lauder's and O. N. Løberg's works on the preparation of herring, and pointed out the great importance of having that portion

of the public which is interested in this question supplied by the Government with a sort of a text-book giving in a brief and concise form all the necessary instructions for successfully carrying on this industry. My translations were printed in a Swedish paper, and likewise in pamphlet form for distribution among the population of the Bohuslän coast. Later, I prepared and published some pamphlets on the pickling and salting of herring, on the herring trade, &c., with the view to awaken new interest in this trade, and in the hope that by introducing improved methods this industry might be further developed, not only as regards the sale of fish, but also as regards the introduction of improved apparatus, &c. In consequence of my endeavors, the Economical Society called in some Scotchmen to teach our people to salt herring after the Scotch method. In May, 1882, I was allowed 1,200 crowns (\$201.60) for a journey to Scotland, which I took the following summer. I studied the Scotch preparation of herring on the spot, and, on my return, publishing an account of my trip and of the observations made.

Relative to the herring trade I have commenced extensive studies, to complete which I should, however, undertake several journeys abroad. What I have published in this direction is, so far, the only systematic review of the subject.

4. CARE OF THE HERRING FISHERIES.

The question as to the care of the Bohuslän herring fisheries has for a long time, and I think unnecessarily, been a disputed one. By the care of a fishery we understand the measures which are taken to make the fishery as productive and permanent as possible. This care may be exercised by the state, by proper legislation and administrative measures, or by private effort, in preparing spawning places, or making such places accessible by fish culture, taking care of the young fish, &c.; it may be exercised in a negative manner by preventing any disturbance of the spawning process and the use of hurtful apparatus, and by limiting fishing as to time and place, &c.

When the great Bohuslän herring fisheries came to a close in 1808, and when those persons who had invested in expensive apparatus suffered heavy losses, producing unheard-of suffering on the coast of Bohuslän, it was natural that people began to think and speculate a great deal on the causes of this misfortune, and on the possibility of seeing these fisheries revived. Among the more educated people the view became prevalent, especially after they had become convinced that the "sea herring" proper had left the Skagerack, that the herring had been chased away by exhaustive fishing, by noise, and by throwing fish-oil refuse into the water. This view was publicly expressed in a pamphlet published by a salter in 1822.

This, and the repeated demands for pecuniary assistance from the Government to aid the fisheries and the poor fishermen, at last induced the

Government to order a scientific investigation with the view to get reliable information as to the actual state of affairs. This investigation was entrusted to Professor Nilsson, who visited the coast of Bohuslän during the summers of 1826, 1827, 1832, and 1833. In his reports Professor Nilsson gave in their main outlines the views given above as to the causes of the herring fisheries coming to an end, and thoroughly refuted (as to some extent M. E. Bloch had done before him) the hypothesis advanced by Dr. J. Anderson, of Hamburg, Germany, that the herring had their home near the North Pole, and migrated thence; but in his zeal he went too far in the other direction, by considering the herring as a fish which is confined to the place of its birth and its nearest surroundings. He further thought that by outward differences of race the herring showed from what part of the sea they came; and, therefore, as "two different races of the same kind" could not be supposed to "live in the same waters, and under entirely the same conditions," the so called "old" herring, or "sea herring proper," the somewhat smaller coast herring which spawns in spring, or the so called "spring herring," and the medium-sized herring which is caught in large quantities during winter, must all be of one and the same kind, belonging to the Skagerack, and thereupon he based his well-known opinion, that by good management, and by taking proper care of the fisheries, new great herring fisheries could be produced. Professor Nilsson thought that all that was necessary to reach this end was to abolish the use of seines, and, as is done on the coast of Holland, to use only stationary nets. Most scientists at the time agreed with these views of Professor Nilsson.

The coast population, however, as well as the authorities of Bohuslän, very emphatically opposed these views of the scientists. Thus it was constantly said that the "old" sea-herring were of a different kind from those herring caught later in small quantities, and that even if the use of seines was prohibited, with the view to spare the small herring, the catches of full-grown herring would not be any larger. Special care was taken to prove that the line-fisheries would suffer if the seines were abolished, because there would be a lack of bait.

These two objections were, of course, met, and, according to the demands of the time, apparently answered by the scientists, who also made several suggestions as to the best way of meeting the demand for bait.

After about twenty years had passed, during which this controversy was going on, the Swedish Parliament, on the 25th August, 1844, on the motion of Mr. Hjort, a member from Bohuslän, passed a resolution that the Government should be requested to put the views of the scientists to some practical use; which resolution, also favored by the Royal Academy of Sciences, led to the new fishery law of June 29, 1852. The provisions of this relative to the care of the herring fisheries were, however, not at all carried out, at least on those coasts where

herring had been caught with nets and seines from time immemorial, and where these fisheries were of considerable importance.

A month previous to the promulgation of this law, which is still in force, the Norwegian Government had an investigation made on the south coast of Norway near the Swedish frontier, with the view to improve the sea fisheries. This investigation, in which, amongst the rest, Prof. H. Rasch took part, led to very different views from those entertained in Sweden. Thus, it was shown that the large seines were comparatively harmless, but that the small seines exercised a hurtful influence on the fisheries. This investigation was of great importance to Sweden, as it was carried on very carefully and in the most exhaustive manner, and along a coast which comes close up to the Bohuslän coast, and greatly resembling it.

The authorities at Gottenburg, therefore, asked the Government to annul the provision of the fishery law relating to the use of seines, basing their request on the opinions of Norwegian naturalists, such as O. N. Löberg and Axel Boeck.

During the first two years of my investigations I treated in the most thorough manner possible the question as to the care of the herring and sprat fisheries, and the alleged help extended to them by prohibiting the use of large seines with narrow meshes, and showed that the strict carrying out of this provision would be hurtful rather than helpful. To prove still more fully that the old views were entirely untenable, I pointed to the regular secular periodicity of the great Bohuslän herring fisheries. The return of a new herring period during the winter 1877-78, although during the ten preceding years fisheries had been going on with large seines having narrow meshes, utterly refuted the old theories on which the provision in question was based.

As regards the secularly periodical fisheries, it would hardly be possible to exercise any special care, as the inroads made by man are very insignificant compared with the enormous masses of herring. Only during that part of the herring period when the herring approach the coast for the purpose of spawning, one should see to it that they are not hindered from going to their spawning places, and that the spawning process is not disturbed by seine fishing. The seine fisheries near the coast cannot be said to have had a hurtful influence on the propagation of the herring, as they do not disturb spawning or hinder fish from approaching the spawning places; they only yield herring which have spawned some time previous, or such as have not yet reached their sexual maturity. Objections may be made to any kind of apparatus no matter how innocent, but in fisheries of such enormous dimensions as the great Bohuslän herring fisheries such objections have no weight.

As regards the permanent small herring fisheries carried on on the coast, something might be done by exercising proper care, and Bohuslän has already, in the regulation of June 19, 1872 (prohibiting small seines with narrow meshes), a suitable legislation in this regard, which, if prop-

erly observed, may do good, or at any rate prevent a good deal of damage. All unnecessary destruction of the fry must, as a general rule, be considered as hurtful, and should, therefore, as far as compatible with the proper supply of bait, be prevented. But such legislation cannot be carried out successfully in the waters near the Norwegian boundary line, unless similar regulations are adopted on the Norwegian side.

The complaints of the decline of the Bohuslän *fiord* fisheries are very old, and it would be necessary to take careful statistics of these fisheries for a considerable length of time, in order to determine whether these fisheries are to some extent periodical, or whether the decline is owing to the lack of proper care.

It will hardly be possible to improve the herring fisheries by artificial impregnation, or to increase the quantity of herring food by throwing organic matter into the water near the coast, as Prof. A. W. Malm proposes. All such propositions must be considered as impracticable attempts to manage the small and unimportant fiord fisheries on the same plan as the entirely different enormous sea fisheries.

5. LEGISLATION REGARDING THE HERRING FISHERIES.

I have made extensive historical and comparative studies with the view of obtaining a basis for special legislation for the Bohuslän herring industry and the other Bohuslän sea fisheries, which, however, should be continued and completed, to meet the demands of the times.

The right of fishing, especially in Bohuslän, has been made the subject of thorough investigations by me, which have finally led me to conclusions far different from those generally entertained. The right of the Crown to the herring fisheries has thus been shown to have been maintained in olden times, and to some extent in the present time; this right has been shown to have referred to the secular periodical fisheries.

I have pointed to the necessity of laws to regulate the herring trade, have called attention to the lack of a fixed measure for measuring the fresh herring, and have advocated that, as regards the herring barrels, a certain minimum size should be fixed.

I have made very extensive preliminary studies not only with the view to become acquainted with all the old Swedish laws relating to the sea fisheries, but also to prepare new laws for these fisheries.

6. ADMINISTRATION (SUPERVISION) OF THE HERRING FISHERIES.

As regards the gathering of the necessary material for drawing up a plan for the administration of the Bohuslän fisheries, I have also done something, principally by making extensive and comparative studies of all the subjects bearing on this question. The studies should, however, be continued and extended by making observations in foreign countries. With the view to encouraging the authorities to lend their aid towards the development of the Bohuslän herring fisheries, I made a motion at

the meeting of the Gottenburg and Bohuslän assembly (legislature), in 1882, that the Government should be petitioned to appoint a special board of directors of the Bohuslän sea fisheries, to reside in the district. This motion was adopted; and a Gottenburg paper contained several articles by me, in which I defined the activity of this new board, and for comparison's sake gave an account of similar institutions in Scotland and Holland.

I gave a full account of the manner in which the official examination of herring in Scotland is carried on, and of the measures formerly taken in Holland in this direction. By numerous newspaper articles I have endeavored to urge the present administration of the Bohuslän fisheries to greater activity, and some extent I have been successful.

One of the principal causes of the unsatisfactory condition of the Bohuslän fishery administration must be sought in the great expositions, which have had a demoralizing influence, and have fostered a dangerous "Chauvinism," the rooting out of which is as difficult as it is essential to the introduction of an improved condition of affairs. I have, therefore, as far as it lay in my power, endeavored to give our people a more correct idea of the true value of these expositions, which are repeated too often, and which take away far too much money from more useful purposes.

7. CARE OF THE FISHERMEN AND IMPROVEMENT OF THE COAST.

I have also done considerable preliminary work towards preparing a complete social and scientific exposition of the best manner of taking care of the herring fisheries, and of advancing the true interests of the Bohuslän coast. During the ten years which I have spent in Bohuslän for the purpose of making observations, I have, as far as lay in my power, worked, by writing and speaking, to improve the economical and social condition of the Bohuslän coast.

As regards advancing the interests of the Bohuslän coast by the Government, I have, partly by motions in the Economical Society of Bohuslän, in the Bohuslän Assembly, and the National Parliament, and partly by addressing petitions to the Government, endeavored to improve the social conditions of this district by having aid extended to the sea fisheries; and I am happy to say that some of my efforts have been crowned with success. I have particularly pointed out the necessity of concentrating the fishing industry in favorably located and well-governed towns, and of taking proper measures for preventing, as far as possible, the numerous and great troubles which followed the close of the herring period during the last century.

But as individual efforts are considered as essential in aiding the Government in its endeavors to further the interests of the fisheries, I drew up a plan for an "Association to promote the Bohuslän fisheries," and during last year's fisheries issued invitations to form such an association, which was done in October last.

8. ECONOMICAL VALUE OF THE HERRING FISHERIES.

As regards, finally, the preparation of a national economy of the herring fisheries, which is of great importance for this whole question, I have also made extensive studies, which I hope to embody in some work on this subject.

That I should meet with many difficulties was, of course, to be expected, but this did not deter me from continuing my studies, especially after I began to realize that the principal mistake of those who had, before me, given the herring question some attention was that they had overestimated the importance of the descriptive treatment of the natural history of the herring, and had neglected the economical aspect of the question.