

VI.—THE NORWEGIAN HERRING-FISHERIES.*

BY A. I. BOECK AND A. FEDDERSEN.

Mr. A. Boeck, who for several years had conducted scientific researches for the Norwegian government in regard to the herring-fisheries, was invited, on his return from the districts of Nordland and Tromsö, in February, 1872, to deliver some lectures in Bergen on the spring-herring fisheries. Although the season was far advanced, the southern herring had not yet made its appearance, and fishermen and salters were in great doubt as to what they should do. Boeck's lectures were therefore received with special attention, and as they contain a great deal of valuable information, we present here copious extracts from them, following the account given in the "*Bergens Adresseavis*," (*Bergen Advertiser*), and "*Bergenposten*," (*Bergen Post*), for February, referring our readers at the same time to an article by A. Boeck, "*Account of the Herring on the Coast of Norway and Bohuslän*,"† (a province of Sweden,) published in the fifth annual volume of our journal, pp. 123, et. seq. We also refer to A. Boeck's work "*On the Herring and the Herring-Fisheries*,"‡ especially on the Norwegian Spring-Herring."

The herring is found, in Europe, from Spitzbergen to the west coast of France, and is caught in large numbers on the coasts of Scandinavia, Great Britain, Ireland, Holland, and France. On the other side of the Atlantic, they are caught from Greenland to the eastern coast of America. In all those places where herring are found in large quantities, and where people have become rich through these fisheries, the number caught has, at times, been exceedingly small, and for long periods the herring have disappeared entirely. This has not only been the case on the coast of Norway, but also in Bohuslän, (western coast of Sweden,) Scotland, Ireland, and France, and people have been reduced to want in consequence of the failure of the fisheries.

In the present century, when science has made such rapid progress, and has, in manifold ways, become tributary to the comforts of life, and when many of the greatest inventions of modern times have sprung from the quiet and unostentatious researches of scientists, it was be-

* Det Norske Sildefiske. Efter Referaterne af Stipendiat A. Boecks Foredrag i Bergen ved A. Feddersen; in Tidsskrift for Fiskeri. Udgivet af H. V. Fiedler og Arthur Feddersen. 7de Aargang. (Kjøbenhavn. Jacob Erslers Boghandel. 1872.) pp. 1-40. Translated from the Danish by O. Jacobson.

† Beretning om Sildefisket ved den norske og bohusslonske Kyst.

‡ Om Silden og Sildefiskerierne, navnlig om det norske Voarsildfiske.

lieved that important results in regard to the herring-fisheries might also be secured by scientific investigation, and many problems be solved which had hitherto been doubtful. It was questionable, however, how far practical results could be hoped for, and how far the causes of the herring's disappearance could be ascertained and means be found to prevent it. Yarrell, the English scientist, lately deceased, said that the herring was a whimsical fish, which had no definite place in which it could be expected with certainty. The famous Danish ichthyologist Kroyer, who had for some time made scientific researches in this direction, in his great work, "*The Fish of Denmark*;"* makes use of these words: "How desirable it is to gain more insight into the natural history of fish is strikingly illustrated by the herring, as many points in its mode of living are still unexplained, and many fabulous accounts are transmitted from one generation to another." The zoologist Van der Hoeven also dissuaded Boeck from occupying himself with these studies, as they would be productive neither of profit nor of honor.

Several scientists have, however, opened the way for such researches. The French zoologists, Audouin and Milne-Edwards, traveled for several years on the coasts of France for the purpose of examining the fisheries scientifically; the only result of their researches, however, being a volume published in 1830 and containing chiefly statistics. The investigations made in Bohuslän, (western coast of Sweden,) by Professor Nilsson, of the University of Lund, are of greater value. The herring had disappeared from that coast in 1803, after having been exceedingly plentiful for more than fifty years. Large sums of money had been employed in establishing salting-houses and oil-refineries, and the government had specially favored emigration to the coast of Bohuslän, where the herring-fisheries for a long time formed a fruitful source of income. No herring were found near the coast; the merchants were idle; and fishermen and salters led a miserable life. Still, people hoped year after year for the return of the herring, and rumors were current that enormous quantities of fish were immediately outside the coast in the so called "Stor rende," (Great Channel.) The government assisted the fishermen, and 50,000 rigsdalers (about \$25,000 gold) were spent in attempts to secure fish from this locality, (the "Stor rende.") Although all these efforts failed, it was still hoped that the herring would return, as scientists had expressed the opinion that only unfavorable circumstances prevented their approach. The fish, however, did not return, and the former extensive fisheries were almost entirely abandoned. The local press zealously advocated new investigations, and Professor Nilsson began in Lund, in 1825, a series of researches. It is to be regretted that Nilsson could not begin this labor until eighteen years after the disappearance of the herring, and that he entered upon these investigations with his opinions firmly fixed. He, therefore, met with much opposition. He renewed his investigations during the years 1828-32,

* Danmarks Fiske.

and visited the Norwegian herring-fisheries, in order to compare them with the Swedish. He endeavors to prove, in his reports, that the herring does not come from the Polar Sea to the coasts of different countries, but, as the well-known zoologist Bloch has remarked, has its permanent place of abode near those coasts where it comes to spawn. He, therefore, thought that the Bohuslän herring never left the Skagerak, and had nothing to do with the Norwegian spring-herring, which was a totally different variety, and that the Bohuslän herring had, therefore, not emigrated to Norway. On the other hand, he at first thought, although he was not quite certain about it, that it had been completely exhausted by the fisheries. At a later date, he abandoned this opinion and supposed that the herring had only been driven away from the coast by the noise of singing and dancing in the fishing-huts, and remained at the bottom of the ocean; and, finally, he came to the conclusion that it was killed by the impurities of fish-oil which were thrown into the sea. He was also of the opinion that the herring would return, if the seines, by which all the young were caught, could be laid aside. As his opinions did not meet with general favor, a committee was appointed, consisting of Count Rosen, Professor Nilsson, and others, which traveled along the whole coast of Bohuslän from Gottenburg to Strömstad, and made numerous inquiries among the fishermen of the different districts. Nilsson's reports, as well as the report of the committee, and two memorials regarding the same matter by Professors Sundevall and Lovén, who concurred in Nilsson's opinion, were printed and distributed in large numbers. We shall have occasion, in the course of this article, to refer to these reports and memorials.

The Dutch government commissioned Lieutenant Kraft to make extensive observations during several years, on the temperature during the season of the herring-fisheries, by means of which it was ascertained at what degree of warmth the greatest quantity of fish was caught. He then prepared a map showing where, at different times, the largest quantity and the best quality of herring were caught. This map was exhibited at the fishing-exposition held in Bergen in 1865.

Observations have been made in England for some time by zoologists and scientists, mostly for the purpose of ascertaining whether the supposition that the fishing-implements had anything to do in driving away the herring was correct or not, and they finally arrived at the conclusion that the great number of old laws which embarrassed the herring-fisheries ought to be rescinded.

In Denmark, Professor Kroyer has made a number of observations, only some of which, however, have been published in his work "*Fish of Denmark.*"

Professor Münter, at Greifswalde, (province of Pomerania, Prussia,) has also made observations concerning the various species of Pomeranian herring, their food, and the temperature most favorable for spawning.

These are the most important practical and scientific investigations

of the herring-fisheries which had been made up to the year 1860, when the Storting, (the Norwegian parliament,) appropriated a sum for similar investigations on the coasts of Norway. Besides these, two investigations of the fisheries have been commenced on a large scale, the one by the imperial German government under the direction of Professor Möbius, for which a very considerable sum has been appropriated, and the other by the Government of the United States under the direction of Prof. Spencer F. Baird, LL.D., who, with several younger scientists, is to examine the fisheries along the entire coast of the United States, for which purpose some Government steamers have been placed at his disposal.

When Mr. Boeck was commissioned to examine the Norwegian herring-fisheries, he could, at first, only follow the same plan in his investigations as other scientists before him had done; but he soon found that these investigations ought to be made on a very different scale, and in other directions, because he discovered that there were other natural phenomena which might influence the migrations of the herring. After having made himself acquainted with these natural phenomena, his attention was naturally led to circumstances which had hitherto not been considered of any importance. The essential point in all such investigations is to gather as much material as possible in the shape of indisputable facts. As these facts could not properly be gathered in a hurried manner, and as it was desirable at the same time to secure some result as soon as possible, Boeck proposed to adopt a provisional theory adapted to such facts as could be ascertained. He saw that two plans might be followed: one was to examine the migrations of fish in relation to meteorological changes, by exact historical data regarding the older fisheries from 1807 to 1852, when the government inspection commenced its reports; the other, to gather facts from old and experienced fishermen. Although the latter plan might seem to be of doubtful value, he soon found that such experience was by no means to be despised. Fishermen are more observant than many suppose. They think, see, and hear a great deal, and although their opinions are sometimes very fanciful, the true can readily be distinguished from the false, and so be made useful. Both plans, however, require to be corrected by scientific investigation. Boeck has adopted the following mode of procedure, endeavoring to accomplish his purpose both by observations and by historical researches:

1. To make observations during the fishing-season on the currents and the temperature of the sea, the nature and form of the bottom, the migrations of the schools of herring, and the influence of these circumstances on the time of their approaching the spawning-places.

2. To collect the most accurate information possible on the migration of the herring, and on the meteorological changes which seem to have influenced it from its beginning, in 1807, until the government inspection commenced.

3. To endeavor to find out, by historical data, the migration of the herring-fisheries at large; how the mass of herring at one time approached one part of the coast of Norway, and then another; or how disappeared entirely; and then to compare these facts with those gathered from other countries, and thus to ascertain if there be any connection between the different herring-fisheries in Norway and other countries; and also to compare the fisheries of former times with those of the present, in order to ascertain if any satisfactory results could be reached with regard to their future condition.

In accordance with this plan, Boeck has, during his sojourn of five years at the fishing-stations of Norway, made personal observations, and has also collected material from archives and libraries. He was greatly assisted in his observations by two citizens of Bergen, the consul Carl Konow, and the banker N. Nicolaysen, who permitted him to use two collections of carefully kept diaries regarding the herring-fisheries from the year 1835, which facts he partly supplemented by notes from *Den bergenske Merkur*, (*the Bergen Mercury*), and from *Stiftstidenden*, (*the County Journal*.) He finally obtained, through the firms of Kjelland & Son and Ploug & Sundt, in Stavanger, a series of observations made on the fisheries previous to the year 1835, which he likewise supplemented by a large amount of written and oral information derived from persons in Stavanger, Skudesnæs, Kopervik, and Haugesund. From all this material there may be compiled a more or less complete account of the fisheries from 1808 down to 1852.

Boeck has draughted, on a large scale, a map of the southern coast of Norway, from Sognefjord to Gottenburg, and the northern part of Jutland. The depth of the sea along the coast is marked by lines in accordance with the information which he had received. Another map, on a much larger scale, embraces the coast from Espevær to Tungenæs. On this there are marked the channels and depths, together with several fishing-banks, to within a mile of the outer coast, which are not usually indicated on the coast maps, and which were carefully pointed out to Boeck by an old fisherman, Henrik Røevar, as well as by other fishermen from Syre and Utsire. The localities indicated on the map last mentioned are the ones to which he devoted special attention. He has chosen this locality, partly because at that time the fisheries were particularly productive in those places, the northern fishery having only just then begun to be of any importance, and the Söndmör fishery being still in its infancy; and partly, because it has always been one of the chief places for catching spring herring. He has also continued his observations there in order to make them the more satisfactory.

When Boeck first went to the fishing-grounds, he determined to follow the advice of the government inspector, which was to go out with the fishing-boats, and also to frequently visit the stations for salting. A fisherman, whose advice he followed, often spoke of putting the nets in the channels, and he found on inquiry, and by observations with the

sounding line, that these channels are valleys at the bottom of the sea, running toward the coast in different directions. Having continued these observations for some time, he was able to corroborate the fisherman's statement that at different times the herring follow certain channels when they approach the coast for the purpose of spawning. It would require too much time to describe the location of these channels in detail, and we hope that Boeck will, at some future day, publish these maps. In one of his lectures he mentioned a circumstance which fortunately was among the first to come under his observation, and which showed conclusively that, during the spawning time, the herring follow these channels; and this he found to be the case invariably. He had made a great many soundings in the channel, extending between Røer and Fæø and stretching toward Hauskeskær, and had placed a chain of nets across it. A large number of fish were caught all along this chain, while another chain, the greater part of whose nets stood on the rocks, with only one end reaching the channel, only caught fish in that portion which touched the channel. He also found it of the utmost importance, for the success of the herring-fisheries, to ascertain which channel the great school of herring follows when it comes in to spawn; for several times he was able to designate with certainty the place where the fish would be on the following day, by knowing where large numbers were caught the preceding day. This, however, he could only do when storm or cold did not interfere with his calculations. He also convinced himself that if several nets are set in such a channel they do not interfere with each other, but that the herring push forward along the channel over and into the nets.

Boeck finally drew attention to the so-called "flak," *i. e.*, large level places at the bottom of the sea covered with rough gravel, which in calm weather are the herring's favorite spawning places. He raised with the dredge large lumps of roe and gravel intermixed. In these places the largest number of herring is invariably caught.

The influence of wind on the fisheries was observed long ago, and the Swedish zoölogist Ekström, and after him Nilsson, attach some importance to it; but in estimating the information obtained from fishermen, they are not sure which wind is favorable for fishing, the one blowing from the coast or the one blowing toward it. The Dutch zoölogists have not been able to discover that the direction of the wind has any special influence on the fisheries, except that a violent gale precludes all possibility of fishing. On the coast of Norway opinions are likewise very much divided on this point, some maintaining one thing, others another. By examining, however, all the annual observations made by the government inspector and by himself, Boeck found, that when the herring is out in the open sea a wind blowing toward the coast favors its approach, while when the herring are near to the coast its formation has to be taken into consideration. *If, e. g.*, the herring occupy an area like the one opposite the southern part of Karmö, between Syre and

Skude, and strong southwesterly gales rage for any length of time, they are prevented from reaching their usual spawning places, and remain a long time outside the channel for some more favorable opportunity. If, however, the storm continues, the herring generally pass into that part of the channel which, stretching by Skude, runs on into the sound of Karm. Fishing may then be carried on up to Salhus and to the end of the Förresfjord. Of this there are many instances as far back as 1815. From the accounts of the government inspector, it will be seen that this was the case in 1857, and most of us will recollect the great fisheries of 1863. A southeasterly wind on this coast will have the same effect, but to a less degree. If the herring keep more toward the south near the Hviding Islands and Roth, both strong southwest and northwest winds will prevent their approach to these islands. In that case the whole school passes by Tunge, and there may be good fishing directly up to Stavanger, as was the case in 1825. Similar facts will become apparent if we advance farther north and inquire into the like circumstances.

If the coast is exposed to strong winds blowing toward it, the herring do not approach it, and the fisheries, if they have commenced, are interrupted. Thus, rich fisheries far in the Bømmelfjord beyond Tittelsnæs, and even far beyond Nyleden, will be a consequence of continual storms, when the herring have been previously outside of Sletten or south of Espevær. Of this there are many instances. Hence it will be seen that the point on which the question turns, is not whether the winds blow toward or from the coast, but what kind of wind prevails at the respective fishing-places, since a wind blowing *toward* the coast may in one place have the same effect as a wind blowing *from* the coast in another.

The temperature of the air also exercises great influence on the fisheries; and this influence has never been underrated, but has always been taken into account, although certain phenomena observed in the fisheries can not yet sufficiently be explained by it. Boeck drew attention to the influence of temperature in his first report of 1861. It has been observed from time immemorial, that the fisheries are not as abundant in cold weather as when the bottom of the sea is disturbed by southerly winds. This has been proved by the experience of several centuries, but only recently have attempts been made to investigate this whole matter thoroughly and scientifically. Even Cuvier and Valenciennes in their great work on fish, in which the herring is discussed at much length, do not enter upon this question. Dutch scientists were the first to devote more attention to temperature, by making a series of observations, with the view of ascertaining during what degrees of temperature the herring-fishery is most prosperous. They found that more fish were caught at a temperature of from 12° to 14° Celsius, than at any other time. The Dutch herring-boats are therefore always supplied with a thermometer, which enables them to place the net at a

proper depth. Professor Münter discovered also that the higher the temperature of the water the deeper the herring keep during the spawning-time, for which reason the nets on the coasts of Pomerania are set deeper in summer than in spring. During his stay on the west coast of Norway, Boeck constantly noticed the temperature, and noted down a large number of observations during different years. In his report for 1862 he showed the influence of cold on the herring-fishery. In that year he examined the temperature at different depths. The weather had been calm, but a severe cold had prevailed for some time, by which the temperature of the sea at a depth of 10 fathoms had been brought as low as $1\frac{1}{2}^{\circ}$ or 2° Réaumur, while at a depth of 30 fathoms it was from 3° to 4° . He noticed that same year, while present at the rich herring-fisheries near Rövær and Skaareholmene, that some fishing-implements, which were placed at a depth of about 10 fathoms below the surface, and were held there by means of buoys, caught but few fish; while others, placed at the bottom in a depth of from 50 to 60 fathoms, caught a very large number. Seine-fishing was also very unproductive during that year, although the schools of herring came in in enormous numbers. The same was the case in 1864, and similar observations might be quoted indefinitely. If we examine these accounts we find frequent references to the fact that the cold prevented the herring from approaching. Thus it was extraordinarily cold in 1855, likewise in 1860; and in 1853 the cold was so severe that the bays and inlets on the outer coast were frozen over, which happens but very rarely, and presupposes a long period of very low temperature. The cold was so severe that the fishermen were obliged, after emptying their nets, to lay them in the water to prevent their freezing quite stiff, and in order that they might have them ready for use again in the evening. The herring-fishery was, notwithstanding this, successful, although the herring for quite a long time remained out in the deep sea and would not approach the coast. A great many instances might also be quoted from observations made in former years and collected by Boeck. It will suffice to mention a few years, such as 1825, 1826, 1828, 1829, 1836, 1840, 1841, and 1844. In several of these years the cold was so severe that nearly all the bays were covered with ice, and in some years even the Bay of Bergen was so much obstructed that all communication was interrupted. Still the fisheries were good, and in some years even unusually so, although the sea had grown cool at a far greater depth and to a greater degree than during the preceding year; for then the cold was not particularly severe, and the temperature, according to the observation of the government inspector, was 1° at a depth of 10 fathoms. Boeck thinks, therefore, that the failure of the fisheries the year before cannot at all be ascribed to the cold. He found that in calm weather the herring seldom approaches the coast except in small numbers when chased by the had-dock, while the chief fishery always commences when a southwesterly or northwesterly wind has stirred up the sea and mingled the lower and

warmer water with the upper and colder. Of this, Boeck gives many examples, partly from his own observations and partly from those of the government inspector. It is important to keep this in mind whenever the influence of the cold is spoken of.

From all this it will be seen that neither the character of the bottom of the sea, nor the direction or force of the wind, nor the temperature of the air and sea by themselves, exercise an influence on the fisheries sufficiently great to cause their cessation, but that these various influences only modify the time and place of the fisheries. The schools of herring that come in from the ocean, seek the coast notwithstanding these influences.

The question, "Where does the spring-herring keep itself, when it is not near the coast?" has been discussed from the earliest times. Shortly before the fisheries commence, the herring may be seen approaching the coast, followed by whales, and the sea then frequently appears quite green from the large masses of fish seen near the surface. After the herring has spawned and gone out into the sea, it disappears. In very early times it was supposed that the Polar Sea was the true home of the herring. The Dutch fishermen on the Shetland Islands noticed that it came from the north. It also approached the coasts of Scotland from the north. The Irish saw the herring pass their coasts from north to south, and the same was observed on the coasts of Norway. It is therefore not at all astonishing that its home was supposed to be in the north, and that the Polar Sea, which, according to the strange fancies of those times, hid so many wonders, was the place from which the herring emigrated every year. The English writer, Dodd, in a book entitled "*Atlas Maritimus et Commercialis*,"* published in 1728, started the theory that the herring emigrates from the Polar Sea. But this theory is brought out in a clearer and more attractive manner in a work by Johann Anderson, burgomaster of Hamburg, and well known for his learning, entitled "*Nachrichten von Island, Grönland*," &c., Hamburg, 1746, (*Account of Iceland, Greenland, &c.*), which appeared in a Danish translation in the year 1784. He first remarks that several well-known persons had seen herring and the bones of herring lying on the rocks of the coast of Greenland. He then shows that the whale, the seal, and the porpoise, whose favorite food is the herring, have their home in those Arctic seas, and that, therefore, the herring must be found there. Far up toward the North Pole, under the broad, icy plain, which never melts, the herring was supposed to live quietly, because neither whales, sharks, nor men could pursue it there; there it also spawned and increased in such numbers that the Polar Sea became too narrow for them, and thence colonies, compelled by actual necessity, emigrated toward the south, just as bees swarm in summer. When such a school of herring issues forth from its icy home, it is immediately attacked by its enemies, who pursue it dur-

* See, also, Dodd (J. S.) Essay towards a Natural History of the Herring. London 1752.—ED.

ing its passage to the south, and finally drive it into the bays and inlets where it is caught. During its passage southward, it dispatches two flank divisions, the right flank toward the coast of Iceland, of whose fate Anderson does not speak in his book, while he does state that the great mass of the herring, when near the coast of Norway, divides into two columns, one of which goes toward the coasts of Scotland and England, where it is for the greater part captured by the fishermen of those countries; while some are driven partly along the eastern coast of England, and partly along the coast of Ireland, till they finally meet in the English Channel, where they are caught by the French fishermen. That school, which, it was conjectured, passed toward Norway, continued its journey along the coast of that country. Some pass through the sound and belts into the Baltic, where the Swedes and Prussians are ready to receive them; another portion of the school follows the coasts of Denmark, Germany, and Holland, while the remainder reach the Atlantic, where they disappear.

This theory became so popular that it has been handed down from one writer to another, even to our time, and has intrenched itself even in text-books on natural history. It met, however, with some opposition, and Bloch, who published in 1782 his book entitled "*Oekonomische Naturgeschichte der Fische Deutschlands*," (*Economical Natural History of the Fish of Germany*), a work very remarkable for its time, raises many weighty objections to it. He first showed that the herring is not so common in the northern countries as was generally supposed, and that it was impossible for it to travel so many thousands of miles in the short period between spring and autumn. Besides, the herring is found at all times of the year in the Baltic and on the coasts of Norway, and the Dutch continue their herring-fisheries even throughout the entire winter until spring. It would also be very remarkable if just the smallest herring should make the longest journey far down to the Baltic. But as Bloch's books were not popular, being only intended for scientists, his opinions did not become widely known. An American by the name of Gilpin,* went even beyond Anderson in promulgating another fanciful migration theory. He showed that herring were also caught in America, and that here it first approached the coast of Florida, and then, passing along Virginia, went as far as Newfoundland, moving, therefore, from south to north, and thus differing from its direction in Europe. The American herring must, therefore, come from schools out of the English Channel; and his theory was that the herring, in the course of a year, described in his migration an ellipse of not less than forty-seven degrees of latitude, crossing the Atlantic twice a year, the first time to escape the strong heat in the south, and

* Gilpin, John, "On the Annual Passage of Herrings," *Transactions Amer. Phil. Socy* II, (1786), p. 236-239.

the second time the severe cold in the north.* Krøyer thinks that if there were any probability in this theory, the herring might justly be compared to the Wandering Jew, who travels unceasingly without finding rest. This theory, however, has not found many advocates outside of America,† and is of no value since it has been proved that the American herring is a species different from ours.

Anderson's theory was violently attacked by Nilsson in 1826 and 1828, who, like Bloch, proved that the herring could not possibly live deep under the ice in the Polar Sea, and much less spawn, as the roe would there miss the most essential conditions for its development, viz, light and warmth. Although the herring was seen to come from the north, it need not necessarily come from the Polar Sea, as it could not possibly travel the long distance of more than a thousand miles, as Anderson maintained that it did. He showed, besides, that on the coasts of Sweden there was found a great number of varieties, which never leave that part of the sea where they are born, (such as the "Strömming," which is found in the Gulf of Bothnia,) while farther toward the south other varieties of the herring are found, those from the western coast being easily distinguished from those of the southern. On the coast of Norway, also, different species of herring are found, which again differ from the Scotch and Dutch herring. Nilsson, therefore, thought it beyond a doubt that the herring does not come from one great common tribe, but that every race has its home outside that coast where it goes to spawn; and that it has its regular dwelling-place in the open sea near such coast. He thus thinks that the Gottenburg herring, which came into the inlets of Bohuslän in such extraordinary large numbers prior to the year 1808, and of which, *e. g.*, in the year 1870, more than one and a half million tons were caught, (which, by the way, was only a very insignificant portion of the whole mass of herring which had gathered there,) has its permanent home in the Skagerak, which is neither very deep nor of very great extent. Cuvier and Valenciennes, also, showed that on the northern coast of France, and not far apart, there were two such tribes of herring, each of which had its separate home in certain basins of the open sea, and that these tribes never intermingled. Münter is also able to show that there is on the coast of Pomerania one tribe of herring which spawns in the autumn, and another which spawns in the spring, differing greatly from each other, although the basins of the sea near the coast where they live are scarcely more than a mile apart. Another proof of the theory that every race of herring has its special dwelling-place in the sea, which it does not leave, except when it approaches the coast for the purpose

* This "theory" was the result of a confusion of two very different fishes under the same name—*Culpea harengus* and *Pomolobus pseudoharengus*—one of which is the true sea-herring, and the other an anadromous species whose ascent of the rivers coincides with the advancing temperature of the new year, and therefore with the latitude—S. F. B.

† The only avowed advocate of the "theory" in America was the originator.—ED.

of spawning, is the fact that the herring is not able to swim very far, since neither the structure of its muscles nor fins is adapted for this purpose. Immediately outside the coast there are small banks on which the fishermen catch cod and other fish, and from these banks the bottom often shelves off with great abruptness to a depth of sea which in some places reaches from four to five hundred fathoms, and which, in the shape of a deep channel, varying in breadth from fifteen to twenty miles, stretches from Sognefjord in a southerly direction along the coast of Norway, making a sharp turn at Lindesnæs, and extending from that point to the mouth of the bay of Christiania. In some places its depth is from four to five hundred fathoms, and deep channels branch off from it toward the mouths of the great bays and inlets on the coast of Norway. In the Skagerak this deep channel is much narrower, and reaches its greatest depth in the neighborhood of Arendal, while higher banks stretch along as far as the northern point of Jutland. It is found near Fedge that, at a distance of twenty miles from land, the bottom of the sea rises up to 70 fathoms, and immediately afterward to between 60 and 50, and all sailors know well how the North Sea rises toward the coasts of England.

North of a line drawn from the mouth of the Sagnefjord to the Shetland Islands, the deep sea extends from the coasts of Norway as far as Iceland and Greenland, and only north of Stat are banks again found outside the coast. It will thus be seen that the herring may very well live in that great and deep sea when they do not linger near the coast. That they live there, may also be argued from the fact that Nilson has found large quantities of herring in the stomachs of haddock caught out in the deep sea. Boeck has likewise found proofs that the herring lives in very deep water, when not near the coast. He has repeatedly examined the stomachs of herring, and, though he found but few remains of food, there were, among these, fragments of crustaceous animals living in the great deep. By means of the dredge he has caught the animals at various depths, from the surface to a point three hundred fathoms below it, and has specially examined those species which serve as food for fish. Through investigations continued during several years, he found that certain species of crustaceous animals (*copepods*) always keep at a certain depth, and in such a manner that those living near the surface are never found at a depth of fifty or sixty fathoms; and that those which live in the deep are never found near the surface. The eucæta kind forms the favorite food of the spring herring, when it is not near the coast of Norway; and this is never found at a depth of less than two or three hundred fathoms. The herring must, therefore, in Boeck's opinion, live at that depth, which is not very far from the coast. He was several times informed by fishermen, especially in 1861, 1864, and 1866, that they, when at a distance from the coast, varying between five and twenty English miles, and in different places, such as to the northwest of Utsire and Sartorö, had sailed through great masses

of herring, which, as they thought, had risen from the bottom of the sea in order to move toward the coast. Some fishermen also showed him herring which had been cast on deck by the waves. Boeck is disposed to concur in Nilson's opinion that the herring never makes long journeys, but that that school, which, during the time of the southern herring-fishery seeks the coast of Norway, keeps out in the deep near that coast. Cuvier and Valenciennes are of the same opinion, for they have, as already mentioned, proved that on the northern coast of France, two species of herring are found not very far apart, which are easily distinguished from each other in the Paris fish-market. These herring are brought to Paris from two villages on the coast adjacent to each other, and they are never mistaken for each other. Their abodes are two different basins near the coast.

Boeck then proceeds to speak of the causes which impel the herring to approach the shore. It is well known that it comes there to spawn; and during the spring-fisheries the largest number caught are herring about to spawn. The stomach of the herring is empty during this whole period, so that it evidently cannot be its intention to seek food at that time. Its desire to propagate dominates for the time being over all other desires, and it seeks places against which it can press its abdomen, and thus make the spawn flow more readily. It does not at all avoid the nets, but seems rather to seek them, of which fact interesting proofs may frequently be seen, such as, that the herring will squeeze itself into the meshes of the net if they are too small to receive it easily. The entire herring-fishery of Norway is limited to catching the herring when about to spawn, which is in marked contrast with the fact that in almost every other country it is supposed that catching fish during the spawning season ruins the fishery. In every roe-herring which is caught 68,000 eggs are prevented from developing, and it may easily be imagined that enormous numbers of unborn fish are destroyed by the spring-fisheries. If the sea did not contain such incredible numbers of them, one year's fishery would entirely destroy the whole species. The empty herring never approach the nets, and are caught only occasionally, since they no longer feel the need of pressing against anything.

In the opinion of several scientists, such as Professors Sundevall and Lovén, every herring is instinctively led to return to the place where it was born, although it be only an island of the smallest dimensions; and that it seeks another place for spawning only when driven away. This opinion is chiefly based on observations of the same habit in the salmon, which always seeks the identical place of its birth.

A writer in the "*Morgenbladet*," (*The Morning Journal*), some years ago, endeavored to prove that those herring which, six years before, were born in a certain spot, returned to it, and that the fishery would always be abundant in the same place after the above-mentioned period, and cited as evidence some extracts from the government inspectors' accounts. This proved a very interesting subject for investigation to

Boeck, and he determined to make it very thorough and extend it over a great many localities. He soon arrived at another result, by using, first, the accounts of the government inspectors; and, secondly, the very minute information regarding the fisheries which he had collected prior to 1852. By thus marking all the places where herring-fisheries had been carried on, and by noting every year where the herring had approached the coast, he found that there were so many exceptions to these six-year periods, that in several places their number by far exceeded the rule; and the same was the case in any period selected at random from one to seven years. Boeck can, therefore, see no law of nature in this, and thinks that the herring does not return to the places from which it came with the same certainty as the salmon does. The approach of the herring, in his opinion, depends on the three conditions mentioned above, viz, *the channels, the wind, and the temperature*. The age of the herring when it approaches the coast to spawn for the first time, belongs to that line of investigations which Boeck has not been able to complete. Nowhere, as yet, has this been accurately ascertained. Some have maintained, but without being able to furnish proof, that the age of the herring, when it spawns for the first time on the coast, varies between one-half and seven years. Boeck is in doubt, whether the herring when fully capable of spawning is exactly six years of age; but he has likewise no means of establishing his own opinion that it is only between three and four years old. He merely remarks that too little attention has been given to the fact that the herring when it spawns has by no means reached its full size, and he has found herring eight inches long which contained roe and milk.

Boeck also spoke of the so-called "*signs*," which in earlier times were closely observed, but to which, at present, little importance is attached. In those early days fishermen thought that all the phenomena which they observed in the sky and the sea must necessarily have some connection with their most important occupation; and we find that there were autumn, winter, and spring signs. Some of these signs for the autumn and winter consisted in the color of the sea, the redness of the sky, the kind of lower animals with which the sea swarmed, and even the roaring of the whales, and the rising of the salmon in the mountain-streams. The well-known Norwegian clergyman, Rev. C. Hertzberg, has, in the "*Budstikken*" (*the Messenger*) for 1821, written an essay on this subject, entitled "*On the Spring-herring and the Signs of its Coming*." At present, however, people have lost all trust in most of these signs, and rely only on appearances furnished by the whale, by certain birds, and by the codfish, which, in many respects, furnish important tokens of the herring's approach. When the time of the herring fishery is near, different kinds of sea-gulls gather in larger numbers than usual; but it is not until the herring comes near the shore and near the surface of the water that these birds can find food among them, and thereby indicate, with greater accuracy, the locality of the fish. The case is different

with the whale and the codfish, whose element is the sea, and who can follow the herring far below the surface. These therefore give more trustworthy signs of the herring's whereabouts than the birds; but, in pursuing the schools of herring, there is also a difference between the whale and the codfish which it may be interesting to notice. The whale can easily be distinguished, even when far out in the sea, as it is obliged to come frequently to the surface for the purpose of breathing, while the codfish always keeps below the surface, and can only be seen when caught. Both of these, while following the "herring mountain," for the purpose of obtaining food, may, however, furnish useful signs for judging of the probable condition of the herring fishery. The whale invariably keeps outside the great schools of herring, along the edges, never attempting to penetrate any farther. It is, therefore, an auspicious sign for the fishermen when they see whales in a wide circle, round some well-known fishing-place. They then know that the herring are approaching the shore in dense masses, and they may justly expect a rich harvest. In the year 1862, Boeck saw whales, in a long and imposing line, stretch from the northwest of Rövær as far as Utsire, and on the following day the fisheries commenced near Rövær and along the entire coast. If, on the other hand, the whales are seen to spread over a large area, or in small numbers, it is safe to predict that the herring will not approach certain places in large masses, but that they will be scattered, and thus the schools be smaller. If, after the fishery has been going on for some time, the whales are seen near the coast in the spawning places, it is absolutely certain that the herring are leaving the coast, although on that day fishing may be very good. In the same year, 1862, remarkable examples of the truthfulness of these phenomena were witnessed. The codfish does not exercise the same influence on the masses of herring that the whale does. Being a very greedy fish of prey, it plunges into the school of herring, scatters them, if possible, surrounds the frightened fish on all sides, pursues them fiercely, and often drives them toward the shore long before the chief mass of the school reaches there. The approach of such smaller scattered schools, before the fisheries commence, are termed, by the Norwegian fishermen, "sejajag," (codfish-chase.) When the school approaches the shore, the codfish is found not only on its edge, but in the middle of it; and if codfish are caught having herring in their stomachs, it is a sign that the herring fishery is near at hand. Of the greediness of the codfish, and its power to scatter the herring-schools, amusing illustrations may frequently be seen in the full seines. This sight is, however, more amusing to the spectator than to the owner of the seine, as it frequently happens that the scared herring press the seine down so heavily as to allow them to escape. Seine-fishermen are, therefore, afraid of the codfish. If the schools are already scattered before coming near the shore, the codfish is found mixed with the herring during the whole fishing season; and it is not a sign of

favorable fishing when, in the beginning of the season, codfish are caught with the herring.

The herring may also be observed spawning within the nets; and, when it is free, it spawns in inlets and on the large flat places at the bottom of the sea, which are covered with rough gravel, ("flak,") where the roe sometimes lies in such enormous quantities as to fill the dredge entirely, when cast in such places. This roe does not, however, lie loose, but is firmly pasted to the bottom by a peculiar glutinous substance which hardens in the course of half an hour, and which, with the rough gravel, forms large cakes. It may happen that violent storms disturb the bottom to such a degree as to tear off the masses of roe, and Boeck relates a very interesting case of this kind. One year such an enormous mass of herring-roe was driven by storms up the Jæder Bay that cart-loads of it were taken away to be used as a fertilizer for the fields, and hogs also fed on it for many days. In these masses of roe the eggs have a certain invariable position, with an opening in the shell of the egg, and the so-called "micropyle" turned upward, so that the fructifying male semen can enter easily. The male fish pour their milt (semen) over the masses of roe which have been deposited by the females, and it is therefore evident that in their approach the females precede the males. In the commencement of the fisheries more females will be caught, and toward the end more males. This was the case near Skaareholmene, and may be a fact of practical value. After there had been very good fishing for some time, one day the greater part of the herring brought to the salting-houses were found to be male fish. Boeck was therefore of the opinion that the approach of the herring had ceased. This was really the case, and it was not at all necessary to explain this circumstance, as was attempted at the time, by a steamer having scared away the herring by the noise of its machinery.

Boeck did not undertake to describe minutely the development of the embryo in all its stages, although it forms a subject for exceedingly interesting investigation, to observe how it is formed from the egg; how the organs by degrees grow together; how the heart begins to beat and the blood to flow. But as all this could not throw any more light on the main question, viz, "whether the spring fisheries are to disappear from the southern fishing-places," Boeck passed over it very briefly. He did say, however, that when the herring emerges from the egg it differs so much in its shape from the grown herring that it resembles rather an eel; and even after it is a month old its shape is not at all like that of the mature herring. In fact, the difference between the young and the old fish is even much greater than that existing between different species of herring.

Boeck also referred to a few species of herring, concerning which opinions have been divided, viz, the great herring and the spring herring. He exhibited a drawing of a great herring from Langenæs, and another of a large spring-herring from Brönö. With regard to

the shape of the great herring, it will be found that the upper outline from the end of the head to the beginning of the back fin is curved, while in the spring-herring it is straight. Its greatest height also is, in proportion to its length, more than that of the spring-herring; and if two equally large specimens are compared, it will be seen that in the great herring the back immediately in front of the back fin is much broader than that of the spring-herring, and that the outline of the belly in the latter is less curved. Boeck has not been able, except in these respects, to discover any difference, although he was told that, according to popular opinion, there was a great difference between these two kinds of herring. Several years ago he was offered an opportunity in Haugesund to examine and compare both kinds with great minuteness. A merchant from Nordland brought a quantity of great herring to Haugesund to be exported. The government officials demanded the usual spring-herring tax on these fish, which the merchant refused to pay, as they were not spring-herring, and as he had already paid tax on them in Nordland. The government officials wished in this case that Boeck would furnish some sure and easily marked characteristics by which the great herring could be distinguished from the spring-herring. He found this at the time to be impracticable, although he examined a great number of both kinds. But when he heard that several persons considered themselves capable of determining in what the difference consisted, he had an interview with them, at which one said that one important difference was, that the membrane of the belly is white in the great herring, but black in the spring-herring. This, however, was found to be only partially the case in some pressed and salted great herring, while with all the others not the least difference could be discovered. Another said there was a difference in the scales, but the cause of this was that the great herring, by a less careful treatment, were deprived of its scales, while they were found in the spring-herring. There was therefore not a single point by means of which these two kinds of herring could be absolutely distinguished, with the exception of the circumstances mentioned above, and these were due simply to the superior fatness of the great herring. Some time after this, however, a characteristic was mentioned by which both kinds it was thought could easily be discriminated. It was affirmed that the great herring was destitute, it was said, of certain bones in the back, which the spring-herring had. Boeck, on hearing this, thought it highly improbable, as the structural forms of the different kinds of herring had been carefully examined, and the conclusion reached that they are entirely the same in most kinds inhabiting the northern hemisphere; while only a few exceptions are found in those of the southern hemisphere. The "*processus spinosus superior*" is double in the herring, which is not the case, for example, with the haddock. On the sides of this bone there are seen two fine bones, and the argument turns on the question whether these are found or not. If we examine, however, a great herring minutely, these bones

are found just as in the spring-herring; but they are frequently overlooked, because the flesh of the great herring is much fatter and looser, and in cutting through its back the knife will easily pass through these soft bones; while in the spring-herring, whose flesh is less fat and therefore apparently coarser and harder, the knife will not pass through so readily, but will glide along the bone when it meets it. In carefully cutting open the fish, the two bones above mentioned will easily be found in both kinds.

Of all the assumed distinguishing marks, then, between the great herring and the spring-herring, only the greater fatness of the former remains. It might be thought that this fatness is caused by the better food which the great herring finds at the greater depth of its abode; but this cannot be the sole reason. Indeed, there is another and more important cause of this phenomenon. In seeing the great herring lying in the boat after it has been caught, one is immediately struck by its smooth and beautiful appearance; while the spring-herring, under the same circumstances, is frequently covered with a filthy slime, a mixture of roe and milk, and in pressing the belly of a spring-herring a stream either of roe or milk flows out, which is not at all the case with the great herring. In opening both, one finds that in the female spring-herring the roe-bags are coarse-grained and soft; while in the female great herring they are fine-grained and hard. It might be supposed that this is a specific difference between them, which, however, is not the case, since it is only caused by the roe-bags being more developed in the spring-herring than in the great herring. In taking the roe-bag of the spring-herring, especially that of a salted one, as its structure can be more easily distinguished, one will find, on opening it with a fine pin, that the roe-bags are not what one would suppose them to be—bags filled with eggs—but that their structure is more complicated. With the aid of the pin, one will easily be able to lay open and follow up certain fine vessels in which the eggs seem to lie, and this is actually the case. The whole roe-bag consists of an infinite number of fine tubes, which, perhaps, can best be compared to greatly-elongated fingered gloves lying exceedingly close to each other and connected by the so-called "binding texture," which is sometimes hard and stiff and sometimes soft. Where, to continue the figure, the fingers of the glove would join that space which is occupied by the hand, a channel leads the eggs out along the whole length of the roe-bag, and its continuation is another channel which opens in front of the dorsal fin. In the finger-shaped channels, the eggs develop from small cells which gradually grow larger. In the great herring, the egg-cells are very small, and the egg-tubes are connected with each other by a thick layer of binding texture filled with fine blood-vessels. In the spring-herring the egg-cells are more than four times as large; the egg-tubes are very thin and fine, and there is scarcely any binding texture. In breaking the roe-bag of the great herring in the middle, it seems to consist only of a somewhat brittle-grained mass;

while in the spring-herring, it is softer and tougher. There is, therefore, no other difference between the roe-bags of the great herring and those of the spring-herring, than that the roe-bag of the former is less developed than that of the latter. In the early part of the fisheries, the roe-bag of the great herring is least developed, while toward the end, certainly in those caught near Selsövik, it is much more developed and softer, and we even find herring among them which are ready to spawn. The first herring is, on the other hand, much fatter than this last from Selsövik, from which it is evident that the fatness decreases in proportion as the sexual organs develop. When the herring comes in from the sea in order to spawn, it, like the haddock, takes no food during the spawning time, and must, therefore, secure the material which is necessary for the development of the roe-bags from its own body; it therefore grows thin in proportion as the sexual organs develop.

Boeck met with a beautiful illustration of this in a great herring from Skarsfjord, six miles north of Tromsö. Among the great herring which he had occasion to examine there, he saw one that was much fatter than the other, and which, on account of its size and beauty, he determined to take home and preserve in alcohol, but he finally opened it to ascertain the cause of its excessive fatness. He found that the herring was a male, and that the right milt was well developed, while, on the left side, only small traces of milt were found. He then observed that an intestinal worm had taken up its abode in the left milt, and had hindered its development. On the same side were found large stripes of fat twisted around the digestive channels; and as this herring had thus not been able to develop its whole milt, it was not obliged to use all the fat in its body, so that some of it lay on that side where there was room for it. Hence it is clear that in this respect there is no difference between the great herring and the spring-herring. He was told by old séine-fishermen that during the first year of the spring-herring fisheries this herring did not approach the coast in a condition ready for spawning, but that it became so only toward the end of the fishery, and that then the herring was much fatter than it is now. Perhaps there is a similar change in store for the great-herring fisheries, so that after some years the great herring will also come near the coast better prepared for spawning, and will consequently be less fat.

Boeck then gave his opinion on the probable future of the spring-herring fisheries in the so-called southern fishing-places, where he had made a number of observations. In what he said he did not wish to assume the character of a prophet; he would only give facts, both for and against, and he would, as he had done before, leave it to each one of his hearers to draw from these facts the conclusions that seemed to him most correct. Four years ago, when the fishery was still good, he had warned people not to put too much faith in its continued success, and not to expend too large sums in the erection of new salting-houses, or the extension of old ones. At that time his warnings were received

unfavorably, as the practical fishermen entertained different opinions, and thought that scientific investigations were of no use as regards the spring-herring fisheries. Many also thought that care should be taken not to say anything which would alarm people in prosecuting their labors. Boeck, nevertheless, deemed it his duty, first privately, and then publicly, in his work "*On the Herring and the Herring-Fisheries,*" to make known the results of his investigations, which he thought were of great importance to the fishermen. If the spring-herring disappeared, and his predictions thus became true, he deserved the thanks of all for having given timely warning of the evil impending; and if his advice had been heeded, thousands of dollars might have been saved, which otherwise must be lost in a trade that was doomed to disappear. People ought not to rely too confidently on the spring-herring fishery as a constant source of income. In examining the history of the fisheries, it would be seen that at times they had been very productive, and then, again, had dwindled down to almost nothing. The fisheries had been abundant during the reigns of Hakon Adelsten and Olaf Trygvason; also, from 1217 to 1340, during which period the spring-herring fishery was of such importance that the law of Magnus Lagaböter contains several paragraphs in reference to them; then again, from 1559 to 1572; from 1640 to 1688; from 1698 to 1784; and finally our period, from 1807 till the present time. It will thus be seen that the herring *can* disappear, and that the fisheries *can* decrease. But now comes the important question, "What can be the cause of this?" Two classes of causes were assigned. The mass of herring has either decreased by being caught in too profuse a manner, by being devoured by fish of prey, or by being destroyed in some other manner, or else the schools of herring have wandered to other places. Professor Nilsson seemed, in the beginning, favorable to the causes first named, but later, he has decided against them, chiefly on the ground of better information. Government Inspector Widegren, however, still clings to them. Boeck himself does not believe that the mass of spring-herring has decreased, but thinks that they no longer approach the shore.

Wherever the herring-fisheries have disappeared the fishermen have been left in great want and the merchants have lost an important source of income. In consequence of the cessation of the fisheries the country has suffered directly and indirectly, and it is therefore not to be wondered at that people in all classes of society have thought over the matter and have tried to discover the cause of the decay. Many reasons were assigned, but none seemed to be plausible. What was given as the cause of the herring's disappearance in one place was found not to be the cause in another. Laws have thus been based on very vague suppositions, and large sums have been expended for carrying on the fishery according to new and hitherto unknown methods; such as by stationary nets in the deep sea, or by drag-nets, but all in vain. The promises of learned men proved futile, and hope alone kept

up the courage of the fishermen and merchants. In earlier times, when people did not seek the cause of various phenomena in nature, but judged things by their appearances, it was thought that God had blighted the herring-fishery, because men had become ungrateful and abused his gifts. Sometimes special causes were assigned for the Divine wrath, and Absalon Pedersen Beyer thought that the herring-fishery disappeared because Cristopher Walkendorph had taken tithes away from the clergy and used them for building purposes. Even in our own days, (1835,) we see something similar to this, in the fact that several members of the British Parliament declared in the House of Commons that the herring had disappeared from a place on the coast of Ireland because a priest had demanded tithes of his parishioners. Casper Seatus tells us, that in the year 1830 the herring left Heligoland, where at that time about two thousand people gained their living from the fisheries, because some young men, in mere wantonness, had cruelly abused a herring. In Stavanger, according to the account of Professor Krøyer, the fishermen, in the year 1830, did not allow a wealthy citizen to hold a masked ball in his own house, for they thought that this would vex the Deity, and that as a punishment He would cause the herring to leave the place.

When this superstitious belief yielded to the better suggestions of the understanding, the decay of the herring-fisheries was sought for in natural causes. In former times it was believed that noise could drive the herring away, and, in 1580, to shoot on board ships was prohibited at Bohuslän. This belief was common even in later days. Thus it was thought that the herring left Bohuslän in 1697 in consequence of the discharge of the guns during a naval engagement, (in the war between the Swedes and Danes;) and the disappearance of the herring from Dynekilur (a gulf on the coast of Sweden) was generally ascribed to the guns of Tordenskjold's (a Danish admiral) fleet. When the herring returned in 1750 a law of 1756 fixed a penalty of 500 rigsdalers (\$250 gold) for discharging a gun from any fortress on the coast, on men-of-war, and on merchant-vessels during the period when the herring was approaching; and as late as 1808 the thunder of guns (in the war between Denmark and England) was considered the cause of the herring's disappearance. Even now the herring fishermen do not like the noise of the steamers, and in 1862 they were not permitted to cross the Sildefjord near Karmö. In Ramsdalen steamers were not considered so obnoxious, and during the great-herring fisheries no instance is on record of the herring having been driven away by the constant passing and re-passing of steamers. In Scotland careful observations have shown that the herring has disappeared from bays which have never been touched by a steamer, and have remained in some portions of the sea where steamers pass daily. Professor Nilsson considers all noise detrimental to the herring-fisheries, and to show how easily the herring can be frightened, he relates that, in 1756, when the fisheries near Rikfjord

were very abundant, the herring left when eight men-of-war anchored there, and this only because the ship-bells were rung every evening, all shooting having been forbidden. He adds that the cause of the herring's disappearance in 1808 was the constant noise in the salting-houses, produced by the manufacture of barrels, and by other work, all the harbor being full of ships and boats waiting for their cargoes of herring, the whole coast and all the islands swarming with people of every age and sex, who had gathered there for the sake of earning money. In the evening there was music and dancing in the fishing-places, and therefore Nilsson says it was no wonder that the herring left.

In Norway the herring does not seem to be so much disturbed by noise, but other causes of its disappearance are given. In Flækkefjord people thought the cause of the herring's departure in 1859 was the strong glare of the List light-house. In other places, however, there was no objection to light-houses; while in Utsire it was even thought that the fisheries began to be very abundant just about the time when the light-houses were erected, the herring, as they supposed, being attracted by the light. The opinion that light-houses have any influence on the herring's appearance or disappearance has now been entirely abandoned. Formerly many supposed that the bad odor spreading over the sea from the burning of sea-weeds caused the herring to leave, and in many places laws were demanded forbidding the act. The burners of sea-weed, however, were of a different opinion, as well as the owners of glass-houses, who used the burnt sea-weed. Professor Rathke was commissioned to examine this matter, and he found that the herring had left places where sea-weeds had never been burned, and continued in others where sea-weeds were burned constantly. It has also been said that the cuttle-fish was a cause of the herring's disappearance, but Boeck has never found a single cuttle-fish in the southern fisheries, while he saw large numbers of them near Langenæs, and many instances were related how the cuttle-fish loved to pursue the herring; but in no instance could it be proved that it had ever driven away even the smallest school.

At one time it was supposed that impurities at the bottom of the sea had an influence on the herring fisheries, and that the herring avoided those places where many impurities were found, because they were unfavorable to the development of the spawn. Such impurities were generally produced by employing imperfect fishing-implements, which left greater or less masses of herring at the bottom, and also by various kinds of refuse being thrown into the sea, which might make it unfit for spawning. On the coast of Norway the former opinion was quite prevalent, it being maintained that in seine-fishing great quantities of dead herring were left in the water. Boeck, during his first stay at the fishing-stations, had his attention directed to this. He also saw that the nets with narrow meshes, which the fishermen have recently begun to use, did not permit larger herring to put the whole head through the

meshes, but that only the front portion entered, so that the fish died at last in endeavoring to push through the meshes, as it never moves backward. When the net is hauled in, these larger herring fall off and remain at the bottom of the sea. He had several times examined such places after the fishing was over, but had never found any large quantity of dead herring at the bottom, even when he used the dredge after particularly rich fishing-seasons. With the water-telescope he could not penetrate to such a depth, but he thinks that the account of great masses of herring lying there is very much exaggerated. On another occasion he saw a large quantity of dead herring lying at the bottom of the sea, but he felt convinced that this could not possibly influence the fisheries, and experience has shown that he was right. When the current is very violent, nets set in exposed places will be driven together and become entangled, so that it is impossible to separate them. He thus witnessed at Björkevær the sinking of such a mass of entangled nets which had been cut off from the buoys, in order to save something. It was important for him to examine the place where this was done, and he went there about two months after this occurrence. The nets were then so much decayed that only small pieces could be recovered, while of the herring only bones and gristly parts were found. But the fragments of the nets and herring were everywhere covered with carrion-eating animals, which had gathered in great numbers. Many other animals were also found. When, later in the same year, he requested some one to procure for him specimens of some of these animals, it was discovered that there was not a trace left of nets, herring, or animals; so that about four months after the close of the fisheries the bottom was quite clean again.

It is, therefore, evident that dead herring could not make the bottom so impure that a year after it should be unfit for the herring to spawn in; and experience has also shown that this is not the case. On the other hand, reports from Sweden, Scotland, and other countries, affirm that seines may be very detrimental to the fisheries, by leaving a great many dead herring at the bottom, and many instances of this are mentioned, such as the well-known fishery near Golten, where, after a great many herring had died during one night, the fisheries were never again successful. Boeck also discovered, several times after seine-fishing, by examining the bottom with the water-telescope, a considerable number of dead herring; but he thinks that the injurious influence is very much exaggerated. Where seine-fishing is carried on in open places the current, sea-animals, &c., will very soon purify the bottom, and only where very large masses of fish have died in deep and narrow inlets will some remains be found the following year. The cause of the herring not returning to such places might rather be occasioned by its irregular habits than by dead fish. In order to adduce more substantial proof of this he caused, according to the government inspector's account, to be marked on a map all those places where seine-fishing had been carried on since 1853, and he found that in some there had been considerable seine-fish-

ing year after year. It was, therefore, beyond a doubt that seine-fishing was by no means so detrimental to the fisheries as was generally supposed. That the seines brought up all the young herring, was entirely unfounded, or, at any rate, but rarely the case; and the small herring, which are frequently caught toward the close of the fisheries, often contain roe which has not been fully developed. He was informed at the great-herring fisheries, and also saw for himself several localities, where large masses of dead herring were said to be, at Selsövik, where, at the bottom of the deep and narrow Gjerres inlet, between 10,000 and 15,000 tons were lying. The following year would show whether they had decayed or not.

In Sweden, the disappearance of the herring had been chiefly attributed to refuse of fish-oil which had been thrown into the sea. This had formed a theme of discussion as far back as the middle of the last century, and Professor Nilson had clearly stated the reasons which favor this opinion. It will be seen that with regard to Bohuslän, his opinion has met with much opposition, while just as many instances are given tending to show that the refuse of fish-oil has no such injurious results. Boeck has not been able to find that these heaps of refuse are so near each other that the herring could find no suitable spawning-places between them. Even if the refuse of fish-oil were the cause of the herring's departure, this could not have been the case in former times, when the herring disappeared from Bohuslän, as at that time there were no oil-refineries either in Norway or in the Limfjord, (in the north of Jutland.)

Boeck's investigations therefore prove that all these causes, which have been mentioned as being instrumental in driving the herring away at different times from different places, either amount to nothing, or have not held good in all cases. He endeavored himself to find causes of the herring's disappearance which would better stand the test of science, but for a long time sought in vain, till at last he thinks that, through the study of history of the herring-fisheries, he has found reasons that will hold good in all cases. During the first year of his stay at the fishing-stations it occurred to him that the herring-fisheries, which formerly had commenced much earlier in the season, sometimes even before Christmas, had more recently begun later in the year, and he was unable to find any special reasons for this. He also noticed that the herring-fisheries were very unproductive near Skudesnæs, where formerly they had been very abundant, and that this could not be ascribed to storms or to any other ordinary cause. In the following year the fisheries commenced still later, and in carefully examining this whole matter he found that at the commencement of the fisheries in 1808 the herring approached the coast in February, while during the following years it came earlier every year, till recently it again came later and later in the season, until this year it came at the end of February. In his work, "*On the herring and herring-fisheries*," he has given the exact date for every year when the herring approached the coast. From these dates it is seen that there is a certain regularity in the time of the herring's approach, which is but slightly

modified by storm and cold. In examining the localities where the herring fisheries are carried on, it will be seen that there is likewise a certain regularity in them. From 1808 and 1819 Skudesnæs was the chief seat of the fisheries on the southern coast, while north of Karmö and Espevær only few herring were caught, not counting, however, the so-called Bergen fisheries from Selbjörn fjord to Feiö. From the year 1819 the herring also began to appear in large masses near the Hviding Islands, Tananger, and Roth, and in 1825 it passed south of Jæder. From 1824 to 1838 we notice a constant tendency in the herring to move south, the schools in that direction increasing every year, so that rich fisheries began to spring up, first near Egersund, then near Sagndal, Rægefjord, and Hækkefjord, while at the same time the fisheries near Skudesnæs gradually grew less abundant. From that time, the herring began again to retreat, and soon disappeared completely south of the Jæder, and more recently from the Hviding Islands and Skudesnæs; while, on the other hand, the fisheries became very important near Rövær. During the last year the fishing has shifted north of Espevær. If this regularity in the change of time and place of the herring movements could only be proved with regard to the southern spring-herring fisheries, it would be an important fact, yet not important enough to allow us to deduce laws that would be applicable in all cases. Boeck, however, found that such was really the case. In examining the information scattered in merchants' account-books, and letters which he was permitted to use in Stavanger, he found that this same law applied in former as well as in later times, and that there was the same regularity in the change of time and place of the herring-fisheries. He has treated this subject at length in his work, "*On the herring and the herring-fisheries.*" Even in examining the dates regarding the herring-fishery in the year 1575, given by Absalon Pedersen Beyer, we find that the fisheries in the beginning of that period commenced toward the end of February. This law is therefore found to apply to three different periods. The same phenomena were observed not only here, but also in other places. This can be shown most conclusively in the Bohuslen fisheries. Boeck found that this regularity was very apparent there in the great fisheries which closed in 1808. In 1756 the fisheries commenced near Styrö and Risöfjord, south of Gottenburg; from there the herring went constantly northward, and in 1773 herring were caught near Strömstad, and, in 1778, near the Hval Islands. As regards the time of its appearance, the herring in 1750 came in October, and from that time always a little earlier, till 1762, when it came on the 16th of August; then again gradually later. For example, in 1780, toward the end of October; 1790, in the middle of November; 1800, about Christmas, and toward the end of that period (about 1808) in February. The same was also the case during the great fishing period, from 1556 to 1590. It will thus be seen that the same law has held good for several centuries and in two different places.

In 1868, when the fisheries were still very abundant, Boeck thought

that he was fully justified in predicting that a change of the fisheries was near at hand; and although in the beginning he met with violent opposition, he saw his predictions verified from year to year. He finally mentioned some other facts. It has been a wide-spread opinion that the herring-fisheries change alternately between the coast of Norway and that of Bohuslän, and that the herring moved between these two places, an opinion which was strengthened by the fact that when, about 1808, the schools of herring left Bohuslän, they made their appearance on the coast of Norway. But Nilsson had already shown that the Bohuslän herring is a totally different species from the Norwegian, and Boeck has proved conclusively that this difference has existed from time immemorial. He has furthermore proved that these two species also differ in the circumstance that they spawn at different seasons of the year, the spring-herring spawning in the spring, and the Bohuslän herring in the autumn. He has also been able to prove by historical researches that, from the very earliest times, both these herring-fisheries have been carried on at the same season, and that only during the last fishing period there was any difference in time. Nor has he found any connection existing between the Norwegian, Dutch, and Danish fisheries. Such a connection may possibly have existed between the Bohuslän fishery and the Dutch-Scotch fisheries, as some data seem to point in that direction.

If the herring should leave the coast of Norway, it will, in all probability, be obliged to seek the other channel, ("Rende,") which Boeck has marked on his map. At a distance of from ten to fifteen miles from the coast of Norway, large banks are found, that have their roots in the North Sea, where the depth of water varies only between 70 and 50 fathoms, a depth which is very favorable to the development of the spawn. Boeck thinks that if the herring disappears from the southern coast of Norway, the fishermen and merchants will suffer in the beginning, but not as much as in former times. The cod-fisheries which have recently commenced, and which he always found to come after a period of herring-fishing, would probably replace the herring-fisheries, after people had become accustomed to them, and had supplied themselves with the necessary implements. Besides, since the intercourse by steamers has become so common, and is even increasing, fishing-places that were formerly considered too remote will be used just as well as those which are near, and herring-fishing will assuredly be carried on at all times on the long coast-line of Norway. The periods during which the herring has disappeared have been neither as long nor as exclusive as is generally supposed; for although we know that the herring left Skudesuæs in 1784, it was caught near Bergen in 1787, and returned there in 1806, while it did not return to Skudesuæs till 1808. Nor has it remained entirely away during the intervening period, since in 1803 there might have been considerable fishing, if people had been prepared for it, for during that year the herring approached the shore in vast numbers.