

VII.—REPORT ON THE PRACTICAL AND SCIENTIFIC INVESTIGATIONS OF THE SPRING HERRING FISHERIES DURING THE YEAR 1880, SUBMITTED TO THE DEPARTMENT OF THE INTERIOR.

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Having been commissioned by the Department of the Interior to make a practical and scientific investigation of the spring herring fisheries, I left Bergen on the 11th of February for Haugesund, and on the 13th of February arrived at the fishing station of *Udsire*. Here I remained till the 9th of March, when I went to *Røvær* to continue some investigations of the spawning of the herring. After a short stay at *Akrehavn* and *Skudesnæs*, where I had an opportunity to gather (from some experienced fishermen) further information relative to the occurrence and nature of the spring herring during recent years, I returned to Bergen on the 20th of March.

As I had occasion to be present during the latter portion only of the spring herring fisheries, and as during the greater part of my stay the weather was unusually stormy, my investigations had necessarily to be more imperfect than they would otherwise have been. The seine fisheries, which have been in operation for some years, and which present features of special interest to the investigator of the spring herring fisheries, were over when I arrived. No fish whatever were caught in seines during my stay at the fishing stations, and fishing was only carried on with stationary nets. During the last two years these fisheries have begun to revive, which is a welcome sign that the spring herring will again follow their usual course along our coasts. These old fisheries, therefore, promise again to be of considerable importance in our own times. A historical investigation of the occurrence of the herring, during the last ten years, also brings to light other phenomena, indicating that a new period of spring herring fisheries is about to be ushered in.

Since Dr. A. Boeck published his classic work, *Om Silden og Sildefiskerierne* (The herring and herring fisheries), in 1871, no work of import-

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ance, at least of a scientific nature, has been published, during the last few years, on the history of the spring herring fisheries. Dr. Boeck and Prof. G. O. Sars have written articles on certain special features of these fisheries, but these articles are far from exhausting their subjects, and, moreover, these two scientists have not had occasion to observe these features in connection with phenomena which only became known during the last few years, and which enable us to understand the former correctly. The herring, during the last ten years and even till quite recently, have exhibited the most remarkable changes, which are not isolated, but form a continuous *development*, one stage of which is closely connected with the other. These changes have been very rapid, and it is only to be regretted that they have not been made the subject of scientific investigations. By examining the numerous reports relative to the course of the fisheries during the fishing season, and by conversing with experienced fishermen, whose recollection of all the circumstances was still vivid, I was, however, enabled to obtain a tolerably correct idea of the history of the last ten years' fisheries, and I shall in this report endeavor to present to the reader its most important features. Till the year 1874 I chiefly based my observations on the reports of the superintendents of fisheries, which form a most valuable source of reliable and unbiased information. One would think that oral reports from different parts of the coast would be likewise reliable with regard to phenomena which have occurred at a comparatively recent period of time, and relating to a subject which long experience should have led the fishermen to examine into closely, viz, the greater or less degree of maturity in herring, their size, weight, &c. These last-mentioned sources, however, I have used with great caution, and shall for the present only refer to them in a general way.

The development of the spring herring, above referred to, has not yet reached its terminal stage. As this development is still going on, it may be expected that several of the phenomena which have characterized its early stages will occur again, and that therefore by a closer examination of such phenomena more light may be thrown upon the early part of this development.

The very remarkable occurrence of herring in unusually large masses during the first years of the last decade has a parallel in the herring fisheries of *each* year. I here refer to the "new herring," or mixed herring, which appeared in enormous numbers prior to the arrival of the spring herring in 1870, but which also appeared during the following years, and whose schools chiefly consisted of so-called "*straalsild*," ray herring, or "*blodsild*," blood herring. It is a well-known fact that these herring appear regularly every year in small numbers, immediately before the arrival of the spring herring. Here, therefore, there still seems to be a chance to make direct observations relative to the more important phenomena of the herring fisheries of the last few years.

The dependence of the herring on the temperature of the sea, which is a most important item in the daily life of the herring, has already formed the subject of investigations by Boeck, and it was my intention to continue these investigations begun by him. With a Negretti & Zambra's deep-water thermometer, which, through Professor Mohn's kindness, was loaned me by the Meteorological Institute, I took a number of observations of the temperature, but unfortunately these were made too late in the season to throw much light on the course of the herring during the present fishing period. These observations, however, furnish results relative to the temperature of the sea at different depths, which are important for us to know in connection with this whole herring question, and which became specially interesting when compared with Boeck's earlier observations.

The observations of the temperature, and other meteorological investigations, made near the coast and with reference to the more or less mature spring herring, are of course as yet an incomplete work, and the most important question connected with the herring problem, the cause of the disappearance of the herring from our coast for years at a time, is probably still far from a satisfactory solution. In order to ascertain whether the temperatures and currents of the sea are really the principal causes of this phenomenon, these meteorological conditions, and their influence on the course of the herring, should be observed *outside* of the spawning season, or during summer, when the herring are out in the open sea. This investigation still belongs to the future. We do not even know for certain where the herring have their summer stations, but only suppose that we know the places where in all probability they must be looked for (see Sars's reports, especially the one for 1873). The first and most important thing to do would be to go through these places with seines, which perhaps would not be very difficult. If such an expedition were made whenever a change should take place in the spring herring fisheries, we would get a good deal nearer to a solution of the above-mentioned most important question—the periodical disappearance of the herring from our coast.

I shall now proceed to give a brief review of the observations made this year, and in doing so I shall have to speak first of the history of the spring herring fisheries in recent times, and in connection therewith of the present condition of the spring herring; and secondly I shall have to add some remarks on the temperature of the sea during the fishing season.

By unceasing and most meritorious labor Boeck has succeeded in showing a certain regularity in those changes to which the fisheries are subject during a so-called "herring period."* According to Boeck's investigations, this irregularity principally consists in the circumstance that during the first part of a "herring period" the fisheries gradually

*Although this term is not entirely justified, I will nevertheless employ it in this report, as from very good causes it has become quite generally adopted.

commence earlier every year, whilst towards the end of the period they gradually begin later. With regard to localities, the herring fisheries move in a certain direction, thus, *e. g.*—according to Boeck—in Bohuslän and in our southern spring-herring district, in a northerly direction, till they reach a point where the fisheries cease.

Similar changes of a regular character have not only been observed on our coast, but also on the coast of Scotland. According to Mr. Wintlar* the herring fisheries in the Sound were, during the herring period that ended in 1875, gradually extended later into the season. In the Great Belt a gradual northward movement of the herring has been observed.† In France a similar phenomenon is said to have been observed during the sardine fisheries, and it therefore seems that these phenomena are of a more general character.

In our *southern spring-herring district* the following changes as to the time of commencement of the fisheries have been observed:‡ In 1808, therefore, in the beginning of our last herring period, the fisheries at *Skudesnæs* commenced on the 6th February. During the following years they gradually commenced earlier, in 1814 on the 1st of February, in 1815 on the 31st of January, in 1817 on January 30th, and from that time on they began in January—the dates varying somewhat—for a long number of years. During the years 1844 to 1847 the fisheries commenced partly in January and partly in December. From 1848 the first herring were regularly caught in December, and this lasted till 1859. From 1860 the herring again commenced to arrive in January, and in 1869 the *spring-herring fisheries* proper did not commence till the 3d February. As regards locality, it was observed that during the latter part of the “herring period” the herring left their southern spawning places near *Skudesnæs* and the *Hviting* Islands, and gradually moved farther north, so that towards the end of the period the principal fisheries were carried on near *Karmoe*.

The year 1869 was distinguished by the late arrival of the herring, and by the fishing stations being far north, as well as by other peculiar features. From 1860, when the herring fisheries for the first time during the “period” commenced late in the season, considerable masses of herring came near the coast, and for several years the fisheries were very good. Even as late as 1868 there were exceedingly successful spring herring fisheries in the southern district, about 500,000 barrels of fish being caught. A significant change, however, took place in 1869. Lieutenant *Heyerdahl*, the superintendent of the southern district, says: “It was very generally noticed in our district that the schools of herring were not of the same size as in former years this must have

* *Tidsskrift for Fiskeri*, new series, iii, 1.

† In the Sound there can hardly be any such movement, as it contains only one favorable spawning place.

‡ See BOECK: *Om Silden og Silde-fiskerierne*, and the reports of the different superintendents.

been the actual fact, unless one supposes that the largest school of herring approached the coast in places where there was no one to observe them. Even at *Udsire*, which is a favorite resort of the herring, the schools were much smaller than usual." In reviewing these fisheries at the present time, we find that these observations were entirely correct. The quality of the herring during that year also goes to corroborate them, for during these fisheries an unusual number of small herring were caught with the spring herring. Generally these small herring only make their appearance after or near the close of the fishing season, and their appearance is always considered as a sign that the schools of spring herring are decreasing in size, and are disappearing from the coast. This mingling of small herring with the spring herring during the fishing season of 1869 has its parallel in the Bohus-län fishing period, which came to a close in 1808, the last years of which likewise distinguished themselves by the frequent mingling of small herring with the larger herring.

From the reports of the superintendents we learn that, in 1869, the schools of herring were often followed by large numbers of coal-fish, which were often noticed in the very middle of such schools. This was the case not only in the southern, but also in the northern district. Fishing was very uneven during this year.

The superintendent of the northern district reports that, in 1869, the number of herring which approached the coast was hardly less than in former years, and that no small herring were found among the spring herring. Soon afterwards, however, the same phenomena undoubtedly began to show themselves in the northern district, although they were not as closely observed as in the southern district, where the year 1869 marks the end of the rich spring herring fisheries. Whilst in 1869 355,000 barrels of fish were caught in the southern district, the spring-herring fisheries proper only yielded 55,000 barrels in 1870. Although this last-mentioned number is probably too low (see report of the superintendent for 1871), the fact remains that the yield was much smaller than in 1869. In 1870 the first school of herring, composed purely of spring herring, were observed on the 20th January, but fishing did not commence till the 10th of February, some of this delay, it is true, having been caused by unusually stormy weather and heavy seas. The fisheries during this season were short and irregular, and the same was the case during the three following years, when only an average quantity of 14,000 to 15,000 barrels was caught. The herring made their appearance sometimes in January and sometimes in February, but it was impossible to fix the exact date of the arrival of the spring herring, as they were very much mixed with "new herring," from which it was difficult to distinguish them. (With regard to these herring more will be said.)

In 1874 the southern spring-herring district only yielded the very small quantity of 3,000 barrels. During this and the preceding years it was proved in the most convincing manner that the cause of this sud-

den and rapid decrease could not possibly be found in any meteorological change which took place near the coast, and which might have prevented the usual number of herring approaching; but that there was, on the whole, no indication that any considerable number of herring had come near the coast. In the beginning of the "period" the prospect seemed very favorable, but these hopes soon vanished. Thus, in 1873 and 1874 only few herring were noticed near the coast during the months of January and February, when generally the more important spring-herring fisheries are going on. The same experience was met with at the outermost station of *Udsire*. As in 1869, so also in 1870, the schools of herring were accompanied by an unusually large number of coal-fish and cod, both in the southern and in the northern district. The same phenomenon was observed in a still more noticeable degree in 1871, both during and after the fishing season. At present I have no data to show to what degree this was observed during the following two years. In 1874, however, the superintendent reports that but few cod were observed; the schools of herring had also decreased in size to such an extent that the cod, the inveterate enemy of the herring, had no special inducement to follow the schools. It has been supposed that an extraordinary increase in the number of the enemies of the herring might be the cause of their disappearance. But there is not sufficient cause to justify this supposition, and it would at any rate be too hasty a conclusion to give this as the principal cause of the disappearance of the herring from our coasts.

The mingling of small herring with the spring herring rapidly assumed larger dimensions. In 1871 it was considered doubtful whether any genuine spring herring were caught; and many experienced fishermen expressed it as their solemn conviction that no genuine spring herring had approached the coast in the southern district during that year. From the report of the superintendent it also appears that the number of small herring was larger than at any previous time; and this was the case both in the northern part of the district, near *Bran-desund*, and in the southern part, near *Rövær*. The average size of the *Rövær* herring was determined by "standard barrels," each of which held 620 to 680 herring. In 1872 such a barrel comfortably held 660 to 720 herring, and there is no longer any talk of unmixed spring herring. But during all these years, even from the season of 1869-'70, other phenomena were observed, which were followed by an increase of spring herring. Of these phenomena I shall have occasion to speak later.

In the *northern district* the spring herring approached the coast gradually, just as in the southern district, towards the end of the last "herring period." From the reports of the superintendents, it appears that in 1852, 1853, and 1854 the first herring were caught in December; in 1855 on the 8th of January; in 1856 on the 15th of January; in 1857 on the 13th of January; during the two following years again on the 15th of January; in 1860 on the 19th of January, and later always after the 19th of January.

As I have already observed, there was hardly any decrease in the size of the schools of herring in the northern district, not even at *Söndmöre*. The total yield in the northern district was 255,000 barrels, and at *Söndmöre* 70,000 barrels.

In 1870, when the fisheries were short and irregular, the yield went down as low as 80,000 barrels in the northern district, whilst at *Söndmöre* it probably amounted to 25,000 barrels. The superintendent says in his report for 1870: "The meteorological conditions were on the whole more favorable than is generally the case, and the almost total failure of the fisheries must therefore be ascribed to the small number of herring which had approached the coast, although sea birds and whales, which are considered sure indicators of the occurrence of herring, showed themselves in the same numbers as during previous years."

A change was also noticed in the quality of the herring. At *Söndfjord* the herring seem not to have been of such even and good quality as at *Nordfjord* and *Söndmöre*. I gather these facts partly from the reports of the superintendents and partly from other sources to which I had access. It is a significant fact that the mingling of different kinds of herring took its beginning in the southern part of the district.

In 1871 it was reported that the herring were of the least even quality near *Bueland*, the southernmost of our more important fishing stations. In the northern part of the district and near *Söndmöre* the herring were of the usual good quality. In the northern district 61,000 barrels of fish were caught, and at *Söndmöre* 8,000. The yield, however, was smaller than it would otherwise have been, on account of storms, the severe cold of winter which set in exceptionally early, and other unfavorable circumstances.

What had been already indicated by the uneven size of the herring during the preceding years took place in 1872. There were hardly any fisheries in the whole southern portion of the northern district as far as *Bremanger*, on the very coast where formerly there had been the best fishing in the whole district. It also appears that the number of herring caught near *Froe Island*, southwest of *Bremanger*, was remarkably small, and that the fish were nearly all of small size. In 1871 the average number of herring caught near *Froe Island* was 504 per "standard barrel," whilst in 1872 it was 522. In the other portion of the northern district the yield was 62,000 barrels, and near *Söndmöre* 115,000, an unusually good yield for these northern latitudes, principally owing to the exceptionally favorable weather. These facts show that great masses of herring still come to these coasts. In spite, however, of the approach of such masses of herring, there seemed to be some indications that the same fate awaited these fisheries as the southern ones, the average number of herring per "standard barrel" being 540, whilst in 1871 it was 530. This was first observed at *Söndfjord*, therefore at the southernmost point of the district. Herring of the same size as those caught in former years could only be counted on

with any degree of certainty in the northernmost portion of this coast, viz, at *Söndmöre*.

In 1873 the average number of herring per standard barrel near *Fröi Island* was 540. But few herring were caught near that station, and no school of any consequence seemed to have approached the coast. The prospects south of *Bremanger*, which during the preceding year had been tolerably good, seem certainly to have been far less favorable. At *Nordfiord* the yield was only about 24,000 barrels, although it must be taken into consideration that the conditions were particularly unfavorable; no decided decrease in the number of herring could, however, be observed. The indications seemed to be that the herring would be smaller in size. At *Söndmöre* no change in the size of the herring could be noticed; the yield at this last-mentioned place was only 6,000 barrels, owing exclusively, however, to the stormy weather.

In 1874 there was no fishing south of *Bremanger* or near this island, except at *Nordfiord*. The yield at the latter place was very insignificant, viz: only 5,000 barrels. There was a very marked decrease in the number of herring, and their size was very uneven, but on the whole smaller than in former years. Now, at last, there were likewise indications that the fisheries would come to an end near *Söndmöre*. In spite of the most favorable weather only 8,000 barrels of fish were caught at this station, and the herring were decidedly smaller, the average number per "standard barrel" being 570 to 580 (against 532 in 1872).

In 1875 there was no fishing whatever north of *Bremanger* in the *Nordfiord*. Near *Söndmöre* it was reported that 3,000 to 4,000 barrels were caught to the northwest of *Stat*. This year must be considered as the closing year of the spring-herring fisheries.

The above brief review of the decline of the spring-herring fisheries shows conclusively that also in the northern district and near *Söndmöre* the herring disappeared gradually in the direction from south to north, the schools decreasing in size from year to year. In the southern district the herring went in a northerly direction, even before the schools began to decrease in size.

The same regular and gradual decrease could be observed not only in each individual fishing-district, but all along the coast where the spring-herring fisheries were going on. The herring first disappeared in the southern district, then in the northern, and finally at *Söndmöre*. After the decrease in the size of the schools had set in, it was slower in the northern district and at *Söndmöre*. For a considerable time large numbers of herring continued to come near these coasts, and disappeared all of a sudden. The average size of the herring also continued to be larger,* and their quality was on the whole better. These phenomenon

* The fact that the herring in the northern district and at *Söndmöre* were larger than those of the southern district, not only during the period when they decreased in numbers, but as a general rule, is—according to *Löberg*—caused by the circumstance that in the first mentioned districts nets with larger meshes are used (See *LÖBERG: Norges Fiskerier*, 1864, p. 47). This assertion, however, needs further examination.

must of course be in some way connected with each other, and doubtless depend on the circumstance that the herring go farther north.

As to time, the spring herring came—as has been said above—later and later towards the end of the period; and this phenomenon was the same in both districts. Another circumstance, relative to the spring fisheries along our entire coast, likewise deserves to be mentioned here, when the spring herring commenced to come later and later in the season, they were first seen in the southern district, then in the northern, and finally, somewhat later at *Søndmøre*, which order of time probably depends on the geographical location of the different districts, and corresponds to the order of place which the spring herring observed when gradually disappearing from our coasts.

With regard to the *great herring fisheries* we can, to some extent at least, observe the same regularity as in the spring-herring fisheries.* It is a well known fact that the great herring commenced to appear near our coasts in 1861, when large schools of them were observed off the northern and western coasts of the Lofoden Islands and *Vesteraalen*. In the beginning, however, they kept at a distance of several miles from the coast, and only approached it in rare cases to within a distance, which enabled the fishermen to catch some. Gradually they were moving farther south. In 1863 they appeared north of *Helgeland*, near *Thøanen* on the Island of *Lurö*, and to some extent also near the *Myk* Islands and near *Rödö*. In 1864 they were observed south of *Helgeland*, near the outer islands of *Herö* and *Vegö*, and also—according to reports from merchants and fishermen of *Christiansund*—still farther south near *Sulen*, *Halten* and *Hitteren*, and at *Nordmøre*, near *Smælen*, *Talgsö*, *Grip*, and *Stemmet*.† At *Nordmøre* there was excellent seine fishing, and large hauls were made; but unfortunately many of these fish were lost again during a most violent storm, which actually resembled a hurricane. The great herring during the following years continued to make their appearance far south, which fact is also mentioned in the reports on the fisheries of Norway, published by the Department of the Interior. During these years the whole coast of Norway from *Karmö* to *Finnmark* was literally surrounded by herring. South of *Helgeland*, however, no great herring fisheries of any importance were carried on. According to the reports published by the Department of the Interior, which speak of the occurrence of great herring near *Vigten*, in the district of *Namdalen*, they seem to have disappeared from those localities at the same time when they moved farther north into the great-herring district proper. During the years 1868 and 1869 there were fisheries as far north

* My success of information for the following review of the great herring fisheries have been the reports published every year and every fifth year by the governors, and by the Department of the Interior.

† See also the report for the five years 1861 to 1865, by the governor of *Romsdalen*, according to which the herring in 1864 and 1865 appeared near *Nordmøre* and near *Romsdalen*. Nothing is said, however, in this report among what class these herring should be counted (with regard to the size of the herring, see *Bocock's* report for 1873, p. 8).

as Finmark, but their yield was only about 2,000 barrels per year. Later than 1869 there were no fisheries in these high latitudes. The great herring-fisheries proper were carried on near the coasts of the districts of *Nordland* and *Tromsö* where the largest number of great herrings approach the coast. After having reached the coast about the same time near *Senjen* in *Tromsö* and near *Vesteralen*, the great schools of herring passed the southern point of the Lofoden Islands, going in a southerly direction to the *Skibbaads* Reefs in Southern *Helgeland*. Smaller schools went further east to the *Gildeskaal* Reefs near *Sydsalten*. One year after the other the great herring returned to exactly the same localities, and the time of their arrival was exceedingly regular. Later the herring went farther north; the *Helgeland* fisheries came to an end, and the great masses of herring turned farther north from the southern point of the Lofoden Islands in the direction of the *Vestfiord*, not a few of them going as far north as Finmark.

The more important data as to time and place of these remarkable migrations are as follows:

In 1868 and 1869 the hitherto insignificant *Gildeskaal* fisheries began to improve, especially at the fishing-stations of *Fuglövær* and *Fleinvær*. In 1869 an enormous mass of herring came to *Fleinvær*, and large numbers also came to *Fuglövær*.

In 1870 herring not only came in large masses to *Fuglövær*, where the fisheries were very good, but also farther north to the *Hellig* Reefs in the district of *Bodö*, where formerly no great herring had been caught. Owing to various unfortunate circumstances not many fish, however, were caught, the yield being only about 2,000 barrels. Even during that year (1870), therefore, a change could be noticed in the migrations of the great schools of herring, many of them going as far north as the *Vestfiord*.

In 1871 enormous masses of herring came near the *Gildeskaal* coast, so that in some places the sounds were absolutely filled with herring. Herring also came to the *Hellig* Reefs, and to *Blixvær* and *Landegade*, and other places in the same district; the yield was 56,000 barrels.

In 1872 large numbers of herring again came to the *Gildeskaal* coast, and to many places on the coast of the *Bodö* district. Near the *Helgeland* Reefs, however, where there had been the most extensive fisheries, but few fish were caught; this applied especially to the three southernmost reefs viz: *Skibbaadsveer*, *Aasvær*, and *Lovunden*. The total yield was only 24,450 barrels, against 294,200 in 1871, when, it is true, the fisheries were exceptionally productive. Farther north, near *Rödö*, in the *Helgeland* district, the yield was 10,500 barrels.

In 1873 but few herring came to the coast of *Helgeland*, excepting, however, the northernmost portion near *Melö*, and the fisheries proved an almost total failure at *Shibbaadsveer*, *Aasvær*, and *Lovunden* (total yield 4,600 barrels), and at *Rödö* (yield 1,000 barrels). At *Melö* the herring approached the coast several times, but even here a decrease

could be noticed (9,850 barrels, against 17,275 during the preceding year). At *Gildeskaal* and *Bodö* large masses of herring were yet found, but their arrival was somewhat irregular; and it seems that especially at *Gildeskaal* the herring sought other reefs than formerly. During this year the herring went farther north into the *Vestfjord*, and an unusually large number was found along the entire coast of *Salten* and far in the *Tysfjord*.

In 1874, the last year when great-herring fisheries were carried on, only a few small schools made their appearance near *Helgeland*. Near *Melö* only 1,220 barrels of fish were caught. Also at *Gildeskaal* in *Salten* the herring failed to put in an appearance, and but very few came to the *Bodö* district, whilst towards the *Vestfjord*, in the *Stegen* and *Hammerö* districts, large numbers came near the coast.

As regards the more northerly localities, large numbers of herring had regularly approached the coast near *Vesteraalen*. In 1871 and the following years they came also to the Lofoden Islands, in particularly large numbers during 1871 and 1872, without, however, making the fisheries in these localities specially productive.

In the *Tromsö* district large numbers of herring likewise approached the coast, but one year they came quite near the coast, and the next they kept at a considerable distance from it, which of course made the fisheries very irregular.

In Finmark there were no fisheries since 1869. Prof. G. O. Sars furnishes the interesting item of information, that considerable numbers of herring were seen in 1873, even near the coast of East Finmark.

It is not known with any degree of certainty how much the herring decreased in number in the northeru portions of the great herring district proper (the districts of *Nordland* and *Tromsö*) during the last year of their occurrence in those parts. At *Salten* a much larger number of herring was caught in 1874 than in 1873; but this circumstance was caused partly by the exceptionally favorable weather, and partly by the fact that the fishermen in 1874 were not as well prepared for fishing on a large scale as in 1873. At *Vesteraalen* about the same number of fish was caught in 1874 as in 1875, and the fisheries of both years were considered good. In the *Tromsö* district the fisheries of 1873 were more productive than in any previous year, the yield being 168,000 barrels. In 1874 the yield was much smaller, viz; 70,000 barrels; but even this fact does not furnish any absolutely satisfactory evidence of a decrease in the number of herring.

In 1875 the fisheries were a total failure everywhere, and there was hardly any indication at all of any great herring having approached the coast. The rumors which were current during the year that the herring showed themselves in the *Nordland* district proved to be unfounded, or at any rate grossly exaggerated. In the *Tromsö* district birds were noticed to hover over the sea, and "it is therefore probable,"

says the governor in his report, "that there were great herring near the coast," but in no case did they approach it very closely.

In 1876 no great herring were found in any portion of the *Nordland* coast. Farther north, in the district of *Tromsö*, it is said that a small percentage of great herring were found among the fat herring.

The great herring fisheries, therefore, came to an end, after a *gradual disappearance of the great masses of herring in a direction from north to south*, in a similar manner as the spring-herring fisheries.

It is peculiar that the great herring did not, like the spring herring, confine themselves to the northermost of their old accustomed landing-places, but sought new places, going north towards the *Vestfjord*. In the occurrence of great herring near the coast of *Finmark* in 1873, we probably find a phenomenon of a similar character. One would think that the great herring also, particularly in 1875, after having left the coasts of *Nordland* and *Tromsö*, would have appeared later in larger numbers near the coast of *Finmark*, but it is expressly reported (see *Norges Statistik*) that in 1875 and the following years no herring came near the coast of *Finmark*.

In 1871, and also later, the great herring went farther up the inland fiords than they had ever done before, and this must be considered as a very marked and remarkable change in the occurrence of the herring, which hitherto had been extremely regular. I will here only note the fact that during the following year, 1872, the *Helgeland* fisheries commenced to decline. The migration of the herring in the direction of the *Vestfjord*, taken in connection with the circumstance that the herring went higher up the inland fiords seems to point to a changed condition of the coast waters towards the close of the great herring fisheries.

With regard to the quality of the herring, it was reported that the great herring caught near *Helgeland* in 1873 were *mixed with smaller kinds of herring* resembling spring herring, which was considered as an indication that the masses of great herring were disappearing. I have no exact information as to the degree to which the herring were mixed. In the northern districts, where the herring did not decrease so much in number, the size of the great herring seems not to have undergone any considerable change. Altogether there was less change both as to number and size in the great herring, till they disappeared entirely, than in the spring herring.

From information found in the reports of the governors regarding the time when the great herring *arrived* at the different fishing stations, it appears that the time of arrival did not undergo any considerable change, and there is no indication whatever that towards the end of the fishing period it took place later in the year. In this respect, therefore, the great herring differs from the spring herring. The conditions under which the great herring lived certainly differed from those of the spring herring, which, as well as in other ways, is shown by the fact

that they arrived on the coast much sooner; on the coast of *Tromsö* and *Vesteraalen* as early as October and September, and at *Salten* and *Helgeland* in November and the first half of December. The exact cause of the difference above referred to is unknown, and it is impossible to decide whether any special significance is to be attributed to it.

There is another circumstance, relating to the time when the great herring fisheries were carried on, which I must mention, although I do not consider it as of primary importance.

The great herring which began to appear on the coast in 1861 came therefore towards the end of the spring-herring period 1807, 1875, and they disappeared about the same time as the spring herring. As regards the former spring-herring period, 1698–1787, I am unable to tell when the great herring disappeared from the coast; but according to reports from the *Nordland* district in the royal Danish archives, it appears that there were great-herring fisheries during the latter half of the century, especially during the years 1760–1770, therefore likewise during the latter part of the herring period.*

It is possible that this appearance of the great herring far north and towards the end of the herring periods is a regular occurrence. The striking phenomenon that both spring herring and great herring disappeared from the coast at the same time also encourages the supposition that their occurrence is subject to common laws of nature. During the last herring period, regarding which we possess fuller and more definite data, the disappearance of the great herring not only took place at the same time as that of the spring herring, but the time of their first appearance in 1861, towards the end of October and therefore *comparatively early*, coincided with a decisive turning point in the history of the spring-herring fisheries; for about that time the spring herring commenced to come to the coast later and later in the season. This may be an accidental coincidence, but perhaps it has some deeper significance. During the latter portion of the spring-herring period, counting in about the last 20 years, a remarkable change was observed in the quality of the spring herring. They decreased in size, and at the same time they are said to have approached the coast in a more mature condition.† It seems as if the spring herring about this time approached the coast under less favorable conditions, since they could not reach their former size. The great herring, which thereupon came very unexpectedly (it was thought in *Nordland* that the great herring did not properly belong to these waters, but had only accidentally found their way there), altogether resembled the spring herring (*Boeck's* report, 1873). The only difference was that they were somewhat larger and less mature when they arrived near the coast. They therefore dis-

* See the report of Governor *Torsö* for the five years 1866–1870. It would be very desirable to get some further information regarding these old great-herring fisheries; but, so far, I have had no opportunity to obtain such information.

† The decrease in the size of the herring I have often heard spoken of. See, also, "*L'industrie de la pêche en Norvège*," par H. B., 1876.

tinguished themselves in those very respects in which the spring herring underwent a change. The great herring, moreover, were much fatter than the spring herring. They evidently lived under more favorable conditions. Should this be an indication of a more intimate connection between the occurrence of the spring herring and that of the great herring? We are justified in asking this question; but we cannot enter further upon this subject, because we still lack more reliable information. The changes through which the spring herring passed need much more accurate investigation. That the great herring only showed themselves several years after these changes had taken place forms no serious objection to the supposition that there is an intimate connection between the two kinds of herring. All that can be said is that the great herring did not show themselves near the coast till that time

After this brief review of the great-herring fisheries we will return to the first year when there were indications that the spring-herring fisheries would come to an end with a view of describing a very remarkable occurrence of herring about that time, in connection with the spring-herring fisheries which have now again begun to spring up on our coasts.

In 1869, as in the preceding year, the spring-herring fisheries commenced very late, we may say not till the 3d of February. But according to the reports of the superintendents a few spring herring mixed with fat herring were caught near *Udsire* as early as the 9th of January. The reports give no further details as to the quality of the herring. In a newspaper article, published about that time, we read as follows: "It seems now to be absolutely certain, that the birds which have recently been seen in the *Udsirefjord* have accompanied large shoals of small herring (probably young spring herring) of the same size as the 'Christiania herring,' mixed with fat herring, some of which contained roe and milt like other spring herring." These herring also showed themselves in other places besides *Udsire*. Thus the superintendents report that herring of different kinds were noticed near the southwestern point of *Karmö*, and the newspaper article above referred to also contains the following: "Such small herring, mixed with fat herring, have also appeared about New Year in large numbers in several places, especially in the *Skjoldsfjord* and *Forresfjord*, in which latter inlet a great many were caught."

Both the fact that the herring were mixed and the time when they appeared, seem to indicate that these herring were "mixed herring" or "new herring," which began to appear in 1869, at the very time when the changes in the occurrence of the spring herring above referred to began to show themselves. The description of the herring suits the "new herring" in every particular. Nobody, however, thought it worth his while to examine further into this matter. During the following year these herring appeared in enormous numbers.

A considerable time prior to the beginning of the spring-herring fish-

eries people were surprised to see large masses of the so-called "new herring" or "mixed herring." Some were caught as early as the middle of December; towards the middle of January, they again began to disappear; some, however, remained till the end of January or the beginning of February, and, even under date of the 11th of February, it was reported in the *Karmesundsposten* (a paper) that small quantities of "new herring" had been seen in the bays, both north and south of *Karmö*. The "new herring" like the spring herring immediately came in near the coast from the high sea in large schools, and were principally caught in seines. They came simultaneously in many places along a considerable extent of coast. They were found everywhere, in the southern, northern, and central spring-herring districts. They even showed themselves as far south as *Egersund*, but especially on the heights of *Bergen*, the largest masses being noticed a little to the west and southwest of that city, on the west coast of the *Sartor* Island. The yield during that year amounted to about 150,000 barrels, which was very little when compared with the large masses of herring off the coast.

The "new herring" differed greatly in size and quality, and they were therefore called "mixed herring." I prefer, however, to call them "new herring," as the name "mixed herring" is apt to confuse, since those spring herring and small herring which are often caught together towards the close of the year's spring-herring fisheries, are frequently called "mixed herring."

When the "new herring" came near the shore, their schools were found to consist of "blood herring," some spring herring, herring of the size of the *Nordland* great herring, and finally some summer or fat herring. The occurrence of summer herring is, to a great extent at least, caused by the circumstance that the schools had fallen in with them near the coast and in the mouths of the fiords and had mingled with them. Whenever there were any considerable fisheries near the mouths of the fiords the superintendents' reports say that there were large numbers of "fat herring" mixed with the other herring. Only in exceptional cases spring herring were noticed in the schools, and had probably found their way there from the great masses of spring herring. They were not fully matured, but the same is said to have been the case during this year with most of the spring herring.* It must be supposed that those herring which in size resemble the *Nordland* great herring, and which also were not fully matured, were nothing but spring herring, many of which reach the same size as the great herring. During the following year, however, still larger herring were caught; and it is not impossible that these herring which arrived off the coast very early in the season, together with the great mass of "new herring," came from farther north, where such large herring have their home. But even these must under all circumstances have been mixed. The largest and most important portion of the schools of "new her-

* BÖECK: *Om Silden og Sildefiskerierne*, p. 111.

ring" was doubtless composed of so-called "ray herring" or "blood herring." As to this fact most fishermen agree in their reports, and quite frequently they call the "new herring" simply "ray herring" or "blood herring."

By "ray herring" or "blood herring" we mean smaller herring which, in small numbers, make their appearance every year, just prior to the arrival of the spring herring. *Boeck** says that the "blood herring" are very lean; that they have hardly any trace of sexual organs, and no fat whatever. He supposes that "possibly they are stragglers from the spring-herring schools of the previous year, which on account of not having ready access to food have not been able to feed enough to have their sexual organs fully developed." *Sars*, referring to *Boeck's* statement, considers them as barren herring. In the Bergen Museum we now have several (12) specimens of herring, labeled "ray herring" or "blood herring," caught during the years 1864 and 1865. It was of course exceedingly interesting to me to examine these specimens. Not one of them could be said to "have hardly any trace of sexual organs," and none were without these organs; both the roe and the milt were distinctly seen and in course of development, though not yet fully matured. With most of the small specimens, measuring 27.5 to 28 centimeters in length, the roe and milt were still in a very early stage of development, in the transition period from stage II to stage III, as *Heinke* terms them;† the largest breadth of the ovary was 6 to 9 millimeters; in some of the other specimens the sexual organs had been further developed; thus in one fish, measuring 27.5 centimeters in length, the greatest breadth of the milt was 17 to 18 millimeters; and in another one, measuring 26.5 centimeters in length, the greatest breadth of the ovary was 16 millimeters, corresponding to *Heinke's* stage III. In larger specimens the roe and milt were still farther developed. All these herring were doubtless what are called "ray-herring" or "blood herring."‡ Most of these specimens came from the Bergen Fishery Exposition of 1865. They were labeled "ray-herring," &c., by experienced men, and were placed on exhibition as representatives of these kinds of herring. From this I am led to suppose, that as far as the roe and milt are concerned, the "ray-herring" differ from the common mature spring herring by a more or less unfinished development of these organs; and this opinion is confirmed by many fishermen whom I consulted on the subject. To mention one case: Regarding those "ray-herring" which formed part of the schools of "new herring," a report from *Stavanger*, under date of January 9, 1873, says that specimens of the "new-her-

* *BOECK: Om Silden og Sildefiskerierne*, p. 23.

† *Die Varietäten des Herings*, 1877, p. 69.

‡ These names are given to the herring according to the greater or less development of the roe and milt, and according to the leanness or fatness of the herring. By "blood herring" the fishermen understand the leanest herring whose roe and milt are in a very early stage of their development. They are called "ray-herring" after they have gone to sea.

ring" caught at *Hirken*, when brought to *Stavanger*, were found to be "ray-herring," and had both roe and milt, though not fully matured. When fishermen, as is often the case, tell you that the "ray-herring" have no roe or milt, such expressions are caused by the circumstance that the roe and milt, as a general rule, are but little developed, and do not strike the eye when the herring are opened. As far as Boeck's description is concerned, it is not certain whether it is based on accurate *personal* observations.

In saying that in the "ray-herring" the roe and milt are not fully developed, we do not imply that these organs never reach maturity, but we only desire to convey the idea that these fish are not yet ready for spawning when they approach the coast.

The size of the herring in the schools of "new herring" varies, according to the reports of the superintendents, from that of the *Nordland* great herring to a very small herring. According to the unanimous testimony of the fishermen, the smallest specimens measured 6 to 7 inches in length. Occasionally some were found which only measured 5 inches. By far the greater number did not reach the size of spring herring, or were, at most, of the size of small spring herring.

The "new herring," and among them especially the "ray-herring," were, during the season 1869-'70, very lean and thin, with a comparatively large head, and seemed (probably only on account of their leanness) to have coarser bones than the spring herring. Some of the "ray-herring" were excessively lean, and had on each side a row of dark stripes running upwards from the belly.

The size and quality of the "new herring" varied greatly from time to time. At first it seemed as if a continuous improvement could be seen in them, but later—about the middle of January—it is again reported that the herring were again small, and varied very much in size. The "new herring" were very different in different places. It is thus specially reported that near the northern fishing stations (particularly near *Florö*) they were larger and of a better quality than farther south. This applied especially to those herring which were caught early in the season, and which by experienced fishermen were considered to be as large as the *Nordland* great herring.

I have no data as to how the "new herring" compared with those small herring which in 1869 began to appear among the schools of spring herring, and I am therefore not prepared to pass an opinion on this subject. Their occurrence is probably connected with that of the "new herring, and possibly it resembled that of the "new herring." A remarkable difference was noticed in the time of arrival. As has already been remarked, the new herring kept near the coast till the end of January, and even far into February, 1870. During the following years it was very generally reported that "new herring" arrived during the spring-herring fisheries, and it seems as if no distinction was made between them and the small herring. Some of the "new

herring" have during these years doubtless been taken for small herring mixed with the spring herring.

Professor Sars has advanced an opinion regarding the cause of the unexpected and numerous occurrence of the "new herring" which corresponds with his well-known theory as to the cause of the disappearance and reappearance of the herrings on our coast during the so-called "herring periods." Professor Sars's theory is certainly ingenious and contains ideas which well deserve to be further examined; but as regards the "new herring" Sars does not seem to have been so fortunate. It must be remembered, however, that it is only the experience gained during the last few years which has enabled us to form more correct opinions regarding this whole question, and that there are still questions of the most vital importance which have not yet been satisfactorily answered.

In accordance with his theory Sars explains the occurrence of the "new herring" in a similar manner, as in former times *Löberg* and *Boeck* have explained the arrival of the ray-herring prior to the beginning of the spring-herring fisheries. Sars is of opinion that the "new herring" are principally "ray-herring," *i. e.*, barren herring and partly young, and therefore not fully matured fish, both of which come nearer the coast than the spring herring. When the enormous schools of spring herring arrive, they drive the "new herring" towards the coast, and this would easily explain the early arrival of the "new herring." The fact that the "new herring" appeared in such large numbers and were mixed with other herring, finds—according to Sars—its natural explanation in the fact that the great mass of the spring herring during this time have been compelled by meteorological causes to keep at an unusually great distance from the spawning places, and had therefore to pass over a much greater distance than otherwise would have been the case. The scattered schools of herring have thereupon been forced to give way by the irresistible advance of the great masses of spring herring, and have by them been driven towards the shore.

When Sars examined the herring fisheries the season of the year prevented him from personally observing the "new herring," and he had to rely on the information furnished by other persons. He supposes that only a comparatively small portion of the "new herring" were fully matured. For this very reason, and because the so-called "herring food"—small crustaceans, &c., is very scarce at the time when the "new herring" come near the coast, Sars is compelled to look for some external cause which would force the herring to go near the coast. This theory of Sars's is, as we have seen, not correct. By far the larger number of the "new herring" were "ray-herring," which were not barren, but had both roe and milt in different stages of development. It may be important to keep these facts in mind in endeavoring to explain the arrival of the "new herring." It will not do to ignore the reproductive instinct, because the "new herring" doubtless contained

roe and milt, and the generative organs in some of the fish were developed to a considerable degree; nor is the occurrence of the "new herrings" in our coast waters exceptional, as similar herring also approach other coasts, where there are no spring-herring fisheries, and where there are no enormous masses of herring to drive them towards the coast.

I therefore considered Sars's theory somewhat doubtful. Ljungman has raised another, and very weighty, objection to this theory, by remarking that Sars has not explained by his theory why such a driving towards the coast of enormous masses of "new herring" has not also taken place during the preceding "herring period."

Some explanation of this, however, is found in Sars's report for 1872, where he says: "Formerly no attention was paid to the new herring, because they were very much mixed with older herring, whilst during the last few years they have been less mixed, because the great mass of older herring coming from the sea spawned in the outermost spawning places." But this explanation pre-supposes, as the fishermen state, that the "new herring" were fatter than the spring herring, but somewhat smaller, and had spawned much earlier. These statements, however, are—as will be seen from Sars's next report—rather unreliable, and are, as far as the time of spawning is concerned, based on a mistake. Sars's theory cannot, therefore, be maintained. The genuine "new herring" which principally made their appearance during the season 1869-70, could, according to the unanimous testimony of the fishermen, be easily recognized both by their leanness and by their small size, as well as by the circumstance that with most of them the roe and milt were but little developed. Later, the "new herring" began to change their size, appearance, &c., finally ceased to be "new herring," and to all intents and purposes assumed the nature of our spring herring. Only a very small number of the original "new herring" were observed, and their appearance was so striking that they could immediately be recognized. Fishermen are very quick in detecting any difference in fish, and it is hardly probable that they would have entirely overlooked the inferior kind of herring, such as the "new herring" then really were. According to Sars's theory one would expect that the schools of spring herring which arrived first, would be particularly mixed with the smaller "new herring," but in these very schools the spring herring were unusually large and little mixed with other herring.

Ljungman's objection, therefore, is still valid. Especially from 1860 on, the "new herring" should have been very numerous and mixed, prior to the commencement of the spring-herring fisheries, as from that year the herring began to approach the coast later in the season, and therefore, according to Sars's theory, probably stayed at a considerable distance from the coast. But even then no unusually large masses of "new herring" were noticed. After they had appeared sporadically in 1860, they suddenly appeared in enormous masses in 1869-70.

On the other hand, the spring herring have, during the last few years, arrived earlier in the season, and some mixed herring have been noticed, which was more unexpected now than during the years preceding 1870. Nor has there been any indication during the last few years of large masses of herring, or so-called "herring-mountains," such as were observed in olden times.

Altogether it does not seem probable that, after 1869, any unusually large masses of spring herring came near the coast. It has always been an open question whether the spring herring, during those years when they did not visit their usual spawning places, had actually left our waters entirely, or whether these same masses of spring herring spawned at a greater distance from the coast, hoping to return to their former spawning places when the conditions should again become favorable. The history of the last decade is of great importance for the final solution of this problem. In the beginning of the decade the prospects were very bright; large layers of roe were said to have been noticed on the bottom of the sea, and it was reported that there were large masses of herring far out in the deep waters. These reports were afterwards acknowledged to have been exaggerated. (See superintendent's report for 1872.) These favorable indications, however, soon began to disappear, and even at the outermost fishing station of *Udsire* there were, after 1873, no indications whatever of the presence of large masses of herring. On the other hand, there was a significant indication of a decrease in the masses of herring, viz, the mixing of small herring among the schools, which became apparent as early as 1869, when the fisheries began to decline, and increased from year to year until the fisheries came to an end. In the enormous masses of herring, or the so-called "herring-mountains," the herring are generally of the same size. When the fisheries again began to flourish, after 1876, it was not the former masses of great spring herring which returned, but comparatively small schools of herring which, as a general rule, were small, and which have gradually increased both in number and size, but have so far not formed regular "herring-mountains." (These herring must be supposed to be descended from the "new herring"; concerning this see farther on.) No one can deny that the former masses of spring herring have disappeared. It cannot be supposed that they were driven away by smaller herring; but they would have disappeared, even if these smaller herring had never shown themselves.

For these reasons I cannot agree with Sars in his theory regarding the "new herring."

I shall now continue my review of the history of the "new herring" after the season of 1869-1870, the principal events of which are as follows:

As I have mentioned before, the "new herring" in 1869-1870, visited a considerable extent of coast, and this continued to be the case during the following seasons. In 1870-1871 they spread still farther, espe-

cially towards the south, where they appeared on the entire coast from *Tananger* (west of *Stavanger*) as far as Cape *Lindesnæs* and remained there, although at a considerable distance from the coast, for several weeks. During the following years they were very generally observed in the south near *Egersund*, *Soggendal* and *Flekkefjord*; they were also seen along the Bergen coast as well as in the northern district. This scattering and the irregularity which these herring exhibited in their visits to different points on the coast, are highly characteristic of the "new herring." On the whole they made their appearance in a manner entirely different from that of the spring herring, and it actually seemed as if they did not feel at home anywhere.

With regard to the number of the "new herring" there was a sudden change after the season of 1869-1870. The approach of great masses of "new herring" about New Year, 1870 (which year is termed the "new herring year" by the fishermen) was certainly brought about by extraordinary causes (strange to say, unusual masses of herring also made their appearance during that year in *Bohus-län*). During the season of 1870-1871 only small numbers of herring approached the coast, and this was also more or less the case during the following years. The numbers of "new herring," however, were somewhat larger than appears from the reports, for they were near the coast earlier, during the spring-herring fisheries proper and far into February, all of which has been passed by in silence in the reports.

The most remarkable change, however, was noticed in the quality of the "new herring." During the following years they became larger and of a more even size, and the number of fish with more fully developed roe and milt had increased considerably. The roe, however, was invariably fine grained—not fit for spawning. During this time new but smaller schools of the original new herring seem to have approached the coast; for quite a number of herring of that kind were caught. Thus during the season of 1872-'73, the "new herring" caught west and north of Bergen were again mixed, as had been the case in 1869-'70. The average number per standard barrel was, according to the reports of the superintendents, about 730. Later the "new herring" in these schools have probably developed in a similar manner as the other "new herring."

Through this development the "new herring" became spring herring and are the very same fish which, during the last few years, have approached our coasts and have become an object for the fisheries.

The fishermen very generally maintain that the spring herring which are caught in our days, are a different kind from the former spring herring, and mention several features in which they are said to differ. Their eggs are said to be smaller than those of the former spring herring; they are certainly fatter, have finer meat, and thinner bones. Some fishermen also say that the shape of the body is comparatively higher and shorter, that the head is smaller, and that the eggs are of a

lighter color, whilst those of the former spring herring had a more brownish hue. Finally, it is sometimes said that the present spring herring have smaller scales* and that they adhere more firmly to the body of the fish.

Most of these features are actually of very little significance, and, in distinguishing one kind of herring from the other, they have no scientific value whatever. But as they are mentioned so frequently, I shall refer to them at greater length.

The smaller size of the eggs means, as will be seen at a glance, nothing more nor less than that they are not yet fully developed; in other words, that the present spring herring do not arrive on our coasts in as advanced a stage of maturity as the former ones. Quite frequently it is positively asserted that even the eggs of the mature herring, which arrive later, in February, have not the same size as those of the old spring herring. But this is simply a mistake. In comparing the eggs of old spring herring—preserved in spirits of wine—with those of the present spring herring, I have been unable to discover the slightest difference in size. In his well-known work, *Om Silden og Sildefiskerierne*, Boeck says that the fully matured eggs of the spring herring measure 1.50 millimeters in diameter; and this is found, if observed with the naked eye, to be the exact measure of the eggs of the present spring herring. In small specimens of the present spring herring, measuring only 28 centimeters in length, I have found the diameter of the eggs to vary from 1.31 to 1.48 millimeters. When eggs, however, measure only 1.31 millimeters in diameter, the difference is so small that it can hardly be observed without a magnifying glass, and, therefore, by no means agrees with the statements of the fishermen.

The greater quantity of fat in the present herring of course depends to a great extent, or almost exclusively, on the fact that these fish are not yet ready for spawning; and the fatness again explains in a most natural manner the circumstance that in the present herring the bones are thinner than in the old ones. In a fat herring the bones are not so distinctly felt as in a lean one, when cut with a knife, and they consequently appear to be thinner and finer. That there is much chance for making mistakes through this very cause is shown by the fact that the fatness of the great herring gave rise to the assertion that they *did not have* a certain row of fine bones along the sides, the so-called "side-ribs," and that thereby they were distinguished from the spring herrings. (*Boeck's report, 1873.*)

The fine quality of the meat in our present spring herring must likewise be ascribed to the circumstance that these fish are not yet ready to spawn, and that, as is always the case prior to the spawning period, the meat is firm and solid. During and after the spawning period the meat becomes looser and of an inferior quality.

* See the reports on the old *Bohus-län* herrings (A. LJUNGMAN: *Preliminär Berättelse för 1873-1874*).

I have measured the length of body, length of head, and the distance between the fins, in some specimens of the former spring herring preserved in the Bergen Museum, and I have also examined the number of rays in the fins, and compared all these data with those of our present mature spring herring. As regards the height of the body, if compared with its length, it is difficult to arrive at an absolutely correct result if the only specimens of which measurements can be taken are preserved in spirits of wine. These measurements prove this, however, that no such change has taken place as is maintained by the fishermen. I am inclined to suppose that a difference can only be noticed between the former spring herring and those of our present spring herring which are not yet ready to spawn, and this difference is only caused by their greater fatness, which makes the body appear comparatively higher and shorter. As soon as the spring herring of the present season spawned they were, as many fishermen were compelled to acknowledge, just as long and lean as the former spring herring. It is well known that in fat herring the head seems smaller than in lean ones, but in our present spring herring it was by no means smaller than in the old spring herring. As regards the distance between the fins and the number of rays in each fin, I could not discover any regular difference. A comparative table, which will be of special interest with regard to the location of the fins, will be published at some future time. The number of rays, both in the present and in the former spring herring, does not correspond entirely with Nilsson's (and Boeck's) statement, and, as might be expected, it varies greatly in the different fish. The dorsal fin does not have 18, but generally 19 rays, and their number even varies from 17 to 20. The anal fin had generally 18 to 19 rays, and in one 20, whilst in another case it had as low as 14, which, of course, was an exceptional case. The pectoral fins had 16 to 17 rays, and the ventral fins had generally 9 bunches of rays, which is the usual number in all herring. When the Danish naturalist *Krøyer* wrote his description of the herring he had before him a specimen of the former Norwegian spring herring, and in counting the bunches of rays doubtless had reference to this kind of herring, and he likewise counted 9 bunches of rays in the ventral fins. The circumstance that Nilsson counted 10 bunches of rays in a former Norwegian spring herring was doubtless caused by his having before him specimens which accidentally had that number. In only one specimen of the former spring herring did I find 10 bunches of rays. One specimen of our present spring herring showed a strange anomaly, the right ventral fin having 9 and the left 8 bunches of rays. One specimen of the great herring had 8 bunches of rays in each ventral fin.

As regards the difference in the color of the eggs (in fish which are ready to spawn), it is impossible at the present time to draw any comparison, as the eggs of the former spring herring have of course lost their original color by being kept in spirits of wine; and as, so far as

I know, we possess no picture of these eggs. The statements of the fishermen relative to the color of the eggs seem but little credible. But the color of the eggs has, under any circumstances, very little to do with the answering of the question, whether the present spring herring are the same kind of spring herring as the former ones. I may as well say here that the color of the eggs, which is produced by the outer shell, differs considerably in the different mature individuals of the present kind of spring herring, without any reference to the size of the fish. The color is generally light brown, sometimes darker, sometimes lighter, and occasionally so light that the brown color can hardly be distinguished. The color of the eggs doubtless varied in the same manner in the former spring herring. In other localities a difference of color has likewise been observed in the eggs of one and the same kind of herring.

But few fishermen knew anything of a difference in the character of the scales. Some of the specimens of the former spring herring which have been preserved in spirits of wine have a more or less well-preserved coat of scales; one specimen, especially, which through the kindness of Professor *Esmark* was loaned to me from the University Museum, showed all its scales in a fine state of preservation. In order, however, to make this comparison really valuable, I ought to have had specimens of our present spring herring of the same size as the old ones, and also a larger number of these last-mentioned fish. The statements of the fishermen relative to the size of the scales seem very doubtful.

Of all the differences mentioned by the fishermen, only one remains to be accounted for, viz: The difference in the development of the roe and milt. In our present spring herring the roe and milt are not as fully developed, when the fish arrive in our coast waters, as in the former ones. The difference, however, is not very great. When our present spring herring first became an object of the fisheries (in 1876) their roe and milt were, according to the statements of the fishermen, still less developed than they are now.

In the "new herring" the roe and milt were not fully developed either, or at any rate there was a great difference between the different individuals as regards their degree of development. In some other respects the present herring resemble the "new herring." Like these they arrive on the coast very early in the season—differing in this respect very much from the old spring herring—so that fishing commences already in the beginning of January. Our present spring herring also show the same tendency to spread as the "new herring," and finally they were, when the fisheries first commenced, of very different size, and, on the whole, somewhat smaller than they are now. Our present spring herring are, doubtless, the descendants of the "new herring." In this way all the points of resemblance between the two can easily be explained.

During the season 1869-1870 the "new herring" were, as a general

rule, not as large as our present spring herring at the time when they first made their appearance, and their roe and milt were not as fully developed. All the reports from the season 1870-1871 say that the "new herring" were somewhat larger than during the preceding season. From the season 1871-1872 it is reported that they were of a more even size. During the season 1873-1874 the number of spawners and milters, or fish with more fully developed milt and roe, was considerably larger; the same observation was, by the way, also made during the season 1871-1872 regarding the small number of "new herring" which were caught during that season. The quality of the fish began to be better, and they are now spoken of as "fat and fine new herring." Many reports of the same nature come to us from the following years. "Such a new herring," it was said, "can hardly be distinguished from a spring herring." Finally, people did not know whether to call them "new herring" or spring herring. Just as the "new herring" had developed gradually, thus the present spring herring have done the same till this year. The present spring herring seem to be nothing else but a continuation of the "new herring," and there is no doubt in my mind that they are the descendants of the latter. After 1870 "new herring" were but rarely found in our coast waters. The same was also the case with our present spring herring, when they first made their appearance, and only gradually they became more numerous. "New herring" of an inferior quality were caught, as has been said above, together with more fully developed "new herring," and they probably have since passed through the same stages of development, and at the proper time turned into our present spring herring.

If you ask the fishermen when the present spring herring first began to show themselves, they generally say that this took place about four or five years ago. Some maintain that it took place as early as 1874, and others even say that they saw such herring in 1870. From what has been said, this difference in the statements is easily explained by the very gradual development of our present spring herring. Some of the so-called "blood herring" which formed part of the "new herring," were, during the season 1869-'70, already so fully developed that they strongly resembled our present spring herring. The opinion, very prevalent among fishermen, that the present spring herring came to our coast waters four to five years ago is evidently based on the fact that they were not till then (1876) recognized as spring herring, and that the fisheries proper cannot be said to have commenced till that year.

In a very interesting treatise on the herring in the Sound and the Belts, *Georg Winther** speaks of a similar development of the herring as that observed in our waters. He says that towards the close of a "herring period" a smaller kind of herring make their appearance at the time when the former herring disappear, and that these small herring soon reach the size of the former herring. Their number increases very

* "Tidsskrift for Fiskeri," new series, iii.

rapidly, just as has been the case with us during the last few years. According to *Winther* the new herring simply take the places occupied by the former herring, and their rapid growth is owing to the favorable conditions under which they live. This does not altogether apply to our "new herring," as they arrived in our coast waters much sooner than the spring herring, which, according to Sars, indicates that they lived nearer the coast than the great masses of spring herring, most of which had, at that time, already left our coasts. Even our present spring herring come much earlier than the former ones.

The important question, therefore, arises: "Where do the new herring come from, which during the season 1869-70 suddenly appeared in large masses?" It might be supposed that the smaller "new herring" were only the younger generations of spring herring, which, after the masses of old spring herring had disappeared, from some unknown cause occupied their spawning-places, and in a few years grew into new masses of old spring herring. This supposition is, to some extent, justified, but it is doubtful whether its principle is applicable in all cases. In solving this question, a more thorough examination of the so-called "ray-herring," which come to our coasts every year, might prove useful. In making a preliminary comparison between several specimens of the same size of the "ray herring" and those herring which, according to Sars, must be considered as fish in the earlier stages of the former spring herring, I could discover no difference except in the varying degree of leanness and fatness.

Our present schools of spring herring are composed of "new herring" and of remnants of the former masses of spring herring. These were mixed with quite a large number of small herring. If these small herring bear more of the character of the "new herring," it will come to almost the same thing to say that our present herring are descended from the "new herring," or from small herring mixed with the spring herring.

It has already been mentioned that our present spring herring have gone through *further* stages of development.

After the new herring had developed in the manner above described, the present spring herring may be said to have begun their existence as such; but still they did not come up to the old spring herring in size or maturity, and moreover they only occurred in small numbers.

As regards their size, it still varied somewhat, like that of the "new herring;" and it must also be taken into consideration that they were still mixed with remnants of the former masses of spring herring.

During the last few years the herring have become larger and of a more even size; but even the year before last they are said to have been smaller than the old spring herring. From all the reports, it appears that this year the herring which arrived first were exceptionally large and of even size. I measured numerous herring caught in the seines. The smallest measured about 27 centimeters in length, large specimens

even measured 34, but these were not very frequent. As a general rule the spring herring measured 31 to 33 centimeters, which must be considered a very good length. It must, however, be remembered, that these measurements apply to herring caught in nets, on the size of the meshes of which the size of the herring caught in them will more or less depend. In order to determine the exact size of the herring, we would have to measure herring caught in seines, but during my stay in the fishing district no fish were so caught. I am therefore not yet prepared to say to what extent the present herring have *in general* reached the size of the former spring herring.

According to the statements of the fishermen, both the roe and the milt had also become further developed. I possess, however, no reliable information on this point. It is certain that our present spring herring at the time of their arrival near our coasts are not as fully prepared for spawning as the old spring herring; they are not ready to spawn till the latter portion of their stay near the coast; this has particularly been observed during the season of 1879-'80, when most of the herring spawned in February. Herring which I examined on the 11th and 12th February of the present year had loose roe and milt. During these very days, and possibly somewhat earlier, the herring had begun to spawn.

Later in the season there were constant indications of spawning; the nets were full of roe, the water was colored by the milt, and herring, when caught, emitted roe or milt upon the slightest pressure. On the 20th of February herring were caught which had almost done spawning.

Whilst but few herring showed themselves near the coast during the first years after 1870, when the transition from "new herring" to spring herring commenced, they gradually began to increase in number from that time. So far, however, no herring mountains, like those which were common in olden times, have been observed. The yield per annum of the fisheries has been as follows during the period 1876, 1880: in 1876 it was 9,500 barrels, in 1877 about 25,000, in 1878 about 32,000, in 1879 about 63,400,* and in 1880 only 30,000, this last low figure being caused, not by any decrease in the number of fish, but principally by the long-continued stormy weather, which prevented the fishermen from going to sea.

Only in the southern districts have the fisheries been of any account. Near *Skudesas* there was considerable seine fishing, and it will be interesting to see whether the herring will again visit this southern point, which, in their northward migration, they left during the last "herring period."

It is a characteristic peculiarity of our present spring herring caused,

*According to *J. M. Nyman's* report made to the government of the *Stavanger* district. From the newspaper reports it appears that of this number 8,000 barrels were caught near *Søndmøre*.

of course, by their not yet being ready to spawn, that for a long time after their arrival in our waters they will stay near the surface of the sea. They sport about in the coast waters in a similiar manner (as Sars supposes) to the spring herring in the open sea, outside of the spawning season.

Whilst the herring thus swim about on the surface, they are eagerly pursued by whales, which divide the large masses of herring into smaller schools, and scatter them in every direction. The occurrence of these whales is a phenomenon peculiar to our present spring-herring fisheries.* They come in large numbers, so that in the beginning the fishermen would not venture out for fear of these immense animals. During the old spring-herring fisheries but little was seen of these whales. On the other hand the large herring whales, which were quite common during the old spring-herring fisheries, are not so frequent now, probably because of the circumstance that these two kinds of whales are bitter enemies. Our present whales, the so-called *stourhval*, will attack the large herring whale and tear large pieces of fat from its sides, for which reason it is frequently called whale hound (*hvalhund*), or fat biter (*spækluuger*). While the so-called *stour* whales follow the schools of herring and feed on them, the herring whales have but little to fear; still they seem to avoid them, and I have often heard the fishermen remark that the great herring whales act as if they were afraid of the *stour*, or great whales, and keep at some distance from them.

As soon as the masses of spring herring, which has especially been the case during the last two years, are ready to spawn, that is in February, all this is very much changed. The herring then go deeper and seek the bottom for the purpose of spawning; and the great whales disappear from the scene. The cause of this repeated disappearance must be found in the fact that it is too difficult for the great whales to follow the herring into deeper waters, or at least that, when the herring go deep, these whales do not find it so easy to satisfy their greedy appetite. The fishermen corroborate this fact, and say that they have had occasion to observe that the great whales are very unsuccessful in their chase of the herring when these have gone into deep water. While the great whales are gone the herring whales have again made their appearance in as large numbers as during the old great-herring fisheries.

The spring herring present in the month of January were pursued by a large number of great whales, which is precisely what happened during the great-herring fisheries in *Nordland*; neither was the great herring ready to spawn. It must, however, also be recollected that great

* It is not certain to what species these whales belong. Two kinds are probably designated by this name (*stourhval*): *Orca gladiator*, la Cep., and *Orca Eschrichtii*, Stp. In January, 1876, a large number of whales were caught near *Udsire*, one of which Mr. Collet (from the description given by Light-house Keeper *Eyde*) supposes to have been the *Orca Eschrichtii*, and not the *Orca gladiator*. (See *Nyt Magazin for Naturvidenskaberne*, 1877, vol. xxii, p. 139.)

whales are certainly more numerous northward. On the other hand, during the previous spring-herring fishing, scarcely any great whales were seen, because the earlier spring herring were gravid the whole time and followed the same course as the spring herring at the present time, in the month of February.

Another peculiarity of the present spring herring which is not yet prepared to spawn is this, that they stay farther out without making any attempt to come near the coast. This year, for instance, there was hardly any seine fishing until the herring had become ready for spawning, and fishing commenced with nets which were set during the night. The same was the case last year and the year before last, when fishing was carried on with floating nets $\frac{1}{2}$ to 2 (Norwegian) miles from the coast.

It has been supposed that by chasing the herring the great whales would prevent them from coming near the coast, as it has several times been observed that these whales keep nearer the land than the "herring whales." This is easily explained, however, by the well-known fact that the "herring whales" are afraid of the great whales, and therefore keep at a greater distance from the coast. It is, of course, not impossible for the great whales to drive the schools of herring away from the coast; but, in chasing the herring about without any particular aim, one would suppose that they would occasionally also drive them towards the coast. This does not therefore appear to be a satisfactory cause of this phenomenon.

It is likewise an open question whether the immature condition can be adduced as a satisfactory reason for the fact that the herring keep at some distance from the coast.

During the last two years even the mature spring herring have not shown any special inclination to come near the coast, and the fisheries have been almost exclusively confined to the little island of *Udsire*, two (Norwegian) miles out at sea, west of *Karmö*. Here the persecutions by the great whales cannot come into consideration, for only very few of these were seen in the *Udsire* waters, and their presence could not possibly have disturbed the herring. Last year we had frost during the fishing season, and, judging from the experience of former years, it was supposed that the low temperature was the reason why the herring would not come near the coast. This year we had very mild weather, and still the herring did not come near the coast. It is well known now, however, that it is not absolutely necessary for the herring to come near the coast for the purpose of spawning. The *spring herring*, it is true, have, as a rule, sought the coast when they wanted to spawn. But, as the spring herring now come in smaller numbers, and as only those fish are ready to spawn which arrive late in the season, it may, of course, easily happen that the spring herring stay in the outer spawning places. If, during the coming years, the spring herring gradually reach their maturity earlier in the season and increase in number, the schools which arrive first will, as usual, come to the coast of *Udsire*,

whilst the schools which follow later will seek other spawning places nearer the mainland.*

In going through various stages of development our present spring herring have evidently come to resemble the former spring herring very strongly. As to size, there is hardly any difference. This, taken in connection with the steady character of the development, which gives cause for the hope that it may continue, seems to augur well for the future and justifies the expectation that we shall again have as large spring-herring fisheries as in olden times.

After having given the above brief sketch of the spring-herring fisheries during the last few years, we must cast a retrospective glance at certain prominent features in this history, and institute a comparison between them and certain features of the old spring-herring fisheries at the time when they, too, after having been on the decline for a number of years, again began to flourish.

The decline of our fisheries extended from 1869–1875, when the number of herring was smallest and the fisheries were at their lowest ebb. But after 1875 the fisheries gradually began to recover, as there was a steady increase in the number of herring. There has, therefore, not been any very considerable interval between the former “herring period” and the one which—to judge from all appearances—is about to begin, but one “herring period” has been closely followed by another. Yea, more. Those herring which during the last few years have come near our coasts as new spring herring, had already come once before, near New Year, 1870, and probably they had also come in 1869, therefore before the former “herring period” had come to a close.

Here there seems to be a difference from olden times, when there was an interval of years between the end of one “herring period” and the beginning of another (twenty years between the last two “herring periods”).

Our present spring herring, moreover, come early in the year, having been caught as early as the first part of January, whilst in the beginning of the last “herring period” fishing commenced very late, which—according to Boeck's observations—seems to be the rule at the beginning of a new “herring period.”

This difference, however, is probably a difference only in appearance, but not in reality. In former times fishing in the open sea with floating nets was unknown, as it has only come into use during the last few years. No exertions were made to seek the herring in distant parts of the coast. To go to *Udsire*, to catch herring, seemed too much of a venture. If matters in this respect were now as they were then, our

*The great whales will then disappear. Any attempt to exterminate them (even if successful) would result only in a very doubtful advantage. The fishermen themselves, as a general rule, are of opinion that the so-called “*Aaler*,” i. e., schools of herring which, chased by the great whales, come near the surface of the sea, are easily discovered, and are therefore easily caught, must be considered as a decided benefit to the fisheries.

present fisheries would not be of any great importance, and at any rate, there would have been a much longer interval between the last and the present "herring period." *Ljungman* already remarks, that a glance at the fishing-apparatus in use, which is only suitable for our rocky and broken coast, will explain the fact that our "herring periods" are so well defined, whilst in other countries, such as Scotland and in North America, where fishing is carried on with purse-nets or floating nets, their beginning and their end can hardly be noticed. It is also a well-known fact, that during the long interval (1787-1807) between the two preceding "herring periods," herring were found near our coast. Thus Boeck reports that in 1803 they showed themselves in large numbers near the coast of Bergen; but few, if any were caught, as they came so unexpectedly. The *Udsire* fishermen say that the year 1808 was by no means the first year when herring came to their coast, but that they were noticed out at sea during several of the preceding years; but people at that time did not think of going to sea even that short distance, to catch herring.

As regards the time of arrival, there has so far at least, been an actual and marked difference between the present and the former spring-herring fisheries.

It must also be borne in mind that the time during which the present fisheries have been going on, very probably does not correspond with the time which is designated as the beginning of the former herring period, but rather with certain years of the interval, when there was no fishing.*

Below I have given a list of different degrees of temperature of the water near the surface and at different depths. As I only had occasion to make observations of the temperature towards the end of the fishing season, and as the fisheries were unfortunately disturbed a great deal by stormy weather, it was impossible for me, this year, to observe the influence of the temperature on the daily course of the herring. These observations, however, will prove of interest even as they are.

Boeck took the following observations of the temperature during the spring-herring fisheries: While at the surface the temperature varied from $0^{\circ}.5$ to 5° C., according to the state of the wind, the difference at a depth of 10 fathoms (almost 19 meters) was only 1° C., that is, the temperature varied from 3° to 4° C., and at a depth of 30 fathoms ($56\frac{1}{2}$ meters) the temperature remained stationary at 4° C., no matter how much the meteorological conditions varied.

* The fisheries even now do not commence till February, about the same time when they commenced in the beginning of the former "herring period." I am not at present prepared to say whether this circumstance has any weight in explaining the difference in the time of arrival of the herring. (See BOECK, *Om Silden og Sildefiskeriene*, p. 109; it is certain that in the beginning of the former "herring period" the herring arrived near the coast some time before the fisheries commenced. Thus Boeck says that in 1814, 1815, and 1816 the whales arrived on the 23d January, which, however, is a late date.)

This year the temperature at the surface varied from $2^{\circ}.5$ to 6° C., while the temperature at the surface varied from $3^{\circ}.5$ to 6° C. The temperature at a greater depth varied as follows: At a depth of 38 to 42 meters, from $4^{\circ}.2$ to $6^{\circ}.9$ C.; at 51 to 53 meters from $4^{\circ}.8$ to $7^{\circ}.3$ C.; at 62 to 66 meters, from $4^{\circ}.7$ to $5^{\circ}.5$ C.; at 76 meters, from $5^{\circ}.1$ to 6° C.; and at 119 to 123 meters, from $6^{\circ}.3$ to $6^{\circ}.7$ C. At a depth of 132 meters the temperature was found to be $6^{\circ}.9$ C., and at 189 meters $7^{\circ}.1$ C.—(See table of temperature.)

In the first place, therefore, the temperature has varied much more than Boeck reported, viz, $2\frac{1}{2}^{\circ}$ C., at a depth of 51 to 53 meters, and, in the second place, it has this year been higher than any which Boeck has given.

In his work "*Om Silden og Sildefiskerierne*," Boeck speaks of a peculiar phenomenon observed in the sea between *Hangesund* and *Udsire*, viz, that the water near *Rövær*, at a certain depth, about 20 fathoms, seemed to be so cold that its temperature was only about 3° C., whilst farther out, not far from *Udsire*, where there was a pretty strong current from south to north, it was much warmer, viz, over 4° C. Boeck was prevented by sickness from making further observations of this strange phenomenon. If further observations should show this statement to be correct, Boeck thinks that this warm current must be a branch of the Gulf Stream, and he inclines to the opinion that in these waters the herring follow such a branch of the Gulf Stream towards the coast, particularly as the herring always approach the coast between *Udsire* and *Rövær*, where the warm current, mentioned by him, is found. Near *Rövær*, Boeck found the so-called "whale food" (*Clione limacina* Phipps), an animal generally occurring much farther north, near *Finmark*, and which was once discovered by Prof. G. O. Sars, near the Lofoden Islands (at *Skroven*). In the polar seas it is found in enormous masses. Boeck supposes that this clione was carried south by a cold polar current flowing nearer the coast than the Gulf Stream.

During my visit to the fishing stations, I one day—the 9th March—when the weather was calm, carefully examined the temperature of the water from *Udsire* to *Rövær* (and on the 11th of March, as far as *Hangesund*), both at the depths given by Boeck, in other depths, and near the surface. The result of these observations is given in a list below. At a depth of about 20 fathoms (38 meters), between *Udsire* and *Urter*, the temperature varied from $4^{\circ}.3$ to $4^{\circ}.5$ C.; on the side of *Urter* towards *Rövær*, the temperature was $4^{\circ}.4$ C., at a depth of 32 meters (bottom); a little (one-eighth Norwegian mile) farther out, towards *Rövær*, it was $4^{\circ}.2$ at a depth of 38 meters; one-fourth Norwegian mile distant from *Urter*, in the direction of *Rövær*, it was, at the same depth, $4^{\circ}.5$ C.; and from there to *Rövær* and *Hangesund* it varied from $4^{\circ}.5$ C. to $4^{\circ}.4$ C.

I must say that, in my opinion, my observations have not corroborated Boeck's statement, not even as to the temperature taken at the same

depths as his observations, and much less with regard to temperature observed at different depths.

As the above report may also be of interest to foreign readers, I shall give below the latitude of most of the places mentioned in it:

Southern spring-herring district: *Latitude*, 58° 55' to 60°.

Northern spring-herring district: *Latitude*, 60° 47' to 62° (*Stat*).

The more important subdivisions of the northern district: *Søndfiord*: *Latitude*, 61° 15' to 61° 55'; and *Nordfiord*: *Latitude*, 61° 55' to 62° 13'.

North of *Stat*, in the southern part of *Søndmøre*, the so-called *Søndmøre* fisheries are carried on.

	Latitude, °
Aasvær.....	66 14
Bergen.....	60 24
Blixvær.....	67 17
Bodö.....	67 17
Brandesund.....	59 54
Bremanger.....	61 51
Bueland.....	61 17
Egersund.....	58 27
Fleinvær.....	67 10
Florö.....	61 35½
Flekkelford.....	58 10
Frøyøen.....	61 47
Fraglövær.....	67 4
Gildeskaal.....	67 5
Grip.....	63 14
Halten.....	64 10
Hammerö (see Stegen and Hammerö).....	
Haugesund.....	59 25
Helligvær.....	67 24
Herö.....	66
Hisken.....	59 44
Hitteren.....	63 30
Hvitingsøerne.....	59 4
Karmö.....	59 8 — 59 25
Landegode.....	67 24
Lindesnæs.....	57 59
Loffoden and Vesteraalen.....	67 20 — 69 19
Lovunden.....	66 22
Melö.....	66 50
Mykøerne.....	66 45
Rödö.....	66 40
Rövær.....	59 26
Sartorö.....	60 20
Senjen.....	69 20
Skibaadsvær.....	66 7

	Latitude, °
Skudesnæs	59 9
Smölen	63 25
Soggendal	58 19
Stavanger	58 58
Stegen and Hammerö	67 40 — 68 15
Stemmet	63
Sulen	61
Trænen	66 30
Tysfjord, mouth of	68 15
Udsire	59 19
Vegö	65 40
Vesteraalen	68 35 — 69 19
Vigten	64 55

Table of deep-water temperature. Observations taken with Negretti and Zambra thermometer, No. 43233.

1880.		Location.	Scale of temperature.				Wind.		Weather.	Sea 0—9.
Day.	Hour.		Depth in meters.	Thermometrical reading.	Correction.	Corrected temperature.	Direction.	Force 0—6.		
Feb. 22	10-11 a. m.	Udsire (north side)	0	3.5	-0.4	3.1	W. SW.	2	7	3
23	do	do	28½	4	-0.4	3.6	do	2	7	3
23	do	do	42	4.5	-0.3	4.2	do	2	7	3
25	10 a. m.	do	0	6	-0.3	5.7	W. NW.	2	5	4
25	do	do	42	6.9	-0.3	6.6	do	2	5	4
25	do	do	51	7.2	-0.2	7.1	do	2	5	4
28	9-10 a. m.	do	0	4	-0.4	3.6	do	5	5	4
28	do	do	23	4.2	-0.3	3.9	do	5	4	6
Mar. 8	2-3 p. m.	½ mile north of Udsire	0	4.4	-0.3	4.1	SW.	2	4	4
8	do	do	62	5.5	-0.3	5.2	do	2	4	4
8	do	do	119	6.7	-0.3	6.4	do	2	4	4
8	do	do	132	6.9	-0.3	6.6	do	2	4	4
5	10-12 a. m.	1 mile north of Udsire (Klækken fishing station).	0	4.5	-0.3	4.2	S.	2	1	3
5	do	1 mile north of Udsire (Klækken fishing station).	189	7.1	-0.2	6.9	do	2	1	3
9	9-9.30 a. m.	Udsire (north side)	0	4.4	-0.3	4.1	SW.	2	4	3
9	do	do	38	4.5	-0.3	4.2	do	2	4	3
9	do	do	76	5.4	-0.3	5.1	do	2	4	3
9	10.30 a. m.	½ mile NW. of Udsire.	0	4.4	-0.3	4.1	do	2	4	3
9	do	do	38	4.4	-0.3	4.1	do	2	4	3
9	do	do	76	5.1	-0.3	4.8	do	2	4	3
9	do	do	123	6.6	-0.3	6.3	do	2	4	3
9	11 a. m.	½ mile NW. of Udsire.	0	4.4	-0.3	4.1	do	2	4	3
9	do	do	38	4.3	-0.3	4	do	2	4	3
9	do	do	76	5.1	-0.3	4.8	do	2	4	3
9	11 a. m.	do	123	6.3	-0.3	6	do	2	4	3
9	do	do	0	4.4	-0.3	4.1	do	2	4	3
9	12 a. m.	½ mile SE. of Urter.	0	4.3	-0.3	4	do	2	4	3
9	do	do	38	4.3	-0.3	4	do	2	4	3
9	do	do	76	5.2	-0.3	4.9	do	2	4	3
9	1 p. m.	Urter (southwest side)	0	4.4	-0.3	4.1	do	2	4	3
9	do	do	23	4.5	-0.3	4.2	do	2	4	3
9	3.30 p. m.	Urter (northwest side)	32	4.4	-0.3	4.1	do	2	4	3
9	4-4.30 p. m.	½ mile NW. of Urter.	0	4.3	-0.3	4	do	2	4	3
9	do	do	38	4.2	-0.3	3.9	do	2	4	3

* Hall storms.

† Rain.

Table of deep-water temperature, &c—Continued.

1880.		Location.	Scale of temperature.				Wind.		Weather.	Sea 0—9.
Day.	Hour.		Depth in meters.	Thermometrical reading.	Correction.	Corrected temperature.	Direction.	Force 0—6.		
Mar. 9	4-4.30 p. m.	½ mile NW. of Urter.....	0	4.4	-0.3	4.1	.....	2	4	3
9	do	do	88	4.5	-0.3	4.2	.....	2	4	3
9	do	do	66	4.7	-0.3	4.4	.....	2	4	3
9	do	¾ mile NW. of Urter.....	0	4.4	-0.3	4.1	.....	2	4	3
9	do	do	88	4.5	-0.3	4.2	.....	2	4	3
9	do	do	76	5.8	-0.3	5.5	.....	2	4	3
9	do	do	0	4.4	-0.3	4.1	.....	2	4	3
9	5 p. m.	½ mile SW. of Røvær.....	88	4.4	-0.3	4.1	.....	2	4	3
9	do	do	76	6	-0.3	5.7	.....	2	4	3
9	do	do	0	4.3	-0.3	4	.....	2	4	3
9	5.30 p. m.	Røvær Harbor.....	7½	4.2	-0.3	3.9	.....	2	4	3
9	do	do	0	4.3	-0.3	4	SE.	1	0	0
11	9-10 a. m.	Røvær (east side).....	88	4.4	-0.3	4.1	.....	1	0	0
11	do	do	53	4.8	-0.3	4.5	.....	1	0	0
11	do	do	76	5.7	-0.3	5.4	.....	1	0	0
11	do	do	0	4.5	-0.3	4.2	.....	1	0	0
11	11 a. m.	½ mile W. of Hangesund.....	88	4.4	-0.3	4.1	.....	1	0	0
11	do	do	0	4.3	-0.3	4	.....	1	0	0
11	12 a. m.	Near Hangesund.....	88	4.4	-0.3	4.1	.....	1	0	0
11	do	do	55	4.6	-0.3	4.3	.....	1	0	0

