

fishing of these young fish with drag-nets as hurtful; but the same may be said of every other coast; but as the law proposed in the above-mentioned memorials only refers to fishing in the larger fiords where the codfish must be supposed to be rather stationary, it would not apply so well to this coast which is so open and unbroken. From what I have learned, drag-nets are rarely or never used here. Frequent conversations with fishermen have convinced me that there is no general dissatisfaction with this kind of fishing-implement, which is scarcely known here, but that there are complaints of an excessive use of hooks and lines. With the exception of the Christiania fiord, drag-net fishing has only been carried on to any extent in and near the Langesunds fiord, chiefly owing to local causes (the many quiet shallow inlets with even, sandy bottoms), which have made the use of this net more convenient here than on the other portions of the coast, which, both on account of the nature of the bottom and the open or unbroken character of the coast itself, is scarcely suitable for any extensive drag-net fishing.

Under these circumstances, I see for the present no necessity for the government to take any steps in the matter, and from another reason I would most decidedly advise not to make any law at least for the present. During my stay on the Langesunds fiord I learned that the regulations made in former times regarding the limitation in the use of the drag-net in the Langesunds fiord and its neighborhood, which are fully justified by local circumstances, do by no means produce the intended result, for I was told that drag-net fishing is carried on now to the same extent as before the law was passed. This is easily explained by the fact that there is no supervision whatever, although such supervision is absolutely required, since drag-net fishing is chiefly going on during the night or very early in the morning (before the break of day). Before there can be any talk of more rigid regulations of the drag-net fishing on coasts where the carrying out of such regulations would be doubtful, there must be some guarantee that these regulations are really observed, at any rate in those places where there is urgent necessity for such regulations. If this is not done, such rigid laws, far from doing any good, will do positive harm, as the moral influence on the sense of justice of the common people will be very bad, if there are laws which only exist on paper and can be transgressed with impunity at any time.

III.

EXTRACTS FROM PROF. G. O. SARS'S REPORT ON THE NORWEGIAN ATLANTIC EXPEDITION OF 1876.

I.—ZOOLOGICAL OBSERVATIONS.

Among the various scientific problems to be solved by this expedition the most important was the examination of the biological condition of

those portions of the sea through which its route lay. The expedition was well supplied with all the necessary apparatus (bottom-scrapers, or dredges, trawl-nets, sieves, &c.), all according to the most recent English models; also a considerable quantity of cordage of different thickness, as well as heavy iron weights for keeping the apparatus on the bottom. A large number of glass jars of every size and quality, from small tubes to cylinders measuring one foot in diameter, were also on board, as well as a considerable quantity of spirits of wine for preserving the specimens which would be collected.

In order to take the best possible care of the zoölogical material obtained by the above-mentioned apparatus, and in order to make those preliminary observations which are of great importance for all future observations, it was thought best to have as many zoölogists as possible on the expedition, as well as an experienced draughtsman. The zoölogists were: Dr. Danielsen, Mr. Friele, and Professor Sars, and the draughtsman's place was filled by the well-known landscape-painter, Mr. Schiertz, whose skilled pencil and unusually sharp faculty of observation proved of great use to the expedition. He has produced a series of masterly colored sketches, which will form a great ornament to those zoölogical treatises which are going to be published as one of the results of the expedition.

The zoölogical work had been distributed in the following manner: Dr. Danielsen, assisted by Dr. Koren, was to observe and describe the echinoderms, geophyreans, and the coral animals; Mr. Friele, the mollusks; Dr. Hansen, the annelids; and Professor Sars, the other classes—crustaceans, pycnogonidæ, the polyzoans, hydroids, sponges, and those lowest organisms forming the connecting link between the animal and vegetable kingdoms (foraminifers, radiolarians, and diatoms). Professor Sars was also to make those observations which referred to the salt-water fisheries.

Every one of these gentlemen is now, and has been for some time, employed in working up his part of the material. But as this is exceedingly rich, it has not been possible so far to finish the observations and give a detailed report. As all the special results will, moreover, go into the general report which will be published at the close of the expedition, it will suffice in this place to give a brief account of the manner in which the biological part of the work has been done, and give some of the more important general results. It must be remembered that these observations, made far out in the open sea from a comparatively small vessel, and at a depth of nearly 2,000 fathoms, are, even under the most favorable circumstances, connected with very great difficulties, and take up considerable time. If, in spite of the long-continued unfavorable weather, a very large quantity of zoölogical material has been collected, this is chiefly owing to the zealous and skilful supervision of the work by the second officer, Lieutenant Pettersen, into whose charge it had been given by Captain Wille.

During the expedition the dredge was used sixteen times; the trawl-net, twelve times; the two combined, twice; and the swab, once. Altogether, not less than thirty-one separate hauls were made, and of these only very few were entire failures, while most of them yielded very satisfactory results. Besides this apparatus, the surface-net has been used very frequently for the purpose of examining the pelagian animals living near the surface. The dredge has also been used from boats in the Sognefjord, near Husö, near Thorshavn, on the Faroe Islands, and in the bay of Reykjavik. Without specifying the numerous animals brought up from the depth of the sea in this manner, it must be said that of nearly all classes new and interesting specimens have been obtained, extensive descriptions of which, accompanied by plates, will be published.

The greatest depth reached during the expedition was 2,000 fathoms, about half-way between Norway and Iceland, and several hauls were made at a depth of upward of 1,000 fathoms. The zoölogical observations were begun in the Sognefjord, where the considerable depth of 650 fathoms was reached, the greatest depth which had ever been examined near our coasts. Here the usual deep-water fauna was found, well known from former investigations, especially those of the Hardangerfjord, although several very rare specimens were also obtained; among the rest, a well-preserved specimen of the species *Brisinga*, given by Asbjörusen (*Brisinga coronata*, G. O. Sars), several specimens of the interesting Gephyre *Priapuloides bicaudata*, Danielsen, hitherto only observed near Vadsö, and large numbers of a beautiful red crustacean with brilliant eyes shining like gold, formerly only found in very small numbers, *Munida tenuimana*, G. O. Sars.

The observations became more interesting when the expedition reached the barrier stretching at some distance from our western coast, whose outermost boundary is the so-called "sea-bridge"—(*Havbro*). Here begins, below a depth of 300 fathoms, the cold area or Polar Sea deep, which hitherto has been but little explored. It has a bottom-temperature of 0° to—1.6° C., and the fauna in accordance with this temperature has a very peculiar character, entirely different from that of our southern and western coast. Seventeen of our hauls were made in this cold area, and from these a tolerably correct idea may be formed of the peculiar physical and biological condition of this region. All over the large depression which occupied the greater portion of the bottom of the sea between Norway on one side and the Faroe Islands and Iceland on the other, the bottom at a depth of more than one thousand fathoms seems to consist of a peculiarly loose, sticky, light, almost grayish-white clay, which contains a great deal of lime, and, after being washed or sifted, proves to consist almost exclusively of shells of a very low organism, a foraminifer, the *Biloculina*. The expedition therefore called this deep-water clay "biloculina clay," to distinguish it from that kind of clay which is found in the warm area at a great depth in the Atlantic, and

which from a totally different foraminifer is called "*Globigerina*." The biloculina clay contains a great deal more lime than the globigerina clay of the Atlantic. When acids are mixed with it, gas develops very freely, and when pressed and dried, it soon turns into a very hard and compact limestone. We see here a complete lime or chalk formation during its period of growth, and its fauna also shows distinct traces of its ancient origin and its near relation to the remnants of organisms preserved in the fossil-bearing layer from the end of the Secondary Period.

We must here mention a beautiful stone lily (*Crinoid*) which measures a span in length, and is probably quite new, of which many live specimens were obtained, and which shows an unmistakable similarity to some of the oldest fossil forms of this group of animals, which is now almost extinct; also a very peculiar and interesting animal of the holothurian kind, enormous chalk-sponges, large numbers of a new and very peculiar pycnogonide, and a remarkable blood-red crustacean with integuments as thin as paper (*Hymenscaris*), besides several other new crustaceans. The mollusk which is most frequent in these parts is the *Siphonodentalium vitreum*, M. Sars, so characteristic of the older glacial clay, which on our coasts is only found alive in the northernmost part of Finmarken. Although the fauna of this great deep is of special interest from a zoölogical and geological point of view, it is on the whole rather monotonous. But where the bottom begins to rise toward the banks, a great difference may be noticed. At a depth of 400 to 900 fathoms, but still within the cold area, we find an exceedingly rich and varied animal life. Contrary to what might be expected from the low temperature prevailing here, we find, in comparison with our coast-fauna, no deterioration of animal life, but a remarkably luxuriant fauna showing itself in the numerous and varying animal forms, and in the comparatively colossal size which some of them reach, one of the polyps (*Umbellularia*) taken here measuring fully four yards in length.

From the specimens taken by the dredge, the trawl-net, and the swab, an approximate idea may be formed of the peculiar character of the bottom in these parts; forests of peculiar tree-like sponges (*Cladorhiza*) cover large portions of the bottom. Between their branches are seen magnificent medusa-heads (*Euryali*) and gaudy-colored animals of the *Antedon* kind, also different crustaceans; amongst the rest the fantastically shaped *Arcturus Baffini*, well known in the Polar Sea, and lazy pycnogonids, some of them of enormous size (measuring a span between the points of the feet), crawl about between the branches sucking their organic juices with their enormous beaks; also a large number of fine plant-like animals (polyzoans and hydroids) which live among the dead trunks and branches which have been deprived of their organic bark-substance. On the open plains among these swamp-forests, beautiful purple-colored sea-stars (*Astrophyton*) and long-armed snake-stars (*Ophiura*) may be seen, as well as numberless *Annelides* of different kinds; crusta-

ceans are swarming everywhere, long-tailed decapods (*Crangon*), finely built musidæ (*Erythrops*, *Parerythrops*, *Pseudomma*), large numbers of amphipods (*Anonyx*) and isopods (*Mumiopsida*). Like tall pine-trees rising above the lower forest trees, the gigantic umbellularia tower above all the rest with their straight trunks and beautiful tops garnished with fringed polyps. The light of day does not penetrate into these depths, but the animals themselves illumine these submarine forests, as nearly all of them are phosphorescent to a high degree, having the faculty of emitting from their bodies a very strong bluish, greenish, or reddish light.

Whenever the dredge or the trawl-net reached this region, which from its most characteristic animal form may well be called the region of the umbellularia, rich zoölogical results were obtained, and in most cases a day was too short a time to examine and preserve all these treasures brought up from the deep. Higher up, at a depth of 200–100 fathoms, and at a distance of 10–20 (Norwegian) miles from the coast, the long-stretched barrier commences, which, so to speak, forms the foundation on which our country rests and which separates it from the so-called Polar deep. This barrier generally commences with a hard stony bottom, and our dredgings were therefore connected with considerable difficulties. Numerous boulders, whose smooth round shape shows distinctly that once upon a time they have been exposed to the powerful influence of great masses of ice, are scattered about on the very uneven bottom, consisting of firm rock, and hinder the operation of the dredge or stop up its opening, so that in most cases only very imperfect specimens of the fauna of this region could be obtained. This fauna has a very different character from the preceding one, and resembles more the usual coast fauna; but it seems to be a rule that at this very point, the edge of the barrier, it is richer than nearer the coast, which seems to agree with the great wealth of fishes known to exist in these regions from olden times.

If in conclusion we combine all the physical and biological conditions—of which only a very superficial idea has been given here—in the portions of the ocean traversed by our expedition, the deeps surrounding our country may from a physiographic and zoögraphic point of view be divided into two very different regions, viz, the warm and the cold area. The former embraces the whole Skagerak and the North Sea and farther north the sea near our coasts till within a distance of 10–20 (Norwegian) miles, including all the fiords, and extends north to the northernmost point of Finmarken. The cold area begins where the bottom slants from the banks towards the great outer deep, extends in a southerly direction as far as the heights of Stadt, and continues in a south-westerly direction in the shape of a narrow wedge between the Faroe Islands and the Shetland Islands to the 60th degree of northern latitude. Towards the north the cold area extends to the North Pole, which is its central point. This area has been examined by the expedition at one

of its southernmost points, where it was found throughout to be very sharply defined from the warm area. The farther north one goes, the less marked does this boundary appear, as the cold area gradually rises from the deep, until in the Polar Sea it is even with the surface and then also occupies the littoral region, thus entirely excluding the warm area. The inner connection with the above-mentioned peculiar physical conditions of the seas surrounding our coast has been made a great deal clearer by the experience gathered during our journey, and an important contribution has been made to the meteorology of the sea in general. A further explanation of these purely physical conditions is also of the greatest importance to zoölogists for the better understanding of the different biological conditions of the sea; but as such an explanation belongs to the physico-meteorological observations, we shall confine ourselves to the purely zoölogical side of the question.

The character of the fauna in the cold area is purely arctic or glacial without any southern specimens whatever, and some of our varieties have already been identified with those gathered in the Polar Seas by the Swedish, German, British, and American Polar expeditions. In a higher latitude these animals, which in the sea traversed by us live only below a depth of 400 fathoms, and are therefore essentially deep-water varieties, live in comparatively shallow water, even up to the surface of the sea. This interesting fact seems to confirm the opinion expressed by several naturalists, that the distribution of animal life in the sea is chiefly dependent on the temperature, whilst the depth has but little influence on it. The purely arctic fauna found on our coast during the glacial period, and which has left its traces in the older glacial shell-banks, was gradually forced to retreat towards the deep, and this was chiefly occasioned by a change of temperature, which of course would be less perceptible in deep water. The place of this arctic fauna was then taken by animals immigrating from the south. In the deepest waters of some of our long and narrow fiords a remnant of this original arctic fauna may yet be found. But it evidently ekes out a miserable existence, which is sufficiently proved by the small size and crippled appearance of the animals. Their ultimate extinction is probably only a question of time. After the temperature of the sea has been studied more thoroughly, this can be fully explained from purely physical causes; for the influence of milder climatic conditions has finally also reached these deep waters of our fiords, so that even at a depth of 650 fathoms the average temperature is $+ 6^{\circ}$ C., a temperature which must certainly have a hurtful influence on the life of these arctic animals. The temperature outside of our sea-banks, even at a much lower depth, has, however, remained the same as it was in the glacial period here as well as close to our coasts. And we consequently find here, although remarkably far south, no sickly or crippled arctic or glacial fauna, but one fully as luxuriant as that of the Polar Sea.

The light which meteorology will be able to throw on some dark

phenomena in the development and distribution of animal life, and likewise the great aid which purely biological facts may furnish to meteorological investigations, make it desirable that these two sciences seemingly so different in their character should no longer remain strangers to each other, but should form an intimate union for the purpose of each contributing its share towards the scientific solution of several hitherto unexplained physical and biological problems which have greatly perplexed the man of science.

2—INVESTIGATION OF THE SALT-WATER FISHERIES.

Besides making strictly scientific investigations, it was likewise intended to observe, whenever an opportunity offered, everything which might have a bearing and throw some light on our important salt-water fisheries. As Professor Sars had studied our fisheries for a number of years, he was commissioned to make these investigations. A number of different fishing implements were therefore furnished to the expedition; *e. g.* hooks and lines and floating nets with different sized meshes. These implements could of course only be used in favorable weather, when the sea was tolerably smooth, which it was hoped would be the case at least part of the three months of the best season of the year occupied by this voyage. But the weather was unfortunately exceedingly unfavorable all the time, so that these fishing implements could scarcely be used at all. From the same reason another important apparatus for measuring the current, chiefly intended for physico-meteorological observations, could not be used. During the few days that the expedition enjoyed fair weather, it was too near the coast to make these investigations specially interesting.

Although the weather placed insurmountable hinderances in the way of the above-mentioned observations, several facts were nevertheless gained, which, in Professor Sars's opinion, are of importance and will serve as guides in future practical and scientific investigations of our fisheries.

The soundings show that there are several fishing-banks near our coast which hitherto have been entirely unknown, and where rich fisheries might be carried on during the summer months.

The so-called "Storegg" off the coast of the Romsdal District has from time immemorial been famous for its immense wealth of fish, and there are mysterious traditions that this is not the only point where similiar extensive fisheries could be carried on, but that there were other rich fishing-banks far out in the ocean, "if people only were fortunate enough to find them."

The mystic idea of the "Havbro", sea-bridge, has been to a great extent explained by the investigations of this expedition. The "Stor-

egg" is nothing else but a portion of the edge of that long barrier which forms our western boundary towards the cold polar deep. The natural reason why that portion of the barrier has been known for so long a time, without, however, leading to any correct knowledge of its exact nature, is this, that here the polar deep approaches nearer to the coast than at any other point, forming a very distinct bay. Even during the soundings made from the steamer *Hansteen* a new portion of the northern continuation of this edge was found, and its existence at several other points has now been proved, as well as the fact that both farther south and farther north it recedes from the coast to a distance of 20–30 (Norwegian) miles. Although this is not the case everywhere, the general rule seems to be that the bottom near the outer boundary of the barrier before sloping toward the great outer deep, rises a little and assumes a hard stony character, exactly like that of "Storegg."

The first line of soundings running from Husö in a northwesterly direction struck this edge at a distance of 20 miles from the coast (stations 16 and 17.)* The bottom, which had so far been soft, suddenly became hard and stony at a depth of 221 fathoms, and continued so even after it had fallen off 70 fathoms toward the outer deep. That the bottom here sloped off very abruptly was proved by the circumstance that at the next station the cold area was reached at a depth of 412 fathoms, and a bottom temperature of -1.3° C. Farther north, on the heights of Troughjem, at a depth of 190 fathoms, and likewise on the boundary-line between the cold and the warm area, a similar edge of rocky bottom was discovered, falling off abruptly toward the west (station 89†). Similar discoveries were also made in the other portions of the sea traversed by the expedition.

Northeast of the Faroe Islands, and at a considerable distance from the same, the expedition was, in spite of the very unfavorable weather, fortunate enough to strike the outermost edge or the most northeasterly point of the long-stretched Faroe bank (station 38),‡ from which its extent and configuration could be somewhat determined, and the nature of this point seems to be very similar to that of the "Storegg." By the line of very careful soundings made from the *Namsemfjord* in a westerly direction, the existence of a hitherto unknown and very sharply marked cross-bank of considerable extent was proved; this bank extended at a comparatively short distance from the coast, at a depth of only 62–92 fathoms, and had a hard bottom (stations 63, 64, 65§). Outside of this bank the bottom sloped off very imperceptibly towards the great deep,

* The exact location of these points is given from the journal of soundings. Station 16: latitude, $62^{\circ} 23.9'$; longitude, $2^{\circ} 17'$ east of Greenwich. Station 17: latitude, $62^{\circ} 33'$; longitude, $2^{\circ} 4'$ east of Greenwich.

† Station 89: latitude, $64^{\circ} 1'$; longitude, $6^{\circ} 7.5'$ east of Greenwich.

‡ Station 38: latitude, $62^{\circ} 57.4'$; longitude, $3^{\circ} 47'$ west of Greenwich.

§ Station 63: latitude, $64^{\circ} 41.3'$; longitude, $9^{\circ} 0'$ east of Greenwich. Station 64: latitude, $64^{\circ} 42'$; longitude, $8^{\circ} 50'$ east of Greenwich. Station 65: latitude, $64^{\circ} 42.5'$; longitude, $8^{\circ} 39'$ east of Greenwich.

but nothing like the "Storegg" could here be discovered. It must likewise be mentioned that in the outer portion of the Sognefjord an extensive plateau was discovered with hard stony bottom and sloping both towards the coast and towards the deep (depth from 260 to 211 fathoms).

There can be no doubt that all the above-mentioned places are excellent fishing-stations. Wherever at some distance from the coast similar banks are found with hard or stony bottom, there have always been large quantities of fish, and although all attempts made during the expedition to attach a short line and baited hook to the plummet proved fruitless, no negative conclusion must be drawn from this very unpractical method of investigation, which under the circumstances was the only one possible.

The kinds of fish found on the banks are chiefly ling, cusk, halibut, and large codfish, the so-called bank codfish. Professor Sars has in his former reports to the department expressed his opinion that the so-called bank-codfish is not a different fish from the well-known winter codfish which comes to our coasts in winter and the beginning of spring for the purpose of spawning. The views formerly entertained of the migrations of the codfish from distant seas have been entirely abandoned by the professor, after he had thoroughly studied the nature of this fish, and the experience gained during this expedition has only served to corroborate his opinion. According to Professor Sars's opinion, all the codfish which visit our coast during the winter and which form the object of our most important fisheries are during the rest of the year found only in that portion of the sea whose bottom forms the barrier towards the outer polar deep as especially the outer side of this barrier (the so-called "Havbro") with its richly-developed animal life and the favorable character of its bottom forms a convenient place of sojourn for enormous numbers of codfish.

It is entirely different with another very important fish, the *herring*. Here the investigations made by Professor Sars have led him to the opposite view. While the cod is a genuine bottom-fish, and as such dependent on the nature of the bottom and the different depth of water, the herring is in its whole character a genuine pelagian fish, and therefore independent of depth of water and the nature of the bottom, but influenced by the physical and biological conditions of the water near the surface. As these change a good deal, this kind of fish had to be furnished with the means of quickly reaching the most favorable portions of the sea. The herring is therefore distinguished from the cod by its elegant compressed or wedge-shaped form, which enables it to shoot through the water as swift as an arrow and travel long distances in a comparatively short time.

The professor, although not taking the old-fashioned view that the spring herrings come from the ice-covered sea near the North Pole, inclines to the opinion that the herring undertakes long and irregular journeys in the open sea, not only when it comes to the coast for the

purpose of spawning, but all the year round. The distribution of the herring in the sea is dependent on the distribution of the small marine animals which form its food. These are all pelagian animals, chiefly small crustaceans which keep more or less near the surface and are well known to our fishermen by the name of "aat." Only when the herring comes to the coast in winter for the purpose of spawning, its migrations are, to begin with at least, independent of the occurrence of "aat." The rest of the year the schools roam about in the outer sea, chiefly seeking that portion where at different times they find the best supply of food. The great schools of herrings may therefore at the approach of winter or when the development of their generative organs drives them toward the coast in order to spawn there, be quite naturally either at a shorter or longer distance from their spawning places, just according to the quantity of food found in different portions of the sea. The professor thinks that this circumstance chiefly causes the fluctuations in our spring herring fisheries. As the migrations of the young herrings commence long before roe and milt are matured, the great mass of herrings, if near the coast at this time, would reach it so early that they would be obliged to stay here a longer time, and thus naturally get nearer the coast, entering the fiords and inlets. In the opposite case, if the mass of herrings should at that time be at a considerable distance from their spawning places, such a long period of time would elapse before they reached these, that the spawning process could be performed immediately on their arrival. The herrings would in that case stay only a short time near the coast, and the spawning would chiefly go on on the outer and less accessible banks; in other words, the spring herring fisheries would be of very short duration or prove an entire failure.

This in brief is the theory which Professor Sars advanced several years ago, after having carefully examined our coasts, as the only possible scientific explanation of the remarkable irregularities which in course of time have been observed in the spring-herring fisheries. There were however at that time but few facts to support this theory. Sailors and fishermen had occasionally spoken of large masses of herrings which showed themselves far out in the open sea immediately before the spring-herring fisheries commenced; whilst others had at different seasons of the year observed large masses of small crustaceans in various parts of the sea. Regarding this last-mentioned phenomenon we likewise have the testimony of reliable naturalists (Kröyer), and from the very portion of the sea which is chiefly concerned here. But all this information is too scattered to prove in an incontrovertible manner that the open sea is really a fit place of sojourn for the enormous masses of herrings which come near the coast at different seasons of the year.

Professor Sars considered it as one of his most important objects on this expedition to examine the distribution of the "herring-food." With this view he examined the sea almost every day, frequently several times a day, with the surface-net. The results of these investigations

entirely confirmed his previous supposition regarding this matter. During the whole voyage from Norway to the Faroe Islands the sea was everywhere filled with enormous masses of the so-called "red herring food" (almost exclusively *Calanus finmarchicus*), which are well known as the favorite food of the herring; and it deserves to be mentioned that the quantity of these animals seemed to increase the farther we got away from the coast and reached its height at a distance of about twenty miles. Besides these animals we likewise observed occasionally farther out at sea another kind of a beautiful blue "herring food" (*Pontella Pattersonii*), which seemed to belong more to the Atlantic, and which in contradistinction to the former might be called "mackerel food," as it probably forms the principal food of the mackerel at those seasons of the year when they are not near the coast. This "food" is also occasionally found among the "red herring food" near the coast, especially during rich summer-herring fisheries. When the expedition took a northerly course from the Faroe Islands towards Iceland, it was very striking that the food seemed to have disappeared from the sea almost entirely. The water had at the same time assumed a very different color. While from Norway to the Faroe Islands it had a deep blue color, it now had a light grayish-green color. This peculiar circumstance, whose definite explanation has not yet been found, but with which the different currents of the sea have certainly something to do, seems to be closely connected with the occurrence of the "food," and will form a subject of investigation for the next expedition. Professor Sars says that he had a very excellent chance to observe this phenomenon from his state-room, whose window was on a level with the water. Whenever the waves covered the window his whole state-room was formerly filled with a dark blue light, whilst now it was a bright greenish light. This color remained as long as the vessel was in Iceland waters, and here the sea did not contain any food whatever. Only when on our return voyage we approached the coast of Norway the sea again showed its blue color and was full of "food."

It must, however, be supposed that the conditions observed during our voyage are not always the same, as some reports say that the sea near Iceland is peculiarly rich in "food." It seems as if the steady westerly gales which prevailed during the expedition, in connection with the strong eastward current, had brought the great masses of "food" nearer to the coast of Norway. If this should really have been the case, which, however, can scarcely be proved conclusively, it would, in connection with Professor Sars's theory regarding the migrations of the herrings, be an indication that the spring-herring fisheries would again be successful in the near future. It may be considered as absolutely certain that wherever there is "herring food" herrings will be found. Although there was unfortunately no chance to corroborate this by direct investigations made by means of floating nets, the indications were by no means wanting that there were herrings where the "food"

was most plentiful. Not a few whales were noticed in these localities, also a large number of sea-birds, and at a considerable distance from the coast, near stations 75 and 76,* large brown spots could be observed in the sea resembling extensive algæ-bottoms, which, however, on close examination proved to be enormous masses of closely packed "food," on which the *Procellaria glacialis*, the constant companion of our voyage, was feeding to its heart's content. It is evident that these enormous masses of "food" had not come here accidentally, nor could it be supposed that far out in the open sea the current alone could have done it. It is much more probable that the schools of herring had chased it here, and that under these brown spots there were dense masses of herrings.

It was very unfortunate that unfavorable circumstances did not allow the use of floating nets, by which the occurrence of the herring in the open sea could easily have been proved. It is to be hoped, however, that the next exhibition will be more successful as regards the weather, and that the herring question will be made more of an objective point, all the more as the expedition will go farther north, *i. e.*, nearer those waters which Professor Sars considers the home of the spring-herring and the great-herring.

IV.

PRELIMINARY REPORT ON THE ZOÖLOGICAL OBSERVATIONS MADE DURING THE SECOND NORWEGIAN POLAR EXPEDITION OF 1877.

The expedition left Bergen on the 11th of June and returned to that place on the 23d of August, and therefore lasted about three months. Its outfit was about the same as during the preceding year. The zoölogical *personnel* was also the same, with the sole exception that Dr. G. A. Hansen accompanied the expedition as passenger, and during the first month also as zoölogist instead of Mr. H. Friele, who was detained by his business and only joined at Tromsö.

Different from last year, the weather was nearly all the time unusually calm, with northerly wind and a comparatively smooth sea, so that even the finest microscopic observations could be made on board. In consequence of the favorable weather the number of working-days was a great deal larger than last year, and the number of stations, which had been ninety-five last year, was almost twice as large.

This expedition investigated a considerable portion of the Northern Sea, viz, from the height of the Vigten Islands (65° northern latitude), which were reached last year, as far north as $71\frac{1}{2}^{\circ}$ northern latitude, and as far west as $11\frac{1}{2}^{\circ}$ western longitude. Eleven different cross-lines were followed in different heights, and some of them a very considerable

* Station 75: Latitude $64^{\circ} 47.2'$; longitude $7^{\circ} 13'$ east of Greenwich. Station 76: Latitude $64^{\circ} 47.4'$; longitude $7^{\circ} 3.6'$ east of Greenwich.