

were dissolved in warm water whose temperature varied between 30° and 60° Celsius. The dissolving process takes place in wooden vessels with hair bottoms, and surrounded by poor heat conductors. After having been allowed to stand in these vessels for twenty-four hours the solution of glue, which is still warm, is drawn off and placed in smaller wooden vessels to cool, when it forms a clear and colorless jelly, which is cut into tablets and dried on nets stretched out on frames, as is done with the common cabinet-makers' glue.

90.—SPAWNING OF SPRING HERRING NEAR NORWAY.*

By S. A. BUCH.

[From report to the Norwegian Department of the Interior, 1884.]

As early as December 7, 1883, some specimens of herring were sent to me from Ekersund. The 10 specimens which I examined were all spring herring. The sexual organs, whose average weight was 37.05 grams, were not yet developed; so that it was not improbable that considerable time would elapse before the herring would come close to the coast. To judge from the specimens which I received, the majority of these fish were females.

Ten days later I received some specimens from Skudesnæs, but they consisted exclusively of so-called "blood-herring," which do not at this time visit our coast for the purpose of spawning.

On December 22 I received from Frederikshald 24 "Hvaløer herring," which were said to be genuine average specimens of a large quantity of herring caught in nets. Of these 24 herring 20 were of different age, and but very few were ready to spawn. Only 4 were spring herring, and had well-developed sexual organs (average weight 40.1 grams), which certainly were somewhat larger than those of the "Ekerøe herring;" nevertheless these herring were by no means ready to spawn. Of these herring 14 were females and 10 males.

On December 24 some herring came from the Hvitings Islands. The average weight of the sexual organs was 47.17 grams, but they were not fully developed, although more so than those which I had received previously.

The herring which I had occasion to examine later I received between February 1 and the middle of March. On February 1 I received 5 specimens from Rødvær, all small herring, still firm and full. One was a "blood-herring," and the rest spring herring, whose sexual organs had an average weight of 25.75 grams.

On February 5 herring that were ready to spawn were this year found for the first time near Utsire. Some of the females had even cast some

* "Vaarsildens Gyldning." Translated from the Danish by HERMAN JACOBSON.

spawn, but this had probably been caused by their having been chased and scared by codfish, an occurrence which seems quite common during the early part of the fisheries. Fifty-three per cent of the herring which I examined were males, and 47 per cent were females. The average weight of the sexual organs was 46.6 grams. The temperature of the water varied from 5°.9 to 6°.3 Celsius.

On February 6 and 7 all the herring caught on the coast near Utsire were full of spawn, which, however, was loose. The temperature of the water on February 6, from the surface to the depth of 70 meters, varied from 5°.9 to 6° and on the 7th at the same depth from 5°.9 to 6°.3 Celsius.

On February 8, 63 per cent of the herring which I received were females and 37 per cent males; and on the 9th 71 per cent females and 29 per cent males. On both days the herring were full of spawn, all of which was loose.

On February 14 I received about 30 codfish, caught at a depth of 120 meters northeast of Nordvaag. The contents of their stomachs consisted in all cases of herring spawn, which, as the embryo was scarcely visible, must have been ejected by the herring during the days immediately preceding February 14.

On February 16 I found spawn, while scraping the bottom near Nordvaag, and lines hauled in the same day were covered with spawn. On the 15th the temperature, at a depth of from 0 to 70 meters, varied between 5°.2 and 5°.6 Celsius, and on the 16th, at the same depth, from 5° to 5°.4.

On February 19 it was observed for the first time this season that herring had spawned in shallow water near Urter; and on the 20th, 21st, and 22d the herring had literally whitened the sea all round Urter. By bottom-scraping some days later great masses of roe were brought to the surface round the Sveaboerne Islands (north of Urter), and between these islands and Urter. Near Urter herring spawn could be found in every sound and bay, from the surface down to a depth of 40 or 50 meters. The temperature of the water near Urter, at a depth of from 0 to 70 meters, during these days varied between 4°.9 and 5°.3 Celsius.

On February 21st 41 per cent of the herring which I received were females and 59 per cent were males; on the 22d 42 per cent females and 58 per cent males; and on the 23d there were among the herring caught near Kalstøe 54 per cent males and 46 per cent females. In average years it is the rule that in the beginning of the fisheries the female herring are in the majority, and only after the fisheries have progressed for some time is this reversed. But this year it was observed as early as February 15, therefore at a time when spawning had just commenced, that the male herring were much more numerous than the females; and this remained so during the rest of the fishing season.

On February 25 the herring spawned near Kvittingerne, and near

Kvalevaag and Salvøe. All the lines were thickly covered with spawn, both in deep and in shallow water. On this day the temperature, at a depth of from 0 to 50 meters, varied from 5° to 5°.4 Celsius. The male fish were, on the whole, still full, and only in exceptional cases a few had ejected a small quantity of milt. In three batches of herring received by me at different hours during the day, the percentage of males was 75, 73, and 72, respectively.

On February 26 I examined the coast from the Ferkingstad Islands as far as Akrehavn and Kvalevaag. In nearly all places where the bottom was clean (covered with coarse and fine sand) the herring had spawned at a depth varying from 10 to 60 meters. Among the number of herring which I examined the males were invariably in the majority. On the 26th the temperature at a depth of from 0 to 70 meters varied between 4°.6 and 5° Celsius.

On March 1 the herring had "whitened" the sea near Sværdholm, the most southerly point in the southern district where spawning was observed during this year's fishing season. The temperature at Veavaag (1½ Danish miles north of Sværdholm) varied between 4°.4 and 5° Celsius at a depth of from 0 to 30 meters.

During the following days I had occasion daily to examine codfish caught between the Ferkingstad Islands and Kvalevaag. As nearly each of these codfish was full, almost to repletion, of herring spawn, and as bottom-scraping invariably brought to the surface a great quantity of spawn, I was confirmed in my opinion that the herring had spawned over a vast area, which from the last herring period was known as a good spawning place. That the herring have spawned successively, and have stayed in this place for some time, is also proved by the circumstance that in the stomach of one cod there were found herring eggs in all stages of development, from recently impregnated spawn to spawn where the shining metal colored iris of the embryo could be seen with the naked eye.

About March 6 and 7 the spawning process may be said to have ceased in the southern part of the southern district. Near Stokvigen, Grotleford, and in the neighborhood of Hisken and Haapollen spawning herring were observed as late as the middle of March. Herring caught on March 21 were found to have finished spawning. During the period from March 10 to 15, the temperature of the water at a depth of from 0 to 70 meters varied from 3°.5 to 4°.7 Celsius between Nökling and Brandesund.

It will be seen that all the spawning observed in the southern part of the district took place from the surface to a depth of 70 meters, and at a temperature of the water varying from 4°.4 to 6° Celsius, while in the northern part of the district, at the same depth, it took place at a temperature varying from 3°.5 to 4°.7 Celsius.

According to my instructions, I was to place impregnated herring spawn in an inclosed basin. I was fortunate enough to find a suitable

locality at Salvöe and Tvilanparholmerne, on the west side of the island of Karmöe. I found, however, that in view of the investigations to be made, it would be of special interest to have these basins stocked with live spring herring, so as to be able to follow the development of the sexual organs until the following year, and, if possible, to throw some more light on the nature and development of the so-called "blood-herring." For this purpose each of the basins was stocked with 500 herring; and among those in the Tvilanpar basin there were some "blood-herring." In one of the walls of the Tvilanpar basin I had an iron grating inserted, so that constant connection with the sea was maintained and the herring were prevented from slipping out. To furnish the herring in this basin with food I placed in it a large number of lobsters with roe, so that the newly-hatched young lobsters might supply food for the herring during summer. In the Salvöe basin the conditions were such as to make it unnecessary to have special connection with the sea, as there is a regular connection at every tide, which, however, does not cause the water to rise so high that the herring could slip out.

During the course of spring and summer I had many opportunities for observing the herring. In April they were lean, and looked in every respect as if they had been starved. In May they had recovered somewhat, and in June they had become so fat that the common people called them "pretty" herring. But the circumstance which was of the greatest interest to me was that on June 20 I found among 10 herring taken from the Tvilanpar basin 2 (a male and a female) full of milt and spawn and almost ready to spawn. It would, of course, be somewhat premature to base on this single instance a theory as to the development of the so-called "blood-herring;" but the fact is nevertheless one of great interest, and I deem it proper to make it known. I cannot force myself to believe that these two specimens should belong to the spring herring; but I am rather inclined to the opinion that they belong to the "blood-herring;" and the conclusion which might naturally be drawn therefrom would be that the "blood-herring" belong to those herring which spawn in summer and autumn, which are found in the shallow portions of the North Sea, and which during July and August are, in enormous numbers, caught by the Dutch and Scotch fishermen. I am convinced that if the investigations relative to herring are to lead to any practical result they should not be made in winter alone; but that the places where the spring herring stay during summer should be sought, and that the winter investigations should be continued during summer and autumn between Norway, the Shetland Islands, and Iceland. For several years I have endeavored to establish seine fisheries on a rational basis in the North Sea, and thus to provide a new source of income for our coast population. I am of opinion that such summer and autumn seine fisheries would be the first practical result of the investigations referred to above, while at the same time our knowledge of the natural history of the herring would be considerably increased.