

XXIV.—THE FRESHWATER FISHERIES OF ICELAND.

[A report to the Assembly of Iceland.]

After making due preparation I reached Silfrastadir, Iceland, on July 19, 1884, and on the following day stopped at Lake Ljosavatn. At Akreyri I had been told that this lake was very deep, and partly for this reason and partly with the view to become acquainted with an Iceland lake as soon as possible, a man and boat were engaged to aid me in inspecting it. On the man taking me to the place where he thought the lake was deepest, I measured 6 fathoms; then 11, 13, 14, and 12. I had now passed the place which was supposed to be deepest, and as the boat was really not safe, I stopped measuring. Afterwards I was told that in some places this lake is 17 fathoms deep. The temperature of the water near the surface was $9\frac{1}{4}^{\circ}$, and at the depth of 8 fathoms 8° Celsius. There are comparatively few fish in this lake, and they are small and not very fat, although I have been informed that some weighed as much as 8 pounds. The fish which I had occasion to examine weighed from one-quarter to three-quarters pound, and appeared in good condition. Most of them seemed to be trout, and but few were mountain-trout. The food of the fish consisted of larves of flies and gnats, and a few small snails.

Just here I must say, regarding the Iceland freshwater fish, that from time immemorial there has been a great confusion of names, both among the fishermen and the writers on this subject. I have not yet been able to finish examining the material I gathered; but I can state that the principal kinds of fish in the fresh waters of Iceland are salmon, trout, mountain-trout, eels, and sticklebacks. I must add, however, that there are different varieties both of the trout and the mountain-trout. The Iceland term *silungur* must be considered as a name borne in common by the various species of trout and mountain-trout, although in some places it means simply the trout, that variety which I would call the "gray trout." The word *sjoreidur* was used both for the trout and the mountain-trout which come up from the sea to spawn in fresh water. By the term *laksebroder* the Icelanders mean the fish which in Denmark is called white trout or salmon trout; *blelja* and *birting* are different

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names for the mountain-trout, and *sjobirting* is the name of the trout which goes into fresh waters from the sea. There are a number of other local names used for these fish.

On July 20 I visited the Falls of the Goda and several points along the Skjalfanda River. A salmon-ladder might easily be constructed on the western side of the little fall, near the grotto, and possibly one might be constructed also near the great fall. The little fall is about 18 or 20 feet high, and the great fall about 42 feet. I took these measurements with a sounding-line, and as near the main current as possible.

The Skjalfanda River does not contain much animal life, and probably there is none at all in that portion which is near the falls. Nor was there any trace of vegetation. Above the Goda Falls the river has several tributaries containing trout and mountain-trout, which also go into the Skjalfanda. In its lower course there are said to be some salmon and trout; but there is no prospect that the fisheries in this river will ever be of any importance, and its whole character shows that it has never been rich in fish.

The Reykiadalsá River, with its tributaries, which flows into the Laxá River, and through the Vestmannsvatn and some other lakes, has an entirely different character. The nature of this valley and its animal and vegetable life show different and much more favorable conditions for the life of fish than the Skjalfanda and the valley through which it flows. In the Reykia valley the salmon are said to ascend very high, and there are many trout and mountain-trout. The salmon fisheries, however, have declined greatly. The spawning season of the salmon is supposed to be in October.

Making Mula my headquarters I made several excursions in the Laxá valley on July 21 and 22. Near Bruarfos there are falls, none of them, however, would hinder the ascent of salmon if the narrow passage on the west side of the largest island was widened somewhat, which could easily be done by blasting on both sides of the narrow passage. It is true that the falls are very long, but as there are resting-places here and there it may well be compared with a large natural staircase, and the fish could doubtless easily ascend it, provided that above the falls they could find natural conditions favorable to propagation and to the existence of young fry. I have not been able to obtain much information as to whether salmon have ever been caught above the falls, but it was thought that no suitable spawning places were there. In this respect I examined its course near Tverá, and also in the neighborhood of the Myvatn Lake, and several places would, in my opinion, be suitable for the spawning of salmon. But I must add that the conditions may be very different during the spawning season from what they were in July when I visited these places; possibly the water of the Laxá is in many places too warm, owing to its tributaries coming from the warm springs in the valley, and also on account of the numerous trout and mountain-trout which devour many salmon eggs.

Below Bruarfos the Kalvflækja flows into the Laxá, close to the old ford. Here there are extensive spawning places of salmon, as there are numerous banks formed by broken pieces of lava. As bridges have recently been built there is no necessity for using the ford during the spawning season (about from September 15 to November 15), and there is consequently no occasion to disturb the salmon during the spawning process. It would be better if the ford was used only from May till the middle of September.

On the right bank of the Laxá I visited the springs of a stream which flows into the Laxá, and which is said to contain numerous young fish. Here I had for the first time an opportunity to make some observations relative to the importance of the lava which forms the bed of many Iceland streams. It has already been stated in Eggert Olafson's and Bjarni Paulsen's valuable reports on Iceland that the salmon like those streams whose beds are composed of lava, because it abounds in hiding-places. Everywhere in Iceland the truth of this statement is borne out by the facts; but possibly the porous mass of the lava-bottom, together with the rapid current, is apt to form suitable hiding-places for the small animals which form the food of the young fish, while at the same time streams with water which is not too cold will form an attraction, when during winter there are cold snow-water and ice in the open river.

The vegetation in the Laxá is found to be very rich, showing many *confervæ* and plants of a higher order. In many places fishing becomes exceedingly difficult, because the hook or the artificial fish becomes entangled among the plants, where there are many places in which snails of various kinds, small mussels, and crustaceans can gather. I have often heard the opinion expressed that the hot springs tend to make the fish fat. This result is, of course, obtained only in a roundabout way. It is the animal life produced by the hot-spring water which furnishes rich food for the fish that makes it possible for them to become fat.

On the whole it must be said that there are spawning places at the mouth of most of the tributaries of the Laxá below Bruarfos. These tributaries are said to have much warmer water in winter than the river itself, as they come from springs in clefts between the lava underneath the meadows. The temperature of these springs is the same all the year round. I found it to be 4° Celsius. For this reason the brooks are always open in winter, and their comparatively warm water goes into the spawning places. Near the springs of one of these brooks, or at any rate somewhere along its course, fish could easily be hatched in sheltered places. To be on the safe side, however, a place should be selected at some distance from the springs, so that the water may contain sufficient air; although it is possible that these streams contain enough air, as many of them are probably nothing else but water from the Laxá, which, through the numberless fissures and clefts in the lava, flows in and out of the river. The water must be considered entirely pure. In passing

through the lava it has been filtered, and there is scarcely any mud, at any rate not in the winter.

The Laxá evidently has all the most favorable conditions for a good spawning place for salmon, and near its mouth are some falls, which do not in the least hinder the ascent of the salmon, but where they like to sport about. The salmon likes foaming waterfalls which seem to have a special attraction for it; this has at least been observed in many salmon waters. The stream of lava in ancient times formed a sort of dam across the river, and over this dam the water rushes with considerable force, forming the Laxamyri Falls. On July 23 I examined this place, accompanied by the thrifty owner, Sigurdjon Johannesson. The falls have five distinct divisions. The eastern part consists of two falls, separated by a large island. The salmon do not ascend the eastern branch, but are found in great number in the western branch. The ascent is easiest in the fourth fall, which consists of five or six natural steps. Near the top of this fall, in the western part, and extending as far as the middle of the stream, there is an apparatus for catching salmon. It consists of fences with perpendicular boards, whose land-arm is supported by five boxes formed of beams and filled with stones, while the outer or free arm has only three such supports. The two lower boxes are close by the side of each other, and to them the salmon-box is attached. This box is constructed of boards and has a triangular shape, and is furnished with an opening through which the salmon leap into the box. The ascent of the salmon is governed by the wind; if the wind is north the salmon go to the eastern, and when it is south to the western branch of the stream. The salmon therefore keep under the wind.

Some salmon are caught by means of sharp iron hooks attached to poles; these hooks are struck into the fish while it is ascending, the fisherman passing the hook through the water at random until he strikes a fish. By this method of fishing many salmon are severely wounded, and even if they are caught they lose their value somewhat as a marketable article. Occasionally salmon are caught also with nets in the deep holes below the falls after the fishermen have spied them from the rocks.

During the last few years the ascent of the salmon has begun late in the season, about June 14, and come to an end in the middle of August. Formerly the salmon began to ascend about May 25. If the salmon ascend early in the season, the fisheries close early. The ascent is easiest for the salmon during high water; that is, at the times of the new moon and the full moon. The difference of depth between the tides is 2 or 3 feet.

The annual income from the Laxamyri salmon-fisheries varies between 2,000 and 10,000 crowns [\$536 and \$2,680]. The fisheries vary a great deal in different years; thus, when I visited Laxamyri only about

4 barrels of salmon had been caught, and there was no prospect that many more would be caught during that season.

From Laxamyri I paid a visit to Benedikt Sveinsson, member of the Assembly. Accompanied by him I visited the Reyder River and its mouth, as well as the place where Mr. Sveinsson intends to start a hatchery at the mouth of a side branch of the river, which he intends to have dug. In olden times salmon are said to have gone up the Reyder River. Since I have learned more regarding those streams in Iceland which are adapted to the raising of salmon, I would not, at least for the present, recommend that any attempt be made to stock the Reyder River with young salmon. A hatching apparatus, however, might easily be constructed, from which other waters might be supplied with salmon or trout.

Sigurdjon Johannesson accompanied me when I left his hospitable and instructive farm, where I would gladly have remained several days. He went with me as far as the Myrarkvisl, a stream which, above Laxamyri, on the right bank of the Laxá, flows into it. The Myrarkvisl is said in former times to have been a good salmon river, and even now some salmon occasionally enter it. It looks to me as if in course of time the Myrarkvisl had gradually become so blocked up by stones and sand that the fish do not venture to enter it, or are actually prevented from entering it. The middle bank might be cut through, and probably also a portion of the grass-covered island which is found there; and the earth and stones which are dug out might be used for closing up the northern and the southern channels.

It can be observed that many of the Iceland streams have gradually undergone changes of current and depth by inundations, ice, landslides, and other causes, which may have had an unfavorable influence on the salmon. This circumstance should also be taken into consideration in judging of a stream which formerly contained many salmon, while now scarcely any are found. But, on the other hand, a stream may, in course of time, become better adapted to salmon. Thus, the earthquake of 1872 produced better conditions for salmon, especially for their ascent, in one of the eastern falls near Laxamyri. Thus far but little attention has been paid in Iceland to the changes which streams undergo in the course of years. The time may come, however, when in Iceland, as in countries where the streams have been constantly watched, natural defects in the rivers will be remedied artificially, and when people will cease to go on reaping the harvest of the water without ever contributing anything toward its increase.

I followed the course of the Myrakvisl to its junction with the Helgá, which comes from the warm springs near Uxahver. The temperature of the Helgá at the point where it flows into the Myrakvisl was 18° Celsius, while the temperature of the Myrakvisl was 13°, and at the point where the waters met 15° while the temperature of the atmosphere was 11½°.

From the Helgá I crossed the Reykiakvisl and traveled across the moor to Bruarfos, whence I followed the course of the Laxá along its left bank as far as Tverá, every now and then paying visits to the river till near midnight. The numerous warm springs contributed their share to give to the river the appearance of steaming, although along this entire course it is broad and flows slowly.

The following day (July 26) I examined a portion of the Laxá above Tverá. The river here is generally low, and there are several islands covered with shrubs. A few trout, weighing 3 or 4 pounds, are caught along the river; and in the deeper places mountain-trout are taken. There was a great abundance of slimy algæ, confervæ, &c. In winter the river is filled with ice, and the water during that season is very high, coming clear up to the edge of the lava bank, filling every fissure and crevice. When the water falls again a number of fish are found in the space between the water and the edge. As there is considerable fall along the entire distance, and as consequently the bottom contains but little sand and gravel, it does not seem probable that the salmon will find many suitable spawning places, which, moreover, would be exposed to many dangers on account of the ice and the rising of the water.

It is also probable that the temperature of the water in winter, even if ice forms here and there, will be so high that hatching will occur sooner than it should. At the same time it should not be forgotten that the high temperature of the water, while accelerating the hatching process, will also promote the development of the numerous small animals which form the food of the young fish. To judge from the various specimens of larvæ, small crustaceans, and snails, the lower grades of animal life are well represented, although of course the variety is not so great as in streams flowing through fertile meadows. The land through which the Iceland streams flow is generally sterile, and this circumstance is sufficient to explain the fact that there is no great variety of species, and that the number of individuals is limited. Iceland forms no exception to the old rule: that it is not enough if there is a sufficient quantity of water; the water must contain enough animal and vegetable life, without which fish cannot exist.

The Myvatn Lake has, from time immemorial, had the reputation of being Iceland's principal trout-lake, and the farmers living on its shores have always been known as expert fishermen. I cannot say that Lake Myvatn, as regards fish and fisheries, came up to my expectations. I remained on its shores five days (from July 27 to August 1), and devoted all my time to an examination of the natural conditions of this lake. As to its natural character, it may be divided in two parts, which may be termed the southern and the northern, although it should be stated that as regards the fisheries the eastern portion is the most important. The varying depth of water seems to determine the fish-life in this lake. The northern, and to some extent also the western, part is

shallow and contains but few fish, while the southern and eastern part is deeper. In this southern part I found a depth of $3\frac{1}{2}$ fathoms, and it was comparatively rich in fish. From these preliminary remarks a tolerably correct idea of the character of this lake is gained. I should state that the only kinds of fish which were observed were the trout, the mountain-trout, and a variety of the sticklebacks.

From all reports it appears that the Myvatn Lake was richer in fish in former times than it is now, but I am inclined to think that the persons who made these reports were mistaken. It is surprising to see how little the Icelanders themselves know about the natural conditions of places which they see every day; and many of these conditions are not rightly understood, simply from lack of sufficient knowledge. As a cause of the decrease in the number of fish it was mentioned that there were in the northern and western portions of the lake many small particles of clay, which were said to have become detached from the bottom through the influence of heat, and which made the water muddy and killed the fish by adhering to their gills. It is true that the water in many places was very muddy; but this was not caused by small particles of clay, but by the spores of a slimy sponge which was "bloom-ing" at the time. The mountain-trout are said to have suffered particularly; and I was informed that during the warm summer of 1880 many fish died. I was told that under these circumstances the fish came near the shore. The fish seem to prefer the east side of the lake, and the natural cause is this, that in this portion numerous little streams flow into the lake from the lava, whose water is purer and cooler than that of the lake. In winter these streams are comparatively warm, at least compared with the water of the shallow lake; and it is, therefore, natural that the fish like to spawn here. Here also they are principally caught. The fisheries are carried on with large nets or pieces of nets which are spread before indentations in the shore and also farther out.

In examining the northwestern, northeastern, and northern portions of the lake I found it on an average only 2 feet deep. In the eastern portion, where most lava blocks are found, there are large holes in the bottom 6 or 8 feet deep. In the shallow places, where the oars continually touch the bottom, it is composed of a soft, dark mud having a bad odor, and covered with a lighter grayish-yellow layer formed by the excrements of various animals. Here and there are patches of milfoil (*Achillea millefolium*), water-plantain (*Alisma*), and a few other aquatic plants. These patches of vegetation hide a rich animal life, such as the larvæ of flies, small crustaceans, and in the upper layer of mud small mussels. Gulls, ducks, and their young find a rich supply of food among these aquatic plants. As a general rule the water is tolerably clear, but in spite of this I could not discover a single fish during my trips across the waters of this lake. It is probable that the shallow, clear water, the muddy bottom, and the numerous birds keep the fish away. I was told that most of the fish caught in this part of the lake

are trout, at which I was astonished, as the mountain-trout is much more inclined to seek the bottom, because it draws the food toward itself, while the trout snatches the food when swimming rapidly. The entire northern portion of the lake is important on account of the numberless ducks found here, so that the profit gained from the sale of eggs far exceeds that obtained from the fisheries.

Besides the cold streams which flow into Lake Myvatn from the lava fields, there are some streams whose temperature is always higher than that of the air. The warm dam near Vogar had a temperature of $19\frac{1}{2}^{\circ}$ Celsius at 1 p. m. on July 28. At the same time the temperature of the water of the lake in the immediate vicinity of this dam was 15° Celsius, both at the surface and at the bottom, while the temperature of the atmosphere was also 15° . It is evident that such favorable conditions of temperature must exercise a considerable influence on the plant and animal life.

At the farm of Mr. Haldur, at Kálfastrand, I had an excellent opportunity to examine thoroughly the character of the fish of Lake Myvatn. Mr. Haldur is one of the most expert and best-informed fishermen on Lake Myvatn, and his information seems to be reliable. Near Kálfastrand the mountain-trout spawn after September 20, and it is supposed that this early spawning season is caused by the numerous springs in this southern part of Lake Myvatn. At Geiteyárstrand the spawning season begins somewhat later. In December it comes to a close, but occasionally specimens of mountain-trout, ready to spawn, have been caught in the latter half of April. I examined some of the several organs of the fish which we caught. Neither spawn nor milt seemed sufficiently developed to warrant as early a commencement of the spawning season as the end of September. The eggs were not larger than grains of mustard, and Mr. Haldur informed me that they reached the size of peas.

On the southern shore of Lake Myvatn I heard people talk a good deal about a little fish which they called *krus*. After many vain endeavors I succeeded in obtaining a piece of this fish. It is nothing but a variety of mountain-trout, but it is remarkably dark, and its head and body appear to be heavier than those of the mountain-trout. It is said to live in the fissures, crevices, and holes of the lava, and it is supposed that many of the subterranean lakes in the interior of the island are connected with Lake Myvatn. It may be that the variety of the mountain-trout which the natives called *krus* is influenced by the stay in these subterranean waters, and that from this circumstance it derives its dark color. The opinion that there is some sort of connection between the various subterranean waters of Iceland is widely spread, and on Lake Myvatn I was shown a ring which had been lost in the lake, and was found in a trout caught in a little lake near Husavik.

The fisheries on Lake Myvatn are carried on with floating-nets and stationary nets. These are 10 or 12 fathoms long and 2 feet deep (four

or five meshes). But the meshes vary in size in the different nets. The nets having the largest meshes are employed in catching male trout, because they have a thicker body, while the females are slender. The floating-nets are always heavier; they are 20 fathoms long, and in the middle 8 feet deep. Occasionally, however, some are used which are 12 feet deep.

Lakes Arnavatn and Sandvatn offer nothing of special interest to the observer; the former contains trout and mountain trout, and the latter mountain-trout alone. While the pack-horses were sent to Lundabrekr I rode with my companion to the Kráká, a considerable stream, which had every appearance of being a trout stream, although at the present time no fisheries were carried on. At Baldersheimar a farmer informed me that in former times there had been fishing in this river; but now no one seemed to care for it. Quite accidentally a trout, weighing 9 pounds when cleaned, had been taken last year on a sandbank. In the streams and ponds surrounding the lake there are small mountain-trout. Fisheries are about to be begun on this river. I was still more convinced of the correctness of my views when south of Baldersheimar I caught a young trout of this year's fry.

The conditions in Lake Svartarvatn are a feeble imitation of those in Lake Myvatn. A depression in a lava bed has to some extent called this lake into existence, and the volume of its waters has been increased by streams flowing into it from the surrounding lava beds. The kinds of fish are the same as in Lake Myvatn, but they are smaller and not so good, probably because the lake is gradually being filled with sand, which kills all animal life. The depth of this lake is slight, not exceeding 6 feet in any place.

Einar Fridericksson deserves great credit for having endeavored to improve the quality of the fish in his waters by introducing a larger breed from Lake Myvatn. For this purpose he had in November, 1883, and January, 1884, eggs of mountain-trout impregnated in Lake Myvatn, and brought the impregnated eggs to Lake Svartarvatn, where they were placed in one of the springs surrounded by stones, so that he could easily inspect them. He brought the eggs from Lake Myvatn in January. The temperature of the air was only 16° Celsius at the time the journey was made; but the eggs were packed in moss and wrapped in hay. After fifty days they were hatched.

I examined the spawning places on the shores of the lake and on the edge of the lava beds where the subterranean water gushes forth. The temperature of the water was 3½° Celsius; it never freezes in winter. For the purpose of spawning, the fish go deep into the holes and caverns under the lava beds; but owing to the drifting sand these spawning places are gradually losing much of their importance. Thus, some years ago sixty male trout were caught in a shallow place with a fish-spear in a single day. The sand will probably eventually fill the entire lake and leave only a few small streams flowing into the Svartá River.

After having passed the river Svartá, I again came to the Skjalfanda. There are some trout in this portion of its course, and the spawning trout ascend all of its tributaries. In the stream called Kalfborgara, east of Lundabrekr, trout weighing 10 pounds are occasionally found. The fisheries are carried on by constructing a dam across the mouth (first in August, and several times later in the season), so that the bed of the stream is laid dry and the fish can easily be caught. The Skjalfanda, from Lundabrekr and as far down as Storevellir, is also a good salmon stream, as there are large spawning places, especially along the eastern bank. Here the river has a comparatively quiet course, is shallow, and, moreover, many tributaries supply it with good water. There is, therefore, a possibility that the salmon will feel at home here, if they can succeed in crossing the Goda Falls.