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54.—THE ICELAND FRESH-WATER FISHERIES.*

In order to get a clearer idea of the hydrographic conditions of Iceland, it was my intention to make a trip to the Isholl Lake, whose natural conditions are said to be very peculiar. But when I learned that there was no boat on this lake, and that it is very limited in extent, I gave up this plan. At present no fisheries are carried on in this lake, for the simple reason that the inhabitants of that neighborhood have no inclination to fish. People prefer to get fresh fish from the Ofiord, which, when received there, are not in a very good condition, and which of course are not improved by being carried on horseback for a considerable distance. There are in the Isholl Lake both trout, and mountain-trout, which are said to be very good. This lake is very deep, being said to reach a depth of 30 fathoms in some places.

On August 8 I made an excursion to Hjaltöre, in order to witness the herring fisheries which were reported to have begun at that place. Upon arriving at Hjaltöre I learned that no herring had as yet been caught. I therefore crossed the fiord to visit Einar Asmundson, a member of the Iceland Assembly, at Nes. In his company I visited Sira Magnus at Laufos, and there examined some so-called *sjöreidur* which had been caught in the falls of the Fnjoská, near the place where it flows into the Ofiord. These fish were simply *birting*, that is to say, nothing but mountain-trout, which had entered the fresh water from the sea. Strange to say, no trout are caught in the falls. This is probably caused by the circumstance that the Fnjoská is not well adapted to these fish, as it is full of rocks; and nowhere could I discover suitable localities for spawning. The Fnjoská has very little vegetation. I have seen mountain-trout leap the falls just as rapidly as trout.

On August 11 I continued my journey, following the course of the Helgá, in which salmon are sometimes said to ascend. Higher up this river I found trout in great abundance. Everywhere there is the greatest quantity of fish-food.

I examined Lake Hraunsvatn as well as could be done during my short stay. It is said to be very deep; but several soundings which I took did not show a greater depth than 32 fathoms. At a depth of 23 fathoms the water had a temperature of 5° Celsius, while at the surface the temperature was 9°. The bottom has everywhere a grayish appearance, being a dark clay bottom, as in the Ljosavatn Lake. In this

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lake the mountain-trout are said to reach a weight of 8 pounds. I caught only one young fish, of a silver white color. But at the mouth of a little stream flowing into the lake I caught quite a number of fish, all of a dark color and very different in shape from fish caught in the lake.

In Lake Heradsvatn there are trout and mountain-trout; the latter are caught in nets, while the trout are caught only occasionally. Unfortunately the rain and fog prevented me from getting a good view of this lake. The Nordrá River is very rocky and has a clean bottom.

At Silfrastadir the river flows through a narrow valley, one rock rising above the other. Here and there there are small even places, and occasionally there is a small island in the river; and in some places there were large and deep holes in the rock filled with water. In some of the largest of these holes I found young fry which had been hatched this year, and also some young fish, probably hatched in 1883. Some of the sandy places in the bed of the river, which during the spawning season are under water, probably serve as spawning places. The water has a milky appearance, and the bottom, as everywhere in this neighborhood, seems to be stony.

On account of the rain I could not examine the river Svartá, which, however, does not offer any peculiar features to the observer.

At Bolstaderhlid I caught ten fish, all trout, weighing about 3 pounds each. These fish had a great many spots. They were lean, and seemed to be exceedingly voracious. Their stomachs were filled to repletion with dark vegetable matter (seeds, stems, old leaves, &c.), which probably had been swallowed, so that nothing which the current carried with it should escape a trial at digestion by these fish; an evident indication that these fish have a hard struggle for existence. I also found in the stomach and the intestinal canal, beetles, spiders, larvæ of a two-winged insect, and in one the remnants of a young trout. There are very few plants in the bed of this river, and none at all along its banks.

After having passed the Svartá and the Blandá, which near the ferry is said to contain no fish, I reached the farm Solheimar on Lake Svinavatn where I remained from August 16 to 18 waiting for better weather. This lake contains trout reaching the weight of 10 pounds. In Lake Svinavatn the *Gasterosteus pungitius* is said to be the principal food of the trout; and in the stomach of the one which I examined I found also remnants of this fish. Fishing is carried on with nets, and with lines with English steel hooks, and pieces of fish for bait. The nets are 12 fathoms long and 1 fathom deep; they are lowered by means of a stone partly sewed up in a piece of cloth. One farmer may catch from two to three thousand during the summer season, which are eaten either fresh or salted. In Lake Svinavatn the trout is of a better quality than the mountain-trout.

The river Laxá, which also receives water from Lake Svinavatn, flows

through the southern part of Lake Laxárvatn. The salmon ascend into the Laxárvatn only far enough to reach the portion of the stream between Lake Svinavatn and Lake Laxárvatn. No salmon are ever said to have been caught and no one had ever noticed that salmon spawned in the Laxárvatn, while they spawn in the stream between the two lakes and in the part of the Laxá River above the falls, below which the principal fisheries are at present carried on. The Laxárvatn has a rich vegetation, and is said also to contain a great many fish. I could not obtain any further information, and there was no boat on this lake. In 1884 but few salmon had been caught; the fish are rather small, and the river cannot be called a particularly good salmon river. There are but few spawning places, and the quantity of the water is not very great; especially below the falls there are large places where the water is very shallow, and there are but few holes. It is exceedingly easy to control the course of the fish and to catch them. On the other hand this river is very rich in fresh-water algæ, and therefore probably furnishes a good deal of food for young salmon. I could not, however, discover any young fish of the salmon kind. I caught several trout weighing about 3 pounds apiece, which were in excellent condition.

On my way to Blónduos I again visited the river Blandá. At present the salmon fisheries in this river are not very extensive, and but few were caught in 1884. Salmon-trout and mountain-trout are caught with nets and lines; near Blónduos fish-pots might be used to advantage.

As the weather became a little more favorable, on August 20 I visited the falls near the mouth of the river Blandá, where most fish are caught. I met the owner of these fisheries, Svenn Christoffersen. He and his father have carried on these fisheries since 1854. As in 1884, there have been periods (as from 1867 to 1869) when hardly any fish were caught.

Nine years ago, however, there were good fisheries, and about two hundred salmon were caught. During that same period a farmer living higher up the river also made good hauls, but at present he catches scarcely any fish. Since 1875 the salmon fisheries have not amounted to anything. Mr. Christoffersen could not tell me in what part of the Blandá the salmon spawn, and no one seems to know anything about it. The largest salmon are generally caught late in summer when the roe-bag is far from being full.

Owing to the decline of the fisheries, Mr. Christoffersen has greatly limited the number of his apparatus. He thinks that the decrease of the number of salmon is caused by the extensive digging for peat which has been carried on of late years; and that the refuse from the trading station and the noise which frequently prevails there has scared the salmon away. The severe winters from 1857 to 1865 have probably more to do with it. In 1880 the river Laxá froze down to the bottom, and the farmer living at Södarnes found many dead fish in the river. I have also made a note of the following statement: When Mr. Christoffersen was

a young man there were only two seals in the river, while now their number is considerable.

Near Hunaos I noticed near the sea about forty seals, while many more could be seen in the lake. The seals are caught with stationary nets, about 16 fathoms long and having meshes 6 inches wide. The seal fisheries begin towards the end of June, and last till the young seals leave their mothers. Shooting is not allowed here. On an average sixty seals are caught per annum, and the net income from this source is about 100 crowns [$26.80].

From Hnaussar, near the river Vatnsdalsá, I went to the river Kornsá. On my way I visited, by the advice of the Rev. Torvald Asgeirsson, who very kindly accompanied me, several places along this river. In many places there have been landslides along the banks. Near one of these an English amateur fisherman a short time ago caught with a fly a male salmon weighing 31 pounds, probably a fish left over from the preceding year. In 1871 salmon were caught to the value of 800 crowns [$214.40], but as a general rule the annual income from the salmon fisheries is from 300 to 400 crowns [$80.40 to $107.20]. At the present time these fisheries are not very remunerative. In 1883 twelve salmon were caught, and in 1884 only one. The lake in the valley is being drained, and meadows are being formed. The entire valley seems to have undergone a complete change at a comparatively recent time, and this change has possibly also caused the decrease in the number of salmon.

After having witnessed the hauling in of the nets in the Vididalsá River, where (especially near Borg) a good many salmon are caught, I staid for awhile at Vididalstunga. Some of the fish which I saw here were young fish in excellent condition. Two male salmon were also caught; the milt was large, but not loose. Here twenty salmon weighing from 8 to 17 pounds were caught in 1884; and at Bordeyri 50 *öre* [13½ cents] a pound were paid for them. Most of these salmon are caught near the mouth of the Fitjá River, below the falls, which the salmon can leap.

Following the course of the river from Vididalstunga, the Kolugil Falls were reached. These are very high, and cannot be passed by the salmon. Occasionally a few salmon and trout are found below the Kolugil Falls; and I succeeded in catching several of them, all of which seemed half starved, nothing being found in their stomachs but a few beetles. I could not discover any young fish. Both rivers form excellent spawning places near Vididalstunga; but no one seems ever to have observed spawning salmon. Páll Pállson Dæli, however, states that the spawning season is late in September and October.

Four years ago, from three hundred to four hundred salmon were caught per annum. It is supposed that the seals congregating near the place where the river flows into the sea have caused this decrease. Every now and then the salmon ascend the river before the 20th of

May, but it often happens that the best hauls are made after the 15th of August.

It is impossible to construct a salmon-way over the Kolugil Falls. A little below the falls a salmon-trap has been placed in one of the branches of the river, but no fish have been caught in it. The salmon follow the main stream, but according to the law no trap can be placed in this. There are, however, only two persons who own these fisheries up to the falls; and as they agree perfectly, this limitation of the law seems very unnecessary.

At Melstadir, which I reached on August 24, and where I met a number of people from the neighborhood, everybody seemed convinced that the seals are the principal obstacle in the way of the salmon fisheries.

In the river Vestrá the salmon can go up as high as Rjukandi; in the Nupsá River they can go only as far as Efrinupr, and in the river Austrá they keep below the Kamb Falls. In 1884 hardly any salmon were caught in this river. On the whole, the natural conditions were very much the same as in the Vididalsá.

The Hrutafjardará three years ago yielded three hundred salmon a year. In 1884 not a single salmon was caught, and in the year previous only two. This river is not well adapted to the salmon, as they can ascend it only about 1 mile from the fiord, when the Rjettar Falls stop their progress. The mouth of the river becomes more and more obstructed by sand from year to year. There are probably not many good spawning places, and the river is easily exhausted.

The Nordrá, which flows into the Hvitá, has no salmon till a short distance below Hvammer, and even here only a few are caught. It is said that it is difficult for the salmon to pass the falls. I think, however, that the salmon might find very good spawning places in the greater portion of the Nordrá, at least up to the nearest falls, below Veidilækia, where at times the salmon fisheries in the deep places are very productive.

In the Hvitá the salmon go only as far as the Kláfbs Falls. A large number go into the Tverá and its tributary, the Kjará. The Tverá is a much larger river than one is led to expect by looking at it on the map. Salmon also go into all the tributaries of the Hvitá and into the Borgarfiord. Among these tributaries containing salmon we may mention the Reikiadalsá, Flokadalsá, Grimsá, Andakilsá, Glufrá, Gufá, and Langá; but the salmon in the last-mentioned stream are small. In the Alftá, north of the Borgarfiord, there are very few salmon. Gudmundur Pálsson informed me that the Hitá is very rich in salmon; and that a good many are also caught in the Kaldá, Haffjardará, and Laxá. Some of these streams are very small, and have hardly any water; but it is probable that they would form an excellent field for observations of the salmon and the salmon fisheries. The salmon do not ascend the Hvitá

till May, and continue in this river till the end of August. Some people, however, informed me that they ascend still earlier in the season. I could not obtain any definite information as regards the spawning. It appears to me that the Icelanders have not paid much attention to the conditions of life of the salmon, which are of great importance as regards any measures for protecting the salmon and promoting the fisheries. The seals ascend the Hvitá as far as Kláffos, and have young ones there, several of which I noticed. In my judgment these falls are not an insurmountable obstacle in the way of the ascent of the salmon, but none have ever been caught above the falls; in fact, I believe no one has ever attempted to fish here. Possibly the river above the falls is too cold to afford proper spawning places.

Near Stafholtseyri and still farther up the Hvitá but few salmon were caught in 1884, nor have many been caught in the tributaries of that river. Thus, one farmer in the neighborhood caught only six in the Reikiadalsá. One salmon was caught as late as the 29th of August.

Near Nordtunga very considerable salmon fisheries are carried on. It seems that the spawning places begin here, and that the wealth of salmon in the Tverá originates here and in the Kjará. In the last-mentioned river large salmon fisheries are carried on, especially from Gilsbakka, whose inhabitants travel several days' journeys to the fishing places on the Kjará. Near Nordtunga salmon are caught early in May. In 1884 the first salmon was caught May 20. The owner of the Nordtunga farm maintained that those fish which ascend the river in May had already gone down the stream at the time of my visit (August 30). He thinks that the salmon which are found in the river in August probably spawn in October, but he has never noticed any salmon spawning. It is evident that there are spawning places near Nordtunga, and in the heaps of sand which are now lying dry we see probably former hidingplaces for salmon eggs.

Fishing is carried on with nets about 8 fathoms long and 1 fathom deep, and, like all nets used in this neighborhood, they are of exceedingly simple construction. These nets cannot carry enough, and do not follow the bottom as they should do. According to the statement of the farmer, the following number of salmon were caught during the last ten years: 1875, 300; 1876, 400; 1877, 500; 1878, 100; 1879, 30; 1880, 200; 1881, 2; 1882, 30; 1883, 14; 1884, 150.

On August 31 I rode up the Kjará River, accompanied by my guide, and took observations along the course of this stream. Near Ornolfstadir the bed of the river becomes rocky, and there are many small falls and deep holes. But it was my impression that as far as I rode (some distance beyond the Ulve Falls) there are no better spawning places than farther down near Nordtunga. I made vain attempts in different places to catch fish with flies or artificial fish, and nowhere could I discover the slightest trace of fish. My guide had no time to take me to

the upper fishing places, because every man was needed in the hay harvest.

Near Hvitávellir there are considerable salmon fisheries, which are carried on in a rational manner by the owner, Mr. Fjeldsted, who, more than most of the Icelanders who possess salmon fisheries, has given some attention to the matter. According to his idea, the salmon enter the mouth of the Hvitá as early as April. In 1884 the small salmon came first, while generally the larger ones are the first; last year the large salmon did not enter the river till July, while generally they come in May. Mr. Fjeldsted catches the largest salmon in the Grimsá, weighing on an average 30 pounds apiece. Mr. Fjeldsted has seen salmon near his farm as early as August and September. On September 6, 1882, he found salmon eggs in the Hvitá, and September 9 he found salmon eggs in the stomach of a *silungur*, which, therefore, must have eaten of eggs which had been freshly laid. In 1878 he found eggs in the spawning places on the 20th and 29th of August. During severe winters Mr. Fjeldsted has seen masses of salmon eggs, frozen together, carried away by the current underneath the ice. According to his idea, the young salmon had already left the river and gone to the sea, so that I would have no chance to see any; and true enough, in spite of all my efforts, I could not discover any. Mr. Fjeldsted has given me some general idea of his fisheries during the last seven years, and termed them, in 1878, tolerably good; 1879, poor; 1880, poor; 1881, very poor; 1882, very poor; 1883, good; and 1884, very good (900 fish).

Farther up the Hvitá and in the Tverá they use besides seines also small nets, which are set from the shore or from a little stone dam, and which are kept extended by the current. The fish going along the banks stick fast in the meshes. Most of the fish, however, which are caught in these small nets are trout. These nets are probably the model for the so-called *krognæt*, which near Hvitávellir is used for catching salmon. This net has two arms, the longer measuring 6 fathoms in length, and the shorter 2½ to 3 fathoms. The width of the meshes is 2¼ inches, and the net is 58 meshes deep. Such a net complete costs from 35 to 40 crowns [about $10]. For a weight a stone is used. This net is not set directly from the shore, but from a stone dam extending from the shore some distance into the stream. It has two openings for the current to pass through, and across these openings nets are extended to catch any fish which might possibly escape by that way. The two arms of the net form a sharp angle. When the fish push against the net they press it into this angle and are retained there. The fish are taken out of the water from a boat, the net being lifted up after the arms have been drawn in.

I heard many complaints of the seals at Hvitávellir. The large gulls also injure the salmon fisheries, as they strike the salmon in the neck when they are in shallow water. Both gulls and eagles render the sal-

mon unconscious by striking them with their beak, and then drag them on shore, where they devour them.

We crossed the river near Grimsá, where some small trout were caught, but where we did not find any salmon as we had expected; and by way of Andakill reached Grund, on the Skorradals Lake. In its western portion this lake is 12 fathoms deep, but at the other end it is said to reach a depth of 20 fathoms. It is said to be 2½ Danish [about 12 English] miles long and of considerable breadth. The mountain-trout found in this lake are called *blásilung*, and frequently some are caught weighing 9 pounds. In this lake the trout never become so large and fat as the mountain-trout. I did not succeed in catching any fish. The water of this lake is very clear, and here and there on the bottom may be seen patches of Myriophyllum. The *blásilung* is said to spawn on stony bottom during September and October.

In the river Laxá there were caught in 1884 about 260 salmon near Leirá. The fish go up as high as the Eirafos Falls. Great complaint is made of the seals, of which I noticed several hundreds. The river Laxá has an excellent fall towards the sea and forms a series of natural steps. The salmon can easily leap all the falls formed by these steps. The river has a tributary called the Baugdá, which comes from the small lake Medallfell, to which the salmon ascend, and are caught in a salmon-trap at the place where the river leaves the lake. The bottom of the river is partly lava and somewhat loose masses of rock. The salmon do not ordinarily ascend this river till about the 10th of June, but occasionally they come as early as the 25th of May. The largest number come from June 24 till July 1, and about August 20 they stop coming. In 1884 about 700 salmon were caught, but among these there were many small fish which should never have been caught. There are also many salmon-trout, but only few mountain-trout. Sira Thorkil Bjarnason, of this place, thinks that fishing is carried on to excess, and that this is probably owing to the circumstance that the fisheries have been let to Englishmen who did not know how to fish, while they paid from 800 to 900 crowns [about $225] for the summer season. Seals are not numerous in this neighborhood, as they are hunted a good deal.

Thingvalla Lake is said to cover an area of from 4 to 5 Danish square miles. Its depth in the northwestern portion is said to be 80 fathoms. In many places the bottom consists of sand and gravel, but generally it is a lava bottom with numerous fissures. Here and there it is covered by vegetation. Unfortunately the continued bad weather prevented me from making many observations. We could barely undertake a little trip in a row-boat. All the following information was furnished by Sira Jens Pállson, who takes a deep interest in the fisheries, and who may be considered entirely reliable. The natural conditions of the Thingvalla Lake (the most important lake in Iceland) are, moreover, so

well known in their general outline that it is not necessary to give a detailed description. The fish found in this lake are the following:

The trout, when it comes up the Oxará River to spawn. It reaches a weight of 22 pounds. By fishing through holes in the ice a number are caught weighing 20 pounds each. The spawning season lasts during September and October. It begins about September 15, and generally ends in November when ice begins to form. The trout does not like ice. The trout are also said to spawn in shallow places near the shores of the lake. It could not be ascertained when the young fry leave the river.

The *blekja* reaches a weight of from 1 to 7 pounds. During summer some of them go up the river. They are generally caught near the coast in shallow water. Of late years attempts have been made to catch these fish farther out, at a depth of from 20 to 30 fathoms, with lines having from 500 to 600 hooks; but these attempts have not been successful, only about ten fish having been caught. The *blekja* spawn after July 15, and the spawning season is at its height from July 20 till August 1. The spawning place is about half a mile from Thingvellir, and has a stony bottom. The spawning season is, at different places, continued far into September. The fish are fattest in spring when the ice begins to break.

The *depla* is a smaller fish, about 12 inches long, and weighing scarcely one pound. Mr. Pállson thinks that it is a small trout, while others are of the opinion that it is a separate species. These fish are caught at the southern end of the lake.

The *murta* is about 6 or 8 inches long, and looks like a young *blekja*. It is said to spawn from the middle of September till November, at the same time as the trout.

I had an opportunity at this lake to see some of these fish in single specimens. The summer *murta* is certainly only a young *blekja*, and it is therefore also called the "barren *murta*." The *blekja* which spawns in July has a red belly and whitish fins; but those which spawn in autumn have a lighter color and their fins are not white. It is probable that the *blekja* which spawns in summer comes from the deep sea. In the stomach of the *blekja* which I examined I found a great many snails, and in the trout I found many young *blekja*.

From Reikiavik I several times visited the river Ellidará and noticed its course and its tributaries, but without making a thorough examination of it. Its wealth of salmon is owing to the favorable condition of its fall, and to its bed of lava with numerous hidingplaces. The salmon found in this river and its tributaries are said to be small.

From the above it will be seen that I visited a large number of the Iceland lakes and rivers. It is true that I failed to visit some important rivers, like the Torsá and the Olufsá, and that I did not examine the Thingvalla Lake as thoroughly as I would like to have done; but my time was limited, and, even if I had had sufficient time, the unfa-

vorable weather which prevailed in the southern part of Iceland during 1884 would have seriously interfered with my observations. Investigations of this character should be continued for some length of time before definite results can be reached, and repeated visits should be paid to most of these localities, and their natural conditions should be examined more thoroughly. I felt this particularly on returning home and looking over my notes and collections. There is no doubt that another visit to Iceland, made about a month earlier than my visit and extended to some rivers and lakes which I failed to see, would serve to furnish a more reliable basis for observations. It should not be forgotten that this is the first attempt which has ever been made to describe the Iceland fresh-water fisheries. Neither Eggert Olafson, Bjarne Poulsen, nor Faber and others have given reliable and full descriptions of these fisheries, and of the natural conditions under which they are carried on. I had to begin from the very beginning, and had no previous observations that could in any way be relied on, wherefore my work must be considered as merely a first attempt.

It is quite natural that, in view of the large number and extent of the rivers and lakes of Iceland, and of the vast quantity of water contained in them, at least during part of the year, we should inquire what economical value they possess as fishing waters. It should at the same time be remembered that something more than water is needed for the life and well-being of fish, and that the weather and the character of the land surrounding the water are of the greatest importance. The weather prevailing in Iceland at certain seasons of the year proves a great hindrance to the life of fish, and the character of the country has a great influence on the number of fish in the fresh waters of Iceland.

The cold weather not only hinders the development of plants and the lower animals in the watercourses and lakes, but it also produces physical conditions which hinder and destroy the life of fish. It is an old saying in Iceland that those rivers which come from the mountains, and which have a whitish color from the inorganic matter which they carry, nevertheless contain salmon, as these fish do not seem to shun muddy water, especially if through it they can reach clear watercourses which they like. But most of the mountain streams are so cold the greater part of the year, and have so much ice, frequently just before summer sets in, that the spawning salmon and the young fry are exposed to considerable danger. The ice dams up the water and disturbs the bottom, carrying along stones and gravel and forming new channels for the water; and it may well be said that where the ice is found in large masses the fish decrease in number. If the cold weather continues for any length of time much bottom-ice forms in these waters, which, when milder weather sets in, rises from the bottom, carrying away sand and gravel and the fish eggs which may be concealed in it. This influence of the ice on the life of fish has been observed in several waters, and in Iceland this is a matter of considerable importance.

There is, moreover, a good deal of rain and snow in Iceland, and all the watercourses are therefore quickly filled with water at the time of the year when the current becomes stronger. Some of the watercourses, therefore, have an entirely different character in winter from that in summer and spring. It is also well known that when there is much rain even the smallest brook in Iceland becomes a rushing torrent which is dangerous to pass. As the mass of water rises and the swiftness of the current increases, the fish of course find it exceedingly difficult to maintain themselves in such streams. On the other hand, low water in summer will, on account of the pure and transparent water of many streams, render it difficult for the fish to hide themselves. Unless they find hidingplaces on the bottom, they will become a prey to their pursuers. Many Icelanders say that, owing to the clearness of the water in the fishing places, the salmon are spied from some projecting rock before the net is cast.

The nature of the surrounding country is at least of as much importance for the life of fish as the weather. The salmon waters of Iceland cannot expect much from the surrounding country. Vast deserts, often covered by enormous masses of snow, or consisting of nothing but stone and sand, with a very scanty vegetation, are not favorable to the development of animal life. The valleys are limited in extent, and contain but little humus or vegetation where animal life can develop. It will, therefore, also be seen that wherever the streams and lakes contain many fish there will be a good deal of grass and many bushes.

The character of the Iceland streams varies a good deal. There are some which flow gently through a flat country; and there are rushing mountain torrents, which flow rapidly from their source to the place where they empty into the sea. These latter must be considered as being very poor fish-streams. There are other streams which have a rapid current, but they have along their course calm places, with a gravel or sand bottom, and holes and depressions, where the fish can during the daytime hide in deep water. These streams are better adapted to fish as the number of these holes increases; that is to say, if they possess other conditions which are necessary for the life of fish. The Iceland streams have one advantage over the streams in the rest of Europe which contain salmon, as their bed for long distances is filled with lava, or as the stream has taken its course over lava-beds. The fissures, holes, and steps of the lava not only furnish excellent hiding-places in these clear streams, but in lava-beds springs are frequently met with whose temperature remains nearly the same all the year round. The importance of this circumstance in a country like Iceland need hardly be explained. It may be proper, however, in this place to contradict the common idea that warm springs are particularly favorable to the development of the life of fish. Warm water may accelerate the hatching process of fresh-water fish spawning in winter, but this is more harmful than helpful, because the early hatching of the salmon

eggs would expose the young fry to great danger whenever there was a thaw in the tributaries where the water is not warmed from hot springs. It is evident, however, on the other hand, that there is some truth in the old saying that fish in watercourses warmed by hot springs get fatter than fish in common watercourses, as warmth increases the lower animal life, and thereby produces more food for the fish.

I have in several places in Iceland caught fish in watercourses whose temperature was low, which had a very barren bottom, and whose surrounding country was bare of plants and animals. Under these circumstances the number of fish was small, as they were obliged to go over a large area to get their food. They were always half starved and very lean. Their stomachs contained all kinds of small animals which the wind had cast into the water, such as beetles, gnats, spiders, and flies, and also all sorts of articles carried away by the water, as pieces of wood, leaves, buds, &c. This shows plainly that, although these streams may have a great deal of water, the number of fish in them will be limited.

There is another circumstance connected with these streams which should be noticed. They vary in course of time, often to such a degree as entirely to change their character as fish-streams. The Norwegian geologist Helland and the Icelander Thorvaldur Thoroddsen have shown that those fiords into which mountain streams empty have gradually been filled by the mud and gravel which these streams carry. At the mouth of such rivers there are large masses of sand, which have gradually filled the fiords into which these streams empty, while the clear rivers empty into deep fiords with an unobstructed mouth. The Héradvatn has heaped up large masses of sand at the bottom of the Skagafiord; the same applies to the Blandá; and the Hvitá has carried so much mud and sand into the Borgarfiord that, according to Thoroddsen's statement, small boats cannot enter when the tide is out. But the salmon must have a free current and fresh water in the mouth of the river which it visits; and wherever it finds sand-drifts, mud, &c., it will keep away. It is evident that these circumstances, in rivers like the Blandá, decrease the number of salmon. This is certainly more likely to be the reason for this decrease than the casting of peat ashes into the water, the digging of peat, or noise.

The Iceland lakes are of considerable importance to the fresh-water fisheries of this country, as they contain a vast number of trout and mountain-trout, which form the object of fisheries, but not to such an extent as might be desired. In some places the farmers go up on the high plateaus to fish in the numerous lakes, and bring home a large quantity of dried, salted, or fresh trout. It is a fact that the life of fish in these, as in nearly all the fresh waters of Iceland, is dependent on the enormous masses of gnats and flies found near them. The mountain-trout, especially, lives on these insects and roots in the bottom, which is filled with the larvæ of flies. I have examined several fish

from these lakes, and have always found the stomach of the mountain-trout full of insect larvæ, while the stomach of trout contained snails and some young fish, generally the young of the mountain-trout.

The Iceland lakes which I visited greatly resemble each other, and, properly speaking, there are only three which are distinguished from the others, namely, the Myvatn, the Svartárvatn, and the Thingvalla. These three lakes have much in common, particularly the circumstance that subterranean springs will furnish all the year round a supply of evenly warm water, and the many fissures and holes which serve as hidingplaces for the fish, and to a certain extent make up for the lack of vegetation.

But the lakes have another advantage. I do not refer to the saying so common in Iceland, that all watercourses which spring from lakes containing fish will have fish, because I am inclined to the opinion that the fish rather come from the rivers into the lakes. Some small lakes, however, are of importance to the salmon rivers to which they belong, if the salmon can get up into them or pass them. These lakes furnish a safe place of sojourn for the salmon which during the course of the summer have gone up into fresh water. The remarkably clear water of the streams, their low water at certain season of the year, and the ease with which fishing can be carried on in them, are very dangerous to the salmon when about to spawn and propagate its species. If the salmon can hide in a lake while its sexual organs are approaching maturity, there will be all the more prospect that it will spawn. Such a lake need not be particularly large, and in Iceland a widening of the stream or an inaccessible canyon between the rocks will yield good results, which will be still further improved if the bottom contains lava. It will be found that some of the best salmon waters of Iceland show these conditions; as, the Laxá in the Tingöre district, the Laxá near Hunafliot, the Laxá near Kjos, and the Laxá (Ellidará) near Reikiavik. It is not by accident that these rivers have got the name "Laxá"—salmon-river. The chief fish of economic value found in the fresh waters of Iceland are the salmon, the trout, and the mountain-trout. There is also a variety of the eel which is peculiar to Iceland. Of other fresh-water fish, I might mention the *Gasterosteus aculeatus*, which, however, is of but little importance.

Both the mountain-trout and the trout are indigenous in the fresh waters of Iceland, and do not leave them—that is, there are tribes of these fish which always remain in the water where they have been hatched and have grown to maturity. But besides these there are tribes, both of trout and mountain-trout, which for a time stay in the sea, and which go into fresh water only to spawn. It is difficult to ascertain how far out to sea they go, but near the Ofiord I have observed all the varieties of the trout and one variety of the mountain-trout, either in the fiord or going up into the streams. I have observed the same in the Southland, and it is nothing strange to see the mountain-

trout go from the seas which surround Iceland up into fresh water, as has been seen on the coasts of Norway, Finland, and Spitzbergen.

It is well known that the salmon go into fresh water solely for the purpose of spawning. For this purpose they come as early as April, and continue to ascend the streams till August. We do not, however, possess any absolutely reliable information in this regard, and it must be presumed that the ascent of the salmon in the Iceland waters is very much influenced by the weather. Not much is known as regards the spawning season, but it scarcely comes before October, although, as has been said above, salmon eggs have been observed in the Hvitá in September. It is possible that there is some mistake about this, as probably also with regard to the statement that spawning salmon have been noticed in the mouth of the river. It must be supposed that the salmon eggs found in the mouth of the river, if they really were salmon eggs, were dead eggs, which by floods or in some other way had been carried away from the spawning places. The common people in Norway also frequently cite the presence of eggs in such places in proof of the assertion that the spawning places of the salmon are at the mouth of the river, or even on the shore; but A. Landmark [the Norwegian inspector of fisheries] states distinctly that such eggs are always dead.

It is very difficult to obtain any information regarding the spawning season of the fish in the various Iceland waters, because very few Icelanders have much knowledge of the life of fish, or have any idea of the importance of such knowledge; and from the same causes it is of course still more difficult to find out how long the young salmon stay in fresh water before they go to the sea. It is of no little importance to obtain some light on this subject, for if the young salmon stay in the rivers for a considerable length of time before they go to sea, they are exposed to the numerous dangers of the Iceland rivers. In Scotland, owing to the favorable conditions of food, salmon develop in from 14 to 25 months. Landmark thinks that in Norway it takes 12 months longer than in Scotland; and that hardly any young salmon in its silvery traveling dress, which the English call "smolt," goes into the sea before it is two years old or more. I do not put much faith in the various statements regarding this subject which I have heard in Iceland, as I have not met a single Icelander who showed any familiarity with this subject. Thus I have been told that English amateur fishermen have from time to time caught smolts, which, according to English custom, they again threw into the water. But it struck me as very strange that among the thousands of fish which passed through my hands in 1884, I only once found a young salmon (near Laxamyri), and this fish was still in its trout stage. It might be supposed that the young salmon of the Iceland streams went to sea at an early age, owing to the lack of food and the unfavorable natural conditions.

The apparatus which the Icelanders use in the fresh-water fisheries are not of a nature to endanger or exhaust the fisheries, and it certainly

cannot be maintained that the decline of the salmon fisheries is caused by the apparatus. All the nets are either incomplete or so poorly made that they barely answer the purpose. The stationary nets are, as a rule, too small, and the seines do not float well in the water. The materials (hemp, wool, wood, and bone) do not at all answer the requirements of modern fishing apparatus. I will only mention, as an illustration, that the bones which are used as sinkers scare away fish that are as shy as the salmon is known to be, by their white color. The salmon-traps near Laxamyri and Ellidará do not deserve any special notice. It is a great mistake, however, that salmon are frequently caught in Iceland with hooks by beating the water at hap-hazard, as these hooks enter deep into the body of the salmon and entirely spoil its appearance and value.

As the salmon fisheries are at present carried on in Iceland, there is no danger that the salmon will be exterminated. But many Icelanders cannot see a salmon within their reach without killing it. They have no idea of leaving the fish in peace during the spawning season; and although there are laws on the subject, many Icelanders pay little attention to such regulations. The apparatus are frequently left in the water so long that they are in danger of being lost. In spite of the many complaints of the decline of the salmon fisheries, the Icelanders, who in many other respects have to rely on their own resources, have no idea that much could be done to improve matters. In olden times, when the salmon were not an article of trade but only an article of food for home consumption, there was some meaning in the regulation that the salmon should be allowed to go into any man's waters. At the present time the alternative is, either to let the entire country enjoy an economical advantage by increasing the value of the different waters, or to let each Icelander have a salmon in his own pot. This may be pleasant enough, but a wise economy would prefer to increase the value of all the waters.

Some choice has also to be made between the salmon fisheries and the seal fisheries, if the former are to be preserved and developed. Here likewise we are confronted by an old saying which is quite common in Iceland, namely, that everything is good as it has been handed down from olden times. This may have been true enough until the exportation of salmon assumed larger proportions; and it may still apply to the seal fisheries, but certainly not to the salmon fisheries. If the Iceland salmon fisheries are to be preserved and developed, the seals should be hunted at all times and in every possible way. The seals destroy a large quantity of salmon. They eat nearly all fish, but they prefer salmon, for the same reason that we like salmon if we can get it. Seals may, therefore, be observed at the mouths of all salmon rivers, and if they chase them up the rivers, they have certainly previously decimated them. A simple sum will illustrate this, and, to understand it, it should be remembered that it is a natural necessity for the salmon to go up the rivers. Let us suppose that a man every year

kills 100 seals, and that he gets 10 crowns [$2.68] for each—a price which, however, he will rarely get in Iceland. This yields him a net income of 1,000 crowns [$268]. I will further suppose that these seals have lived 4 months (120 days) near the mouth of some river, and that every day each seal has devoured 5 pounds of salmon. They would, therefore, have destroyed 60,000 pounds of salmon, to the value of about 20,000 crowns [$5,360], at a low calculation. It is easy to draw the moral from the above.

It is not easy to say what income the Iceland salmon fisheries yield at the present time; or, at least, I am not in possession of the necessary data. It is said that about 500 tons of salt salmon are exported every year. This is certainly not much, but in time this quantity might be increased, and the salmon fisheries would certainly yield better results if the salmon were properly treated. This should be the aim of all progressive fishermen in Iceland. Among other things I would recommend packing in ice, slighter salting, and smoking. The question of packing salmon in ice is at present discussed in Iceland, but no definite conclusion has as yet been reached. At present the Icelanders salt their salmon too much, and most fish dealers would prefer salmon which is not salted so much, as salmon salted in this manner are not so valuable as an article of trade. Hence, it would be worth while to try a better method of salting.

One difficulty, however, will always have to be contended with in Iceland: the fishing places are generally at a considerable distance from each other and from the trading stations. Transportation becomes expensive and difficult if the fish (as should always be done) are salted or packed in ice immediately after they are caught.

The seal fisheries should be free to every one, so that the greatest possible number of seals would be destroyed. As both the trout and the mountain-trout are dangerous enemies of the eggs and the young of the salmon, they should not be protected. The trout fisheries should therefore be free, except in the spawning places of the salmon, from September till May 1. The people living along the salmon streams would therefore not have to forego the pleasure of eating fresh fish.

The deep Thingvalla Lake, which contains a great many fish, is a lake where salmon might be introduced with advantage. It is well known that in some inland lakes there is a variety of the salmon which never goes to the sea, and of all the Iceland lakes the Thingvalla Lake is the one particularly adapted to this kind of salmon. For this reason about 3,000 nearly-hatched salmon eggs were, during the winter of 1884–'85, brought to Thingvellir, where they are further developed, and the young that are hatched will be placed in the Oxará. It is the intention to place several thousand young salmon in the Thingvalla Lake every year, and thus to provide this lake with a good stock of this fish.

There is but little occasion to make experiments in introducing finer kinds of fish. The few kinds of fish found in Iceland are all of such excellent quality that it would hardly pay to introduce others.