62.—MEMORIAL ADDRESSED TO THE BUREAU OF AGRICULTURE OF THE IMPERIAL SENATE FOR FINLAND, JANUARY 20, 1883, IN REGARD TO THE ADVISABILITY OF INTRODUCING ARTIFICIAL FISH-CULTURE IN FINLAND.*

By PROF. A. J. MALMGREN.

After having visited, in September last, the piscicultural establishment of Nikolsk, in the Government of Nowgorod, in compliance with a written request of the bureau of agriculture of the imperial senate, dated June 15, 1882, I now take the liberty, in obedience to one of the instructions therein contained, to report on my journey and the observations made during the same, giving at the same time my opinion as to the advisability of introducing artificial fish-culture in Finland, and more especially as to the practicability of employing the system adopted at Nikolsk.

After having been furnished with a letter of introduction from Baron E. af Forselles, then vice-governor-general, to the various authorities of the empire with whom I would come in contact, I started for St. Petersburg on the 10th of September, accompanied by the inspector of the depot at Hyvinge, captain in the guards Fr. Häyrén, who was to act as my interpreter. Soon after my arrival at St. Petersburg I was furnished with another letter of recommendation, principally through the kindness of Mr. E. Streng, first secretary in the imperial ministry of Domains, to the director of the piscicultural establishment at Nikolsk. On the following day I left St. Petersburg by the Nikolajew Railway, traveling about 250 wersts [167 miles], as far as the station of Waldaika, and on the next day 78 wersts [52 miles], by stage-coach to Nikolsk, which is about 40 wersts [27 miles] distant from Waldai, the capital of that district. Here we staid 24 hours with the amiable director of the establishment, Dr. O. Grimm, professor at the Academy of Forestry in St. Petersburg, who had spent his summer vacation here with his family, and lived in a house belonging to the establishment and located between the fish-ponds.

The founder of this establishment is Wladimir Pawlowitsch Wrasky, a man of noble ancestry, whose mother is said to have been a Tolstoi. Whilst pursuing his studies at the University of Dorpat, where he obtained the degree of "Candidate," he read the works of Coste and other authors on artificial fish-culture, which awakened such a lively interest in him for this new industry, which was then but little known and had hardly been put to a practical test, as to determine him to devote him-

*"*An die Ackerbau-Expedition im kaiserlichen Senat für Finnland von dem Inspector der Fischereien den 20 Januar abgegebene Gutachten, in wiefern es geeignet wäre in Finnland künstliche Fischzucht einzuführen.*" Helsingfors, 1883. Translated from the German by HERMAN JACOBSON.

NOTE.—Professor Malmgren is the inspector of fisheries in Finland.—C. W. S.

self entirely to fish-culture. After having made himself acquainted—both by experiments of his own and by journeys in foreign countries—with the methods then applied to artificial fish-culture, he commenced during the years 1855–1856 to establish on his family estate a pisciculturaI institution after the model of the one at Hüningen, in Alsace. The location selected by him was the lower portion of a valley between Lake Pestow and Lake Welje, into which a small stream flows. Here he made 13 large and small ponds, or basins, according to the directions of Sudakewitsch, which involved a very considerable expense. At the time of our visit, however, only six large ponds seemed to be occupied. These ponds are connected with each other, and with the stream referred to, by means of sluices and subterranean channels, so that they can be filled or emptied as occasion requires. The hatching-house, built solidly and furnished in the most lavish manner, is of such vast dimensions that several millions of fish-eggs can be hatched at one and the same time. This hatching-house shows, even more than the large ponds (all of which had to be dug out), how firmly the founder of the establishment was convinced of the profitableness of the undertaking. This conviction prompted him to shun no expense to make his establishment a model one, arranged according to a plan of his own, and furnished with all the mechanical appliances then known.

After Wrasky had sunk all his property in this undertaking, he formed an association, which expended its entire capital of 41,000 roubles [about $28,700] in maintaining and developing the establishment. Although this association received a subsidy of 30,000 roubles [about $21,000] from the Government, it soon became financially embarrassed, and owing to this circumstance the Government took possession of the establishment. This took place in 1868. Wrasky had meanwhile become poor, and the association bankrupt. It has never been known with absolute certainty what it cost to start the piscicultural establishment of Nikolsk; Sudakewitsch says in his report that it was upwards of 100,000 roubles [about $70,000], whilst Professor Grimm estimates it at 200,000 roubles [about $140,000]. I could not learn what are the present expenses of keeping up the establishment, but Professor Grimm told me that there was an annual appropriation for it, amounting to 3,000 roubles [about $2,100], of which 2,400 roubles [about $1,680] was his fixed salary.

The hatching-house, the most important part of the establishment, consists of one very large room with four heating apparatuses, and several small rooms which are used by the director as a laboratory and for various other purposes. It is located immediately below the largest pond, and is furnished with many pipes, which uninterruptedly supply all the water needed in this establishment. Along the middle of the large rooms there extends a deep and spacious basin laid in brick, which, if necessary, can be divided into several small basins, so that the fish can be kept separate during the process of hatching. The in

pregnated eggs are hatched on eight large hatching-frames resting on a walled foundation of so-called Putiloff stones, arranged on both sides in double rows. According to Professor Grimm's opinion they are sufficient to receive at one and the same time 5 million eggs of the *Coregonus*,* or 2 million trout-eggs. Besides these expensive hatching-frames another peculiarity deserves attention, viz, the fact that the impregnated eggs, for the purpose of developing, are placed on square porcelain plates, having a surface of about 4 square inches, with a low edge, bent upwards; and that these plates are placed close to each other on the bottom of the hatching-frames, where an uninterrupted stream of water is caused to flow over them. Although this method (to cause water to flow over the eggs) is said to have produced excellent results, it must be considered as antiquated, after cheaper methods, saving both space and water, have been invented in America and have been introduced very extensively not only in that country but also in Europe. The hatching-house of Nikolsk is under the care of a superintendent and assistants, who live in the establishment.

The Nikolsk ponds are used partly for keeping and raising the breeding fish, trout and *Coregonus*, partly for raising sterlet, and several other less valuable kinds of fish. A special superintendent had charge of these ponds and attended to the feeding of the fish kept in them. He likewise was furnished with a house by the establishment.

As the kinds of fish which are raised in Nikolsk (the *Coregonus* and the trout) are not found there, it became necessary to get the first fish from St. Petersburg, a distance of about 350 wersts [233 miles]. The trout which are now in the ponds belonging to the Nikolsk establishment came from streams near Gatschina (Sudakewitsch) and the *Coregonus* from fish-tanks in St. Petersburg. It is true that trout have been found at Jaschelbitsch, distant about 35 wersts [23 miles], but only quite recently they have been used, to a limited extent, for the purpose of obtaining spawn. This circumstance, *i. e.*, the lack of spawning fish in the immediate neighborhood and the isolated location of the establishment, as well as the insufficient means of communication, have of course restricted its work in more ways than one. The largest number of eggs which have been in the establishment at the same time is 300,000; but generally it is much smaller, hardly 100,000. The entire number of trout and *Coregonus* eggs which have been raised here in the course of ten years seems not to have been more than what is raised in some of the larger piscicultural establishments in Germany in one year. The annual production of young fry in some of the salmon-hatching establishments which formerly existed in Finland was at least as great if not greater than that of the Nikolsk establishment; at least, judging from the statistics furnished by Professor Grimm. Thus there were in 1861 deposited in the hatch-

* *Coregonus maræna* Bloch. *Marän* in the original, here and throughout the paper. For facts regarding the habitat and culture of this species see Report of Prof. S. F. Baird, Commissioner, for 1876-'77, pp. *39, *40.—C. W. S.

ing-boxes of the salmon-hatching establishment near Kexholm, in Finland, about 300,000 eggs, from which there were raised more than 200,000 young fish, which were placed in the Wuoksen River; and in the Kymmene establishment [also in Finland] there were often raised about 100,000 young salmon per annum. Professor Grimm has, therefore, seen fit to establish a branch of the Nikolsk establishment in the building of the Imperial Museum of Agriculture in St. Petersburg, where the hatching of *Coregonus* and salmon eggs is carried on upon a larger or at least just as large a scale as in Nikolsk, but with more modern apparatus and at far less expense.

As regards the other work of the Nikolsk establishment, and the rerults obtained by it, I take the liberty to refer my readers to two reports published in a Russian journal* by Professor Grimm, the one embracing the period 1869–1880, and the other the year 1881. One need not be a specialist to learn from these reports that the Nikolsk establishment, as a financial enterprise, or judged according to its usefulness to the Government, is and always will remain a failure. Although, judged from a technical point of view, the establishment is a model one, and the judicious management of Professor Grimm leaves nothing to be desired, its financial or economical results are either none at all or utterly insignificant when compared with the size of the establishment and the amount of money required even now for its support. The few hundred trout and *Coregonus* which are at present carefully tended in the Nikolsk ponds, and which, according to Professor Grimm's report, are the only visible result of the 25 years of the existence of this establishment, would, if brought into the market, even in St. Petersburg, not realize the sum required to support the establishment for a single year. Fishing in Lake Pestow, which belongs to the establishment, has not increased, in spite of the most zealous attempts to raise fish in that lake. In 1872 more fish were caught in that lake than during any of the succeeding years, even more than 1881, which was considered a good fish year. Very few *Coregonus* and still fewer trout are found in the lake, although since Wrasky's time every year a large number of young fish of both kinds have been placed in it. It appears from Professor Grimm's report that in 1870 there were caught in Lake Pestow, in all, 71 *Coregonus* and 6 trout, and 1873 only 4 *Coregonus* and no trout. The transplanting of fish, which is done here in the same manner as in Finland, by transferring mature spawning fish from Lake Welje to Lake Pestow, has been productive of better results. Thus the little märäne (*Coregonus albula*), which was transferred to Lake Pestow in 1872, has become entirely acclimatized, although even now it does not occur in any very considerable number; and the smelt, of which a large number of matured specimens were placed in Lake Pestow in 1872, have increased to such an extent that annually 150 to 200 pud [5,400 to 7,200 pounds] of these fish are caught. The number of trout, however, seems

* *Sel. Khoz. Ilys.* St. Petersburg, 1881 and 1882, Vols. XXXVI–XXXIX.

to have decreased, as the smelt have increased. The yield of fish of the Pestow Lake is the same as it was in former times, which proves that no sheet of water can produce more fish than is determined by its quantity of suitable fish-food.

As a correction of and addition to Professor Grimm's report respecting the persevering attempts, to transfer the *Coregonus* to the river Wolga, by transferring young *Coregonus* from Nikolsk to Lake Seliger, which is connected with the Wolga, I take the liberty to state, as I have been informed by Professor Grimm, that no *Coregonus* whatever are found in Lake Seliger, and that, so far at least, they have not been acclimatized in the Wolga. It seems to be certain that the Wolga *Coregonus* mentioned by Wassiltschikoff as found in the neighborhood of Nischnij Nowgorod, are no *Coregonus* but grayling. As regards the results of the transfer from Nikolsk of young fish and impregnated eggs of *Coregonus* and trout, which has been made every year since 1870, Professor Grimm could not give me any further information than that a trout-hatching establishment near Moscow, which got its fish from Nikolsk, had been reasonably successful, and that the experiment of stocking a small pond near St. Petersburg with young trout, made by an employé of the Museum of Agriculture and a farmer of the neighborhood, yielded a few hundred roubles the first year after the fish had been placed in said pond, but that during the following year the experiment proved an entire failure. It is probable that the trout-food in this pond had been used up during the first year, and that, as usual, it was difficult to renew it.

Professor Grimm informed me that he had made an interesting experiment with sterlet, which I feel it my duty to communicate here. During the years 1869–1871, 120 young sterlet had been brought to Nikolsk and placed partly in Lake Pestow and partly in the ponds belonging to the establishment. These fish grew and flourished till they had reached their natural size, but they never spawned, and none of them had either roe or milt during all the time they were at Nikolsk. The observation is said to have been made in Russia, especially in some convents, that this fish is not capable of propagation in lakes or ponds or in stagnant water. The sterlet is a genuine river-fish, which only propagates its species in rapidly flowing water. It spawns in spring, after the water in the rivers and streams begins to fall, and its eggs, which adhere to stones and other objects, are said to develop in an incredible short time, viz, four days. It seems, therefore, that it is exceedingly difficult to transplant this fish by means of the transferring of impregnated eggs. It is said, on the other hand, that young sterlets can easily be transported a considerable distance; they can be bought at a reasonable price at Samara from Messrs. Mjäsniskoff and Tischinskij (see the "*Golos*," No. 311, November 15, 1882). In view of the high price of these fish Professor Grimm intends to devote himself, in future more than heretofore, to the raising of sterlets in the Nikolsk ponds, because,

owing to the great expense of transportation from Nikolsk to St. Petersburg and Moscow, the raising of other kinds of fish does not offer any great inducement. As early as during the reigns of Frederick I and Frederick the Great, sterlets were introduced in Prussia and placed in several lakes, where, however, they did not propagate. The same will doubtless be the case with those sterlets which the Duke of Sutherland some time ago transferred to a lake in Scotland.

As regards the mission of the Nikolsk establishment to serve as a school of fish culture, it has not been carried out in any degree worth speaking of, because, on account of its out-of-the-way location, the establishment is but rarely visited, and has, in fact, until quite recently hardly been known.

As regards fish-culture in Russia in general I gathered the following data: According to Sudakewitsch, Dr. J. Knoch had, as far back as 1857, commenced to raise carp in some ponds on the estate of Strelna, belonging to the Grand Duke Konstantin Nikolajewitsch; and somewhat later the same doctor is said to have founded a piscicultural establishment on an estate belonging to the Grand Duke Nikolai Nikolajewitsch, but with what result I could not learn. Several scientists have also occupied themselves with the artificial hatching of fish-eggs, but they did this exclusively for scientific purposes and for studying the early development of the different kinds of sturgeons, especially the sterlets. During the last few years Mr. K. Muschinsky, a banker, has hatched *Coregonus* and trout eggs in his house in St. Petersburg, No. 54 Newski Prospect, and has had the young fry transported to his estate in Poland. Among those persons in Russia who have begun to take a lively interest in fish-culture, since the Berlin Exposition of 1880, Chamberlain and Counsellor of State W. von Greig occupies the most prominent place. At Weessen, one of his estates in Courland, he has founded an extensive and model piscicultural establishment, with large ponds, aqueducts, and cascades. According to the report of the German Professor Benecke, sterlets and carp had been raised there as early as 1881; the young fry of the latter fish had been brought from Germany; they also raise there brook and lake trout and *Coregonus*. When Professor Benecke visited the establishment it was not yet finished, but there was every prospect of its completion within a short time. After the model of the aristocratic German Fishery Association in Berlin, of which the German Crown Prince is the patron, and Chamberlain von Behr, of Schmoldow, has been director for the last 7 or 8 years, there was founded last year at St. Petersburg the "Russian Association for the furtherance of the Fishing Industry and Fish Culture." This association is patronized by Grand Duke Lergej Alexandrowitsch; Chamberlain W. von Greig is its president, and Prof. O. Grimm its secretary. The first work of this association will probably be to draw up suitable fishery regulations for Russia. According to Professor Grimm there are in Russia proper no laws whatever to regulate the fisheries, whilst there are some, though of comparatively ancient date, in the Baltic provinces.

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Before passing an opinion as to the advisability of introducing artificial fish-culture in Finland I deem it proper to give a brief review of the present condition of fish-culture in several foreign countries; more especially because the experiences made at Nikolsk during the last 25 years would by no means be considered as encouraging to those who wish to introduce fish-culture in their own country. This applies, however, only if one desires to make fish-culture financially profitable, and does not consider it merely as a pleasant pastime, or as an opportunity for making interesting experiments.

FRANCE.

I begin with France because the impetus for the more general introduction of artificial fish-culture came from that country during the first years of the reign of Napoleon III. Prof. Emile Blanchard, member of the Institute in his work, published in 1866, *Les Poissons des eaux douces de la France*, has given, pp. 571–697, a review of the history of fish-culture in France during the present century, and pp. 610–623, an interesting and instructive *résumé* of the necessary conditions for the well-being and increase of fish, both of which articles appeared in a Swedish translation in 1869, in my "Journal for Fisheries and Aquiculture". I inclose a number of this journal, and take the liberty to direct attention to the two articles in question, p. 33 and p. 74, with the remark that, according to M. J. Clave, *Revue des deux Mondes*, January, 1868, p. 146, the large piscicultural establishment at Hüningen, in Alsace, which, up to the year 1862 had cost the Government about 600,000 francs [$120,000], and where, from 1855–1862, about 30 million eggs of fish belonging to the salmon family had been hatched, had increased the stock of fish in the Seine, Loire, Garonne, and the Rhine only by a few trout and other salmonoids. The interest in artificial fish-hatching which sprang up very suddenly in France, and which soon became very general, diminished in the same degree as the exaggerated expectations regarding it proved vain, and when the Empire fell it had almost died out entirely.

GERMANY.

That branch of industry which the Germans term "pond-culture," which mainly employs itself in the raising, in ponds, of carp and recently also of trout, is of very ancient date. But not till after Alsace had been annexed to Germany, and the French establishment at Hüningen had become the property of the German Government, and Germany had become an empire, did an interest in fish-culture begin to be awakened in Government circles. In Berlin the German Fishery Association was formed under the patronage of the Crown Prince of Germany. As

regards its activity, it must be said that the history of this association is the history of artificial fish-culture in Germany during the last ten years. At the instance and by the aid of the German Fishery Association, the great majority of whose members are high officials, members of the aristocracy, and wealthy landed proprietors, there sprang up, within a short time, many private piscicultural establishments great and small, in different parts of the empire, whose main object was to produce young fish in an artificial way, and by placing them in open waters to stock these anew with fish, and thus to furnish an additional supply of cheap and wholesome food for the large population of the empire. The object was, therefore, altogether the same as that which the Imperial Government of France had in view twenty years earlier. Some idea may be obtained of the extent of the activity of this association when we state that in the year 1880–1881, more than 6,000,000 impregnated fish-eggs, 1,800,000 salmon-eggs, and 2,600,000 eggs of the *Coregonus* were hatched in the establishments of the association. In the following year the number of eggs hatched was 4,000,000, among them 1,270,000 salmon-eggs. The largest and most famous piscicultural establishments in Germany, which sell, at fixed prices, young fry and impregnated eggs, mostly of the salmon and *maräne*, are: the well-known Government establishment at Huningen, in Alsace, under the superintendence of Director Haack; Radolfzell, on the Lake of Constance, and Selzenhof, near Freiburgh, in Baden, both belonging to Mayor Schuster; Lübbinchen, near Guben, belonging to Mr. R. Eckardt, and Berneuchen, belonging to Mr. Max von dem Borne. The above-mentioned gentlemen are at the same time the most famous and most experienced pisciculturists of Germany. During the last five years the German Fishery Association has endeavored to acclimatize various American fish. The beginning was made with the shad (*Alosa præstabilis* DeKay) which is found in very large numbers in the American rivers. This fish in its looks and habits resembles the German may-fish, and the "Wolga herring" (*Clupia caspia* Eich.), which ascends the river Volga from the Caspian Sea in enormous numbers. The attempt to acclimatize it in Germany, however, did not prove successful. At the same time attempts were made to acclimatize in the Danube the California salmon (*Salmo quinnat*, Rich). The attempt to keep these fish alive in some ponds proved successful, but their transfer to the Danube, although made on a large scale, has not been accompanied by any favorable result, nor are the prospects for the future very promising; for it is well known that all attempts made in America to introduce this salmon in the rivers on the Atlantic coast, have proved failures, although the placing of the young fry in the rivers was done under the superintendence of highly experienced and persevering pisciculturists. There have also been introduced in Germany impregnated eggs of the following kinds of American fish: the American fresh-water salmon (landlocked salmon), *Salmo fontinalis* (a kind of saibling), and *Salmo irideus*, as well as a kind of American *Coregonus* (*Coregonus al-*

bus). Young fish have been raised from these eggs, and are carefully nursed in ponds. As all kinds of salmon are voracious fish of prey, and as the above-mentioned American salmon are no better in this respect than those of Germany, the economical result of these experiments, even if successful, which so far cannot be said of any of them, cannot be considered as very great.

As regards the results of the placing in open waters of the young fry of salmon and of other fish of this kind, as well as of *Coregonus*, there are, with the exception of a few trout brooks of which it can be proved that after the placing in them of young fry there was a temporary increase of trout, no data to show that the number of fish have actually increased in the waters stocked. The salmon fisheries in the Weser and the Elbe seem to have improved somewhat; but this may easily be explained by the fact that in Germany, since 1874, the salmon is strictly protected during the spawning season. It is true that Max von dem Borne has spoken of numerous successes, but his assertions have frequently been clothed in very indefinite terms, and are often emphatically contradicted by other authors, and are consequently open to severe criticism. This applies, for instance, to his statement that the number of salmon in the Rhine and in the Oder had increased considerably after they had begun to place annually large quantities of young salmon fry in these rivers and their tributaries. As regards the Rhine he bases his assertion principally on some data relative to the quantities of salmon brought to the market of the Kralingsche Veer in Holland during the years 1870–1880, communicated by firm of Ten Houten & De Raadt. It is said that the number of salmon received at the above place was 21,687 in 1870, and 41,736 in 1880. It should be observed, however, (1), that the nummer of salmon was largest in 1873 and 1874, when the association began its activity, viz, 58,384 and 77,070 respectively, and that it gradually decreased to 38,914 in 1879, and to 41, 736 in 1880; (2), that the supply of one kind of fish in a market, which is not the only one where such fish are sold, depends on so many different circumstances, that an increase or decrease of this supply cannot, even with any degree of probability, be considered as an indication of the greater or less success of the fisheries. It must also be taken into consideration that all along the upper Rhine, especially in the neighborhood of Basle, there are heard numerous and loud complaints that the salmon fisheries in this part of the Rhine have decreased. As regards the lower Rhine, similar complaints have been published in the journals, for instance from the neighborhood of Wesel. In the *Deutsche Fischerei-Zeitung*, No. 28, 1881, p. 230, L. Prenger & Son say in a letter from Wesel, with regard to the salmon fisheries in the Rhine: "People both on the Upper and Lower Rhine complain in the most piteous manner of the poor fisheries;" and in the same journal, No. 42, 1882, October 17, p. 336, it says literally in a communication from Basle: "The result of the salmon fisheries at our fishing-stations during the last four years is not more than 10 per cent. of the results

of the years 1875–1878, and at most of these stations not enough is made to pay two fishermen, as the income from the fisheries barely suffices to pay for the nets." Jacob Glöckner also states, in an article entitled *Vom Rheine* [From the Rhine], published in No. 9, 1882, of the same journal, that the number of fish in the Rhine was much larger twenty to thirty years ago. It is said that for the last fourteen years a large number of young salmon have annually been placed in different parts of the river Oder; nevertheless the editor of the *Deutsche Fischerei-Zeitung* says in No. 41, 1882, p. 330 of that journal, that no increase in the yield of the salmon fisheries can be noticed. It cannot therefore be decided with absolute certainty whether the artificial hatching of salmon has really proved a success in these rivers, as is maintained by the zealous member of the German Fishery Association Max von dem Borne. It is also very remarkable that the German Government, which heretofore had specially favored every enterprise of the German Fishery Association, and which had lent strong material aid to the great international Fishery Exposition inaugurated by the association in 1880, absolutely refused any Government aid to the representation of Germany at the International Fishery Exposition which in the present year is to be held in London, in consequence of which refusal the association has been obliged to give up all idea of being represented at the London Exposition.

The association has recently addressed a petition for aid to the German Parliament, but the finance committee of that body is said to have refused to grant this petition.

AUSTRIA.

Recently several private piscicultural establishments, on the German model, have been founded in different parts of the Austrian Empire, and the young fish hatched in these establishments have as a general rule been placed in open waters. But the largest, most famous, and oldest of these establishments, "The Central Institution for Artificial Fish Culture," at Hellbrunn, near Salzburg, which had been in existence for nearly 17 years, and where annually as many as 3,500,000 fish-eggs, principally of salmonoids, *Coregonus*, and graylings, had been hatched, was closed last year, owing to "slack business." The article which Andrae Schreyer wrote in a piscicultural journal on this establishment, the prospects of which were at one time exceedingly hopeful, is not without interest. The establishment was laid out according to a very extensive plan, no less than 31 ponds belonging to it; and in addition to these the Salzburg Association for Artificial Fish Culture, to which the establishment belonged, owned two large lakes, the Hinter Lake and the Waller Lake. Impregnated eggs and young fry from this establishment were sent far and near, and whatever young fry could not be sold were placed in ponds, lakes, and other open waters. In the beginning, when the interest in artificial fish-culture was still at its height, the estab-

lishment could hardly get enough eggs and young fry to supply the demand; but after a while the demand grew less, so that there was a superabundance of eggs and young fish. The raising of fish in ponds did not prove as successful as desired, the open waters not showing any larger number of fish than before, and, as we said above, the Hellbrunn establishment had to be closed last year owning to "slack business."

UNITED STATES.

During the last twenty years a number of Americans have become famous in the annals of pisciculture, partly by new discoveries in the technical part of fish hatching, partly as practical pisciculturists or patrons of pisciculture. Among these men deserve to be mentioned: Livingston Stone, Seth Green, T. B. Ferguson, C. G. Atkins, J. Williamson, M. G. Holton, F. N. Clark, J. H. Slack, F. Mather, R. E. Earll, M. McDonald, H. C. Chester, and, above all, Prof. Spencer F. Baird. Several States of the Union have fish commissions which, in their various hatching establishments, produce an almost fabulous quantity of fish, which are placed in open waters. Just as in Europe, these fish mostly belong to the salmon and *Coregonus* families, but the Americans also hatch artificially the shad (*Alosa præstabilis*) which ascends the rivers from the sea in large numbers for the purpose of spawning; and recently some salt-water fish have also been hatched artificially. In the year 1877 a steamer, the Fish Hawk, was constructed exclusively for hatching shad. It gathers easily sufficient quantities of roe and milt from a number of fishing stations located at a considerable distance from each other, and takes the young fish to those waters for which they were destined. Steamers are also said to have been used for the hatching of cod, for the purpose of conveying millions of young cod to coasts where they had not hitherto been found.* It is well known that the cod propagates its species in enormous numbers. Its roe develops whilst floating in the water and in one female cod as many as 9 million eggs have been found (*Nilsson*). Attempts have also recently been made to acclimatize foreign fish. Thus the carp has recently been introduced from Europe, and it seems as if its culture in ponds, on the German model, has a future in America. In California and Oregon the hatching of salmon eggs is said to be carried on on a large scale in the McCloud River and the Clackamas River, partly at the expense of the "Association for Preserving and Protecting Salmon," which has given a considerable sum for this purpose. We are informed that in these salmon hatcheries from 14 to 20 million salmon eggs have been hatched in one year.† In Michigan,

*This is a mistake. Only one lot of cod have yet been hatched, and those were released at Gloucester, where hatched. It was a very successful experiment, and the Commissioner hopes to hatch cod on a large scale at the Wood's Holl Station hereafter.—C. W. S.

†The salmon hatched and planted in McCloud have produced remarkable results, increasing the yield of the salmon canneries from 25 to 50 per cent. See accounts elsewhere.—C. W. S.

according to E. M. Miller's statement, 100 million fish-eggs have been hatched during the years 1873–1881, and placed in open waters, but with what results I have not been able to learn with absolute certainty. The same applies to American fish production in general, with exception of the shad culture, which has been successful in so far that the shad is now found in rivers where formerly it was unknown.

CANADA.

In 1865 Mr. Samuel Wilmot began to introduce artificial fish-culture in Canada. At Newcastle, in the Province of Ontario, where he resides, he established a salmon-hatchery, which soon gained considerable reputation. This was acquired by the Colonial Government and extended in 1869. Mr. Wilmot has gradually succeeded in founding, at Government expense, several similar establishments for raising the American maräne, the whitefish. The number of these establishments in 1880, according to Raveret-Wattel, was 7, and according to E. M. Miller, 10, kept up at annual expense to the Government of £5,000. Mr. S. Wilmot is the director and superintendent of these establishments. It is his aim also to produce as many young fish as possible. The entire quantity of fish eggs hatched in all the Canadian establishments till the end of the year 1880 is estimated at 200,000,000. The number hatched in 1880 was 26,000,000, divided as follows: 18,000,000 whitefish, 4,000,000 salmon, 4,000,000 lake trout, and 125,000 brook trout. From these 26,000,000 eggs there were obtained 21,500,000 young fish, which were placed in open waters. All the above information is given by E. M. Miller, member of the Michigan Fish Commission. As regards the practical results of this enormous production of young fish, we possess no reliable data. Miller says that the number of *Coregonus* had increased in the Detroit River; but it cannot be ascertained whether this increase holds any reasonable proportion to the large sums annually spent for producing young fish. I know from personal observation, however, that after fishing had been strictly prohibited for a certain period in autumn, the number of *Coregonus* in some of our Finland rivers increased very considerably. The quantity of fish caught annually in any body of water is, moreover, not the same every year, but is subject to great changes which are beyond human control.

ENGLAND, SCOTLAND, AND IRELAND.

For many centuries Great Britain has sought to preserve and increase the stock of fish in her rivers by strict legislation, and especially by rigid protective measures; these endeavors have been successful, and there is at present no country in Europe whose salmon-fisheries could vie with those of Great Britain. Artificial fish-culture has also been attempted in Great Britain, more than twenty years ago. Even quite recently some private hatcheries have been established, but artificial

fish-culture has never been one of the prominent British industries, and the Government has never appropriated a single penny for this cause; for experience had shown that strict and continued protection of all fish belonging to the salmon kind, at least during their spawning season, is the most efficient and only safe means of preserving and increasing the stock of fish in the rivers. Among those persons who have recently evinced great interest in fish-culture, the Duke of Sutherland deserves special mention. He is said to possess several model establishments for hatching salmon, in which as many as 800,000 eggs can be hatched per annum. Since 1873 he places every year more than 500,000 young fish from his establishments in various waters, among the rest in Loch Brora, on whose shore his largest hatchery is located. Although the number of fish annually caught in this lake has not increased perceptibly, it has been found that the breed has been improved, which is supposed to be owing to the employment of select breeders from the Tay, the Tweed, and the Rhine. Some English pisciculturists principally aim at producing a superior quality of fish by crossing the breeds, as is done with domestic animals, and, according to their own statements, they have been successful. There are also in Great Britain large trout-hatcheries carried on on business principles. The principal ones are those of Sir James Maitland, in Howietown, near Stirling, where, besides large quantities of shell-fish, the flesh of at least three horses is used per week for feeding the trout. Mention should also be made of Mr. Joseph I. Armin-stead's Troutdale fishery, near Keswick, in Cumberland, and Mr. Charles Capel's Cray fishery, near Foots-Cray, in Kent.

NORWAY.

In Norway, where the fisheries form one of the principal industries of the country, a good deal of attention was given to artificial fish-culture thirty years ago, both by the Government and the public, in consequence of the impetus given by France. According to official data, there have been started in Norway since 1856 no less than about 240 private piscicultural establishments, one-third of which were devoted to the hatching of salmon eggs, and two-thirds to the hatching of trout and *Coregonus*. But a very large number of these establishments, after having been in existence for a shorter or longer period without being able to show any result whatever, were gradually closed; so that during the winter 1878–1879 only 38 were still in operation—16 for salmon, and the rest for other fish. The majority of these 38 establishments were comparatively small, and only 5 of them produced about 100,000 young fish apiece. Although for a number of years 1 to 1½ million young salmon had been produced annually, it appears from the statement of Mr. A. Landmark, inspector of fisheries, in his financial estimate for last year, that there are no absolutely certain proofs that the salmon-culture has so far proved any benefit whatever to Norway. In his observations accom-

panying the draft of a new "law for protecting salmon and lake trout," dated Septemder 16, 1881, Mr. Landmark says very emphatically, on page 66: "It is but too certain that the number of salmon in our country is, on the whole, smaller at the present time than in 1848, when we got our first law for protecting the salmon-fisheries." Mr. Landmark thinks that the production of young fry of the salmon in Norway has been carried on on too small a scale, and that this is the cause why the rivers do not contain more salmon. Following up this idea, and evidently influenced by the reports of the enormous production of young fish in the United States of North America and Canada, he urged the Government to found a large salmon-hatchery on the Topdal River; but the Norwegian Government did not deem it proper to lay a proposition to that effect before the Storting [Norwegian Parliament], at least during the session of 1882. Relative to the fisheries in the interior of the country, especially the trout-fisheries, Mr. Landmark declared, February 5, 1881, at the meeting of the "Norwegian Association of Huntsmen and Fishermen," that the fisheries had been more productive in olden times than at present, and that only in a few places there had been some slight improvement in consequence of various measures taken recently by the Government and by private individuals; and yet there had been in operation in Norway, since 1856, for a longer or shorter period, about 150 piscicultural establishments, founded for the avowed purpose of improving the fisheries in the interior of the country!

SWEDEN.

At the same time as in Norway, considerable interest was also taken in pisciculture in Sweden, and a large number of great and small establishments were founded. Near Östanbäch, at the mouth of the Angerman River, the Government established a so-called "Normal Institution of Fish-culture," in which instruction was given; but after having been in operation for 18 years it was closed, and has not been opened again. Pisciculture in Sweden has not been able to show any very considerable econmical advantages, and during the last ten years the interest in this cause has been on the wane. More recently, especially since the Berlin Fishery Exposition of 1880, the interest in pisciculture began to revive, and at present a number of salmon-hatcheries are in operation on several Swedish rivers, among others in the Ljusne River, the Dal River (Elfkarleby), the Klar River, the Lagaå, the Nisson, and others. Granting the impossibility to regulate, on a large scale, the quantity of fish in open waters by means of pisciculture, the superintendent of fisheries, Dr. R. Lundberg, nevertheless favors the artificial production of fish because he sees in it "an important aid to prevent the decrease of fish, which is invariably brought about by the increasing number of fishermen, by manufacturing establishments, by rafting, &c. "Several economical associations in the provinces have, for the last thirty years, paid persons to instruct the masses on the subject of fish-culture and rational

fisheries, and it is stated that the activity of these teachers of pisciculture "promises well for the future." As far as I know, it is impossible, after thirty years of artificial fish-culture, to show any increase in the quantity of fish in the open waters of Sweden; but it seems that, so far at least, the Swedes are determined to continue their efforts in this direction. In 1879 a landed proprietor in Schoren [the most southerly province of Sweden] commenced to raise carp in ponds; and there is a reasonable prospect that this kind of fish-culture, if carried on rationally and cautiously, will prove profitable, because the carp can easily stand the climate in the southern part of Sweden.

FINLAND.

As regards our own country, artificial fish-culture was advocated here more than a hundred years ago, by Magister C. R. Gjers, in a treatise published by him at Åbo, in 1771, "On the causes of the decrease of the Government salmon and *Coregonus* fisheries in the river Kumo," but as far as known, without any practical result. In consequence of the impetus given by France, however, earnest efforts were made during the years 1858–1867 in behalf of fish-culture. During the period 1858–1862 a number of private individuals started various piscicultura lestablishments, under the guidance of my predecessor, H. J. Holmberg, who had studied the organization of such establishments in Norway. The most important establishments of the kind were in possession of the following persons: Stockfors, on the Kymmene River, owned by Counsellor Schatelowitz; Abborfors, on the same river, by Major-General Clayhills; Hovinsaari, in the district of Kymmene, by Mr. Druschinin; the establishment in the neighborhood of Kexholm, on the Wuoksen River, by Mr. Lebedeff; the one on the Urpala River, in the Wiburg Government, by Mr. Alfthan; the one near Tammerfors, by von Nottebeck; the one at Svartå, by Baron F. Linder; and the one in the District of Kronobarg, by Rev. Mr. Hartman. The three last mentioned establishments raise principally brook trout and lake trout. During the years 1863 and 1864 two large salmon-hatcheries were established by associations of salmon-fishers, the one on the the Uleå River, and the other on the Torneå River. For a number of years these establishments have annually placed a large quantity of young fish, principally salmon, in the rivers on whose banks they are located; thus the establishments on the Kymmene, Uleå, Urpala, and the one near Kexholm, have annually placed as many as 100,000 young fish apiece in open waters, the Kexholm establishment during one year even as many as 200,000, without any noticeable increase of the quantity of fish in any of the above mentioned rivers. The production of young fish, therefore, gradually ceased in all these establishments; and the result of these earnest endeavors, made at considerable expense, was altogether a negative one and did not induce people to imitate them. The great expectations which had been raised in Finland, as in other countries of Europe, with regard to the artifi-

cial production of young fish, were here, as elsewhere, doomed to disappointment.

Fish-culture, in the widest sense of the term, embraces (1) fishery legislation, (2) pond-culture, (3) transplanting fish, and (4) production of young fish in an artificial manner and the placing of the young fish in open waters, or what is known as artificial fish-culture.

Fishery legislation forms in all countries an object of serious attention of the government and the legislative bodies. It aims at maintaining in open waters all those conditions which are necessary for the propagation, increase, life, and well-being of fish. In Finland this legislative work did not commence till 1786, when excellent fishery regulations were promulgated; and after the fishery regulations of the year 1865 were made, the work went on uninterruptedly by making various local laws securing the protection of certain species of fish during the spawning season, as well as the manner of superintending the waters and regulating fishing in such a manner as to sufficiently protect the propagation of fish in the natural way, to protect the young fish, to prevent any impure or poisonous matter from getting in the water, and to secure all those conditions which are necessary for the well-being of the fish and the reproduction of food in so far as this is dependent on the aquatic vegetation, &c. I venture to say that Finland has not been backward in this respect, although many gaps are yet to be filled, and many improvements in the details will have to be introduced as greater experience is gained.

The pond-culture of the Germans—that is, the raising of certain kinds of fish, especially carp, in ponds—is, as far as I know, in no part of Germany an object of direct care of the state, but is left entirely to private effort. According to a statement by P. Dabry de Thiersant, the Chinese only raise fish living on vegetable food; and these fish are raised from roe impregnated in the natural way and gathered in the rivers. In Europe the fish which are principally raised in ponds are carp, which live on vegetable matter, and, though to a less degree, brook trout and fresh-water trout and saibling, partly in ponds and partly in brooks. As these last mentioned kinds of fish are found in Finland, it must be supposed that it would be possible for us also to raise them in ponds; but whether it would be a source of profit is another question. These fish require exclusively animal food, flesh or fish, which makes their support quite expensive, so much so, in fact, that it will only pay in localities where fish fetch a very high price. It has been calculated that it requires 5 kilograms horse flesh or other flesh, or a corresponding quantity of fish, to raise 1 kilogram trout. German trout-culturists get as much as 4 marks (95 cents) per pound for their trout, and with such prices this industry of course becomes profitable. Mr. A. Haldenwang, proprietor of the well known piscicultural establishment at Gaisbach, near Baden-Baden, says, in his report for 1881, that he gets from 3 to 5 marks (71 cents to $1.19) per pound for his trout. Our long and severe winters, last-

ing from six to seven months, and great variations in the depth of the water, would moreover place great difficulties in the way of successful trout-raising, and would still further increase the expense. As regards the carp, which, in central Europe, is raised cheaply and with comparative ease, I believe that, in view of our climatic conditions, it would not pay to raise carp in Finland. The northernmost countries where carp culture is regularly and successfully carried on are Holstein and Courland. Even in Schleswig people complain of lack of success in carp culture. Carp were centuries ago, introduced in Schonen, the southernmost province of Sweden; but they are not found farther north in Sweden. All the attempts of King John III to raise carp on the island of Öland have proved futile. In Norway the carp has been acclimatized in only two places, viz, near Farsund, in the southernmost part of the country, and at Milde, near Bergen. According to Grimm, carp are said to be found near St. Petersburg, in some of the ponds belonging to the Imperial country seats, and, according to Kessler, also near the Convent of Walamo, but there is no attempt made at carp culture. Carp were first introduced in Finland in 1861, when Chamberlain Baron von Linder placed some in a pond on his estate of Svartå, but they are said to have died out after a few years. Attempts in this direction had also been made prior to 1861, but likewise without result. The carp requires constant care and protection, just like a domestic animal, for, in spite of its enormous power of propagation—a large female carp producing as many as 1,200,000 eggs—it will not be able after having been domesticated for centuries, as it has been in Central and some parts of Northern Europe, to successfuly compete with other fish in open waters in the battle for existence. As I remarked above, attempts to raise carp have been made in the Swedish province of Schonen since 1879.

The stocking of waters with certain kinds of fish by transferring the young, and the attempts to acclimatize fish, have in no European state been made directly by the Government, but they belong entirely to private enterprise, or are managed by societies or associations formed for the purpose. In Finland this way of carrying on fish-culture has been common for a long time, and during the last twenty years fish have been successfully transplanted in considerable numbers. The interest in such attempts among our people is by no means on the decrease, but is, on the contrary, very lively, especially since the Imperial Senate, in 1879, commenced to award small annual prizes for the successful and profitable transplanting of fish. More than fifty such awards have been distributed during the last four years, principally among the peasants; and in several cases the transplanting of various specimens of *Coregonus* has proved a decided benefit to entire villages and communities. As the transplanting of fish, either by means of impregnated roe or young fry, or by mature spawners and milters, is so easy a matter that even peasants, who may otherwise not be very bright, can do it, I do not consider it necessary that the

Government should take special measures for furthering this kind of fish-culture.

As regards fish-culture proper, artificial fish-culture, which consists in the production of young fish in special establishments and the placing of these young fish in open waters, the opinion has now very generally gained ground in Europe that it is entirely useless to apply this kind of fish-culture to those kinds of fish which spawn in spring and summer. They are endowed with such a powerful faculty of propagation, and their impregnated roe develops in so short a time, that wherever the necessary conditions for their well-being exist, sufficient young fry is produced by nature's own activity, in a much safer way than man can do it, if only care is taken that there is a sufficient number of mature spawners and milters and suitable spawning-places. One of the most competent authors on this subject, Mr. H. Haack, director of the German piscicultural establishment at Hüningen, says in his official Reports on the Berlin International Fishery Exposition of 1880, page 34: "I have, for twenty years, made exhaustive experiments in artificially raising most of those fish which spawn in summer, and in most cases I have succeeded in raising a few thousand young fish of these kinds; but I have nevertheless arrived at the conviction that all efforts made in this direction have been mistakes, for even in the smallest open spawning-ponds a hundred times more favorable results were obtained than by the most careful artificial culture."

The quantity of fish in any body of water is always in direct proportion to the quantity of suitable food for the fish in their various stages of development; but this quantity of food, though different in the different waters, is always strictly limited by nature; and it is not often in the power of man to change this proportion for the better. It is, therefore, impossible to make any water produce a larger quantity of fish by the artificial hatching of young fish than the quantity of food which it is able to produce entitles it to, no matter how large the body of water. It is by no means the number and size of the various bodies of water in a country which determine the quantity of fish in that country, but the quantity of suitable food which is produced in its waters.

As will be seen from the above review of the present condition of artificial fish-culture, it is only those fish which spawn in winter, the salmon and other salmonoids, as well as some fish of the *Coregonus* family, which both in Europe and America have formed and still form the principal objects of cultivation in special esta blishments. Although the cultivation of these kinds of fish in Europe has been carried on for thirty years, in some countries even on a very large scale, we have no positive proof from any European state that this cultivation has, to any noticeable degree, increased the quantity of fish in the open waters, with the exception of a few trout-brooks, or that it has brought finan-

cial results commensurate with the expense, or that it has become a matter of great public importance. It is true that, in some cases, artificial fish-culture has made it possible to transplant some kinds of fish to countries and waters where formerly they were not found, and that in other cases it has facilitated this transplanting process, but these results possess more of a scientific than of a financial interest. It is absolutely certain that in countries where the most persistent and the strongest efforts have been made to increase the quantity of fish in the open waters by producing young fish in an artificial manner, as in France and Norway, the hopes entertained of the economical importance of artificial fish-culture have been thoroughly disappointed. I purposely refrain from speaking about artificial fish-culture in America, because I am not sufficiently acquainted with the condition of affairs in that country, and have not been able to obtain any reliable information on the subject, and finally because the experience gained there seems of too short a date for forming any definite opinion. Suffice it to say that in Europe artificial fish-culture has left nothing but disappointed hopes, and in many cases even considerable financial losses. Under these circumstances, and as in the whole of Europe there are on the one hand about 500 private piscicultural establishments, but on the other hand only three such establishments supported by Government funds, the German one at Hüningen, the Russian one at Nikolsk both of which, as we have seen, have cost enormous sums and have been of little use—and the one at Engelstein on the Chiem Lake in Bavaria, a small establishment for raising lake-trout, I do not feel justified in advocating the establishment at Government expense of institutions for raising young fish in an artificial manner; all the less because 15 to 20 years ago people in Finland made very earnest, but also very fruitless endeavors in this direction. I would also mention in this place that a meeting of fishermen, pisciculturists and friends of the fisheries, called by the Austrian Fishery Association, and held in Vienna, April 29 and 30, 1882, under the auspices of the Austrian ministry of agriculture, answered one of the questions which came up for discussion, viz, "Is it desirable to found piscicultural establishments at the expense of the Government?" in the negative.

If, however, the Imperial Senate should feel inclined to order further experiments in artificial fish-culture in Finland, I am of opinion that we ought to use a method of hatching roe which saves more space, and, above all, which is cheaper than the one employed at Nikolsk; and I would recommend the well-known Norwegian method, which has been found to answer the purpose in every respect, or, still better, some more modern method, for instance, with the California or Williamson's hatching-boxes, which has been tried in Sweden and Germany.