

# XXXI.—A REVIEW OF THE FAILURES AND SUCCESSES OF ARTIFICIAL FISH-CULTURE.\*

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Professor Malmgren, of Helsingfors, Finland, in his memorial addressed to the Bureau of Agriculture of the Imperial Russian Senate for Finland, recently published,† has spoken so strongly against the introduction of artificial fish-culture in Finland that it seems proper to make this question the subject of a thorough investigation. As Professor Malmgren honored me by sending me among others his pamphlet, I feel justified in thus publicly discussing it.

With a view of familiarizing the reader with Professor Malmgren's pamphlet I must give the following statements contained in it:

When the Imperial Senate began to consider the question of introducing artificial fish-culture in Finland Professor Malmgren was commissioned to visit the Russian Government fish-cultural establishment at Nikolsk (in the southwestern part of the Government of Novgorod), and to prepare a memorial on the subject. He went to Nikolsk in September, 1882, traveling by railroad from St. Petersburg to Waldaika (a distance of 250 versts [167 miles], 1 verst being equal to about 1,067 meters or two-thirds of a mile), and from Waldaika to Nikolsk (52 miles) by stage coach. Nikolsk is about 40 versts [27 miles] from Valdai, the principal city of the district.

The fish-cultural establishment of Nikolsk was founded in 1855 by Mr. Wrassky, the owner of the estate, on the model of Huningen, in a valley watered by a small brook. Everything was on a large scale. It comprises thirteen large and small ponds, which are fed from the brook. The hatching house is very conveniently arranged, and its apparatus can contain 2,000,000 trout eggs. As the trout and the *maräne* [a fish of the genus *Coregonus*], the two kinds of fish which were to be raised at Nikolsk, were not found in that neighborhood, the fish required for propagation had to be brought from St. Petersburg, therefore over a distance of about 330 versts [220 miles]. There are trout in waters distant from Nikolsk about 35 versts [24 miles], but it is only recently

\* *Professor Malmgren und die künstliche Fischzucht.* From the *Deutsche Fischerei-Zeitung*, Vol. VI, Nos. 44, 46, 47, 48, 49, and Vol. VII, Nos. 1, 2, 3, 4. Stettin, October, 1883, to January, 1884. Translated from the German by HERMAN JACOBSON.

† Translation in *F. C. Bull.*, 1883, pp. 363-381.

that a small number have been brought from there to Nikolsk for the purpose of propagation. Owing to the lack of spawn the Nikolsk establishment has never been worked to its full capacity. The largest number of eggs hatched in a year was 300,000, but generally it is only about 100,000.

It is not surprising that, under such unfavorable circumstances, the establishment did not flourish, and that its founder sunk in it his whole fortune. He thereupon formed an association, which spent 41,000 rubles [\$30,094] on the establishment, without, however, being able to make it prosper, in spite of a subsidy of 30,000 rubles [\$22,020] from the Government. The association was dissolved, and in 1868 the Government took charge of the unfortunate establishment. The expense of starting it was 100,000 rubles [\$73,400], and, according to some estimates, even 200,000 rubles [\$146,800]. At present the Nikolsk establishment belongs to the Government, and may be said merely to exist. For its maintenance 3,000 rubles [\$2,202] are annually appropriated, of which sum 2,400 [\$1,762] go toward the salaries of the various officials.

As has already been said, the establishment has been anything but a success. The neighboring lake of Pskov, which has been stocked by the Nikolsk establishment with *maräne* and trout (we are not informed whether it was *Trutta fario* or *Trutta lacustris*) has yielded only very insignificant results, as, according to the official reports in 1870, seventy-one *maräne* and six trout were caught, and in 1871 only four *maräne*. In this connection, however, I would say that fish like the *maräne* and the trout generally stay near the bottom of the lake the greater part of the year, and only rise to the surface during the spawning season. The results of placing in a lake young fish of these kinds cannot be judged by the number caught occasionally at other seasons, more especially as these fisheries depend greatly on the state of the weather. Observations relative to this question should, therefore, be taken during the spawning season. Whether this was the case as regards the lakes near Nikolsk cannot be learned from Professor Malmgren's pamphlet.

The Nikolsk establishment has evidently proved a failure, and it is probable that it will never reach a flourishing condition, nor will it, owing to its isolated location, ever become suitable for a school of pisciculture. The entire undertaking suffers from the circumstance that it was commenced on too large a scale and with a certain financial recklessness, instead of starting from a small beginning and gradually being enlarged as it showed signs of prosperity. Nikolsk is one of those unfortunate institutions which have been established in an entirely unsuitable location, but which one does not like to abandon on account of the large sums expended. Establishments of this kind drag out a sickly existence and are more hurtful than helpful to the cause, as they become discouraging examples. I therefore agree with Professor Malmgren in his unfavorable criticism of the Nikolsk establishment, but this is no reason why he should judge unfavorably of fish-culture in general.

## RUSSIA.

Professor Malmgren takes occasion to remind the reader that for more than twenty years Finland possessed salmon-hatching establishments, which owed their existence to the impetus given by France through its establishment at Hünningen. The superintendence of salmon-culture in Finland was principally in the hands of Professor Holmberg, of Helsingfors, who had studied artificial fish-culture in Norway. During the period of 1858 to 1864 salmon hatcheries were established on the Kymmene River, on the Wuoksen (near Kexholm), on the Ulea, Tornea, and Urpala, which, however, were as little successful as some other establishments devoted to the hatching of brook trout and lake trout. Some of these hatcheries produced 100,000 young salmon per annum; Kexholm even as many as 200,000, without, however, causing any noticeable increase in the number of fish. Professor Malmgren simply mentions this fact, without telling us anything regarding the causes of the failure. I am inclined to think that probably one of the principal causes, as in many of the Swedish and Norwegian fish-cultural establishments, must be found in the use of warm spring water, which is more or less lacking in air. In countries of the latitude of Sweden and Norway spring water is used for artificial fish-culture, if possible near the source, because many of the waters freeze entirely during the severe winter. On account of its greater degree of warmth spring water is not so liable to freeze, but it is apt to develop the eggs and young fish prematurely, so that the latter have consumed the umbilical sac and are ready to be placed in open waters at a time of the year when everything is still covered with snow and ice. If these tender young fish are placed in open waters at this season they must perish, partly on account of their not being able to resist the severe weather, and partly owing to the fact that at this season of the year those insects on which they principally feed have not yet made their appearance. If these young fish were, at this season, placed in ponds and ditches, in order to raise them there, the fact that these waters would be more or less covered with a sheet of ice would be prejudicial to their growth. Under these circumstances it is not surprising that the young fish are decimated; and if, on the other hand, the fish-culturist wishes to keep the prematurely developed young fish in the hatching tanks till spring, he is obliged to supply artificial food, which, especially if the number of fish is large, will have its peculiar difficulties. At the same time the fish growing from week to week in the warm spring water, which more or less lacks oxygen, will not get the quantity of fresh air necessary for their development, and consequently large numbers of them will die. As fish-culturists in Sweden and Norway, where Professor Holmberg studied fish-culture, work with spring water, it is probable (although Professor Malmgren does not say anything about it) that this has also been the case in Finland. This sup-

position is confirmed by the fact that the impetus given to fish-culture in Finland came from France, and its model establishment at Huningen, whose operations were based on the spring water theory, that fatal theory which works on the supposition that success in hatching can be obtained only by keeping the water as much as possible at an even temperature. This very theory has proved very hurtful to the development of artificial fish-culture, for, owing to its application, many piscicultural establishments have failed.

In my review of the "Guide to Artificial Fish-Culture," by Mr. Hettig, royal inspector of fisheries for Norway, published in Circular VII of the German Fishery Association for 1871, and giving a sketch of fish-culture in Norway, I have pointed out the unsatisfactory results of the exclusive use of spring water (see Circular VII, 1871, pp. 42-45), and to this day fish-culture in Sweden and Norway is languishing from this cause. Mr. von Yhlen, royal inspector of fisheries for Sweden, in his article on salmon culture in Sweden, published in the *Deutsche Fischerei-Zeitung*, complains of the serious drawbacks of working with spring water, and advises to cool it with ice. But if spring water has not, for some time, flowed above the ground, the cooling with ice can not remedy the most serious evil, namely, the lack of air. In some establishments there is a contrivance for turning the spring water to a spray, and thus to saturate it with oxygen, before it enters the hatching apparatus. But this contrivance is of a somewhat complicated character, and requires special conditions of level in order to obtain the necessary pressure for making the water rise; and even then it is doubtful whether the water, during the short time which is occupied by turning it to spray, is able to absorb enough oxygen to afford the necessary amount of air for large quantities of eggs and young fish. In large establishments it would, moreover, be very difficult to subject the necessary quantity of water to this process. I would advise all Scandinavian fish-culturists to choose for their establishments locations where they have both river and spring water; whenever there is any lack of river water, spring water may, in case of necessity, be temporarily employed, or mixed with the supply of river water. The artificial hatching of winter fish-eggs will yield favorable results only when the development of spawn and fish in the hatching house keeps step with the conditions of free nature, which can only be obtained by employing river, brook, lake, or pond water. I would, therefore, also urgently recommend for Russia, where efforts are now being made to spread artificial fish-culture, to study this important water question and decide it as indicated above. Unless this is done, there will only be new disappointments, which will cause people to take the dark view of artificial fish-culture which we find in Professor Malmgren's report. This report contains but little information relative to artificial fish-culture in Russia, and, owing to the lack of material, I am not able to supplement this report. Professor Malmgren mentions the efforts made by Dr.

Knoch, who in 1857 constructed carp ponds on an estate belonging to the Grand Duke Constantine Nikolajewitsch, as to the results of which, however, Professor Malmgren's report is silent. I remember, however, to have read somewhere that Dr. Knoch succeeded in artificially raising the sterlet, which fact seems to have been unknown to Dr. Malmgren. (Later I shall have occasion to revert to the fish-cultural establishment in or near Suwalki, in Poland, which seems to have been successful in raising *Coregonus* for the Raygrod Lake.) After mentioning the artificial hatching of trout and *Coregonus*, undertaken by Mr. Muschinsky, a banker of St. Petersburg, who had the young fish raised by him transferred to his estates in Poland, Professor Malmgren speaks of the Russian Fishery Association (founded in 1881 on the model of the German Fishery Association), whose president, Counselor von Greig, has established artificial hatcheries on his estates in Courland, which seem to be planned on a large scale. Our best wishes follow this young association, before whose activity a large field seems to be open. May its motto be in general, "The right fish in the right water." We hope that it will not waste its strength in irrational efforts, such as have been made in Russia by endeavoring to raise sterlets in ponds; but that it will engage in practical fish-culture, whose efforts are directed not towards forcing nature from its wonted course, but to make the life and habits of fish the basis in all undertakings of this kind. It is also to be hoped that the Russian Fishery Association will not be guided by *dilettanti*, whose efforts but too often resemble a straw fire, which soon burns out and leaves nothing but disappointment.

With his criticism on the Nikolsk establishment, Professor Malmgren combines a review of artificial fish-culture and its results in other countries, and arrives at the conclusion that nowhere have remarkably successful results been obtained. In view of this opinion of Professor Malmgren, I must state that he has certainly not made the necessary observations to enable him to come before the public with such a sweeping assertion. I have taken the trouble to collect data for refuting his statements. These data would have been more numerous if it had not been for the circumstance that this whole literature, not very rich in itself, was very much scattered, and often difficult of access. I have gathered my information principally from the circulars of the German Fishery Association and from the files of the *Deutsche Fischerzeitung*, those publications which, during late years, have furnished the most important information relative to the subject of artificial fish-culture, and which have also been perused by Professor Malmgren. But even with this small amount of material, I feel confident that I can show conclusively that Professor Malmgren is exceedingly unjust in speaking disparagingly of artificial fish-culture and its results. Following, with some slight deviations, the order in which Professor Malmgren speaks of the different countries, I shall begin with France, which, in 1850 and the following years, gave a new impetus to artificial fish-culture.

## FRANCE.

Professor Malmgren, referring to the review of the history of artificial fish-culture in France, contained in Blanchard's work "*Les poissons des eaux douces de la France*" ["Freshwater Fish of France"], (Paris, 1866), remarks that the sudden interest in fish-culture which had been awakened about 1850 had, after many disappointments, already almost died out prior to 1870; and in this opinion I must entirely agree with him. But when he attempts to use this fact in depreciating artificial fish-culture in general, he proves himself prejudiced and insufficiently informed.

There are two reasons why artificial fish-culture in France did not realize the hopes, which it must be confessed were of the most extravagant kind, entertained by many Frenchmen.

The first is the spring water theory. Nurtured by mere book-learning, this theory became the Alpha and Omega of the artificial culture of the salmonoids, which was at that time aimed at almost exclusively. It was thought that keeping the hatching water at as even a temperature as possible was an essential condition for the development of the eggs and young fish. Hence the endeavors to obtain the spring water as near its source as possible, and to carry it through tubes or pipes, so it might not lose any of its warmth. The evils resulting from this spring water theory I have already referred to above, under the head of Russia. The great Government establishment at Huningen was the representative and advocate of this theory; and in this respect it has exercised a positively hurtful influence on the development of artificial fish-culture, not only in France, but also in other countries. We would be able to chronicle far greater results if fish-culture had not for twenty years, 1850 to 1870, been absolutely governed by this spring water theory. How were matters managed in Huningen during this period? Towards the end of December, at the latest during the first days in January, the shipping of the winter fish-eggs, which had been impregnated so as to become visible to the naked eye, was generally finished.\* As the persons to whom these eggs were shipped followed the example of Huningen and also operated with spring water, the young fish which were raised had generally lost their umbilical sacs about the middle of February, and had either to be placed in open waters, or to be fed artificially in the various establishments. The difficulties arising from this method have already been mentioned under the head of Russia. It is therefore by no means a matter of surprise that many of the fish raised in this unnatural manner perished, and that no results of any importance could be chronicled.

The second cause why fish-culture in France did not make sufficient

\* After Huningen passed into the possession of Germany strong endeavors have been made to remedy these evils, and during late years great progress has been made in this direction.

progress must be sought in the fact that much time and energy was wasted in most unpractical experiments by attempting to raise valuable fish according to methods totally opposed to their mode of life. Thus, attempts were made to raise salmon (*Salmo salar*), sea trout (*Trutta trutta*), and lake trout (*Trutta lacustris*) in ponds. These experiments, of course, proved unsuccessful, and people began to lose faith in fish-culture. Any one who wishes to acquaint himself with this subject should read Blanchard, and he will get a very clear idea of French fish-culture, which never got beyond mere dilettantism. Only in exceptional cases were moderate results obtained in the raising of brook trout.

In stating that up to 1862 the Huningen establishment had cost the Government 600,000 francs [\$115,800] without being able to show corresponding results, Professor Malmgren forgets that Huningen distributed all eggs gratuitously, and therefore derived no income from this source; while the expenses for procuring fish-spawn were very considerable. While in the possession of France, Huningen was an expensive institution; it supported numerous agents, and paid high prices for eggs, all of which cost considerable sums. When Professor Malmgren lays special stress on the fact that, during the period of 1855 to 1862 about 30,000,000 salmon eggs were impregnated in Huningen, I must confess that I do not consider this an unusually high figure, for it would only be about 3,500,000 per annum. If we consider that France (not counting in her colonies) was at that time a country with an area of 207,480 square miles, and a population of 38,090,000, the quantity of eggs given above is by no means very large, especially in view of the great liberality of the French Government which gratuitously sent to foreign countries large quantities of eggs. All these facts seem to have been overlooked by Professor Malmgren.

In spite of all the disappointments to which France was doomed, Blanchard, from whose above-mentioned work Dr. Malmgren derives his information, is by no means positively opposed to artificial fish-culture; all he desires is, as he states on pp. 610-623 of his work accompanying (in translation) Dr. Malmgren's report to the Senate, that fish-culture should be carried on in a rational manner, and particularly that fish should not be raised in a way totally different from their accustomed mode of life, and that, under all circumstances, fish should be placed in waters where they find a sufficient quantity of wholesome food. In short, Blanchard wants the right fish in the right water. He also wishes the law to protect the waters from pollution, and desires fish-ways to aid the ascent of the migratory fish. That France, in spite of numerous failures, has not finally abandoned artificial fish-culture will be seen from the fact that she has, at Government expense, founded a new establishment at Epinal, in the Vosges Mountains, which operates with river water and seems to obtain good results. (See article by Meyer: "*Ein Besuch der neuen französischen Fischzuchtanstalt bei Epinal*," in *Deutsche Fischerei-Zeitung*, 1883, pp. 164 and 180.)

## GERMANY.

I now turn to Germany and shall here pay special attention to the results of salmon-culture, because it is aided by Government subsidies, and because it is the principal field of activity of the German Fishery Association, of which Professor Malmgren speaks so unfavorably. Moreover we possess more material relative to salmon-culture, while the results obtained by private efforts, which have principally been devoted to the cultivation of the brook trout, have become but little known. I shall begin with the waters in the eastern part of Germany and gradually proceed toward the west.

In the Courland Sea and the inland waters of East Prussia the salmon fisheries had considerably declined about the year 1870. As Beerbohm states in his *Die Fischerei des Kurischen Haffs und der Nebengewässer* (the fisheries of the Courland Sea and adjacent waters), the salmon fisheries in these waters had almost come to an end about that time, simply owing to the lack of fish. Throughout the whole of East and West Prussia a similar decline of the salmon fisheries was reported. The fishery association of these two provinces has made the furtherance of their fisheries its special object, and in its efforts has been aided by the Government and the German Fishery Association. From small beginnings it has risen slowly but steadily, and, thanks to the indefatigable activity of Professor Benecke, of Königsberg, is constantly spreading a greater interest in the fisheries among the general public of East and West Prussia. As regards the efforts of this association in the line of salmon-culture, we must state that young salmon fry were first placed in the waters of East Prussia in 1877, circumstances, however, not permitting operations on a large scale. During last winter about 300,000 salmon eggs were hatched in East Prussia, assuredly no insignificant quantity. Also in West Prussia, near Elbing and Marienwerder, and in the river Rhede, near Danzig, young salmon fry have been placed in the water, though only in small quantities.

Nor can we pass by in silence the placing of young salmon fry in waters in the region of the Upper Vistula in Galicia, through the aid of the German Fishery Association, and the energetic efforts of Professor Novicki in Cracow. Including the year 1883, a total of 361,000 young salmon have been placed in Galician waters, a quantity which, considering the extent of the Vistula region, cannot be called very great.

As a result of these efforts made both in East and West Prussia and in the Upper Vistula region, we must doubtless consider the appearance, during the last few years, of enormous numbers of young salmon along the entire coast of Prussia from Hela to Memel. Many wagon-loads of these fish have been brought to market, unfortunately among them fish measuring from 20 to 30 centimeters [8 to 12 inches] in length. We may, therefore, hope that the salmon fisheries will increase considerably,



both in the inland waters of East and West Prussia and in the region of the Vistula.

A striking illustration of the success of artificial salmon-culture is furnished by the small coast river Rhede, flowing into the bay of Putzig, north of Danzig. In the autumn of 1871, 2,100 nine-months'-old salmon were, at the expense of the Government, furnished by the hatchery of Prince Wied, at Aubach, near Neuwied, and I was commissioned by the German Fishery Association to take them in charge. There were placed in the river Rhede 1,600 of these fish, and the remainder were sent to Stolpe in Pomerania. Mr. Muller, of Tschischdorf, successfully conveyed these fish to their destination, and they were placed in the Rhede, from which the salmon had entirely disappeared. In July, 1875, numerous salmon, measuring about 50 centimeters [20 inches] in length, ascended the river from the sea, evidently some of the fish which we had placed in these waters four years ago (German Fishery Association, 1876, p. 158). The hatchery founded in Oliva by the chief forester, Mr. Liebeneiner, has, since 1874, continued to stock the Rhede with young salmon (8,000 in 1874, and 31,000 in 1876). Gradually the Rhede salmon fisheries increased in importance; thus, during the season of 1879-'80 a much larger number of salmon were caught than during the preceding season (German Fishery Association, 1880, p. 103). As Mr. Liebeneiner says in his report for 1880-'81, the salmon fisheries in the waters near the mouth of the Vistula and in the bay of Putzig have increased very considerably, but it is difficult to obtain an exact estimate of the result of these fisheries, as the fishermen endeavor to keep it secret. It is a fact, however, that many hundred-weights of salmon have been shipped from the stations of Rhede, Kielaw, and Zappot.

The Fishery Association of East and West Prussia has also given some attention to the raising of *Coregonus*, although, so far, with one exception to which we refer below, without much success, in spite of the fact that, since 1879, very considerable quantities of young *Coregonus* have been placed in different waters. It is true that recently some *Coregonus* have been caught in various lakes, but only occasionally and in small numbers. (As I have done under the head of Russia, I would also advise in East Prussia greater care of the *Coregonus*, especially during the spawning season.) The raising of *Coregonus lavaretus* has also met with numerous failures, although we are happy in being able to chronicle at least one good result, in the bay of Putzig. After about 20,000 young fish of this kind had, in 1879, been placed in a brook near Oliva, quite a number of these fish were, during the following years, observed in various parts of the bay of Putzig, and in the autumn of 1882 a larger number of these fish were caught than had been the case for a long time. (Report of the Fishery Association of East and West Prussia for 1882-'83, p. 27.)

Professor Benecke, of Königsberg (Circular of German Fishery As-

sociation, 1881, p. 150), also reports that large *maräne* have been found in the Raygroed Lake (southeast of Lyck), belonging partly to Prussia and partly to Russia, while formerly they did not occur there. After a few such fish had been caught in that lake during the winters of 1879-'80, quite a large number were caught in 1880-'81. During the following years large *maräne* have often been caught there. It has been impossible, however, to obtain more information on the subject, as the persons who rent the fisheries have an interest in keeping the results secret, the fish being quietly shipped to Poland. It is probable that these *maräne* came from the neighboring Russian fish-cultural establishment of Suwalki, where the *maräne* of the Ladoga and Peipus Lakes has been cultivated for many years. These facts speak strongly in favor of the success of Russian fish-culture, as no fry of that fish have been planted in this lake on the Prussian side.

I now come to the region of the Oder River, a review of whose salmon culture I gave in Nos. 28 and 29, Vol. VI of *Deutsche Fischerei-Zeitung*, so that here I may confine myself to the following statement: Starting from a small beginning in 1868-'69, the enterprise gradually assumed larger dimensions. Up to 1879 the largest number of salmon-eggs hatched in one year was 365,000 (in the winter of 1871-'72). Since 1871 there has been a noticeable increase of salmon off the mouth of the Dievenow, the eastern channel connecting the Great Haff with the Baltic Sea, although prior to that year the salmon fisheries of this region had declined so much that many fishermen emigrated to Eastern Pomerania. From 1871 the salmon fisheries off the mouth of the Dievenow increased from year to year till (according to statements furnished by the fishermen) the spring fisheries alone yielded 45,212 pounds in 1875, and 52,293 pounds in 1876. Owing to a combination of different unfavorable circumstances the yield was not so good during the following year. In the early part of the summer of 1880 so many young salmon were caught that many of them could not be sold as food, but had to be used as manure. Since 1877 the salmon also increased considerably off the mouth of the Swine and Peene. Also, in the present year (1883) a large number of salmon have been caught on the coast of Pomerania (*Deutsche Fischerei-Zeitung*, 1883, p. 293), which undoubtedly is owing to the planting of young salmon fry further up the Oder and in some of its tributaries.

Although the salmon-culture of the Oder region has borne rich fruit in the sea outside the mouth of the Oder, the same cannot be said of the entire valley of the Oder. The salmon seemed principally to go into the rivers Warthe and Netze, where these fish, which had become rare in these rivers, again made their appearance in large numbers since 1874. Thus in 1873 at Landsberg, Driesen, and Steinbusch, respectively, 9, 9, and 6 salmon were caught; while in 1875 in the same localities there were caught 205, 154, and 120 large fish. During the following years the salmon fisheries were not so productive, owing to unfavorable

conditions of water and temperature; in the autumn of 1882, however, 94 salmon were caught at Steinbusch. If, in spite of these facts, the salmon visit the Upper Oder irregularly, the reason must be found in the condition of the sandy bed of the river.

On the Mecklenburg coast formerly from 80 to 100 salmon were caught per annum; but since the fish-cultural establishment of Schwerin (under the superintendence of Mr. Brüßow) has planted young salmon and sea trout in the open waters, the annual yield of the Mecklenberg fisheries has been about 2,000, and in 1882 these were principally young fish weighing from 3 to 8 pounds apiece. Very remarkable results can be chronicled for the Darssow Inlet. After the Schwerin establishment had, in 1870-71, commenced to plant young fry in the river Stepenitz, many salmon have been caught in the Darssow Inlet, a fact which the fishermen at first attempted to keep secret. Very good sea-trout fisheries have sprung up on the coast near Doberan, the fish weighing from 1 to 2 pounds, since the Schwerin establishment began to plant most of its young fry in the Doberan stream near Wismar. (See *Deutsche Fischerei-Zeitung*, 1882, pp. 170 and 171; 1883, p. 18; also, Von dem Borne's "*Fischerei-Verhältnisse des Deutschen Reiches*," &c., Berlin, 1860, p. 83.)

Since 1860 the river Trave has been stocked with young salmon from the piscicultural establishment at Lubeck, and the experiment has proved very successful. Besides the blue-backed salmon there were also found silver-colored Rhine salmon, as eggs of both kinds had been hatched. At one haul 800 pounds of Rhine salmon were caught near the mouth of the Trave. (See Circular 1 of the German Fishery Association, 1871, p. 90, and Fritsche's "*Die Flussfischerei in Böhmen*," Prague, 1871, p. 45.) The Trave salmon fisheries developed still further, after (since 1872) the fish-cultural establishment of Gremsmühlen, near Eutin, (under the superintendence of Mr. Bruhns) began to plant salmon fry in the river Schwarzan, which flows into the Trave. In 1878 the Haffkrug fishermen caught 2,000 pounds of salmon, a larger quantity than had hitherto been taken here. In 1879 the fishermen of Niendorf, Schaarbeck, Haffkrug, and Sierksdorf caught 6,400 pounds of salmon during the period from the beginning of April till the 25th of April. Unfortunately we have no data respecting the Schlutup and Travemünde fisheries, where likewise many salmon were caught. (Report by Mr. Bruhns in Circular of the German Fishery Association, 1879, p. 69, and 1881, p. 148.)

I now come to the river Weser, whose salmon-culture I have already spoken of in the current volume (Vol. VI) of the *Deutsche Fischerei-Zeitung*, p. 182. The salmon fisheries near Hameln, where these fish meet their first hinderance in ascending the stream in the shape of a large weir, furnish a good basis for judging the results of artificial salmon-culture. After the Hameln town council had taken an interest in the matter, and had established a salmon hatchery, which was placed in charge of Mr. Schieber, the planting of salmon fry was begun in

1858. In that year 80,000 were planted; in 1859 and 1860, 30,000; none in 1861, 1862, and 1863; and from 1864 to 1866 a quantity varying between 28,000 and 39,000 per annum. After another interval of two years, the number planted annually from 1869 to 1874 varied between 10,000 and 45,000. As regards the following years I have no data.

To give an idea of the results obtained, I shall first give an example from the so-called "good old times." From a report for the year 1713, it appears that in that year there were caught near Hameln, all in all, 245 salmon, weighing 2,019½ pounds. (See Circular of the German Fishery Association, 1880, p. 69.) After the planting of young fry, referred to above, the Hameln salmon fisheries increased in a wonderful manner, the number of salmon being noticeably less in those years when no young fry were planted. There were caught, in 1862, 2,600 salmon; in 1863, 4,000; 1864, 5,000; 1865, 1,500; 1866, 1,100; 1867, 900; 1868, 1,500; 1869, 1,800; 1870, 2,000; 1871, 600; 1872, 2,200; 1873, 1,000; 1874, 7,500; 1876, 2,300; 1877, 1,870; 1878, 1,200; 1879, 487; 1880, 1,250. The statistics of the last two years, however, do not comprise the number of fish caught near Wehrbergen and Lachem. For the years 1881, 1882, and 1883, I possess no data.

The annual rent for the salmon fisheries near the Hameln weir was, in 1856, only 1,830 marks [\$439]; it rose to 12,000 marks [\$2,856] for the three-years' period of 1866 to 1868; declined to 5,537 marks [\$1,317.80] and 4,665 marks [\$1,070.27] in 1869 and 1874, respectively; rising again to 15,285 marks [\$3,637.83] for the period from 1875 to 1879; and was 15,660 marks [\$3,731.08] in 1877-79; and 10,005 marks [\$2,381.19] in 1880. The Hude salmon fisheries, below the weir, the private property of some citizens of Hameln, rented for 18 marks [\$4.28] in 1846, later for 300 marks [\$71.40], and for 4,560 marks [\$1,086.28] during the period from 1877 to 1880. These figures certainly prove the success of salmon planting in the Weser. In Hameln we find the very rare instance of fisheries whose results do not shun publicity, because the fisheries are rented to joint-stock companies whose shareholders demand full and accurate statements.

Above Hameln, also, the salmon fisheries show a large number of fish, compared with previous years, whenever the condition of the river enabled the fish to pass the weir referred to above. Thus, in the autumn of 1865, the Fulda salmon fisheries were so productive that a pound of salmon sold for 30 pfennige [about 7 cents]. Mr. Schieber, of Hameln, caught 65 salmon from the 5th to the 8th of November, near Daub's Mill, on the river Eder, a tributary of the Fulda (see Circular of the German Fishery Association, 1872, p. 195). Of late years the Fishery Association of the district of Kassel has also taken up salmon-culture, and plants salmon fry in the waters of that district, so that we may look for still further development of the salmon fisheries.

If during the last few years the Hameln salmon fisheries have been less productive, the reason therefor must be found in unfavorable

conditions of the water and the weather, and also in the fact that numerous salmon fisheries are now carried on also in the Weser below Hameln. Preuss says, in an article published in the *Weser-Zeitung* in 1874, and reprinted in the circulars of the German Fishery Association, 1874, pp. 74 *et seq.*, entitled "Fish and Fisheries of the Lower Weser," that the salmon fisheries had reached their lowest ebb; in that year a single large salmon (weighing 25 pounds) had been caught near Kaseburg, while smaller fish, weighing from 1 to 2 pounds (here we recognize the results of the Hameln establishment) were more frequent. About the year 1879 the salmon fisheries of the Lower Weser began to increase very perceptibly. In 1879-'80 an unusual number of salmon, weighing from  $3\frac{1}{2}$  to 5 pounds, were observed near Stolzenau, and in 1880-'81 extraordinarily large quantities of salmon were caught. It deserves to be mentioned that at that time, even during the most successful fishing season, nearly all the fish caught weighed 9 or 10 pounds, a uniformity which had never been observed before, and which also points to the planting of artificially-hatched fry farther up the river. (See "Report by Mr. Kleinschmidt, of Stolzenau," in Circulars of the German Fishery Association, 1878, p. 147.)

The salmon fisheries of the Lower Weser, which formerly had hardly amounted to anything, began to develop rapidly, and new fisheries were started. On the river banks from Oslebshausen ( $1\frac{1}{2}$  German miles [6 or 7 English miles] below Bremen), as far as the Baden Hills ( $2\frac{1}{2}$  German miles above Bremen), there are now said to be 16 or 17 salmon fisheries. In Bremen itself four different fishery associations are engaged in the salmon fisheries (*Deutsche Fischerei-Zeitung*, 1883, p. 35). Although some of the Bremen salmon fisheries are not favorably located, the Lower Weser has nevertheless, of late years, yielded a considerable number of salmon. In February, 1882, for instance, so many Weser salmon were brought into the Geestemunde market that they were sold at 1 mark 70 pfennige [40 cents] per pound. In the spring of 1883 the salmon fisheries of the Lower Weser were still more productive. In view of these circumstances, it is not surprising that the Hameln salmon fisheries do not always yield as good results as in former times, when there were but few such fisheries on the Lower Weser.

The territory of the River Ems, where the salmon fisheries had also declined, and, properly speaking, have, with few exceptions, never amounted to much, has since 1878 been stocked with young salmon on a large scale by the German Fishery Association. A small beginning in that direction had been made in 1872 and 1874, when 17,000 young salmon were planted. As to the results, I have but very few and imperfect data, as many portions of this territory are but sparsely populated, and but little attention is given to the salmon fisheries and their statistics.

Near Quakenbruck there were exceptionally successful salmon fish-  
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eries in the autumn of 1874, while during the following years, they were poor. The successful fisheries of the year 1874 may possibly be traced to the planting of young salmon in 1872, for the male salmon often leave the sea and ascend the rivers in their third year. In the autumn of 1881 a considerable number of salmon were observed at the Hanock-en-fahr weir (which has a salmon-way) above Lingen. In the Hopster River (*i. e.*, in its lower portion) there were caught, in 1880, 9 salmon; in 1881, 62; and in 1882, inclusive of those caught in the lower portion of the Voltlager stream (a tributary of the Hopster River), about 500 pounds. The Quakenbruck salmon fisheries in the river Haase, in 1880, yielded 20 salmon; in 1881, 50; and in 1882 (including some fish caught in the Wran, a tributary of the Haase), 900 pounds.

Near Friesaythe (Oldenburg) the annual yield of the salmon fisheries was, under favorable circumstances, about 40 fish; while in the autumn of 1882, although the fisheries could only be carried on for eight days, owing to the high water, 30 salmon, weighing on an average 10 pounds apiece, were caught during that short time, from which we may draw the conclusion that a larger number of salmon than usual came that way.

I must not forget to notice that a number of salmon made their appearance in the river Werse (a tributary of the Ems), near Munster, where I planted young salmon in 1878. Favored by the high water, a number of salmon coming from the sea crossed the weir in the Ems near Rheine and ascended the Werse, where, in the beginning of July, 1882, salmon very unexpectedly made their appearance near the Havichhorst Mills. Owing to the lack of the necessary fishing apparatus, only a few could be caught; but when the water had again become clear some 20 salmon could be observed in front of the mill-dam. Even the oldest inhabitants could not recollect ever having seen salmon in that neighborhood. (See Circulars of the German Fishery Association, 1882, pp. 129 and 130; 1883, p. 15.) In July, 1883, some more salmon were seen in the Werse, and both in its lower portion, as well as in the Ems, near the place where the Werse flows into it, many such fish have been observed, as is stated in the official reports.

I now come to the Rhine, one of our most important salmon rivers, and my observations will of course also embrace the Netherlands, where the Rhine flows into the sea.

When the French Government was still in possession of Huningen, it took great trouble to introduce young salmon in the Rhine valley, and since 1870 Germany and Switzerland have continued to plant young salmon. During the period from 1879 to 1881, young salmon from Huningen have also been planted on French territory near the sources of the Moselle, near Epinal, &c. The Netherlands have also followed the example set by Germany, and the Dutch Government pays rewards for the planting of young salmon.

The largest share of the Rhine salmon fisheries at present belongs

to the Netherlands, which country makes the very best use of her natural advantages. The Dutch catch a very large quantity of salmon; and even in poor years the monthly yield of their salmon fisheries is estimated at about 10,000 fish (*Deutsche Fischerei-Zeitung*, 1880, p. 269). The success of the salmon fisheries in the Rhine valley, from the Dutch-German frontier, mainly depends on high water in the Netherlands at the seasons when the salmon ascend the river, and when the Dutch fisheries either come to a close or are only carried on in a desultory manner. Unsuccessful German and Swiss salmon fisheries (as those of 1879 and 1880), even when the conditions of water and weather are not entirely unfavorable, must not lead us to the conclusion that the planting of young salmon in the German portion of the Rhine valley has been a failure. Thus, Mr. Bieler, of Basel, reports, in 1880, that for the last three years there had been more *sälmling* (salmon which have not yet been to sea) in the Rhine, than the oldest fishermen could recollect (*Deutsche Fischerei-Zeitung*, 1880, p. 411). Not to trace such facts to the planting of artificially-hatched young salmon is sheer obstinacy in spite of better knowledge. If we could get reliable and full reports on the Dutch salmon fisheries, conclusive proof could doubtless be furnished of the good results of the planting of young salmon in the middle and upper valley of the Rhine. Unfortunately this has, so far, not been possible. The statistics of the salmon brought to the Kralingsche Veer (the largest Dutch fishmarket) do not give us the full figures, because the dealers often buy their fish direct from the fishermen. The number of fish brought to the Kralingsche Veer by the fisherman has also decreased, owing to the fact that all fish brought to that market have to pay a tax of 5 per cent of their value. While in 1863 35,300 salmon were brought to the Kralingsche Veer, the number in 1869 was only 15,500, which decrease, under the existing circumstances, can by no means be construed into a decline of the Dutch salmon fisheries. (See Mr. Quakernaat's Dutch report, in Circulars of the German Fishery Association, 1871, I, p. 24.) During the period from 1870 to 1880 the largest number of salmon brought to the Kralingsche Veer in a year was 77,070 (in 1874), and the smallest 21,687 (in 1870). (See Circulars of the German Fishery Association, 1881, p. 148.)

In view of the Dutch robbery-system of fisheries, we may well maintain that, if Germany and Switzerland did not annually plant large quantities of young salmon, the Dutch fisheries would not long continue as successful as they are at present. Such rich fisheries cannot merely be the result of natural spawning, for on the Upper Rhine the waters in which the salmon find suitable spawning places are anything but numerous. To become convinced of this, one has only to see the rivers and streams which in Baden flow from the Black Forest into the Rhine, and which in their lower and middle course have generally been subjected to so many improvements that it would be hard for the salmon to find a spawning place; numerous weirs, moreover, hinder the

salmon from reaching the upper and more favorable portions of these tributaries of the Rhine. If Germany and Switzerland were for a number of years to cease planting salmon fry in the Rhine valley, the results of the Dutch salmon fisheries would soon undergo a change, and the Dutch might be induced to carry on their fisheries in a more reasonable way. But, as it is, we go on planting salmon fry from year to year and only reap those fruits of our trouble which mere accidents procure for us.

That in spite of this, and in spite of unfavorable years, the salmon fisheries on the Upper Rhine have, on the whole, progressed, will be seen from the rent paid for the salmon fisheries near Badish and Swiss Laufenburg. In 1860 the rent was 4,000 francs [\$772]; in 1866, 8,000 francs [\$1,544]; in 1872, 17,000 francs [\$3,011]; in 1878, 23,600 francs [\$4,554.80]; and in 1880, 30,500 francs [\$5,886.50]. (See Circulars of the German Fishery Association, 1882, p. 170.)

A remarkable proof of the success of planting young salmon was furnished in the river Kyll, flowing into the river Moselle below Treves, where many years ago salmon had become a great rarity. After I had in 1876 planted salmon fry in this river, by commission of the German Fishery Association, the first salmon made their appearance in the Kyll in the autumn of 1879, when about 30 were caught near Ehrang, while in the autumn of 1880 the number rose to 150. We should not fail to mention that the fish which were caught in the Kyll, in order to reach that river, had to clear the weir at the junction of that river with the Moselle, which they were enabled to do at certain times by the unusually high water. Many of the salmon, however, will have found it impossible to do this, and they would remain in the Moselle and become the prey of the fishermen of that river. The good salmon fisheries in the Lower Kyll in the autumn of 1880 lowered the price of salmon in that part of the country to 50 pfennige [11½ cents] per pound. As regards the following years I have no statistics.

Of late years the Fishery Association of the rivers Ruhr and Lenne, at Menden, in Westphalia, has begun to plant salmon fry, and already good results are apparent, especially since the murderous trap at Broich was abolished. Whenever the condition of the water is any way favorable, numerous salmon make their appearance in front of the weir in the river Ruhr, near Witten, and some of them even go as far as Arnsberg, a thing which did not happen before for a great many years.

Another, though not such a striking, example of the success of artificial salmon-culture was furnished last winter at Freiburg, in Baden, when, favored by the high water, a number of salmon ascended the river Dreisam as far as the city of Freiburg, no doubt as a result of the planting of salmon fry farther up the river some years previous. The oldest people at Freiburg do not recollect ever having seen salmon before in that part of the Dreisam. During ten days about 100 pounds of salmon were caught, all young male fish, with the exception of an



old female, weighing on an average 5 pounds. These salmon were caught only with the view to get eggs for artificial hatching; if the salmon fisheries at that time had not been closed for others on account of the season of prohibition, they would, although somewhat hindered by the high water, have yielded still better results. In the Danube, where formerly there were no migratory salmon, the German Fishery Association has, in the upper parts of the river, for some years planted fry of Rhine and California salmon. The results of these plantings have not yet appeared.

From this brief review it will be sufficiently evident that the efforts of the German Fishery Association have not been in vain, but have, in many instances, been crowned with remarkable success. In spite of this, Professor Malmgren thinks that the German Fishery Association has lost the confidence of the Government, for, on p. 14 of his pamphlet, he says: "It is a very noteworthy fact that the German Government, which hitherto has specially favored the enterprises of the German Fishery Association, and which very materially aided the Berlin Exposition of 1880, which had been planned by that association, last year refused even the smallest appropriation to enable Germany to be represented at the International Fisheries Exhibition in London, in consequence of which the association has been compelled to abandon its idea of participating in that exhibition."

Any one who can read between the lines will readily see that Professor Malmgren thereby means to intimate that the German Fishery Association, whose work had been in vain, had lost the confidence of the German Government, as was shown by its refusal to grant an appropriation. Professor Malmgren may rest assured that the refusal of the appropriation was not owing to this cause. Before the president of the association made the request of the Government he asked a number of the members for their opinion on the subject. I was also asked for my opinion, and I do not hesitate to give once more the views expressed by me at the time. I thought it my duty to call attention to the fact that England, although occupying a very prominent position among the nations engaged in fisheries, refused to participate officially in the Berlin Exposition. Only a few firms engaged in the manufacture of fishing tackle had made an exhibit, and besides these, if I remember right, a few private individuals had exhibited a few insignificant articles. Every visitor to the Berlin Exposition will remember the scantiness of the English department. Even the Chinese had shown more sympathy with our efforts than proud Britain, which looks with envy upon our great national uprising, dating from 1871. After Germany had sufficiently shown at the Berlin Exposition what it can do in the matter of fisheries, and as we, after England's action in 1880, did not feel under any special obligations towards that country, my opinion was that, under the circumstances, it would be best for Germany not to be officially represented at the London Exhibition, all the more as a considerable

sum would have been required to do this in a manner worthy of our country. I believe that many other persons entertained the same views. If the president of the German Fishery Association asked the German Government for an appropriation, it was a step dictated by simple politeness. The Government did not comply with the request, because it thought that no special advantage could be derived from our being represented at the London Exhibition. The president of the German Fishery Association has not been painfully disappointed thereby, nor has the German Government by its action intended to express any displeasure with the association, for, at the instance of the Government, a number of prominent members of the association were sent to London in order to report on the exhibition. These reports are to be published by the German Fishery Association, for which purpose the Government has granted an appropriation.

#### AUSTRIA.

In this country artificial fish-culture has also, during the last ten years or more, made good progress. Very remarkable results have been obtained in Bohemia as regards the salmon-culture of the valley of the Elbe, and this at a very trifling expense, as has already been stated under the head of Germany. Young salmon have also, during the last few years, been planted in the territory of the Upper Vistula, but so far no results can be recorded. Austria has more especially devoted her efforts in artificial fish-culture to the various kinds of trout, and, as I have been informed, very satisfactory results have been obtained by private individuals.

If Professor Malmgren endeavors to find some connection between the closing of the Salzburg establishment (founded in 1865) and the decline of artificial fish-culture, he certainly labors under a mistake. It is true that Professor Malmgren mentions the article on the Salzburg establishment, by M. Schrayner (*Deutsche Fischerei-Zeitung*, 1882, p. 151), but without quoting those passages which show its defects. Schrayner states expressly that the Salzburg establishment was by no means a model institution, but that it suffered from a combination of unfortunate circumstances. The two branch institutions of Seekirchner and Hintersee, although in a good condition, were not able to save the main establishment. As early as 1871 I learned from very good authority that the establishment rested on an unsound basis, and would sooner or later have to be closed. Why does Professor Malmgren pass these facts in silence, although he must certainly have been acquainted with them from Schrayner's article?

#### ENGLAND.

Professor Malmgren questions whether artificial fish-culture has met with any success in England, and ascribes the increase in the number of fish to the strict observance of the seasons of prohibition. People

in England, however, feel convinced that artificial fish-culture has contributed its share towards the development of the salmon fisheries, of course aided by the strict prohibitory measures, to which our German fishermen object so much. It is beyond a doubt that the large salmon-cultural establishment at Stormontfield has greatly promoted the Tay salmon fisheries. I possess no extended information relative to the English fisheries, but I have been told recently that in July, 1883, the Scotch salmon fisheries were exceptionally productive, especially near Carloway, Loch Resort, Uig, and Kean. One hundred salmon have been caught there at a single haul, weighing from 10 to 30 pounds apiece. In consequence of these rich fisheries the price of salmon fell to 6 pence per pound. At the same time great quantities of salmon were observed near the Lewis Islands. People there are generally convinced that these results are due to artificial salmon-culture in connection with the prohibitory measures (*Deutsche Fischerei-Zeitung*, 1883, p. 279). As far as I can learn, people in England are likewise satisfied with the results of artificial trout-culture, and during his visit to the London Exhibition, Professor Malmgren might have learned that people in England do not share his gloomy views regarding artificial fish-culture in general.

A very encouraging fact is mentioned regarding Loch Leven; one hundred years ago the income from the fisheries in that lake did not amount to more than £700 per annum, while now, thanks to artificial fish-culture, it is upwards of £3,000 [\$15,000]. As an instance of the way in which even comparatively poor fishermen are benefited by artificial fish-culture, we may mention the fishermen of Costa (Yorkshire), who annually plant from 12,000 to 14,000 trout fry in their waters and obtain very good results. (See report by Raveret-Wattel in Circulars of the German Fishery Association, 1882, p. 65.) The number of fishery associations in England is very great. Unfortunately the English waters, in spite of all prohibitory measures, suffer frequently from the injurious influences of manufactures, and artificial fish-culture will doubtless do its share towards remedying this evil.

#### SWEDEN.

The great activity in the field of artificial fish-culture which we find in Sweden, is, according to Professor Malmgren, without any result as regards the increase of fish in the open waters. He mentions, among the rest, the closing by the Government of the normal fish-cultural establishment of Ostanbeck, after it had been in existence for eighteen years. I do not know what circumstances have brought about this result, but it seems to me a forced conclusion to consider it, as Professor Malmgren does, as an indication of the decline of artificial fish-culture in Sweden, especially if we consider the undoubted results of artificial fish-culture in other parts of that country.

Before I give any instances I must once more refer to the difficulties

already mentioned under the head of Russia, under which fish-culture labors in the North of Europe, owing to the spring-water theory. If fish-culture in Sweden had not to suffer from these difficulties it would undoubtedly be able to show much greater results. Mr. von Yhlen, the Swedish inspector of fisheries, discussed this whole question some years ago in an article on "salmon-culture in Sweden" (*Deutsche Fischerei-Zeitung*, 1880, pp. 130, 189, and 214), and has recommended the use of ice for cooling the spring water.

In spite of this, artificial salmon-culture in Sweden has not been a vain labor, as Professor Malmgren seems to think it has. Although the data in my possession are very scanty, they nevertheless show some remarkable instances of the success of salmon-culture. According to the official report, Sweden, in 1883, had 60 fish-cultural establishments, mostly engaged in salmon-culture (*Deutsche Fischerei-Zeitung*, 1883, p. 45). The following data will show that, on the whole, the labor of these establishments has not been in vain. In 1870 the Nissa River, which flows into the Cattegat near Halmstad, did not contain a single salmon. After it had been stocked with salmon fry, 25,000 pounds of salmon were caught in 1878, a result which, in Sweden, is traced directly to fish-culture. (See *Deutsche Fischerei-Zeitung*, 1878, p. 355.)

Salmon-culture is also carried on on the Laga River (which flows into the Cattegat south of the Nissa). The salmon fisheries in that river had steadily increased for several years, and in the autumn of 1881 such an extraordinarily large number of salmon was observed that, near Karsefors, they actually filled the river from bank to bank. (See *Deutsche Fischerei-Zeitung*, 1882, p. 237.)

On the Ljusne River, which flows into the Gulf of Bothnia, and which possesses several salmon-cultural establishments, the salmon fisheries are exceedingly productive. Near Ljusne, where the principal salmon-fisheries are carried on, there were caught, in 1881, 3,432 salmon, weighing 67,160 pounds, and valued at 30,481 crowns [\$8,168.90]; and this result is considered as entirely due to the fact that salmon fry have been repeatedly planted in the Ljusne River.

Near Carlstad, on the Wener Lake, the salmon fisheries became unusually productive towards the middle of June, 1883, from 400 to 500 salmon being brought to market every day (*Deutsche Fischerei-Zeitung*, 1883, p. 219). Are we not justified in ascribing this to the results of salmon-culture on the Klar River, which flows into the Wener Lake?

#### NORWAY.

The reports on artificial fish-culture in Norway, and especially on salmon-culture, are somewhat contradictory; but, on the whole, the results do not appear to have been very satisfactory.

As Professor Malmgren shows from official documents, 240 private fish-cultural establishments have been started in Norway since 1856, the majority of which were engaged in the culture of trout, *salbling*, and

*marine*, while only about one-third devoted themselves to salmon-culture. The greater number of these establishments have been closed in course of time, owing to the unsatisfactory results, so that in 1878-'79 only 38 were in existence, 16 of which were engaged in salmon-culture. Most of these 38 establishments are very small, only 5 reaching an annual production of 100,000 young fish. Although for a long time 1,000,000 to 1,500,000 salmon fry have annually been planted, no certain proof can be furnished—as Mr. Landmark, inspector of fisheries, states in his report for 1881—that artificial fish-culture has been in any way a benefit to the Norwegian salmon fisheries, which on the contrary seem to have declined.

As Director Haack says in the Official Reports on the International Fishery Exposition at Berlin, 1880, in the chapter on fish-culture (p. 37), salmon-culture in Norway was carried on in 50 rivers, as he was orally informed by Mr. Wallem, the Norwegian commissioner. Although this culture is not carried on extensively, the salmon fisheries, formerly on the decline, are said to increase slowly but steadily.

A report from Christiania, published in the *Deutsche Fischerei-Zeitung*, 1882, p. 28, describes the Norwegian salmon fisheries in 1881 as on the whole satisfactory. In the northern districts these fisheries were not so productive as formerly, but along the entire southern coast, from Arendal to Namsøe, both in the sea and in the rivers, it was better than during the preceding years. In spite of this the report says that it cannot be denied that the salmon fisheries are on the decline, and the cause of this is thought to be the very lax way in which the prohibitory measures are observed.

It appears from the above that the condition of affairs in Norway leaves much to be desired. I have not been able to obtain any further information as to the causes of the closing of so many fish-cultural establishments, but I am inclined to believe that one of the principal causes is the spring-water theory, to which I have already referred under the heads of Russia and Sweden. This method will secure only insignificant results, and be the source of many disappointments. It should, moreover, be taken into consideration that salmon-culture in Norway is only managed on a small scale by the various establishments, and doubtless with considerable loss. If, in addition to this, the prohibitory measures are not strictly observed we need not be surprised if the salmon fisheries do not increase as much as is hoped for. It is probable, however, that they would have declined still more if they had not here and there been aided by artificial fish-culture.

The Norwegian Government is fully aware of the necessity of a change as regards the stricter observance of the prohibitory measures, and some time ago laid before the Storting (the Norwegian Parliament) the draft of a law aiming at a uniform regulation of the salmon and salmon-trout fisheries. Among the reasons for this law the decline of the salmon fisheries is mentioned, and their promotion by strict

prohibitory measures pointed out as an urgent necessity. The proposed provisions of the new law go very far, prohibiting, among the rest, the catching of salmon and salmon-trout in the sea from August 26 to April 14, and in the rivers from August 26 to April 30. (See *Deutsche Fischerzeitung*, 1883, p. 262.)

#### DENMARK.

Although Professor Malmgren does not mention this country in his report, I must briefly refer to it. For the information given below I am obliged to the editor of the Viborg Fishery Journal.

As in Denmark the fisheries are not regulated by law, and prohibitory laws are unknown, artificial fish-culture is only carried on to a very limited extent. Years ago salmon-culture was carried on in Denmark, but only on a very small scale. In Jutland there are at present only five fish-cultural establishments, principally engaged in raising sea and brook trout. The quantity of eggs annually hatched in these establishments varies from 20,000 to 300,000, and the fry obtained in this way is planted in lakes, ponds, and brooks. The oldest fish-cultural establishment in Jutland is the one in Viborg, which was founded in 1865, in order to stock the lakes of that neighborhood with lake trout (*Trutta trutta*), which hitherto were not found there. The acclimatization of this trout in the lakes near Viborg has been successful, and this migratory fish has become a permanent fish. Since the Viborg establishment has annually planted 20,000 of the fry of this fish, several hundred pounds of *Trutta trutta*, mostly weighing from 5 to 10 pounds apiece, are annually caught in these lakes. The result would be still better if circumstances did not prevent the use of large nets and allowed only the use of small nets and lines. These acclimatized sea trout differ from their relations in the sea by having a shorter and broader shape; their flesh is never red, but always white. Although the Viborg establishment is only of limited extent, the results obtained are nevertheless a proof of the of success artificial fish-culture.

It is a very remarkable fact that of late years numerous schools of young salmon have made their appearance near the Danish island of Bornholm. Enormous quantities of these fish have been caught there during the last few years. I would, in this connection, refer to an article by Finn on the fisheries of young salmon near Bornholm (*Deutsche Fischerzeitung*, 1883, p. 145), which, written in favor of prohibitory measures, says that beyond a doubt these young salmon came from the rivers of some other country on the Baltic, as no salmon-culture whatever is carried on in Bornholm. It is probable that these young salmon are the products of Swedish and German salmon-culture. Just as with us, the Bornholm fishermen maintain that these young salmon are not *Salmo salar*, but a smaller kind of salmon spawning in the sea, a vague assertion which is only made in excuse of these reckless fisheries.

## UNITED STATES.

Professor Malmgren admits that some good results have been reached in shad-culture, but as regards the results of other fish-cultural experiments he is exceedingly skeptical. The results obtained in shad-culture deserve some fuller mention than Professor Malmgren makes of them. The shad had become somewhat rare in the American rivers, so much so, in fact, that when Professor Baird in 1873 intended to make a beginning with shad-culture in the Savannah River, Georgia, he could not obtain there the necessary spawners. The first attempt at shad-culture was made in the Connecticut River in 1867, and during the period from 1868 to 1873, 29 shad hatcheries were engaged in the culture of that fish in the United States. Convincing proof of the favorable influence of artificial fish-culture was furnished in the Connecticut River, where young shad had been planted since 1867. In the spring of 1870 unusually large schools of this fish were observed in Long Island Sound, near the mouth of the Connecticut River, and in May of the same year such enormous masses of shad were caught in the river as to throw into the shade even the best fish years of former times, some hauls yielding from 2,000 to 3,000 fish. The number of fish caught in 1871 and 1872 was even greater, exceeding anything since 1811. In 1872 the price of shad on the Connecticut River fell to from 5 to 10 cents apiece.

On the Hudson and the Merrimac the number of shad has likewise increased greatly. On the Hudson the price of shad in 1877 fell to 5 or 6 cents apiece, and these fish were cheaper than 20 years ago, when the price was three times as high. (Circulars of the German Fishery Association, 1874, p. 68; 1875, p. 327; 1877, p. 43.)

Satisfactory proof of the success of salmon-culture in the United States has also been furnished in the Connecticut River. After the salmon, in consequence of the construction of a weir, had since 1798 gradually disappeared from this river, a beginning was made in 1869, with the planting of salmon fry above the weir. In 1878, the salmon again made their appearance in the Connecticut River, and by the middle of June of that year 500 salmon had been caught. (See Von Behr's "*Amerikanische Lesefrüchte*" in Circulars of the German Fishery Association, 1878, p. 77, and 1879, p. 08.) Artificial salmon-culture has likewise proved very successful in California. As Professor Baird reports, the stock of fish in a California river, where annually 2,000,000 fry had been planted, rose from 5,000,000 to 15,000,000 pounds. (*Deutsche Fischerei-Zeitung*, 1838, p. 316.)

Successful attempts have also been made in the United States to cultivate artificially the cod. After the United States fish-cultural establishments at Gloucester and Wood's Holl, Massachusetts, had planted fry of the cod, the fishermen on the coast of New Hampshire, near Portsmouth, in the autumn of 1882, observed great numbers of small cod-

fish, measuring from 4 to 6 inches in length, something which had never been observed before. (*Deutsche Fischerei-Zeitung*, 1882, p. 369.)

Artificial fish-culture in the United States has been materially aided by the Government, and has been very successful. It should, however, be remembered that all these experiments have been made in the American style, that is, on a vast scale, the number of young fry planted far exceeding those planted in Germany.

#### CANADA.

The same zeal for promoting the fisheries has been displayed in Canada, in whose waters the number of fish had more or less decreased. Since the end of the sixth decade of the present century it has been the aim of the Canadian Government to promote the fisheries by suitable prohibitory measures, by aiding artificial fish-culture, and by constructing fish-ways. As Professor Malmgren states in his pamphlet, it was Samuel Wilmot who earned great credit by introducing artificial fish-culture in Canada. In the autumn of 1866 Wilmot made the first experiments with salmon-culture in Baldwin Creek (now Wilmot's Creek), a small river in Ontario. At that time salmon were not frequent in that part of Canada, for in the autumn of 1867 only about 30 were caught. In the autumn of 1868 numerous young salmon made their appearance in Wilmot's Creek, measuring about 22 inches in length; among all these salmon there were only three old ones. For twenty years no young salmon had been seen in these waters, and there could hardly be any doubt that this was a result of artificial fish-culture. The continued planting of fry since 1868 has tended to increase the number of salmon, so that in 1869 in the fish-house, which the salmon enter of their own accord for the purpose of spawning, more than three-hundred were observed at one and the same time. A great many more, engaged in spawning, were observed in the portion of the river extending from the fish-house to the lake (two English miles). (See Jagor, *Fischerei in Kanada*, in Circulars of the German Fishery Association, 1873, pp. 20 and 21.)

After such favorable results the Canadian Government has not failed to extend material aid to artificial fish-culture, so that in 1881 there were ten hatcheries where, besides salmon, the whitefish (a kind of *maräne*), lake trout, and brook trout were cultivated, the two last-mentioned kinds, however, only on a limited scale. Satisfactory results were reached with whitefish in the Detroit River, where the Canadians in 1878 caught 45,800; in 1879, 77,700; and in 1880, 103,500. The current expenses for Canadian fish-culture in 1880 amounted to 12,000 marks [\$2,856], and in that same year 21,500,000 fry were produced, among these 1,800,000 whitefish. In rivers where the salmon had become exceedingly rare, these fish have increased from year to year, thanks to the active efforts in the matter of fish-culture. (See Raveret-Wattel's Report on Foreign Fisheries in Circulars of the German Fishery Asso-



ciation, 1882, p. 68 *et seq.*; and Report of the Michigan Fish Commission in Circulars of the German Fishery Association, 1882, p. 71.)

Professor Malmgren thinks that there are no reliable data on the results of fish-culture in Canada, and that the undeniable fact of an increase in the number of fish must be owing to strict prohibitory measures. Without attempting to inquire why Professor Malmgren feels constrained to doubt the reliability of the Canadian reports, I must state that, for my part, I am inclined to believe that the undoubted results are caused by culture and prohibition combined. Why should the increased number of fish be caused only by natural spawning protected by prohibitory measures? Does Professor Malmgren not consider artificially-produced fry capable of life and development, or does he share the opinion of some people, that only artificially-produced fry, but not that which is produced naturally, becomes the food of larger fish? I am not able to explain the contradiction in Professor Malmgren's views, and shall be greatly obliged to any one who will assist me in solving this problem.

I herewith close this sketch, which gives merely an outline of the results which, so far, we have been able to chronicle in the matter of artificial fish-culture. The reader may judge for himself, whether the verdict which Professor Malmgren has pronounced on artificial fish-culture is justified by the facts. Let us rejoice in the results reached so far, and not be discouraged by pessimistic views like those expressed by Professor Malmgren, but continue to develop this industry in a rational manner. Quiet labor will find its reward in the future.

FREIBURG, BADEN, GERMANY.



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