American Fisheries Society
Transactions
1881

# AMERICAN FISHERIES SOCIETY

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# TRANSACTIONS

Volume 10

1881

# TRANSACTIONS

—OF THE—

# AMERICAN

# FISH CULTURAL ASSOCIATION.

## TENTH ANNUAL MEETING,

Held at the Directors' Rooms of the Fulton Market Fish-Mongers' Association, in the City of New York.

March 30th and 31st, 1881.


NEW YORK.

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# OFFICERS, 1881-82.

ROBERT B. ROOSEVELT, - - - PRESIDENT.
*New York City.*

GEO. SHEPARD PAGE, - - - VICE-PRESIDENT.
*New York City.*

EUGENE G. BLACKFORD, - - TREASURER.
*New York City.*

BARNET PHILLIPS, - CORRESPONDING SECRETARY.
*Brooklyn, N. Y.*

JAMES ANNIN, JR., - - RECORDING SECRETARY.
*Caledonia, N. Y.*

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FRED. MATHER, - - - *Forest and Stream.*

G. BROWNE GOODE, - - - *Washington, D. C.*

SAMUEL WILMOT, - - - *Ottawa, Ont.*

BENJAMIN WEST, - - - *New York City.*

THOMAS B. FERGUSON, - - - *Baltimore Md.*

JAMES BENKARD, - - - *New York City.*

JOHN B. MORGAN, - - - *Brooklyn, N. Y.*

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# TENTH ANNUAL MEETING

—OF—

# THE FISH CULTURAL ASSOCIATION.

WEDNESDAY, March 30th, 1881.

THE meeting was called to order in the Director's Room of the Fulton Market Fish-Mongers' Association, in the City of New York, by the President, Hon. ROBERT B. ROOSEVELT.

The Secretary read the minutes of the last meeting, which were approved.

Mr. MATHER then proposed an amendment to the Constitution to permit honorary members to be elected by a two-thirds vote, the same to be added to the Constitution as part of Article II, relative to members, and to read as follows: "Any person shall, upon a two-thirds vote of the Society, be considered as an honorary member of the Association."

MR. MATHER'S proposition was approved of.

MR. MATHER then proposed for honorary membership Dr. Theodatus Garlick, of Bedford, Ohio, the first American fish culturist, which was unanimously carried.

MR. E. G. BLACKFORD then announced the forced absence of the Vice-President of the Association, Mr. George Shepard Page, who was then in England.

THE Treasurer, Mr. E. G. BLACKFORD, then read the following letter from Mr. Page, dated at London, England, March 14th:

"As you are aware, there is to be a fishing exhibition at Norwich, England, Easter week, and Mr. Huxley will read a paper

there on the herring family. In all his magnificent collection of fishes he has no shad. I have urged him to introduce shad into the English, Scotch and Irish rivers. Indeed, knowing that none existed there, was the principal object of my visit to Mr. Huxley. It seems that Mr. Huxley had thought something of this kind would be well to do, but was not familiar with their habits or the food of the shad. Of course, on my part, I was only too happy to present details in regard to our shad. I may, perhaps, have rehearsed a great deal of that information we all get at our meetings. Anyhow, I told him that you would undoubtedly be glad to send over immediately by steamer a half dozen specimens on ice, a part of which he could preserve in alcohol at South Kensington, and the balance to be exhibited at the Norwich Fish Show. Mr. Huxley will, of course, give you credit for the same, both at the exhibition and at the museum. Mr. Huxley is also very desirous of knowing by what means he can secure millions of shad eggs the ensuing season, and I shall use my best exertions to aid in that matter, providing I can secure your valuable assistance. Just think that perhaps by our efforts we might succeed in giving some of these 35,000,000 English people as food, such a fish as the shad, and that there is a possibility that in eight or ten years these fish would be so abundant as to be had at a low price. Mr. Huxley will endeavor to convince landlords and those owning rivers that the modest shad will not eat up the aristocratic salmon. I want to add that I spent yesterday evening with Professor Huxley, and met there a great many people, and they were informed of the proposed plan for the introduction of shad into English waters, and that fresh shad and eggs were to be sent to Norwich in the future. Mr. Chamberlain, M. P., for Birmingham, was very much interested; since the fish business may come under his supervision he has promised to do all in his power to advance it. Professor Huxley would like you to send a few fresh herrings with the shad, so that he may compare them with the English fish."

MR. ROOSEVELT.—I believe that Mr. Mather has eaten the shad of Germany, and perhaps he will tell us how they compare with ours?

MR. MATHER.—The fish which is called shad in Europe is inferior to ours in flavor. In 1874, at the request of Professor Baird, I attempted to take young shad to Germany, but the attempt was a failure. At that time the question arose as to the comparative value of the two shads, some of the Germans holding that their maifish was as good as the American. This, of course, could not be decided by argument, and so it rested until last summer, when at the Berlin Fishery Exhibition it occurred to Mr. Von Behr, the well-known President of the German Fishery Association, to have some of their fish brought down for the American Commission to bring to the test of the knife and fork. Unfortunately, Prof. Goode and Mr. True were absent. That day and I was alone. We had a gridiron improvised from wire, for this household implement is unknown in Germany, and some shad were broiled and some boiled and served with sauce after the German fashion. The broiled fish was pronounced best by all—five Germans and Prof. Ward, of Rochester, N. Y., and myself—but we did not think it equal to American shad by any means.

MR. ROOSEVELT.—Will Prof. Goode tell us the ichthyological differences between the American and the European fish?

PROF. GOODE.—There is a difference observable in the scales, which in the fish of Europe are thicker and do not lie as closely as in the American. There are other differences in the opercular bone which show them to be a different species.

The following paper was then read by the PRESIDENT, on Hybridizing Fishes, by Mr. Seth Green :

MR. PRESIDENT AND GENTLEMEN OF THE AMERICAN FISH CULTURAL ASSOCIATION :—You have again met for the purpose of mutual benefit and an interchange of knowledge, such as has come under our observation during the past year.

The subject of hybridizing is one which has been demanding the attention of fishculturists, more or less, for the past few years, and whether any of the varieties of our fishes can be im-

proved upon by crossing the different breeds, is still a question. Of one thing we are certain, and that is, we would never know unless we tried. We know that many varieties of stock have been greatly improved by putting together different strains, and also that fruits and vegetables have been rendered more palatable by grafting and other methods of infusing the sap of the different varieties into each other. These questions are of comparatively old standing, and it has been definitely decided in many cases just which kinds will be improved upon by the process of hybridization. The field for experiment is large, and, as we live in a world of progression, there will doubtless be constant advances in these branches, as well as in other things. Hybridization with fish for the purpose of bettering them, as food, and also producing fish suited to the nature of our different waters is the problem we are trying to solve. We cannot change the natural characteristics of our different bodies of water, and hence we find it necessary to produce varieties of fish which will thrive and multiply in them or learn from experiment and observation which species will do the most good when deposited in certain waters. With plants and animals it has been learned which varieties can be crossed advantageously, and which are productive of the best results, but with fish this has not been ascertained, but there is no question but what it will in time.

There are very many difficulties attending the hybrydization of fish—much more so than in anything else. One of the troubles lies in keeping the experiment constantly under the eye, thus enabling you to watch the different stages of development accurately, and the habits of water animals cannot be as closely observed as those on the land. At different periods during my career as a fishculturist I have made several experiments with fish in hybridizing. The most successful one that I have been enabled to watch clear through has been brought out this winter. Three years ago, in the fall of 1877, at the New York State Hatchery, we crossed the female native brook trout with the male Lake Ontario salmon trout. A good per centage of the eggs taken and impregnated hatched. The offspring were healthy and they continued to thrive. The fish are a fine, trim-built fish, resembling both parents; they will weigh at the present time

from three-fourths to one pound each. Last November they commenced to spawn for the first time. They commenced the first and continued until the 12th of November, during which time we succeeded in taking 19,400 spawn, the males and females both being fertile. The eggs hatched in about ninety days, the season being prolonged by the unusual cold winter. The yolk sack has now disappeared and the young fry are feeding and doing well. The question now arises, Will they be capable of reproducing their own kind? My opinion is they will, but time will tell. I shall endeavor to put a few thousand into some of our lakes and streams and thus determine to what waters they are best adapted.

My next most successful experiment was with the cross between the California salmon and brook trout. They are now four years old and, like the salmon trout and brook trout hybrids, resemble both parents. The cross was made with female brook trout and male California salmon. Nearly all the fish have a deformed appearance; a few of them are perfect fish. Last season they exhibited signs of spawning. There were either no males among them, or, if there were, they were not fertile. On attempting to take the spawn from them the vent was found to be too small to pass the eggs. The aperture was enlarged and spawn taken and impregnated with brook trout milt. None of them hatched. The eggs were nearly the size of salmon eggs. The parent fish have done well and some of them will weigh nearly, if not quite, two pounds. I do not think this cross will ever amount to anything. The salmon used were those kept in confinement and not as large or in as good condition as in their natural state. I am of the opinion that if the perfect salmon and brook trout could be brought together a perfect cross might be made, or at least the experiment would be worth trying.

I have made several other experiments in hybridizing, such as crossing the hybrids with brook trout and also crossing them with salmon trout. I have also crossed the brook trout with the California mountain trout, all of which have been attended with more or less success. I have this season been trying a series of experiments in impregnating the eggs of brook trout, the results of which will undoubtedly be interesting to the society. My

first experiment was as follows : By using a small glass syringe I injected the milt of the male brook trout into the vent of the ripe female brook trout and left it there thirty minutes before taking the eggs. The result of this experiment was an impregnation of 75 per cent. In my second experiment I took the spawn from brook trout directly in a vial, and corked tightly, taking care that no water was allowed to get in. I then placed the vial under water and left it forty minutes, after which brook trout milt was put on them and remained in vial thirty minutes, the result of which was an impregnation of 75 per cent.

Third Experiment.—I injected milt of brook trout into ripe female, and allowed it to remain fourteen hours before taking. 15 per cent. of them proved to be good.

Fourth Experiment.—I injected milt of brook trout into ripe female, and allowed it to remain in fish twenty-four hours before taking. In this experiment none of the eggs were fertilized.

Fifth Experiment.—I injected milt of brook trout into ripe female, and left it in fish one minute before taking. 40 per cent was impregnated.

Sixth Experiment.—Took brook trout spawn in vial corked tightly, and placed under water for nine hours, after which milt was put on them. 15 per cent. of the eggs were impregnated.

Seventh Experiment.—Spawn was taken from female brook trout three hours after she had died, and milt from live male brook trout put on them. In this experiment 15 per cent. were found to be good.

As all fishculturists know the spawn of brook trout taken in the usual way adheres to the pan for from twenty minutes to half an hour directly after taking, we tried the experiment of putting them directly on the hatching trays within one minute after they were taken, and kept the pan in motion so they could not stick. The result of this experiment shows that the impregnation takes place almost instantaneously, as fully 95 per cent. were impregnated

During last summer I spent considerable time on several of our inland lakes investigating them, and teaching the local inhabitants how to catch the fish with hook and line with which

their waters have been stocked by the New York State Fish Commission. My efforts were attended with great success; I made several large catches, and taught many others how to do so. The effect will be to stop illegal modes of taking fish to a great extent in our inland waters. When the people learn that they have a fish barrel at their door, and can take a fish dinner in a short time, when they feel so disposed, they will see to it that the laws are enforced.

I learned during my investigations that the alewives breed in our inland lakes. This I consider a very valuable discovery. As fish food their value is inestimable, and all our lakes can be stocked with them. They are much more valuable than the fresh water herring, for the reason that they spawn in the spring and the eggs hatch in a few days. Whereas, the herring cast their spawn in the fall and are all winter in hatching, and consequently a much larger percentage of them is destroyed. The alewife hatches at a low estimate one hundred and fifty young fry for every one of the herring. It would be an impossibility to overstock any waters containing the alewives for food, and the fish found in the waters containing them are in the best possible condition. I hope to be able to stock several of our lakes with the alewife during the coming summer. This winter has been unusually severe and the ice has formed to a great thickness, and snow has fallen upon it to a considerable depth. In all small bodies of water, unless air holes are cut, there is always great mortality among the fish, caused by stagnation and lack of oxygen. Many of our larger inland lakes that do not usually freeze entirely over have this season been covered in some instances with ice two feet in thickness. While this would not materially affect the fish in ordinary winters where this is of short duration, I am of the opinion that where it has extended over a period of several months a great many fish will be destroyed by suffocation.

Waters can easily be depleted in this way to a great extent and no one ever be the wiser, for, contrary to the general opinion that all fish float when dead, my experience is that not one in ten ever comes to the top of the water.

MR. BLACKFORD.—I would call attention to one remark made by Mr. Green on the death of fish below the ice. If this is the case generally we should take measures to prevent it, and perhaps it would be well to invite discussion of this subject.

MR. ANNIN.—I saw a pond on the Genessee Flats, this winter, which was frozen over, and contained perch, catfish, etc. The ice was three feet thick, but near the head was a small spring, and it was packed full of small fish, all alive.

MR. MATHER.—The case mentioned by Mr. Annin is different. In the winter of 1855 I was trapping about the Grant River, Wisconsin, and near it along the Mississippi. There were along the latter river numerous sloughs where in the overflows the fish were left. One of these I knew to be full of fish in the fall, and in the winter cut through the ice to spear them. They were all dead and the stench was fearful.

MR. ROOSEVELT.—Mr. Annin tends to confirm Mr. Green. The fish were distressed, and crowded to the spring holes for relief. If there had been no springs to make an opening the fish would have died.

PROF. GOODE.—I do not care to argue this question, but having given some attention to the hibernation of fishes in cases where they assume a torpid condition and vitality seems suspended, it may be well to state that in Africa there are fishes which live in a state of æstivation or a suspension of life in summer. They live in the mud when the ponds dry up, and wait for the rainy season to release them. We also know that in high Northern latitudes the fish go into a state of hibernation as the temperature falls to a certain point. Mr. Mather has published some experiments with mud-minnows. I should think that in some cases the instinct of hibernation might be hereditary, and often death might ensue while the fishes were torpid.

DR. HUDSON.—The question arises if a pond of large size freezes entirely over. Most large bodies of water have air holes.

MR. MATHER.—The one to which I referred on the Mississippi bottoms had no air hole. It was about three acres in extent, and perhaps five feet deep, with two feet of that solid ice from shore to shore.

THE SECRETARY then read a communication by Mr. H. D. McGovern, on the Habits and Food of the German Carp :

It is with pleasure that I place before you some of my experience with fishes, more particularly the carp, during the past year. In the carp I have taken great interest, and have been, I am glad to say, successful in developing their growth in our New York State waters. My first mention will be of a lot of eighteen-months-old carps, thirty-five in number, placed by me in a pond prepared for them. The pond was three feet in depth, there being a bottom of mud or fine loam of six inches. Some of my carp would turn the scales at two and a half pounds previous to placing them in the pond, which was constructed for observation and fed from springs. In the early part of January I kept an air hole open in the ice which had accumulated on the pond, and fed the fish by means of a wooden spout, one foot square and four feet long, inclosed in a large sheaf of cat-heads and closed at the opening with a wad of salt grass to keep the frosty air from entering the tube or shaft. When I wanted to feed my carp I would remove the grass wad and drop my food down the aperture, after which I would obscure the light from the opening by throwing a coat over my head, and would then be rewarded by seeing all fish within range of the opening at the bottom. By this means I could ascertain the fish most relished by the carp. And here it is well to say that they disposed of oat meal dough and a dough of rye meal mixed with chopped cabbage more quickly than any other kind of food given them. My shaft worked well until the temperature fell to zero, for then, notwithstanding the covering of reeds or cat-heads, it closed up, and I was compelled to cut holes in the ice and remove all the particles remaining.

After the opening was cleared I would drop in food, and as the fish were not shy they would come to the opening and hover

around after eating. Then suddenly you would see a fine carp turn over on its side and, as if attracted by magnetism, come to the under part of the ice and there stick fast. I extricated some few, which you will see on exhibition in the market, with my other fish on Mr. Blackford's stand. I could have saved more of them, but, to use an old fisherman's phrase, I could not see the point of wasting a mackerel to catch a sprat. Now, gentlemen, I am inclined to think that a carp pond should be at least four feet deep, with a foot of soft bottom, making in all five feet. I say this only for our Northern waters, and would not recommend feeding in the months of December, January and February, as I think the fish I have mentioned would have gone in the mud and be safe now had I not given them the habit of being fed in frosty weather. They are a fish that I can assure you will withstand any amount of handling in moderate weather, and live longer out of water than any other fish I have ever handled. Some time ago I took an eighteen-months-old carp from my pond—its weight was about two pounds—folded it in a piece of wet bagging, brought it to my home, No. 288 Fulton street, a distance of four miles, and laid it on a slab while I partook of dinner. I then started with it for New York, and arrived at Mr. Blackford's stand two hours and thirty minutes from the time the fish was taken from the pond. I placed the fish in one of the tanks, and in presence of many of the market men the carp swam off as if it had only been changed from one tank to another. There was no swooning nor cause for resuscitating. I would still further inform those who may have carp in their ponds, not to be astonished if, after placing them in one pond, at the lapse of a month or two they find them in an adjacent one having no seeming connection with the first. The fact is, the carp will jump three feet, and then like an eel wriggle its way over damp grass, and make its way to other waters. This has been my experience, and having had, previous to its introduction from Germany by Prof. S. F. Baird, but very little knowledge of the fish. I suppose some of my associates in this body are still in the same position of uncertainty in regard to the carp as I was in previous to my personal investigation.

MR. ANNIN.—My experience with carp has been that I received seventeen from Mr. Blackford and have only one left.

A MEMBER.—I would like to ask if we have not had the carp in the Hudson River for years? I have heard of their being caught there quite often, but do not know if they are the same as the so-called German carp.

MR. ROOSEVELT.—I have seen many hundreds of the carp in the Hudson. They seldom grow above a pound in weight, but in Ohio they have a carp which weighs several pounds; as much as seven, I think.

PROF. GOODE.—The fishes spoken of are not the German carp which has lately been introduced. The latter are best for warm waters, especially in the Southern States. In the national carp ponds at Washington there are now two hundred of the original carp brought from Germany some four years ago; many of them are so large that they cannot be put in an ordinary wash-tub. The smallest of them will weigh over fifteen pounds. So great has been their growth in America that the Germans have applied for some of the stock to improve their own. A carp sent to Texas when only a few inches long, grew to eight pounds in one year.

MR. MATHER.—I collected all the accounts of the growth of carp in America, and read them before the Central Fishcultural Society at its last meeting at Chicago. It was published in *Forest and Stream* of January 27th, of this year, and will soon appear in the report of the society referred to, of which I have the honor of being corresponding secretary, and I will be pleased to mail that report to any members of this association who may apply for it.

MR. ROOSEVELT.—I forget what that large carp in Ohio is called. I gave some account of it in a book of mine, published many years ago.

PROF. GOODE.—The President probably refers to some of the

"carp-suckers," which from their superficial likeness to the carp, are so called. They are common in the Ohio Valley and occur in the great lakes. They were called *Carpiodes* by Rafinesque and belong in the family *Catostomidæ* or suckers, and not in the family *Cyprinidæ*, where the carps are. There are half a dozen or more species, which are locally known as spear fish, moon carp, etc.

MR. MILLER.—We have quantities of Ohio carp here at times in Fulton Market. They are slightly red.

MR. BLACKFORD.—The fish referred to is the Lake Sheepshead, *Haploidonotus grunniens*, and not the one referred to by Mr. Roosevelt and Prof. Goode.

MR. MILLER.—I once had a Hudson River carp which lived two days out of water in the bottom of a barrel, and when put in an aquarium he swam off none the worse for it.

MR. PHILLIPS.—The fish which is called carp in the Hudson is simply an uncolored gold fish.

MR. MATHER.—Mr. Phillips is correct. The mark which distinguishes the true carp from the gold fish is the fact that the former has a barbel or beard attached to each side of the upper jaw, near the angle of the mouth, while the gold fish has none. The Hudson carp has no barbels.

MR. PHILLIPS.—I once went up the Hudson to collect these carp for the Smithsonian at a time when it was claimed by some that there were good carp in the Hudson. A gentleman of color professed to be able to get them in quantity and I employed him. He brought in a very poor specimen which, as he promised more, I threw away ; but no more were forthcoming, and I was forced to return without the specimens.

MR. MATHER.—You will find the Ohio carp figured in the first annual report of the fish commissioners of that State for 1875

and 1876. It has the rays of the front part of the dorsal fin exceedingly elongated.

DR. HUDSON.—Among the carp distributed by Prof. Baird are three varieties of one species. There is the scale carp, which is covered with scales; the mirror carp, which has a few large scales in different parts, or perhaps a row of them along the back, and the leather carp, which is naked. Mr. Hessel thinks the latter are best, and Prof. Baird thinks that all the carp in America are tending to the nude variety and will eventually become so.

MR. ROOSEVELT.—In Europe they have worthless varieties of carp as well as good ones.

MR. BLACKFORD.—If you will take a walk through Fulton Market some morning you will hear the cry, "Here is your German carp!" but so far there have been no true carp in the market. There have been several different fishes sold as the German carp here, among them the fish called "Buffalo" in the West. I have not eaten them, and do not know how they would compare with the carp.

MR. MATHER.—I have eaten both fishes, and while they are neither of them what we would call first-class fishes, the carp are the better of the two. I have eaten carp that were very good and carp that did not seem so good. The Germans often cook carp in beer or with a beer sauce, which is no doubt excellent to those who are accustomed to it, but did not strike me as being a delicate combination. The carp has a more solid texture than the Buffalo fish. The excellence of the carp lies in the fact that it grows in waters which produce nothing edible, and in the inland portions of the South and other parts where there are no good fish.

MR. ANNIN.—To what class does the Buffalo belong?

PROF. GOODE.—It is also one of the *Catstomidæ* or suckers. There are two genera now, according to the latest authorities, the *Ichthyobus* of Rafinesque and the *Bubalicthys* of Agassiz.

MR. MORGAN.—Will the carp take the hook ?

MR. ROOSEVELT.—We read of its doing so in Walton and the older angling books ; modern books do not say much about it.

THE SECRETARY then read a paper by Dr. Tarleton H. Bean, entitled, A Contribution to the Biography of the Commercial Cod of Alaska :

" The codfishery of Alaska has nearly ended its second decade, yet we did not know positively until the summer of 1880 what species is the object of that fishery. Most writers have referred to it under the name of *Gadus macrocephalus*, which was created by Tilesius for the Kamtchatkan cod, the figure of which suggests that it was based upon a deformed individual. Cope, in 1873, described the young of the common Alaska cod as *Gadus auratus*, from specimens collected by Prof. George Davidson, at Unalashka. Steindachner, in the Proceedings (*Sitzungsberichte*) of the Vienna Academy, lxi., 1, 1870, adopts the name *G. macrocephalus* for a large cod taken in Decastris Bay ; in this example the length to the head is contained exactly three times in the length of the extreme end of the pointed caudal peduncle. The same proportion may, however, be found in any place where large numbers of *Gadus morrhua* are taken, and it is only a matter of individual variation. The Commissioner of Fish and Fisheries, Prof. S. F. Baird, with a view to investigating the fisheries and the fish of Alaska, sent the writer to that territory to collect specimens and statistics during the summer of 1880. Thus an opportunity was gained for comparing the Alaskan cod directly with that of New England and of Europe, and for determining that the commercial cod of both oceans is the *Gadus morrhua* of Linnæus. I have not seen the species from Kamtchatka, but there is no probability that it is different from the Alaskan. It is a matter of daily experience to find long-headed and short-headed cod in the same school off the New England coast, the length of the head being one of the most variable characters. A series of cod showing just such variation, has lately been received from Alaska by the National Museum.

Golden cod, red cod and other algæ forms are as well-known at the Shumagin Islands as they are around Cape Cod and Cape Ann. Even the beautiful lemon-yellow fish, which occasionally are found in the Ipswich Bay schools, are duplicated in Alaskan waters. Nor does the similarity between the commercial cod of the two oceans end with external characters which are taken into account in determining specific relationship, for we find a wonderful resemblance in habits and in their food. Thus the shore fish about Kodiak make their appearance in schools similar to ours—first, the "herring school;" next, the "lant school;" then the "capelin school;" followed by the "squid school" and the "winter school." Besides these there is an abundance of bank fish, which are always larger than those previously named. All of the food-fish of the cod here mentioned are exceedingly abundant. The herring is not identical with the common sea herring of the Atlantic, but it is wonderfully like it. The lant is closely related to one of our New England species; the capelin is the same as ours. The squid is a species of *Octopus* (*O. punctatus* Gabb).

The cod come on the rocks in twenty-five to thirty fathoms about Kodiak to spawn in November and December, just as they do in the East, and these spawning fish will sometimes lie perfectly still on the bottom and refuse to take the hook. Young cod swarm near the shores, just as they were observed to do in Gloucester Harbor after the experiments of the U. S. Fish Commission with artificial propagation. On the 13th of July, 1880, our seine took young cod at St. Paul, Kodiak Island. We dredged numbers of them near our anchorage at Belkofssky, on the peninsula of Aliaska, July 23rd, 1880, averaging one and one-half inches in length. On the following day young cod of the same size were found in the stomach of a large one of the same species caught near Oleny Island in seven fathoms of water. On the first of October, in the harbor of Chernofssky, Unalashka Island, the cod fry were very abundant and had reached a length of four inches. At Iliuliuk, on the north end of the same island, young cod of the same length were seined at various times from October 6th to October 18th; they fairly swarmed around the wharves, eagerly biting at anything in the form of bait and

readily fastening themselves on hooks intended for much larger fish.

The resemblance between the Atlantic and Pacific cod-fishing grounds is strengthened by the presence in Pacific waters of a genuine pollock—not the fierce, cod-devouring tyrant of the East, but a prettier, weaker relative, greatly loved and grievously persecuted by the cod. We have not yet heard of a haddock. (*Melanogrammus*), hake (*Phycis*), or of a cusk (*Brosmius*) in Alaskan waters. The only members of the cod family definitely known are the true cod (*Gadus morrhua*), the tom-cod (*Microgradus proximus*), the polar-cod (*Boreogadus saida*), the "wachna" (*Gadus wachna*, Tilesius) and the pollock (*Pollachius chalcogrammus*). Wherever the true cod is found occurs also the halibut (*Hippoglossus vulgaris*), the same as the Atlantic species. These two prime fish are associated; they come almost to the doors of the fishermen, and are present now around the shores of Alaska in the profusion which attended the infancy of the Cape Cod fishery.

DISTRIBUTION.

The cod seems to be entirely unknown as far south as San Diego, California. A circular sent by the Chief of the Bureau of Statistics to Mr. W. W. Bowers, Collector of Customs at San Diego, elicited the following response: "I referred the circular to Dr. G. W. Barnes, the president of a society of natural history, and to various fishermen, but cannot ascertain that the cod-fish is known to exist in any of the waters adjacent to this port." On the Heceta bank, north north-west from Cape Oxford, Oregon, cod are found. The Indians residing on that coast report this fish as quite abundant in the summer months, and they are said to be large, solid and delicious.

J. L. McDonald, in a book entitled "Hidden Treasures, or Fisheries Around the Northwest Coast," states that "cod are taken in very limited numbers off the Farralones; they are lean and very poor, and resemble the jaundiced cod on the Grand Bank." James G. Swan, in a report on the food fishes of Cape Flattery, Washington Territory, writes that "the cod of the North Pacific is not found in abundance at Cape Flattery; occasionally it is brought in, but it is by no means common. It seems

to inhabit the deep water of Fuca Strait, and for that reason is seldom fished for, except occasionally some of the older fishermen will try during very fine weather to take fish in eighty fathoms. Further up the Sound and in Hood's Canal, and a few other localities, the *Gadus* is taken, but it is small—evidently a young fish. Although its existence is well-known to residents on Puget's Sound, it is not taken in sufficient quantities to be relied on as a food fish." Mr. H. A. Webster, Collector of Customs at Port Townsend, Washington Territory, writes thus to the Chief of the Bureau of Statistics: "The cod, I believe, is always present in the waters of Fuca Strait and Puget Sound, but in such limited quantities that catching has not been pursued as a business, and the knowledge of their habits is very limited. Young cod, about the size of shad, have been somewhat abundant in Puget Sound during the winter months. Cod weighing from four to six pounds have been taken during the summer months by Indians at Nee-ah Bay. The presence of small cod in the winter months in Puget Sound and at the mouth of the Strait of Fuca, is an indication that large quantities may be found in the neighborhood of Cape Flattery—say west of Tahosh Light and south from Vancouver Island. No efficient search has been made off the coast of Washington Territory for this valuable fish."

At Sitka, Indians brought a few cod to our vessel in June, 1880. The cod were reported abundant and readily caught, but the halibut, the many fine "bass" (*Sebastichthys*, several species) and "rockfish" (*Hexagrammus*) seemed to have greater popularity. Mr. A. T. Whitford told me that the cod spawn in the vicinity of Sitka in spring, and that they have a remarkable number of eggs. We bought a fine cod twenty-six inches long for ten cents here. At Port Mulgrave, Yakutat Bay, we took but one cod in the harbor during the day spent there; this one was large but sick. Good fish are to be had in the deeper water outside. Nothing but handlines were used from the vessel. Capt. J. Haley reports cod very abundant on the Hoochenoo bank in Chatham Strait. The bank extends from Hoochenoo Point to Point Samuel. He also states that there is a bank off Point Gardiner, and that there are banks on the east shore of Baranoff Island, near Poghibshi Strait; also

that small cod are abundant in Prince Frederick's Sound. While on a visit to the Aleut village near Graham Harbor, Cook's Inlet, we were told by Mr. Cohen that cod are present there throughout the year. On the 6th of July, in Refuge Cove, Port Chatham, Cook's Inlet, a great many fine young cod were seined. It was in Port Chatham that we first saw capelin schooling. Plenty of excellent cod were caught with lines from the vessel. Around the island of Kodiak cod are very numerous. On the 9th of July, while the "Yukon" was lying at anchor in the harbor of St. Paul, schools of these fish were seen swimming about her. These were fine, lively fish, evidently the first of the summer run, which Mr. B. G. McIntyre informed me had not yet begun. Young cod were seined on Wooded Island, July 13th. Between Kodiak and Unalashka are the extensive and well-known banks Portlock, Seminoffsky and the Shumagins, which have furnished the great bulk of the cod so far taken in Alaska.

There are cod banks in the vicinity of Unalashka. We had no difficulty in catching all we wanted with a small trawl line, or with hand-lines late in July. Native fishermen at Iliuliuk were bringing in bidarka loads of beautiful fish, most of which were very large, to dry them for use in winter. The wonderful abundance of young cod three to four inches long was a feature here in October. Cod have been reported as far west as the island of Atka of the Aleutian chain. Cod have been reported abundant in Bristol Bay; they appear to be uncommon in Norton Sound, though occurring again more abundantly further north as far as the ice line. The eastern portion of Behring Sea may yet furnish important supplies of cod in suitable depths, since there is an abundance of its favorite food—notably sand launce, capelin, smelt, herring and pollock, which last is probably the "whiting" spoken of by Seeman as occurring abundantly in Hotham Inlet, Kotzebue Sound. At the island of St. Paul cod are taken rarely, the fur seal having a monopoly of the catch. At St. Lawrence Island Messrs. Maynard and Elliott caught cod on the 22nd of August, 1874. The great fishing grounds of Kamtchatka are in the Okhotsk Sea and the Sea of Kamtchatka.

We were informed by one of the whaling captains in Plover Bay last September, that he has caught cod off the heads off Mar-

cus Bay, East Siberia. Off Indian Point (Cape Tchaplin), East Siberia, a little further north than Marcus Bay, we were told by Eskimo, who came aboard the vessel, that they sometimes take cod at that point.

In the Arctic Ocean we saw no traces of the *Gadus morrhua*, its place being supplied to some extent by myriads of small polar cod (*Boreogadus saida*), which, like the pollock, has the lower jaw longer than the upper. On the 19th of August, 1880, in latitude 60 deg. 45 min. north, longitude 166 deg. 35 min. west, we saw great numbers of young *Boreogadus ;* from an inch to an inch and a half long, swimming under the tentacles of a *Cyanea*-like jelly-fish.

COMMON NAMES.

J. G. Swan writes that the cod is called "Kadatl" by the Makah Indians. The Sitkas call it "Sacht." A Kodiak Eskimo, to whom I showed one of the fresh fish, told me that they knew it as "Ah-mo-doc'." The Russian name for the species is "Treska" —a name pretty widely known in the territory. It is worthy of remark here that natives generally distinguish closely the "Wachna" from the "Treska." To the fishermen generally the fish is known as "the cod." Men who have come to the Alaskan grounds from New England have brought with them the terms "rock cod" and "kelp bangers" for certain individual varieties. "Rock cod" are the variously colored algæ fish, exactly similar to those known by the same name at Gloucester. "Kelp bangers" are shore fish that frequent the kelp, as their name suggests. "Wachna" is a term applied to the tom-cod and also to a species very different structurally from this.

SIZE.

J. G. Swan reports that none but small cod occur in Puget Sound and Hood's Canal. I measured several fresh ones at Sitka which were bought from Indians ; one taken May 30th was 662 millimeters long, two others secured June 12th, were 435 millimeters and 542 millimeters respectively. Capt. J. Haley informed me that he purchased 10,000 fish in two weeks from Indians on

the Hoochenoo cod bank, which averaged three pounds each when dried. The largest he saw weighed thirty pounds. He saw a few young fish. A cod caught by us in the Harbor of Port Mulgrave, Yakutat Bay, June 24th, measured 870 millimeters. It was stout and heavy, but sick. In Port Chatham, Cook's Inlet, two healthy fish among a lot taken July 5th, measured 722 millimeters and 750 millimeters ; one of these was a spent female. Off Marmot Island (Portlock Bank) on the 8th of July, we caught with hand-lines in a very short time preceding dark, twenty-six cod, fine, plump and healthy, averaging not less than twelve pounds. Capt. D. C. Bowen, who passed twenty-five years on the eastern fishing banks, gave me the following information about the shore fish around Kodiak :

First comes the "herring school," consisting of medium size fish, continuing from May 1st to June or July ; then the "lant school," short, thick, well-meated, but not so large as the herring school, June to July, After this the "capelin school" of good-sized fish, about equal to Newfoundland cod, July to September. Last, the "squid school," averaging twelve pounds each. All of these are shore fish ; the bank fish are always larger. Capt. J. C. Caton, who is well acquainted with the Shumagin fishery, says that in 1867 the "Sanborn" took 60,000 fish, averaging 2¼ lbs., ready for market. Now vessels will average eighty tons (60,000 fish) of 2½ lbs. each. Capt. C. told me that none of the fish are so large as the George's cod. Capt. Andrew Anderson informed me that when he was mate in the "Wild Gazelle," in 1873, she took on Seminoffsky Bank 93,000 fish in three months, averaging 2½ lbs. dressed. In 1874 she caught 97,000, averaging 3 lbs. Capt. H. R. Bowen, of St. Paul, Kodiak, gives the average of the shore fish there as six pounds round, and says that the largest weigh fourteen pounds. Thomas Devine, in charge of McCollum & Co.'s fishing station at Pirate Cove, Shumagins, gives me as an average of the fish there something between eight and twelve pounds, the largest weighing fifty pounds round. On the 19th of July I saw many fish brought to this station by dorymen. One of the men had 157 for his day's catch, none of them being less than twenty-six inches in length, and many of them weighing not less than thirty pounds ; the smallest weighed about eight according to my

estimate. Prof. George Davidson, assistant to the United States Coast Survey, in his report on Alaska, states, that in north latitude 53 deg. 39 min., west lon. 164 deg. 10 min., in fifty to sixty fathoms of water, many cod were caught from his vessel, the largest being thirty-seven inches long; several reached thirty-six inches; the finest was thirty-six inches long, twenty-three inches girth, and weighed twenty-seven pounds, was very fat, etc., etc. In the New York *Times*, of July 15th, 1879, is found the following extract from the report of Capt. White, of the United States Revenue Marine Service, who was on duty in the Alaska waters in 1878: "One day when sounding south of Kodiak, wishing to lay in a stock of codfish, I ordered the sails set back, and prepared twenty lines with four or five hooks to each line. Puget Sound clams were used as bait, and in two hours we caught two hundred and fifty fish weighing thirty to forty pounds each."

From Dr. A. Kellogg, of San Francisco, surgeon and botanist of one of the Coast Survey's expeditions, I have the following memorandum: "I copy from my diary *verbatim* the very brief note made on the spot relative to the cod caught on board the 'Lincoln,' lat. 58 deg. 30 min. north, lon. 164 deg. 30 min. west: cod eighteen inches girth, thirty and one-half inches length, fourteen and one-half pounds; twenty and one-fourth girth and thirty-four inches long, weight twenty to twenty-two pounds; three feet long and twenty-three inches girth, twenty-seven pounds." We were in the harbor of Iliuliuk, Unalashka, from the 27th of July to August 3rd, and from October 6th to 18th, 1880. Between the first two dates we saw native fishermen daily bringing in cod for winter use. The fish were caught near the village, and were uniformly good-sized, many of them of fifteen to twenty pounds in weight at least. Men were sent out from the vessel also to supply us with fresh fish. They generally fished on the ridge at the entrance to Port Levasheff, and never failed to secure a good supply of cod averaging fully twelve pounds. In October there was no falling off in the supply, and the size was about the same. In deeper water further from the village we took larger cod. I find in the notes of Prof. D. S. Jordan the following comparison between the Okhostk cod and that of

the Shumagin Islands: "Okhotsk cod are larger and more numerous than Shumagin cod, but they are thinner, less fat and more pot-bellied, and weigh rather less when dressed—80,000 Shumagin fish, dressed, weigh 260,000 pounds; 80,000 Okhotsk fish, dressed, weigh 220,800 pounds. The latter are poorer perhaps because they are caught so early in spring. They are fatter in July; fishing, however, begins in June." For the dressed Shumagin fish this gives an average of three and one-quarter pounds each, and for the Okhostk two and three-quarter pounds. The average for the Shumagin fish agrees substantially with that given by most persons who have furnished information about the Alaska cod. Prof. Jordan's information was obtained from the foremost fish merchants in San Francisco, and mine from captains of fishing vessels.

### SHAPE AND COLOR.

With reference to the Shumagin cod, Capt. J. C. Caton informed me that most of them have black napes, but there are some white napes. Some of the fish we caught on Portlock Bank, July 8th, 1880, had black napes, and others white napes. Thomas Devine, who has charge of McCollum & Co.'s fishing-station at Pirate Cove, Shumagins, reports mostly black napes, some white or gray. Capt. H. R. Bowen, of St. Paul, Kodiak, Id., says they "very seldom find fish with white napes—generally black." Capt. D. C. Bowen, of the same place, told me that white nape and black nape fish both are caught; black napes being most plenty. He says that white napes are generally young fish; the big ones are almost always black napes. Capt. J. Haley informed me that the Hoochenoo cod have black napes. These statements coincide with my own observations at various points along the coast of Alaska, and it seems to be true that black napes predominate among the Alaskan cod. Two large ones, measuring 722 and 750 millimeters, caught in Port Chatham, Cook's Inlet, July 5th, 1880, had black napes. The same variations in the external colors of the fish exist as are known in the Atlantic; the shore fish are generally darker than the bank fish, and a reddish tinge is very

common. Rock cod are as well-known as with us. Mr. Devine states that very pretty yellow cod are sometimes taken. Capt. H. R. Bowen says that the deep water fish are generally light in color. Mr. Devine informed me that the winter fish are whiter than those of any other season. The same gentleman mentions peculiarities of shape among the cod, as, for example, "bull-eyed" fish with prominent eyes, and "seal-head" fish with short snout and wide forehead. The shore fish which were brought to us by Indians from Old Sitka were always dark-colored, with long heads and eyes far apart, and with conspicuous blotches, in general appearance often resembling the small cod taken in shallow water off South Greenland—the *ogac* form of the common cod. There are no differences, so far as general appearances go, between Alaskan and New England cod; it would be impossible to tell one from the other if they were mixed in a tank without tags or some other means of identification.

### DISTRIBUTION.

In general terms, we may say that cod are found around the whole southern shore of Alaska, and westward along the Aleutian chain as far as Atka, extending on the western shore not much beyond Bristol Bay, though they have been observed as far north as St. Lawrence Island. They are said not to penetrate far into Cook's Inlet. We caught several large ones in Chugachik Bay, but they were sick. In Port Chatham, which is near the entrance to the inlet, we found them common and good. Mr. Cohen told me that cod are present all the year near Fort Alexander. In Refuge Cove, a small arm of Port Chatham, we took many young cod in brackish water. At Chernoffsky, also, on the island of Unalashka, we again found them abundant in brackish water associated with young *Oncorhynchus*, *Salvelinus malma*, *Ammodytes*, *Lumpenus* and *Cottus*. Several small streams flow into Chernoffsky Bay at this point, and the young fish were taken in water varying from three feet to one fathom in depth close to the shore. Fish of considerable size (weighing several pounds) were taken from the wharves at Iliuliuk during our stay. Cod are quite abundant close to the shores of the Kodiak group, the Shumagins and Unalashka Island. I have seen them taken in about

nine feet of water at Iliuliuk, and at a depth of at least fifty fathoms off Cape Cheerful. Mr. Devine, of Pirate Cove, says they are caught as far as thirty miles off Seminoffsky Island as deep as forty-five fathoms, and that on the middle ridge, in sixty to seventy fathoms, the best fish are taken with hand-lines.

Capt. H. R. Bowen states that they are caught in three feet of water sometimes at the village of St. Paul, but these are always sick fish. Wherever there are soundings good fish may be caught. The cod of the Shumagins are generally taken at such short distances from the shores as can be readily reached in dories. The fishermen go out in dories from their vessels, or from the fishing station, in the morning, and return in time to dress the fish aboard or on shore in the evening.

## MOVEMENTS, ETC.

### MIGRATIONS.

Mr. J. B. McIntyre, Mr. D. C. Bowen and Capt. H. R. Bowen, all agree in stating that cod remain throughout the year around the island of Kodiak. They were scarce last winter on account of the extreme cold, and up to the time of our arrival at St. Paul (July 9th, 1880) the customary summer sun had not yet begun. Between that date and July 14th, however, we saw schools of them around the vessel where she lay at anchor. According to Mr. Bowen they made their first appearance at St. Paul, May 7th, 1880. Capt. Bowen states that they are always found in the same places. Mr. McIntyre said that they were so scarce about St. Paul last winter that the natives could not catch enough of them for their own use.

According to Capt. J. C. Caton, cod are present around the Shumagin Islands all the time, but at some seasons they are very scarce. The best fishing is in February, commencing about the 10th and lasting to March 10th. Most of the vessels coming up get their best fish and best fare in July. Sometimes they do well in May. The fleet come up late in April or early in May, and stay until the 10th or 15th of August.

Mr. Thomas Devine, who manages the permanent fishing station on Popoff Island, Shumagins, also informed me that cod

are to be found all the year, but that they go into deep water in cold snaps and toward evening. He stated that the schoolfish leave in August or September, and return in January and February. They seem to move off to the southward and to return from the southward and westward.

With reference to the bank, twenty miles east northeast of Seminoffsky, Capt. Andrew Anderson told me that the fishing is best in August and September. The "yellow fish," *Pleurogrammus monopterygius*, school there abundantly about the middle of August and will follow the bait up to the top of the water. Cod will bite at the yellow fish in preference to anything else.

Mr. Marcus Baker has translated for me a note by Ivan Veniaminoff, on the marine fishes of the Unalashka region, in which occurs the following sentence: "Some of these, and especially the cod, in the winter go off shore into deep water, but in summer time they are found along the shores of certain bays and in shoal water."

SCHOOLING.

Mr. D. C. Bowen, of St. Paul, distinguishes various schools of cod about the Island of Kodiak, which vary in size and other particulars, and take their names from their favorite food during the time of their stay. He gives them in the following order: First, the "herring school," consisting of medium sized fish, which come about May 1st and stay until June or July; next, the "lant school," feeding on sand-launce (species of *Ammodytes*), made up of short, thick, well-meated fish, not so large ae those of the herring school, which are present in June and July. Then follows the "capelin school" (the capelin is our *Mallotus villosus*), July to September; these are good-sized fish, about the same as Newfoundland cod. The "squid school" comes in August or September, and remains until October. The fish of this school average twelve pounds in weight. The schools so far enumerated are all shore fish, and they are always smaller than bank fish. From October there are winter schools in some places; these are generally short, thick fish.

Capt. J. C. Caton says that they catch males and females together in the spawning season, and that they do not school when spawning.

Mr. Wm. J. Fisher has furnished the following information concerning the schooling of cod around Kodiak, which he obtained from Capt. H. R. Bowen : Cod associate in schools generally from May to the middle of September, and they live independently the rest of the year, the severity of the winter having much influence. At different seasons and in different places there are different schools. Males, females and young are found in the same schools. The movements of the schools are affected by the presence of food and by the state of the tide, the fish taking the hook more readily at slack water.

Mr. Devine speaking about the Shumagin cod told me on the 19th of July, 1880, that they found the fish both in schools and independent. There were "picking fish" at the time, and there had been "no great flush" of school fish this year. Different schools are found at different seasons and in different places. Mr. Devine says that males, females and young are not found associated. The males go together at certain times and the females. At the spawning season there are more females than males. The movements of the schools are very much affected by sharks especially, and dogfish to some extent. Dogfish are not abundant; sharks are quite so. The dogfish is identical with our Atlantic spined dogfish. We did not get a specimen of the shark, but the National Museum has a couple of small ones from Sitka, which are very close if not identical with *Galeorhinus galeus.* As for the influence of the tides, Mr. Devine says that fishing is best during the spring tides, and poorest in slack tides. Sometimes the cod have such a superabundance of food that they refuse to take the hook. My own observations at various points along the Alaskan coast, seemed to indicate that young cod, from two to four inches in length, prefer to school near the shores in sheltered coves where the water is shallow, and often where it receives a large admixture of fresh water. At Iliuliuk I found myriads of such young fish playing about the wharves, eagerly seizing the hooks baited for larger prey. Occasionally a larger cod, say of sixteen or eighteen inches in length, would be caught in the same vicinity, but almost invariably we found the small fry unmixed with older fish. The supply of food forms a very important motive for the presence of cod in particular places at certain

times. When we were in Port Chatham, for example, capelin were schooling there abundantly, and we caught fine cod freely. On Portlock Bank, again, capelin were plentiful, and nearly every cod examined had its stomach filled with them.

At the Shumagins "England hake," or more properly pollock (*Pollachius chalcogrammus*) were abundant in July, and the cod were feasting on them. The "yellow fish" (*Pleurogrammus monopterygius*) is one of the finest of all baits for cod, and will play an important part in the future of the fishery. This "yellow fish" is said by Capt. Andrew Anderson, to be very abundant, about the middle of August, on the off-shore bank, twenty miles east northeast of Seminoffsky, where they are found schooling, and will follow the bait up to the surface of the water. It is to be noted that August and September are the best months for cod on this bank. The herring (*Clupea mirabilis*) also has a great deal to do with a prosperous cod fishery. Capt. J. Haley told me that herring are wonderfully plenty on the Hoochenoo bank at the fishing season, and that there are enormous quantities of fine herring in Prince Frederick's Sound, where also small cod are abundant.

### ABUNDANCE.

Before entering into an examination of the influence of modes of fishing and practices of the fishermen upon the abundance of fish, it will be well to review the actual numbers taken at different times and places. Captain Haley secured 10,000 fish in two weeks from Indians on the Hoochenoo Bank, and could have got many more. The Indians caught these cod with bark lines, on barbless bent iron hooks, two of them going off in a canoe and bringing in from twenty-five to fifty fish, which were quite enough to satisfy their laziness.

Mr. D. C. Bowen states that as many as five hundred have been taken in a day by one hand-liner, on Portlock Bank, and that the average catch of the whole season, per man, is seventy-five a day. Here may be repeated the statement of Capt. White, of the United States Revenue Marine Service, who reported the capture, south of Kodiak, of 250 fish, weighing thirty to forty pounds each, with twenty lines, having four or five hooks each.

This number was taken in two hours. From the New York *Times* of July 15th, 1879, I extract a sentence by William S. Dodge, formerly Mayor of Sitka, to the effect that: "At Kodiak, Henry Richard and Thomas Bache, fishermen, caught alone, with hook and line, within the last six months, 22,000 cod."

Captain Andrew Anderson told me at St. Paul, that with a crew of ten men, on Seminoffsky Bank, he has caught as many as 4,000 in a day, and that his average catch there was from 1,600 to 1,800 daily. Mr. D. C. Bowen stated that John McCathrine and a man named Smith, caught 1,700 cod in a day on one trawl (a 12-line trawl of 600 or 700 hooks) in Unga Straits. Their average catch was 1,200 fish. A correspondent of the San Francisco *Post*, writing of the season of 1876, says: "One man on board the schooner Selma, which arrived the other day, had 13,000 fish to his credit," etc. These were caught during a season of four months. Captain J. C. Caton, who has been familiar with the Shumagin fishery ever since the second year of its existence, affirms that fish are plenty enough to supply a large market when that is found. The evidence of all the fishermen goes to prove that the great want is not fish, but demand for fish. One such customer as Gloucester would whiten the Gulf of Alaska with hundreds of sails where now there are less than a dozen, and there is every indication that full fare will repay the venture.

As to the influence of fishing and its accompanying practices, we have information from only two points—St. Paul, Kodiak and Pirate Cove, Shumagin. Capt. H. R. Bowen, of the former place, says that cod are as abundant there now as they were when white man began fishing; that their haunts and habits have not been changed by the influence of man, and their numbers have not been diminished by over-fishing. Trawls have never been used in that vicinity. He regards the practice of throwing gurry overboard as injurious to the fishery; the cod, he says, will leave and their place be taken by sculpins. Mr. Thomas Devine, of Pirate Cove, said that cod are scarcer there now than they were five years ago. He accounts for their decrease by the increased fishing, the injurious effects of trawling and of throwing overboard gurry from the vessels, and to some

extent by the capture of the mother fish, which will sometimes take the hook freely. The lost gear attendant upon trawling has a bad effect upon the fishery.

FOOD.

The food of the cod in the Pacific is as plentiful and as varied as in the Atlantic. Most other fishes of suitable size are liable to suffer from its voracity, while certain species for which it has an especial liking are slaughtered in great numbers. There is a wonderful abundance of invertebrated animals, such as quid, shrimp, holothurians, crabs, marine worms, sea-fleas; and, in short, just such forms as are well known to every fisherman on the eastern grounds. The waters of the Alaskan fishing grounds fairly swarm with this kind of life suitable to the wants of the cod. The fish which constitute in large measure the food of the cod are herring (*Clupea mirabilis*), capelin (*Mallotus villosus*), lant (*Ammodytes*), halibut (*Hippoglossus vulgaris*), whiting or England hake (*Pollachius chalcogrammus*), sculpins (*Hemilepidotus Jordani* and *trachurus*, also *Cottus polycanthocephalus*), and yellow fish or striped fish (*Pleurogrammus monopterygius*). Sometimes young cod are swallowed by older ones. I have seen a species of *Liparis* from a cod stomach on Portlock Bank. The yellow fish is the best bait for cod, according to Capt. Anderson and Capt Caton. Another food fish of the cod is worthy of mention here, because of the interest which attaches to its common name of "Cusk"(*Bathymaster signatus*)—a species very different indeed from the cusk that is so much eaten for cod in the Eastern States.

Mr. Devine says that sick cod are sometimes seen feeding at the surface, and sometimes healthy fish will chase bait up. In this way yellow fish will attract cod to the surface, and capelin will also. I have counted forty capelin in one cod taken on Portlock Bank, July 8th, 1880.

REPRODUCTION.

According to Mr. D. C. Bowen, cod about Kodiak come on the rocks in twenty-five to thirty fathoms, spawning in November and December. Capt. H. R. Bowen, of the same island, states that cod, full of eggs, are caught in February; the eggs

are very light straw color and about as large as number 12 shot. He says that eggs and milt sometimes run from the fish after they are caught. Capt. J. C. Caton informed me that cod spawn around the Shumagins in February on sandy bottom in shore, and that they will bite freely when spawning. Mr. D. C. Bowen says that at certain times spawning cod will lie perfectly still at the bottom and not take the hook. Mr. Thomas Devine tells me that the Shumagin cod spawn in rom ten to fifteen fathoms of water in January and February; the size and color of the eggs are the same as in the Eastern cod. The wharf at the Pirate Cove fishing-station is sometimes covered with spawn which has run from the fish after they were landed. He says that during the breeding season the males are long and slim and the females are short and deep. The smallest codfish he has recognized as such, were about six inches long, and they appeared in May or June. The smallest ones seen by Capt. Bowen were, also, six inches long; they made their appearance about July, and were in company with old fish On the 6th of July, 1880, we seined many young cod in Refuge Cove, Port Chatham, Cook's Inlet, where the water was less than a fathom in depth, and was largely diluted by fresh streams. At Belkoffsky, on the Peninsula of Aliaska, young cod about one and one-half inches long were dredged on the 23rd of July. On the following day, while laying on the west side Oleny Island, a cod one and one-half inches long was found in the stomach of a large one.

On the 1st and 2nd of October we seined many young cod at the head of Chernoffsky Bay, Unalashka; from the 6th to the 18th of the same month we saw them in great numbers swimming around the wharves at Iliuliuk, Unalashka, very active, and wonderfully greedy. We may, therefore, say that from May to October, at least, young cod are found in shallow water near the shore, and that about the middle of the latter month they have reached an average length of four or five inches. At Iliuliuk, when a jig or a baited hook was let down into the water it would be at once surrounded by a throng of nibbling fry, not at all frightened by the presence and antics of numerous small boys. These small fish frequently succeeded in fastening themselves on the hooks, and

were pulled out on the wharf, either to be eaten or used as bait, or thrown away.

## ENEMIES, FATALITIES, ETC.

### DISEASES.

As a rule, all large cod caught in harbors in shoal water are sick. On the 24th of June, 1880, one was taken in Port Mulgrave, Yakutat Bay, that measured 34¼ inches in length, and was stout and heavy, but sick and unfit for food. The gills were not bright red as in a healthy fish, but dull and faded; the colors of the body were also dull. Numerous parasites were present externally, and the abdominal viscera were infested with worms. A very unpleasant odor came from the belly when it was opened. On the 2nd of July, in Chugachik Bay, Cook's Inlet, three large cod were caught from the vessel, all of which were sick, their abdominal viscera being lined with worms and giving off a bad odor, yet the fish were quite heavy. On the 5th of July a healthy cod 28 2-5 inches long, and blind in both eyes, was caught on a hook in Port Chatham near the entrance to Cook's Inlet. The fish was entirely free from parasites. Its stomach contained only the herring with which the hook was baited. Instead of the transparent aqueous humor in the anterior chamber of the eye there was an opaque white substance, the result, doubtless, of an old injury. A second fish taken here (about an inch longer than the blind one) seemed to be perfectly healthy, but there were numerous small worms on the intestines. In its stomach were an *Ammodytes*, a little wad of kelp, and a pebble.

In examining a fresh fish caught near Sitka I found the inside of its mouth containing many lernæan parasites.

Capt. H. R. Bowen has never seen deformed cod in the vicinity of Kodiak, but diseased ones are common. He has frequently noticed ulcerated sores along the body, and especially on the head. Dead cod have never been seen to his knowledge. Mr. Devine, of the Shumagins, has seen cod sometimes with their backbone broken, causing a deformity known as "rose bones;" but he has never seen dead fish in any quantity at or near Pirate Cove. In earlier years, he says, you could heave up hundreds

of sick cod at the wharf; sometimes you would take the cod long, thin and gaunt, and after taking out the bone you might 'read the Bulletin through them."

PARASITES.

Mr. Devine mentions, as external parasites found on Shumagin cod, "cuttle-fish, welks, worms and fish-lice." The commonest external parasites observed by me were small lernæans.

ENEMIES.

Around Kodiak seals and sea-lions prey upon cod, frequently taking them from the line, according to Capt. Bowen.

Mr. Devine tells me that sharks are very abundant about the Shumagins and very destructive to cod; dogfish (*Squalus acanthias*) also prey upon cod, but they are not abundant. We caught comparatively few dogfish during the summer—one at Port Althorp, one on Portlock Bank and many at Sitka.

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## EPOCHS IN THE HISTORY OF FISH CULTURE.

BY PROF. G. BROWN GOODE.

(Prof. Goode remarked that the paper was tentative, and that he had no intention of treading on the toes of any one, but merely of arranging each important triumph of fish-culture in its order of sequence, and that he would be glad of corrections.)

It has been my aim in the following paper to recount, in chronological order, the principal steps in the progress of fish culture in Europe and America. No originality of matter or of method is claimed. The work has been done for my own convenience, and that of others who may have felt the need, often felt by me, of a concise summary of the facts in the history of the artificial propagation of fish. This paper has been hastily prepared, and, perhaps, contains misstatements or omissions. Criticisms or corrections will be received gladly, especially if they relate to statements concerning priority of invention. Without further introduction, I will proceed to the consideration of the first and greatest epoch.

I. 1741—*The Discovery of the Art of Fish Culture.*—In the year 1741 the art of fish culture was discovered by Stephan Ludwig Jacobi, a wealthy landed proprietor living at Hohenhausen, a small village in the duchy of Lippe, in Northwestern Germany. This discovery was not made public until 1763, thirty-eight years after the time when Jacobi, a youth of seventeen years, first conceived the idea of artificially fertilizing the eggs of fish for the purpose of restocking ponds and streams, and began a series of painstaking experiments.

There is so much of interest in these early efforts at fish-breeding, that I shall not hesitate to speak of them somewhat at length, quoting pfreely from a paper recently published by my friend, Dr. Ludwig Hapke of Bremen, who has taken the pains to visit the home ef Jacobi, and to correct many errors concerning the worker and his work, which may be found in all the writings hitherto published on the subject of fish culture.

Stephan Ludwig Jacobi was born April 28th, 1709, upon his ancestral estate of Hohenhausen, in the province of Varenholz. After a few years of study, under a private tutor, he was sent to the Gymnasia of Lemgo, Detmold and Hamburg. In 1734 he entered the University of Marburg, where he spent four years in the study of jurisprudence, philosophy and mathematics. In 1738 he turned his attention to agriculture, and, in 1741, after his marriage, he assumed the management of the estate which he had inherited from his father. In 1745 he was appointed "Landlieutenant," or Lieutenant of Militia. He was not, however, a military man, though he is spoken of as an army officer in all works on fish culture. Like many of the leading landed proprietors of Germany, he engaged in various enterprises not strictly agricultural, though properly pertaining to his functions as landlord. The village of Hohenhausen, which was located upon his estate, was a prosperous settlement of about one thousand inhabitants.

Among the industries in which he was engaged was the management of a flour-mill, a vinegar factory and a factory for the fabrication of starch from potatoes. He was also employed in public service, having been chosen superintendent of the work of building a canal from Schottmar to Uffeln, an enterprise by which numerous meadows and swamps were reclaimed from the water, and which was also of importance in the years of destitution (1771 and 1772) in providing work and food for many hundreds of suffering peasants. He was, however, particularly devoted to the culture of fruit and of fish, and is said to have employed successfully for many years a system of rotation of crops. Certain extensive tracts upon his estate he was accustomed to devote for a certain period to fruit-growing, then, by overflowing, to give

them up with equally satisfactory results to the rearing of fish. As late as 1805 the twelve little troughs which he used in hatching fish eggs, as well as the other apparatus devised by him, were still to be seen by those who were sufficiently interested to enquire for them.

Jacobi was a man of commanding stature and fine personal appearance. He died, aged seventy-five years, on the 22nd of April, 1784, his widow surviving until 1805. He left twelve children, the eldest of whom, Gerlach Ferdinand Jacobi, inherited the estate, and, up to his death, in 1825, continued the fish-breeding industries which had been established by his father,

The "Father of Fish Culture" was, in the opinion of Dr. Hapke, one of the most important scientific investigators of the age in which he lived. A pupil of the renowned Christian Wolf, the disciple of Leibnitz, the predecessor of Kant, he was trained in the best methods of the mathematicians and natural philosophers of his day and nation, He was unfortunate in being ahead of his time. He was a citizen of one of the smallest of the, at that time, infinitessimally small German provinces, and was in the prime of life when the Seven Years' War occurred [1756–1763], and when the social and scientific development of Germany was retarded by internal dissensions. He appreciated the full scientific and practical import of his discovery and lost no opportunity to make it public and to introduce it into general usefulness. He himself published papers in various periodicals, and was in constant correspondence with the chief naturalists of Germany and France, like Buffon, Lacepede, Fourcroy and Gleditsch, while also encouraging others to give publicity through the press to the methods and results of his labors. A contemporary biographer wrote: "By reason of his discovery of the method of artificially fertilizing the eggs of fish, as well as many useful discoveries in physics and mechanics, he was well known to the academies of Berlin and St. Petersburgh, as well as within the narrower limits of his own fatherland." [Lippische Intelligenzblatter, 1768, p. 585.] He was so well known throughout the country that a letter sent to him from the American Colonies sometime between 1760 and 1770, and addressed to *The Trout Culturist Jacobi, Germany*, passed safely to his address. [HAPKE, Dr. L. Zur Entdeckungsgeschichte des Konstlichen Fishzucht. Abhandlungen des Naturwissenschaftlichen Vereins, Bremen, VI., 1876, pp. 157–164.]

It is claimed by many French writers that the process of artificial fecundation was discovered as early as 1420, by Dom Pinchon, a monk in the Abbey of Reome. This claim was not advanced until 1854, when the Baron de Montgaudry called attention to certain manuscript records at that time in his possession, found among the archives of the

abbey. The claim is a somewhat feeble one, and it is believed by many authorities that the practice of the French monk was simply to collect and transplant the eggs which he had found already naturally fertilized, thus discovering artificial breeding, but not artificial propagation. However interesting to the antiquarian, the proceedings of Dom Pinchon had no influence upon the progress of fish culture. [MONTGAUDRY: Bulletin de la Societe Zoologique d'Acclimatation, Paris, I., 1854, p. 80. HAIME: Revue des Deux Mondes, June, 1854, and Report U. S. F. C., Part II., 1873 (pp. 465–492), p. 472 (translation.) MILNER: Report U. S. F. C., Part II., 1873, p. 531. MILLET: La Culture de l'Eau, p. 128. HAPKE: op. cit., p. 151. MOLIN: Rationelle Zucht der Susswasserfische, etc. Wien, 1864, p. 4.]

To Germany, beyond question, belongs the honor of discovering and carrying into practical usefulness the art of fish culture. Upon the estate of Jacobi as has been seen, it was carried on as a branch of agriculture for nearly eighty years—from 1741 to 1825—though it was nearly one hundred years before public opinion was ripe for a general acceptance of its usefulness. Recognition of fish culture was finally brought about by the zealous advocacy of men of science in France, Scotland, Bohemia and Switzerland. During the interim it appears to be certain that at no time was the practice of fish culture from a practical standpoint entirely abandoned by citizens of Germany.

II. 1763—*Announcement of the Discovery of Fish Culture.*—In 1763 some anonymous contributor to the Hanoverian Magazine published a description of the methods employed by Jacobi in the artificial culture of trout and salmon. [Hannoversche Magazin, 1763, Erster jahrgang, p. 363.] On the 5th of August, 1765, Jacobi himself, in the same periodical, recounted the story of his experiments and their results. [HAPKE: op. cit., p. 160. HAIME: op. cit., p. 474. MILNER: op. cit. p. 531. MILLER: op. cit., p. 127. BLOCH: Hannoverschen Magazin, 1782, pp. 337–360. KRUNITZ: Encyklopadie, 1778, p. 456. MEZLER: Landwirthschaft's Kalender, Stuttgart, 1771, p. 72.]

III. 1764—*Indorsement of Fish Culture by the Savans of Germany.*—In 1764, in the year after the announcement by Jacobi of the results of his experiments, Dr. J. G. Gleditsch, a renowned botanist, presented to the Berlin Academy of Sciences a communication, in which he pointed out the importance of the new discovery. [GLEDITSCH: Denkschriften. der Koniglichen Akademie zu Berlin, xx. (1764), 1766, p. 47.]

IV. 1770—*First French Publication of a Treatise on Fish Culture.*—In 1770 the memoir of Jacobi was published in Paris in an abridgment of the Memoirs of the Academy of Berlin. [Memoires de l'Academie Royale de Prusse, etc.] In Duhamel Dumonceau's "General Treatise

upon the Fisheries," published in 1773, was published a translation of Jacobi's memoir on artificial propagation. [DUHAMEL DU MONCEAU: Traite General des Peches, publie par ordre de l'Academie des Sciences. Paris, 1773, part ii., p. 209.]

V. 1771—*First Recognition by Governments of the Importance of Fish Culture.*—George III., of England, recognizing the importance of the discovery of Jacobi, granted to him a life pension. [PEZAY: "Soirees Helvetiennes," Amsterdam, 1771, p. 169. MILLET: op. cit., 1870, p. 128.]

VI. 1772—*First Public Demonstration of the Principles of Fish Culture.*—In 1772, Prof. Adanson, in his lectures in the Royal Garden of Paris, now the Garden of Plants, demonstrated to his hearers by practical illustration the processes of fish culture. [MILLET: op. cit., p. 128.]

VII. 1788—*First Publication in English of a Treatise on Fish Culture.*—A translation of Jacobi's memoirs was published in London, in 1788, under the title, "S. L. Jacobi's Method of Breeding Fish to Advantage."

VIII. 1791—*Beginnings of Fish Culture in Italy.*—As early as 1791, Joseph Bufalini, of Cesena, in Northern Italy, had succeeded in artificially fecundating the eggs of many species of fish. [*Opuscoli Scelti di Milano*, XV., 1791. *Vis Litteraire de Spallanzani*, by Tourdes, p. 63.] Little has, however, since been done in Italy, particularly in the way of public fish culture.

IX. 1800–1840—*The Work of Early Disciples of Jacobi in Germany.*—As we have already seen, the son of Jacobi carried on fish culture at Hohenhausen from 1784 to 1825. According to Hartig and Von Kaas, the forester Franks, and perhaps others, practiced successfully the methods of Jacobi at Steinburg, in Lippe Schaumburg, soon after their promulgation. Head-forester Martens made some successful trials at Schieder in 1827, which were continued for many years. In 1837, Court-hunter Schnitger, a pupil of Martens, established in Lippe Detmold, Jacobi's own province, a trout-breeding establishment, which, in 1844, was still in successful operation. Here were made some interesting observations upon the influence of temperature on the development of eggs. In 1840, Knoche published an account of successful experiments at Oelbergen. [HARTIG (Ernst Friedrick): Lehrbuch der Teichwirthschaft, 1831, p. 411. KNOCHE: Zeitschrift fur den landwirthschaftlichen verein des Grossherzogthums Hessen, No, 37, 1840, p. 407. WAGENER: Vaterlandische Blatter, Detmold, 1844. HAPKE: op. cit., p. 161. HAIME: op. cit., p. 476. BLANCHARD: op. cit., p. 589.]

X. 1820—*Initial Efforts at Fish Culture in France.*—About the year 1820, MM. Hivert and Pilachon fertilized the eggs of the trout, and attempted to restock the waters of the provinces of Haute Marne, in

Eastern France. [MILLET: op. cit., p. 128, BLANCHARD: op. cil., p. 374.]

XI. 1824—*Beginning of Fish Cultvre in Bohemia.*—In 1824, in the duchy of Horazdovic, in Bohemia, successful experiments in salmon culture were carried on by Director Studeny, the young fish dying when fingerlings. [FRITSCH: Die Flussfischerei in Bohmen, Prague, 1871, p. . HAPKE: op. cit., p. 162.] In 1853, a new interest was awakened in Bohemia by the experiments of Prof. Purkynje in trout culture.

XII. 1837—*Beginnings of Fish Culture in Great Britain.*—In 1837, Mr. John Shaw, after studying for several years the habits of the spawning salmon, succeeded in fecundating their eggs and raising the young fish to the age of two years. His experiments, though undertaken chiefly to demonstrate the identity of the fishes known as the *parr* and the *smolt* with the young of the salmon, were of great importance in the development of fishcultural science in Great Btitain. [SHAW, JOHN: An account of some experiments and observations on the pan and on the ova of the salmon, proving the pan to be the young of the salmon. Edinburgh New Philosophical Journal, XXI., 1836, pp. 99–110, Experiments on the growth of the salmon, Proc-Royal Society, Edinburg, I., 1838, pp. 178–9, pp. 275–9, Edinburgh: New Philosophical Journal, XXIV., 1838, pp. 165–179. Observarions on the growth of the salmon. London, Smyman, 1840, p. 11.]

Gottlieb Boccins claims to have successfully raised young trout at Chalsworth and Uxbridge, England, as early as 1841. [BOCCIUS, GOTTLIEB: A treatise on the management of fresh-water fish, with a view to making them a source of profit to landed proprietors. London, 1841, 8vo. A treatise on the production and management of fish in fresh waters, by artificial spawning, breeding and rearing. XXX., London, 1848.]

In 1854, the Brothers Ashworth hatched 260,000 young salmon at Lough Corrib, in Ireland, and soon after similar enterprises were undertaken for the River Tay, by Mr. Ramsbottom, and for the Dee, by Mr. Ayrton.

XIV. 1842–1844—*Experiments of Remy and Gehin.*—In the year 1842, according to various French authorities, an illiterate fisherman, named Joseph Remy, living in the mountains of Vosges, after studying for some years the spawning habits of the trout in the brooks about his home, succeeded in fecundating and hatching their eggs, and in feeding the young fish until they were old enough to shift for themselves. In the latter part of his undertaking he had an associate named Antoine Gehin. These fishermen were actuated solely by professional zeal,

and before their labors became generally known, had succeeded in rearing to a marketable size several thousands of trout. In 1843, Remy, in a letter to the Prefect of the Vosges, narrated the results of his experiments, and in the following year he and his colleague received a premium from a local society—the Society of Emulation of the Voges.

An immense stress has been laid upon the importance of these men to fish culture, particularly by French writers, Quatrefages, Haxo, Milne Edwards, Haim and others, an importance which I am, however, unable to appreciate to the same extent as they. In the first place, it seems somewhat improbable that the art of fertilizing fish eggs was, as is usually claimed, an original discovery of these men. Jacobi's experiments had been published nearly eighty years, and in the French language, in various popular treatises on fish and fishery, for fully seventy years. Remy was not so thoroughly illiterate as is usually represented, or he could not have communicated his observations in writing to the provincial authorities, nor have become a candidate for an award from a scientific society. It seems quite unlikely that the names of Jacoby and Goldstein were to him entirely unfamiliar. Consider, too, that the reputed discovery of Dom Pinchon, in the fifteenth century, was made in the neighboring province of *Cote d' Or*, while in *Haute Marne*, the remotest portions of which are not thirty miles distant from Vosges, local experimenters, as early as 1820, "had succeeded in hatching the eggs of the trout and obtaining their young to replenish the brooks and creeks of that district." [MILLET: op. cit., p. 128.]

Even the claim that the labors of the Vosges men were of immense importance to fish culture in France is not so clearly tenable. When the important essay of Quatrefages was published in 1848, their work was unknown to its author, and to this essay all Frenchmen agree in ascribing great influence in stimulating their national efforts in fish culture.

I hope it is not uncharitable to suggest that the chief significance to fish culture of the work of Remy and Gehin lies in the opportunity it afforded to France to throw its energies into the field without acknowledgment of indebtedness to Germany. At the same time I am not disposed to deprive their experts of the commendation which they deserve for their practical successes in fish breeding. The French Government, when in 1850, after resolving to make a grand experiment in stocking the waters of France with fish, seriously considered the question of giving to Remy and Gehin the direction of a portion of the enterprise as a recompense for the merit of having created a

new branch of industry in France—an encomium which they thoroughly deserved, [HAXO: ——— Reflexions sur l'Ichthyogenie, ou des œufs des poissons l'eclosion Epinal: Impremerie de Cabane, 1851. 12mo. German edition, Leipzig, Spamer, 1855. MILNE EDWARDS, A.: Annales des Sciences, Naturelles, Paris. 3d series. XIV., 1850, p. 53. MILLET: op. cit., p. 129. HAIME: op. cit. Annales de la Societe d'Emulation des Vosges. V., 1844, p. 301.]

XV. 1842—*Beginnings of Fish Culture in Switzerland.*—A decree of the Swiss Government, issued in 1842, gave complete instructions to fishermen upon the method of artificially propagating fish. [VOGT: —, HAIME: Revue des Deux Mondes, 1854.] As early as 1784 Spallanzani, Prevost of Geneva, who had been one of the first to recognize the value of the discovery of Jacobi, published a treatise "On the Artificial Propagation of Animals and the Nature of Hermaphrodites," in which he detailed the results of experiments made by himself. [BOSGREN, 186.] In 1857 was founded the establishment at Zurich, soon followed by many others. [BOUCHON BRANDELEY, Rep. U. S. F. C., Part II., p. 575.]

XVI. 1848—*Revival of Interest in Fish Culture Among the French.*—In 1848 was published the celebrated memoir of Quatrefages upon "Artificial Fertilization in Fish Culture," to the influence of which Haime and other French writers attribute the new interest in fish culture, which was for several years quite absorbing, which resulted in many improvements in the art, and to which, indeed, may be directly attributed the general revival of interest on the subject, which soon spread to America and elsewhere, and which has not since abated. [QUATREFAGES, A. DE: Des fecondations artificielles appliques a l'eleve de poissons. Comptes Rendus of the Academy of Sciences of Paris. XXVII., 1848, pp. 413–416. Revue des Deux Mondes, Jan. 1, 1849.]

XVII. 1850—*Encouragement of Fish Culture by the French Government.*—In 1850, Prof. Alphonse Milne Edwards, Dean of the Faculty of Sciences of Paris, was instructed by the French Minister of Agriculture to ascertain the value of the facts recently published concerning fish culture. He visited England, and also the establishment of Remy and his associate in the Vosges, and published a report, in which he recounted that the Government takes measures to stock the streams of France with fish.

In 1850 was established at Huningen, in Alsace, the first fish breeding station, or "piscifactory," as it was named by Prof. Coste. The year 1850 should be memorable in the annals of fish culture, since it marks the initiation of public fish culture. To the establishment at

Huningen the world is indebted for some important practical hints, but most of all for its influence upon the policy of governments. The fortunes of war and conquest have now thrown Huningen into the hands of the German government. [COSTE (J. J. M.): Notice Historique sui l'etablissment de pisculture de Huningen. Paris, 1850. Instruction practiques sur la pisciculture, survies de memoirs et de rapputs sur le meme sujet. Avec figures, Paris, Massen, 1853, 12mo. DETZEM et BERTOL: Fecondation Artificielle des Poissons. Mem. de la Soc. d'Emulation des Doubs, 1851.]

XVIII. 1850—*Beginning of Public Fish Culture in Norway.*—In 1850 the Storthing or Parliament of Norway voted 3,000 specie thalers for the prosecution of fish culture. Norway is thus entitled to share with France the honor of pioneership in fish culture, though by reason of her remoteness, her influence has not been so extended. [HAPHE, op. cit., p. 160.] It is worthy of mention that about 1850 the art of fish culture was again independently discovered by one Jacob Sandungen, a Norwegian peasant. [MOLIN: op. cit.]

XIX. *Beginnings of Fish Culture in Finland.*—For a third or fourth time the art of fish culture was independently discovered by a Finnish peasant named Matts Thomasson Wallila about the year 1852.] MOLIN: op. cit., p. 7.]

In 1857 H. J. Holmberg was sent by the Russian Government to Sweden and Norway to see how far the methods of fish culture then employed were applicable to Finland. [MOLIN: p. 10.]

In 1862, through the labors of Holmberg, who in that year became inspector of pisciculture in that country, the first breeding station was established. In 1873 there were already ten large establishments in this province. [SOUDAKEVICZ: Rep. U. S. F. C., Part II., p. 512.]

XX. 1853—*Beginnings of Fish Culture in the United States.*—In 1853, Dr. Theodatus Garlick and Prof. H. A. Ackley, of Cleveland, O., succeeded in artificially propagating the brook trout (*Salvelinus fontinalis*), This may be considered as the beginning of fish culture in America, though allusion must be made to the claim of Rev. Dr. Bachman, of Charleston, S. C., who has published an account of experiments successfully carried out, in 1804, upon the corporal (*Semotilus corporalis*) and the trout. Bachman's experiments, even if successful, a point not yet demonstrated, bear much the same relation to the history of American fish culture that those of Dom Pinchon bear to those of France. Dr. Garlick's paper "On the Artificial Reproduction of Fishes," was read before the Cleveland Academy of Natural Sciences, Feb. 14, 1854, though not printed until 1857. Dr. Bachman's claim was not pub-

lished until 1855. [MILNER: Rep. U. S. F. C., Part II., p. 533. GARLICK, Ohio Farmer, 1857.]

In Mr. Milner's excellent paper on "The Progress of Fish Culture in the United States" may be found accounts of the experiments of other pioneers, Kellog and Chapman in 1855, Muller and Brown in 1857, Ainsworth in 1859 and Seth Green in 1864. The experiments of Captain N. E. Atwood in 1856 are also deserving of prominent mention [Report Mass. Commissioners, 1856.]

In 1854 was published, in New York, by the Appletons, a treatise on Artificial Fish Breeding. This, in connection with the publication of the results of Garlick and Ackley's work in 1857, and the report of the Massachusetts Commission in the same year, to which was appended a translation of the essay of Jules Haime, had a most important influence on the development of public interest in fish culture. The writings of Coste, too, were in the hands of many Americans.

XXI. 1854—*Beginnings of Fish Culture in Belgium.*—In February, 1854, a fish-breeding establishment was organized by the Belgian Government, De Clerg, an engineer, having been sent, in November, 1853, to France to investigate the subject of fish culture therein. [MOILN: op. cit., p. 8.]

XXII. 1854—*Beginnings of Fish Culture in Holland.*—In 1854 the King of Holland established a fishery commission, and set up a hatching apparatus in his palaces at Bois and Wiss. [MOLIN: op. cit., p. 8.]

In 1860, a fishcultural establishment was founded in the Zoological Gardens at Amsterdam, which was successful in the culture of salmon. [DE BONT: La Culture du saumon et des ses congeneres et la Pisiculture au Jardin Zoologique d'Amsterdam—Amsterdam, 1872. BOUCHON-BRANDELET: op. cit., p. 215.]

XXIII. 1854—*Beginnings of Fish Culture in Russia.*—In 1854 V. P. Vrasski, after studying the French literature of fish culture, made experiments on the eggs of the eel, pout and the trout, and after independently discovering the process or dry impregnation, in 1860, established an extensive breeding station at Nickolsky, in the province of Novgorod, which was afterward extensively subsidized by the Russian Government. [SOUDAKEVICZ: Report of U. S, Fish Commission, Part II., 1853, p. 504.]

A large government establishment was founded in the province of Suwalki, in 1860, breeding trout, salmon and several species of whitefish. [IBID, p 512.]

XXIV. 1856—*Beginnings of Public Fish Culture in the United States. Massachusetts Fish Commission.*—May 16, 1856, the General Court of Massachusetts appointed three commissioners "to ascertain and report

to the next General Court such facts respecting the artificial propagation of fish as may tend to show the practicability and expediency of introducing the same into the Commonwealth, under the protection of law." Capt. N. E. Atwood, one of the commissioners, experimented with the trout and succeeded in fecundating, though not in hatching, their eggs. He also made observations upon the breeding of mackerel, having in contemplation their artificial propagation. The committee published a report giving a resume of past progress in fish culture, and a translation of Jules Haime's famous essay in the *Revue des Deux Mondes.* Public opinion was not, at this time, quite ripe for the substantial encouragement of fish culture, and it was not until 1865 that Massachusetts established its fish commission upon the present basis. [MASSACHUSETTS: Report of Commissioners appointed under resolve of 1856, etc., 1857, p, 54.]

XXV. 1856—*Discovery of the Russian Method of Dry Impregnation.*—Mr. V. P. Vrasski, a Russian fish culturist, discovered, in 1856, the dry method of impregnation, not publishing his results, however, until 1871. The same or a similar method was described by Carl Vogt as early as 1857. [MILNER: op. cit., p. 540.]

XXVI. 1857—*Early Action of the States of Vermont and New Hampshire.*—In October, 1857, a report on the artificial propagation of fish was made to the General Assembly of Vermont by Mr. George P. Marsh. At almost the same time a similar report was made to the Legislature of New Hampshire by Mr. A. H. Robinson. These had an undoubted effect on public opinion, and led to the efforts at restoring the salmon streams which shortly followed. [VERMONT: Report made under authority of the Legislature of Vermont on the artificial propagation of fish, by George P. Marsh, Burlington, 1857, 8vo. p. 52, appendix.]

XXVII. 1857—*First Attempt at Propagation of Whitefish.*—In November, 1857, Mr. Carl Muller, of New York, and Henry Brown, of New Haven, obtained whitefish eggs, in Lake Ontario, impregnated them, and transported 1,000,000 to Lake Saltonstall, near New Haven. In 1858 the experiment was repeated. No results are reported. [Report U. S. F. C., II., pp. 534-545. Report of Commissioner of Patents for 1859, 1860, p. 227.]

XXVIII. 1857—*First Attempt at Propagation of Lake Trout.*—In the same manner, in 1857 and 1858, Messrs. Muller and Brown transported several millions of lake trout eggs. No results are reported. [Report U. S. F. C., l. c.]

XXIX. 1857—*First Attempt at Propagation of Pike-Perch.*—In May, 1857, Messrs. Muller and Brown obtained fertilized eggs of pike-perch,

and planted them in Lake Saltonstall. They are supposed to have been destroyed by the fall freshets. [Report U. S. F. C., l. c.]

XXX. 1862—*First Attempt to Introduce Salmon into Australasia.*—This attempt was made by Mr. H. R. Francis, from England to Tasmania, and was a failure. In 1864, and in subsequent years, successful efforts were made, From 1869 to 1876 many hundreds of these planted salmon were found. [Report N. Y. F. C., II., pp. 7–24; VI., pp. 819–23.]

XXXI. 1864—*First Breeding of Salmon in America.*—In 1864 Mr. James B. Johnston, of New York City, hatched out in the studio building in New York city the eggs of salmon procured by him in Europe. None of the fry were liberated. [NORRIS: American Fish Culture.]

In 1865, it is said, Seth Green applied to the French Establishment at Huningue for some salmon eggs, and received 5,000, which died, however, in the New York Custom House.

XXXII. 1864—*The Establishment of the Green Hatching House.*—Mr. Seth Green was the first American fish culturist who carried on fish culture upon a basis pecuniarily profitable. [NORRIS: op. cit., p. 99. MILNER: op. cit. p. 535.]

XXXIII. 1865—*Establishment of the New Hampshire Fish Commission*—In 1865 Henry A. Bellows and W. A. Sanborn were appointed Fishery Commissioners and Dr. W. W. Fletcher, of Concord, N. H., was sent by the State Legislature to Canada to obtain salmon eggs. This was the first practical move in public fish culture in America, though Massachusetts, as has been seen, made a preliminary step ten years before [MILNER: l. c., p. 543. Report of the Select Committee on Fisheries 1865. Reports of the Commissioners on Fisheries made to the Legislature of New Hampshire. I., 1866; II., 1867; III., 1868; IV., 1869; V., 1870; VI., 1871; VII., 1872; VIII., 1873; IX., 1874. X., 1875; XI., 1876; XII., 1877; XIII., 1878; XIV., 1879; XV., 1880; XVI., 1881.]

From 1866 to 1879 the State of New Hampshire appropriated $22,663 for purposes of public fish culture*.

XXXIV. 1865—*Establishment of the Fish Commission of Vermont.*—In 1865 the Fish Commission of Vermont was established, Albert D. Hagar and Charles Barrett being appointed commissioners.

From 1871 to 1879 $7,800 was appropriated for purposes of public fish culture. [Reports of the Fish Commissioners of the State of Vermont. I., 1866; II., 1867; III., 1869; IV., for 1871-2 (1872); V., 1873-4 (1874); VI., 1876; VII., 1877-8 (1878); VIII., 1879-80 (1880).]

*For this and other statements as to amount of money appropriated for fish culture by the various States, I am indebted to Mr. C. W. Smiley.

XXXV. 1865—*First Effort at Propagation of Codfish.*—In March 1865, Prof. G. O. Sars, then engaged in investigating the codfisheries of the Lofoten Islands, Norway, succeeding in fertilizing and hatching the eggs of the cod. This appears to have been the first attempt to propagate sea fish artificially. [Rep. U. S. F. C. V. p., 583.]

XXXVI. 1865—*Beginning of Fish Culture in Austria.*—In 1865 the Government establishment at Salzburg was founded, and in 1873 every province in the Empire was provided with its own breeding establishment. [BOUCHON-BRANDELET: Report U. S. F. C., Part II., p. 518.]

XXXVII. 1866—*Establishment of the Fish Commission in Connecticut.*—In 1866 the Fish Commission of Connecticut was established, F. W. Russell and Henry C. Robinson being appointed Commissioners. From 1868 to 1880 $43,300 was appropriated by the State for purposes of public fish culture. [Reports of the Commissioners, I., 1867; II., 1868; III., 1869; IV., 1870; V., 1871; VI., 1872; VII., 1873; VIII., 1874; IX., 1875; X., 1876; XI., 1877; XII., 1878; XIII., 1879; XIV., 1880.]

XXXVIII. *Establishment of the Pennsylvania Fish Commission.*—In 1866 the Pennsylvania Commission was organized, but no regular commissioners were appointed until 1870, when James Worrall was elected by the Legislature to that office. From 1873 to 1880 the State has appropriated $99,030 for purposes of public fish culture. [Reports of the Commissioners for the Restoration of the Inland Fisheries, I., 1870 (1871); II., 1871; (1872); [see Report U. S. Fish Culture, II., p. 782]; III., 1873 (1874); IV., 1874 (1875); V., 1876 (1877); VI., 1877 (1878); VII., 1878 (1879).]

XXXIX. 1866—*The Establishment of the Canadian Commission of Fisheries.*—The Dominion of Canada this year established its Fishery Commission, which has since, under the direction of Commissioner W. F. Whitiker, performed such efficient service.

XL. 1867—*The Establishment of the First Hatching Establishment in the United States for Public Fish Culture.*—Although New Hampshire, as has just been stated, was first to take active measures toward restocking its streams, Massachusetts in 1867 again took the lead, establishing a hatchery for shad at South Hadley Falls on the Connecticut River. [MILNER: op. cit., p. 542, Massachusetts Reports.]

XLI. 1867—*The Invention of the Seth Green Shad Box.*—While operating on the Connecticut River in 1867, Mr. Seth Green devised that form of floating hatching box, with wire bottom, tilted at an inclination toward the current, which bears his name and which has been so extensively used in shad hatching in all parts of the United States. [MILNER: op, cit., p. 543. Rep. Mass. Comm. Fisheries, 1868, p. 35, pl. 11.]

XLII. 1867—*Successful Propagation of the Shad.*—The shad was this year successfully propagated at South Hadley, Mass., by Mr. Seth Green, working in behalf of the New England Commissioners, and at his own expense, though the apparatus was provided. This was the first attempt to propagate any member of the herring family. [MILNER: l. c., Mass. Reports, ll. c.]

XLIII. 1867—*Establishment of the Maine Fish Commission.*—The Maine Fish Commission was organized by the appointment, as commissioners, of Nathan W. Foster and Charles G. Atkins. From 1867 to 1880 appropriations were made to the amount of $36,975. [Reports of the Commissioners (later Commissioners) of Fisheries for the State of Maine, I., II., 1877, 1868 (1869); III., 1869 (1870); IV., 1870; V., 1871 (1872); VI., 1872 (1873); VII., 1873 (1874); VIII., 1875; IX., 1876; X., 1877; XI., 1878; XII., 1879; XIII., 1880.]

XLIV. 1868—*Establishment of the New York Fish Commission.*—The New York Commission was organized in 1868, the Hon. Horatio Seymour, Hon. Robert B. Roosevelt and Seth Green being chosen Commissioners. From 1868 to 1879 $165,000 was appropriated for fish culture. [Reports of the Commissioners of Fisheries of the State of New York, I., 1869; II., 1870; III., 1871; IV., 1872. V., 1873; VI., 1874; VII., 1875; VIII., 1876; IX., 1877; X., 1878; XI., 1879; XII., 1880.]

XLV. 1868—*The Successful Propagation of the Lake Whitefish.*—The successful propagation of the Lake whitefish was first accomplished in 1868 by Mr. Seth Green, at the New York State Hatching House at Caledonia, and by Mr. Samuel Wilmot of the Canadian Fish Commission. In 1869 Mr. N. W. Clark, of Clarkston, Mich,, was successful in several efforts. [MILNER: Report U. S. F. C., II., pp. 545-552.]

XLVI, 1869—*Beginning of Shad Culture in the Hudson River.*—In 1869 Mr. Seth Green, acting for the New York Fish Commission, began the culture of shad in the Hudson River. [MILNER: Report U. S. F. C., II., p. 544. Reports, New York Commission.]

XLVII. 1870—*Establishment of the Deutscher Fischerei Verein.*—In 1870 was established a German Fishery Society, which has had so powerful an influence upon the progress of fish culture in Europe. Prominent among its originators were Messrs. Von Behr, Von Bunsen, Peters, Wiltmacly and Virchow. [Circulars of the German Fishery Society, 1870 to 1880.]

XLVIII. 1871—*Establishment of the California Fish Commission.*—In 1870, by the election of B. B. Redding, S. R. Throckmorton and J. D. Farwell as commissioners, the California Commission was established. From 1870 to 1879 $37,000 was appropriated for purposes of fish cul-

ture. [Reports of the Commissioners of Fisheries of the State of California, I., 1870-1871 (1872); II., 1872-3 (1874); * * *.]

XLIX. 1870—*Establishment of the New Jersey Fish Commission.*—In 1870 the New Jersey Commission was organized, B. P. Howell and J. H. Slack, Commissioners. From 1871 to 1880 the appropriations were $29,500. [Reports of the Commission of Fisheries of the State of New Jersey, I., 1871 (1870?); II., 1872 (1871?); III., 1872; IV., 1873; V. 1874; VI., 1875; VII., 1876; VIII., 1877; IX., 1878; X., 1879; XI., 1880.]

L. 1870—*Establishment of the Rhode Island Fish Commission.*—In 1868 Rhode Island appointed commissioners to investigate the practicability of restocking the waters of the State with salmon and other migratory fish. In 1871 regular Commissioners of Fisheries appear to have been first chosen, these being John H. Barden, Newton Dexter and Alfred A. Reed, Jr. Between 1870 and 1879 the State appropriated $10,500 for purposes connected with fish culture and the fisheries. [Reports of the Commissioners on Inland Fisheries, I., (?), 1869; II., 1872; III., 1873; IV., 1874; V., 1875; VI., 1876; VII., 1877; VIII., 1878; IX., 1879; X., 1880.]

LI. 1870—*Atkins' Device of Penning Migratory Fish.*—This device, which was provided for in 1870, but not carried into effect till the following year, consisted in obtaining seed fishes by purchase through the whole period of immigration into the rivers prior to spawning, and preserving them in ponds for from four to six months. "This," says Milner, "is an original method, never, I believe, before adopted in any country." [MILNER: l. c., p, 543.]

LII. 1870—*Successful Propagation of Lake Trout.*—Although experiments with this species were made in Connecticut as early as 1857, and also by Mr. Wilmot in 1868, and by Mr. N. W. Clark in 1870, the first considerable success was that by Mr. Seth Green in the same year. [Reports New York Commission. MILNER: Rep. U. S, F. C., Part II., p. 553.]

LIII. 1871—*Establishment of the American Fish Culturist Association.*—In 1871 the American Fish Culturist Association was organized. Its original members were William Clift, A. S. Collins, Fred. Mather, Dr. J. H. Slack and Livingston Stone. Its influence upon public opinion, and the aid it has rendered to fish culture, have been important beyond the possibility of statement. Its meetings have all been held in New York city, with the exception of the special meeting in Philadelphia in October, 1876. At the seventh annual meeting, 1878, the name of the society was changed to "The American Fish Cultural Association." [Transactions American Fish Culturists Association, I., 1872, II.,

1873; III., 1874; IV., 1875; V., 1876; VI., 1877; VII., 1878; VIII., 1879; IX., 1880.]

LIV. 1871—*Establishment of the Alabama Fish Commission.*—The Alabama Commission was organized in 1871 by the appointment as Commissioners of Charles S. G. Doster, Robert Tyler and D. R. Hundley. [Report of the Commissioners to encourage fish culture, I., 1872; II., * * *. ]

LV. 1871—*Discovery of the American Method of Dry Impregnation.*—The American method of dry impregnation was discovered and practiced by Mr. C. G. Atkins in 1871. [MILNER: l. c., p. 541.]

LVI. 1871—*Transportation of Fish Across the American Continent.*—In 1871 young shad were successfully transported from the Hudson River to the Sacramento River, California. [MILNER: Rep. U. S. F. C., II,, p. 544.]

LVII. 1871—*Introduction of Shad into California.*—See LVII. above.

LVIII. 1871—*Establishment of the United States Fish Commission.*—On the 9th of February, 1871, Congress passed a joint resolution which authorized the appointment of a Commission of Fish and Fisheries. The duties of the Commissioner were thus defined: "To prosecute investigations on the subject (of the diminution of valuable fishes) with the view of ascertaining whether any and what diminution in the number of the food-fishes of the coast and the lakes of the United States has taken place; and if so, to what causes the same is due; and also whether any and what protective, prohibitory or precautionary measures should be adopted in the premises, and to report upon the same to Congress."

The resolution establishing the office of Commissioner of Fisheries required that the person to be appointed should be a civil officer of the Government, of proved scientific and practical acquaintance with the fishes of the coast, to serve without additional salary. The choice was thus practically limited to a single man for whom, in fact, the office had been created. Prof. Spencer F. Baird, at that time Assistant Secretary of the Smithsonian Institution, was appointed and entered at once upon his duties. Up to 1880, $476,200 had been appropriated for the use of the Commission. [See G. BROWN GOODE. The first Decade of the U. S. Fish Commission; its plan of work and accomplished results, scientific and technical. *Proceedings of the American Association for the Advancement of Science,* XXIX, 1880, pp. 563-574. *Forest and Stream,* XV, pp. 85-7. *Chicago Field,* XIV, p. 58. *Nature,* (London), XXII, pp. 597-9. *Circular Deutscher Fischerei Verein,* 1880, pp. 190-7. Report Smithsonian Institution, 1880, pp. 140-9.]

LIX. 1871—*Introduction of Shad into the Great Lakes.*—The introduction of shad into the Great Lakes was accomplished in 1871 by the New York Fish Commission, a quantity being placed in the Genesee River, a tributary to Lake Ontario. [Report U. S. F. C., II., p. xvii.]

LX. 1871—*Introduction of Shad into the Mississippi.*—In 1871 shad were introduced into tributaries of the Ohio and Mississippi Rivers by the U. S. Fish Commission, by the hands of Mr. Seth Green and Mr. William Clift. [Report U. S. F. C., II., p. xvii.]

LXI. 1871—*Establishment of the Salmon Breeding Establishment at Orland, Me.*—This was erected at the joint expense of the Fish Commissions of Maine, Massachusetts and Connecticut. [Report U. S. F. C., II., p. lxvi.]

LXII. 1872—*Importation of Rhine Salmon.*—A gift from the German Government, of 250,000 eggs, and 500,000 obtained by purchase, brought to this country under the charge of Dr. Hessel, arriving late in the fall. The 4,000 or 5,000 which were sound were planted in a tributary of the Delaware. [Report U. S. F. C., part II., xxii.]

LXIII. 1872—*Beginning of the Propagation of California Salmon.*—This work, begun at the suggestion of Mr. R. B. Roosevelt, was accomplished in October, 1872, for the U. S. Fish Commission by Mr. Livingston Stone. [Report U. S. F. C., II., xxiii.]

LXIV. 1872—*Invention of the Green Trough.*—This device, which was an improvement upon the former used by Coste and Atkins, was perfected in 1872, in the progress of experiments on whitefish. [MILNER: Report U. S. F. C., II., p. 546-556.]

LXV. 1872—*The Invention of the Holton Fish-Spawn Hatcher.*—The Holton Fish-Spawn Hatcher, devised in 1872 by Marcellus G. Holton patented March 18th, 1873, is of much importance in the hatching of whitefish eggs. [MILLET: Report, U. S. F. C., II., p. 546, plate liv.]

LXVI. 1872—*The Work of Propagating Fish Undertaken by the U. S. Fish Commission.*—At the suggestion and through the influence of the American Fish Culturist's Association. The recently established United States Fish Commission was charged with the task of restoring fish to the depleted waters of the United States. [Report U. S. F. C., II,, xvi.]

LXVII. 1878—*Invention of N. W. Clark's Fish-Hatching Trough.*—This important piece of apparatus was devised in 1873 and patented March 3rd, 1874. [MILNER: Report U. S. F. C., II., p. 546 pl. xv.]

LXVIII. 1872—*Invention of the Clark Transporting Case.*—This device was successfully used in transporting whitefish eggs to California. [MILNER: Report U. S. F. C., II., pp. 547-9.]

LXIX. 1872—*Invention of the Williamson or California Hatching Trough.*—This apparatus, similar to the Clark trough except that the water flows from below instead of from the top, was invented about 1872. [MILNER: Report U. S. F. C., II., p. 547.]

LXX. 1872—*Introduction of Whitefish into California.*—In February, 1872, the U. S. Fish Commission shipped 216,000 whitefish eggs from Clarkston, Mich., to San Francisco. [Report U. S. F. C., II., p. 550.]

LXXI. 1872—*Establishment at the Salmon Breeding Establishment at Bucksport, Me.*– In 1872 the extensive salmon breeding establishment at Bucksport, Me., was erected under the direction of Mr. C. G. Atkins and at the joint expense of the Fish Commission of Maine, Massachusetts and Connecticut, and of the United States Commission, which contributed funds to the amount of half the expense. This establishment has since passed entirely under the control of the United States Commission. [Report U. S. F. C., II., p. xviii.]

LXXII. 1873—*First Propagation of the Striped Bass.*—In May, 1873, Mr. M. G. Holton succeeded in propagating this species artificially at Weldon, N. C. [Report U. S. F. C., Part II., pp. 553-554.]

LXXIII. 1873—*The California Aquarium Car.*—In 1873 Mr. Livingston Stone, under the auspices of the U. S. Fish Commission and that of California, fitted up an aquarium car in which it was proposed to carry many species of fish to California. The car was capsized June 8th, in the Elkhorn River, Nebraska. In 1874 the experiment was repeated in behalf of the California Commission, [Report U. S. F. C., II., xxxvii.]

LXXIV. 1873—*Establishment of the Ohio Fish Commission.*—The Ohio Fish Commission was established in June, 1873, by the appointment as commissioners of John H. Klippart, John Hussey and Dr. E. Stirling. By act of April 26th, 1876, the commission in its present form was organized. Up to 1880 $29,000 had been voted for fish culture. [Reports of Ohio State Fish Commission (I.), 1874; I., (1875-6). 1877; II., (1877) 1878; III., (1878) 1879; IV., (1879) 1880; V., (1880) 1881.]

LXXV. 1873—*Establishment of the Wisconsin Fish Commission.*—In 1873 an appropriation was made by the Legislature to be expended under the direction of the U. S. Commissioner of Fisheries. In 1874 William Welsh, A. Palmer and P. R. Hoy were elected commissioners. Up to 1880 $38,860 had been voted for fish culture. [Reports I., 1874; II., 1875; III., 1876; IV.,1877; V., 1879; VI., 1880.

LXXVI. 1873-4—*Culture of the Land-Locked Salmon.*

*Establishment of the Hatching Station of Grand Lake Stream.*—Expe-

riments were begun at Sebec Lake, in 1873, under the auspices of the Massachusetts, Connecticut and United States Fish Commissions, and a station erected under the direction of Mr. H. L. Leonard. In 1874 this was transferred under the same auspices to Grand Lake Stream, and placed in charge of Mr. C. G. Atkins. [Report U. S. F. C., IV., p. *25.]

LXXVII. 1874—*Attempts to Transport Living Shad Across the Atlantic.*—The first trip was made with young fish by Messrs. Fred Mather and A. Anderson, in August, 1874, who lost the fish ten days after going to sea; the second by Messrs. H. W. Welcher and Monroe A. Green, who attempted to carry the eggs, which were destoyed before they reached the steamer. [Report U. S. F. C., III., pp. 328, 330. 338-9.]

LXXVIII. 1874—*Successful Propagation of the Oquassa Trout.*—In October, 1874, the Maine Fish Commission obtained 30,000 eggs, 5,000 of which were sent to New York. [Maine Reports. ROOSEVELT AND GREEN. Fish Hatching and Fish Catching, p. 136.]

LXXIX. 1874—*First Attempts to Propagate Grayling.*—In April, 1874, Mr. Fred Mather visited the Au Sable River, Mich., to experiment on the propagation of the grayling. From the 1st to the 3rd no ripe fish were found. He took 180 adult fish alive to his ponds at Honeoye Falls, N. Y. [*Forest and Stream*, vol. II,, p. 164.] On the 30th of April, 1874, Mr. Seth Green visited the river for the same purpose. Finding that the fish had finished spawning, he dug some fertilized eggs from the bottom of the river, which he subsequently hatched. [ROOSEVELT AND GREEN. Fish Hatching and Fish Catching, pp. 133-135.]

LXXX. 1874—*Propagation of the Sea Bass.*—In September, 1874, the eggs of the Sea Bass, *Centropristes atrarius*, were successfully fertilized at the U. S. Fish Commission Station at Noank, Conn. They did not however, hatch.

LXXXI. 1874—*Establishment of the Iowa Fish Commission.*—The Iowa Fish Commission was established by act of the Legislature, March 19th, 1874. S. B. Evans, B. F. Shaw and C. A. Harris were appointed commissioners. Up to 1880 $22,750 had been appropriated for fish culture. [Reports (biennial), I., (1874-5) 1876; II., (1875-6 and 1876-7) 1877; III., (1877-8 and 1878-9) 1880.]

LXXXII. 1875.—*First Artificial Impregnation of Grayling Eggs*—In April, 1875, Mr. Fred Mather made a second attempt to take grayling spawn on the Au Sable River, Mich. He found them ripe from the 6th to the 10th, and 10,000 were impregnated and afterward hatched,

by F. N. Clark at Northville, Mich., and himself at Honeoye Falls, N. Y. [*Forest and Stream*, Vol. IV, p. 214.]

LXXXIII. 1875—*Invention of the Mather Hatching Cone.*—The principle of suspending eggs in water by a stream, admitted at the bottom of a cone, and thereby hatching them in a bulk instead of in layers, was discovered in 1875 by Mr. Fred Mather and his assistant, Charles Bell. [*Forest and Stream*, Vol. VI., p. 19; Report U. S. F. C., III., p. 372-376, IV., p. 1,012.]

LXXXIV. 1875—*Hatching of Sturgeon.*—In 1874 efforts were made by Seth Green in behalf of the New York Commission to hatch sturgeon. In 1875 their efforts were successful. [ROOSEVELT AND GREEN. Fish Hatching and Fish Catching, p. 164.]

LXXXV. 1875—*Invention of Chase's Self-Picking Apparatus.*—This ingenious device for the removol of dead eggs from hatching jars was invented by Oren M. Chase, of Detroit, Mich. [Report U. S. F. C., IV., p. 1,012; VI., p. 616.]

LXXXVI. 1875—*Establishment of the Minnesota Fish Commission.*—This Commission was created in 1875, David Day, M. D., Horace Austin and A. W. Lathan being appointed commissioners. Up to 1880 $22,500 had been appropriated for fish culture. [Reports: I., 1875; II., 1876; III., 1877; IV., 1878; V., 1879; VI., and VII., 1880.]

LXXXVII. 1875—*Establishment of the Virginia Fish Commission.*—The Virginia Commission was organized in 1875, Hon. Alex. Mosely, Dr. W. B. Robertson and Dr. M. G. Ellzey being appointed Commissioners. Reports: I., 1875; II., 1876; III., 1877; IV., 1878; V., 1879; VI., 1880.]

LXXXVIII. 1876-77-78—*Restoration of Salmon to the Connecticut River.*—In 1876 a single salmon was taken in the Connecticut; in 1877 several; in 1878 more than 600 individuals. These were the first seen in the river since the exclusion of the species from the river by the building of the Millers' River Dam in 1798. [Report U. S. F. C., V., p. 36*; VI., p. 31.]

LXXXIX. 1876—*Introduction of Whitefish into New Zealand.*—At the request of the Government of New Zealand the U. S. Fish Commission sent a lot of whitefish eggs to that country, a portion of which arrived in good condition. [Rep. U. S. F. C., IV., p. *27.] 1877.—Through the mediation of the U. S. Fish Commission arrangements were made between the Government of New Zealand and Mr. Frank N. Clark for the sending of whitefish eggs to New Zealand. The experiment was successful. [Rep. U. S. F. C., V., p. 39.]

XC. 1876—*Establishment of the Arkansas Fish Commission.*—The Ar-

kansas Commission was organized in 1876, N. H. Fish, J. R. Steelman and M. B. Pearce being appointed commissioners.

XCI. 1876—*Establishment of the Kentucky Fish Commission.*—By fish law of Kentucky, approved March 20th 1876, the Kentucky Commission was organized by the appointment of ten commissioners, one from each congressional district. Mr. Pack Thomas was the active worker and was elected President of the Board. Up to 1880 $11,000 had been appropriated for fish culture. [Reports: I., 1876; I., 1878; II. (second biennial), 1879.]

XCII. 1877—*Establishment of the Kansas Fish Commission.*—In 1877 Mr. D. B. Long was appointed Commissioner of Fisheries for Kansas. Up to 1880 $2,000 had been appropriated for fish culture. [Reports: (biennial), I., 1878; II., 1880.]

XCIII. 1877—*Introduction of the Madue Maraena into the United States.*—By the courtesy of Mr. R. Eckhardt, of Lubinchen, Germany, who presented 1,000 eggs of the Madue Maraena (*Coregonus maraena*) to the U. S. Fish Commission, this species was introduced into Gardner's Lake, Michigan. [Rep. U. S. F. C., IV., p. 16*; V., p. 40*.]

XCIV. 1877—*Artificial Hatching of the Herring and Discovery of a Method of Retarding their Development.*—Experiments were successfully carried out by Dr. H. A. Meyer, of Kiel, Germany, in hatching and retarding the development of the eggs by cold, and in hatching them by Vinal N. Edwards, of the U. S. Fish Commission. [Rep. U. S. F. C., V., p. 45*"; VI., p. 629.] These experiments in hatching were repeated at the U. S. F. C. station in Gloucester in 1878, by Mr. Frank N. Clark. [Rep. U. S. F. C., VI., p. 39.]

XCV. 1877—*Establishment of the Clackamas Hatchery.*—A hatching station established by the salmon canners of the Columbia River, and carried on under the supervision of Mr. Livingston Stone. [Rep. U. S. F. C., V., pp. 22*, 31*.] This was continued, by the aid of the U. S. F. C., in 1878. [Rep. U. S. F. C., VI., p. 27.]

XCVI. 1877—*Introduction of Carp into the United States.*—On the 26th of May, 1877, Mr. Rudolph Hessel, acting for the U. S. Fish Commission, deposited 227 leather and mirror carp and 118 scale carp in the ponds of the Maryland State Hatching House at Baltimore. A few carp had some years previously been introduced by Mr. Poppe, of Sonoma, Cal., which were utilized for his own private purposes. [Rep. U. S. F. C., V., p. 42.*].

XCVII. 1877—*Establishment of the Government Carp Ponds.*—The Government carp pond on the Monument Lot, Washington, were established in 1877 by the passage of an appropriation by Congress.

From this pond several hundred thousand carp have already emanated to all parts of the United States. [Rep. U. S. F. C., V., p. 43*.]

XCVIII. 1877—*Introduction of California Salmon into Europe.*—On the 18th of October Mr. Fred Mather sailed for Europe with 300,000 eggs of the California salmon from the U. S. Fish Commission, consigned to England, France, Germany and Holland, all of which, except 25,000, which were packed in a refrigerating box of his own construction, perished. [Rep. U. S. F. C., V., p. 34*.]

On the 23d of October, 1878, Mr. Mather again arrived in Bremenhaven with 250,000 eggs for Germany, 100,000 for France, 15,000 for Great Britain, and 100,000 for the Netherlands. This venture was entirely successful.

XCIX. 1877—*Discovery of Planted Salmon in the Delaware River and in the Susquehanna.*—In November, 1877, a mature female salmon was taken in the Delaware, at Trenton, supposed to have been planted in 1872 or 1873. In 1878 several hundred were taken. [Rep. U. S. F. C., V., p. 36*; VI., p. xxxi.]

May 11th, 1878, a salmon 40½ inches large was captured in the Susquehanna at Havre de Grace. [Rep. U. S. F. C., VI., p. xxxi., 941.]

C. 1877—*Invention of the Ferguson Plunging Buckets for Hatching Fish.*—In 1877, the system of plunging buckets, worked by steam, for hatching shad in tidal waters, then newly devised by Major T. B. Ferguson, was first tested at Havre de Grace by the joint efforts of the United States and the Maryland Fish Commissions. In 1878, 10,000,000 shad were hatched out with this apparatus by the U. S. Fish Commission. [Rep. U. S. F. C., V., p. 847, VI., p. lvi., 611.]

CI. 1877—*Establishment of the Colorado Fish Commission.*—In 1877 Mr. Wilson E. Sisty was chosen commissioner for Colorado. Up to 1880 $2,400 had been appropriated for fish culture. [Reports I. and II., 1879 (?); III and IV., 1881.]

CII. 1877—*Establishment of the Nevada Fish Commission.*—A fish commission for Nevada was created in 1877, and Hon. H. G. Parker appointed commissioner. Up to 1880 $5,000 had been appropriated for the use of the commissioner. [Reports (biennial), I., 1879.]

CIII. 1877—*Establishment of the West Virginia Fish Commission.*—In 1877, the West Virginia Commission was established by the appointment of John W. Harris, Henry B. Miller and C. S. White as commissioners. Up to 1880 $3,900 had been appropriated for the purposes of fish culture.

CIV. 1878—*Invention of the Wroten Bucket.*—This ingenious contrivance, a modification of the Chase jar, was invented in 1878 by W. T. Wroten. [Rep. U. S. F. C., VI., p. 616.]

CV. 1878—*Introduction of Soles into the United States.*—On the 6th of January, 1878, Mr. Mather, who had been sent to England by the U. S. Fish Commission for the purpose of procuring a supply of soles, deposited two soles on Stelwagen Bank in Cape Cod Bay. [Rep. U. S. F. C., V., p. 47, 866.]

CVI. 1878—*Captures of Planted Shad in California Rivers.*—In the year 1878 over a thousand shad were caught in the Sacramento River, being fish planted in 1871 by Seth Green for the California Fish Commission, or of others sent in subsequent years by the U. S. Fish Commission. [Report U. S. F. C., VI., p. xxxvii.]

CVII. 1878—*Capture of Planted Shad in the Ohio and Mississippi Rivers and the Rivers of Alabama.*—In the spring of 1878 several hundred shad, doubtless from those planted in 1872, were taken in Ohio River at Lowville. These were derived from a deposit of 30,000 made by Seth Green in the Allegheny River, and by Wm. Clift at Salamanca, N. Y., in 1872, in behalf of and at the expense of the U. S. Fish Com. Others taken at Madison, Ind.; Mt. Carmel, Ill.; Steubenville, Ohio; Nashville, Tenn. Shad were taken also in the Coosa River, Ala. [Report U. S. F. C., VI., p. xxxvii-ix.]

CVIII. 1878—*The Successful Propagation of Cod.*—In the fall of 1878 an experiment of propagating codfish was carried on by the U. S. Fish Com. at Gloucester, under the supervision of Mr. J. W. Milner and Capt. H. C. Chester. About 9,250,000 eggs were obtained, and about 1,500,000 were hatched out and turned into the narbor, where in the subsequent years young cod have been unusually numerous. [Rep. U. S. F. C., VI., p. xviii., p. 725.]

CIX. 1878—*Establishment of the Tennessee Fish Commission.*—In February, 1878, Gov. Porter appointed three fish commissioners for the State. They were: W. W. McDowell, of Memphis; Geo. F. Akers, of Nashville, and W. T. Turley, of Knoxville. No money had been appropriated, and the Commissioners have done some work at their own personal expense.

CX. 1878—*Establishment of the Utah Fish Commission.*—The Utah Fish Commission was created by Act of the Legislature, February 22, 1878. Albert P. Rockwood was appointed commissioner. No money had been appropriated up to 1880.

CXI. 1879—*Artificial Propagation of the Haddock*—In May, 1879, the eggs of the haddock were successfully fertilized and large numbers of young were hatched by Mr. R. E. Earll at the U. S. Fish Com. station in Gloucester. [Rep. U. S. F. C., VI., p. 730.]

CXII. 1879—*Invention of the McDonald Fishway.*—In August, 1878, Col. M. McDonald, Fish Commissioner of Virginia, devised a form of

fishway different in principle from all previous, by means of which the water from the dam is delivered down a straight incline sluiceway at an angle of 30 deg. without practical acceleration of velocity. [Report Va. Fish Com., 1879.]

CXIII. 1879—*Establishment of the South Carolina Fish Commission.*—A Fish Commission for South Carolina was created by Act of the Legislature, approved Dec. 23rd, 1879, it was continued under the direction of the Department of Agriculture, A. P. Butler, Commissioner. In 1879 $800 was appropriated and $661.60 was expended. No special appropriation has since been made, the expenses being met by the Department of Agriculture.

CXIV. 1879—*Establishment of the Nebraska Fish Commission.*

CXV. 1879—*Establishment of the Texas Fish Commission.*

CXVI. 1879—*Establishment of the Wyoming Fish Commission.*—The Wyoming Fish Commission was established by an act, passed in December, 1879, which provided for the appointment of a Commissioner, with such deputies throughout the Territory as he might choose to appoint, and appropriated $1,600 for the purpose for the two years ending December, 1881. Henry B. Rumsey was appointed Commissioner, and he appointed Dr. M. C. Barckwell and Otto Gramm as deputies.

CXVII. 1879—*Organization of the Central Fishcultural Society.*—This society held its first meeting at the Palmer House, Chicago, Oct. 1st, 1879, in pursuance to a call by B. F. Shaw and F. Mather.

CXVIII. 1880—*The Building of the Fish Hatching Steamer, Fish Hawk.*—In 1880, the steamer Fish Hawk, built by the United States Government for the service of hatching fish on a very extensive scale, was launched at Wilmington, Del.

CXIX. 1880—*The Successful Propagation of the Spanish Mackerel.*—In June and July, 1880, the Spanish Mackerel was successfully propagated by Mr. R. E. Earll, at Crisfield, Md., at the same time the King Cero, (*cybium regale.*)

1880—*The Propagation of the Moonfish* (*Parephippus faber.*)—At the same time and the same place the moonfish was hatched.

CXX. 1880—*The International Fishery Exhibition at Berlin.*—From March 20th to June 20th, 1880, the International Fishery Exhibition was held in Berlin, Germany. The Exhibition, though general in its scope, was intrinsically a fishcultural exhibition, the chief interest being concentrated in those matters which relate to the culture and preserva tion of fish.

The prizes in fish culture were distributed as follows:

| | Gold Medal. | Silver Medal. | Bronze Medal. | Hon. Mention. |
|---|---|---|---|---|
| United States.. | 6 | 1 | 1 | 2 |
| Germany..... | 3 | 1 | 3 | 11 |
| Russia..... | 1 | 1 | 1 | 1 |
| Norway..,..... | — | 1 | — | 1 |
| Sweden..... | — | 1 | — | — |
| Austria..... | — | — | 1 | — |
| Switzerland.... | — | — | 1 | — |

MR. ANNIN moved a vote of thanks to Prof. Goode for his valuable paper. Carried.

MR. BLACKFORD thought it a long needed work which had now been done, and would serve as a record.

DR. HUDSON asked why the "McDonald fishway" alone was mentioned when there are many others.

PROF. GOODE: All others are merely modifications of existing plans which have been in use in other countries, and the record of whose invention is lost. The McDonald fishway is a new and an original principle.

MR. MATHER: If the McDonald fishway works as well as it appears to in model, it is bound to be the fishway of the future. It looks to be perfect when water is run through a working model.

MR. BLACKFORD: I would refer to the letter of Mr. Page on the introduction of shad into England, and ask if it can be done?

PROF. GOODE: Mr. Mather has had some experience with their ocean transportation, and I would call on him.

MR. MATHER: The shad which we took over in 1874 died at Southampton from starvation. The full account can be found in the reports of the United States Fish Commission. I believe that if the eggs could be retarded in their hatching until the steamer is five or six days out they might be taken over safely. The trouble is that there is no food in the water taken out to sea as there is in river water, when we cross our continent.

MR. PHILLIPS: How low a temperature would it require to keep them for that length of time, and how low a degree can the eggs of this summer spawning fish bear?

MR. MATHER : Perhaps a steady temperature of 65° Fahr. would retard them for five days, but it would require careful experiment. I doubt if they would hatch at 50 degrees, or if they did burst the shell, if they would live to take food.

PROF. GOODE : The eggs of the sea herring have been kept for a long time and hatched, and it has been argued from this that it can be as readily done with the shad, but the case is very different. Dr. Meyer, of Kiel, kept herring eggs for months by the use of ice.

MR. MATHER : Whitefish eggs can also be kept. I saw them in December in Clark's hatchery, which were kept in an ice chest, and Mr. Clark thought he could keep them until June.

PROF. GOODE : It is easy enough to keep the eggs of fishes in a refrigerator if they are of a species which, like the herring, spawn on a falling temperature ; but the shad spawn on a rising temperature. They will wait about rivers until the water gets warm enough to suit them, before they deposit their spawn.

MR. BLACKFORD : The Professor's explanation is conclusive that the eggs of shad will not bear the same treatment as the fall spawners. Mr. Phillips has some facts on the sturgeon fisheries which are important, and we would like to hear from him.

MR. PHILLIPS : I have been surprised at the amount of sturgeon which comes to New York—2,000,000 pounds. It is now scarce. The men who smoke sturgeon have asked me to lay the fact of their growing scarcity before this Association. I think it would be desirable to propagate this fish.

PROF. GOODE : The sturgeon fishery ranks in value among the first fifteen valuable fisheries of the country, leaving out the Mollusks. Its annual value is $350,000.

THE PRESIDENT then said that if there was nothing else of importance before the meeting to-day he would call for the Treasurer's report.

Report of the Treasurer accepted.

Election of officers being next in order, a Nominating Committee was appointed.

The meeting then adjourned until 12 o'clock the following day.

## SECOND DAY.

The meeting was called to order, and the Nominating Committee reported in favor of the following officers, who were elected :

Robert B. Roosevelt, President.
Geo. Shepard Page, Vice-President.
Eugene G. Blackford, Treasurer.
Barnet Phillips, Corresponding Secretary.
James Annin, Jr., Recording Secretary.

### EXECUTIVE COMMITTEE.

Fred. Mather, G. Browne Goode, Samuel Wilmot, Benjamin West, Thomas B. Ferguson, James Benkard, John B. Morgan.

The following members were present: R. B. Roosevelt, E. G. Blackford, James Annin, B. Phillips, F. Mather, C. M. Evarts, G. Browne Goode, J. B. Morgan, J. S. W. Thompson, E. R. Wilbur, W. A. Conklin, H. D. McGovern, Dr. Hudson, S. B. Miller, Al. Haley, Geo. Lamphear, Dr. J. B. Trimble, Asa French, Geo. Ricardo, Geo. Chappel.

### NEW MEMBERS.

Robert T. Morris, 10 Morton street, New York; David T. White, New York; Wm. A. Wilcox, Boston; Chas. Barrett, Grafton, Vt.; Chas. Hawlett, Woodsburg, L. I.; Prof. Atwater, Middletown, Conn.; G. N. Woodruff, Sherman, Conn.; John D. Hicks, Roslyn, L. I.; Samuel Whitney, Katonah, N. Y.; Frank Endicott, 57 Beekman street, New York; Geo. H. Shafer, Fulton Market; Abel Crook, 99 Nassau street, N. Y.

## GENERAL STATISTICS.

BY BARNET PHILLIPS.

Last year one of our most useful and practical members, Mr. G. S. Lamphear, presented to the notice of this meeting carefully prepared statistics, relating to the total pounds of each kind of fish received in the wholesale markets of this city. These tables, the result of a great deal of careful investigation, were perhaps the first of the kind ever brought to your notice. I need not suggest to you all the deductions which arose from these figures. I may cite, however, the following. It is only by such exact figures that we can arrive at positive determinations in regard to the abundance or a scarcity of any particular fish. Now, this abundance or scarcity may be general or local. New York city, with capacious maw, devours an incalculable quantity. I use the word incalculable perhaps in a poetic sense, for it is more or less impossible to count the fish. To be less vague, let us say that our markets draw to themselves an enormous quantity of fish. If fish, then, be scarce in one locality, this want of fish is supplied necessarily from another quarter. This area of productive water is then, by means of easy transportation, always yielding a certain quantity of fish. Say that cod are scarce off Sandy Hook—the demand for cod brings in fish from Gloucester, from Maine. Take striped bass. It may not be found at one season in the North River, but the supply may come from the Delaware or from the Chesapeake. It is, then, the gross quantity of fish received in New York which tells us absolutely whether a fish is generally scarce or plenty. Now, with such tables as have been made by Mr. Lamphear, to be supplemented later by other compilations which the United States Fish Census will shortly have ready, I believe we will get to the great bottom facts in regard to fish, whether caught on our coast or in our inland waters or lakes. If we do get these figures as accurately as human investigations can make them, we shall then better determine what kind of fish, being scarcer, may present themselves to our special care as worthy of culture.

It would be very presumptuous on my part, not having the

whole series of figures, to advance any judgment on this subject. I may, however, be very certain that in some special localities sea fish are scarcer than they were in former years. Professor Baird informs us on the best authority—and I may say that no one is more careful and accurate than our most distinguished fellow-member, the United States Fish Commissioner—that halibut, once plenty, are becoming scarcer every day. Formerly it was caught near shore in large quantities ; to-day long and expensive trips have to be made to secure it. Spanish mackerel is also another most prominent case of the absence of a fish, most particularly in the waters adjacent to this city. Although it does not come within the province of this brief paper to enter into details accounting for the absence of the Spanish mackerel in New York waters, I can only state that it is believed to arise mainly from the dumping of the city refuse in our bay.

Now, as to that great staple fish which forms the bulk of our fish food, cod, perhaps its absence in certain localities will be found to be quite positive, though such want of fiish in one area may be made up by catches in other quarters. The object, then, of such specific investigations derivable fron the examination and comparison of this vast series of fish tables, which will be submitted to the United States Fish Commissioner, will he to eliminate these facts: Whether fish of a certain kind have been plenty or scarce. There is every reason to suppose, in looking at this vast subject in a general way, that constancy being a rule of nature, the quantity of the sea fish will not vary a great deal when an average of years is taken. It is unsafe to corner nature. The year 1880 may have been a bad year for fish, which we will call A and a good one for another fish, which we will call B. But had we been able to study the decade from 1870 to 1880, we might have found in certain years A was plenty and B scarce, and so the general average of A and B were about the same. But now, though we might arrive at this deduction, that is no reason why we should not, if we could, try and make A and B plenty all the year raund. A is scarce off New York Bay and continues getting scarcer, and fairly plenty off Cape Cod. To get the fish A from Cape Cod may be easy enough, but still A will cost a fraction more to bring it to New York market. These

are then some of the great problems which the Fish Ceusus will solve; it will give us exact determinations, and, having some fixed basis to work upon, we will no longer be in the dark.

Might I be allowed to state that public opinion, even special opinion in regard to such matters, is worth very little? We are all inclined to take too narrow views of such objects as surronud us. Our own horizon is necessarily limited. A fisherman, a single dealer, may form his own personal experience declare that fish are scarce, and so they may be. The fisheaman may have had bad luck or the dealer few consignments. These individual experidnces are perfectly correct, but their general deductions may be absolutely incorrect. Then again, popular opinion in regard to fish is prone to error. Providing fish remain in the same quantity, are there not incalcalably more mouths to eat them? It is not possible to imagine that while fifty years ago there was one fish and more for every New Yorker (say in 1831), in 1881 there is not one-half of a fish for each person, and that the extra person must be satisfied with the bones? All this means that the fish being the same in the sea, even with increased fishing, there are more fish wanted. The fish is then a fixed quantity, the methods and men necessary to get more fish augment, but the number of people who want to eat fish, must eat fish, increases faster than the other two. There might be then a time arrived at—we do not pretend to fix the date—when the one fish would have to go round among three, five, ten people. If the example of the wants of a single large centre of population may be precised, does not the same rule of supply and demand hold good for the whole country?

Now comes in that which this Association are doing their utmost to advance, and that is fish culture. We have then, say, that fixed quantity, the normal number of fish, and that constantly increasing hunger of many more mouths to eat this normal number. Is the first to remain a rigid quantity? The American Fish Cultural Association believe that this need not be fixed, but that there are possibilities of increasing the number of fish. Now, not so many years ago, all the ends of this association were limited to trout culture. We have expanded somewhat since then, and with us the science and detail of fish culture

has wonderfully broadened. We are not now bound within the comparative narrow limits of a stream to grow our fishes. Our pond has widened out until it has become almost an ocean, or if not an ocean, any long expanse of sea coast on which the sea breaks. What has been the great progress in these last two or three years has been made in the direction of the propagation of sea fish, and it is in this direction that the United States Fish Commission is advancing, and it is to this that the attention of the members of this association is called. We began with the ornamental, we have come down, or come up to the absolutely practical, unornate but useful. From what so many of our good and intelligent newspaper friends will insist on calling "speckled beauties," we must now come to the descriptive of the commonplace cod. We want the handsomest flowers in the fish bouquet—to use a doubtful metaphor—but we mu t not forget those other vegetables, the potatoes and the turnips. From the horticulturists we may derive both pleasure to the eye and sometimes to the taste, and even the humble kitchen gardener may learn a lesson from him. It is these trout, a handsome show of which Mr. Blackford will present to-morrow, which has made us proficient, as I have been endeavoring to explain, in other larger and better ways.

If then I were to tell you that I believe, from something like an actual count, errors excepted, that last year 49,442,900 pounds of fresh fish of all kinds were received in New York, worth $3,339,827, and that these represented 55,373,862 individual fish—halibut of 150 pounds, or smelt, eight going to a pound, being all counted. Let us hope that by fish culture our children may see these numbers very greatly increased, not only by the introduction of new fishes, which stupid prejudice now turns away from, but by the actual propagation of more fish.

Mr. Blackford called attention to a few viviparous perch from California, sent by Mr. B. B. Redding. They were examined and two were opened but the insides were too decomposed to trace the presence of young.

## FISHES WHICH CAN LIVE IN BOTH SALT AND FRESH WATER.

BY FRED. MATHER.

In respect to the medium which they inhabit fishes may be divided into three classes, viz.: salt water fishes, fresh water fishes, and a third class which can live in either fresh or salt water indifferently. There is no name for this class, that I can learn, and, if there is no objection, I will propose to call them *Amphiœcious* fishes, from the Greek *Amphi*, both or everywhere, and *Oikeo* to inhabit. This class includes many fishes besides the anadromous fishes which leave the sea and seek the rivers to spawn, and the catadromous fishes which leave the fresh to spawn in salt or brackish waters, as the eel does. It contains fishes which seem to be indifferent to the medium which they breathe so far as its saltness or freshness is concerned, provided the change is not made too suddenly, and it is an open question if the chemical properties of salt water are of as much importance to the fishes living in it as its destiny is, but it is one that I have no inclination at present to discuss.

Foremost among the fishes which seem at home, as far as breathing and procuring food are concerned, in either salt or fresh water, are most members of the salmon family. I say *most* members because there are some which do not seem to have been observed in salt water, but as I think it highly probable that all members of this family, which as at present constituted includes the salmons, trouts, smelts and the *coregoni* or "whitefishes," "lake-herrings," graylings, ciscoes, etc., are descended from a common ancestor and have been differentiated by physical causes, there would seem reason to suppose that the graylings and other untried members might live in salt water also. These fishes may not be able to increase their species without access to fresh waters, as the density of salt water is probably too great for the gills of the embryo, even if it did not destroy the embryo before its gills were formed. In some experiments which I made a few years ago with young quinnat salmon of six months old, it was found that when placed in sea water they showed signs of uneasi-

ness at first, then of a desire to keep their noses out into the air and to jump out of the tank, after which they became exhausted and began to die in half an hour after immersion in it. This trial did not prove that salmon of six months old could not have lived in sea-water provided the change had not been sudden. In a state of nature there are no such sudden changes, and young fish making their first voyage from the upper waters of a river to the ocean may consume several months in the journey, dropping down gradually and hardly noticing the increasing density from day to day to which they have become accustomed.

The list of fishes which live in either salt or fresh water as given by the late Prof. Milner is as follows :

| | |
|---|---|
| Salmon | *Salmo salar* |
| Sea-trout | *S. immaculatus* |
| Brook-trout | *S. fontinalis* |
| Whitefish | *Coregonus sp.* |
| Smelt | *Osmerus mordax* |
| Four-spined stickleback | *Apeltes quadracus* |
| American sole, or hog choker | *Achirus lineatus* |
| Tom cod | *Microgadus tomcodus* |
| Striped bass, or rockfish | *Roccus lineatus* |
| White perch | *Morone americana* |
| Silver gar, or bill fish | *Belone longirostris* |
| Shad | *Alosa sapidissima* |
| Alewife | *Pomolobus pseudoharengus* |
| Tailor (shad) | *P. mediocris* |
| Hickory shad, or toothed herring | *Dorosoma cepedianum* |
| Eel | *Anguilla bostoniensis* |
| Sharp-nosed sturgeon | *Acipenser oxyrhynchus* |
| Short-nosed sturgeon | *A. brevirostris* |
| Lamprey | *Petromyzon americanus* |

Of these nineteen fishes Prof. Milner says : "Eight of the fishes named are believed to enter the rivers solely for the purpose of spawning." The genus *Pomolobus* has been divided by Prof. Goode, since Mr. Milner wrote, into two species, it would therefore add another.

To this list I can add :

Ten-spined stickleback ..... *Pygosteus occidentalis*
Flounder ..... *Pseudopleuronectes americanus*
Killy fishes or mummies ..... *Cyrrinodontidæ sp. sp.*
Anchovy or spearing ..... *Engraulis vittatus*
Sawfish ..... *Pristis antiquorum*

The flounder I have taken in Currituck Sound, which is fresh water now, but was salt twenty years ago. It was in winter and not in the spawning season. A species of ray was found in the interior of Eastern Africa and the sawfish is said to exist in Lake Nicaragua and in Laguna de Bay, near Manila. The others I have taken in fresh water or experimented with in aquaria. I also hear that pike (*Esox*) are taken in the brackish and even salt waters of Maryland, but diligent inquiry among fishermen on the south side of Long Island, where the little "mud pike" (*E. americanus* or *E. fasciatus*) is found in great numbers, failed to learn of its going into salt water, although found in the salt bays where fresh water pours in. Animals with soft skins are easily affected when changed from fresh to salt water. Frogs die soon, and, as they breathe by means of lungs, it follows that it is entirely from osmosis, or absorption by the skin, and probably our catfishes (*Siluridæ*) would not stand the change well, although there are two marine species (*Ælurichthys marinus* and *Ariopsis milberti*) on our coast.

I am informed by Professer G. Brown Goode that sting rays (*Trygon centrura*) are found in Lake Harney on the headwaters of the St. John's River, in Florida, while the following species are often found in the river in pure fresh water above Jacksonville :

Sheepshead ..... *Archosargus probatocephalus*
Sailor's choice ..... *Lagodon rhomboides*
The flounder, or New York fluke ..... *Paralicthys dentatus*
Triple tail ..... *Lobotes surinamensis*
Whiting ..... *Menticirrus alburnus*
Yellow tail ..... *Bairdiella punctata*
Menhaden ..... *Brevoortia tyrannus*
Cutlass fish ..... *Trichiurus lepturus*
Silver moon-fish ..... *Vomer setipinnis*

and perhaps twenty others, but the above are the principal fishes in point of value.

It is interesting to note that none of these fishes enter fresh waters in the Northern States, and it immediately raises the question why they do so in Florida? Possibly it is only in the winter time, as the large striped bass (rockfish) run up the Hudson at the same season; probably an instinct connected with hibernation, as it is certainly not for food or the purpose of spawning. It would be interesting to know out of all this class of fishes, for which I have proposed the name *Amphiœcious*, how many would breed in their new home; for while a salmon or a shad might exist for years in salt water, I would be surprised to learn that their eggs would hatch in the water of the ocean. According to Eckstrome, species of the pike-perch, *Stizostethium*; the miller's thumb, *Cottus gobio*; the ling or eel pout, *Lota vulgaris*, and a species of *Acerina*, a perch-like fish, were found in the brackish waters of the Baltic Archipelago. In the Caspian sea Eichwald found a species of Cyprinus; the pike, *Esox lucius*; the common river perch, *Perca fluviatilis*; the loach, *Cobitus fossilus*, and a *Stizostethium*. Of mammals, birds, reptiles, crustaceans, mollusks and worms I have taken no account, for although not foreign to the subject, they would tend to swell this paper beyond its limits.

It does not appear that it is due to any toxic action that some fresh water fishes die in salt water, but rather a difference in the density of the fluids, just as we would die in a short time under the great pressure to which sub-marine divers are subjected. The reverse would occur in salt water fishes when introduced into fresh water. They would then resemble ourselves on mountain tops where the blood is forced by internal pressure from the nose and ears, and the "baloon sickness" is felt. A French investigator, M. Paul Bert, has examined the causes of death in fishes and reptiles when changed from fresh to salt water, and is of the opinion that the cause does not reside in any poisonous quality of sea water, but is simply a phenomenon of osmosis, or transmission of fluids through the membranes; or, in other words, absorption of a heavier fluid in a membrane already filled with a lighter one. An example is cited of a frog which, when plunged into sea-water, it is claimed, loses one-

third of its weight, and if only one foot of the frog be immersed in it, the blood globules can be seen to leave the vessels and distribute themselves under the skin. If an animal be taken whose skin is not so absorbed, the same results appear in its bronchial system. When salt water fishes die from sudden introduction into fresh water endosmosis takes place, which is about the same thing under a reversed condition—the body of the fish containing a denser fluid than its new medium. If the slime be removed from a fish its death will be accelerated when the change of water is made. This is illustrated by the eel, which can bear these sudden changes if uninjured, but if a portion of its protecting mucous coating be removed, its skin becomes absorbent of the surrounding medium and it dies. The eel, which seems at home everywhere, puzzled M. Bert in a curious manner, but in the end confirmed his theory He had already experimented with them in changing fresh water ones into salt water, and found that they were indifferent to the change, and, wishing to continue his experiments, he directed his assistant to introduce the fish and report the results. To his great surprise the eels died after being three or four hours in salt water, and a long search failed to show why it was that they lived when he placed them there, and died when his assistant did so. Finally he found that on account of the eels being so slippery his assistant had used a cloth in handling them and rubbed off their slime, while M. Bert used his wet hands to which very little adhered. Osmosis had occured in the denuded portions and the eels died. Observations on introducing sea fish into fresh water producad analogous results. The gills were the seat of alterations, the same as those noted in the fresh water fish ; and he observed that the life of sea fish could be prolonged after the change by adding salt, which also tended to confirm his views.

The shad, which passes so much of its life in the sea, cannot live there when first hatched. The experiments conducted by Prof. Milner and others, by direction of Prof. Baird, at Noank, Conn., in 1874, while I was on the way to Germany with young shad, showed that the newly hatched fish soon died under a gradual addition of sea water. My shad starved to death on the tenth day, as we reached England, and as it was impossible, and is

yet in our ignorance, to feed the fry, it was hoped that they could be trained to endure sea water and find food in it as they do in river water when we transport them inland.

Concerning the alewife in fresh water, the Watertown, N. Y., *Times* said, in June, 1878: "In the bay at Dexter they are having a great run of small fish at the present time. The species is new down there, and they are called shad and 'herring.' They are only caught in nets, and in such great quantities that they are almost valueless. They are sold at twenty-five cents per barrel, and farmers are buying them for manure." The fish proved to be one of the species of alewife and not young shad, as some of the fishermen supposed, as proved by the following letter from Dr. Bean written to me shortly after in reply to one in which I sent the account:

SMITHSONIAN INSTITUTE, Washington.

MR. FRED. MATHER.—Your letter and article on a supposed shad in Lake Ontario particularly attracted my attention. The Institution has received specimens of the so-called shad, and also from Cayuga and Seneca lakes, New York. These fishes were not shad, but alewives, *Pomolobus pseudoharengus*. The individuals from Lake Ontario were spent females and could not be distinguished from the average alewife of the coast, even by their size. The Cayuga and Seneca Lake specimens were *young* females and males. The ova of the females was quite immature. These alewives differ from the coast alewife *only in size*. I have compared the last specimens with a large series from the coast, and find no other difference.

Yours very truly,
TARLETON H. BEAN.

It is evident that the alewife is not appreciated at its full value among the people residing near its new home. It is a fish of great value, coming in enormous schools, and when they learn to eat it in its fresh state and salt it for winter, they would grieve to lose it. It is not a fine fish in the epicurean sense, but like the farmer's pork barrel, it is a good reserve to draw upon when the butcher fails to get through the snow drifts.

There are many good fishes which can safely be transplanted from salt water to fresh, and one object of this paper has been to show that it can be done with certain species if done gradu-

ally. Among the most valuable of these are the smelt, the striped bass, the tom-cod and the alewife. The smelt is already established in fresh water in Vermont, New Hampshire and New York. The Vermont Fish Commissioners say that smelt have been fully established in every lake into which they have been placed and heard from, and it is a curious fact that the people have not found out what a truly excellent fish this is for the table, its insignificant size seeming to fully protect it, save from an occasional fisherman who has taken them for *bait.* This use of smelts would cause smelt-fishers to raise their eyebrows and examine the man who did such a thing in their presence ; but the rural angler will get over that in time, which will educate him that the little smelt has other uses and a higher value. The report truly says of the smelt : " When they come to be established wherever there is a fit lodgment for them, that event alone will fully pay for all the expenses incurred since the formation of the Commission."

In New York it has been established so long that the memory of man runneth not to the contrary, and in the Adirondacks the guides call it " frostfish " and salt it down. It is found in some of the Fulton chain of lakes and not in others, a very interesting account of which will be found in *Forest and Stream* some time during the coming month (April), from the pen of Mr. E. R. Wilson. They are locally known as frostfish in that region. Mr. Wilson says : " Some time ago I observed in your columns an inquiry relative to the finding of smelts or " frostfish " in fresh water. The so-called frostfish is found in several lakes of the Fulton chain, in the 'John Brown's Tract.' Most visitors to that region have annually wondered at the sight of the old wooden weirs or 'picket lines' set up in the inlets. These fish run up the shoal inlets between those lakes in October, or about the period of the advent of frost—whence the peculiar title—at which time they are taken and salted down in considerable numbers by the guides for home use, and occasionally sent to the adjoining settlements. The fish is a regular habitant of Second, Fourth and Eighth lakes of the Fulton chain, and also Racquette Lake —all deep waters. They seem to stick to the deeper lakes, except in the spawning season, and are a favorite dainty for the salmon

trout, as I have frequently caught the latter all through the summer, both by trolling and deep fishing, which, on opening, almost invariably contained the remnants of frostfish. Early in 1862 a party of us camped at the head of Fourth Lake and set buoys for salmon trout. The suckers had not commenced to run, and we had no bait, so sent back to Arnold's for a net, which we set out well in the lake, off the mouth of the inlet. On hauling it the next morning we found the 'net proceeds' comprised suckers and (tell it not, for we let them go), speckled trout, with some twenty frostfish. After baiting the buoys we found that the 'lakers' bit best at the latter. The guides claim to prefer the fresh frostfish as an article of diet to any trout that swims. They run remarkably uniform in weight, say about one pound, and are somewhat slim in proportion to length, with bright white scales, and flesh of firm texture and light color. They have a long nose, and are evidently a bottom fish. The guides say that the young, when hatched, immediately head for deep water, and reappear only to spawn when fully grown.

"There is a physical oddity in the topographical distribution of this fish. Eighth Lake is entirely disconnected from Fourth Lake, or any others on the chain, and Racquette has a long land barrier from any waters known to contain this finny denizen. A veteran visitant to the Nothern Wilds, Mr. L. H. Redfield, of Syracuse, advances the theory that fish spawn are transported over long distances by being entangled in the feet of wild fowl, and also that mature fish are carried over intervening land through the agency of water spouts. Without the aid of some similar hypothesis, it would seem difficult to account for the presence of finny population in certain localities. I once stumbled upon a little bowl of a lake in that section, away up close to the crest of a mountain, swarming with trout and the course of its only outlet, a mile or two long, would have broken the neck of an Alpine goat to descend, and his very heart to look at the cataract descent. There are two lakes near the mouth of the Moose River, severally known as "Indian" and "Squaw" lakes, separated by high falls impassable for fish, while the lower pond literally teems with trout, yet my companion trappers and guides

asserted roundly that not a fish had been taken in the upper waters. From sheer contradictory "cussedness" I fished it for the best portion of three days with fly-bait—from shore and dug out—and with every possible device and captivation, without raising a fin. The water was clear, the season right and every surrounding apparently favorable, yet I couldn't circumvent the first sight of a scale from its crystalline depths. To discount my disgust I caught a dozen or so *Salmo fontinalis* from the lower lake, and transported them safely into a camp-pail through the woods to the upper sheet, where I trust they have since followed the scriptual injunction in their new Eden. Eheu! that I might revisit those shores next summer and see.—E. R. WILSON."

Mr. N. K. Fairbank, of Chicago, one of the Fish Commissioners of Illinois, owns a part of Geneva Lake, just over the line in Wisconsin, and has ordered a million of smelt fry from Mr. Ricardo this spring. Mr. Fairbank has succeeded in completely land-locking the quinnat salmon, an account of which can be found in *Forest and Stream* of February 10th, of this year; they have not only lived but have spawned.

The introduction of a new fish requires that the people should be educated to appreciate it. The small size of the smelt in the case of the people living near the Vermont lakes led them to neglect it for any purpose but bait, and there are people who are accustomed to seeing them eaten who think it necessary to remove the head and the bones. This may be necessary in the case of the large Eastern smelts, which sometimes weigh half a pound but in the delicate little New Jersey smelts, they are simply cooked without opening and taken in the fingers by the tail and eaten, there being no waste whatever.

The striped bass is another fish which, although we do not know of its being perfectly acclimated in fresh water, I believe would readily become so; and in this connection permit me to quote from *Forest and Stream* of to-day (March 31) as follows:

STRIPED BASS IN LAKE ONTARIO.

We saw the following in the Watertown *Times* of March 15th: 'Clark & Robbins, the fish merchants of Sacket's Harbor, had

brought to their office the other day a sea bass, probably the only one ever caught in the lake or river. It was caught in Chaumont Bay and weighed six pounds. They are a very fine fish, and it is thought by some that this is a forerunner and that there will be others caught."

We immediately wrote the firm named, inclosing drawings of two fishes which might be meant by the term "sea bass," and received the following reply:

SACKET'S HARBOR, N. Y., March 24th.

"Your favor of the 21st inst. at hand with inclosure of slip from the Watertown *Times*, also drawings. The fish taken here was the lower one in drawing—*Roccus lineatus*—or striped bass of New York.

It is the first one ever seen by us taken from these waters, and we have an idea that it found its way up here by following the alewife, The specimen was very handsome, and there is no doubt as to its identity, The great question here is, "What will be the ultimate result of the appearance here of the alewife?" Have they caused the extermination of the native ciscoe? Will the alewife remain with us, or are they to disappear as mysteriously as they came, or will some of the food fishes of the salt water become *habitues* of our lake?

These are questions we hardly dare venture an opinion on, as we really can see no good that is to be enduring by the appearance of the alewife in our waters.

We should be glad to read your opinion on these questions, and would be pleased if the Department at Washington would appoint a commission to investigate. The subject needs to be dealt with in a masterly manner. CLARK & ROBBINS."

The Ogdensburg *Journal* has an article on the alewife as follows, for we think we are correct in assuming that they refer to this fish when they speak of menhaden, which do not go into fresh waters in this latitude. It says:

"Considerable interest will hang upon the question, 'What effect did the singular mortality noticed last year have upon the alewives or menhaden of the St. Lawrence?' The total absence from the fish market of the old-fashioned ciscoes of Lake Ontario, reminds us that this species of fish have been supplanted by the newcomers as certainly as the aborigines have disappeared before the whites on the land. If it shall turn out that the men-

haden are as numerous as ever the present season, the fish commissioner should take some steps to investigate them and teach the people how to utilize their presence. If the presence of the sea bass recently caught near Sacket's Harbor comes from the following of the menhaden to our waters, and other species are liable to do the same thing, fishermen and fish eaters may be benefited by the facts. We suggest the superintendent of the Fishery Department send a duly qualified deputation to the St. Lawrence in June of the present year, to investigate the menhaden visitation which takes place at that time."

The people are alarmed at the new visitation; but, in my opinion, when they learn that the alewife can be eaten and salted for winter they will find that its greatly increased numbers will make it a more valuable fish than the lamented "cisco," as it breeds faster, being a spring spawner and therefore hatching quicker, as well as having smaller eggs and many more of them.

There may be no fresh water fishes which would be of practical value if introduced into salt water, but it is interesting from a zoological point of view to know that some of them will live there. The brook trout of Long Island run down into the salt bays and the sea and feed on shrimp, and some species of white fish are recorded by Pallas as living in the sea and sending off legions into the streams flowing from Lake Baikal, from whence some of the young return and some remain in fresh water forever; while shad have been taken in the Genesee River, in western New York, and in Lake Erie, at Toledo, as well as in Lake Champlain. It is also reported that two valuable salt water fishes of Europe, the basse (*Labrax*), and the gray mullet (*Mugil*), are artificially bred in pure fresh water in the Lake of Acqua, near Padua, at the head of the Adriatic.

## POACHERS.

BY JAMES ANNIN, JR.

I shall endeavor to give a list of some of the most destructive frequenters of the trout pond and stream which have come under my observation, and also some of the remedies used.

First, I have the kingfisher. His notes are heard from early spring until cold weather in late fall, and sometimes he will appear during the winter, like some sportsmen I have seen who could not stand it until the season opened in the spring, but they must just go and take a look at the stream where, during the summer past, they had had such fine sport.

This bird is never satisfied. From daylight to dusk he is on the lookout, and ever ready to plunge in after any fish which may be exposed.

I honestly think that a kingfisher, undisturbed during his stay on or near the stream, will take as many trout as the average sportsman. Some say, Why don't you shoot them? Well, cold lead is very good when you get the time and chance to send it after them, but you can't be on the look-out all the time, and I think the best way to get the fellow out of harm's way is to trap him. For that purpose I have used small, round steel traps, the kind without the shank or tail-piece, fastening them on the end of a pole, say ten or fifteen feet long, and then putting them up along the stream near enough to a good fishing spot, so that the bird may think it a splendid point to make observations from. When the trap is set and in position the little plate or drop is a little the highest part of the trap, and as he flies up and drops on the trap you have him every time, and by both legs. I have taken as many as three of the birds in one trap during a day. It is always ready; it costs nothing to keep it running besides the first cost of the trap. Occasionally you will have a visit from some other variety of birds. I have taken large fish-hawks, owls, etc.; never but one robin.

Next come the ducks, wild and domestic. The latter are very destructive, not only to the fish but to the fish food of the stream. They are almost always at work feeding during the day, and are not easily driven away.

The best plan is to have no ducks yourself, and if your neighbors have them and they come on your premises, offer to buy them, and with the understanding if they have more and they trouble you that you will shoot. I have seen a tame duck catch and swallow a trout six inches long.

But few species of wild duck trouble fish much, but during the past winter I was annoyed by a flock of what I called sawbills or sheldrakes. Most of the streams throughout the country were frozen, and they came to our Caledonia Spring Creek as that never freezes. I had a hard time with them for about two weeks in trying to keep them off. If occasionally I could get a shot they would only fly to the other end of the stream, and would soon be back. (The stream is only about one mile long.) They would go over the large spawning beds where you could see from one hundred to a thousand fish, and after they had been over it you would not see a fish, and could not find one near for all that day, and once or twice it was the third day before they began to show up again.

I found that shooting did not work, so I made some scarecrows out of old clothes and set them up on the bank of the stream. That did very well for a day or two, but they soon saw through the fraud and were as bad as ever. I then thought I would try something that would move, as I saw that a boat on the stream, or a person in motion would start them the moment they saw it, even if a long way off. So I made some small red flannel flags and put them by the side of the scarecrows, and that did the business, and I had no more trouble with the sheldrakes.

Next I have the common hoot or screech owl. I have but little to say about them, as they have given me but little trouble or damage that I know of. What first made me suspect that they were up to some mischief was that I found them in my steel traps that were set for muskrat, mink, etc. In setting traps for these we generally place them under the surface of the water from one to four inches, and when I found the owls in them I

could not make out what they were after in the water, but I soon found that it was for the fish-food in the stream, such as the fresh water lobster, caddis worm, shrimp, etc. So that if not a direct enemy to the fish they indirectly do much harm, as I said under the head of Poachers No. I. I have taken them during the night in the traps placed for kingfishers.

Then comes the heron, the "blue heron," and what a wicked fellow, dealing death to everything in the fish line that he once strikes with that long, heavy and sharp bill of his. Most of his poaching is carried on after dark and early mornings. During the day you find him in the more secluded parts of the stream or marshes, but after dark he will come into any of your shallow ponds, coming to within a rod or two of your house, and as the fish move around (he standing in the water perfectly motionless), and come within his reach, he strikes, and good-bye to the fish if he hits him. From what I have seen myself and heard from others, I think the bird capable of getting outside of from one to two dozen, three dozen trout in one night.

During the summer, when I have been out night-fishing, I have often heard within a short distance of me a great flopping and disturbance in the water. The next morning I have often gone to the spot as near as possible, and found the mark of the heron's feet, and very often near by the stream a large trout, say from one-half to one pound in weight, dead, with a hole in his back or side into which you could put your finger, and sometimes going through the fish. I suppose the fish found in this shape were a little too large and strong for the heron, and got away from him, but only to die from the effects of the wound.

If you see their marks, or think herons are visiting your ponds or stream, at once get out your steel traps, and at the spot frequented most set one, two or three, the more the better. Set them in the shallow water or soft mud without baiting. Secure the trap well, for when they find themselves caught they start to fly, and will carry it off unless proper precaution is used. I have taken several in this way, and sometimes in winter. When you find one in your trap be very careful about going very near until you have quieted him with a long club or a charge of shot, for

they are savage, and can and will inflict a bad wound, as I know from experience.

The bittern, a bird something after the nature of the heron, only very much smaller, must do some damage. I always shoot him when I can.

Then I have the muskrat. In his poaching he is after much the same food as the owls, only I think not quite as much of a variety. The only thing I have observed him taking was the caddis worm, which he has a great liking for. I have seen at least a peck of the empty caddis worm cases in one pile on the bank at the water's edge, which he had taken from the stream. He is also troublesome, and sometimes causes much damage by undermining the banks of your ponds, and by eating off the slats to your screens. I also make way with these by trapping in the winter and spring. At this season their fur is in prime order, and will sell for enough to pay for the time and trouble. I sell every spring from ten to fifteen dollars' worth of their fur. I have never seen any evidence of their catching or eating fish.

Then comes the mink, which is one of the greatest enemies the fishculturist has to contend with. If a trout is in the stream or pond, and they want it they will have it. If they get the notion of coming to one of your ponds they will follow it up until the fish are gone. If you don't keep good watch they will have half of them before you are aware of it. As soon as you think a mink is taking your fish lay for him. See how and where he goes into the pond. You will soon see that he enters at about the same place each time ; then set your trap just under the water, so that when he slides down (as he thinks) into the pond he will slide into the trap instead. In this way I took the mother and brood of four almost full-grown minks in two nights. One mink may destroy a hundred dollars' worth of fish in a short time. They often appear to catch them for the sport of the thing. I have seen them slide down the bank of a stream into the water, coming up with a fish, and repeating it time and again, hardly ever failing to get one.

*Snakes.*— I will not say all the snakes found along a stream will catch fish, but I have seen what I called a water-adder, thirty inches long, catch a trout of five ounces in weight, and I have

seen one of the same variety killed and opened that had three trout in his stomach. A gentleman told me this spring, that last summer he was passing near a pond which contained brook trout, and he saw a snake glide down the bank into the water, and as the water was clear he watched him. He went into some moss that was on the bottom of the pond. Entering the moss from below, soon he saw his head appear in the top of the bunch of moss, and then, for the first time, he noticed a small trout, about four inches long, that was almost over the snake's head. After slowly drawing his head out a little he made a dart for the fish and caught him; then came out on the bank. The only method I have found for their destruction is to kill them whenever they come in your path. In the months of May and June they may be found along the banks of streams or ponds sunning themselves, when a charge of No. 6 or 8 shot will put them on the retired list.

Last, but not least, I have the one coming more directly under the title of my paper, man. He knows better, but I am sorry to say that he steps over the mark very often, and in many cases proves the most troublesome of all, often deserving a charge of fine shot. If you commence an action against him, many (I am very sorry to say it) of our justices only wink at the offender, and he goes free. We know of the justice himself going on a private and posted stream, knowing it to be so, and afterwards telling of the good luck he had. A certain class of our people regard it as a smart thing to take trout from your pond or stream without being caught. But if any one should steal a chicken from them they say, "Oh that's a different thing." I have caught boys and men on my stream and a sign prohibiting fishing within ten feet of it. I have spoken to the boys' fathers and had each one make good promises that they would see to it that their boy never was there again, but when your back was turned laugh at you, and make brags to their neighbors of what a good mess of trout his boy caught. I think it will be a long time before all of our people get educated up to the point that they see the stealing of a few trout a sin.

I think some good would be accomplished if every sportsman and member of sporting clubs throughout the country would see

that at conventions or caucuses for nomination of local or town officers, the nominee for justice is one that will stand firm and give the offender the full extent of the law.

## THE EEL QUESTION.

BY PROF. G. BROWN GOODE.*

### NUMBER OF SPECIES OF EELS IN AMERICA.

It is the disposition of American ichthyologists to accept, for the present, the views of Dareste, and to consider all the eels of the northern hemisphere as members of one polemorphic species. Gunther is inclined to recognize three species in North America: one the common eel of Europe, *Anguilla vulgaris;* one the common American eel, *Anguilla bostoniensis*, which he finds also in Japan and China; and the third, *Anguilla texana*, described and illustrated by Girard, in the Report of the United States and Mexican Boundary Survey, under the name of *A. texana*, which, he remarks, is scarcely specifically distinct from *A. bostoniensis*, from which it differs only in the greater development of the lips. The distinction between *A. bostoniensis* and *A. vulgaris*, as stated by him, consists chiefly in the fact that the dorsal fin is situated a little farther back upon the body. so that in the former the distance between the commencement of the dorsal and anal fin is shorter than the head, while in the latter it is equal to or somewhat longer than it. This character does not appear to be at all constant.

### GEOGRAPHICAL DISTRIBUTION OF THE EEL.

We may therefore provisionally assume the identity of the eels of the old and the new world, and define their distribution somewhat as follows: In the rivers and along the ocean shores of Eastern North America, south to Texas and Mexico, and north at least to the Gulf of St. Lawrence, but absent in the waters tributary to Hudson Bay, the Arctic Sea and the Pacific; present

*This paper, in a more extended form and with illustrations from anatomical designs, is published in the Bulletin of the United States Fish Commission, Vol. I., 1881, pp. — to 124.

in Southern Greenland (?) and Iceland, latitude 65 deg. north; on the entire coast of Norway, from the North Cape, latitude 71 deg., southward; abundant in the Baltic and in the rivers of Russia and Germany, which are its tributaries, and along the entire western and Mediterranean coasts of Europe, though not present in the Black Sea, in the Danube, or any other of its tributaries, or in the Caspian; occurring also off Japan and China and Formosa; also in various islands of the Atlantic, Granada, Dominica, the Bermudas, Madeira and the Azores.

### GENERAL NOTE ON HABITS. [Professor BAIRD.]

The habits of the eel are very different from those of any other fish, and are as yet but little understood.

"This, so far as we know," writes Professor Baird, "is the only fish the young of which ascend from the sea to attain maturity, instead of descending from the fresh to the salt water. Its natural history has been a matter of considerable inquiry within a few years, although even now we are far from having that information concerning it that would be desirable, in view of its enormous abundance and its great value as a food fish.

"The eggs of the eel are for the most part laid in the sea, and in the early spring, the period varying with the latitude, the young fish may be seen ascending the river in vast numbers, and when arrested by an apparently impassable barrier, natural or artificial, they will leave the water and make their way above the obstruction, in endeavoring to reach the point at which they aim. Here they bury themselves in the mud and feed on any kind of animal substance, the spawn of fish, the roes of shad, small fish, etc. At the end of their sojourn in the ponds or streams they return to the sea, and are then captured in immense numbers in many rivers in what are called fish-baskets. A V-shaped fence is made, with the opening down stream into the basket, into which the eels fall, and from which they cannot easily escape. This same device, it may be incidentally stated, captures also great numbers of other fish, such as shad, salmon, and other anadromous fish, to their grievous destruction.

"As might be expected, however, the Falls of Niagara consti-

tute an impassable barrier to their ascent. The fish is very abundant in Lake Ontario, and until artificially introduced was unknown in Lake Erie. At the present time, in the spring and summer, the visitor who enters under the sheet of water at the foot of the falls will be astonished at the enormous number of young eels crawling over the slippery rocks and squirming in the seething whirlpools. An estimate of hundreds of wagon-loads, as seen in the course of the perilous journey referred to, would hardly be considered excessive by those who have visited the spot at a suitable season of the year."*

INTRODUCTION OF EELS INTO NEW WATERS IN THE UNITED STATES.

In describing the geographical distribution of the eel it was stated that it occurs in the rivers and along the ocean shores of North America. This being the case, as might be supposed, there are many inland lakes and streams of the United States in which this fish does not occur; for instance, in the chain of great lakes above Niagara Falls and in the upper waters of other streams in which there are considerable obstructions. The cutting of canals in various parts of the country has, however, produced a great change in their distribution; for instance, it is stated by Mitchell† that eels were unknown in the Passaic above the Great Falls until a canal was cut at Paterson, since which time they have become plentiful in the upper branches of that river. They have also been placed in many new localities by the agency of man. Concerning this Mr. Milner remarks:

"The eel (*Anguilla bostoniensis*), appreciated in some localities and much vilified in others, is another species that has been frequently transplanted. It is pretty evident that it never existed naturally in the chain of great lakes any higher up than Niagara Falls, although specimens have been taken in Lakes Erie and Michigan. Their existence there is with little doubt traceable to artificial transportation.

"A captain of a lake vessel informed me that it was quite a common thing some years ago to carry a quantity of live eels in

*MS. note by Professor Baird.

†Transactions Lit. and Phil. Soc. New York, I., p. 48.

a tub on the deck of a vessel while on Lake Ontario, and they were often taken in this manner through the Welland Canal. He said that it was a frequent occurrence on his vessel, when they had become tired of them, or had procured better fishes, to turn the remainder alive into the waters of Lake Erie.

"In 1871 Mr. A. Booth, a large dealer of Chicago, had an eel of four pounds weight sent him from the south end of Lake Michigan, and a few weeks afterward a fisherman of Ahneepee, Wis., nearly 200 miles to the northward, wrote him that he had taken a few eels at that point. It was a matter of interest to account for their presence, and a long time afterward we learned that some parties at Eaton Rapids, Mich., on a tributary of the lake, had imported a number of eels and put them in the stream at that place, from which they had doubtless made their way to the points where they were taken. The unfortunate aquarium-car, in June, 1873, by means of the accident that occurred at Elk-horn River, released a number of eels into that stream, and about four thousand were placed by the United States Commission in the Calumet River at South Chicago, Ill.. two hundred in Dead River, Waukegan, Ill., and three thousand eight hundred in Fox River, Wisconsin."*

They have since been successfully introduced into California.

### GUNTHER ON THE LIFE-HABITS OF THE EEL.

Concerning the life-history of the eel much has been written, and there have been many disputes even so late as 1880. In the article upon Ichthyology, contributed to the Encyclopedia Britannica, Gunther writes:

"There is no group of fishes concerning the classification and history of which there is so much doubt as the eel family; an infinite number have been described, but most are so badly characterized, or founded on individual or so trivial characters, that the majority of the ichthyologists will reject them."‡

In his Catalogue of the Fishes in the British Museum, Dr. Gunther has claimed to retain those as species which are distin-

*Report U. S. Fish Commission, p. 2, 1874, 526.

‡Gunther, Catalogue of Fishes British Museum, VIII., p. 24.

guished by such characters that they may be recognized, though he remarks that he is by no means certain whether really specific value should be attached to them, remarking that the snout, the form of the eyes, the width of the bands of teeth, etc., are evidently subject to much variation. In his more recent work he remarks, "Some twenty-five species of eels are known from the coast waters of the temperate and tropical zones."

### DARESTE'S VIEWS.

Other recent writers have cut the knot by combining all of the eels into three or four, or even into one species, and it seems as if no other course were really practicable, since the different forms merge into one another with almost imperceptible gradations. In his monograph of the family of Anguilla-formed fishes† M. C. M. Dareste remarks:

"Dr. Gunther has recently published a monograph of the apodal fishes, in which he begins the work of reducing the number of specific types. The study of the ichthyological collection of the Paris Museum, which contains nearly all of Kaup's types, has given me the opportunity of completing the work begun by Dr. Gunther, and of striking from the catalogue a large number of nominal species which are founded solely upon individual peculiarities.

"How are we to distinguish individual peculiarities from the true specific characters? In this matter I have followed the suggestions made with such great force by M. Siebold in his History of the Fresh Water Fishes of Central Europe. This accomplished naturalist has shown that the relative proportions of the different parts of the body and the head vary considerably in fishes of the same species, in accordance with certain physiological conditions, and that consequently they are far from having the importance which has usually been attributed to them in the determination of specific characters.

"The study of a very large number of individuals of the genera *Conger* and *Anguilla* has fully convinced me of the justice of this observation of Siebold; for the extreme variability

†Comptes Rendus of the Academy of Sciences. Paris.

of proportions forbids us to consider them as furnishing true specific characters.

"I also think, with Siebold, that albinism and melanism, that is to say, the diminution or augmentation of the number of chromatophores, are only individual anomalies and cannot be ranked as specific characters. Risso long since separated the black congers under the name *Muræna nigra*. Kaup described as distinct species many black Anguillas. These species should be suppressed. I have elsewhere proved the frequent occurrence of melanism and albinism more or less complete in nearly all the types of fishes belonging to this family, a fact especially interesting, since albinism has hitherto been regarded as a very exceptional phenomenon in the group of fishes. This also occurs in the *Symbranchidæ*. I have recently shown it in a specimen of *Monopterus* from Cochin China, presented to the museum by M. Geoffroy St. Hilaire.

"I must also signalize a new cause of multiplication of species; it is partial or total absence of ossification in certain individuals. This phenomenon, which may be explained as a kind of *rachitis* (rickets), has not to my knowledge been noticed, yet I have found it in a large number of specimens. I had prepared the skeleton of a *Conger* of medium size, the bones of which are flexible and have remained in an entirely cartilaginous state. Still it is not necessary to prepare the skeleton to determine the absence of ossification, for we can establish this easily in unskinned specimens by the flexibility of the jaws. It is very remarkable that this modification of the skeleton is not incompatible with healthy existence, and that it does not prevent the fish in which it is found from attaining a very large size.

"Those fishes in which ossification is absent are remarkable by reason of the great reduction of the number of teeth, which, although the only parts which become hard by the deposit of calcareous salts, remain, however, much smaller than in individuals whose skeletons are completely ossified.

"We can thus understand how such specimens could present characters apparently specific, and that they should have been considered by Kaup as types of new species. These considera-

tions have led me to reduce, on an extensive scale, the number of species in the family.

So, in the genus *Anguilla*, I find but four species: *Anguilla vulgaris*, occurring throughout the northern hemisphere, in the new world as well as the old. *Angutlla marmorata* and *A. mowa* of the Indian Ocean, and *Anguilla megalostoma* of Oceanica.

"There are at least four distinct types, resulting from the combination of a certain number of characters; but the study of a very large number of specimens belonging to these four specific types has convinced me that each of these characters may vary indepenednntly, and that consequently certain individuals exhibit a combination of characters belonging to two distinct types. It is therefore impossible to establish clearly defined barriers sepa rating these four types.

"The genus *Anguilla* exhibits, then, a phenomenon which is also found in many other genera, and even in the genus *Homo* itself, and which can be explained in only two ways: Either these four forms have had a common origin, and are merely races, not species, or else they are distinct in origin, and are true species, but have been more or less intermingled, and have produced by their mingling intermediate forms which coexist with those which were primitive. Science is not in the position to decide positively between these alternatives."

### ANCIENT BELIEFS CONCERNING THE REPRODUCTION OF THE EEL.

The reproduction of the eel, continues Benecke, has been an unsolved riddle since the time of Aristotle, and has given rise to the most wonderful conjectures and assertions. Leaving out of question the old theories that the eels are generated from slime, from dew, from horsehair, from the skins of the old eels, or from those of snakes, and the question as to whether they are produced by the female of the eel or by that of some other species of fish, it has for centuries been a question of dispute whether the eel is an egg-laying animal or whether it produces its young alive; although the fishermen believe that they can tell the male and female eels by the form of the snout. A hundred years ago no man had ever found the sexual organs in the eel.

Jacoby has remarked that the eel was from the earliest times a riddle to the Greeks; while ages ago it was known by them at what periods all other kinds of fishes laid their eggs, such discoveries were never made with reference to the eel, though thousands upon thousands were yearly applied to culinary uses. The Greek poets, following the usage of their day, which was to attribute to Jupiter all children whose paternity was doubtful, were accustomed to say that Jupiter was also progenitor of the eel.

"When we bear in mind," writes Jacoby, "the veneration in which Aristotle was held in ancient times, and still more throughout the Middle Ages—a period of nearly two thousand years—it could not be otherwise than that this wonderful statement should be believed and that it should be embellished by numerous additional legends and amplifications, many of which have held their own in the popular mind until the present day. There is no animal concerning whose origin and existence there is such a number of false beliefs and ridiculous fables. Some of these may be put aside as fabrications; others were, probably, more or less true, but all the opinions concerning the propagation of the eel may be grouped together as errors into three classes:

"(I) The beliefs which, in accordance with the description of Aristotle, account for the origin of the eel not by their development from the mud of the earth, but from slimy masses which are found where the eels rub their bodies against each other. This opinion was advanced by Pliny, by Athenæus, and by Oppian, and in the sixteenth century was again advocated by Rondelét and reiterated by Conrad Gessner.

"(II.) Other authorities base their claims upon the occasional discovery of worm-like animals in the intestines of the eels, which they described, with more or less zealous belief, as the young eels, claiming that the eel should be considered as an animal which brought forth its young alive, although Aristotle in his day had pronounced this belief erroneous, and very rightly had stated that these objects were probably intestinal worms. Those who discovered them anew had no hesitation in pronouncing them young eels which were to be born alive. This opinion was first brought up in the Middle Ages in the writings

of Albertus Magnus, and in the following centuries by the zoölogists Leuwenhoek, Elsner, Redi, and Fahlberg; even Linnæus assented to this belief and stated that the eel was viviparous. It is but natural that unskilled observers, when they open an eel and find inside of it a greater or smaller number of living creatures with elongated bodies, should be satisfied, without further observation, that these are the young of the eel; it may be distinctly stated, however, that in all cases where eels of this sort have been scientifically investigated, they have been found to be intestinal worms.*

"(III.) The last group of errors includes the various suppositions that eels are born not from eels, but from other fishes, and even from animals which do not belong at all to the class of fishes. Absurd as this supposition, which, in fact, was contradicted by Aristotle, may seem, it is found at the present day among the eel-catchers in many parts of the world.

"On the coast of Germany a fish related to the cod, *Zoarces viviparus*, which brings its young living into the world, owes to this circumstance its name *Allmuter*, or eel mother, and similar names are found on the coast of Scandinavia."

"In the lagoon of Comacchio," continues Jacoby, "I have again convinced myself of the ineradicable belief among the fishermen that the eel is born of other fishes; they point to special differences in color, and especially in the common mullet, *Mugil cephalus*, as the causes of variations in color and form among eels. It is a very ancient belief, widely prevalent to the present day, that eels pair with water snakes. In Sardinia the fishermen cling to the belief that a certain beetle, the so-called water-beetle, *Dytiscus Roeselii*, is the progenitor of eels, and they therefore call 'this mother of eels.'"

### SEARCH FOR AND DISCOVERY OF THE FEMALE EEL.

A scientific investigation into the generation of eels could only

*It is very strange that an observer, so careful as Dr. Jacoby, should denounce in this connection the well-known error of Dr. Eberhard, of Rostock, who mistook a species of zoarces for an eel, and described the young, which he found alive within the body of its mother, as the embryo of the eel. In Jacoby's essay, p. 24, he states that the animal described by Eberhard was simply an intestinal worm, an error which will be manifest to all who will take the pains to examine the figure.

begin when at the end of the Middle Ages, the prohibition which the veneration for Aristotle had thrown over the investigations of learned men was thrown aside. With the revival of the natural sciences in the sixteenth century we find that investigators turned themselves with great zeal to this special question. There are treatises upon the generation of the eel written by the most renowned investigators of that period, such as Rondelet, Salviani, and Aldrovandi. Nevertheless, this, like the following century, was burdened with the memory of the numerous past opinions upon the eel question, and with the supposed finding of young inside the body of the eel.

The principle supporters of the theory that the eel was viviparous, were Albertus Magnus, Leuwenhoek, Elsner, Redi, and Fahlberg. The naturalists, Franz Redi and Christian Franz Paullini, who lived in the seventeenth century, must be mentioned as the first who were of the opinion, founded, however, upon no special observations, that the generation of the eel was in no respect different from that of other fishes.

In the eighteenth century it was for the first time maintained that the female organs of the eel could certainly be recognized. It is interesting that the lake of Comacchio was the starting point for this conclusion as well as for many of the errors which had preceded it. The learned surgeon, Sancassini, of Comacchio, visiting an eel fishery at that place in 1707, found an eel with its belly conspicuously enlarged; he opened it and found an organ resembling an ovary, and, as it appeared to him, ripe eggs. Thereupon he sent his find, properly preserved, to his friend, the celebrated naturalist, Valisneri, professor in the university of Padua, who examined it carefully and finally, to his own great delight, became satisfied that he had found the ovaries of the eel. He prepared an elaborate communication upon the subject, which he sent to the Academy at Bologna.*

At the very beginning there were grave questions raised as to the correctness of this discovery. The principal anatomical authority at Bologna, Professor Valsalva, appears to have shared

* I fail to find any record of the publication of this paper, except that given by Jacoby, who states that it was printed at Venice, in 1710 with a plate, and subsequently, in 1712, under the title "Di ovario Anguillarum," in the proceedings of the Leopold Academy.

these doubts, especially since shortly after that a second specimen of eel, which presented the same appearance as that which was described by Vallisneri, was sent from Comacchio to Bologna. The discussion continued, and it soon came to be regarded by the scientific men of Bologna as a matter of extreme importance to find the true ovaries of the eel. Pietro Molinelli offered to the fishermen of Comacchio a valuable reward if they would bring him a gravid eel. In 1752 he received from a fisherman a living eel with its belly much extended, which, when opened in the presence of a friend, he found to be filled with eggs. Unfortunately the joyful hopes which had been excited by this fortunate discovery were bitterly disappointed when it was shown that the eel had been cunningly opened by the fisherman and filled with the eggs of another fish. The eel question came up again with somewhat more satisfactory results when, in the year 1777, another eel was taken at Comacchio which showed the same appearance as the two which had preceded it. This eel was received by Prof. Cajetan Monti, who, being indisposed and unable to carry on the investigation alone, sent a number of his favorite pupils to a council at his house, among whom was the celebrated Camillo Galvani, the discoverer of galvanism. This eel was examined by them all and pronounced to be precisely similar to the one which had been described by Vallisneri seventy years before. It was unanimously decided that this precious specimen should be sent for exhaustive examination to the naturalist Mondini, who applied himself with great zeal to the task, the results of which were published in May, 1777. The paper is entitled "De Anguillæ ovariis," and was published six years later in the transactions of the Bologna Academy.* Mondini was satisfied that the supposed fish which Vallisneri described was nothing but the swimming bladder of the eel in a diseased state, and that the bodies supposed to be eggs were simply postules in this diseased tissue. In connection with this opinion, however, Mondini gave, and illustrated by magnificent plates, a good description and demonstration of the true ovaries of the eel, as found by himself. This work, which in its beautiful plates illustrates also the eggs in a magnified fold of the ovary, must be regarded as classical work, and it is an

act of historic justice to state that neither O. F. Müller nor Rathke, but really Carlo Mondini was the first discoverer, describer, and demonstrator of the female organs of the eel, which had been sought for so many centuries.*

Three years later, entirely independent of Mondini, the celebrated zoölogist, Otto Friedrich Müller, published his discovery of the ovary of the eel in the "Proceedings of the Society of Naturalists," at Berlin.

The discovery of Mondini was next specially brought into prominence through Lazzaro Spallanzani. This renowned investigator, in October, 1792, went from Pavia to the lagoons of the Po, near Comacchio, for the sole purpose of there studying the eel question. He remained at Comacchio through the autumn; he was, however, unable to find anything that was new regarding the question, but in the report upon his journey of investigation he entirely threw aside the discovery of Mondini, and announced that the ovaries discovered by this authority were simply fatty folds of the lining of the stomach.†

It was without doubt this absolute negative statement of such a skilled investigator as Spallanzani which for a long time discouraged further investigations on the eel question, and allowed what had already been discovered to be regarded as doubtful, as finally to be forgotten. So when Professor Rathke, of Königsberg, in his assiduous labors upon the reproductive organs of fishes, in the year 1824, described the ovaries of the eel as two cuff and collar shaped organs on both sides of the backbone, and in the year 1838 described them as new, he was everywhere in Germany (and to a large extent to the present day) regarded as

*O. F. Müller, Bemühungen, bei den Intestinal Wurmern.

†Prof. G. B. Ercolani, of Bologna, and also Crivelli and Maggi, in their essays published in 1872, have rightly stated that Mondini's priority of discovery has been overlooked in Germany. Neither Rathke nor Hohnbaum-Hornschech nor Schlüser have mentioned his work. S. Nillson, in his Skandinavisk Fauna, 1855, says nothing of Mondini. He mentioned as the first discoverer of the ovaries O. F. Müller, while Cuvier, in his Historie Maurelle de Poissons," assigning the honor rather to Rathke. Th. von Siebold is the first to announce in his work, published in 1863, Die Süsswasserfische Von Mitteluropa, page 349, that Mondini, almost contemporaneously with O. F. Müller, and independently from him, discovered the ovaries of the eel. The error, as was discovered by Italian zoölogists later than by those of Germany, arofe from the fact that the announcement of Müller's discovery was printed in 1780, while that of Mondini, which was made in 1777, was first printed in 1783.

the discoverer. The first picture of the ovary after that of Mondini, and the first microscopical plate of the egg of the eel Hohnbaum-Hornschuch presented in a dissertion published in 1842—a paper which should be rightly considered as of great importance in the literateure of this question. The questions concerning the ovaries of the eel may be regarded as having been brought to a distinct conclusion by Rathke, who in the year 1850, published an article describing a gravid female eel, the first and only gravid specimen which had, up to that time, come into the hands of an investigator.*

### HUNT FOR THE MALE EEL AND ITS DISCOVERY BY SYRSKI.

The history of the search for the female of the eel having been given, for the most part, in a translation of the work of Dr. Jacoby, it seems appropriate to quote the same author concerning the search for the male eel, which, though much shorter, is none the less interesting.

In the dissertation of Hohnbaum-Hornschuch, published in 1842, the opinion was expressed that certain cells found by the author in the ovaries which differed from the egg cells by their form and contents, should be regarded as the spermary cells of the eel, and that the eel should be regarded as hermaphrodite. Six years latter Schluser presented an interesting dissertation upon the sexes of lampreys and eels, in which he pronounced these opinions of Hohnbaum-Hornschuch to be erroneous, and expressed the opinion that the male eel must be extremely rare, or that it was different, perhaps, from the female. From this

*_Rathke_, who first, since Mondini, has in detail described (1824, 1838, and 1850) the ovaries of the eel, is considered by some to have recognized them; but this, however, is not true, the additions made by him to Mondini's description being to a great extent erroneous. It is not true that the transverse leaflets are wanting in the ovaries of the eel, as he asserts in his last work, contrary to his former description, which was probaly based on the law of analogy, and that thereby they are distinguished from of the salmon and sturgeon. It is not true, what Rathke likewise asserts, that the genital opening of the eel consists of two small canals, for I have invariably only found one, which opens in the urethra. Rathke has certainly described the eggs quite exactly, distinguishing the larger whitish ones, having a diameter of about one-fifteenth of a line, and the smaller transparent ones, with the germinal vesicle inside; but Mondini likewise says: "*innumeras sphærulas minimas, æquales, pellucidas, divisas tamen, quæ in centro maculam ostendebant, ecc. vedi*," thus showing the true nature of the ovaries and the eggs, and contrasting them with the fatty formation and with the ovaries and eggs of osseous fish." (Syrski).

time up to the beginning of 1870 a male eel was never seen, nor do we find any opinions expressed concerniug the form of the male of the eel or its reproductive organs.*

According to Robins in 1846, George Louis Duvemoy (Cuvier, Anatomie Comparée, ed. 2, 1848, tome viii, p. 117) described the ruffle-tube type of the testis of the lampreys and eels, with the free margin festomed in lobules, shorter to the right than to the left, like the ovaries, etc. He added: "At the breeding season, we perceive in it an innumerable quantity of granulations, or small spermatic capsules, the rounded form of which has often led to their being confounded with the ovaler, at least as the eels, in which, in reality, these capsules are nearly of the same size as the ovules, but the latter are distinguished by their oval form." The ovular are spherical, and not oval; but the other facts are fundamentally correct. It is also in error that Duvemoy adds (p. 133): "The eels and the lampreys have no deferent, canal, any more than an oviduct. Like the ova the semen ruptures the capsuler in which it has collected and diffuses itself in the abdominal cavity, whence it is expelled in the same way as in the ova." But he correctly describes the place of opening of the penbucal canal, the waters, etc. Robin, Comptes Renders, 1881, p. 383,

By some droll coincidence the university of Bologna and, soon after, that of Pavia, were again prominent participants in the eel tournament. At the meeting of the Bologna Academy, December 28th 1871, Prof .G. B. Ercolani read a paper upon the perfect hermaphroditism in the eel.*

Fourteen days later Prof. Balsamo Crivelli and L. Maggi read a detailed and elaborate paper upon the "true organs of generation in eels." These investigators, without concerted action, had all at once brought up the celebrated issue of the previous century ; this time, however, having specially in view the male organs of the eel, while all were convinced that they had reached a final result by their investigations. The results were certainly very peculiar. In the paper of Ercolani it was claimed that the

*Iacoby states that in a paper by Rathke, published in the *Archiv fur naturgeschichte* in 1838, he remarked, "I expect soon to be able to say something concerning the male organs of the eel."

It would be very interesting to know whether in the papers left by this skillful investigator there may not have been recorded some valuable observations concerning the male eel.

snake-like folds of fat, which had formerly been noticed near the ovarium, were nothing else than the spermaries of the eel, and that upon the left side of the animal this organ developed into a true testicle, while the one upon the right side shrank up and became functionless. In the work of Crivelli and Maggi, on the other hand, the folds of fat next to the ovary were also considered to be the male organs of the eel, while the one on the right-hand side of the animal was considered without any doubt to be the male reproductive organ. The last-named authorities described the spermatozoa which they had seen in this stripe of fat upon the right side. Since these stripes of fat were universally found in all eels, and always in connection with the former, the investigators could come to no other conclusion than that the eels were complete hermaphrodites.

The male organ of the eel, as described by Ercolani, as also by Crivelli and Maggi, shows how carefully investigations may be expended upon things which are not in the least equivocal, since there was not the slightest trace of structure like that of a spermary. The cells of this body in the lining of the stomach next to the ovary are simply fat cells, with all the characteristic peculiarities, just as they are given in all the manuals of histiology. Professor Rauber, of Leipsic has examined these fat cells carefully, and they have also been investigated in many eels by the writer, Dr. Jacoby. Never has anything but fat cells and blood vessels been found in them. The so-called spermatozoa, described in the work of Maggi and Crivelli, proved to be miscroscopic fat particles or crystalline bodies, such as are commonly found in fat cells.†

In the meantime, at Trieste, the question concerning the male organs of the eel was making a very important advance. Darwin had already expressed the opinion that among nearly all fishes the female was larger than the male. He states that Dr. Günther had assured him that there was not a single instance among fishes in which the male was naturally larger than the female.

†In a microscopic investigation of fatty tissues it is very easy for the so-called Brownian molecular movements to be mistaken for moving spermatozoa, especially in fishes whose spermatozoa, if not very much magnified, shows only the head and appear like little bodies globular in form.

This opinion may, perhaps, have induced Dr. Syrski, director of the Museum of National History at Trieste, now professor in the university of Lemberg, when he undertook, at the request of the marine officials of Trieste, the determination of the spawning time of the fish which were caught in that region, and was obliged to take up the eel question, to devote his attention especially to the smaller eels. Dr. Hermes, in behalf of Dr. Syrski, protests against this idea, stating, on the authority of the latter, that the published opinions of Günther and Darwin were unknown to him prior to the publication of Jacoby's paper. Up to that time every investigator had chosen for investigation the largest and fattest of eels, thinking that the largest and oldest specimens must have the most highly developed organs of generation. On Nov. 29th, 1873, Syrski found in the second specimen which he investigated—an individual 15 inches long, which is now preserved in the museum at Trieste—a completely new organ, which had never before been seen within the eel by any former investigator, although tens of thousands of eels had been zealously studied.* Syrski published his discovery in the April number of the proceedings of the Imperial Academy of Sciences, Vienna, in 1874. The most important point of the discovery was stated to be that in all the specimens of eels in which the Syrskian organ was found, the well known collar-and-cuff shaped ovary, the female organ of generation, was entirely wanting. It was evident from this that eels were not hermaphrodites. The question now arose, is the newly discovered organ in the eel, in its external form, as well as inner structure, so different from the ovary that it could be considered as a partially developed or peculiarly shrunken ovary? According to all researches which have up to this time been made, there is the highest kind of probability that this newly discov-

* "I commenced my investigations," writes Syrski, "on the 29th November last year (1873), and already in the second eel which I dissected on that day I found the testicles, and therefore a male individual of the eel. I sent in March of the following year (1874) to the Academy of Sciences in Vienna a preliminary communication, which was read at the public session held the 15th April, and printed in the reports of the academy."

In 1875 Professor Von Siebold found male eels in the Baltic at Wismar, although this discovery was not at that time made known to the public. They have since been found in the German Ocean, in the Atlantic, and in the Mediterranean.

ered structure is actually the long sought male organ of generation. The investigator cannot, however, answer this question with complete certainty, since the thing which, is most necessary to the solution of this question, namely, the finding and the recognition of the spermatozoa, has not yet been accomplished.

In February, 1879, Professor Packard announced the discovery of spermatozoa in eels from Wood's Holl, Mass., but soon after declared that this was a mistake, and that he had been deceived by molecular movements among the yolk nuclei in the female organs. The discovery of spermatozoa in the spermaries of the conger-eel, recently announced by Dr. Hermes, of Berlin, is, however, sufficient to demonstrate fully the correctness of Syrski's theory. The confirmation in the case of the common eel is solely a matter of time.

### HOW TO DISTINGUISH MALE AND FEMALE EELS.

#### INTERNAL CHARACTERISTICS.—BENECKE AND SYRSKI.

The differences between the organs of sex in the eel are well described by Benecke. The ovaries of the eel are two yellowish or reddish-white elongate organs as broad as one's finger, situated alongside of the backbone, arranged in numerous transverse folds, extending through the entire length of the abdominal cavity. They have no special opening to the outside of the body, and their contents must be discharged into the abdominal cavity and must find exit through the very small opening situated behind the anus. These two bodies, on account of their great size, are of course not easily overlooked, but they contain such a great quantity of fatty cells and the eggs imbedded in them are so small and delicate that one might easily believe, even after a superficial microscopic examination, that the whole organ consists only of fat. While the eggs of other fishes measure from one to three millemeters in diameter—and sometimes are much larger—still the eggs in the ovary of the eel have, on an average, a diameter of about one millemeter, and are so closely surrounded by fatty cells with outlines much more strongly marked that it requires great skill to prepare a microscopic slide in which they shall be as plainly visible as they are in the

accompanying illustration, in which they are magnified 150 diameters. When a person has a microscope which magnifies only 100 diameters, it is best to put a portion of the ovary in water when dissecting it, in order that the eggs may be easily found. It is much easier to find the eggs in young eels, 7 or 8 inches in length, than in the adult fish, since in the former, although the ovaries and the eggs are smaller, the fat cells have not made their appearance, and the eggs are, therefore, plainly visible at the first glance through the microscope. The number of eggs is extraordinarily large, amounting to many millions. The eggs of larger size, which sometimes are found in great quantities in eels that have been cut up and have been considered to be eel eggs, have always proved to be the eggs of other fish which they have swallowed, and in the course of cutting them up have been found in the eel's belly.

The male eels, which are found only in the sea and in the brackish water, are much smaller than the females, rarely exceeding 15 or 16 inches in length; in them, in the place of the ovaries in the female, are found spermaries, which differ in appearance in the manner heretofore referred to. These consist of two tubes which stretch the whole length of the body cavity, situated close to each other, and provided with numerous sacculations. Ripe spermatozoa are as rarely found in these organs as eggs ready to be laid have been found in the ovaries of the female. According to many accounts the male eels, which later were found also by Von Siebold in the Baltic Sea at Wismar, differ from the females in the possession of a proportionally sharper snout, less conspicuous dorsal fins, darker colonation of the back, a more prominent and metallic luster upon the sides, the clean white coloration of the belly, and the larger size of the eyes. I propose to reproduce here the original descriptions and figures of Syrski, the discoverer of the male eel.

### EXTERNAL CHARACTERISTICS.—JACOBY.

The external differences presented by living eels (remarks Jacoby), corresponding to the presence of an ovary and the supposed male organ, are very interesting.

The most important, writes Jacoby, is (1) the difference in the size and length of the animal. Syrski states that the largest eels found by him with the supposed male organ measured about 17 inches, 430$^{mm}$. I have, however, found specimens with this organ at Trieste and in Comacchio which measured 17 to 19 inches, 450 to 480$^{mm}$. All the eels which exceeded this size, for instance those which were over 3 feet in length, 1$^{m}$, many of them growing to the thickness of the arm of a strong man, have been hitherto found to be females. The other recognizable external character in the female are (2) a much broader tip of the snout in comparison with the small, either attenuated or short and sharply pointed, snout of the eel with the supposed male organ; also (3) a clearer coloration in the female, usually of a greenish hue on the back, and yellowish or yellow upon the belly, while the others have a deep darkish green, or often a very deep black upon the back and always a more perceptible metallic luster upon the sides (I, once in a while, found eels covered all over with a brownish tint, always possessing the organ of Syrski), usually exhibiting also a white color upon the belly. In addition (4) there is an important external character in the height of the dorsal fin; all females have these fins much higher and broader than the eels of the same size which possess the supposed male organ. Finally (5) there is a character, which is not always a safe one, in the greater diameter of the eye in the eels with the supposed male organ. Eels with quite small eyes are almost always found to be females; eels with the organs of Syrski usually have comparatively large eyes, yet female eels with quite large eyes are not unusual.

The following proportional measurements, the average results of the study of a great number of eels measured by me, will be of general interest; column *a* gives the total length of the eel; *b* the breadth of the snout between the nostrils; *c* the breadth of the snout between the eyes; *d* the length of the snout from the center of the eye to its tip; *e* the average measurement of the eyes; *f* the length of the head to the gill-opening; *g* the height of the dorsal fins, all the measurements being given in millemeters.

| | A. Eels with supposed male organs. | | | | | | | B. Female eels. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *a.* | *b.* | *c.* | *d.* | *e.* | *f.* | *g.* | *a.* | *b.* | *c.* | *d.* | *e.* | *f.* | *g.* |
| I | 480 | 6 | 13.5 | 15 | 8 | 52 | 5 | 480 | 8 | 12 | 17 | 5 | 62 | 9 |
| II | 470 | 6 | 10.5 | 12 | 7 | 54 | 6 | 475 | 7 | 14.5 | 16 | 8 | 59 | 9.5 |
| III | 445 | 5 | 11 | 12 | 6 | 47 | 6 | 440 | 8 | 12 | 14 | 5 | 56 | 7.5 |
| IV | 411 | 4 | 9 | 12 | 5.5 | 47 | 6 | 410 | 8 | 12.5 | 13 | 7.5 | 51 | 7 |
| V | 386 | 4.5 | 9 | 12 | 5.5 | 46 | 4 | 378 | 7 | 11 | 12 | 5 | 49 | 7.5 |
| VI | 370 | 3.5 | 7 | 10.5 | 5 | 40 | 6 | 369 | 7 | 11 | 13 | 6.5 | 51.5 | 7 |
| VII | 344 | 4 | 7.5 | 10 | 4.5 | 40 | 5 | 342 | 6 | 8 | 11 | 4.5 | 44 | 6.5 |
| VIII | 319 | 4 | 7 | 10 | 5 | 40 | 4.5 | 313 | 5 | 8 | 10 5 | 3 5 | 41 | 6 |

According to the distinguishing mark which have been given, special reference having been paid to th eight and narrowness of the dorsal fin, much success has be met with in picking out, in the fish-market of Trieste, the s which possessed the organ of Syrski; absolute certainty in ognizing them cannot, however, be guaranteed. If one is sea ing among living eels with no characters in mind with the ex tion of the first—that of length—he will find in every ten eels, on an average, eight females, and two with the supposed male organ; but, if the selection is made with a careful refere e to all these marks of difference, the proportion changes, an out of every ten examples about eight will be found with thesupposed male organ.

For another excellent discussion wit figures of the characters of male and female eels, the reader isreferred to a translation of an article by S. Th. Cattie, in the roceedings of the U. S. National Museum, vol. iii, pp. 280–4.

### QUESTION AS TO THE VIVIPAROUS NATRE OF EELS.—BENECKE.

The discovery of the two sexes hasnot, however, writes Benecke, settled the question whether te eel lays eggs or brings its young alive into the world. Therehas always been a strong disposition to adopt the latter hypotesis, and there are many people at the present day who claim t have been present at the birth of young eels, or to have founda quantity of young eels in adult eels which have been cut ope. Frequently ichthyologists hear accounts of occurrences of his kind, and receive specimens of supposed little eels from on to two inches in length, which have been kept alive for severi days in a glass of water. These are usually thread worms, *Asuris libeata*, which live by

the hundred in the intestinal cavity of the eel, and which may be easily distinguished from the eels of the same size by the sharp ends of the body, the absence of fins, of eyes and mouth, and by the sluggishness of their motions. The smallest eels, less than an inch in length, have already the complete form of the adult, and are also transparent, so that with a magnifying glass one may perceive the pulsations of the heart, and see behind it the brownish-red liver; the mouth, the pectoral, dorsal, anal, and caudal fins are easily seen, and the black eyes cannot be overlooked. In addition to the intestinal worms, the young of a fish of another family, *Zoarces viviparus*, have given opportunity to the ignorant for many discoveries; for instance, Dr. Aberhard, in No. 4 of the *Garten-laube* for 1874, described and illustrated an "embryo of the eel," which, in company with about a thousand similar embryos, had been cut out of the belly of an eel. This tolerably good drawing at first sight is seen to represent the embryo of zoarces which is almost ready for birth, since it still possesses a very minute umbilical sac. It is very evident that the minute egg of the eel could hardly produce a great embryo with an umbilical sac which exceeds by more than a hundred times in size the whole egg. It is also evident that the imagination of the writer has exaggerated the 200 or 300 young in the zoarces to a thousand.

HUNT FOR YUNG EELS.—JACOBY.

As might have been foreseen (continues Jacoby), Syrski's discovery drew attention anew to the solution of the eel problem. In the spring and summer of 1877, the German and Austrian papers and journals were full of articles and paragraphs upon this subject. Among others the following announcement made the rounds of the press: "Hitherto, in spite of all efforts, science has not succeeded in discovering the secret of the reproduction of the eel. The German Fischerei-Verein in Berlin offers a premium of 50 marks to the person who shall first find a gravid eel which shall be sufficiently developed to enable Professor Virchow in Berlin to dissipate the doubts concerning the propagation of the eel. Herr Dallmer, of Schleswig, inspector of fish-

eries in that province, offered to transmit communications to Berlin, and in 1878, in the January number of the German Fishery Gazette, he published a detailed and very interesting report of his proceedings. He wrote, among other things, that it was quite beyond his expectation that this announcement would have found its way into nearly all the German journals between the Rhine and the Weichsel, and from the Alps to the sea. The number of letters which he received first rejoiced him, then surprised him, finally terrified him, so that at last he was obliged to refuse to attend to the communications. He had learned at Berlin that an equal number of communications from all parts of Germany had been received, sent directly to the address of Professor Virchow. Objects which professed to be young eels cut out of the parents, but which were really thread worms, were sent to him by dozens; the most incredible stories, usually from women, about great thick eggs which they had found in eels, were received by him. A witty Berliner communicated to him in a packet sent by express the information that the eel problem was now happily solved since a lady eel in Berlin had given birth to twins. Finally Herr Dallmer found himself compelled to insert the following notice in the Schleswiger Nachrichten: 'Since the German Fischerei-Verein has offered a premium for the first gravid eel, the desire to obtain the prize, curiosity, or the desire for knowledge has created so lively an interest upon this point that it might almost be called a revolution. I at one time offered, when necessary, to serve as an agent for communication, but since business has compelled me to be absent from home a great part of the time, I would urgently request that hereafter packages should be sent direct to Professor Virchow in Berlin. I feel myself obliged to inform the public upon certain special points. The premium is offered for a gravid eel, not for the contents of such an eel, since if only these were sent it would be uncertain whether they were actually taken from an eel. The eel must always be sent alone; the majority of senders have hitherto sent me only the intestines or the supposed young of the eel, which were generally intestinal worms; the eel itself they have eaten; nevertheless the prize of 50 marks has been expected by nearly all senders, etc. By this

transfer of the responsibilities, the inspector of fisheries has rendered a very unthankful service to Professor Virchow; he was obliged to publish a notice in the papers in which he urgently stated that he wished to be excused from receiving any more packages, for he would hardly know what to do with them. The comic papers of Berlin now circulated the suggestion that hereafter the eel should be sent to the investigators only in a smoked state. This amusing episode is interesting in showing how remarkable an interest the whole world was beginning to take in the eel problem."*

UNDOUBTED NORMAL REPRODUCTIVE HABITS OF THE EEL.—BENECKE.

It may be assumed with the greatest safety (writes Benecke) that the eel lays its eggs like most other fish, and that, like the lamprey, it only spawns once and then dies. All the eggs of a female eel show the same degree of maturity, while in the fish which spawn every year, besides the large eggs which are ready to be deposited at the next spawning period, there exist very many of much smaller size, which are destined to mature hereafter, and to be deposited in other years. It is very hard to understand how young eels could find room in the body of their mother if they were retained until they had gained any considerable size. The eel embryo can live and grow for a very long time supported by the little yolk, but when this is gone it can only obtain food outside of the body of its mother. The following circumstances lead us to believe that the spawning of the eel takes place only in the sea: (1) that the male eel is found only in the sea or brackish water, while female eels yearly undertake a pilgrimage from the inland waters to the sea, a circumstance which has been known since the time of Aristotle, and upon the knowledge of which the principal capture of eels by the use of fixed apparatus is dependent; (2) that the young eels with the greatest regularity ascend from the sea into the rivers and lakes.

All statements in opposition to this theory are untenable, since the young eels never find their way into land-locked ponds in

* Zoologischer Anseiger No. 26, p. 193; American Naturalist, vol. 13, p. 125, and Jacoby, p. 44.

the course of their wanderings, while eels planted in such isolated bodies of water thrive and grow rapidly but never increase in numbers. Another still more convincing argument is the fact that in lakes which formerly contained many eels, but which, by the erection of impassable weirs, have been cut off from the sea, the supply of eels has diminished, and after a time only scattering individuals, old and of great size are taken in them. An instance of this sort occurred in Lake Müskendorf, in West Prussia. If an instance of the reproduction of the eel in fresh water could be found, such occurrences as these would be quite inexplicable.

In the upper stretches of long rivers, the migration of the eels begins in April or May, in their lower stretches and shorter streams, later in the season. In all running waters the eel fishery depends upon the downward migrations; the eels press up the streams with occasional halts, remaining here and there for short periods, but always make their way above. They appear to make the most progress during dark nights when the water is troubled and stormy, for at this time they are captured in the greatest numbers. It is probable that after the eels have once returned to the sea, and there deposit their spawn, they never can return into fresh water but remain there to die. A great migration of grown eels in spring or summer has never been reported, and it appears certain that all the female eels which have once found their way to the sea are lost to the fisherman. In No. 8 of the German *Fischerei Zeitung* for 1878, Dr. Schock published certain statements sent to him by Dr. Jacoby. It is remarked in this paper, among other things, that after the deposition of the spawn, the female eel dies a physiological death, and that occasionally the sea in the neighborhood of the mouths of rivers has been found covered with dead eels whose ovaries were empty. When, where, and by whom this observation was made, and who pronounced upon the empty ovaries in these dead fish is unfortunately not mentioned.

A great number of the eels remain in inland waters while others proceed to the sea, either because their eggs are at this time not sufficiently ripe, or perhaps because they are sterile. It would seem probable that the increase in the size of the eggs in

the wandering eels begins to be very rapid after August and September, while in the earlier months of the year, in all eels of moderate size, the eggs were at the utmost but about 0.09 in diameter. In September of the same year, I found (as an average of numerous measurements) a diameter of 0.10; in October, 0.16; in November, 0.18 to 0.23, while the eggs showed other characters connected with approaching maturity which earlier in the season were not to be seen. All the eels which were captured later—in December and in January—part of which came from rivers and harbors, part from the harbor of Putzig (Putziger Wiek) had eggs measuring from 0.09 to 0.09$^{mm}$, while, very exceptionally, some measured 0.16$^{mm}$, although among the fish examined were some which measured 3 feet in length.

### DO MALE EELS LEAVE THE SEA AND ENTER FRESH WATER.

This problem is one of great interest, both to the biologist, and the fish culturist—it is in fact this one disputed point still remaining to be solved. Upon its solution appear to depend the final decision of the question still so warmly debated both in Europe and America. "Do eels breed in fresh water only, in salt water only, or in both fresh and salt water." As has already been stated, the theory for a long time generally accepted, is that the eels are "catadromous" descending to the sea to spawn. This theory is, however, sharply contested by many observers, chief among whom on this side of the Atlantic is the Hon. Robert B. Roosevelt, President of the American Fish Cultural Association. It appears probable to the writer that the truth lies somewhere between these two extremes, and that it will be hereafter ascertained that the eel, like a majority of other animals, has flexible habits, sometimes deviating from its ordinary custom, which appears to be to spawn in salt or brachial water.

Male eels have been found in the following localities:

(1.) In 1874 by Syrski, in the fish markets of Trieste; these markets being supplied with eels from Chroggia on the Adriatic, and to a lesser extent from the lagoons of Commacchio.

(2.) In 1875, on the coasts of France, by Dareste.

(3.) In 1875, among specimens of *Anguilla marmarata* from India.
(4.) In 1875, in the Baltic, at Wismar, on the Danish coast, by Prof. Von Siebold.
(5.) In 1877, in the lagoons of Commacchio, by Jacoby. Among 1,200 specimens, five per cent. were males; while among these, less than 15 inches in length, 20 per cent were males. This was in brachial water. (See paragraph XIX).
(6.) In 1879, at Trieste, by Dr. Hermes, who found 15 males among 20 eels selected by Dr. Syrski.
(7.) In 1880, on the Baltic coasts of Denmark, by Dr. Hermes. Out of one lot of 39 from Wismar, he obtained 8 males, thus repeating Von Siebold's observation.
(8.) In 1880, from the Baltic between Zealand and Saland, Denmark. Out of one lot of 36, Dr. Hermes obtained 8 males.
(9.) In 1880, in France, by Robin.
(10.) In 1880, by Catter.
(11.) In 1880, by Dr. Hermes, at Cumlosen, on the Elbe, about 120 miles from the German Ocean.
(12.) In 1880, at Rugers on the Baltic, by Dr. Hermes, who found $44\frac{1}{2}$ per cent. males in one lot of 137.
(13.) By Dr. Pauly, among eels planted at Hünnigen, in Elsass.-Sothringen. See below.

It has been shown by Dr. Pauly that among the very young eels [monté], taken near the mouths of rivers, is a considerable percentage of males, which, when transplanted to fresh water, will then retain their masculine characters and develop into perfect adult males. This discovery is, of course, of the utmost importance to fish culturists, making the attempt to introduce eels into new waters. Its importance has already been pointed out by Director Huack.

The practical lesson to be learned is simply this—that young eels, for introduction into strange waters, must be taken from very near the mouths of rivers, in order that both males and females may be secured. The interest to zoologists lies in the fact that Pauly's discovery renders the theory of Von Siebold less plausible, indicating that the sexes of the young eels are

differentiated before they begin to mount the rivers, and that the males do not ascend beyond the limits of brackish water.

Dr. Pauly's discovery is so interesting that I propose to translate his own account of it. The investigation was made, I believe, in Munich, and the report from which I quote was published in the Austro-Hungarian *Fishery Gazette*, at Vienna, December 23d, 1880. Dr. Pauly writes: "During the past year I have received from Court-Fisherman Kuffar a large number of eels, which I have used in my investigations. The large individuals, all of which came from the lakes of northern Italy, were females. I received, however, from the same individual, another lot of eels, consisting of much smaller individuals, weighing from 20 to 90 grains (2-3 of an ounce to 3 ounces), also taken in fresh water. At the request of Professor Von Siebold, I had paid particular attention to the sexes of the eels which I was engaged in investigating, and to my great astonishment I found that a large majority of these small eels [19 out of 27] were males, possessing instead of the familiar ovaries, the "lappenagan" described by Dr. Syrski. A histological examination of these organs convinced me that the structure of these tissues agreed with that described by Freud."

* * * * * * * *

My next inquiry was very naturally concerning the locality whence these eels had been obtained. I learned that Kuffer had received them two years before from Director Huack at Hunningen, and upon questioning Director Huack learned that they had been brought from a French river, the *Sevre niortaise*, where they were caught as young fry [montrée] at a distance of ten or twelve miles from its mouth, and furthermore were at the time of examination about four years old. The small size of these fish, their age being taken into consideration, satisfied us that they had been reared in captivity since uncultivated eels would have been much heavier. The females in this lot of eels exceeded the males in length and weight and exhibited those external characters described by Jacoby as indicating sex.

The locality in the *Sevre niortaise* where these fish were taken may easily, especially at flood tide, have been within the limits

of brackish water; my observations do not prove, therefore, that male eggs enter fresh water.

Dr. Jacoby found male eels in the lagoons of Commacchio, where the water is brackish. These males must have ascended in the "mountry" as fry, and probably at the approach of sexual maturity descend with the females to the sea. My investigations and those of Jacoby prove only this: that the young female eels do not necessarily break away from their parents and from their birth-places at sea, and entirely alone proceed upon their migrations, while the males scatter through the sea, but that their brothers seem to accompany them part of the way upon their journey. But how far? Do the males know where pure fresh water begins, and are the fry of different sexes found mingled together only at the river mouths? If we bear in mind the fact that the male organs had so long escaped discovery, that, on account of their crystal-like transparency, their detection in a fresh eel is so difficult, etc., may we not admit that past conclusions are probably erroneous, and that although thousands of fresh water eels have been studied by different investigators, male eels may yet be found in our streams, especially when more of the smaller individuals have been examined.

* * * * * * *

Dr. Pauly then discusses the observations of Dr. Hermes who found 11 per cent. of males among eels taken at Willenberg, on the Elbe about 120 miles from the German Ocean, and no males whatever at Havelberg, 20 or 30 miles higher up the stream, and closes his essay with the following conclusion: "*Male eels undoubtedly ascend the rivers, but the numerical percentage of males to females appear to diminish as one proceeds up the streams.*" This fact is opposed to the theory proposed by some one that young eels are at first of undifferentiated sex and have the tendency under the influence of fresh water to become females, under that of salt water to develop male characters."

## STRANGE MISSTATEMENTS IN ICHTHYOLOGICAL LITERATURE.

One may conclude from these observations that the eels preparing to spawn leave the inner waters early in December and

seek out the deeper places of the sea, where they cannot be caught with our ordinary implements of capture. The eel eggs can only be found by a systematic investigation of certain parts of the sea bottom with the dredge and the microscope. This investigation might also include the sinking of the migrating eels in special cases to the bottem of the sea, in order to determine whether, under these circumstances, the eggs would ripen more rapidly. By using the largest fish for this purpose one could arrange, by means of small openings in the cages, to permit the entrance of the small male eels. At any rate, there is no doubt from these observations that the spawning period of the eel takes place in winter.

In an article by Guido Lindenhain, entitled "The Natural History of the Eel" (*Zur Naturgesehicte der Aale*), which has recently been published in the Austro-Hungarian *Fishery Gazette*, extending through six numbers, a fanciful contributor of that paper, among other wonderful things, claims to have discovered the spawning of the eel in rivers and ponds. I will allow the very sagacious gentleman to recount his summer-night's dream in his own words, in order to show with what certainty and precision the most baseless fables concerning the natural history of the eel are even yet narrated:

"The methods of spawning by the eel," writes this keen observer, are very interesting, but to observe them is very difficult and tiresome, and, indeed, only possible when the spawning places have already been determined by experience. One must remain for many nights upon the shore, hidden behind the bushes, with unflagging attention, until these nocturnal adventurers have come into the shallow water and made their presence known by their snake-like motions at the surface. As soon as they have gathered together upon their chosen haunts there is a great commotion in the water, and powerful blows are heard, so that the water splashes up a considerable distance, and the surface is covered with little waves, as if some great object was moving about, after which one gets glimpses of parts of the bodies of the contending rivals of the happy spawning fishes themselves. After the duration of an hour or so it is again quiet, and one sees that the water is moved in different directions in serpent-

like waves, which become less and less apparent to the eye of the observer, while the eels are leaving the spawning-places and are betaking themselves to hunt for food or are seeking their customary quiet dwelling-places. If the observer, moved by overwhelming curiosity, comes on the following day to the same place, he sees nothing, but if he looks with a strong magnifying-glass carefully over the water-plants, he discovers little greenish-white eggs resting upon the bottom, out of which the young eel will escape in about six weeks."

It is only to be regretted that the enterprising observer has not illustrated the whole development of the egg by photographic views of his fancies.

Another wonderful story was narrated by Dallmer.*

A Flensburg eel-smoker told him that once, in April, one of the sacks in which eels had been sent to him, after it had been emptied, was put into the water with the others; after having been tied up he found, after eight to fourteen days, millions of living young eels from one to two inches long. He thought that fertilized spawn had been left in the bag which, in eight to fourteen days, had developed into fishes of one to two inches in length. A million of young eels of 1½ inches in length would take a space of 9,761 cubic inches, which would be much more than a sack could contain. Such a quantity of little fishes would scarcely be able to find in a sack tied together at its mouth food enough to enable them to grow from a very minute size (the eggs in the ovary have been found only $0.23^{mm}$ large, and may, perhaps, when laid, measure $0.5^{mm}$) in eight days to a length of from one to two inches; let us, however, suppose that the eel-smoker had confounded a hundred little eels with as many millions, it could hardly, even then, happen that these little animals in from eight to fourteen days could have grown to 160 times their original dimensions. The story would be much more probable if it were supposed that the young eels in their wanderings toward the fresh waters had, perhaps, found their way into a bag which was not tied up at its mouth.

* Fische und Fischerei im Sussen Wasser, Segeberg, 1877.

In De La Blanchêre's "Nouveau Dictionaire general de peche, Paris, 1868," occurs the following paragraph, without any indication of its source: "Chenu and Desmarest do not hesitate to state that the eel spawns upon the mud after a kind of copulation; that the eggs remain, adhering together, joined by a glutinous substance analogous to that which connects the eggs of the fresh-water perch, and forms little pellets or rounded globules. Each female, as they have succeeded in observing, produces annually many of these masses. The little fish soon hatch out and remain, for the first few days after their birth, together in these masses, but when they have reached a length of 4 or 5$^{mm}$ they shake off the bonds which hold them and soon ascend in great bodies the streams and brooklets near which they find themselves."

According to this, the eggs are deposited in masses of slime, inside of which the young hatch out in the course of a few days, and a few days later they shake themselves free and swim about at liberty.

When and where these investigators have made such observations is not to be found out from the "Dictionaire;" at any rate, it is very hard to understand how they have proved that the same female eel yearly lays several sets of eggs.

### BENECKE ON THE MOVEMENTS OF YOUNG EELS.

Benecke gives the following thorough discussion of the movements of young eels:

The young eels, hatched out of the eggs at sea, doubtless live at the bottom until they grow, through consumption of rich food substances there to be found, to a size from 1 to 3 centimeters. When they have attained this size they begin their wanderings in immense schools, proceeding to ascend into the rivers and lakes. These wanderings of the young eels have been known for a very long time; for instance, in the lagoons of Comacchio, in which they may be found, for the most part, after they have gained the length of from 6 to 8 millimeters, and in France, later also in England, Denmark, Sweden, and, more recently, in Germany they have also been observed.

According to the French reports young eels are hatched out early in the winter, and in February, having attained the length of 4 or 5 centimeters, they appear in the brackish water at the mouth of the Loire in immense numbers, soon to begin their wanderings up the stream. They swim in crowded schools at the surface of the river right up to the banks, and little detachments of the army deploy at the mouth of each tributary and pursue their wanderings along its course. These swarms of young eels are called in France "Montèe," in Italy, "Montata." The number of the young fish is, as might be expected from the number of the eggs in the ovary of the eel, wonderfully large. Redi has recounted that from the end of January to the end of April the young fish continue wandering up the Arno, and that in 1867 over 3,000,000 pounds of them were taken in five hours. Into the lagoons of the Comacchio the eels pour from February to April. In March and April they have been noticed in many French rivers, in which the migration continues for from eight to fourteen days. The first account of these wanderings in Germany was that given by Von Ehlers. In 1863 he wrote to Von Siebold: "This took place about ten years ago, in the village of Dreenhausen, in the Province of Wesen, in the Kingdom of Hanover. As we were walking, towards the end of June or the beginning of July, on a dike, which at that place projects out into the Elbe, we noticed that along the entire shore there might be seen a moving band of a dark color. Since everything which takes place in the Elbe is of interest to the inhabitants of that region, this phenomenon immediately attracted attention, and it soon became apparent that this dark band was composed of an innumerable body of young eels, which were pressing against each other, as, at the surface of the stream, they were forcing their way upwards towards its source, while they kept themselves so close to the shore that they followed all its bendings and curves. The width of this band of fish at the place where it was observed (where the Elbe has a considerable depth) was perhaps a foot, but how deep it was could not be observed, so thickly crowded together were the young eels. As they swam a great number could be taken in a bucket, and it was very annoying to the people who lived along the Elbe that so long as

the procession of fish lasted no water could be taken out of the river which was not full of the little fish. The length of the young eels was, on an average, from 3 to 4 inches; the thickness of the body was about equal to that of a goose-quill. By themselves might here and there be seen swimming eels of greater size, but none of them were probably more than 8 inches in length. All of them, even the smallest, were dark colored. This wonderful procession of fishes continued unbroken and of the same density throughout the whole of the day on which it was first observed, and continued also upon the following day. On the morning of the third day, however, not one of the young eels was to be seen."

Similar observations have been made at Wittenberg, on the Elbe. Kuppfer observed great quantities of young eels, of about 3 centimeters in length, in the brackish water of the Eider, at Freiderickstadt; so also did Von Stemann.

"Every year," writes the latter, "from April to the end of June, there appear great masses of young eels, which are present in large schools toward the Upper Eider, seeking in every way to pass each other. In April the first eels show themselves generally singly; cold weather has evidently kept them back up to this time; since this year, until to-day, no ascent whatever has taken place, and now the approach of the great schools is beginning. Where the current is feeble, the procession is broad; but where the eels encounter a strong current—near a mill—it becomes small, and presses close to the shore, in order to overcome the currents. The little animals swim eagerly and rapidly along near the banks until they find a place over which they decide to climb. Here they lie in great heaps, and appear to await the rising of the tide, which makes their ascent easier. The tide having risen, the whole mass begins to separate without delay; eel after eel climbs up on the steep wall of rock, determined to reach the little pools, at the height of 15 or 20 inches, into which some of the water from the Upper Eider has found its way. Into these holes the little animals creep, and have yet to travel a distance of 40 or 50 feet under the roadway before they can reach the Upper Eider. Another detachment betakes itself to the sluice-ways, and clings to the cracks in the wood;

also around the mills their ascent may be observed, especially about sunrise." *

Davy sends a similar account from Ireland. He was a witness of the ascent of young eels, or "elvas," at Ballyshannon, at the end of July, 1823; he speaks of the mouth of the river under the fall being "blackened by millions of little eels about as long as a finger, which were constantly urging their way up the moist rock beside of the fall." "Thousands," he adds, "died; but their bodies, remaining, served as a ladder by which the rest could make their way; and I saw some ascending even perpendicular stones, making their way through wet moss or adhering to some eels that had died in the attempt." †

Such is the energy of these little animals that they continued to find their way in immense numbers to Loch Erne.

In the little eels which ascend the rivers there are no traces of sexual organs, but in the fresh water they develop only into females. One of the most recent observations made by Dr. Pauly, in Munich, would appear to contradict this idea, since he discovered male eels among the fish which were brought with a lot of young eels to Heningen, were kept there for two years in ponds, and were finally released in the fish pond of Court-Fisherman Kauffer. We should bear in mind, however, that these young eels were captured at the mouths of fresh rivers in brackish water; and that among the numerous small eels which swim in the brackish water there must be many larger specimens, in which the male organs have already begun to develop. Such are doubtless those which were sent in the male condition to Heningen and Munich, and were there recognized as males.

* Professor Benecke had in his possession some of the young eels, which escaped from all the vessels in which they were confined, and even climbed to the ceiling of his room.

† Eel-fairs in Connecticut.—Fresh water eels may be caught in large numbers, in weirs along the lake streams, when descending at the fall equinox to deposit their spawn in some lower region, and in the following August their offspring, from three to six inches long, return in immense numbers. The basin of the Still River Falls, near Colebrooke line, is for several days alive with them. They may be seen laboriously crawling up every rock which is moistened by the spray of the fall, and endeavoring to reach their ancestral lake or dam. At the foot of the Niagara Falls this phenomenon may be witnessed on a large scale at the same season of the year or later, and probably in other places where the fall is too high and the current too swift for the young eels to stem it without contact with the rocks.—Annals of Winchester, Conn., Boyd, p. 26.

This presumption can be set aside only if male eels shall hereafter be found among the fish which are caught in the upper part of rivers in the condition of young fry.

Concerning another important fact which is connected with the movements of the young fry of the eel, I became acquainted last year (in the course of an exploration of the waters of the district of Konitzkunde) with the river Brahe, at Muhlhof, above Rittel, where a high dam was built in 1846 and 1847 for the purpose of watering a large system of meadows by the overflowing of the stream. Below the dam is an inclined plane (constructed of boards), about 300 feet long, built for the purpose of preventing the water, which rushes out when the sluicegate is opened, from washing away the bottom of the stream and its banks. This plank floor consists of two layers, the lower one of 2-inch, the upper one of 3-inch boards. The grade of the dam at Muhlhof (33 feet 3 inches) has entirely cut off the ascent of the fry of the eel into the upper part of the Brahe and the lakes tributary to it, and the number of eels caught above the dam—which was formerly very considerable—has become reduced almost to nothing. In the year 1847 the construction of the dam and the inclined plane was completed; in 1852 the upper layer of the planks on the plane had warped and sprung up in many places, so that it had to be torn up for repairs. The cause of the warping was immediately discovered: thousands of eels—as thick as a man's finger—somewhat flattened in shape, and, on account of the absence of light, of a pure white color, filled the space between the two layers of planks, and their united pressure from beneath had caused the upper layer to yield; these eels had found their way between the boards as fry, where they had found sufficient food and had grown to such a size that the pressure of their united strength had pushed up the roof of their prison. These facts, observed by an old millwright, were communicated to me by Privy Counsellor Schmid, of Marienwerder, who supervised the construction of the Muhlhof dam, and he fully confirmed them.

Eels of 4 inches in length, which in May are plenty in fishponds, by the end of October reach a length of 10 inches and the thickness of a man's little finger; in the following fall they

measure from 20 to 24 inches, and in the third year are ready to be eaten. On account of their rapid growth and hardy nature, in consequence of which latter they live in mud-holes and unprofitable waters of all kinds, the breeding of eels is a very remunerative business. The young fish (of which, at the time of their first appearance at the mouths of rivers, it takes 1,500 to 1,700 to make a pound, while, when taken later and a little further from the sea, it takes only 350 or 400 for the same weight) may be obtained at low prices from France through Huningen, or in Germany from Randesberg, and, through the Berlin Aquarium, from Wittenberg, and, when the temperature of the air is not too high, may be carried in soft moss throughout all Germany.

According to the statement of the well-known Paris fish-merchant, Millet, two pounds of eels, planted in a muddy pond in 1840, in five years yielded 5,000 pounds of fine eels.

### OBSERVATIONS OF DR. HERMES IN 1881 ON THE CONGER.

The observations of Dr. Otto Hermes, director of the Berlin Aquarium, who has recently discovered the true nature of the organ of Syrski in the conger, are extremely interesting.

"Since Syrski, in 1874 found the organs in *Anguilla vulgaris*—which are called by his name, and which, by him and most zoölogists, were taken for the male reproductive organs—it is only necessary that a ripe male eel should be found that in order to settle forever the question of the sexes of the eel. Up to this time all efforts have failed to reach the desired result. The histiological investigations of the Syrskian organs pursued by S. Freud render it more probable that these were young roes; yet there remained all the time a doubt, since the spermatozoa had not been actually observed, and this uncertainty is an insuperable obstacle to the acceptance of the Syrskian discovery. The supposed discovery of spermatozoa by A. S. Packard in the male eel proved to be another delusion. The contradiction of this imaginary discovery appeared in No. 26 of the second volume of the *Zoologische Anzeiger*, p. 193, in which it was stated that the motile bodies were not spermatozoa, but yolk particles. This

correction was also made by Von Siebold's assistant, Dr. Paul,* and by S. Th. Cattie.

It is well known, as Von Siebold remarks, that young eels, ascending the rivers, developed into females and that the males remain in the sea or at the mouths of rivers. This statement cannot be exactly demonstrated, since among 250 eels, from 11 to 15 inches in length, taken in the vicinity of Cumlosen, I found 13 males or 5 per cent. (Cumlosen is situated in the vicinity of Wittenberg, and is at least 120 miles from the mouth of the Elbe). How large the percentage of difference between the neighborhood of the mouth of Elbe and places situated farther up the stream, as regards the proportion of males and females, may be, I have hitherto, from want of material, been unable to decide. Forty from the Havel at Havelberg (about 20 miles above Cumlosen) were all females. Out of 137 eels taken in the bays at Rugen, in the Baltic, I found 61 or 44½ per cent. males, while at Wismar, on the Danish coast, the males only constituted 11 per cent. Whether these facts have any connection with the discovery of the hitherto unknown spawning places of the eels, it is hoped that further observations will determine.

When Cattie, in his already cited work, gives it as a determined fact that the eels wander into deep water here, in order to let their generative organs attain maturity, which happens in six or eight weeks, and that the old male and female eels, after the reproductive act, die, according to my knowledge, there are wanting observations which will give this a scientific foundation. What Von Siebold and Jacoby only state as probable appear to him (Cattie) to have become already established facts.

As far as the distinction between male and female eels by external characters is concerned, the eels sent to me, some time in November, from the coast of Schleswig showed so great difference in color that their sender, the fish-master Hinkleman, was able to decide without difficulty between males and females. The former were distinguished by a specially brown coloration, while the females, in addition to greater size, almost without exception exhibited a dull steel-gray color. Among the males

* Austrian *Fishery Gazette*, 1880, No. 12, p. 90.

were found many specimens of $17\frac{4}{5}$ inches in length, which I was careful to note because Syrski had only found the size of $16\frac{4}{5}$ inches. In Comacchio, according to Jacoby, a specimen of $18\frac{1}{5}$ inches had been found.

JACOBY'S TOUR TO COMACCHIO IN 1877, AND HIS CONCLUSIONS.

"In the fall of 1877," writes Jacoby, "I undertook a journey from Trieste, by way of Ravenna, to Comacchio; convinced of the difficulty of the questions to be solved by my own previous labors, I had not great hopes of finding sexually immature eels, either gravid females or mature males. My highest aim was at the beginning to determine the following points: (1) Whether evidences of preparation for breeding might not be found in the eels which were wandering in the fall toward the sea; (2) to what extent eels with the organ of Syrski could be found participating in this migration; (3) as far as possible to obtain eels from the sea at a distance from the coast in order to compare their organs of reproduction with those of the eels in the lagoons.

"In determining the answers to the first two questions I was able to make some new and interesting discoveries, but with regard to the latter, my most diligent efforts were absolutely fruitless.

"I found that the eels when migrating to the sea in the fall took no food. In many hundreds examined by me, caught during their movement, I found stomach and intestines entirely empty; that the eels during their migrations eat nothing is also known to all fishermen and watermen of Comacchio. At the same time, the eels which remained in the lagoons were more or less filled with food, not only those which were not sufficiently mature to migrate, but also a breed of eels which never goes to the sea, but remains throughout its entire life in the lagoons.

"There may be found in Comacchio, and doubtless everywhere where eels live in great numbers in brackish water along the coast, a peculiar group of eels which, as far as I could determine, consists entirely of sterile females. These female eels with ovaries present a very peculiar phenomenon; when they are opened one finds instead of the well-known yellowish-white,

very fatty, cuff-shaped organ, a thin, scummy, slightly folded membrane, not at all fatty, often as transparent as glass, and of about the same proportional size as the so-called cuff-shaped organ. When this membrane is examined under the microscope there may be seen in it eggs very transparent in appearance, with yolk-dots absent or with yolk-dots very small and few. This organ appears to be an abnormally-developed ovary incapable of fertilization. These sterile females, which I found of all sizes, even up to the length of 27 inches, present all of the acknowledged female characters in great prominence and in an exaggerated degree; the snout is broader, and often, especially at the tip of the under jaw, extraordinarily broad; the dorsal fins are, on the average, higher; the eyes are much smaller, especially in large specimens, and the coloring is clearer; the back of a clearer green and the belly yellower than in the normal female. The flesh of these sterile females has a very delicate flavor, and quite different from that of other eels. I was quite astonished at the fine flavor when I tasted them for the first time in Comacchio. The flesh, as the expression goes, melts upon the tongue. It is even possible to distinguish them while living, by feeling them with the hand, their soft bodies being very different from the hard, solid, muscular flesh of the others.

"In Comacchio these eels are called 'Pasciuti.' Coste called them 'Priscetti,' and defined them to be those eels which had not become ripe, but which were at least a pound in weight. The name 'Priscetti' is, however, very incorrect, as I have

| A.—Sterile female or Pasciuti. | | | B. Normal Female. | | | C.—Eels with supposed male organs. | | |
|---|---|---|---|---|---|---|---|---|
| | *a.* | *b.* | | *a.* | *b.* | | *a.* | *b.* |
| I | 508 | 10 | I | 511 | 8 | I | — | — |
| II | 480 | 8.5 | II | 497 | 7 | II | 480 | 6 |
| III | 458 | 11 | III | 465 | 9 | III | 470 | 6 |
| IV | 443 | 9 | IV | 447 | 7 | IV | 445 | 5 |
| V | 426 | 8.5 | V | 425 | 6 | V | 428 | 5 |
| VI | 408 | 8 | VI | 407 | 6 | VI | 403 | 5 |
| VII | 395 | 11† | VII | 396 | 7 | VII | 396 | 5.5 |

become convinced by questioning the fish inspectors and by hearing the conversations of the fishermen. 'Pasciuto' means 'pastured,' and the fishermen understand by this, those eels

which do not migrate, but which remain through the whole year feeding in the lagoons. They include, however, under this name, eels of two kinds—the sterile females already described, and the eels which are not yet ripe, as well as the normal females and supposed males, whose period of migration is somewhat remote. This circumstance is a cause of much difficulty to the investigator.*

"The studies on the second point to be solved were of special interest, viz., the determination of the presence and the behavior of eels with organs of Syrski, at Comacchio. I can answer this question very briefly, since among 1,200 specimens examined by me at the fishing stations and at the so-called eel-factories (with the exception of the largest specimens, which are always females), I found on an average of five per cent. with the organ of Syrski; of the eels under 15 inches in length (45 centimeters) on an average there were 20 per cent., so that the conclusions as to their abundance were very similar to those at Trieste, where the fish market is supplied, for the greater part, with eels from Chioggia, and to a less extent with those from Comacchio.

"In Comacchio the largest eels with the organ of Syrski, which I have observed, were about 17 inches (48 centimeters) in length, the smallest about 9 inches (24 centimeters). All of these were found among the eels taken during their migration to the sea, and, like the females, were found with stomachs completely empty or slightly filled with a slimy substance. It was impossible to find in any specimen a more advanced development of the Syrskian organ than in those examined in summer at Trieste.

"With reference to the third question undertaken by me, which relates to the actual kernel of the eel question, that is, the possibility of obtaining the eels which have migrated out to sea,

* It has been noticed by many early writers that there are certain eels which never come to the sea—Risso, in his "Histoire Naturelle," tome 3, p. 198, and S. Nilsson, in his "Scandinavisk Fauna," tome 4, p. 663. The latter called this variety "Grasaal," or grass-eel, and spoke of its yellowish-green coloration and the soft, delicious flesh. Strange enough, both these writers spoke of the sharper snout of this eel, and Risso, who founded upon it another species, *Anguilla acutirostris*, described it as brackish above and silvery below. These descriptions apply in every particular to the non-migratory eel at Comacchio. Jacoby remarks that all the sterile females brought to him under the name "Pasciuti," were distinguished by their broad snouts. The following tables were prepared at Comacchio. *A* gives the total length of the body of the eel; *b*, the breadth of the snout between the nasal tubes, in millimeters.

in order to obtain in this manner the sexually mature milters and spawners, I have been unable to obtain any results. I have, so far as my opportunities permitted, left no stone unturned to gain its solution. I went out to sea from Magnavacea and from Codigoro, on Chioggian vessels, and many times have fished myself, and have stimulated the fishermen by offers of reward to endeavor to obtain eels at sea, but I am forced to the conclusion that with the ordinary means this cannot be done.

"Intelligent grey-headed fishermen of Chioggia, who by means of their fishing apparatus know this part of the Adriatic as well as they know their own pockets, have assured me that throughout their entire lives they have never caught a grown-up river eel in the sea at any distance from the coast. The eels which were brought to me at Mannbach as having been caught in the sea, and which I found to be the ordinary females, or eels with the Syrskian organ, were either from localities close to the shore where they are not rare, or were taken in the Palotta canal. There was no lack of attempts at deception. Fishermen took eels from the shore with them in order to be able, on their return, to claim that they had been caught at sea. In the immediate neighborhood of the coast they are, as it has been stated, in the spring-time not rare, and there are not the slightest differences between these and the eels of the lagoons. I found both females and eels with the organ of Syrski with their reproductive organs in the same immature condition as in Comacchio; evidently they had just come through the Palotta canal from the lagoon into the sea. A certain distance, perhaps one or two marine miles from the coast, every trace is lost of the adult eels which wander by the many thousand into the sea. Strange as this problem appears at first sight, it is easily understood when the character of the fishing apparatus is considered; the nets are those used in the capture of lobsters, and are worked over the bottom; they have meshes much too large to hold the eels, or, when they are small-meshed, they do not reach the bottom. The problem can only be solved by using apparatus constructed especially for the purpose."

The economical value of the eel as a food fish has been well established, and it is now greatly sought after for introduction

into the localities where, for some physical or other reason, it is unknown. The advantages as summed up by a German writer, are, first, that an eel will live and grow in any water, however warm, and whatever be the general character of the bottom, though it prefers the latter when muddy and boggy; second, the eel requires no special food, but devours any thing, living or dead; it is an excellent scavenger, feeding upon dead fish, crabs, etc., as well as upon any living prey it can secure; third, but few conditions can interfere with its development, and it grows with very great rapidity, being marketable at the age of three years; fourth, the young, on account of their hardiness, can be transported in a crowded condition, and to any distance, with very little risk of destruction. These considerations are, in the main, well established, and there is no question but that the eel can be introduced in many waters to advantage, supplementing the earlier inhabitants. It has been planted in the waters of the upper lakes and the Mississippi River; in the latter they have reached an advanced development. It is, however, a very undesirable inmate of rivers in which fish are taken by means of gill-nets, the destruction of shad and herring in the waters of the Susquehanna and others further South being enormous. It is not unfrequent that when a gill-net is hauled up, the greater part of the catch consists simply of heads and backbones, the remainder being devoured by myriads of eels in the short time the net is left out. The spawning shad are considered by them a special delicacy, and are found emptied at the vent and completely gutted of the ovaries. Sometimes a shad, apparently full, is found to contain several eels of considerable size. They do not seem to be very destructive of living fish of any magnitude, although the young fry are devoured with gusto.

Mr. Roosevelt: Views differ as to the movement of eels, which perhaps, are influenced by the localities where they live, and investigators have, in my opinion, searched for spawning eels in the wrong places—along the bottom of the salt water, instead of in fresh water ponds and streams. Long Island eels may differ from other eels, but at my pond, there, I think, it is conclusively proved that the young descend to the sea after

hatching, and do not ascend from the salt to fresh water while they are in the fry state. Fish generally go down stream tail first and head up stream, and inexperienced observers would conclude they were ascending, but they are only feeling their way cautiously along. The screens in the troughs at my place were so arranged, that they showed distinctly which way the body of eels was moving; individuals often returning on their course as salmon do when playing about the mouth of a river, and preparing to seek their spawning grounds in the upper waters, but the great mass descending regularly although gradually. The young not much longer or thicker than a big pin, semi-translucent, would collect in a solid body first above, not below the upper screen, then if undisturbed they would work their way through this and collect in the same way above the next, and so on, down past three screens and through two preserves. They were never seen in considerable numbers below any obstruction, although single ones would remount the trough once in a while. Large eels begin moving in our fresh water ponds in March, and as the young appear about April 1st, it is probable the parents spawn in early spring. The young then descend to the salt water where they grow. This is the habit with all other migratory fish. Why should eels be an exception? They are caught in the fall in the larger rivers, and are generally supposed to be then seeking the sea, but it may be that they are ascending the rivers then.

MR. HEWLITT: On nights and rainy days they try to ascend, when coming from sea. Then they go in May. Where they go I don't know.

RECESS.

PROFESSOR GOODE: One or two points I beg to submit. I have no desire to contradict Mr. Roosevelt. Have not made any investigations myself, and only stand on the assertions made by friends in Germany. If we admit Mr. Roosevelt's theory what are we going to do with the observers who see them going up stream. Eels are seen on dry land—going up dams and in crawling up, have heads up. Many have been seen stopped on

lower side of dams, when they could go down. As to the descent of large eels in fall—if it is not so, why are all eel fisheries arranged to intercept downward migration?—Most fresh water eels are caught in that way.

Mr. Blackford called attention to a few viviparous perch from California, sent by Mr. B. B. Redding. They were examined and two were opened, but the insides were too decomposed to trace the presence of young.

Unfortunately the best specimen was left on Mr. Blackford's stand in the market, which Mr. Mather had dissected and found filled with young.

*Salmo purpuratus*, from Alaska, were shown in alcohol. They were from the National Museum and were collected by Captain Beardslee, U. S. N., and identified by Dr. Bean.

An express messenger here delivered a package from Professor Baird to Mr. Mather, which proved to be an elegant diploma, awarding him a gold medal from the International Fishery Exhibition at Berlin, 1880, for his invention of the conical hatcher for shad eggs.

## THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF FISH.

BY PROF. W. O. ATWATER, WESLEYAN UNIVERSITY, MIDDLETOWN, CONN.

[This paper gave an account of the progress during the past year and the results of the work upon the composition and economic values of our food fishes, of which an account was given in the last meeting of the association and reported in this journal. A full report of the investigation up to the present time is to appear in the next report of the United States Fish Commission. In view of these facts and expectation that the work will in the near future have progressed so far as to permit more sat-

isfactory generalization, the paper was confined to a very brief statement of some of the more simple and practical results.]

The research, a brief abstract of some of the more interesting practical results of which is given below, has been going on for two or three years at Wesleyan University, under the auspices of the Smithsonian Institution and the United States Fish Commission, and now includes chemical analysis of fifty-three samples of American food fishes. Some forty-one samples have been previously analyzed in Europe. An idea of the extent of the work may be had from the fact that in the manuscript of the report prepared for publication in the next report of the U. S. Fish Commission, the figures, by which the main results of the analysis are expressed in tabular form, fill some seven or eight large folio sheets.

The samples analyzed were procured in part from fish markets in Middletown, Conn., where the analysis were made, but mostly from New York through the courtesy of Mr. E. G. Blackford, Treasurer of the American Fish Cultural Association, to whose help, in numerous ways, especial thanks are due.

### MATERIALS OF WHICH FISH ARE COMPOSED.

Considered from the standpoint of the food value, fish, as we buy them in the markets, consist of—

1. Flesh or edible portion.
2. Waste—bones, skins, entrails, etc.

The proportions of waste matter in different kinds of fish and in different samples of the same kind in different condition vary widely. Thus a sample of flounder contained 68 per cent., of waste matter and only 32 per cent. of flesh, while one of halibut steak had only 18 per cent. of waste and 82 per cent. of edible materials. Among those with the most waste and least edible flesh are the porgy, bass, perch, lobster and oyster. Among those with the least waste are fat shad, fat mackerel and dried and salt fish,

Coming to the edible portion, the flesh, we find this to consist of—

1. Water. 2. Solid—actual nutritive substances.

The proportions of water and solids in the flesh of various kinds of fish are much more variable than most people would suppose. Thus the flesh of flounder had 85 per cent. of water and only 15 per cent. of solids, while that of salmon 36½ per cent. of solids and 63½ per cent. of water, and the flesh of dried, smoked and salt fish have still less water. Among the more watery kinds of fish are the flounder, cod, striped bass and blue fish. Among those with less water and more solid sare mackerel, shad, salmon and salt and dried fish. In brief, as compared with ordinary meats, the flesh of fish generally, though not always, contains more water.

To get the actual nutritive substance in a sample of fish we must subtract first the waste—the entrails, bones, skins, etc.—which leaves the flesh. Then we must allow for the water in the flesh. What remains will be the total edible solid or actual nutritive substance in the sample.

The percentages of total edible solids in the different samples analyzed were more varied than those of waste and of water. Thus 100 lbs. of flounder, as found in the markets, contained only 5 lbs of solids; 100 lbs. of lobster, 8 lbs.; haddock, 9 lbs; blue fish, 11 lbs.; cod, 12 lbs.; salt cod, 20 lbs.; salt mackerel, 15 lbs.; shad, 16 lbs.; salmon, 27 lbs.; smoked herring, 28 lbs.

## THE NUTRITIVE VALUE OF FISH.

The value of the flesh of fish as food, like that of other meats, is decided, not only by the total amount of nutritive materials, but also by the ingredients, of which the most important are the albuminoids and fats.

The albuminoids, such as wheat-gluten, white of eggs, lean meat, curd, etc., are the nitrogenous constituents of foods, which make the lean flesh of the human body, the muscle, the connective tissues, skin, etc., and are the most important of the nutrients. Next in importance are the fats, such as oil, lard, butter, etc.; and last in importance are the carbohydrates, such as sugar, starch and the like. With the albuminoids alone we might maintain life a good while; but with the fats and carbohydrates alone starvation would soon follow. Now the flesh of fish, like

other animal foods, consists mainly of albuminoids, with more or less fats and very little of the carbohydrates. With this preliminary statement the following table of analysss of some of our most common food-fishes will be easily understood.

As was explained in the article on this subject in the last report of the association, chemical and physiological investigation have carried us so far as to enable us, when we know the chemical composition of different kinds of food, to determine approximately their relative values for supplying the wants of the body. Thus in Germany, where the most accurate and thorough investigation of these subjects has been made, it has become customary to compute the relative nutritive values of foods of similar kinds. We may, for instance, take as a standard four different kinds of flesh. Some are ordinary kind, as beef of medium quality. If we attribute a certain value to each pound of albuminoids and fats in this, and the same value to the same ingredients in other kinds of animal food, we may get at a valuation of each which will enable us to compare them with each other.

In the table which follows the albuminoids are estimated as worth three times as much as the fats, weight for weight. That is, a pound of albuminoids is assumed to be equal in food value to three pounds of fats. A pound of carbohydrates (extractive matters in the table) is assumed to be equal to three-fifths of a pound of fats. The nutritive valuations of a number of different kinds of animal food, as computed in this way, are given in the table on the following page.

### THE TABLE.

For the sake of comparison the compositions and valuations of several other sorts of animal food are given with those of the fish. The figures for meats, game, fowl, milk, eggs, etc., are from European sources, few or no analyses having been made in this country. As will be noticed the first column gives the percentages of edible solids in the fish as received for analysis, some being whole, others dressed, *i. e.*, with head, entrails, etc., removed. The remaining columns refer to the flesh, free from entrails, bone, skin, and other matters:

| Composition and Valuation of Animal Food. | In Whole Sample. | In Flesh. Free from Bone and other Waste. | | | | | |
|---|---|---|---|---|---|---|---|
| | Edible Solids. (Actual Nutritive Materials in Samples). Total per cent. | Water. | Solids. Actual Nutritive Materials. Albuminoids. Protein. | Fats | Extractive Matters. | Mineral Ingredients. | Nutritive Valuation. Medium Beef = 100. |
| *Meat.* | | | | | | | |
| Beef, lean | ..... | 76.71 | 20.61 | 1.50 | .... ... | 1.18 | 91.3 |
| " medium | ..... | 72.25 | 21.39 | 5.19 | ..... | 1.17 | 100.0 |
| " fat | ..... | 54.76 | 16.93 | 27.23 | ..... | 1.08 | 112.0 |
| Veal " | ..... | 72.31 | 18.88 | 7.41 | 0.07 | 1.33 | 92.4 |
| Mutton, medium | ..... | 75.99 | 18.11 | 5.77 | ... .. . | 1.33 | 86.6 |
| Pork, fat | ..... | 47.40 | 14.54 | 37.34 | ..... | 0.72 | 116.0 |
| Smoked Beef | ..... | 47.68 | 27.10 | 15.35 | ... .... | 10.59 | 146.0 |
| " Ham | ..... | 27.98 | 23.97 | 36.48 | 1.50 | 10.07 | 157.0 |
| *Game, Fowl, Etc.* | | | | | | | |
| Venison | ..... | 75.76 | 19.77 | 1.92 | 1.42 | 1.13 | 88.8 |
| Hen | ..... | 70.06 | 18.49 | 9.34 | 1.20 | 0.91 | 93.9 |
| Duck | ..... | 70.82 | 22.65 | 3.11 | 2.33 | 1.09 | 104.0 |
| *Milk, Eggs, Etc.* | | | | | | | |
| Cow's Milk | ..... | 87.41 | 3.41 | 3.66 | 4.82 | 0.70 | 23.8 |
| " " skimmed | ..... | 90.63 | 3.06 | 0.79 | 4.77 | 0.75 | 18.5 |
| " " cream | ..... | 66.41 | 3.70 | 25.72 | 3.54 | 0.63 | 56.1 |
| Butter | ..... | 14.14 | 0.86 | 83.11 | 0.70 | 1.19 | 124.0 |
| Cheese, skimmed milk | ..... | 48.02 | 32.65 | 8.41 | 6.80 | 4.12 | 159.0 |
| " fat | ..... | 46.82 | 32.62 | 20.54 | 1.97 | 3.05 | 151.0 |
| " very fat | ..... | 35.75 | 27.16 | 30.43 | 2.53 | 4.13 | 163.0 |
| Hens' Eggs | ..... | 73.67 | 12.55 | 12.11 | 0.55 | 1.12 | 72.2 |
| *Fish (fresh).* | | | | | | | |
| Halibut | 21.45 | 74.31 | 18.20 | 6.35 | ..... | 1.14 | 87.9 |
| Flounder | 5.97 | 83.85 | 14.20 | 0.70 | ..... | 1.25 | 62.4 |
| Cod | 11.45 | 82 76 | 15.65 | 0.34 | ..... | 1.25 | 68.2 |
| Haddock | 8.88 | 81.22 | 17.26 | 0.16 | ..... | 1.36 | 74.0 |
| Alewives | 11.95 | 75.84 | 18.75 | 3.94 | ..... | 1.43 | 86.8 |
| Eels (salt water) | 22.50 | 70.48 | 18.85 | 9.77 | ..... | 0.90 | 95.6 |
| Shad | 16.29 | 68.17 | 18.81 | 11.66 | .. .... | 1.36 | 98.2 |
| Striped Bass | 8.94 | 78.85 | 17.86 | 2.15 | .. .... | 1.14 | 80.4 |
| Yellow Pike Perch | 8.4 | 79.62 | 18.54 | 0.47 | ..... | 1.37 | 80.9 |
| Black Bass | 9.57 | 77.84 | 19.66 | 1.01 | . . ... | 1.44 | 86.5 |
| Mackerel | 15.48 | 72.32 | 18.30 | 8.15 | ..... | 1.23 | 90.9 |
| Bluefish | 10.96 | 78.16 | 19.32 | 1.25 | .... ... | 1.27 | 85.4 |
| Salmon | 32.99 | 63.52 | 19.73 | 15.67 | . ... | 1.08 | 107.9 |
| " Trout | 14.38 | 66.80 | 17.22 | 14.69 | ... ... | 1.29 | 95.7 |
| Brook " | 10.77 | 77.06 | 18.45 | 3.08 | ..... | 1 14 | 84.2 |
| Whitefish | 13.69 | 70.08 | 22.10 | 6.20 | ..... .. | 1.62 | 104.5 |
| Porgy | 9.76 | 75 84 | 18.15 | 4.65 | ..... | 1.36 | 85.2 |
| Blackfish | 10.72 | 76.16 | 20.78 | 2.79 | ... ... | 1.27 | 93.9 |
| Red Snapper | 10 10 | 76.74 | 20.53 | 1.31 | ..... | 1.42 | 90.7 |
| Smelt | 12.51 | 79.75 | 16.43 | 1.92 | ..... | 1.90 | 73.8 |
| Spanish Mackerel | 20.65 | 67.78 | 21.35 | 9.40 | ..... | 1.50 | 105.9 |
| White Perch | 9.41 | 75.53 | 19.28 | 4.00 | ..... | 1.19 | 89.2 |
| Maskallonge | 12.52 | 75.32 | 20.26 | 2.87 | ..... | 1.55 | 91.8 |
| Herring | 11.52 | 67.70 | 19.42 | 11.40 | .. | 1.48 | 100.4 |
| Sheepshead | 11.99 | 71.63 | 20.69 | 6.68 | ..... | 1.10 | 96.9 |
| Turbot | 15.61 | 70.14 | 14.47 | 14.13 | ..... | 1.26 | 84.3 |
| *Spent Fish (fresh)* | | | | | | | |
| Salmon (male) | 14.87 | 75.13 | 19.52 | 4.55 | ..... | 0.80 | 91 0 |
| " (female) | 12.17 | 78.34 | 17.65 | 2.84 | ..... | 1.17 | 80.4 |
| " land-locked (male) | 10.97 | 78.37 | 16.33 | 4.03 | ..... | 1.27 | 86.0 |
| " " (female) | 10.74 | 79.53 | 17.32 | 1.95 | .... ... | 1.20 | 77.4 |
| *Prepared Fish.* | | | | | | | |
| Boned Cod | 30.91 | 52.60 | 24 58 | 0.39 | .... ... | 5.94 | 106.9 |
| Salt " | 20.45 | 53.67 | 23.50 | 0.58 | . ... | 3.45 | 102·5 |
| Smoked Halibut | 31.63 | 50.83 | 18.44 | 15.58 | ..... | 0.60 | 102.2 |
| " Herring | 28.66 | 35.75 | 31.52 | 18.60 | .... ... | 2.15 | 163.2 |
| Canned Salmon | 29.95 | 65.96 | 21.09 | 11.10 | ... ... | 1.85 | 107.2 |
| Salt Mackerel | 30.97 | 44.69 | 17.74 | 23.87 | .. .... | 1.25 | 111.1 |
| *Invertebrates.* | | | | | | | |
| Lobster | 7.98 | 84.79 | 11.69 | 1.83 | ..... | 1.69 | 50.3 |
| Scallops | 17.47 | 82.53 | 15.90 | 0.03 | ..... | 1.54 | 68.8 |
| Oysters (European) | ... .. | 89.70 | 4.90 | 0.40 | 2.60 | 2.40 | 21.0 |

Three things should be said with reference to the table: First —The figures represent general averages. Sometimes different samples of the same kind of flesh will show widely varying percentages of constituents. This is particularly true of the fats, and to a less degree of the water.

Second—The figures of some of the kinds of food are based upon few analyses. More are needed to show the actual range of variation and the averages.

Third—The nutritive valuations are of necessity crude, and to be relied upon rather as approximations than as accurate quantitative statements. Much more chemical and physiological investigation is needed to make our knowledge of these as complete and satisfactory as it should be.

Looking down the figures in the table we note that the actual nutritive value is decided not only by the total amount of nutritive material and by ingredients of the same, the most valuable being the albuminoids or protein substances, the fats having less value.

Taking medium beef (flesh free from bone) at 100, the flesh of the different samples of fish varied from 62 to 163. Among those that excelled medium beef are smoked herring, 163; salt mackerel, 111; salmon, 108; canned salmon, 107; boned cod, 107; Spanish mackerel, 106; whitefish, 105; salt cod and smoked halibut, 102; herring, 100; shad, mackerel and eels vary between 90 and 100; turbot, white perch, alewives, between 80 and 100; haddock stood at 75, cod at 68, and flounder at only 62. In general, the fatter fish are more valuable than the leaner.

Some very interesting results are found in comparing the foul of spent fish with the same in good condition. As it becomes lean the fish loses nutritive value in three ways: first, in decrease of weight; second, in relative increase of waste and decrease of flesh; and, third, in the deterioration of the quality of the flesh which, in the lean fish, is more watery and considerably less valuable pound for pound than the flesh of the same fish in good condition. Thus the flesh of spent salmon was rated at 85, while that of fat salmon came up to 108. There is in this a strong argument in favor of legislation against the capture of fish out of season.

The practical application of these facts is of the utmost value. The same nutritive substances in the different samples of fish were found to vary from 40 cents to $3 per pound. It makes little difference to the man with $5,000 a year whether he pays 40 cents or $4 a pound for the albuminoids of his food, provided it suits his palate, but to the housewife whose family must be supported on $500 a year it is a matter of great importance.

As regards the value of fish as brain food, continued investigations confirm the statements of a year ago, that fish are no richer in phosphorous than other animal foods and are worth no more in nourishing the brain.

NEED OF POPULAR INFORMATION CONCERNING THESE MATTERS.

In Germany, whither we have to look for the best of our definite knowledge of these matters, information like that given above is widely and generally diffused among the people. Tables like those above are published in pocket diaries [a sample of one of these diaries was shown to the audience] and used for constant reference by hundreds of thousands of people, in all ranks and conditions of life.

We want statements of this sort concerning our own foods, and in such form that the people can make use of them.

As has been said, the investigations in this department of science have hitherto been confined to Europe. It is time that they be taken up on this side of the Atlantic. We are recognized as the first fish culturists of the world. Why should we not have a thorough investigation into the economic values as well as the methods of propagation of our fish?

Mr. Phillips then offered the following:

*Resolved*, That the American Fish Cultural Association heartily appreciates the importance of the investigations upon the nutritive value of fish, now being carried on by Professor Atwater, the results of which have been in part communicated by him at its meetings in 1880 and 1881, and that in the opinion of the members of the Association, the importance of these researches to the fish industries of the United States can scarcely be over esti-

timated. We would, therefore, urge upon the United States Commissioners of Fisheries, the importance of encouraging these investigations to the fullest extent possible. Carried.

Mr. Crook, President New York State Association for Protection of Fish and Game, then requested the members to send communications on subjects of interest in time for their June meeting, papers to be ready by the middle of May. Resolutions thanking the Fish Monger's Association for the use of the room were passed, and the meeting adjourned.

(*The Executive Committee of the American Fish Cultural Association, regret the delay in the publication of the present report. One paper of great importance had to be verified as to dates; some of the data having been subject to corrections at a late period.*)

## TREASURER'S REPORT.

*American Fish Cultural Association in account with Eugene G. Blackford, Treasurer.*

| | | | | |
|---|---|---|---|---|
| 1881. | | | | |
| March 25th. | By amount annual dues received, | | | $213 00 |
| 1880. | | | | |
| March 30th. | To balance due Treasurer, | $131 70 | | |
| June 24th. | " J. M. Davis, for printing reports, etc. | 98 50 | | |
| July 22d. | " Postage stamps, and stamped wrappers, | 6 71 | | |
| April 6th. | " Stationery for meeting, | 82 | | |
| 1881. | | | | |
| March 30th. | " Stationery for meeting, | 2 00 | | $239 73 |
| | Balance due Treasurer, | | | $26 73 |

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—OF THE—

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