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UNITED STATES COMMISSION OF FISH AND FISHERIES,
Washington, D. C.

For the purpose of utilizing and of promptly publishing the large amount of interesting correspondence of the Fish Commission in reference to matters pertaining to fish-culture and to the apparatus, methods, and results of the fisheries, Congress, on the 14th day of February, 1881, by joint resolution (H. Res. 372), authorized the publication annually of a Bulletin, a portion of the edition to be distributed signature by signature, and the remainder in bound volumes. The present volume is the second of this series, and contains many announcements which are believed to be of great importance in relation to the subject in question.

CHAS. W. SMILEY, A. M., is the *Editor* of this volume.

SPENCER F. BAIRD,
Commissioner.

JOINT RESOLUTION authorizing the Public Printer to print reports of the United States Fish Commissioner upon new discoveries in regard to fish-culture.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Public Printer be, and he hereby is, instructed to print and stereotype, from time to time, any matter furnished him by the United States Commissioner of Fish and Fisheries relative to new observations, discoveries, and applications connected with fish-culture and the fisheries, to be capable of being distributed in parts, and the whole to form an annual volume or bulletin not exceeding five hundred pages. The extra edition of said work shall consist of five thousand copies, of which two thousand five hundred shall be for the use of the House of Representatives, one thousand for the use of the Senate, and one thousand five hundred for the use of the Commissioner of Fish and Fisheries.

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STOCKING THE STETTINER HAFF WITH CARP.*

[From the Magdeburgische Zeitung, No. 501, Magdeburg, October 27, 1881.]

A truly gigantic enterprise which will greatly increase our sources of national wealth, if successful, is at present agitated by the well known pisciculturist, M. von dem Borne, of Berneuchen, viz, the stocking of all the waters belonging to the mouths of the Oder, *i. e.*, the Stettiner Haff, the Papenwasser, and the Dammsche See, with the highest esteemed German food-fish, the carp. This large expanse of water, extending far to the east and west of the usual steamboat route, is only partially know to the visitors of our Baltic watering-places; it embraces an area of 87,000 hectares, or more than 15½ German square miles= about 214,985 (English) acres. If every hectare of water is on an average stocked with 250 carp it would require the enormous number of nearly 22,500,000 of carp, which, placed in these waters when young, would after three years be fit for the market, and would—even if during that period many of them should have been destroyed—furnish ample food to a vast number of our population.

No one will deny that this is a grand idea, and the only question was for Mr. von dem Borne to furnish the proof of its practicability. Mr. von dem Borne has done this in the presence of a specially invited company of representatives of the authorities most interested in this matter, by laying his plan before them on the occasion of large pond-carp fisheries near his estate of Berneuchen. The result was such as to remove all doubt from the minds of those present as to the feasibility of Mr. von dem Borne's plan for increasing the productiveness of large sheets of fresh water. It may therefore interest our readers if we lay before them an outline of this plan.

The main question is, whether it is possible to produce about 22 millions of young carp in four years and place them in the Stettiner Haff. As pisciculture has reached a high degree of development in our coun-

*"Die Besetzung des Stettiner Haff's mit Karpfen."—Translated by HERMAN JACOBSON.

try, one might think that the easiest way of solving the problem would be to obtain the necessary carp from our piscicultural establishments, commissioning them to furnish as many young carp as possible, paying perhaps 3 marks (71 cents) per 100. In this way the required number of fish could be procured in a comparatively short time. But at this rate the cost of stocking the Stettiner Haff with carp would be between 600,000 and 700,000 marks, not counting the expense of transporting the fish. Although this large sum might pay some interest at a future time, the expense of starting the enterprise would be too great, and the parties to profit by this arrangment would be the piscicultural establishments and not the people.

Another way of solving the problem would be to adopt the method followed for a number of years by the eminent pisciculturist, Mr. Eckardt of Lübbinchen, by which impregnated carp-eggs can be sent a great distance, and by which the German Fishery Association has succeeded in stocking with carp some of our largest German rivers within a comparatively small number of years. The objection might, however, be raised that it would not be advisable to place the young fry of the carp, immediately after leaving the eggs, in the large basin of the mouths of the Oder, where strong winds often prevail and produce considerable waves. Mr. von dem Borne's plan, therefore, proposes that the parties most interested in the fisheries of the Stettiner Haff, *i. e.*, the local authorities, should procure the required 22,000,000 of carp, not by buying them, but in the simplest manner in the world, by raising them.

In order to fully understand this plan, we have to give a brief review of artificial carp culture, as it has been developed among us in a most rational manner. Not only during the last few years, but for centuries, the nutritious, delicate, golden-yellow carp has been the favorite of our nation. The carp, the unassuming inhabitant of our numerous marshy ponds, has by its peaceful nature become almost as much of a domestic animal as the hog or the goose. All during the Middle Ages carp formed the favorite dish during the Lenten season; and to-day more than ever it is, at certain seasons of the year, the favorite food of a large number of our population, and has, in the shape of "carp in beer," become a characteristic national dish of the Germans. The flesh of the carp contains (in proportion) as much nutritious substance as the finest piece of beef, and is peculiarly suited for making a savory dish; it is moreover entirely free from the disagreeable fishy taste found in many other fish. Owing to the very limited development of its brain, the carp possesses but little ambition, and is content to grovel in the mud of our ponds, generally living on small aquatic plants, and only occasionally allowing itself the luxury of a larva or of an insect. Its excellent appetite is followed by favorable results sooner than is the case with any other artificially raised fish; and its well-rounded body soon assumes such proportions as to make the pike—that most voracious fish-of-prey—absolutely harmless, for the simple reason that no pike can be found large enough to swallow such a carp. The carp occasionally, as in the famous carp ponds of Charlottenburg, near Berlin, reaches the age of a hundred and more years.

It is well known that all fish have a very large number of eggs. As the "first incarnation" of the vertebrate type, the last and highest grade of which is man, their body has such very simple fundamental forms as to enable nature to produce its germs in every female fish in hundreds of thousands of copies. Even in this respect the carp occupies, on account of the large number of its eggs, a very prominent place among fish. It nevertheless indulges in the pleasure of spawning only once a year, in spring, when the warm May sun raises the temperature of the ponds to a comfortable condition. Then its "spawning season" commences, and the male and female fish may be seen, principally during the early hours of the morning, swimming about in the water at a lively rate, emitting the eggs and milt among the reeds and aquatic plants. After eight to eighteen days thousands of young fish leave the eggs. In order to spawn successfully the carp must not be disturbed in the least, and it is absolutely necessary that *no pike should be allowed in the pond;* for otherwise the carp will not spawn. All these peculiarities are of course well known to the pisciculturist, and he manages his ponds by showing due regard to them. If he wishes to obtain young fry from his carp, he is careful to keep pike out of his ponds; if, on the other hand, he wants to raise large carp, he prevents them from spawning by placing a few pike in the pond. Much to the disgust of the carp the pike plays the part assigned him with the indefatigableness and energy of a policeman, keeping the carp constantly in motion and chasing them through every part of the pond. The result is a very fine, even breed of carp, with hardly any small fish, because the pike, proceeding in a most summary manner, will simply devour any fish which are smaller in size than itself.

The swiftness and strength of the pike are, however, also the cause of the presence of this most dreaded of all fish-of-prey in all our lakes and ponds, where it seriously interferes with the increase of the carp. As Mr. von dem Borne says in his work Die Fischzucht (Pisciculture), second edition, P. Parey, Berlin, 1881, the pike in one week eats a quantity of fish equal to at least twice its own weight. Owing to the very general occurrence of the pike, and the extremely small size of its fry, it is absolutely impossible to keep it out of carp ponds which are fed by a brook or other running water, and, mainly owing to this reason, the raising of a large number of young carp, even in carefully managed ponds, is connected with innumerable difficulties, of which Mr. von dem Borne treats fully in his book. After the cause of the evil has been recognized it is comparatively easy to remove it, viz, to select only such ponds as spawning ponds which have absolutely no connection with other waters. Such ponds are supplied with the necessary water either from springs or by rain or snow. Nearly every farmer can have such a pond. Any alder-marsh or peat-bog with some water can be transformed into a carp pond by making a single dike with a pipe for drawing off the water, which can then be kept at the required depth of one meter, and be let off whenever necessary. By constructing this dike from the mud of the pond itself a deep place is formed, the so-called "fish-pit," in which, whenever the water is let off, all the fish gather, so that they can easily be caught.

But to return to the plan proposed by Mr. von dem Borne: This plan simply consists in constructing such ponds near the shores of the Stettiner Haff in every place where this can possibly be done. In these ponds, which of course would be entirely free from pike, a number of millions of young carp could be raised every year, and in autumn transferred to the Haff. If, for example, the entire 22,000,000 of carp are to be raised in three years, the ponds referred to would have to produce on an average a little more than 7,000,000 per annum.

The principal point which Mr. von dem Borne desired to prove by the draining of the ponds last week on his estate of Berneuchen, was that whenever mature carp are allowed to propagate undisturbed, the result is absolutely enormous. It was his object to give his visitors a correct idea of a genuine fish harvest, such as will presumably be had in the future in the Stettiner Haff. In answer to Mr. von dem Borne's friendly invitation, a large number of gentlemen interested in pisciculture had come to Berneuchen, among whom we noticed Councillor von Bünau, superintendent of fisheries of the Stettiner Haff, and Forester Baron von Dicker, both from Stettin; Governor von Heyden, Forester von Waldow, Superintendent of Fisheries von Barnekor, all three from the district of Frankfurt-on-the-Oder. The neighborhood of Berneuchen was represented by Councillor Jacobs, from the district of Landsberg, Councillor von Kalkreuth-Hohenwalde, and the landed proprietors von Sydor-Bärenfelde, von Klitzing-Charlottenhof, and others. With his usual hospitality, Mr. von dem Borne received his numerous guests in the old and spacious mano house of Berneuchen, and made them feel at home during their stay, which extended over a period of several days. Every day a district of about 2 hectares or 8 acres was gone over with the fishing apparatus, the water having been let off a few weeks beforehand, so that the fish had all returned to the deepest place in the pond, the so-called "fish-pit" referred to above. In this place the water was only knee-deep. About 9 a.m. we reached the ponds, after having traveled for some time through dense forests. The dark, muddy water revealed absolutely nothing of its contents, although its agitated surface indicated that the muddy pool, scarcely measuring 30 paces in diameter, contained numerous small and a number of large fish, which manifested their presence by a greater or less commotion in the water. The fishermen soon commenced their work, and during the first forenoon went over the so-called "Maxa-pond." At the first haul the net could barely hold the densely crowded mass of fish, which, in spite of the most violent struggle for liberty, was safely brought to land. Here the foreman of the fishermen dipped out the harvest with purse-nets, and deposited the fish in large baskets, transferring every time hundreds and thousands of small, golden-yellow young carp, which measured on an average 5 to 6 centimeters, and occasionally some magnificent food-carp and delicate leather carp. Basket after basket did the men carry up the steep bank, and, separating the large from the small fish, put them in enormous tubs half filled with fresh water, where the little fish remained quiet, gathered in dense crowds, whilst the large ones, as if by common consent, engaged in a sort of swimming race, swimming invariably to the left, round the tub, after having expressed their first astonishment by standing on their heads and beating the water with their tails. The next part of the programme was to count the fish, by repeatedly filling a certain standard measure, and thereby calculating the entire quantity. A number of wagons were on hand, each supplied with several fish-kegs half filled with water, and the measuring and loading of the wagons soon commenced, the pond meanwhile having been emptied after seven or eight hauls. All this time the water was being let off.

Although every one of our party was well supplied with rubber boots and warm clothing, the fine rain and raw air soon seemed to penetrate even the thickest covering. It was, therefore, with no common pleasure that we were called on to witness the preparations for an original and savory meal, which the forester of Mr. von dem Borne cooked with consummate skill, closely following the method employed by the North American trappers and sportsmen during their camp-life in the vast forests of the Western Hemisphere. Four plump carp were cleaned, washed, well strewed with salt and pepper both on the inside and the outside, and thereupon wrapped—each one separately—in a white sheet of paper well buttered. Round this a sheet of newspaper was wrapped, the package was for a few moments dipped in cold water, and finally placed on a bed of hot coals of an open fire. Above the four carp came a layer of raw potatoes, which were thus baked in the ashes. The dining-room was just as primitive as the preparation for the meal, and consisted of an open frame shanty of the simplest construction. In about half an hour the "pepper carps" were ready for the table. Full of their own juice, they formed a most tempting and delicious dish, and being handed round, together with potatoes, on large napkins, satisfied even the most epicurean taste, and were washed down by an excellent bowl of punch (amid great merriment). After the meal we again turned our attention to the fish, which had meanwhile all been placed on the wagons. The result of this forenoon's work was 90,000 small and 528 large carp, this whole enormous number having been produced from 570 large carp, which Mr. von dem Borne had placed in this small pond—not quite as large as the Lustgarten in Berlin—in the beginning of April of the present year—only six to seven months ago. While the 570 large carp had been reduced to 528 by fish of prey, thieves, and other causes, but had increased in weight, the total number of 90,000 beautiful young carp had originated in this time. There was, of course, not a single pike in the pond, and nothing whatever was brought up in the nets with the fish but a number of frogs, water-beetles, and sticklebacks. These three last mentioned are notorious enemies of the roe of the carp, and we were destined to learn on the following day how dangerous they may become to the roe.

Wonderfully rich as was the result from the Maxa-pond, it was hardly the original intention that it should be so, for all these 90,000 young carp had come into life contrary to regulations and owed their existence to a mere accident. It had by no means been the intention that the 570 large carp should spawn in this pond, but they were intended to grow up into large food-carp. For the simple reason that they were not yet supposed to be ready for spawning, no pike had been placed in the pond with them, and about a dozen of the carp which were fully prepared for spawning had made good use of this circumstance, and had done their utmost to stock the pond with young fish. If the pond had been intended for a spawning pond, twelve spawners and six milters would have been sufficient for a pond of two hectares. This number had been placed in the large "Dachsberger" pond, which, on the second day of our visit, was subjected to the same process of fishing as the Maxa-pond. We were now destined to witness the injurious influence of other enemies of the carp than the pike. The young carp in this pond were on an average six times as heavy as those captured on the previous day, and the total yield was twice as large as that of the Maxa-pond. The increase in the size of the eighteen carp originally placed in the pond was also much greater than that of the carp placed in the Maxa-pond; but the total number of fish captured fell below the expectation. Even during the first haul we were struck with the unusually large number of sticklebacks which were brought up with the carp. Large numbers of these dangerous fellows were boldly pushing their way in the tubs among the pretty golden-yellow young carps, in some cases, it is true also struggling for life, as they cannot live without fresh air as long as the carp. What damage was done by these fish of prey, which, by persistent attacks, even succeed in killing large fish, during one summer, to the young carp of the Dachsberger pond, may be gathered from the circumstance that we only captured 23,600 young carp, whilst in other years as many as 100,000 to 150,000 had been caught every autumn. In stocking the Stettiner Haff such circumstances should be taken into consideration, the recurrence of which may in this case be avoided by simply laying the pond dry and pouring in a solution of lime and water. The average production of a hectare of water may therefore be calculated at 45,000 young carp per annum. In order, therefore, to produce the required number of 22,000,000 of carp in four years, all that would be necessary would be to construct and put in working order about 120 hectares of spawning ponds. According to Mr. von dem Borne's former experience, the result would be still more favorable. He found that a good spawning-pond produces on an average 50,000 to 75,000 young carp, per hectare, in one year, so that 80 to 90 hectares of spawning ponds would be sufficient to stock the Stettiner Haff with the required quantity of carp within four years.

In answer to the question, whether there are near the Stettiner Haff places suitable for the construction of such ponds, the administration of forests for that part of the country has returned an affirmative answer. In the extensive government forests on the western shores of the Stettiner Haff, between Ueckermünde, Pölitz, and the Papenwasser, there are a number of marshy places which, as far as their productiveness as forest land is concerned, are practically useless. With very little trouble, in many cases by merely constructing a dike with a pipe for draining off the water, very fine spawning-ponds for carp could easily be constructed in the immediate neighborhood of the Stettiner Haff. Only nine fully matured carp per hectare, each weighing about four pounds, placed in these ponds in the spring, would in the autumn of every year yield 40,000 to 70,000 young carp per hectare. If one wishes to save the expense of constructing a number of ponds, it will be sufficient to commence with one pond, and let the young carp grow large enough to become spawning carp after three years, and then stock the other ponds with these carp. The transportation of the young carp to the Stettiner Haff could be accomplished by wagons or by trenches leading from the Haff into the ponds; and this should be done every year in October. The question arises whether the Haff is suitable for carp? or if wind and waves, and the numerous enemies of the carp, especially the pike, or lack of food, or the salt water from the Baltic which occasionally enters the outer mouth of the Oder, might injure the carp? In reply we must say that the carp lives under the same conditions as the bream, and is everywhere found in its company; and since we find the bream in the Stettiner Haff, there is not the slightest doubt that the carp can also live in these waters. We must of course be prepared to see the Haff pike, that most voracious fish of prey, devour many thousands of the delicate young carp, and the herons, gulls, sea-eagles, and other enemies of the carp do their share in destroying the young fish. Very probably the most dangerous of all enemies of the carp, man, will capture the young fish before they have reached their full size; but there is no doubt that the flat bottoms of the Haff, which, especially in the west, are rich in the best humus, will provide an inexhaustible supply of food for the carp, and afford many excellent places of refuge. Against the fish-of-prey we shall declare open war, and as for man, the fiercest of these enemies of the carp, is concerned, we shall endeavor to limit his power for evil by carrying out a long and often talked of plan, viz, to build a swift small steamer, which will act as the policeman of the Haff. Millions of young fish will be furnished for the Haff every year from the safe spawning ponds, and make up for any losses. Success will surely crown these efforts at last, and our waters will again be filled with fish. A successful experiment, like the one we have described, will soon be imitated in other parts of our country, and our lakes and rivers will no longer, as at the present time, when our fresh-water fisheries have reached the lowest stage of their decline, only yield an average annual increase of 2 marks (47 cents) per hectare; but will equal in productiveness the finest and best cultivated portion of our land, and the income from each hectare of water will be at least twenty times as large as the one mentioned above. Whenever this takes place, our pisciculturists, and among them Mr. von dem Borne, with his 600 acres of water, will be the first to feel the consequences of the change, for fish will become much cheaper, and the fishing-waters will yield less income, in proportion as the condition of the lower classes of our population is improved by cheaper food. But this disinterested man, who has conceived the vast plan of stocking the Haff with carp, will not be influenced by such narrow considerations. The execution of this plan will prove a great blessing to our people, for we shall again see the carp, which has been banished from all tables except those of the rich on account of its high price, grace the table of our middle and poorer classes.

APPEARANCE OF DOGFISH (SQUALUS ACANTHIAS) ON THE NEW ENGLAND COAST IN WINTER.

By J. W. COLLINS.

(Letter to Prof. S. F. Baird.)

In the Cape Ann Advertiser of February 10, 1882, I find the following paragraph: "Immense schools of dogfish, extending as far as the eye can reach, have appeared off Portsmouth, an unusual sight in winter." Is it not possible that the presence of dogfish in such abundance in that vicinity this winter may have something to do with the scarcity of the cod in Ipswich Bay?

It is a fact well known to fishermen that dogfish in summer will drive the various species of bottom fish from the grounds, and it may be that they are quite as voracious and troublesome to the cod in winter as in warmer weather.

SMITHSONIAN INSTITUTION,
Washington, D. C., February 18, 1882.

REPLIES TO QUESTIONS OF HERR VON BEHR, CONCERNING SALVELINUS FONTINALIS AND SALMO IRIDEA.

By LIVINGSTON STONE.

I.—BROOK TROUT (*Salvelinus fontinalis*).
II.—CALIFORNIA TROUT (*Salmo iridea*).

1.—We always hear now that *Salmo fontinalis* is rather a *Salvelinus* (and there is no doubt about it), but don't you have our *Trutta fario?* You use the words *Salmo fontinalis* and brook trout as synonymous, while formerly we thought brook trout to be our *Trutta fario!*

A. It is true that the New England brook trout, sometimes called the American brook trout and commonly known by the name of *Salmo fontinalis*, is properly a Salvelinus (*Salvelinus fontinalis*), but the *Trutta fario* of Great Britain and the continent of Europe does not exist and has never existed in America. The common brook trout (*Salvelinus fontinalis*) of New England and other States of the Atlantic slope is not the common brook trout of Europe (*Trutta fario*).

My following questions are meant about *Salmo fontinalis* (*Salvelinus*):

2.—How heavy do they get?

A.—The *Salvelinus fontinalis* or common brook trout of the Atlantic slope varies very much in size and weight. Those found in high altitudes in the very small and usually cold rivulets that form the headwaters of the streams are the smallest, and often are of such diminutive size that they will not average over two or three ounces each. The larger and somewhat warmer brooks lower down, that are formed by the confluence of these little rivulets, furnish the next larger size of *fontinalis*, and so on till we come to the streams emptying into the ocean or the Great Lakes, where we find the largest of the species.

Brook trout were thought to attain the weight of 9 or 10 pounds until the famous 10-pound trout caught by Mr. George Sheppard Page in the Rangely Lakes was declared to be *Salmo oquassa*, since which time the reputed maximum weight of *fontinalis* has had to fall a little, though I still think it possible for *fontinalis* to attain a weight, under the most favorable circumstances, of 7 or 8 pounds; but Atlantic brook trout of 3 or 4 pounds are now getting extremely rare even in tidal streams, and in the brooks farther in the interior a pound or three-quarters of a pound is considered a good weight for *fontinalis*.

3.—Are they living in the same water with *Trutta fario* or *Salmo iridea?*

A.—*Salvelinus fontinalis* has never been found naturally living together with *Trutta fario* or *Salmo iridea*. But since the introduction by human agency of *fontinalis* in Great Britain, *fontinalis* has occupied the same waters with *Trutta fario*, and since the California brook trout have been brought to the Atlantic slope and Atlantic brook trout have been carried to the Pacific slope these two latter varieties (*Salvelinus fontinalis* et *Salmo iridea*) have lived together in the same waters.

4.—What time are *Salmo fontinalis* caught by angling?

A.—*Salvelinus fontinalis* can be caught by angling in the latitude of New York City from about the 1st of April to about the 1st of October, though I believe the close season begins somewhat before October 1. Before about the 1st of April the water is usually so cold that the trout do not feel much like biting, and after the 1st of October the spawning season is so near that they do not care then much about bait or any food. As one goes farther north the season for angling begins later and ends earlier. Trout are not found much south of the latitude of New York City, except at high levels.

5.—With what fly or bait?

A.—Trout fishing in this country is done mostly with artificial flies. The different varieties of flies used are innumerable. Those which are considered the most effective, taking the season through, are perhaps the "Professor," "Montreal," "Jenny Lind," "Coachman," "Black Gnat," and "Cowdung." When bait is used the common angle worm is the favorite lure for trout, but grasshoppers, various flies and insects, and particularly the grub worm, are used at different seasons and in various localities with good results. Salmon spawn also makes a good bait when it can be procured.

6.—Do they spawn also in lakes like other *Salvelinus*, or only in rivulets like *Trutta fario?* What months?

A.—Atlantic coast trout, like *Trutta fario*, spawn almost exclusively in brooks and rivulets, and manifest a strong impulse to ascend the streams to a considerable distance. When, however, they cannot do better, they will, like other charrs, spawn on the shores of lakes, always seeking either a springy spot or a clean gravelly one, or both. Their spawning months vary very much, probably according to the temperature of the water. At the Cold Spring trout ponds, at Charlestown, N. H., the trout almost invariably begin to spawn the second week in October, and end before Christmas. Farther north in ordinary brooks they spawn earlier. Farther south they spawn somewhat later, and in ponds or streams which are fed by springs large enough to keep the water of very even temperature through the cold months, the trout spawn from the 1st of November till some time in April.

7.—Are they thought good for pond culture?

A.—In America, *Salvelinus fontinalis* takes the first rank as a fish to be cultivated in ponds, provided the ponds are fed by springs or cold running water. Ponds not possessing these qualities are unsuitable for brook trout.

8.—There seem to be different kinds of *Salmo fontinalis* in United States, for when some time ago I received a box of eggs, which were first cabled as *lake trout*, but afterwards declared by you to be *brook trout* (*Salmo fontinalis*), you especially remarked that these *Salmo fontinalis* eggs were of a special excellent variety, and my German breeders observe that these eggs are so very large that they indeed had believed them to be lake-trout eggs.

A.—There is, properly speaking, but one kind of *Salvelinus fontinalis*, but they vary very much in quality. For example, the small fish of the small, high rivulets, though very sweet and delicious when cooked, are not nearly as handsome and plump and tempting in looks as the trout lower down, say in the Cape Cod and Long Island streams. Neither do they ever grow as large, neither are their eggs as large. As to the eggs of the largest breed of brook trout are fully twice as large as those size of the eggs, I think I may venture the assertion that the of the fish of mountain rivulets.

9.—Of what State and lake were these? So I dare say you have different kinds of *Salmo fontinalis*. Is this the case? I bought, for some years, eggs of Mr. Annin and of the Charlestown Cold Spring trout ponds. Were these probably of the same kind as those you presented to me a short time ago?

A.—The eggs sent to Germany, and first by mistake called lake trout, were true "*fontinalis*." They were from Mr. Clarke's ponds in Michigan. They were eggs of the same variety of fish (*Salvelinus fontinalis*) as those received from Mr. Annin and from the Cold Spring trout ponds at Charlestown, N. H.; but Mr. Clarke's eggs were from exceptionally fine fish.

10.—You observed that you had a *Salmo iridea* hatching-house in one of your Eastern States. Do the *Salmo iridea* spawn there at the same time as in California—in the spring? Which months are the spawning time in California (McCloud River), and which in the Eastern States hatching-house?

A.—In the McCloud River they spawn from about the middle of Januray to the middle of May; but so varied in elevation, latitude, and temperature is the State of California that *iridea*, I have been informed, is spawning somewhere in the State every month in the year.

It is unquestionably true that the spawning season of *Salmo iridea* depends on the climate, that expression being understood to include all climatic influences of every kind.

Salmo iridea spawns in the McCloud River, as has been mentioned, from the middle of January to the middle of May. In the eastern hatching-houses the same fish spawns in March, April, and May.

11.—Does this *Salmo iridea* keep, in *ponds*, its stronger appetite and greater vitality they speak so much of in California?

I read in the small book "Fish Hatching, Fish Catching," that they are more vigorous in every way than the Eastern trout, but are not as handsome, have no carmine specks, but will live well in captivity and grow rapidly.

A.—*Salmo iridea* retains its capacity for eating voraciously when confined in ponds, and when confined seems to keep up its well-deserved reputation for having a hardy and vigorous organization, though I should hardly want to admit that *iridea* possesses any greater vitality than *fontinalis.* I agree entirely with your quotation from "Fish Hatching and Fish Catching," that they are more vigorous in every way than the eastern trout, but are not as handsome, have no carmine specks, but will live well in captivity and grow rapidly, except that I should want to substitute the word "hardy" for "vigorous." It does not seem to me that the California brook trout are more vigorous than the Atlantic brook trout, but they are nudoubtedly more hardy.

Mr. von dem Borne desires me to ask the following question:

12.—What kind of places do those four above-mentioned fishes select for spawning: running or still water, on plants, on stones, on gravelly or sandy or muddy bottom; in deep or shallow water?

A.—In reply to Herr Borne's inquiry, allow me to say that *Salvelinus fontinalis* and *Salmo iridea* always seek clear, running water and a gravelly bed where they may deposit their eggs.

13.—Is there only but one California trout, or is the trout of McCloud River the true rainbow trout, and has California another mountain trout?

A.—There is but one California trout which has been introduced into the Atlantic States, and, indeed, but one that has been much cultivated. This is *Salmo iridea*, or the "rainbow trout," or the "Califonia mountain trout," or "McCloud River trout," these four names last given being synonymous. Whenever any one hears anything about *Salmo iridea*, or "rainbow trout," or "California mountain trout," or "McCloud River trout," he may know that the same fish is always meant under all these different names. California has several other mountain trout, but they are not yet generally known or much cultivated.

14.—Which one do you intend to send us?

A.—Consequently the California trout which Professor Baird intends to send to Germany is the fish (*Salmo iridea*) just mentioned.

15.—What month does it spawn? Californian *Salmo quinnat* spawns at home much earlier than our *Salmo salar*, but I might suppose that this entirely depends on the climate, because the California salmon which our Mr. Schuester raised in his tanks up to spawning time did not spawn in the California time, but in our *Salmo salar* time (November), or very near so.

A.—This question has already been answered under 10, which see.

RESULT OF PLANTING SHAD IN THE OHIO RIVER.

By WILLIAM GRIFFITH.

The first white shad of the season was taken on the Falls yesterday. This makes the sixth consecutive run of white shad in the Ohio river.

LOUISVILLE, KY., *May* 7, 1881.

THE DISAPPEARANCE OF SARDINES FROM THE VENDEAN COAST, AND ITS CAUSES.

By GEORGE GIFFORD.

[From Dispatch No. 66 to Department of State. Transmitted to the United States Fish Commission by J. C. Bancroft Davis, Assistant Secretary.]

The sardine having long been the principal item of export to the United States from this part of France, its disappearance is a matter of considerable commercial importance. For the fishermen themselves it is an overwhelming calamity, as the phylloxera is for the vintners on the Charente.

The sardine has generally appeared on the Vendean coast about the 1st of May, and, following the shores of the Bay of Biscay northward, has furnished occupation to some 15,000 Vendeans and Bretons, and 3,000 boats. Formerly the annual catch was worth at least $3,000,000. But in 1879 the sardine suddenly disappeared for the most part, and the two following years having given most unsatisfactory results, it is with a heavy heart that the discouraged fishermen are now fitting out their boats for the season, which begins next month. The commercial houses engaged in the preparation of the fish for the market have in a measure escaped loss by advancing their prices, but charity alone keeps the fishermen from absolute destitution.

This disappearance of the sardine has been coincident with an extraordinary change of climate, which has attracted the attention of meteorologists and other scientific observers, who have endeavored to establish some relation between the phenomena. The winter on the Breton coast is generally characterized by a low barometer and very frequent rains. During the four months from November, 1878, to February, 1879, for example, it rained at Nantes the extraordinary number of 79 days, and at Lorient 86 days, while the average rainfall in Western France during that time was about 15 inches. During the corresponding months of the season which has just passed it did not rain at all on this coast, and the high barometric pressure has been almost incessant. The storms, the arrival of which has ordinarily been predicted with so much accuracy from New York, have passed to the north, and the southwest wind, laden with moisture and bringing frequent rains, has given place to a dry wind from the northeast. And this in a somewhat less degree was also the meteorological history of 1880–'81, and of the preceding year.

The effect of this high pressure and change of wind on the temperature has been by no means constant. The average winter temperature in Western France is not far from 45° Fahr. But the winter of 1879–'80, with its cloudless sky, was one of extreme rigor, during which the Loire was for several weeks frozen over. During the winter just past, the sky being often concealed by a thick fog, there has been neither snow nor ice on the Lower Loire. But the constant features of the three past winters have been the relatively small rainfall, the high barometer, and, for the first two years, the absence of the sardine on the coast during the following summer.

Mr. Blavier, president of the Main-et-Loire Industrial Society, has recently read a paper before the Academy of Sciences, in which he accounts for these facts by the alleged displacement of the Gulf Stream, one branch of which ordinarily leaves the coast of the Bay of Biscay, rendering the climate very much warmer than that of corresponding latitudes in North America. The sardine always follows this warm current, and has now accompanied it in the new path which it has made for itself in the ocean. According to Mr. Blavier, the fishermen have no reason to anticipate a good catch until the breaking up of those great ice masses in Baffin's Bay which, it is believed, have for several years obstructed the flow of that cold arctic current by contact with which off the Banks of Newfoundland the Gulf Stream has hitherto been deflected toward Europe.

If this view be correct, the coming season will be as unproductive as those which have preceded. In that case the misfortune of the Vendean and Breton fishermen, however regretable in itself, cannot fail to encourage the "sardine" industry which has already acquired so considerable a development in the United States.

UNITED STATES COMMERCIAL AGENCY,
Nantes, April 3, 1882.

GROWTH OF GERMAN CARP SENT TO SAVOY, TEXAS, BY THE UNITED STATES FISH COMMISSION.

By SAMUEL JOHNSON.

(Letter to Prof. S. F. Baird.)

My carp which you sent me the 10th day of January last are doing well. Some of them are eight inches long. The shorest one that I received was one and a half inches long then and is four inches long to-day. They grow like China pigs, when fed with plenty of butter-milk. I feed them on the scraps from the table. They love good biscuit the best. They eat meat, bread, salad, or worms, and everything I give them. They are perfectly gentle and come at the rattle of a sheep's bell to be fed. I feed them as I would chickens, and intend to feed them every day. I have plenty of water for thousands of them. I would not take one hundred dollars for what you sent me. I can make them weigh five or six pounds this summer by feeding them well.

SAVOY, TEX., *April* 24, 1882.

INFORMATION CONCERNING THE BLUE CARP.

By G. LEONHARDT.

[Translation of letter to von dem Borne.]

HONORED SIR: In reply to your inquiry of the 14th instant I have to state, greatly to my regret, that I cannot supply you with *blue spawning-carp* this spring, as I finished the stocking of my ponds last week, and sent all superfluous fish, which happened to be very fine, five years old, and weighed from 7 to 8 pounds each, to the fish merchant.

In autumn, however, I hope to be able to furnish you such fish from the Waage-gut ponds; and I herewith make you this offer.

For years these blue carp have existed here, *mixed with the yellow carp;* and I therefore cannot promise a pure and permanent breed. Owing to the lack of separate ponds, *I cannot raise each kind by itself.*

I entirely agree with what Mr. R. Eckardt, of Lübbinchen, says regarding this carp, in No. 11 of the Deutsche Fischerie-Zeitung. In spite of its delicate nature, it stands our winters, which occasionally are very severe, as well as other carp.

HUBERTUSBURG, SAXONY, *March* 16, 1882.

CAPTURE OF LAND-LOCKED SALMON AT OSWEGO, NEW YORK.

By GEORGE MORGAN.

[Letter to Seth Green.]

DEAR SIR: A few days ago another salmon was taken here while pumping out a dry-dock; this makes the fourth inside of a year. I am of the opinion that they are the offspring of those planted by you several years ago, while others believe to the contrary. I base my opinion on the fact that *in thirty years previous none have been caught or seen here.* I would be very much obliged if you would give me your opinion, and at the same time inform me when you will be ready to give us the California mountain trout.

OSWEGO, N. Y., *April* 26, 1882.

NOTES ON THE FISHERIES OF GLOUCESTER, MASSACHUSETTS.

By S. J. MARTIN.

(Letters to Prof. S. F. Baird.)

The George's vessels have not done much during the past week. They have to go to Grand Manan after bait. That makes the trips longer. Three halibut fares have been landed this week—small fares. Halibut bring a high price. They sold all the week at 9 cents per pound for white, and 6 cents a pound for gray. The outlook for fresh fish is good. Haddock have not sold less than 2½ cents per pound. Cod sold for 3 cents a pound all the week. There is a good school of cod in Ipswich Bay—large fish. Schooner Rising Star caught 20,000 pounds in three days. The rest of the boats have done as well. One of the Rockport boats set 12 nets where they were getting 6,000 pounds on trawls in one day. When they hauled the nets they got 200 pounds. They cannot get trawl-fish in nets, or net-fish on trawls; that has been well tried. The southern mackerel fleet have not done much. The schooner Mertie Delmar was in New York Monday; she had 130 barrels of medium sized mackerel caught 30 miles southeast from Cape Henry. Last year the first mackerel were caught on the 23d day of March. The next were caught April 19, when 12 sail arrived with 1,705 [barrels]; the next were caught April 25, when 30 sail arrived in New York with 6,000 barrels of fresh mackerel. The mackerel sold in New York Tuesday at 10 and 12 cents each. All the old mackerel are out of the market. The first salt mackerel will bring a good price. I hope the mackerel-catchers have learned a lesson during the past summer about selling their mackerel out of pickle to save inspection. They began to sell mackerel out of pickle five years ago. The last three summers it has been carried on extensively. Mackerel were sold out of pickle last year for $4 per barrel and were sold afterwards for $10 per barrel. I don't see where the general inspector gets his pay when mackerel are sold out of pickle, that is, if he gets so much for inspection on a barrel. Perhaps the law is altered; if not, there is a good deal of *hush money.* When mackerel are sold out of pickle it hurts the market. When the speculators get them the fish are all culled over: number *ones* made of number *twos;* number *twos* of number *threes* and they make twelve twenty-pound kits out of a barrel. If a man buys inspected mackerel he gets what belongs to him; if they are not inspected he does not.

The boat which arrived from Ipswich Bay this morning was the Annie Hodgdon with 15,000 pounds of nice cod in two days fishing with trawls.

A school of haddock has made its appearance on the coast during the past three days. One man, in a dory, yesterday, caught 500 pounds about one-half mile southeast from Eastern Point. If there is plenty of bait the small vessels will do well. The prospect is good for all kinds of fish.

GLOUCESTER, MASS., *April* 16, 1882.

There were 64 arrivals from the fishing-grounds during the last week: 25 from George's, 13 from the Western Bank, 2 halibut catchers, and 24 from shore fishing. Two vessels have done well seining herring: schooner Northern Eagle seined 200 barrels in three days; schooner Phantom seined 250 barrels last week. Two hundred barrels were caught in the trap at Kettle Island. The herring sold fresh to the vessels for bait at $2.75 per barrel. The herring have not been so plentiful on the coast for thirty-five years. The half-sized herring came first, then the large ones. Yesterday schooner Northern Eagle seined 60 barrels at the mouth of the harbor. They were schooling a distance of 20 miles yesterday northeast and southwest. The herring are very large. There are four vessels with seines after herring. The George's vessels are doing better since the fresh herring have come. I told George he had better take his seine and try to seine some herring. He did so, and sold $430 worth in three days. It appears that all kinds of fish are inshore. The mackerel are close to the shore. Vessels went out of New York Saturday and returned Monday morning with 150 barrels of mackerel—so they are close to the shore. Twenty-four thousand pounds of large cod were caught last week in 7 fathoms of water off Newburyport Bar. Haddock have been caught within one-fourth of a mile from the shore in large numbers. Whales are close to the shore. I will tell you about the water: The last day of April the water was 50; the first day of May it was 46. This is the third time I have seen it work the same way. It happens on a high course of tides.

Fresh fish are low. Halibut sold yesterday at 5 cents per pound. Haddock sold at 90 cents per hundred pounds and fresh cod at one and one-half cents per pound.

GLOUCESTER, MASS., *May* 7, 1882.

During the past week there have been 36 arrivals from George's, averaging 18,000 pounds per vessel. Eight sail arrived from Western Bank, averaging 60,000 pounds to a vessel; four sail with fresh halibut, averaging each 45,000 pounds; twenty-two sail from shore-fishing, averaging 12,000 pounds to a vessel; 12,000 pounds have been landed by the small boats. Three hundred and thirty-five barrels of herring have been caught and sold here during the last week. Most of the herring sold at $3 per barrel to the fishermen for bait. Fresh halibut are low; they sold by the cargo yesterday at 4½ cents per pound. The price of all other fish is the same as last week. The seining of herring is a new branch of the business, in which there are four vessels engaged when there is a chance. I thought the storm would drive them off, but it did not seem to. The men went down to their nets this morning and obtained one-half barrel to the net. The weather has been very bad here since Wednesday, the wind northeast blowing a gale. There is a heavy sea on the coast. A large fleet of vessels is in the harbor waiting for a chance to go out.

One salmon and one mackerel were caught in the trap at Kettle Island, Gloucester Harbor, yesterday. The salmon weighed 9 pounds and sold at 50 cents a pound.

GLOUCESTER, MASS., *May* 14, 1882.

More fish were landed at Gloucester last week than any other during this season. There have been 53 arrivals from the fishing grounds—11 sail from Western Bank, with good fares; 28 sail from George's, with good fares; 13 sail from shore fishing; one with fresh halibut, two with salt. Yesterday there were a half million pounds of fish in the harbor on board vessels. The weather has been bad on the coast. The fishermen have not had it so bad on the Banks. The schooner Joseph Story arrived last night; she has been south after squid. The squid fishing is a failure this year. She has been gone three weeks, and got a bucketful of squid. She has been as far as Newport, and found nothing but a few scattering squid. Two barkes arrived yesterday from Liverpool with cargoes of salt; so it has been a prosperous week for Gloucester. Some of the vessels are fitting out for Greenland. I think five sail will go this summer.

Arrivals for the past week are as follows: 660,000 pounds salt fish from Western Banks, 560,000 pounds from George's, 65,000 pounds shore fish, 45,000 pounds halibut, 655 barrels mackerel. A good week's work.

GLOUCESTER, MASS., *May* 21, 1882.

There have been 20 arrivals from Gloucester this week; 18 from Western Bank; 3 from the Banks, with fresh halibut; 6 from the inshore grounds.

Mackerel are taken now with seines in Boston Bay and off Chatham. Mackerel have advanced—salt mackerel 50 cents on a barrel. The demand for all kinds of fish is large. Dried George's cod have advanced $1 on a quintal. The fishing looks well for this season. There are no mackerel in the market. Schooner Geneva Mertis was here yesterday with 50,000 pounds of pollock caught with seines off Chatham. They sold at $1.75 per hundred pounds, which was the largest price paid for green pollock since the war. George's cod have been selling at $3.50 a hundred out of the vessel. All kinds of fish are high. You will find by the monthly reports on fish that the Western Bank vessels have done well. Two schooners arrived this morning from Grand Bank with halibut, 35, 000 each. A vessel is in Boston with 200 barrels of fresh mackerel caught off Chatham.

GLOUCESTER, MASS., *May* 28, 1882.

GROWTH OF MIRROR CARP SENT TO GEORGIA BY THE UNITED STATES FISH COMMISSION.

By E. HEYSER.

(Letter to Prof. S. F. Baird.)

Thinking you might be interested in hearing from the mirror carp you so kindly furnished me with in November, 1879, I am pleased to be able to inform you that they have grown finely, and now weigh from 4 to 6 pounds each, and at this time have a large number of young ones just out and hatching.

OFFICE OF CLERK SUPERIOR COURT, MORGAN COUNTY,

Madison, Ga., May 11, 1882.

THE FISHERIES OF THE GULF OF MEXICO.

By M. L. WOOD, U. S. N.

It is my impression that when fully developed, as they doubtless will be some day in the near future, the fishing interests of the Gulf will compare favorably with those of the fishing banks of Newfoundland. At present, however, there is no comparison.

Another thing that will tend to make Gulf fishing a financial success is the apparently insatiable appetite of the Cubans for fish, either fresh or salted. Even now the shipments of fish, alive, on ice, and salted, each week from Key West, are surprising.

Now, of course, only small sailing vessels, badly equipped and with no means of keeping ice, and no facilities for obtaining it, go on the fishing banks, and in two days' time fill their wells with all the live fish possible, and load with salt fish. If there happens to be a favorable wind, some of the fish are alive, and some that have died are still in good enough order to be either sent north from Pensacola or Cedar Keys, or shipped to Havana from Key West. One of the most delicious fishes of the Gulf, the red snapper, does not live well in captivity, and does not take salt very readily. As for myself, I prefer the red snapper to almost any other fish, excepting the pompano, when fresh.

The "snapper banks," where the fish are caught, and several kinds besides snappers are caught together, are quite common in the Gulf; their location is always a difficult subject, excepting for a few of the well-known ones close to ports.

The number of "banks" is much larger than is generally supposed, even by the fishermen themselves, as each skipper always holds in reserve some favorite spot, and if necessary to prevent intrusion, will fish for hours with unbaited hooks when a supposed rival approaches.

Again, as there has been no supply, there is but little demand, and the fish caught near the northern Gulf coast bring very low prices. When a successful fishing vessel comes in the market is glutted, and at other times fish are scarce and the prices high.

At Pensacola some steps are being taken to handle the fish economically, but as yet nine-tenths of the fish—the best ones—are sent to New Orleans.

I believe the places for catching fish in the Gulf are very numerous, and the quantities of fish practically inexhaustible.

I also believe there is a sort of migration from one sort of bottom to another, depending upon causes which at present, owing to the lack of investigation, are involved in obscurity. This investigation, I very much fear, will not be undertaken or carried out successfully until the government takes it in hand. No private individual or corporation could afford to devote the time necessary to hunting up the rumored banks, or examining a place from which the fish have gone to find out the reason of their departure.

There is no reason that I can see why, if the fish banks of the Gulf were as well marked out and the habits of the fishes as well understood as they are on the Newfoundland banks, the fishing interests of the Gulf should not develope enormously. By the refrigerator-car plan—both afloat and ashore—every city and town of the United States would become a ready market for a moderate supply of fresh fish. Such a plan would require the attention of capitalists to be drawn to its advantages, and these advantages would only show themselves when the sources of the supply have been accurately determined, and the conditions affecting the supply well enough investigated. This would require the location and the limits of each "snapper" bank to be practically determined, so that steamers fitted for refrigerating could make the rounds of a certain number of banks, and lose no time hunting a very indefinite spot, such as most of the snapper banks of the Gulf are at present.

U. S. S. GEDNEY,

Navy Yard, New York, May 17, 1882.

SUGGESTIONS FOR TRANSPLANTING CLAMS FROM THE PACIFIC OCEAN TO THE ATLANTIC.

By R. E. C. STEARNS.

(Letter to Prof. S. F. Baird.)

In relation to the transplanting of the West American clams, *Glycimeris generosa*, *Saxidomus aratus*, and *Schizothærus nuttallii*, to the Atlantic seaboard of the United States, I have to submit the following:

Immediately after the receipt of your letter of the 6th February, referring to the first species, and Mr. Hemphill's recommendation thereof as a valuable edible, I took the necessary steps to inform myself as to the best locality from which to obtain a supply, and subsequently made arrangements, which are now pending, for a supply to be sent me promptly by express as soon as the tides are low enough to permit the same to be obtained, and gave particular and explicit instructions as to the manner of packing, so that no lack of care need occur to prevent the successful transmission as far as San Francisco. Transmission is much more direct, and less time is lost, by forwarding from Olympia on Budd's Inlet (which appears, everything considered, to be the best place to obtain them), via Portland, Oreg.; Portland and Olympia being connected by rail, and the steamer communication between Portland and San Francisco being more frequent than by the Puget Sound steamers to San Francisco. The Portland market is supplied with *Glycimeris* from Budd's Inlet.

It is not unlikely that the *Saxidomi*, recommended by Mr. Dall, and my favorite *Schizothærus*, can also be obtained at the same place and at the same time, which will save great trouble and expense and kill *three* "birds with one stone." I am of the opinion, however, that in order to be successful, I shall have to go up myself. As to the method of conveyance, after a careful consideration of the question, and of Mr. Hemphill's views, as expressed in his letter to you, of October 17, 1881 (page 200 of Bull. U. S. F. C.), I think the plan suggested by him, in the main, is the one to be pursued, for I do not believe that any fair percentage of either species can be carried through alive to the Atlantic coast packed in seaweed. All of these species are *Gapers*, otherwise I should think the chances better. The lowest tides occur in the last of May and the first half of June, when the weather is quite warm on this side of the continent, and often so on the Atlantic side. Ice, a good supply of salt water procured outside of the bay of San Francisco, where it is pure, and careful attention while on the cars will also be needed; and finally, the locality on your side wherein to plant them must be determined on beforehand. As to the character of the station in Budd's Inlet, as to climate and sea-bottom, reference to the Coast Survey chart of said inlet, and to the Coast Pilot of Washington Territory, will furnish most of the information necessary in this direction. Dr. Dall knows the climatal peculiarities. I have discussed this point with various intelligent persons on this side, and all parties, I find, agree with me, that the Chesapeake Bay region is more likely to meet the requirements than any other place on the Atlantic side. You are better able to judge of this matter correctly than we are here.

I have a letter from Hemphill at hand. He informs me that his intention is to be here by the middle of this month and to go east to Minnesota by June 1, if possible. It occurs to me that an arrangement might be made with him to superintend the transmission overland and take care of the tanks *en route*, for then we should be morally certain that no pains would be spared to make the experiment a success, so far as the transshipment part is related to the whole matter.

If you are disposed to authorize the expense, as indicated in the foregoing, and the employment of Mr. Hemphill to take charge, as suggested, from San Francisco, to your hands, or your orders, please telegraph me at once, as I want every moment to push matters, so that the plan above outlined may be carried out.

Tanks must be made and cans for sea-water, &c., got together, and arrangements made with the railroad folks, so that there will be no hitch to endanger our movements by delays.

BERKELEY, CAL., *May* 8, 1882.

LIST OF WATER PLANTS FOR CARP PONDS.

By LESTER F. WARD.

[The following list embraces only such plants as were named in a list furnished by Mr. Rudolph Hessel, Superintendent of the Carp Ponds. The names given in that list where obsolete are placed in parentheses, the modern ones standing before them. The vernacular name of each is added whenever it is known, and the localities of the American species are given according to the best authorities. When found in the vicinity of Washington the particular locality is mentioned. In the case of exotics the general region of the globe is stated.]

RANUNCULACEÆ.

Crowfoot family.

Ranunculus aquatilis, L.—White Water-Crowfoot.

The type is rare, but the var. *trichophyllus*, Gray, is common in the United States. The var. *heterophyllus*, DC. (*R. heterophyllus*, Weber), is chiefly a European form.

Ranunculus multifidus, Pursh. (*Ranunculus fluviatilis*, Bigel).—Yellow Water-Crowfoot.

East New England to South Pennsylvania, Illinois, and Northwest.

Caltha palustris, L.—Marsh Marigold. Cowslips.

Common North and West.

NYMPHÆACEÆ.

Water-Lily family.

Cabomba Caroliniana, Gray. (Not in original list, but known to be in the carp ponds. Probably wrongly named.)

Florida to North Carolina and westward.

Nymphæa odorata, Ait.—Sweet-scented white Water-Lily.

Found at Great Falls and below the Long Bridge. Common in the Northern States.

Nymphæa tuberosa, Paine.—Tuber-bearing Water-Lily.

Western New York to Michigan, Illinois, and probably in the Southern States.

Nuphar luteum, Smith.—Smaller yellow Pond-Lily.

Chiefly European; the var. *pumilum*, Gray (*N. pumilum*, Smith), is not rare northward in the United States.

HALORAGEÆ.

Water Milfoil family.

Myriophyllum.—Water-Milfoil.

Six species are found in the Northern United States, of which *M. spicatum* is the most common, and occurs sparingly near Washington.

Hippuris vulgaris, L.—Mare's Tail.

New York to Kentucky and northward; rare in the United States; more common in Europe.

ONAGRACEÆ.

Evening Primrose family.

Trapa natans, L.

Europe, Siberia.

UMBELLIFERÆ.

Parsley family.

Oenanthe sarmentosa, Presl. (*Phellandrium aquaticum*, L.).

Oregon and Washington Territory.

PRIMULACEÆ.

Primrose family.

Hottonia inflata, Ell. (*H. palustris*, Pursh.).—Featherfoil.

Massachusetts to Louisiana.

LENTIBULARIACEÆ.

Bladderwort family.

Utricularia vulgaris, L.—Bladderwort.

Throughout the North and West.

POLYGONACEÆ.

Buckwheat family.

Polygonum (*amphibium*, L.?).—Water Persicaria.

Common. Has been sparingly found near Georgetown, D. C.

CERATOPHYLLACEÆ.

Hornwort family.

Ceratophyllum demersum, L.—Hornwort.

Abundant.

ARACEÆ.

Arum family.

Acorus calamus, L.—Sweet Flag. Calamus.
Common.

LEMNACEÆ.

Duckweed family.

Lemna trisulca, L.—Duckweed. Duck's-meat.
Widely diffused.

Lemna minor, L.
America and Europe.

Lemna gibba, L.
Chiefly in Europe, but has been found in Arizona.

TYPHACEÆ.

Cat-tail family.

Typha latifolia, L.—Cat-tail Flag.
Very common.

Typha angustifolia, L.—Narrow-leaved Cat-tail.
Less common, but found in this District and notably in a pond near the foot of Eighteenth street.

NAIADACEÆ.

Pond-weed family.

Potamogeton natans, L.—Pondweed.
Common.

ALISMACEÆ.

Water-Plantain family.

Alisma natans, L.—Water-Plantain.
Europe, Siberia.

Sagittaria variabilis, var. *latifolia*, Eng. (*Sagittaria latifolia*, Willd.).—Arrowhead.
Common.

Butomus umbellatus, L.
Europe; Northern Asia.

HYDROCHARIDACEÆ.

Frog's-bit family.

Anacharis Canadensis, Planchon. (*Elodea Canadensis*, Michx.).—Water-weed.
Common.

Vallisneria spiralis, L.—Tape-grass; Eel-grass.
Common.

IRIDACEÆ.

Iris family.

Iris pseudacorus, L.
Europe; Siberia.

JUNCACEÆ.

Rush family.

Juncus effusus, L. (=*J. conglomeratus*, L.).—Common Rush.

CYPERACEÆ.

Sedge family.

Scirpus lacustris, L.—Bulrush. Tule.
Common.

GRAMINEÆ.

Grass family.

Zizania aquatica, L.—Indian Rice. Water Oats.
Potomac Flats, &c.
Glyceria aquatica, Smith.—Reed Meadow-grass.
Common northward.
Glyceria fluitans, R. Br.
Common, but has not been found nearer Washington than Great Falls.
Festuca fluitans, Leeds.
Europe.
Phragmites communis, Trin. (*Arundo Phragmites*, L.).—Reed. Cane.

CRYPTOGAMIA.

Azolla Caroliniana, Willd.
New York to Illinois and southward.

HOLLAND CARP PUT INTO HUDSON RIVER ABOUT 1830.

By BARNET PHILLIPS.

(Letter to Prof. S. F. Baird.)

To-day Mr. James Benkard, vice-president of our fish cultural association, told me that his grandfather, Capt. Henry Robinson, had, about 1830, first brought carp from Holland and put them in his ponds at Newburg, and that he had therefore reason to suppose that the carp in the Hudson were derived from these. In Frank Forester's "Fish and Fishing," of 1849, page 166, you may find a statement to this effect, which Mr. Benkard says is substantially correct.

I have thought these data might be useful when the whole history of the carp in American waters is to be written up.

TIMES OFFICE, *New York*, *May* 31, 1882.

SHAD-HATCHING AND CARP CULTURE.

By S. G. WORTH.

(Monthly report, Department of Agriculture, North Carolina, February, 1882.)

The chief feature of the present month in fish culture is the refitting of the shad hatchery on the Albemarle Sound. Such changes and improvements are now being made that we hope to do a work double that of any previous year. The hatching capacity, which is now four million, will be increased to nine million a week. The additional space added will be occupied by hatching vessels on a new and improved method, the eggs being hatched in glass bottles. Fifty thousand eggs are to be hatched in a bottle of one gallon capacity, and during the process everything can be seen, and every dead egg removed without removing the stopper. For this improvement the country is indebted to Col. Marshall McDonald, of Virginia.

The method heretofore followed consists in placing the eggs in large cones, three feet high (the large end turned upwards), and applying a constant jet of water in from below. The apparatus of this kind being yet on hand and in good order, will still be used, the glass bottles being added to afford greater capacity. This addition, with such other improvements as are now being added, will place North Carolina on a par with any State, and I hope that results will prove us even in advance. We shall be more completely equipped than we have ever been, and with a stronger purpose. We confidently expect to double the catch in our waters in a few years with native fish, introducing at the same time such other fish as are considered of value.

No hatching of the land-locked salmon or California trout was undertaken the past season, owing to the fact that they were adapted to a rather restricted class of streams, while the German carp will prove more valuable in the same localities, and in the whole State besides. The German carp will suit the western counties, and will at the same time do equally well in every other quarter of the State. While the land-locked salmon and California trout already introduced are most excellent game fish, we have considered that but a secondary matter. While they suit the cold mountain streams, they do not suit the middle or lower streams; and while the carp cannot be recommended especially for mountain *streams*, there is not a mountain farm that does not possess every facility for raising them, and in quantities to supply a family. We therefore deem it better to suspend the salmon and trout work for one season, at least, and make necessary arrangements to propagate the carp at home, and in larger quantities than we could hope to procure them from the United States Commissioner at Washington. During the past three months 2,500 have been received and shipped by express to all parts of the State.

The demand for carp in the State is far beyond our present ability to supply. This is not surprising when it is known that they grow from minnows to three and four pound fish in one summer. And this is not all. They do this without being artificially fed; and if it should for any reason become desirable to feed them, they will eat grain and vegetables freely. Names are daily added to the list of applications. It is a great pleasure to note this fact, but we beg all those who applied later than January 20 not to expect any fish before October or November, for it is impossible to supply them.

The board of agriculture, at the last meeting, favored the construction of suitable ponds for breeding the carp at home. Much care has been taken in the selection of a site for the ponds near Raleigh. We propose to build breeding ponds and hatch sufficient quantities annually to supply many ponds throughout the State.

From many sources I learn that dams have broken, and that the carp have escaped, and as a general thing the application is renewed. Now, it cannot be expected that we should furnish such ponds with another shipment the present season, until we have sent each applicant one lot. This we have to refuse, for we cannot get fully around the first time with the short stock at our command.

The dams should be packed down and built at least two feet above the level of the water, and as a rule, the waste water should be carried around one end of the dam, through the hillside.

No time should be lost during the present spring season to introduce water plants into the ponds containing the carp. For this purpose the water lilies and cresses are excellent, and in no case should the ponds be left unprovided.

SPAWNING OF CARP IN A SMALL BASIN AT BRENHAM, TEXAS.

By T. W. MORRISS.

(Letter to Prof. S. F. Baird.)

Two years ago I procured of your department some carp. The largest are now about 2 feet long. This spring I constructed a small basin in my yard in which I placed five of them—a haphazard move, for I did not know the male from the female. About the 10th of this month I discovered a large number of young fish, which are now about 2 inches in length. My object in this arrangement is to hatch them in my small pools and, when large enough to take care of themselves, to place them in my ponds, of which I have four separated by dams. The ponds altogether are about 400 yards long, from 50 to 60 feet wide, and varying in depth from three to ten feet, with muddy bottom.

BRENHAM, TEX., *May* 17, 1882.

CARP CULTURE IN TEXAS.

By F. L. YOAKUM, Palastine, Tex.

[From the Galveston Weekly News, March 9 and 16, 1882.]

If young carp fish, three or four inches in length, be placed in a lake or brook in March, in September following they will be grown to the length of from ten to fourteen inches, and will weigh sometimes from one to one and a half pounds. It requires three years to bring a trout up to one pound. Such is the wonderful growth of this new food-fish now being introduced into our lakes and brooks for propagation. These fish subsist mainly upon vegetable food, but will not refuse a worm or insect when opportunity offers. "They grow in any kind of water," but we must beware of waters tinged too strongly with turpentines or products of coal distillation. They grow faster with good, natural, and abundant food, in nice, pure water. Too much feeding injures the water by the souring of the remaining surplus. The natural food of this fish is the products of various water plants, some of which I will now proceed to describe:

1. *The great Caladium esculentum.*—This plant grows luxuriantly in water twelve inches deep, or on the banks hard by. It has esculent roots, filled with farinaceous and amylaceous matter, and is in some places used as human food; hence the specific name. The plant is well suited to lakes; also as fish shelter as well as food. Planted in the margin of the lake, six to twelve inches deep in water, it will throw up continuously, three to four feet above the surface, immensely large leaves, sometimes two or three feet wide and three or four feet long, giving the shores or banks quite a subtropical appearance in the size and splendor of its foliage.

2. *Nymphæa odorata.*—This charming water plant grows in from a few inches of water to four feet deep, and yields an abundance of farinaceous matter in its stems, leaves and roots. (See Case's Botanical Index, page 98.) It grows luxuriantly in water, and its leaves, one foot broad, lie flat upon the water, affording shade to the finny tribes beneath. Its curling stems make a safe lodgment for the eggs of the carp, and its pure white flowers which dot the lake over, filling the valley with fragrance, ripen seeds which are full of nutrition.

3. *Nuphar advena.*—Calhoun, of the Southern Stock Journal, is mistaken as to the species (*luteum*) of our *Nuphar*. The yellow flowers of this species have the odor of brandy, and leaves both floating and erect. This is the American species. The *luteum* is the European, and the seed contain a large quantity of farinaceous matter, and some species are used for food in other countries. When planted in a lake or aquarium it makes a more vigorous growth than any other variety

of aquatic plant, consequently it contributes more toward purifying the water by the large amount of oxygen supplied it, and carbon absorbed from it, which is so important to pure water and healthy animal life in confinement. (See Case's Botanical Index, page 8.) We fear that its rapid growth renders it too uncontrollable in small ponds, but such luxuriance of development well suits it to large lakes, where the amateur will experience much pleasure in watching its triumphant progress over the waters.

4. *Nelumbium luteum.*—There is a strange grandeur and an exquisite beauty about this plant which excite the admiration of all romantic lovers of flowers, a sweet lovliness about them which creates a desire to possess and cultivate some of them. All water lillies are lovely, but this one is gorgeous. The flowers are a light canary color, varying from light to pink, and often five inches in diameter, and exquisitely fragrant. The seed receptacle, like the flowers standing out of the water, is a flat, circular surface, and constitutes the base of an inverted cone, which is perforated with holes for the accommodation of the nuts. These are the water chinquepins. "The root contains a large percentage of mucilaginous and farinaceous matter, and is said to be one of the best known native vegetables for food." (See Botanical Index, page 77.) "The tubers are farinaceous and edible." (See Gray's Manual of Botany, page 56.) We are apprehensive, also, that the plant would not suit small lakes on account of its rapid growth; it might fill them up with roots; but give it the great lakes of Texas, and we vouch for its success and its sublime developments in yielding food and shelter.

5. *The Nasturtium officinallis, or Cress.*—This is a favorite fish salad for the table of the Cyprinæ. They devour it greedily. "They are particularly fond of water cresses and other juicy plants." (See Dr. Hessel in American Agriculturist, where he teaches us that carp fish can hear.) Plant the cress hard by the edge of the lake, and it will send its limbs far out in the water.

6. *Zizania aquatica, or Water Rice.*—This grass produces many slender, linnear seeds, which are farinaceous and well suited to water. When alone it flourishes. It grows in shallow water, which is always found around well-constructed ponds. "The luxuriant water oat should be planted in every pond devoted to carp culture. These plants yield great quantities of seed, of which the fish are extravagantly fond." (See Calhoun, in the Southern Stock Journal, vol. 6, No. 21, in which he calls it *Zinania aquatica*, or Water Oat), which shows, at least, that he was striking at the same thing.

7. *Typha latifolia, or Water Mace.*—This is a grand marsh or aquatic herb with nerved, linear, sessile leaves. The flowers and fruit are elevated on a dense cylindrical spike, terminating the stem, at least six feet above the roots, but sometimes ten feet. It will grow in water perhaps six feet deep. Its small nutlets fall into its native water and germinate in the mud at the bottom. All seeds during the process of

germination are sweet and nutritious. It gives a peculiar aspect to lakes that is both rare and pleasant. The adornment of our artificial lakes should receive some attention. When we visit some of our natural lakes we find them almost filled and surrounded with strange and beautiful forms of vegetable life, which accompanments render these places a great deal more attractive. The very wildness which these curious children of nature are capable of superadding to a pure and placid lake surrounded by echoing shores and reverberating hills, mingle with the charms and pleasures of such places and sweeten and hallow such impressions of the beautiful and picturesque upon those seeking the innocent enjoyments of life. We should add these native ornaments and rare water plants to our convenient lakes and make them the most delightful of the home scenes and associations.

8. *Pancratium rotatum.*—In the evening and morning, and when the clouds are over the sun, this plant unfolds its snow-white imperial flowers, all arrayed in royal robes, and bearing a white, delicate crown about two feet above the water or marsh. It is well styled the "wild crown imperial."

9. *Saururus cernuus.*—This is rather a delicate plant among the aquatic plants. It waves a small white plume, which bends gracefully to the side opposite to the wind, and presents quite a military appearance among the lake plants for a little fellow.

10. *Sagittaria hastata.*—The foliage of this plant has a very rich appearance. The leaves, as the name indicates, are in the form of arrow or spear heads, but on a large scale, and are quite peculiar in their surface markings. Grows two feet high.

11. *Sarracenia purpurea, or Flava.*—The leaves of this plant are pitcher shaped and are usually half filled with water. The flower is a large nodding, something between the form of a side-saddle and a Dutch pillion; an indescribable curiosity to the uninitiated.

12. *Iris lacustris.*—This has sword-shape and grass-like leaves, and large showy flowers, of all the rainbow colors—hence the name.

13. *Pontederia cordata.*—This is a strong water plant, and grows in shallow water. Through its collection of heart-shaped leaves it throws up occasionally a stem or scape, terminated by a beautiful spike of violet-blue flowers. The heart-shaped leaves and pretty flowers do not stand far above the water's surface.

14. *Acorus calamus*, Calamus Flag.—Its creeping roots, which are pungent and aromatic, send up sword-like leaves and stems. A valuable addition to lake plants on account of its usefulness as a domestic medicine, and a pleasant aromatic carminative.

I am perfectly familiar with all the above plants and have transplanted them to my own fish lakes, and know well that they are useful.

Anybody can make a pond, but it may not be durable in its planning or its structure or in the exit of its superfluous water. The earth should be well packed while it is in its naturally moist condition. If too dry or wet it does not pack well. The best packing is secured by building with a scraper and two mules. The mules pack as you go. When you have ascertained the elevation of water which you desire, make your banks about eighteen inches higher and finish up on a perfect level. Have the top of embakment broad enough for a walk—say from four to six feet wide. The sides should slant at about forty-five degrees. The Burmuda grass makes a firm sod. One of our oldest-inhabitant rains ran over my dams covered with Bermuda lately and never fazed them. Willow holds the dam against floods, but they become trees, and make the lake filthy and impure with rotting leaves. Plant no deciduous trees about lakes. Plant only such vegetables as fish eat for food, and these should be water-plants.

Some use a square wooden or a round iron pipe or tube for the conduit. Some place this conduit about the desired water level and others place it almost or quite down to the natural bed and turn the lower end up to the desired level of the lake surface. In either case the same objection obtains—the fish escape. If a wire gauze or network be placed over the tube it soon clogs up with moss, and the lake runs over, washes down, and fish escape at last. Another objection is that the least jar or wrench of the tube makes a break in the dam, and the consequences are ruinous. Here is my plan: I make a solid earth dam as aforesaid, and at the side which suits the purpose best, and in the natural ground I dig a ditch large enough for escape of water, very slightly inclined along the declivity of the hillsides, which shall discharge its water gradually all along its mossy or grassy edge until it wastes entirely away. No misfortune ever can happen to such an exuent of the waters and no fish, old or young, escape in the running season. Very little engineering is required for this construction. Once in about two months moss and water rice, or other aquatic growth, should be cleaned out of the ditch. I used two little ditches on either side of the lake for this purpose and that of watering a strawberry patch and a summer garden in the valley between them.

Some prepare for this by laying a pipe in the bottom of the lake and dam, and through this turn off the water when necessary, which is very seldom. This is all nice; but I still contend for the solid banks. The pipe is foreign matter and resists the settling of the earth and leaves just under it a loose stria and perhaps an open fissure where a break may commence. Also, when you turn off the water the fish, little and big, may escape, unless you get down to the mouth of the discharge pipe at the bottom and cover it with a wire screen. This soon gets filled with moss, mud, and trash, which requires another dive, &c. On the solid bank system use large hose on the syphon system. Muzzle the entrance with wire gauze. Get up on the dam midway; throw the hose into the lake and fill with water. Thus filled, and while it is in the water, stop the end intended for the exit and draw it over the bank and lay it in the ravine below. Unstop it and the discharge commences. You can draw out your hose from the bottom of the lake from time to time, examine and cleanse the wire screen just below the surface of the water and let it down into the bottom again. This is so convenient.

Sometimes the crawfish will give you an exit and save you the trouble of emptying your lake. The crawfish always begins to pierce the dam an inch below the surface of the water above. Then he descends in a devious way to the other side. He soon makes a spring. If that crawfish had to pass through a bed of loose, wet sand he would never make it. Guard his entrance, determined by the above natural instinct, with a layer of six or eight inches of sand and he will not turn off the lake any more. The sand falls in faster than he gets it out. You have beat him.

Never plant a deciduous tree, nor let one stand inside of the lake inclosure. Every leaf will tumble before the wind, and rests not until it sinks to the bottom of the water. This will render the bottom of the lake filthy and the water impure. Evergreen trees will not do this. Their needle-shaped leaves behave themselves, and lie under their own trees to decay. Almost every lake which lies in a hollow or ravine has a considerable watershed above. The water collected by this wide table of land must be turned around the lake and emptied into the ravine below. In order to do this it is not absolutely necessary to make one large ditch on both sides of the lake. A large ditch begun above, by running across the ravine obliquely at the head of the lake and continued to an exit below, is sufficient to discharge the floods that come from hills or fields above. It is desirable to have one side of the lake accessible by an easy descent through a floral garden or undulating lawn. The water which runs into the lake on the other side may be turned away by a few furrows nicely engineered along the hillsides, so as to empty below the lake also. These striations can be worked into the general design for effect.

RESULT OF PLANTING SHAD IN THE MUSKINGUM RIVER.

By CHAS. W. SMILEY.

Young shad were planted by the United States Fish Commission in the Muskingum river at Bayard, Ohio, in 1875, and at Zanesville in 1876. Mr. G. H. H. Moore, a messenger of the Fish Commission, reported May 26, 1882, that while on a trip with fish to the Ohio river he was informed that fifty white shad had lately been taken at the State dam near New Philadelphia, Ohio, from the Tuscarawas river, which is a tributary of the Muskingum.

DECREASE OF FISH IN SQUAMSCOT RIVER, NEW HAMPSHIRE, ON ACCOUNT OF REFUSE MATTER FROM GAS WORKS.

By S. B. SWETT, M. D.

"Paul may plant," &c., but there will be no increase, as long as the refuse matter from gas works is allowed to flow into the streams.

In the year 1839 I went to Exeter, N. H., on Squamscot River, which is at the head of navigation, and had great sport in the next spring angling for white perch and striped bass, during one tide having caught a bushel with rod and line; the bait being young eels, of which I could scoop up a pint at a time in the holes in the rocks under the dam. After three or four years I found that there was great scarcity of bait as well as perch, &c., except dead perch, of which there were a a large quantity floating on the surface of the river at every tide. The alewives began to appear in less quantities each year, and eels in the winter became very scarce, so much so that from a barrel a day, which for years had been an ordinary day's work for a man, a bushel was rarely secured. In 1837–'38 bass were so plenty during the winter in the river that they brought only one to three cents a pound, on the ice, and several teams from Canada and the north loaded there with them for a return freight at that price rather than go ten miles farther to the sea for frozen codfish as they had intended. The first haul of alewives made in the river in a seine amounted to 36 hogsheads, in the year 1818 or 1819, which is as many or far more than are secured now in an entire summer. As the perch became more scarce, as well as the bait and all other fish, I began to look for a cause, and found that the Exeter Cotton Factory had a small gas-meter to make gas for the factory, and the whole of the refuse was allowed to flow into the river, so that even with any bait it was necessary to go some distance down stream below the factory and the oily, tarry mass floating on the surface of the water in that region, to take any fish, and then very few were caught and less each year. After a few years a company started some gas works on the river one-half mile below the factory to supply the town, and dug a drain down into the river to discharge all their refuse thereby, and since that it is difficult to obtain a mess ever so small of fresh fish in the river within four or five miles of those works. Shad, bass, and occasionally a salmon, and once in the year 1860 a sheepshead of 7 lbs., were taken in the traps or weirs set for alewives; but even the alewife fishery is almost abandoned, and now not a dozen small eels could be secured under the dam where I could have secured a million in a day from 1839 to 1850 or 1860.

BOSTON, MASS., *Jamaica Plain District*, *May* 20, 1882.

 Sept. 25, 1882.

A REVIEW OF THE SILUROID FISHES FOUND ON THE PACIFIC COAST OF TROPICAL AMERICA, WITH DESCRIPTIONS OF THREE NEW SPECIES.

By DAVID S. JORDAN and CHARLES H. GILBERT.

Our knowledge of the marine Siluridæ of the west coast of Mexico and Central America has been due entirely to the labors of Gill, Günther, and Steindachner. Sixteen species apparently valid have been made known by these authors, to which three others are added in the present paper. Fourteen species were obtained by Mr. Gilbert at Mazatlan and Panama. All of these we have here redescribed, and the synonymy of the remaining species is given, together with a key by which they can be readily distinguished.

Genus ÆLURICHTHYS Baird & Girard.

Ælurichthys Baird & Girard, Proc. Ac. Nat. Sci. Phila. vii, 26.

ANALYSIS OF SPECIES OF ÆLURICHTHYS.

a. Dorsal spine produced in a band-like filament which nearly or quite reaches the caudal fin; maxillary barbel and pectoral filament reaching past the vent; fontanelle distinct, broader than pupil; occipital process little conspicuous; anterior lobe of anal not reaching base of last rays; anal and usually ventrals above, with a conspicuous black blotch .... PINNIMACULATUS, 1.

aa. Dorsal spine not produced in a filament; maxillary barbel reaching little if any more than half way to vent; pectoral filament rarely reaching vent; fontanelle inconspicuous, not so broad as pupil; occipital process prominent, especially in the males; anterior lobe of anal high, in the adult reaching past last rays; anal and ventrals without conspicuous black blotch .... PANAMENSIS, 2.

1. Ælurichthys pinnimaculatus Steindachner.

Ælurichthys pinnimaculatus Steindachner, Ichthyol. Beiträge, iv, 15, 1875, taf. viii. (Altata; Costa Rica; Panama.)

Habitat.—Pacific coast of tropical America; Mazatlan; Altata; west coast of Costa Rica; Panama.

Head $4\frac{1}{10}$ ($5\frac{1}{4}$ in total with caudal); width of head 5; depth $5\frac{1}{5}$ (7). D. I, 7; A. 5, 23. Length (28347) 20 inches.

Body elongate, compressed, the head broad and depressed, the anterior profile concave, rising rapidly to the front of the dorsal fin; head considerably broader than deep; interorbital space about $1\frac{1}{2}$ in head; breadth of mouth about 2, length of snout 5. Eye moderate, anterior, 5 to 7 in head, placed close to the angle of the mouth, and not much above its level.

Teeth all pointed; vomerine and palatine teeth, forming a continuous, rather narrow, crescentiform band, the four different components indicated by slight constrictions, which are most distinct in the young; vomerine bands somewhat broader than palatine bands, which are not prolonged backward.

Maxillary barbels compressed and band-shaped, their attenuated tips reaching more or less past the front of the anal fin. Mental barbels short, nearly 3 in head.

Occipital process longer than broad, ascending rather steeply backward, forming an angle with the rest of head, reaching nearly to the base of the dorsal, its surface covered with smooth skin. Fontanelle rather broad, extending from the snout to the base of the occipital process, its posterior part narrow, groove-like. Shields of head mostly smooth, the temporal region and occipital process often with small granulations. Cheeks hard and prominent, the region between them and top of head somewhat concave.

Dorsal spine ending in a long, band-like, obliquely striated and articulated filament, which extends more or less past base of caudal. Adipose fin short and high. Caudal widely forked, the upper lobe somewhat longest, about one-fifth longer than head. Anal somewhat emarginate, a little shorter than head, the anterior lobe falling considerably short of the base of the fin. Pectoral spine ending in a band-like filament like that of the dorsal spine; the filament varying in length, usually reaching nearly to last rays of anal. Humeral process covered by soft skin.

Color dark brown, with bluish luster, silvery below; a round pale spot in the center of fontanelle (traces of which are seen in all our species of *Arius* and *Ælurichthys*); fins all pale; the anal with a large, roundish, black blotch in front; the upper edge of the ventrals usually, but not always, with a similar black blotch.

This species is generally abundant along the Pacific coast of tropical America, although less common than *Ælurichthys panamensis*. It reaches a length of about 2 feet. Specimens were obtained at Mazatlan and Panama.

SPECIMENS IN UNITED STATES NATIONAL MUSEUM.

28192. Mazatlan. Gilbert.
28347. Mazatlan. Gilbert.
29447. Panama. Gilbert.
29456. Panama. Gilbert.
31016. Panama. Gilbert.
Panama. Rev. Mr. Rowell.

2. **Ælurichthys panamensis** Gill.—*Bagre.*

Ælurichthys panamensis Gill, Proc. Ac. Nat. Sci. Phila. 1863, 172 (young; Panama); Günther, Fishes Centr. Amer. 1869, 476 (copied from Gill); Steindachner, Ichth. Beiträge, iv, 14, 1875, taf. ii (Magdalena Bay; Altata; Panama).

Ælurichthys nuchalis Günther, Cat. Fishes Brit. Mus. v, 179, 1865 (♂, Panama); Günther, Fishes Centr. Amer. 476, 1869, pl. 81, f. 2.

Habitat.—Pacific coast of Central America; Magdalena Bay; Mazatlan; Altata; Punta Arenas; Libertad; Panama.

Head $3\frac{3}{5}$ ($4\frac{3}{5}$); width of head $4\frac{4}{5}$; depth $4\frac{1}{3}$. D. I, 7; A. 5, 21. Length (29174) 18 inches.

Body little elongate; the head rather broad, but not much depressed; the anterior profile scarcely concave, elevated in front of dorsal fin; head somewhat broader than deep; interorbital space about $1\frac{3}{5}$ in head; breadth of mouth $1\frac{3}{4}$; length of snout $3\frac{1}{4}$; eye rather large, 5 to 7 in head, placed close to the angle of the mouth, and not much about it; vomerine and palatine teeth confluent into a band, the component parts indicated by conspicuous constrictions, more or less separated in the young; vomerine patches considerably larger than those on the palatines, the latter not prolonged backward.

Maxillary barbels compressed, of varying length, longest in the young; in the adult rarely reaching beyond the middle of the pectoral spine. Mental barbels short, about 3 in head. Occipital process varying with the sex—in the male broad-ovate, somewahat constricted toward the base, nearly as broad as long, in the females more or less narrow, the form and degree of roughness extremely variable; the plates rough-granular in old males, nearly smooth in the females, the occipital process being more or less coarsely striate; cheeks little prominent; fontanelle narrow, not very conspicuous, forming a groove which extends from the interorbital space to the base of the occipital process.

Dorsal spine slender and rather short, not produced into a filament, the greatest height of the fin $1\frac{3}{5}$ in head, the anterior margin of the spine weakly and bluntly serrated; adipose fin short and high; caudal widely forked, the upper lobe little longest, slightly shorter than head; anal high anteriorly, emarginate, the anterior lobe much highest in the adult, in which it extends considerably beyond the last rays of the fin. Pectoral spine slender, ending in a band-like filament, which usually reaches about to the vent. Humeral process covered by soft skin.

Color brownish above, with bluish and golden reflections, paler below, the white of the lower parts almost everywhere soiled with dark punctulations, which are especially numerous on the lower side of the head. Dorsal dusky; other fins pale, more or less soiled by dark points; the pectorals and ventrals more or less dusky above, but without distinct dark blotches; barbel dark: a pale spot in the center of the fontanelle.

This species is extremely common for the whole length of the Pacific coast of tropical America. It reaches a length of about 20 inches, and is known to the fishermen as "*Bagre.*" It is rarely eaten. It was observed by Mr. Gilbert at Mazatlan, Punta Arenas, Libertad, and Panama.

We are unable to find the type of this species in the Museum.

SPECIMENS IN THE NATIONAL MUSEUM.

28181. Mazatlan. Gilbert.
28294. Mazatlan. Gilbert.
29174 (5 specimens). Mazatlan. Gilbert.
29310. Punta Arenas. Gilbert.
29606. Mazatlan. Gilbert.

Genus GALEICHTHYS Cuv. & Val.

Galeichthys C. & V. Hist. Nat. Poiss. xv, 29.

3. **Galeichthys peruvianus** Lütken.

Galeichthys peruvianus Lütken, Vid. Medd. 1874, 205 (Callaõ); Steindachner, Ichth. Beitr. iv, 34 (Altata; Panama; Callaõ).

Habitat.—Pacific coast of tropical America, from Mexico to Peru; Altata; Panama; Callaõ.

No specimens of this species are in the National Museum.

Genus ARIUS* Cuvier & Valenciennes.

Arius Cuvier & Valenciennes, Hist. Nat. Poiss. xv, 53.

Ariodes, *Hexanematichthys*, *Guiritinga*, *Hemiarius Cephalocassis*, *Netuma*, *Pseudarius*, *Notarius*, *Ariopsis*, and *Leptarius* of authors.

ANALYSIS OF SPECIES OF ARIUS.†

a. Bands of palatine teeth, each more or less produced backwards‡ on the pterygoid region, from the inner posterior margin or angle; teeth villiform; vomerine bands of teeth contiguous or confluent. (Species with coppery luster in life.) (*Netuma* Bleeker.)

b. Ante-dorsal shield large, not crescent-shaped, its length on the median line more than one-tenth that of head; vomerine bands of teeth united.

c. Ante-dorsal shield much broader than long, its anterior margin truncate; occipital process very short, truncate behind; fontanelle short, ending obtusely at a point much nearer tip of snout than front of dorsal; head $3\frac{1}{4}$ in length. ALATUS, 4.

cc. Ante-dorsal shield longer than broad, its anterior margin acute; occipital process short, emarginate behind; fontanelle large, ending acutely at a point nearer base of dorsal than tip of snout; head $3\frac{1}{4}$ .... BRANDTI, 5.

aa. Ante-dorsal shield small, crescent-shaped, its length on the median line much less than one-tenth head.

d. Vomerine bands of teeth fully confluent with each other, and usually with the palatine bands also.

e. Interorbital area more or less uneven, ridged, or granulated.

f. Fontanelle obtuse posteriorly, not prolonged in a groove behind; shields coarsely granular; barbels short; caudal less than two-thirds head; head very large, $3\frac{1}{3}$ in length. KESSLERI, 6.

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* Some of the generic names included in the above synonymy may, perhaps, be worthy of retention. All the American species examined by us are, however, in our opinion, fully congeneric, although four subgenera may be recognized among them.

† *Arius felis* (L.) J. & G., the common species of the coasts of the United States, is here inserted for purposes of comparison. *Arius troscheli* is omitted, the description of the shields of the head being insufficient for comparison.

‡ This character has not been verified in *A. alatus;* which, however, doubtless agrees with *A. brandti* in this respect.

ff. Fontanelle acute posteriorly, prolonged in a groove; shields finely granular; barbels rather long; caudal more than two-thirds head; head 4 in length .... INSCULPTUS, 7.

ee. Interorbital space flat and smooth, a triangular smooth area extending backward from it.

g. Groove of fontanelle almost obsolete, not reaching occipital process; occipital process about as broad at base as long, its margins concave; caudal a little shorter than head; head $3\frac{1}{5}$ in length; shields of head rather coarsely granular .... PLANICEPS, 8.

gg. Groove of fontanelle well defined, reaching occipital process; occipital process longer than broad, its margins straight: barbels short, compressed at base; caudal as long as head; head long, $3\frac{3}{5}$ in length, its shields finely granular; pectorals and ventrals sometimes black at base. PLATYPOGON, 9.

dd. Vomerine bands of teeth separated on the median line *; fontanelle prolonged backward in a groove; interorbital area with smooth ridges.

h. Mouth large, its breadth half or more length of head; spines low, less than two-thirds head; head large, $3\frac{2}{3}$ in length.
ELATTURUS, 11.

hh. Mouth small, its breadth much less than half head; spines high, not much shorter than head; caudal nearly as long as head; head small, 4 in length........... OSCULUS, 12.

aa. Bands † of palatine teeth, without backward prolongation on the inner margin; vomerine bands of teeth not confluent; ante-dorsal shield small, crescent-shaped; species mostly with blue luster in life.

i. Eyes placed well above level of angle of mouth.

j. Teeth on vomer and palatines villiform or bluntly conical, not granular. (*Hexanematichthys* ‡ Bleeker.)

k. Interorbital area flattish and smooth, without ridges or granulations; fins not low, the spines more than half head; gill-membranes not meeting in an angle.

l. Fontanelle prolonged backward as a narrow groove.

m. Inner edge of bases of paired fins jet-black; occipital process short, less than one-third head.

n. Occipital process emarginate at tip; bands of palatine teeth moderate (varying with age); barbels rather short; head $3\frac{4}{7}$ in length .... ASSIMILIS, 13.

nn. Occipital process truncate at tip; bands of palatine teeth small, not twice as large as vomerine bands; barbels rather long; head $3\frac{3}{8}$ in length.
CÆRULESCENS, 14.

mm. Inner edges of paired fins pale; occipital process long, its length about one-third head, its tip convex; head $3\frac{3}{4}$ in length .... FELIS.§

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* This character varies somewhat with age, and may prove unreliable.

† This character has not been verified in *cœrulescens*, *melanopus*, and *fürthi*.

‡ = *Notarius*, *Leptarius*, and *Ariopsis* Gill.

§ *Silurus felis* L. Syst. Nat: *Arius milberti* Cuv. & Val. xv, 74: *Arius equestris* B. & G. Proc. Ac. Nat. Sci. Phila. 1855, 26. Cape Cod to Texas; everywhere very abundant along the Atlantic coast of the United States.

ll. Fontanelle not prolonged backward in a groove: bases of paired fins pale; body slender; caudal about as long as head .... GUATEMALENSIS, 15.

kk. Interorbital area with smooth ridges; fins very small, the spines less than half head; fontanelle very short, not prolonged in a groove behind; gill-membranes meeting in an angle; shields smoothish; vomerine bands separate; barbels extremely long; head 4 in length; body very slender .... DOWI, 16.

kkk. Interorbital area with four very rough granulated ridges; shields of head coarsely granular; vomerine and palatine teeth on each side confluent in a small roundish patch; gill-membranes not forming an angle; fontanelle prolonged backward in a groove; spines high; head $4\frac{1}{2}$ in length .... DASYCEPHALUS, 17.

jj. Teeth on vomer and palatines granular (*Arius* C. & V.); shields not very rough; fontanelle groove-like posteriorly.

o. Vomerine teeth coarse, the patches near together; ventrals pale; head $3\frac{3}{8}$ in length.............. FÜRTHII, 18.

oo. Vomerine teeth small, the patches widely separated; ventrals jet-black on the inner margin; head $3\frac{1}{2}$ in length .... MELANOPUS, 19.

hh. Eyes placed very low, not above the level of the angle of the mouth (*Cathorops* J. & G.).

p. Body slender, compressed; shields of head rugose rather than granular; fontanelle groove-like posteriorly, interorbital area with smooth ridges; fins high; jaws thin, with thin lips; teeth on palate bluntish-conical, forming two large patches, separated on the median line by a very wide space; barbels long. HYPOPHTHALMUS, 20.

4. **Arius alatus** Steindachner.

Arius alatus Steindachner, Ichth. Beitr. iv, 19, taf. vi, 1875 (Panama); Steindachner, Zur Fisch-Fauna des Cauca und der Flüsse bei Guayaquil, 1880. 45, taf. v f. 2 (Guayaquil).

Habitat.—Pacific coast of Tropical America; Panama; Guayaquil.

This species is known to us only from the accounts given by Dr. Steindachner.

5. **Arius brandtii** Steindachner.—*Bagre Colorado.*

Arius brandtii Steindachner, Ichthyol. Beiträge, iv. 21, taf. iii, 1875 (Altata; Panama).

Habitat.—Pacific coast of tropical America; Mazatlan; Altata; Punta Arenas; Panama.

Head $3\frac{1}{4}$ ($3\frac{5}{8}$); width of head $4\frac{1}{5}$ ($4\frac{5}{6}$); depth 5 ($6\frac{1}{5}$); length (28230) 24 inches. D. I, 7; P. I, 12; A. 3, 16.

Body comparatively robust, broad anteriorly; head not much depressed, broader than high; eye moderate, 7 to 8 times in length of head; width of interorbital space $1\frac{2}{3}$; breadth of mouth $1\frac{2}{3}$; length of snout $3\frac{1}{4}$.

Teeth all villiform; band of vomerine teeth simple, trapezoidal, quadrangular, longer than broad, without division on median line; band of palatine teeth very large, each separated in young specimens from the vomerine band by a narrow toothless line; in old specimens the vomerine and palatine bands are wholly confluent; each palatine band with a narrow backward prolongation on the median line. Band of premaxillary teeth broad, about six times as long as wide. Lower jaw included.

Maxillary barbel nearly or quite reaching gill-opening. Outer mental barbels about two-fifths head; the inner nearly four-fifths.

Ante-dorsal plate much larger than usual in this genus, shaped like an armorial-shield, its posterior margin concave, its anterior end acute, wedged into a deep emargination of the occipital process, the two becoming co-ossified with age. Length of ante-dorsal plate on the median line 5 to 6 in head, a little more than its width; occipital process short and broad, much broader than long; its median line with a broad keel, its edges nearly straight. Shields all coarsely granular, the granulations anteriorly forming radiating striæ.

Fontanelle large, claviform, broadest posteriorly, its posterior end about midway between tip of snout and front of dorsal; its greatest breadth about equal to the diameter of the eye and one-sixth its length; a short groove extending backward from its obtuse tip; sides of fontanelle bony and granulated for its whole length, the granules extending forward to opposite nostrils.

Dorsal spine strong, $1\frac{3}{5}$ in head, moderately compressed; pectoral spine $1\frac{4}{5}$ in head. Axillary pore obsolete. Humeral process coarse, granular, broad, nearly half length of pectoral spine. Base of adipose fin scarcely two-thirds length of anal, its posterior margin little free. Caudal deeply lunate, small, its upper lobe slightly the longest and narrowest, $1\frac{2}{5}$ in head. Ventrals not quite reaching anal; vent much nearer base of ventrals than anal.

Dark brown, with strong bronze luster above, white below; dorsal dusky, especially above; pectorals blackish; anal dark; caudal rather pale; ventrals usually dark towards the tip, their inner side pale; maxillary barbel dusky; mental barbels pale.

This species is not rare along the Pacific coast of tropical America, specimens having been observed at Mazatlan, Punta Arenas, and Panama. At Mazatlan, it is known as "Bagre Colorado", and is said to reach a larger size than any other of the Cat-fishes. It is used for food.

SPECIMENS IN UNITED STATES NATIONAL MUSEUM.

28230. Mazatlan. Gilbert.
29254. Mazatlan. Gilbert.
29262. Panama. Gilbert.

6. **Arius kessleri** Steindachner.

Arius kessleri Steindachner, Ichth. Beiträge, iv, 24, 1875, taf. v (Altata; Panama).

Habitat.—Pacific coast of tropical America; Altata; Panama.

Head 3$\frac{1}{3}$ (4); depth 6 (7); width of head 4; length (29252) 14 inches. D. I, 7; A. 4, 13.

Body rather long and low; the head long, broad, and much depressed, much broader than deep. Eye very small, about 10 in head, placed well above the mouth. Interorbital space 2 in head; snout 3$\frac{1}{3}$; breadth of mouth 2.

Mouth large, with thickish lips, the upper jaw considerably projecting. Teeth all villiform, rather pointed. Vomerine patches rather large, roundish, usually fully confluent into a trapezoidal band, without division on the median line, and separated by a very narrow groove from the palatine bands. Palatine bands very large, broadly triangular, with a backward prolongation from the inner margin, as in *A. brandti*. (Teeth on vomer and palatines all forming one continuous band in old specimens, according to Steindachner). Bands of teeth in jaws broad, the jaws strong. Barbels rather short and very slender, the maxillary barbels reaching little past base of pectoral; outer mental barbels about reaching gill-opening; inner about as long as snout.

Ante-dorsal shield short, crescent-shaped, rough, but without median keel. Occipital process long, narrowly triangular, its edges straight, its length one-fourth to one-half more than its width at base, its median line sharply keeled.

Fontanelle broad and shallow, its posterior end obtuse or almost truncate, its tip not prolonged in a groove, its edge bounded by a bony ridge, which is not granulated in front of middle of eye; end of fontanelle about midway between tip of snout and front of dorsal; its greatest width about equal to length of eye. Shields of head all very coarsely granular, the roughnesses extending forward about to the eye. Gill-membranes forming a very broad free fold across isthmus.

Dorsal spine moderate, a little more than half head, about equal to pectoral spine. Humeral process triangular, granular, not quite two-fifths length of pectoral spine. Axillary pore obsolete. Adipose fin long and low, its posterior margin little free. Caudal short and broad, the upper lobe longest, 1$\frac{2}{3}$ in head. Anal and ventrals rather small, the vent close behind the latter.

Color dark brown, with bronze reflections; belly white. Fins all dusky in one specimen, in the other mostly pale. Maxillary barbels dusky; others pale.

Two large specimens were obtained at Panama.

SPECIMENS IN UNITED STATES NATIONAL MUSEUM.

29252. Panama. Gilbert.
29413. Panama. Gilbert.

7. Arius insculptus, sp. nov.

Head 4 (4$\frac{2}{3}$); depth 5$\frac{2}{3}$ (6$\frac{3}{4}$); width of head 4$\frac{3}{5}$. Length (29415) 13$\frac{1}{2}$ inches. D. 1, 6; A. 4, 14.

Body moderately elongate, little compressed, the caudal peduncle slender and short. Head shortish, low and broad, anteriorly depressed. Eye rather large, $6\frac{1}{2}$ in head, placed rather high; interorbital space flat and nearly smooth, 2 in head; snout 3; breadth of mouth $\frac{13}{10}$. Snout very bluntly rounded, almost truncate in front.

Mouth large; teeth all villiform; vomerine bands of teeth large (fully confluent with each other in the type, partly separated in smaller examples), and with the large, club-shaped band on the palatines, from which they are separated by a slight furrow and constriction; palatine band of teeth with a backward prolongation. Premaxillary band of teeth large. Maxillary barbel long, somewhat compressed, extending to middle of pectoral spine. Outer mental barbel reaching base of pectoral spine; inner 2 in head.

Ante-dorsal shield short, crescent-shaped, without median keel, its tips produced, its length on the median line about two-fifths the length of one of its halves. Occipital process about as broad at base as long, with a moderate median keel, its lateral margins somewhat concave. Fontanelle becoming gradually contracted at a point a little nearer base of dorsal than top of snout, thence forming a narrow groove, which extends to within the diameter of the pupil of the base of the occipital process, this groove sometimes nearly obsolete. Greatest width of fontanelle about three-fifths diameter of eye. Granulated striæ extending along the sides of the fontanelle to a point opposite or in front of middle of eye.

Shields of head finely and evenly granulated, the roughnesses more uniform than usual and many of them arranged in lines, especially anteriorly. Opercle not striate, the skin marked with fine vermiculations. Gill-membranes forming a broad fold across the isthmus.

Dorsal and pectoral spines long, about equal, $1\frac{1}{3}$ in head. No axillary pores. Humeral process very large, triangular, finely granular, about half as long as pectoral spine. Adipose fin large, without free tip. Upper lobe of caudal longest, $1\frac{1}{5}$ in head. Anal and ventrals moderate, the vent close behind the latter.

Color rather pale; belly pale. Fins and barbels all pale, or but slightly tinged with dusky.

A single adult male specimen was obtained at Panama. Two smaller ones are in the Museum collection, also from Panama.

SPECIMENS IN UNITED STATES NATIONAL MUSEUM.

29415. Panama. Gilbert.
30977 (2). Panama. Rev. Mr. Rowell.

8. **Arius planiceps** Steindachner.

Arius planiceps Steindachner, Ichth. Beitr. iv, 26, taf. iv, 1875 (Panama; Altata).

? *Sciades troscheli* Gill, Proc. Ac. Nat. Sci. Phila. 1863, 171 (Panama).

Habitat.—Pacific coast of tropical America; Altata; Panama.

Head 4 ($4\frac{1}{5}$); depth $5\frac{1}{3}$ ($5\frac{2}{3}$); width of head 5; length (29417) 11 inches. D. I, 7; A. 4, 13.

Body comparatively elongate; the head small, rather narrow, depressed anteriorly; the snout rather narrow and moderately rounded. Eye moderate, placed well above mouth, its length $5\frac{1}{2}$ in head. Interorbital space flat and smooth, $2\frac{1}{4}$ in head; snout $3\frac{1}{5}$; breadth of mouth 2.

Mouth rather large, with thickish lips. Teeth villiform. Vomerine bands moderate, confluent with each other and with the much larger ovate palatine bands; a slight constriction or furrow marking the divisions. Palatine bands each with a backward prolongation. Premaxillary band moderate. Barbels very short; maxillary barbel scarcely or not reaching to base of pectoral; outer mental barbel scarcely past gill-opening below; inner shorter than snout.

Ante-dorsal shield short, anteriorly truncate, not keeled, the length on the median line about half of one of its halves. Occipital process subtriangular, rather narrow, truncate behind, its margins straight, becoming concave forward, its width at base about equal to its length; fontanelle an almost obsolete groove, its posterior end not reaching base of occipital process by about the diameter of the eye; the groove extending forward to a point about midway between tip of snout and base of dorsal spine. Anterior to this point is an equilateral triangle, flat, covered with smooth skin, the base of the triangle formed by the smooth, flattish, interorbital area. Shields of head rather coarsely granular-striate, the granulations beginning anteriorly about opposite posterior margin of eye. Opercle scarcely striate. Gill membranes forming a moderate fold across the isthmus.

Dorsal spine high, about equal to pectoral spine, and but little shorter than head. No axillary pore. Humeral process triangular, granulated a little more than one-third length of pectoral spine. Adipose fin rather long. Upper lobe of caudal longest, a little shorter than head. Ventrals and anal moderate.

Color brownish, not very dark; belly pale, thickly speckled with brown; fins more or less dusky; maxillary barbels black; mental barbels pale.

Two specimens were obtained at Panama. They disagree in several details from Steindachner's description, and it is possible that they belong to a different species. The head in Steindachner's types is $3\frac{3}{4}$ to $3\frac{4}{5}$ in length, and the occipital process is narrower and less widened anteriorly.

SPECIMENS IN UNITED STATES NATIONAL MUSEUM.

29417. Panama. Gilbert.
29500. Panama. Gilbert.

9. **Arius troscheli** (Gill) Günther.

Sciades troschelii Gill, Proc. Ac. Nat. Sci. Phila. 1863, 171 (Panama).
Arius troschelii Günther, Cat. Fish. Brit. Mus. v, 1864, 150 (copied from Gill).

Habitat.—Pacific coast of Central America; Panama.

This species is apparently related to, *A. planiceps*, &c., but on account of the insufficiency of the description we are unable positively to assign its place in the genus. It may possibly be identical with *A. planiceps.*

The type of the species cannot now be found in the Museum.

10. Arius platypogon Günther.

> *Arius platypogon* Günther, Cat. Fishes Brit. Mus. v, 147, 1864 (San José de Guatemala); Steindachner, Ichthyol. Beiträge, iv, 17 (Magdalena Bay; west coast Central America; Callaõ).

Habitat.—Pacific coast of tropical America, from Lower California to Peru; Magdalena Bay; Mazatlan; Libertad; Punta Arenas; San José de Guatemala; Panama; Callaõ.

Head $3\frac{3}{5}$ ($4\frac{3}{5}$); width of head $4\frac{3}{5}$; depth $5\frac{1}{5}$ ($6\frac{3}{5}$); length (28286) $15\frac{1}{2}$ inches. D. I, 7; A. 4, 14.

Body rather elongate, the head not very broad nor much depressed, a little broader than deep. Eye rather large, 5 to 6 in head. Interorbital space slightly more than half head, a trifle less than width of mouth; length of snout $3\frac{1}{5}$ in head.

Teeth all pointed; bands of vomerine teeth small, roundish, their boundaries traceable by a slight depression in the young, in the adult fully confluent with each other and with the palatine bands; palatine bands broad, ovate, several times as large as the patches on vomer, continued backwards over the pterygoid region; premaxillary band rather broad, 5 to 6 times as broad as long; maxillary barbel reaching past base of pectoral in the young, not to gill-opening in the adult; its base a little broader and more compressed than usual in *Arius;* outer mental barbels 2 in head; inner $2\frac{1}{2}$.

Ante-dorsal shield very short, lunate, subtruncate in front, its breadth more than three times its length on the median line. Occipital process long, triangular, with straight margins, its length about $1\frac{3}{5}$ times its width in front, its broad median line rather sharply keeled. In the young it is proportionally shorter, little longer than broad. At the beginning of this keel is the end of the long, narrow, groove-like fontanelle, which extends forward to a point just behind the eye, where it merges into the flattish and smooth anterior part of the head. Shields of head all finely granular, the granules rarely forming distinct lines.

Dorsal spine long, $1\frac{1}{3}$ to $1\frac{1}{2}$ in head, the soft rays projecting beyond the spine. Pectoral spine about as long as dorsal, sharply serrate behind, the anterior serræ not very sharp; axillary pore small or absent. Humeral process nearly smooth, rather narrow and short, half length of pectoral spine. Adipose fin short and rather high, its base barely two-fifths length of base of anal. Caudal deeply forked, its upper lobe longest, and slightly falcate, about as long as head. Ventrals reaching anal in the females, shorter in the males. Vent nearer base of ventrals than anal.

Color in life very pale olive brown, with bronze and blue reflections;

white below. Fins all pale, the tip of anal and edges of caudal somewhat dusky; female with fins rather darker, the upper edge of the pectorals and ventrals largely black; in the male these fins are pale, or somewhat brown above. Maxillary barbels blackish; lower pale.

Generally abundant along the Pacific coast of tropical America. Specimens were observed by Mr. Gilbert at Mazatlan, Libertad, Punta Arenas, and Panama. It reaches a length of about 18 inches, and is seldom eaten.

The males of this species, according to Dr. Steindachner, carry the eggs in their mouths until after hatching.

SPECIMENS IN UNITED STATES NATIONAL MUSEUM.

28215. Mazatlan. Gilbert.
28259. Mazatlan. Gilbert.
28262. Mazatlan. Gilbert.
28286. Mazatlan. Gilbert.
29257. Punta Arenas. Gilbert.

11. Arius elatturus, sp. nov. (29408.)

Head $3\frac{2}{3}$ ($4\frac{1}{3}$); depth $5\frac{3}{4}$ ($6\frac{3}{4}$); width of head $4\frac{2}{5}$; length (29408) $12\frac{1}{2}$ inches. D. I, 6; A. 4, 14.

Body low, not very elongate, the head rather short and very broad, much broader than deep, the snout depressed and very broadly rounded, almost truncate. Eye moderate, placed rather high, its diameter 7 in head. Interorbital space $2\frac{1}{6}$ in head; snout $3\frac{1}{3}$; breadth of mouth $1\frac{7}{8}$. Mouth large, with thickish lips, the upper jaw considerably projecting. Teeth on vomer and palatines villiform, but bluntly conical, less acute than in most of the species. Vomerine patches oblong, small, separated by a narrow interspace from each other and from the palatine bands, which are roundish and comparatively small, with a backward prolongation. Teeth in the jaws in broad bands. Barbels rather short, the maxillary barbels reaching a little past base of pectorals, the outer mental barbels a little past gill-opening, the inner a little more than one-third head.

Ante-dorsal shield not very short, crescent-shaped, with a distinct median keel, its length on the median line about one-third its breadth. Occipital process short, broadly triangular, with concave sides which spread out abruptly near the base, forming a sort of shoulder; its length scarcely equal to its width at base. Median keel well developed.

Fontanelle broad and shallow, abruptly narrowed posteriorly at a point a little nearer base of dorsal than tip of snout, but extending as a groove to a point distant less than a diameter of the eye from the base of the occipital process, this groove indistinct in the smaller specimen. Greatest width of fontanelle scarcely more than half eye. Shields of head granular-striate, the roughness less coarse than in *A. kessleri*. Interorbital space with two prominent ridges and numerous striæ, none of them granular, the granulations chiefly confined to the region behind widest part of fontanelle. Opercle striate. Gill-membranes forming a moderate fold across isthmus.

Dorsal spine low, shorter than pectoral spine, which is $1\frac{3}{5}$ in head, the anterior edges of both bluntly serrate. Humeral process broadly triangular, granulated, not two-fifths length of pectoral spine, much smaller than in *A. insculptus*. No axillary pore. Adipose fin long and low, without free posterior margin. Lower fins of moderate length; vent much nearer ventrals than anal. Caudal short, the upper lobe longest, $1\frac{3}{5}$ in head (a little more than half head in the smaller specimens).

Color dusky above, the lower parts soiled with dark points. Fins all more or less dusky with dark points. Maxillary barbels dusky, others pale.

One male specimen was obtained at Panama.

SPECIMENS IN UNITED STATES NATIONAL MUSEUM.

29408. Panama. Gilbert.
30995. Panama. Rowell.

12. Arius osculus sp. nov. (29476.)

Head $3\frac{7}{8}$ ($4\frac{3}{4}$); depth $6\frac{1}{4}$ ($7\frac{2}{3}$); width of head $4\frac{3}{4}$; length (29476) 11 inches. D. I, 7; A. 4, 14.

Body moderately elongate, the head short, rather narrow, tapering forwards, considerably broader than deep. Eye small, $7\frac{1}{2}$ in head, placed well above the mouth. Interorbital space $1\frac{9}{10}$ in head; snout 3; breadth of mouth $2\frac{2}{5}$.

Mouth very small for the genus, with thick lips. Teeth on vomer and palatines villiform, but rather coarse and bluntish. Vomerine patches small, rather longer than broad, separated on the median line, and each also separated by a narrow groove from the large and roundish palatine bands, which have a distinct backward prolongation. Premaxillary band of teeth very broad, barely 3 times as long as wide. Barbels short, the maxillary barbels reaching slightly beyond base of pectorals, the outer mental barbels scarcely past gill-opening below; inner mental barbels about as long as snout.

Ante-dorsal shield short, crescent-shaped, granulated, but without median keel, its length about one-fourth its breadth. Occipital process narrow, its edges almost parallel until abruptly widened at base; the narrow part considerably longer than broad, with curved edges. A well-developed median keel. Fontanelle broad and shallow, abruptly contracted at a point midway between tip of snout and end of occipital process, thence continued backward as a narrow groove to a point less than an eye's diameter in front of the base of the occipital process. Greatest width of fontanelle about three-fifths eye. Shields of top of head all coarsely and rather sparsely granular, and anteriorly striate. Interorbital space nearly plane, with a few low, smooth ridges. Opercle scarcely rugose. Gill-membranes forming a narrow fold across isthmus posteriorly.

Dorsal spine very high, $1\frac{1}{5}$ in head, a little longer than pectoral spine. Humeral process granular, not quite two-fifths length of pectoral spine. No axillary pore. Adipose fin adnate posteriorly. Caudal long, its upper lobe longest, somewhat falcate, $1\frac{1}{10}$ in head. Anal rather high.

Color brown, with bluish reflections; lower parts dusky, with dark punctulations. Fins all blackish; maxillary and outer mental barbels dusky.

A single male specimen was obtained at Panama.

SPECIMEN IN UNITED STATES NATIONAL MUSEUM.

29476. Panama. Gilbert.

13. Arius assimilis Günther.

Arius assimilis Günther, Cat. Fish. Brit. Mus. v, 146, 1864 (Lake Yzabal); Günther, Fish. Centr. Amer. 1869, 474; Steindachner, Fisch-Fauna des Cauca etc. 1880, 39 (no description; Magdalena River, in brackish water).

? *Arius seemani* Günther, Cat. Fish. Brit. Mus. v, 147, 1864 ("Central America": specimen with the fontanelle extending to base of occipital process).

? *Arius cœrulescens* Günther, Cat. Fish. Brit. Mus. v, 149, 1864 (Huamachal).

Arius guatemalensis Steind. Ichth. Beitr. iv, 18, 1875 (Magdalena Bay; Altata Panama).

Habitat.—Both coasts of tropical America; Magdalena Bay; Mazatlan; Altata; Panama; Lake Yzabal (in Guatamala, tributary to Bay of Honduras); Magdalena River (tributary to Caribbean Sea).

Head $3\frac{4}{7}$ ($4\frac{3}{5}$ in total); width of head $5\frac{1}{5}$; depth 5 ($6\frac{5}{6}$); length (28299) 11 inches. D. I, 7; A. 4, 14. In the largest specimen (29213) the head is 4 in length.

Body comparatively elongate, the head depressed but not very broad, somewhat broader than high; eye rather large, 5 to 6 in length of head; width of interorbital space $2\frac{1}{4}$ in head; breadth of mouth $1\frac{3}{4}$; length of snout $3\frac{1}{3}$.

Teeth all villiform; bands of vomerine teeth separated by a rather wide interval, each small, roundish, confluent with the neighboring palatine band, the junction marked by a slight constriction; palatine bands ovate, broad behind, varying considerably in size and somewhat in form, the width ranging from one-third diameter of eye to two-thirds, being generally largest in adults; band of palatine teeth without backward prolongation; band of premaxillary teeth rather broad and short, its length about 5 times its breadth. Maxillary barbel reaching a little past base of pectoral in the young, scarcely to gill-opening in the adult; outer mental barbels 2 in head, inner 3.

Ante-dorsal shield very short, narrowly crescent-shaped, its length on the median line not more than half that of one of its sides. Occipital process subtriangular, not quite as long as broad at base, with a strong median keel, its edges slightly curved. A short distance in front of the beginning of the keel is the end of the very narrow groove-like fontanelle, which is somewhat widened anteriorly, finally merging into the broad, flat, smooth interorbital area, the boundaries of which are not well defined; shields of head unusually smooth, all finely and very sparsely granular, the granules not forming distinct lines.

Gill-membranes forming a rather broad fold across isthmus.

Dorsal spine long, usually, but not always, shorter than the pectoral spine, about $1\frac{3}{4}$ in head; axillary pore absent. Humeral process rather broadly triangular, not much produced backward, less than half length of pectoral spine, its surface not granular, covered by skin. Adipose fin half length of anal, its posterior margin little free. Upper lobe of caudal longest and somewhat falcate, about as long as head. Ventrals about reaching anal in the females, shorter in the males. Vent much nearer base of ventrals than anal.

Color olive green, with bluish luster, white below; upper fins dusky olivaceous; caudal yellowish dusky at tip; anal yellowish with a median dusky shade; ventrals yellowish, the basal half of the upper side abruptly black; pectorals similarly colored, the black area rather smaller; maxillary barbel blackish; other barbels pale.

Very common at Mazatlan, where it is the most abundant species of the genus. It reaches a length of less than 18 inches. It was not observed at Panama by Mr. Gilbert. According to Günther and Steindachner this species occurs on both sides of the isthmus. It is not improbable that *Arius seemani* and *cærulescens* Gthr. are identical with it. Our specimens answer the description of *assimilis* better than that of either of the others.

SPECIMENS IN UNITED STATES NATIONAL MUSEUM.

28161. Mazatlan. Gilbert.
28189. Mazatlan. Gilbert.
28210. Mazatlan. Gilbert.
28213 (2). Mazatlan. Gilbert.
28221. Mazatlan. Gilbert.
28232. Mazatlan. Gilbert.
28276. Mazatlan. Gilbert.
28304. Mazatlan. Gilbert.

14. Arius cærulescens Günther.

Arius cærulescens Günther, Cat. Fishes Brit. Mus. v, 149, 1864 (Rio Huamuchal; west coast of Guatemala).

Habitat.—Pacific coast of Central America; Rio Huamuchal.

This species is unknown to us. It is certainly very close to *Arius assimilis*, if not identical with it.

15. Arius guatemalensis Günther.

Arius guatemalensis Günther, Cat. Fish. Brit. Mus. v, 1864, 145 (Guatemala; Chiapam): Günther, Fish. Centr. Amer. 1869, 293 (name only): not *Arius guatemalensis* Steind.

Habitat.—Pacific coast of tropical America; Mazatlan; Chiapam.

Head $3\frac{5}{7}$ ($4\frac{2}{3}$); width of head 5 ($6\frac{1}{5}$), depth $6\frac{1}{3}$ (7). Length (28140) $12\frac{1}{2}$ inches. D. I, 6; P. I, 10; A. 3, 15.

Body slender, its width anteriorly greater than its depth; caudal peduncle compressed, short; distance from end of anal to base of median caudal rays about one-half length of head. Head depressed, not very broad; its depth at posterior margin of branchiostegal membranes less than three-fifths its width; interorbital region flat, smooth, the smooth area forming a broad equilateral triangle, its base at the interorbital space, the apex at a point four-ninths the distance from snout to dorsal, the triangle forming the termination of the almost obsolete fontanelle; top of head, occipital process, and ante-dorsal shield finely granular, some of the anterior granulations only arranged in lines, none of them in radiating striæ. Occipital process broadly trapezoidal, its width slightly greater than the length of its side, with a slight or obsolete median carina; its posterior margin truncated; its sides slightly convex posteriorly, concave toward the front; ante-dorsal shield small, narrow, crescent-shaped, its median length about half the length of its side. Eye small, 6 in head; interorbital width $2\frac{2}{7}$ in head; snout 4 in head; breadth of mouth 2. Maxillary barbel very slender, reaching base of pectoral spine; outer mental barbel to well beyond margin of branchiostegal membranes, its length about half head; inner mental barbel 3 in head.

Teeth all villiform; width of premaxillary band about one-sixth its length. Vomerine and palatine bands of teeth, fully confluent on each side, forming together a crescent-shaped patch, narrowly divided on the median line of the vomer; form of vomerine band similar to that of the palatine band. Palatine band of teeth without backward prolongation. Opercle with radiating ridges; humeral process granular, narrow, produced backward, not quite half-length of pectoral spines; no axillary pore. Gill-membranes forming a narrow fold across isthmus.

Dorsal short, its base about equal to that of adipose dorsal; dorsal spine robust, but little shorter than pectoral spine, about three-fifths length of head; its anterior serræ small and tubercle-like; its posterior edge, as well as that of pectoral, retrorsely serrate; soft rays of dorsal rays extending much beyond the spine, the longest about three-fourths length of head. Adipose dorsal about one-half as high as long, its posterior margin largely free. Caudal very widely forked, the upper lobe falcate, nearly one-third longer than the lower, as long as head. Anal short and low. Distance from vent to base of ventrals slightly more than one-half its distance from origin of anal. Pectoral spine very strong, much stronger than dorsal spine, its anterior margin with serræ towards the tip, becoming small tubercles towards base; inner edge with strong retrorse serræ, the soft rays longer than spines, reaching three-fourths distance to base of ventrals.

Color very dark bluish or greenish above; sides with bronze lustre: belly silvery. Mental barbels white, with black edge; maxillary bar bel blackish; fins all blackish, the caudal nearly uniform; the paired fins darkest on the inner side. Sides with vertical series of mucous pores, conspicuous in life.

This species is not uncommon at Mazatlan, where several specimens were obtained by Mr. Gilbert. Four specimens from Colima are also in the National Museum. It was not observed at Panama.

The original description of this species is brief and not entirely correct. That it was intended to refer to the species here described we have ascertained by the examination of Dr. Günther's original types in the British Museum.

SPECIMENS IN UNITED STATES NATIONAL MUSEUM.

28140. Mazatlan. Gilbert.
29284. Mazatlan. Gilbert.
28289. Mazatlan. Gilbert.
28290. Mazatlan. Gilbert.
29647. Mazatlan. Gilbert.
8144 (4). Colima. John Xantus.

16. Arius dowi (Gill) Günther.

Leptarius dowii Gill, Proc. Ac. Nat. Sci. Phila. 1863, 170 (Panama; "generic" diagnoses and measurements).

Arius dovii Günther, Fish. Centr. Amer. 1869, 476 (copied from Gill).

Habitat.—Pacific coast of Central America; Panama.

Head 4 ($4\frac{3}{5}$); depth $6\frac{1}{2}$ ($7\frac{1}{2}$); width of head $5\frac{1}{5}$; length (29529) 10 inches. D. I, 8; A. 4, 12.

Body elongate, narrow and slender, the caudal peduncle $1\frac{2}{5}$ in head. Head low and narrow, tapering anteriorly, the snout sub-truncate. Eye small, 7 in head, placed rather high; interorbital space little arched, with ridges and depressions, $2\frac{4}{5}$ in head; snout $3\frac{4}{5}$ in head; breadth of mouth $2\frac{1}{5}$ in head.

Mouth moderate, with thinnish lips; teeth villiform, bluntish; vomerine teeth forming two smallish, rounded patches, separated by a moderate interspace; each patch confluent with the neighboring palatine patch, which is rounded and rather large; the suture marked by a constriction. Palatine bands without backward prolongation. Premaxillary band of teeth broad.

Barbels very long; maxillary barbel extending well beyond tip of pectoral fin; outer mental barbel reaching well past front of pectoral; inner $2\frac{4}{5}$ in head.

Ante-dorsal shield comparatively large, not distinctly crescent-shaped, its divisions produced backward, their length about twice the length of the shield on the median line; anterior margin with two emarginations, the point fitting into an emargination of the occipital process; antedorsal shield without keel. Occipital process very broad and short, its edges nearly straight, its breadth at base considerably greater than its length; its median line with a rather low keel. Fontanelle broad and very short, ending obtusely at a point not far behind eye, the distance from this point to tip of snout $1\frac{2}{3}$ in its distance from base of dorsal. Each side of fontanelle with a conspicuous smooth ridge, the two ridges converging anteriorly; shields of head rather finely granulated, few of the granulations forming lines, none of them extending farther forward than posterior margin of eye. Opercle striate.

Gill-membranes meeting below in a sharp angle, forming a rather broad fold across isthmus.

Dorsal spine very short, its length a trifle less than pectoral spine, $2\frac{1}{4}$ in head. Axillary pore obsolete. Humeral process granulated, rather narrowly triangular, a little less than half length of pectoral spine, which extends barely two-fifths the distance to the ventral fins; adipose fin long and low, very nearly or quite coterminous with the anal; caudal narrow, rather short, the upper lobe longest, $1\frac{3}{5}$ in head; anal rather low and short; ventrals short, the vent not far behind them.

Color dusky above, pale below, the fins all more or less dusky; maxillary barbels dusky, others pale.

A single young male specimen was obtained at Panama.

This is one of the more aberrant species of the genus. It is, however, not distantly related to *A. guatemalensis*, and there is certainly no sufficient ground for its separation from "*Hexanematichthys*" as a distinct genus, "*Leptarius*" Gill.

The original type of this species cannot be found.

SPECIMEN IN UNITED STATES NATIONAL MUSEUM.

29528. Panama. Gilbert.

17. Arius dasycephalus Günther.

Arius dasycephalus Günther, Cat. Fish. Brit. Mus. v, 1864, 157 (Oahu, Sandwich Islands); Steindachner, Ichth. Beitr. iv, 1875, 26 (Panama; no description).

Habitat.—Tropical parts of the Eastern Pacific; *Sandwich Islands; Panama.

Head $4\frac{1}{2}$ ($5\frac{2}{5}$); depth 6 ($7\frac{1}{4}$); width of head $5\frac{1}{3}$; length (29400) 11 inches. D. I, 7; A. 4, 17.

Body elongate, compressed behind, the head small, narrow and moderately depressed anteriorly, the snout not very blunt. Eye rather large, placed somewhat above level of angle of mouth, its length 5 in head; width of interorbital space $2\frac{1}{6}$ in head; breadth of mouth $2\frac{1}{2}$; length of snout $3\frac{1}{4}$.

Teeth villiform, those of vomer and palatines rather coarse, bluntly

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* Three species (*Arius dasycephalus, Chætodon humeralis,* and *Isesthes brevipinnis*), belonging to the fauna the Pacific Coast of Central America, are recorded by Dr. Günther from the Sandwich Islands. In these cases we strongly suspect that there has been a confusion of localities among the specimens in the British Museum, and that all came from America.

conic; bands of vomerine teeth separated by a rather broad area, each confluent with the neighboring palatine band, the two forming a small oblong patch much smaller than the eye, the division between the palatine and vomer scarcely appreciable. Palatine bands without backward prolongation. Bands of teeth in jaws short and broad. Maxillary barbel reaching about to middle of pectoral spine; outer mental barbel to base of pectoral; inner slightly more than half head.

Ante-dorsal shield short, crescent-shaped, a little more than three times as broad as long on the median line. Occipital process sub-triangular, its sides straight, slightly longer than broad, its median line rather sharply keeled. Close in front of its base begins the deep fontanelle, which is narrow and groove-like posteriorly, becoming rather abruptly broader above the opercle, then gradually narrowed anteriorly.

Ridges bounding fontanelle prominent anteriorly to a point just behind vertical from nostrils, coarsely granular for their whole length, the granules mostly arranged in one series. Between these ridges and the eye on each side is another ridge extending obliquely backwards and inwards from above front of eye, likewise very coarsely granular, the granules mostly in two series. Shields of head all rough granular, the granules forming irregular lines. Gill-membranes forming a narrow fold across isthmus.

Dorsal spine moderate, about equal to pectoral spine, $1\frac{1}{4}$ in head. Axillary pore present, small. Humeral process broad, scarcely granular, about two-fifths pectoral spine. Adipose fin rather long and low. Caudal long, the upper lobe longest, somewhat longer than head. Anal long and high, its outline emarginate, its longest rays a little more than half head. Ventrals long, the vent nearer their base than that of anal.

Color dusky, the entire ventral surface soiled with dark points; fins all largely blackish; barbels black.

Two specimens were obtained at Panama. This species may be known at once by the four granulated ridges, which extend the length of the interorbital space.

SPECIMENS IN UNITED STATES NATIONAL MUSEUM.

29400. Panama. Gilbert.
29478. Panama. Gilbert.

18. Arius fürthii Steindachner.

Arius fürthii Steindachner, Ichth. Beiträge, iv, 29, 1875 (Panama).

Habitat.—Pacific coast of Central America; Panama.

This species is known to us only through the description of Steindachner.

19. Arius melanopus Günther.

Arius melanopus Günther, Cat. Fish. Brit. Mus. 1864, v, 172 (Rio Motagua; east coast of Guatemala); Steindachner, Ichth. Beitr. iv, 1875, 29 (Panama).

Habitat.—Both (?) coasts of Central America; Rio Motagua; Panama.

This species is known to us only from the descriptions of Günther and Steindachner.

20. Arius hypophthalmus Steindachner.

Arius hypophthalmus Steindachner Ichth. Beitr. iv, 31, 1875, taf. x, (Panama).

Habitat.—Pacific coast of Central America; Panama.

Head $3\frac{2}{5}$ (4); depth $4\frac{2}{5}$ ($5\frac{1}{4}$); width of head $5\frac{1}{2}$; length (29508) 14 inches. D. I, 7; A. 2, 20.

Body elongate, compressed, the back rather abruptly elevated at front of base of dorsal. Head rather long, narrow, much depressed anteriorly, as high at occiput as broad. Snout rather narrow and thin, rounded anteriorly; the mouth small, the upper jaw much projecting. Eye small, placed low, with no vertical range, its middle below the level of angle of mouth, 7 in head; interorbital space $2\frac{1}{6}$ in head; breadth of mouth $2\frac{1}{2}$; length of snout 3.

Palatine teeth small, bluntly conic, almost granular; vomerine bands of teeth separated by a very wide interval about equal to eye; on each side, fully confluent with and scarcely distinguishable from the palatine band, which forms a large oblong patch rather broadest anteriorly. Palatine band without backward prolongations. Both jaws very thin, depressed, their bands of teeth narrow. Barbels very long and slender, the maxillary barbel extending nearly to middle of pectoral spine; outer mental barbels nearly as long as maxillary barbel, considerably longer than head, extending well past base of pectoral; inner mental barbels almost reaching base of pectoral.

Ante-dorsal shield very short, narrowly crescent-shaped, its length on the median line scarcely more than one-fifth its width. Occipital process subtriangular, somewhat emarginate behind, in the adult specimen longer than broad, its sides concave. Its sides slope steeply from the median line, which forms an angle rather than a keel. A short distance in front of the base of the occipital process is the pointed termination of the long and rather narrow fontanelle, which is widest above the cheeks, tapering slowly forward and more rapidly backward. On each side of the fontanelle anteriorly is a ridge composed of a rather feeble bone, striate, but not granular, and like the rest of the interorbital space, covered with thick skin. An oblique ridge extends upwards and backwards between the above-mentioned ridge and the eye, the interorbital region being more uneven and covered by thinner skin than usual in this genus. Shields of head all rugose, moderately rough, but scarcely granular, the depressions being rather of the nature of reticulating furrows; young specimen with the plates more granular. Opercle with distinct radiating striæ. Gill-membranes forming a very narrow fold across the isthmus.

Dorsal spine long, $1\frac{1}{2}$ in head, considerably longer than the pectoral spine. Axillary pore well developed. Humeral process very short, nearly smooth, less than one-fourth length of pectoral spine. Adipose fin rather high, its posterior margin largely free. Upper lobe of caudal short, scarcely longest, 1½ in head. Anal comparatively long and high, its longest rays 2¼ in head, its margin somewhat concave.

Ventrals moderate. Vent much nearer base of ventrals than anal.

Color rather dull grayish brown, with bluish and purple reflections above, paler below; fins all pale, or the lower more or less dusky. Maxillary and outer mental barbels blackish.

This species is not very abundant at Panama, where two specimens were obtained.

Among the species here noticed, this is decidedly the most aberrant. It may be considered as the type of a distinct subgenus, characterized chiefly by the position of the eyes. This group may be known as *Cathorops*. (*Καθοραω*–to look down; *ὤψ*–eye.)

SPECIMENS IN UNITED STATES NATIONAL MUSEUM.

29436. Panama. Gilbert.
29508. Panama. Gilbert.

INDIANA UNIVERSITY, *May* 27, 1882.

A POOR SEASON FOR SHAD HATCHING IN NORTH CAROLINA.

By S. G. WORTH.

(Letter to Col. M. McDonald.)

I have been in Raleigh a week getting the affairs of my shad work fixed up. We had poor luck at Avoca; hatched only 2,260,000 fish. We attended every haul at Dr. Capehart's fisheries, and for more than a week attended three fisheries on the Roanoke. I also attended three other fisheries near Plymouth (on the Roanoke) for three days, and many of the dip-nets at Weldon. It would appear that the cause was due (1) to the cold and variable weather, and (2) to the poor character of fishing done at Sutton Beach, our chief source of supply.

The catch in Albemarle Sound, according to Dr. Capehart, is smaller than usual; but I am disinclined to think so. He had an inferior season, running about 7,000 shad below last year. The catch on the Roanoke was better than for years; and I learn that the same increase was apparent on the Neuse and Tar. The Cape Fear was below last year very considerably. Your jars worked beautifully, and the additions to the glass tubes were found unnecessary.

DEPARTMENT OF AGRICULTURE,
Raleigh, N. C., May 20, 1882.

A REVIEW OF THE SPECIES OF STOLEPHORUS FOUND ON THE ATLANTIC COAST OF THE UNITED STATES.

By JOSEPH SWAIN.

Our knowledge of the Anchovies of the Atlantic coast of the United States has been confused and imperfect. Among them I recognize three species, the synonymy and diagnostic characters of which I give in the present paper.

I am indebted to Professor Jordan for the use of his collections and library, and for valuable suggestions.

ANALYSIS OF SPECIES.

a. Body elongate, little compressed, the depth less than one-fifth the length; snout pointed; insertion of dorsal about midway between root of caudal and end of snout; caudal peduncle long and slender; depth 6 in length; silvery lateral band broad, diffuse, broader than eye. D. 14; A. 19 .... PERFASCIATUS, 1.

aa. Body compressed, little elongate; the depth more than one-fifth the length; insertion of dorsal nearer root of caudal than tip of snout.

b. Anal basis moderate, its rays about 20; snout pointed, projecting much beyond lower jaw; depth $4\frac{2}{3}$ in length; silvery lateral band very sharply defined, almost as broad as eye .... BROWNI, 2.

bb. Anal basis elongate, its rays about 26; snout rather blunt, not projecting much beyond lower jaw; depth about four in length; silvery lateral band diffuse, narrow, not much broader than pupil .... MITCHILLI, 3.

1. **Stolephorus perfasciatus** (Poey) Jor. & Gilb.

?*Engraulis argyrophanus* C. & V. Hist. Nat. Poiss. xxi, 49, 1848 (equatorial Atlantic).

Engraulis perfasciatus Poey, Memorias Cuba, ii, 313, 1860 (Havana); Poey, Syn. Pisc. Cub. 421, 1868 (Havana); Günther, Cat. Fishes Brit. Mus. vii, 391, 1868 (San Domingo; Cuba).

Stolephorus perfasciatus J. & G. Syn. Fishes North America, 273, 1882 (Wood's Holl, Mass.).

Habitat.—Cape Cod to Cuba; Wood's Holl, Massachusetts; Havana; San Domingo.

Head $3\frac{3}{4}$ ($4\frac{1}{4}$ in total); depth 6 ($6\frac{2}{3}$). D. 14; A. 19.

Body elongate, less compressed than in *S. browni;* belly slightly compressed, not serrated. Depth of head $1\frac{3}{5}$ in its length. Snout pointed, projecting beyond lower jaw, about 5 in head, its profile below not concave. Eye 4 in head. Mouth somewhat oblique; maxillary truncate, not reaching quite to base of mandible. Teeth on mandible and maxillary weaker than in *S. browni.* Opercle short, oblique. Gill-rakers as long as snout. Insertion of dorsal about midway between root of caudal and end of snout. Caudal peduncle long and slender. Caudal fin forked. Anal rather short, without basal sheath, its base $5\frac{1}{2}$ in length of fish. Pectoral short, $2\frac{1}{2}$ in head. Ventrals 3 in head.

Silvery lateral band broad, one-half wider than eye, bordered above by a dusky stripe. Tip of snout and upper part of head rather dusky, color otherwise as in *S. browni*. Described from a single specimen from Wood's Holl, Mass.

Engraulis argyrophanus, taken by Kuhl and Van Hasselt in the equatorial Atlantic, during their passage from Europe to Batavia, as described by C. & V., does not materially differ from *Engraulis perfasciatus* Poey, but, owing to the inadequate description and the locality, I have queried their identity.

2. Stolephorus browni (Gmel.) J. & G.

"*Piquitinga*, Marcgr. Pisc. Bras. 159."

"*Menidia*, Brown, Jam. 441, tab. 45, fig. 3."

"*Argentina*, sp., Gronov, Zoophyl. 112, No. 350."

Atherina browni Gmel. Syst. Nat. 1397, 1788 (Atlantic Ocean; Pacific. After *Brown*).

Engraulis browni C. & V. Hist. Nat. Poiss. xxi, 41, 1848 (New York; Havana; Jamaica; Martinique; Vera Cruz; Brazil); Poey, Memorias Cuba, ii, 312, 1860 (Havana); Poey, Sys. Pisc. Cub. 419, 1868 (Havana); Günther, Cat. Fishes Brit. Mus. vii, 389, 1868 (Atlantic; Pacific Coast of Central America*); Jor. & Gilb. Proc. U. S. Nat. Mus. 1878 (Beaufort, N. C.).

Stolephorus browni J. & G. Syn. Fishes North America, 273, 1882 (Cape Cod to Brazil).

Clupea vittata Mitchill, Trans. Lit. & Phil. Soc. N. Y. i, 456, 1815 (New York); Dekay, New York Fauna, 254, 1842 (*copied from Mitchill*); Storer, Syn. Fishes North America, 457, 1845 (New York).

Engraulis vittatus Baird, Ninth Smithsonian Rept. 1854, 347 (Beaseley's Point, New Jersey).

Engraulis piquitinga "Spix, Pisc. Bras. tab. 23, fig. 1 (not good)."

Engraulis tricolor Agass. Pisc. Bras. 51, 1850; Poey, Memorias Cuba, ii, 314, 1860 (Havana).

Argentina menidia "Gronov, Syst. ed. Gray, 141."

Engraulis mitchilli Günther, Cat. Fishes Brit. Mus. vii, 391, 1868 (Atlantic coast of America; Cayenne. Description confused with that of *E. mitchilli* C. & V.),

Engraulis hiulcus Goode & Bean, Proc. U. S. Nat. Mus. ii, 343, 1879 (Clear Water Harbor, Fla.).

Stolephorus hiulcus J. & G. Syn. Fishes North America, 237, 1882.

Habitat.—New York to Brazil; Hudson River; New York Harbor; Beaseley's Point, New Jersey; Beaufort, North Carolina; Clear Water Harbor, Florida; Havana; Jamaica; Martinique; Vera Cruz; Cayenne; Brazil.

Head $3\frac{3}{4}$ ($4\frac{1}{3}$); depth $4\frac{3}{4}$ ($5\frac{1}{2}$). D. 15; A. 20.

Body oblong, compressed; the belly compressed, somewhat serrated. Head moderate. Snout pointed, projecting much beyond lower jaw, its length less than diameter of eye, about 5 in head, its profile below slightly concave. Eye about $3\frac{1}{2}$ in head. Mouth oblique; maxillary pointed, reaching almost to gill-openings. Teeth evident on maxillary and mandible. Cheeks triangular, scarcely larger than eye. Opercle

* This and other references to *Stolephorus browni* from the Pacific Coast apparently refer to the related but distinct species, *Stolephorus ischanus* J. & G.

rather short, oblique. Length of gill-rakers equals two-thirds the diameter of eye. Insertion of dorsal about midway between root of caudal fin and anterior border of eye. Caudal peduncle robust. Caudal fin deeply forked. Anal moderate, with basal sheath, the length of its base $4\frac{3}{4}$ in head. Pectorals nearly 2 in head. Ventrals short, $3\frac{1}{3}$ in head.

Color in spirits slightly olivaceous; side with a sharply defined silvery band, about as wide as eye, more distinct than in our other species. Snout yellowish; top of head dusky; sides of head lustrous silvery; caudal light, with many dark points; dorsal little dotted; anal and pectoral scarcely specked. Described from numerous specimens from Beaufort, N. C., and a specimen from the coast of Brazil. The specimens obtained by Professor Baird at Beesley's Point, New Jersey, belong to this species.

Günther's description of *Engraulis mitchilli* does not conform to *S. browni* in depth of body and in the number of anal rays; these characters probably indicate a confusion with *E. mitchilli* C. & V. *Engraulis hiulcus* Goode and Bean differs from *S. browni* in a body less deep and in having two more rays in the anal—differences which scarcely sustain the validity of the species.

3. **Stolephorus mitchilli** (C. & V.) J. & G.

Engraulis mitchilli C. & V. Hist. Nat. Poiss. xxi, 50, 1848 (New York; Lake Pontchartrain); Poey, Syn. Pisc. Cub. pp. 421 and 422, 1868 (Havana).

Stolephorus mitchilli J. & G. Proc. U. S. Nat. Mus. 1882.

Engraulis vittata Storer, Fishes of Mass. 341, 1867, pl. xxvii, fig. 3. (Description incomplete and erroneous; the figure good, and evidently referring to *S. mitchilli*. Provincetown, Mass.)

Engraulis duodecim Cope, Trans. Amer. Philos. Soc. 1866 (Beeseley's Point, N. J. Description erroneous* if intended for this species).

Habitat.—Cape Cod to Texas and Cuba; Provincetown; Wood's Holl; Pensacola; Lake Pontchartrain; Galveston; Havana.

For detailed description of *S. mitchilli*, see J. & G., Proc. U. S. Nat. Mus. 1882.

INDIANA UNIVERSITY, *June* 11, 1882.

ON A COLLECTION OF FISHES FROM THE LOWER MISSISSIPPI VALLEY.

By O. P. HAY.

The fishes described in the following paper were collected mostly by the author during the summer of 1881. The first point visited was Memphis, Tenn. My collections there were made during the latter part of June, on the Arkansas side of the river. The seining was done there, as I was obliged for the most part to do it elsewhere, in the shallow

*This species differs from *E. browni* in having the dorsal fin entirely anterior to the anterior ray of the long and deeply concave anal and in the serration of its belly. (*Cope.*)

ponds along the river, which had been filled during the period of high water. From Memphis I proceeded to Vicksburg, Miss., where I spent several days during the early part of July. The collecting was done on both the Mississippi and the Louisiana sides of the river. My next work was done along the Big Black River, near Edwards, where the railroad leading to Jackson crosses this stream.

At Jackson, Miss., a very thorough search was made of Pearl River and the ponds and small streams of the vicinity. A portion of the collection was made at this point about the middle of July, and another portion about the middle of August. In the latter month a day was spent along the Big Black at Vaughan's Station, along the New Orleans and Chicago Railroad, in Yazoo County. Another day was devoted to seining in the Yalabusha River, at Grenada, in Yalabusha County; and this ended my work in that region for the season.

I have included also a few species that were sent to me from Enterprise, Miss., on the Chickasawha River. One of them, *Labidesthes sicculus*, had not previously been obtained from that part of the State, while the other specimens enable me to give more complete descriptions than have yet been given of the species to which they belong.

In this paper I enumerate 64 species, 5 of which I describe as new to science. One new genus is established, belonging to the Cyprinidæ.

ETHEOSTOMATIDÆ.

1. Ammocrypta vivax, sp. nov.

In form and general appearance closely resembling *A. pellucida* (Bd.) Jor. Body elongated and terete. Depth in the length, 7 times or more. Head contained in the length 4 times. Snout gradually decurved; intermaxillaries protractile. Mouth moderate, horizontal, the maxillaries reaching back to a vertical from the anterior border of the orbit. Teeth on the vomer, intermaxillaries, and mandibles rather weak. Eye equal to the snout, and contained in the length of the head 3½ times; interorbital space narrow. Cheeks densely covered with small scales. Opercles overlaid with a few rather large scales.

Body completely covered with small, usually strongly ctenoid scales, except the regions immediately in front of and behind the bases of the paired fins. There are 65 rows of scales running across the distinct lateral line. Of the horizontal rows of scales, 6 lie above the lateral line and 10 below it.

The rays of the fins are as follows: D XI, 10; A I, 9. The spinous and soft dorsals are separated by a space equal to one-half the length of the head. The two portions of this fin are about equal in height, the longest ray of each being contained twice in the length of the head. The base of the spinous dorsal is four-fifths the length of the head; that of the soft dorsal about one-half the same unit. The anal is short and high, its base less than one-half the head, while the longest ray is equal to three-fourths the head. As to position, the spinous dorsal begins at a point three-eighths of the distance from the snout to the base of the caudal, the soft dorsal two-thirds of this distance, and the anal immediately under the first ray of the soft dorsal. The single spine of the anal is soft and weak.

The pectorals and the ventrals extend backward to about the same point, a little more than half-way from the base of the pectorals to the commencement of the anal. The caudal peduncle forms about one-fourth of the length exclusive of the caudal fin.

In color this fish, while living, resembles the other species of this genus, being indeed almost as pellucid as *A. beanii;* and at first it was supposed to be that species. The sides are ornamented with about 10 dusky blotches, most distinct posteriorly. Along the back there are about 14 similar blotches. The occiput is sprinkled with black specks, and a few of these are scattered over the snout. The belly, chest, and lower parts of the head are colorless. The fins appear to be marked in no way except with a few black dots.

Only a single specimen of this species was secured. Its length to the base of the caudal is $1\frac{2}{3}$ inches, taken from the Pearl River at Jackson, Miss.

2. Ammocrypta beanii Jor.—*Bean's Darter.*

Ammocrypta gelida, HAY, Proc. U. S. Nat. Museum, iii, 1880, 490.

One specimen of this species was taken, along with the preceding, from the Pearl River at Jackson. It is but an inch and one-eighth long, and resembles those taken in Eastern Mississippi, and described, as cited above, under the name of *A. gelida.* I have no doubt now, however, that they ought to have been included under Professor Jordan's species.

3. Ioa vigil, sp. nov.

The following description is drawn from a single specimen, which has a length of 1 inch to the base of the caudal:

Body slender, head long, caudal peduncle compressed and comparatively deep. The fish, therefore, appears to have nearly the same depth everywhere.

Top of the head sloping gradually from the occiput to the snout. Length of the head in that of the body, $3\frac{3}{4}$ times; therefore long and pointed. Upper jaw projectile, the furrow separating the skin of the premaxillaries from that of the forehead being evident. Mouth large, terminal, slightly oblique; the jaws equal. The maxillaries extend back to a vertical from the anterior edge of the pupil. The jaws both straight, the tip of the lower not being curved downward, as in *A. pellucida.* Upper and lower jaws armed with recurved teeth. Vomer apparently with teeth.

Opercular spine well developed. Opercles and cheeks apparently devoid of scales. Eye large, its diameter in the length of the head 3 times, exceeding the length of the snout. Interorbital space very narrow.

Depth of the body in its length 6 times. Caudal peduncle in length of the body 4 times. Its depth in its length twice.

Dorsal fin-rays X, 12; the spinous and soft portions well separated. The spinous dorsal beginning at a point one-third of the distance from the snout to the caudal fin. Its length four-fifths and its height one-half the length of the head. Soft dorsal with the same dimensions as the spinous dorsal. The distance between the last spinous ray and the first soft ray equal to two-thirds the length of either portion of the dorsal. Anal fin II, 10. Its length equal to two-thirds the length of the head, and its height one-half the head. This fin begins immediately opposite the first soft dorsal ray. The hard rays are slender and about one-half as long as the longest soft rays.

The posterior portion of the body is densely sealed. There appear also to have been some scales on the anterior portion of the body above the lateral line, but in the single specimen known they are now missing. There are apparently no scales on the interior half of the body below the lateral line. There would probably be about sixty transverse rows of scales. The lateral line is deficient on five or six of the last scales of the caudal peduncle.

The color of this little fish is pale straw, or in life, perhaps, pellucid. It is marked with some blotches and specks of olive, about 10 square spots along the back, and about as many along the lateral line. The spots are most distinct on the hinder portion of the body. Along the sides the last 4 or 5 are considerably the largest. There are a few specks of olive between the lateral and dorsal rows of spots. The top of the head is dusky, and there is a small but very distinct black spot at the base of the caudal. There are no distinct markings below or in front of the eye.

From the Pearl River at Jackson, Miss.

4. **Percina caprodes** (Raf.) Grd.—*Hogfish.*

Specimens of this species were captured at Vicksburg and at Jackson, Miss.

5. **Alvordius aspro** Cope & Jor.—*Black-sided Darter.*

One specimen was secured while seining in the Yalabusha River at Grenada. It thus appears to have a very wide geographical distribution

6. **Hadropterus spillmani** Hay.—*Spillman's Darter.*

I have another specimen of this fish from the Chickasawha River, at Enterprise, Miss., but I obtained none in other parts of the State. It is not unlikely that this will prove to be a variety of *H. nigrofasciatus.* However, there appear to be some differences between the two that, so far as we yet know, are constant.

7. **Boleosoma olmstedi** (Stor.) Ag.—*Johnny Darter.*

A very few specimens of this Darter were obtained in the Big Black River, near Edwards, and again in the Yalabusha at Grenada. As it appears to be quite certain that the forms called *B. olmstedi* and *B. maculatum* belong to the same species, the older name, given above, must take precedence.

8. Pœcilichthys butlerianus,* sp. nov.

Body elongated, compressed; back somewhat arched.

Head rather large, contained in the length 4 times. Snout gradually decurved. Mouth of medium size, very slightly oblique. Lower jaw equal to the upper. Maxillary reaching back to a vertical from the anterior edge of the pupil. Upper jaw not projectile. Eye in the head $3\frac{1}{2}$ times. Length of the snout three-fourths the diameter of the eye. Depth of the body in the whole length to the caudal $5\frac{5}{6}$ times; caudal peduncle in the length $3\frac{1}{2}$ times; its depth one-third its length.

There are 44 transverse rows of scales, 3 longitudinal rows above the lateral line and about 12 below it, counting to the middle line of the belly. The lateral line is incomplete, there being pores in about 18 scales. It extends back to the last ray of the spinous dorsal. As indicated by the small number of rows of scales above it, it runs high up on the body.

The structure of the fins is shown by the formula D. IX, 11; A. II, 6. The spinous dorsal is as long as the head; its longest spine is contained $1\frac{2}{3}$ times in the length of the head. The soft is in length four-sevenths and in height three-fifths the length of the head. Anal in length five-sevenths and in height one-third the head. Pectorals and ventrals reaching back nearly to the vent. Both these fins are narrow and pointed. The caudal is rounded. The spinous dorsal begins at a point one-third of the distance from the snout to the base of the caudal. The anal begins at a point one-half the distance from the posterior edge of the preopercle and the base of the caudal.

The opercles have a row of enlarged scales along their lower edge. The cheeks are densely covered with small scales. Chest naked. Opercular spine well developed.

As regards color, this fish is pale below, almost white, from the snout to the caudal fin. On the chest and abdomen this white area extends upwards on each side as high as the upper edge of the base of the pectorals. On the caudal peduncle it is very narrow. The sides are ornamented with irregular blotches of olive. On the caudal peduncle these blotches are confluent into somewhat indistinct zigzag markings. Along the back are about ten square blotches of the same olive color. The center of the operculum has a triangular blotch. The occipital region is dusky. There is a dark spot behind the eye, a dark streak across the snout from eye to eye, a spot just above each eye, and a streak below each eye. The eye, therefore, seems to be in the center of a dark cross. There is also a small black spot at the insertion of the caudal fin.

*An abridgement of this description will be found in Jordan & Gilbert's Synopsis Fishes N. A., p. 519.

The ventral fins are white, the pectorals and anals nearly white. The dorsals and the caudal are ornamented with narrow dusky bars, which run transversely to the fin-rays. In life there is a scarlet band running along near the upper edge of the spinous dorsal.

The specimen from which the above description is taken has a total length of two inches. It was seined from a shallow pool along the Big Black River, near Vaughan's Station, Yazoo County, Mississippi, on the 20th of August.

In the collection of fishes made at Memphis is another and smaller specimen of this species, the colors of which are arranged according to a more definite pattern. The square olive blotches along the back are more distinct. From each of the anterior five or six there is a narrow band of the same color running downward and forward to the ventral region. On the posterior half of the body there are five or six bands, somewhat broader than the oblique ones just mentioned, that alternate with the dorsal blotches and run directly downward.

9. Vaillantia camura (Forbes) Jor.

Boleosoma camurum, FORBES, S. A. Bull. No. 2, Ills. Lab. Nat. Hist., 1878, 40.
Vaillantia camura, JORDAN, D. S. Bull. U. S. Nat. Mus., No. 12, 89.
Vaillantia chlorosoma, HAY, O. P. Proc. U. S. Nat. Mus., iii, 1880, 495.

One specimen of this species was obtained at Memphis, Tenn., and another at Jackson, Miss.

It now appears to be highly probable that the specimens that I described as *V. chlorosoma*, from Eastern Mississippi, belong to Professor Forbes's *Boleosoma camurum*, found in Illinois.

10. Microperca prœliaris Hay.—*Southern Least Darter.*

This species was originally described from a single specimen seined at Corinth, Miss. On my last trip I succeeded in getting additional specimens at Memphis, from the Big Black at Edwards, and from the Pearl at Jackson. It therefore appears to be a common and rather widely-diffused species. It is known also from Alabama. The characters assigned the species in the original description hold good in the case of the new materials, except that my last specimens all have two anal spines instead of one, as in the type. Two are probably the normal number.

LABRACIDÆ.

11. Morone interrupta Gill.—*Brassy Bass.*

Two small specimens of this fish were secured at Memphis. It is reported to be a very common fish at some seasons, and to be very highly prized for food.

CENTRARCHIDÆ.

12. Pomoxys sparoides (Lac.) Grd.—*Grass Bass.*

Abundant specimens were captured at Memphis, Vicksburg, Edwards, Vaughan's, and Grenada.

13. Pomoxys annularis Raf.—*Crappie.*

Probably even more abundant than the preceding; found at Memphis, Jackson, and Vaughan's.

14. Centrarchus macropterus (Lac.) Jor.—*Long-finned Sunfish.*

Many specimens were seined from ponds along the Big Black west of Edwards. A few were taken at Jackson.

15. Lepomis pallidus (Mitch.) Gill & Jor.—*Blue Sunfish, "Blue Brim."*

This species was found at every locality visited, except Memphis, where the failure to get it was no doubt accidental. Vicksburg, Edwards, Jackson, Vaughan's and Grenada.

16. Lepomis obscurus (Ag.) Jor.—*Blue-mouthed Sunfish.*

One adult specimen was taken at Jackson.

17. Lepomis humilis (Grd.) Cope.—*Red-spotted Sunfish.*

A number of specimens of a *Lepomis* are in the collections from Memphis, Vicksburg, and Jackson, which I refer to this species. They belong to that section of the genus characterized by having palatine teeth. The gill-rakers are about as long as those of *L. pallidus.* The opercular membrane is elongated into a conspicuous "ear." This is narrower at the base than further back, so that its shape is peculiar. There is a large black spot near the extremity of the flap; and this is surrounded by a broad band which, in alcoholic specimens, is silvery white; but which, in life, is probably of an orange or red color. The operculum is covered with large scales. The forehead is slightly convex to near the posterior border of the eye. At this point the front is suddenly elevated so as form an angle between the head and the body.

18. Lepomis megalotis (Raf.) Cope.—*Sun Perch.*

Lepomis fallax HAY, Proc. U. S. Nat. Mus. iii, 1880, 499.

Specimens of this variable fish were obtained at all points, except Memphis. Some of the specimens cannot be distinguished from specimens taken in Indiana, while others have quite a different appearance. Two small specimens captured in the Big Black at Vaughan's are of a dark color, and have a very short opercular flap. In other respects, however, they agree with typical specimens.

I have in my collection a fish from the Chickasawha River that I am compelled to refer to this species, but which departs still further from the ordinary form. The body is low for the genus, the height being contained $2\frac{2}{3}$ times in the length. The outline is regularly arched from the lip to the dorsal fin. The flap is not large, and is narrowly bordered with a pale color; the eye is large, greater than the length of the snout, and contained in the head 3 times. Its color is its most remarkable feature, if there can be anything remarkable about the variations in color that a fish may exhibit. The snout and upper part of the head are of a livid blue; the flap is black, while the rest of the body is very pale, almost white, with a few dusky markings along the side. Running along each side of both the dorsals and of the anal there is a scarlet streak. The dorsal spines are low and slender, and the gill-rakers short.

Lepomis fallax is doubtless a form of *L. megalotis.*

19. **Apomotis cyanellus** (Raf.) Jor.—*Blue-spotted Sunfish.*

A number of fine specimens of this fish were captured at Memphis, and others at Jackson.

20. **Chænobryttus gulosus** (C. & V.) Jor.—*Black Sunfish.*

Abundant everywhere. From the Mississippi at Memphis and Vicksburg, the Big Black at Edwards and Vaughan's, the Pearl at Jackson, and the Yalabusha at Grenada.

21. **Micropterus salmoides** (Lac.) Henshall.—*Large-mouthed Black Bass, "Trout."*

An abundant fish everywhere. The young are found in every pond. Specimens were obtained at the same localities as the preceding.

I have never succeeded in finding in the South a specimen of the small-mouthed black bass, *Micropterus dolomieu* Lac.

APHREDODERIDÆ.

22. **Aphredoderus sayanus** (Gilliams) DeK.—*Pirate perch.*

This was found to be a rather common fish at most of the localities visited. Specimens are in the collections from Memphis, Vicksburg, Jackson, and Vaughan's.

SCIÆNIDÆ.

23. **Haploidonotus grunniens** Raf.—*White Perch, Drum Grunter.*

Specimens of this species were secured at Vicksburg only. Evidences of its occurrence at Jackson were obtained. I have seen it captured by a fisherman at Demopolis, Ala., at the confluence of the Black Warrior and Tombigbee Rivers. It is esteemed as one of the best food-fishes.

ATHERINDIÆ.

24. **Labidesthes sicculus** Cope.—*River Silverside.*

This curious fish has representatives in my collections from the Mississippi at Memphis, the Big Black at Edwards, the Pearl at Jackson, the Yalabusha at Grenada, and the Chickasawha at Enterprise. It is, therefore, probably distributed from Michigan to the Gulf of Mexico.

25. **Menidia audens,*** sp. nov.

In form and appearance much like *Menidia notata*, but with a broader, flatter head and a narrowed lateral silvery band.

Head in the length of the body to the caudal 4½ times. Diameter of

*An abridgment of this description will be found in Jordan & Gilbert's Synopsis Fishes N. A., p. 908.

the eye equal to one-third the length of the head, to the snout, and to the interorbital space. The width of the head across the occiput is equal to one-half the length of the head. Lower jaw oblique and equal in length to the snout. Mouth small, the cleft being about one-half the length of the lower jaw. Upper jaw concave and protractile. Lower jaw projecting slightly beyond the upper.

The greatest depth in the length 6 times. The caudal peduncle is a little shorter than the head and its medium depth one-half its length. Dorsal fin IV or V–I, 8 or 9; Anal I, 17 or 18. The first spine of the the dorsal is situated a little in front of the first anal ray, and somewhat nearer the base of the caudal than the snout. Height of spinous dorsal equal to one-half the head. The two dorsals are separated by a space equal to twice the diameter of the eye. Beginning of the second dorsal two-thirds of the distance from the snout to the base of the caudal. Its height and length each equal to one-half the length of the head. First anal fin ray situated equally distant from the posterior border of the eye and the base of the caudal. Length of anal equal to head, its height three-fifths of the same unit. Pectoral fins extending beyond the insertion of the ventrals; the latter attaining the vent.

The anal aperture is a longitudinal slit, having a length in the larger individuals, equal to two-thirds the diameter of the eye. The beginning of the first, or spinous, dorsal is immediately over the anterior end of this slit.

There are 45 transverse rows of scales, and 10 horizontal rows at the beginning of the first dorsal. The top of the head is covered with large scales as far forward as the anterior margin of the pupil. This covering of scales descends on each side, overlying the opercle and sending forward below the eye a row of enlarged scales to the angle of the lower jaw. On the lower edge of the operele are two rows of smaller scales. The lateral line runs above the silvery band for about 8 scales anteriorly, after which it drops below this band and continues thus until near the caudal fin where it runs into the band. This stripe, so characteristic of this genus, lies principally on the fifth row of scales below the dorsal fins. It is lacking on the upper and the lower ends of the scales of this row, while it involves the lower ends of those of the fourth row and the upper ends of those of the sixth row. Its width is one-half the diameter of the eye. Its upper edge is bordered by a narrow line of leaden blue. The scales of the body have entire edges. The postero-superior and postero-inferior borders of each scale are straight and meet each other at an obtuse angle. The exposed portions of the scales are therefore rhombic.

The color is about that of *M. notata*. The edges of the scales on the upper surface are marked with a row of black dots, but not so conspicuously as the above species. There is a dusky band along each side of the anal fin. Soft dorsal, caudal, and pectoral fins sprinkled with black dots; other fins plain.

A few specimens were obtained at Memphis; many at Vicksburg;

one from the Big Black at Edwards; and a few from the Pearl River at Jackson. The total length of the largest specimen is 3 inches. It perhaps ascends from the Gulf, although no specimens have yet been received from salt water.

CYPRINODONTIDÆ.

26. Zygonectes dispar Ag.—*Striped Minnow.*

A female of this species was obtained in the Big Black River, near Edwards, and a male in the Pearl at Jackson It has not been known hitherto to occur further south than Southern Illinois.

27. Zygonectes notatus (Raf.) Jor.—*Top Minnow.*

Numerous specimens were obtained at Jackson, in the ponds along the Pearl River, and in a branch of the Yalabusha at Grenada.

28. Gambusia patruelis Baird & Girard.

Zygonectes melanops HAY, Proc. U. S. Nat. Mus. iii, 1880. 501.

A large number of specimens of the above species were found wherever I made collections during the past summer, except at Memphis. I had previously found the same fish at Artesia and Macon in Eastern Mississippi, and supposed that it was Professor Cope's *Zygonectes melanops*. In re-examining my materials from Artesia I found a single male that had been previously overlooked. This male possessed the peculiar intromittent anal fin of *Gambusia*, and therefore furnished a clew to the disposition to be made of the specimens. The males appear, for some reason, to be very rare. Out of twenty-four specimens that I have from Artesia but one is a male. Several specimens of those collected at Macon are yet at hand, but all are females. Of thirty-two specimens collected at Vaughan's all are females. I have one male from Vicksburg and another from the Big Black at Edwards. All these males are considerably smaller than the average of the females. The description of Professor Cope's species agrees so well with the females of *Gambusia patruelis*, it may be a question whether it was not founded on such females.* There is but one character that appears to distinguish the two, and that is the position of the dorsal fin with respect to the anal. In *Z. melanops* the dorsal is said to have its beginning opposite the middle of the anal; in my specimens of *G. patruelis* it begins opposite the seventh anal ray. *Zygonectes atrilatus*, Jordan & Brayton, is also probably the same fish.

A large proportion of the females in my collections are greatly distended with the partially-developed young.

Localities.—Vicksburg, Edwards, Jackson, Vaughan's, Grenada.

* This conclusion has been independently reached by Messrs. Jordan & Gilbert in the current volume of the Proceedings: *cf.* Proc. U. S. Nat. Mus. v, 1882, 257.

ESOCIDÆ.

29. **Esox reticulatus** Le Sueur.—*Green Pike.* "*Jackfish.*"

Several specimens of fishes belonging to the genus *Esox* were obtained in the Big Black, near Edwards, and in pools along the Pearl at Jackson, which I refer to the above species. I am not able to distinguish my specimens from specimens of *E. reticulatus* from New England. The dorsal rays number as high as 17, as in *E. reticulatus;* while there are said to be but 12 in *E. Ravenelii.* The series of vomerine teeth is certainly not longer than the palatine, while they are posteriorly weak and scattering.

30. **Esox umbrosus** Kirt.—*Little Pickerel.*

This appears to be a very abundant fish in the Lower Mississippi Valley, as well as further north. Specimens were secured at Memphis, Jackson, Vaughan's, and Grenada.

HYODONTIDÆ.

31. **Hyodon selenops** Jor. & Bean.—*Southern Moon Eye.*

Two specimens of this beautiful species were caught for me in the Pearl River at Jackson.

32. **Clupea chrysochloris** (Raf.) Jor.—*Skip Jack.*

Two small specimens were secured at Vicksburg.

33. **Dorosoma cepedianum** (LeS.) Gill.—*Hickory Shad.*

Abundant everywhere. Collected at Memphis, Vicksburg, Edwards, Jackson, and Grenada.

CYPRINIDÆ.

34. **Hyborhynchus notatus** (Raf.) Ag.—*Blunt-nosed Minnow.*

Specimens of this widely distributed species were obtained at Vicksburg, in the Big Black at Edwards, and in the Yalabusha at Grenada.

35. **Hybognathus nuchalis** Ag.—*Blunt-jawed Minnow.*

Hybognathus argyritis HAY, Proc. U. S. Nat. Mus. iii, 1880, 503 (in part).

Of the minnows in my collection belonging to the genus *Hybognathus*, there are two well-marked species. One of these I refer to Agassiz's species, *H. nuchalis*, the other to *H. argyritis*, Girard. The examination of a considerable number of specimens has led me to recognize the following differences: *H. nuchalis* has a small eye, its diameter being equal to or less than the snout. The mouth is small and horizontal; the lower jaw is shorter than the upper, and is received within the upper in the closed mouth, so that the mouth is inferior. The suborbital bones are broader than in *H. argyritis*. This difference is especially noticeable in the case of the anterior suborbital, which in the species last named is very narrow. It may be said that in *H. nuchalis* the anterior suborbita is twice as long as wide, while in *H. argyritis* it is three times as long as wide. The intestines of both species vary much in length. Those of *H. nuchalis* are usually from 7 to 10 times as long as the whole body, but are occasionally shorter.

H. argyritis has a large eye, its diameter exceeding the length of the snout. The mouth is small, but more oblique than in the other species; while the lower jaw is fully equal to the upper. The intestines are shorter than in *H. nuchalis*, being generally about 4½ or 5 times as long as the body. Now and then one is found with the elementary canal 7½ times the body. The most obvious distinctions between the two species are to be found in the size of the eye and the position of the mouth, whether terminal or inferior.

The specimens of *Hybognathus* that I collected at Macon, Miss., and described as above cited, belong here. Those collected at Enterprise were properly assigned to the next species.

Numerous specimens collected at Memphis, Vicksburg, Edwards, Jackson, Vaughan's, and Grenada.

36. Hybognathus argyritis Grd.—*Silvery Minnow.*

These appear to be quite as abundant as the preceding. Found at the same places.

Tirodon, gen. nov.

Pharyngeal teeth 2, 4–4, 2; compressed, not hooked, and with a broad triturating surface. Pharyngeal bones broad and sharply curved. Intestinal canal elongate and convoluted. No barbels at the angles of the mouth. Upper jaw protractile; both jaws thin. Dorsal over the ventrals.

(Etymology: τείρω, to wear away; ὀδούς, tooth.)

This genus is undoubtedly very closely related to *Hybognathus*, differing apparently in no important respect except in having two rows of pharyngeal teeth instead of one. This character has hitherto been regarded as of sufficient value to distinguish genera, and I follow custom. The intestinal canal in the specimen in my possession is not so elongate as in species of *Hybognathus*, being but 3½ times the length of the body; but this canal in the latter genus varies so greatly in length in individuals of the same species that its shortness in the case before us may be an individual peculiarity.

37. Tirodon amnigenus, sp. nov.

Form and general appearance much as in *Hybognathus argyritis*. In the single specimen known the head is broad while the body is much compressed. This may be due to mechanical injury to the specimen. Head long, contained in the body 3½ times. Both upper and lower jaws thin, the lower slightly the longer. Mouth rather more oblique than in *Hybognathus argyritis*, rather small, the maxillary not extending back to a vertical from the front of the eye. Eye contained in the head 3 times, equal to the snout.

Teeth 2, 4–4, 2, without hook and with a masticatory surface; appearing to differ from those of *Hybognathus* only in being in two rows.

Lateral line complete, running rather low anteriorly. Transverse rows of scales 38. Of the horizontal rows of scales there are five between the lateral line and the front of the dorsal, and three between the lateral line and the base of the ventrals. Dorsal I, 8; Anal I, 7. Dorsal slightly nearer the base of the caudal and the snout, beginning slightly in front of the ventrals, rather high, four-fifths the length of the head; its length one-half the same unit. Anal small; its height scarcely two-thirds the length of the head; its length about one-third the head.

Caudal peduncle short, contained in the length of the body nearly 5 times; its depth about one-half its length.

Color in spirits a clear yellowish green. The lower jaw, the sides of the head, and the body below the lateral line silvery. On the scales above the lateral line from head to tail there is a great number of minute black dots. A few of these occur just below the lateral line anteriorly, while on the hinder half of the body these punctulations are condensed into a dark line just above the line of pores. A row of black points arises at the beginning of the anal, and runs on each side backward to the base of the caudal. Top of the head dusky, fins pale.

A single specimen, $1\frac{1}{4}$ inches long, was obtained in the Pearl River at Jackson, Miss.

38. **Alburnops taurocephalus** Hay.—*Bull-headed Minnow.*

This minnow appears to have a wide distribution in the South. I obtained specimens of it at Memphis, Vicksburg, Jackson, and Grenada.

39. **Alburnops xænocephalus** Jor.

Numerous specimens of this species were seined in the vicinity of Jackson.

In the autumn of 1881 I received from Mr. W. A. Warner, of Enterprise, Miss., a number of fishes which had lain in alcohol but a short time. Among these were several belonging to this species which showed some peculiarities of coloration that I have not seen described. The ground color on the upper half of the body is olive, below it is pale. A blue band runs along the side, palest on the anterior half, deepening posteriorly to indigo, and ending at the base of the caudal in a spot of the same color. Top of the head, opercles, and a band across the snout, leaden blue. Snout above the blue band rosy. Tip of lower jaw blue. A dark blue stripe along the back, broadest in front of the dorsal. Body below the lateral line white, except that there is more or less blue on the belly, and a blue streak on each side of the anal fin. The dorsal and the caudal fins are red.

40. **Alburnops longirostris** Hay.—*Long-nosed Minnow.*

No specimens of this species were found on my last excursion. I have additional specimens from the Chickasawha River at Enterprise. In these the edges of the scales, especially on the upper surface of the body, are tinged with purple. There is a faint band of purple along the sides, while the whole top of the head, the opercles, and the snout are bluish purple. The bases of the dorsal and caudal fins are red. These colors are soon lost in alcoholic specimens.

41. Hemitremia maculata Hay.—*Spot-tailed Hemitreme.*

Several specimens of this species were secured at Vicksburg and at Jackson.

42. Luxilus cornutus (Mitch.) Raf.—*Common shiner.*

No specimens of this species were found in Western or Central Mississippi. It is abundant enough in the eastern part of the State. I have adult specimens from Enterprise.

43. Luxilus stigmaturus Jor.—*Spot-tailed Minnow.*

Luxilus chickasavensis HAY, Proc. U. S. Nat. Mus. 1880, iii, 506.

This proves to be an exceedingly variable species, both in the form and proportions of the body and in the style of its ornamentation; and on one of its forms was established the species *chickasavensis.* I have now specimens from the Big Black at Edwards, and from the Pearl at Jackson. These, together with specimens from Eastern Mississippi and from the Alabama River, enable me to give a more comprehensive description of the species. In form the fish varies from stout and heavy to elongated, the depth running from $3\frac{1}{3}$ to 5 times in the length. The number of scales in a horizontal row ranges from about 36 to 45. The large jet-black spot at the base of the caudal fin is one of the most distinctive marks of the species; but in some of my specimens from the Big Black even this spot is obsolete. In other specimens taken along with these the spot is very distinct. The diameter of the eye is usually somewhat less than the length of the snout, sometimes equal to it; but in a few specimens it is contained nearly twice in it.

A few of the specimens that I obtained were quite highly colored. The sides of the body were of a bright leaden blue, this color sometimes extending down to the bases of the paired fins. The scales on the dorsal region were olive, edged with blue. Top of the head and a streak along the back also blue. The base of the caudal red, the top blue. The base of the dorsal red, the upper half filled with white satiny pigment. Anal and paired fins also charged with the same pigment. The resemblance of such highly colored individuals to *L. analostanus* in their full nuptial dress is so complete that they might easily be mistaken for the latter species, were it not for the black caudal spot.

Sometimes the males have considerable areas of their bodies covered with tubercles. Most commonly we find the tip of the snout swollen and densely covered with prickles. Behind this the region in front of the eyes, the whole upper surface of the head, and the middle line as far back as the dorsal fin are furnished more or less with similar prickles.

In some cases we may find along the exposed edge of every scale, on each side of the body below the lateral line, beginning as far forward as the bases of the ventrals, a row of small, hard tubercles. These become larger and more numerous over the anal fin and on the caudal peduncle, and make these regions decidedly rough to the feel. They even continue down on to the anal rays. Some of the males thus tuberculated show the faintest outlines of the caudal spot.

44. Ericymba buccata Cope.—*Silver-mouthed Dace.*

This is one of the most common species of the *Cyprinidæ* in the Chickasawha River, but I have met with it at no point in the South nearer the Mississippi River. I have specimens taken at Enterprise, in the autumn, that are much more highly ornamented than any that I have seen elsewhere. The edges of all the scales on the upper half of the body, except a triangular patch from the back of the head to the dorsal fin, are broadly edged with blue. Top of the head to the lower edge of the orbit blue. Snout blue. An ill-defined band of blue along the sides, most intense behind. Many blue specks scattered over the body below the lateral line and behind the ventrals. Dorsal and caudal red.

45. Opsopœodus emiliæ Hay.—*Emily's Minnow.*

A very common minnow throughout the region visited. Collected at Memphis, Vicksburg, Jackson, and Grenada.

46. Minnilus dilectus (Grd.) C. & J.—*Delectable Minnow.*

Collected at Memphis, Vicksburg, Edwards, Jackson, Grenada.

47. Minnilus rubripinnis Hay.—*Mississippi Red-fin.*

No specimens of this species were obtained on my last trip. From new material obtained from the Chickasawha, in the autumn, and which had lain in alcohol but a short time, I add the following particulars as to the coloration: The scales above are olive, with dusky edges. There is a broad blue band along the sides, which becomes narrower, better defined, and of an indigo hue on the caudal peduncle. Whole top and upper half of the sides of the head, together with the tip of the lower jaw, blue. A blue streak on each side of the anal fin. A narrow dusky line running along the back from the occiput to the caudal fin. Dorsal fin red, with a blue stripe running along the tips of the rays. Caudal mostly red. Other fins and the lower part of the body white.

48. Minnilus lirus Jor.—*Steel-sided Minnow.*

Notropis lirus JORDAN, Annals N. Y. Lyc. Nat. Hist., xi, 1877, 342.

At Memphis I caught a single specimen of a *Minnilus* which I cannot distinguish from typical specimens of *M. lirus* from the Etowah River, in Georgia.

49. Notemigonus chrysoleucus (Mitch.) Jor.—*Shiner.*

Found in abundance in the little lakes and ponds along the Mississippi at Memphis and Vicksburg, in the Big Black at Edwards and Vaughan's, and in the Pearl at Jackson.

50. **Semotilus corporalis** (Mitch.) Putnam.—*Horned Dace.*

A few were found along the Big Black near Edwards.

51. **Ceratichthys amblops** (Raf.) Cope & Jor.—*Big-eyed Chub.*

A few good specimens were secured in the Pearl River at Jackson.

CATOSTOMIDÆ.

52. **Moxostoma macrolepidotum** *var. duquesnii* (Le S.) Jor.—*Red Horse.*

One well-characterized specimen of this species was obtained at Jackson, Miss.

53. **Moxostoma pœcilurum** Jor.—*Variegated-tailed Mullet.*

Moxostoma macrolepidotum et pœcilurum HAY, Proc. U. S. Nat. Mus. iii, 1880, 512.

Two small specimens of a *Moxostoma* that were caught at Jackson are referred, with a good deal of doubt, to this species. They appear to have some indications of the peculiar coloration of the caudal fin of this species. The specimens of this genus described as above cited from Eastern Mississippi were all of this species, as a re-examination of my collection has shown. No doubt it exists throughout the southern half of the State.

54. **Cycleptus elongatus** (Le S.) Ag.—*Black Horse; Missouri Sucker.*

One specimen having a total length of 21 inches was taken from the Pearl River.

55. **Carpiodes carpio** (Raf.) Jor.—*River Carp Sucker.*

This is an abundant fish everywhere in the region visited. Specimens were obtained at Memphis, Vicksburg, Edwards, and Jackson.

56. **Ictiobus cyprinella** (C. & V.) Ag.—*Brown Buffalo Fish.*

Quite as common as the preceding. The young were taken at Memphis, Vicksburg, Edwards, and Vaughan's. One specimen 9 inches long was taken in the Big Black near Edwards.

SILURIDÆ.

57. **Ictalurus punctatus** (Raf.) Jor.—*Channel Cat.*

Common everywhere and attaining a great size. Taken at Vicksburg, Edwards, Jackson, and Grenada.

58. **Amiurus melas** (Raf.) Jor. & Copeland.—*Black Cat.*

Abundant everywhere. Specimens taken at every point visited, except Grenada.

59. **Amiurus marmoratus** (Holb.) Jor.—*Marbled Cat.*

Two specimens that I refer to this species were captured at Memphis.

One has a total length of 14 inches. The head is as broad as long and contained in the body 3½ times. Depth in the length 3½. Anal fin scarcely one-fourth the length of the body. The body narrows rapidly posteriorly. Interorbital space in the head 1⅗ times. Branchiostegals 10.

60. **Noturus leptacanthus**? Jor.

Noturus leptacanthus? HAY, Proc. U. S. Nat. Mus. iii, 1880, 514.

In giving an account of a collection of fishes made in Eastern Mississippi in 1880, I referred to Professor Jordan's *Noturus leptacanthus*, with some hesitation, a specimen that I captured at Enterprise, Miss. I have now another specimen that I caught in a small sandy creek flowing into the Big Black River near Edwards. This preserves the characters shown by the Enterprise specimen, the spines being one-half, or nearly one-half, the length of the head. Without being able to compare it with typical specimens of *Noturus leptacanthus*, I am not prepared to describe it as a new species.

ANGUILLIDÆ.

61. **Anguilla rostrata** (Le S.) DeK.—*American Eel.*

The head of a specimen of the common eel was given me by a fisherman at Jackson.

AMIIDÆ.

62. **Amia calva** L.—*Bowfin Mud-fish; "Grinnell."*

Many of these were taken at Memphis. They are eaten by the negroes.

LEPIDOSTEIDÆ.

63. **Lepidosteus osseus** (L.) Ag.—*Garfish.*

A very common fish. Found at Memphis, Vicksburg, and Jackson.

64. **Atractosteus tristœchus** (Bloch & Schn.) Gill.—*Alligator Gar.*

Many of these were captured at Memphis, Vicksburg, and Jackson. One has a length of 19 inches. They are said to grow to a length of 8 feet or more.

RECAPITULATION.

The following table indicates the distribution of the species in the waters of Southwestern Tennessee, and in the northern two-thirds of the State of Mississippi, as shown in the collections that I have thus far made. In the first column are included the species collected at Corinth, Miss., Memphis, Tenn., and Vicksburg, Miss. In the second are checked the species collected at Edwards, Vaughan's, and Grenada, in the Big Black, and its tributary, the Yalabusha. The third column indicates the species taken from the Pearl. In the fourth column are noted the species taken from the Tombigbee and the Chickasawha. To enable us to compare these Southern fishes with those of the Mississippi Valley further north, I have added a fifth column, in which are checked those species that occur north of Kentucky. All, or nearly all, of these are found in the State of Illinois.

Table showing the distribution of the fresh-water fishes of the Lower Mississippi Valley.

	Mississippi.	Big Black.	Pearl.	Tombigbee and Chickasawha.	Upper Mississippi Valley.
1. Ammocrypta beanii Jor			×	×	
2. Ammocrypta vivax Hay			×		
3. Ioa vigil Hay			×		
4. Percina caprodes (Raf.) Grd	×		×	×	×
5. Alvordius aspro Cope & Jor		×			
6. Hadropterus spillmani Hay				×	
7. Boleosoma olmstedi (Stor.) Ag		×		×	×
8. Nanostoma elegans Hay				×	
9. Nanostoma zonale (Cope) Jor				×	×
10. Pœcilichthys artesiæ Hay				×	
11. Pœcilichthys saxatalis Hay				×	
12. Pœcilichthys butlerianus Hay	×	×			
13 Vaillantia camura (Forbes) Jor	×		×	×	×
14. Microperca prœliaris Hay	×	×	×		
15. Morone interrupta Gill	×				×
16. Micropterus salmoides (Lac.) Hens	×	×	×	×	×
17. Ambloplites rupestris (Raf.) Gill				×	×
18. Chænobryttus gulosus (C. & V.) Jor	×	×	×	×	×
19. Apomotis cyanellus (Raf.) Jor	×		×	×	×
20. Lepomis pallidus (Mitch.) Gill & Jor	×	×	×	×	×
21. Lepomis obscurus (Ag.) Jor			×	×	
22. Lepomis humilis (Grd.) Cope	×		×		?
23. Lepomis megalotis (Raf.) Cope	×	×	×	×	×
24. Centrarchus macropterus (Lac.) Jor		×	×	×	×
25. Pomoxys sparoides (Lac.) Grd	×	×		×	×
26. Pomoxys annularis Raf.	×	×	×	×	×
27. Elassoma zonatum Jor				×	×
28. Aphredoderus sayanus (Gms.) DeK	×	×	×	×	×
29. Haploidonotus grunniens Raf	×		×	×	×
30. Labidesthes sicculus Cope	×	×	×	×	×
31. Menidia audens Hay	×	×	×		
32. Zygonectes notatus (Raf.) Jor		×	×	×	×
33. Zygonectes dispar Ag		×	×		×
34. Gambusia patruelis B. & Grd	×	×	×	×	?
35. Esox reticulatus Le S		×	×		
36. Esox umbrosus Kirt	×	×	×		×
37. Hyodon selenops Jor & Bean				×	
38. Clupea chrysochloris (Raf.) Jor	×		×	×	×
39. Dorosoma cepedianum (Le S.) Gill	×	×	×	×	×
40. Hyborhynchus notatus (Raf.) Ag	×	×		×	×
41. Hybognathus nuchalis Ag	×	×	×	×	×
42. Hybognathus argyritis Grd	×	×	×	×	×
43. Tirodon amnigenus Hay			×		
44. Alburnops taurocephalus Hay	×	×	×	×	
45. Alburnops xænocephalus Jor			×	×	
46. Alburnops longirostris Hay				×	
47. Hemitremia maculata Hay	×		×	×	
48. Luxilus cornutus (Mitch.) Raf				×	×
49. Luxilus stigmaturus Jor		×	×	×	
50. Ericymba buccata Cope				×	×
51. Opsopœodus emiliæ Hay	×	×	×	×	
52. Minnilus dilectus (Grd.) C. & J	×	×	×	×	×
53. Minnilus rubripinnis Hay				×	
54. Minnilus lirus Jor	×				
55. Minnilus punctulatus Hay					
56. Minnilus bellus Hay				×	
57. Notemigonus chrysoleucus (Mitch.) Jor	×	×	×	×	×
58. Semotilus corporalis (Mitch.) Putnam		×		×	×
59. Ceratichthys biguttatus (Kirt.) Grd				×	×
60. Ceratichthys amblops (Raf.) Cope & Jor			×	×	×
61. Moxostoma macrolepidotum (Le S.) Jor			×		×
62. Moxostoma pœcilurum Jor				×	
63. Erimyzon sucetta (Lac.) Jor				×	×
64. Catostomus nigricans Le S				×	×
65. Cycleptus elongatus (Le S.) Ag			×		×
66. Carpiodes carpio (Raf.) Jor	×	×	×		×
67. Ictiobus cyprinella (C. & J.) Ag	×	×			×
68. Ictalurus punctatus (Raf.) Jor	×	×	×	×	×
69. Amiurus vulgaris (Thomp.) Nelson				×	×
70. Amiurus melas (Raf.) Jor. & Copeland	×	×	×	×	×
71. Amiurus marmoratus (Holb.) Jor	×				×
72. Leptops olivaris (Raf.) J. & G				×	×
73. Noturus gyrinus (Mit.) Raf				×	×
74. Noturus leptacanthus ? Jor		×		×	
75. Anguilla rostrata (Le S.) DeK					×
76. Amia calva L	×				×
77. Lepidosteus osseus (L.) Ag	×		×		×
78. Atractosteus tristœchus (Bloch & Schn.) Gill	×		×		×

A glance at the above table will suffice to show that the fish fauna of all the streams in the region under consideration is essentially the same. Indeed it appears to me that it would be somewhat hazardous in the present state of our knowledge to say that any fish now known from but one or two of these streams will not yet be found in all.

All the species in the table except *Morone interrupta*, *Minnilus lirus*, *Amiurus marmoratus* and *Amia calva*, have been collected by myself in the State of Mississippi. These species also doubtless occur in that State.

BUTLER UNIVERSITY, *Irvington, Ind., July* 26, 1882.

STRIPED BASS IN PIANKATANK RIVER, VIRGINIA.

By R. HEALY.

[From a letter to Prof. S. F. Baird.]

I see it stated in the New York Herald, under the heading "Sea-fish culture," that the "eggs of the striped bass have been hatched in many instances, but the place where they spawn in numbers sufficient to make it profitable to seek them on their breeding-grounds, has never yet been discovered." If this be true, probably I can give you a clew.

The Piankatank River, upon which I live, is about 65 miles long. About 30 of this is estuary. The remainder is a fresh-water stream, about 25 or 30 feet wide, which makes its way, for 30 miles, through an alluvial country, and for 15 miles of the lower part through a cypress swamp. The water is clear but dark colored, and the stream is 2 or 3 feet deep, with bars of white sand, and deeper holes where the bottom is covered with leaves and fallen wood. Up this stream, as far as I can remember, two kinds of rockfish have been caught; one a large fish with the stripes upon the sides broken; on the other the stripes run from head to tail. The first we know as bass, the other as rock-fish. These fish when full of roe are called green-roe rock. They come up the river late in February and in March, and years ago were very abundant. They are becoming scarce in consequence of the high price of fish at the North, and the many devices to catch them, among others that of an old fellow named Norton (since dead), who used to make a coarse wattle across the stream with a large hole in it. At this he would stand with a large hand-net, in the night, and whenever he felt a fish, would raise it quickly and land the fish on shore. All these fish had large green roes—very fine—finer than shad or herring.

A friend of mine told me that one morning Norton brought him three of these fish, and told him he had taken over a dozen during the night, and would have taken more but that an immense fish had broken his net. I have seen them taken in seines, but never with hook and line. Those that bite at hooks have very small roes, yellowish-white, which are called "he-roes." These fish are becoming scarce. Very few large ones are now caught, and none but large fish have the green roes. I never saw a green-roed rock less than 2½ feet long; some are much larger.

A good many small fish, 2 or 3 inches long, are seen in the summer and in the winter; sometimes thousands are caught at a haul from 10 to 20 inches long. I recollect a haul made about 40 years ago, when 800 of these fish, over 3 feet long, were taken, and I think the largest weighed over 70 pounds. Rockfish could be bought then for less than a cent a pound. Now they are worth 8 cents at the seine.

HARMONY VILLAGE, VA., *January* 30, 1882.

ANSWERS TO QUESTIONS RELATIVE TO CATFISH.

By CHARLES E. HIESTER.

A.—NAME.

1. What is the name by which this fish is known in your neighborhood?—A. The catfish.

B.—DISTRIBUTION.

2. Is it found throughout the year, or only during a certain time; and for what time?—A. They are found in warm days in February, and all through the warm weather; when the water freezes they go into the mud.

C.—ABUNDANCE.

3. If resident, is it more abundant at certain times of the year; and at what times?—A. They are most abundant about May 1.

4. How abundant is it, compared with other fish?—A. At least fifty times more abundant than any other.

5. Has the abundance of the fish diminished or increased within the last ten years?—A. Increased.

6. If diminished or increased, what is the supposed cause?—A. Almost every egg hatches, and the young ones are not relished as food by other fishes on account of their stingers: bass and pike are about the only fish that can eat them.

D.—SIZE.

8.* What is the greatest size to which it attains (both length and weight), and what the average?—A. Fourteen inches length; 1 to 1¾ pound. Average, 10 or 11 inches; and average weight, three-fourths of a pound.

9. State the rate of growth per annum, if known; and the size at one, two, three or more years.—A. One year old, 3 inches; two years old, 5 to 6 inches; after that, cannot say.

10. Do the sexes differ in respect to shape, size, rate of growth, &c.?—A. No difference except just before spawning.

*Certain questions in the list were not answered and their omission accounts for the numbers not being consecutive. For full list of questions see Report of the Commissioner, part I, page 3.

E.—Migrations and movements.

25. Are these fish anadromous; that is, do they run up from the sea into fresh water for any purpose? And if so, for what?—A. I don't think the catfish is anadromous.

30. What are the favorite localities of this fish? Say whether in still water or currents, shallow or deep water, on the sand, in grass, about rocks, &c.—A. Still, deep water, with mud bottom.

31. What depth of water is preferred by these fish?—A. Three to four feet appears to suit them very well.

32. What the favorite temperature and general character of water?—A. Still, cloudy water, near the temperature of spring water, but warmer.

F.—Relationships.

33. Do these fish go in schools after they have done spawning, or throughout the year, or are they scattered and solitary?—A. Before spawning they go in schools; after spawning the large ones scatter.

34. Have they any special friends or enemies?—A. Enemies. Musk-rats and snapping turtles take them from behind, and eat all but the head and stingers; pike and bass take them head first and swallow the whole fish. They live and thrive in the midst of their enemies. In one winter, in a single runway 10 feet wide and 100 yards long, 20 bushels of marketable fish were taken; and in the same winter we caught 75 snappers, weighing from 4 to 10 pounds, and 115 muskrats, within a space of three-fourths of a mile immediately surrounding the runway.

35. To what extent do they prey on other fish, and on what species?—A. Never found another fish inside of a catfish.

36. To what extent do they suffer from the attacks of other fish or other animals?—A. Less than any other fish, on account of their stingers.

G.—Food.

37. What is the nature of their food?—A. They appear to live on the larvæ of insects and on flies that fall into the water; they never jump out of the water.

H.—Reproduction.

40. Is there any marked change in the shape or color of either sex during the breeding season; or any peculiar development of, or on any portion of the body, as the mouth, fins, scales, &c.?—A. No change in color, but softer.

41. Are there any special or unusual habits during the spawning season?—A. They burrow under the mud.

43. At what age does the male begin to breed, and at what age the female?—A. Two years.

46. Where do these fish spawn, and when?—A. In shallow water; in June.

48. Is the water ever whitened or colored by the milt of the male?—A. Just where the spawn is the water appears to be cloudy.

49. What temperature of water is most favorable for hatching?—A. Ordinary ditch water in June, away from the spring.

50. At what depth of water are the eggs laid; if on or near the bottom?—A. One to three feet, and on the bottom.

51. What is the size and color of the spawn?—A. Color, dark brown; size varies with the age of the fish.

52. What is the estimated number for each fish, and how ascertained?—A. Never counted them; should judge from 1,000 to 2,000.

54. Do the eggs, when spawned, sink to the bottom and become attached to stones?—A. They sink to the bottom; do not know whether they are attached or not.

55. Do the fish heap up or construct any kind of nest, whether of sand, gravel, grass, or otherwise; and, if so, is the mouth, the snout, or the tail used for the purpose, or what: and, if so, how is the material transported; or do they make any excavation in the sand or gravel?—A. They make no nest at all that I have seen.

56. Do they watch over their nest, if made, either singly or in pairs?—A. They watch singly.

57. When are the eggs hatched, and in what period of time after being laid?—A. Cannot say certainly, but think in two or three days.

58. What percentage of eggs laid is usually hatched?—A. Every egg.

59. What percentage of young attains to maturity?—A. All, except those destroyed by snappers, muskrats, and bass, which is a very small percentage; never saw a dead one.

60. What is the rate of growth?—A. About 3 inches a year.

61. Do the parents, either or both, watch over the young after they are hatched?—A. One parent watches *under* them after they are hatched.

62. Do they carry them in their mouth or otherwise?—A. No.

63. What enemies interfere with, or destroy the spawn or the young fish? Do the parent fish devour them?—A. I know of no enemies to either, and think the parents do not devour them.

64. Are the young fish found in abundance, and in what localities?—A. Yes: they travel in schools in shallow water.

65. On what do they appear to feed?—A. Never saw them feed on anything.

I.—Artificial culture.

66. Have any steps been taken to increase the abundance of this fish by artificial breeding?—A. No.

K.—Protection.

67. Are these fish protected by law, or otherwise?—A. No.

L.—Diseases.

68. Has any epidemic or other disease ever been noticed among them,

such as to cause their sickness or death in greater or less number?—A. No, except sulphur water from the mines along the Susquehanna.

M.—Parasites.

70. Are crabs, worms, lampreys, or other living animals found attached to the outside or on the gills of these fish?—A. Never found any.

N.—Capture.

71. How is this fish caught; if with a hook, what are the different kinds of bait used, and which are preferred?—A. For hook, red angle-worm.

72. If in nets, what kind?—A. Funnel or set net.

73. At what season and for what period is it taken in nets, and when with the line?—A. Pond fish are best in the spring. River fish are caught all the year round, but principally in spring.

76. Is the time of catching with nets or pounds different from that with lines?—A. No.

O.—Economical value and application.

78. What disposition is made of the fish caught; whether used on the spot or sent elsewhere; and, if so, where?—A. The demand of the home market for these fish is in excess of the supply.

79. What is its excellence as food, fresh or salted?—A. It is one of the very best of the small pan-fishes, and has no noticeable small bones.

80. How long does it retain its excellence as a fresh fish?—A. As long as any other fish, and longer than most of them.

81. To what extent is it eaten?—A. It is eaten and relished by all classes of people, and they would eat more of them if they could get them.

82. Is it salted down, and to what extent?—A. It is not salted down, because the demand of the fresh fish exceeds the supply.

83. Is it used, and to what extent, as manure, for oil, or for other purposes, and what?—A. Its quality as a table fish will ever prevent it being used for any other purpose.

84. What were the highest and lowest prices of the fish per pound during the past season, wholesale and retail, and what the average, and how do these compare with former prices?—A. Retail, 12 to 20 cents; average, 15 cents. The price does not vary in our market.

86. Where is the principal market of these fish?—A. They will sell anywhere.

Harrisburgh, Dauphin County, Pa., *March* 21, 1882.

REPORT ON THE EDINBURGH FISHERIES EXHIBITION.

By J. A. LEONARD.

[Dispatch to the State Department; transmitted to the U. S. Fish Commission.]

The International Fisheries Exhibition referred to in previous dispatches from this consulate, was held at Edinburgh, Scotland, opening on the 12th and closing on the 29th of April, 1882. It was, both in the extent of the exhibition and in the attendance it attracted, very satisfactory. Notwithstanding the prevalence of bad weather during much of the time, the attendance was quite large, the number of visitors ranging from 7,000 to 15.000 a day, and aggregating about 150,000 for the whole sixteen days. The visitors were principally from Scotland, and most of them from places easily accessible to Edinburgh. It was remunerative, taking in about $29,000 as the proceeds of admission tickets. The exhibition was under the control of the Scotch Fisheries Improvement Association and other societies, and was intended to include all kinds of articles connected with or illustrative of the fisheries of the world. The number of exhibits was 527, of which 302 were from Scotland, 89 from England, 44 from Sweden, 31 from Norway, 21 from Germany, 12 from Denmark, 4 each from Ireland, the United States, and Italy, 3 each from Russia, France, and Switzerland, 2 from Canada, and 1 each from Holland, Spain, Iceland, China, and Africa. It will be noticed that there were very few exhibits from the United States.

Messrs. Conroy, Bissett & Mallison, of New York, had on exhibition some samples of fishing-rods of their manufacture. Their peculiarity consisted in being made of cane split and joined in such a way as to secure lightness, combined with strength, and they were, besides, very handsomely finished. I was told by a Scotch manufacturer that the Americans gave their rods a finish that cannot be got in this country, but that the American article costs more than those made here, say about $5 on a $30 set. A silver medal was awarded to Conroy, Bissett & Mallison for their exhibition of rods and tackle. The Gloucester Isinglass and Glue Company, of Gloucester, Mass., made an excellent exhibition of several varieties of isinglass and glue manufactured from fish-skins, samples of articles in the manufacture of which they are used, specimens of fish-skins before manufacture, and samples of guano. They were awarded a silver medal for glue and isinglass, a silver medal for the application of them to many useful ends, and a diploma for guano made from the refuse of the company's manufacture. E. G. Blackford, of Fulton Market, New York, sent from there samples of American fresh fish, striped bass, shad, red snapper, pompano, and brook trout. Hugh D. McGovern, of Brooklyn, N. Y., had on exhibition a rare prepared specimen, a year-old trout, surmounted by the fish-eating bug, *Belastoma* *grandis*, which was destroying the fish by piercing its head. There were some samples of canned fish from the United States, exhibited by importers, among collections showing their imports from different countries. Models of California salmon-breeding trays with catch-box were exhibited by Max von dem Borne, of Berneuchen, Custin, Prussia. He was awarded a silver medal for the deep and for the plain California trough. A collection of very handsome, large, colored illustrations of the game water fowls and game fishes of America were exhibited by Professor Archer, director of the Edinburgh Museum of Science and Art. A series of large, handsome photographs of American salmon were exhibited by John Clark, of Glasgow, Scotland, for which he was awarded a diploma. A plaster cast of an American black bass was exhibited from the collection of the late Frank Buckland.

The most extensive contribution to the exhibition was the Swedish collection, comprising preparations from the Gotenborg Museum, showing all the stages of development of fish and their condition at different periods of life, a large number of scientific specimens and curiosities obtained in the Arctic voyage of Professor Nordenskjold in the Vega, and a great variety of products of the fishing industry of Sweden. In the department of the history of fishing there was an interesting collection of fishing implements found in the Swiss lake dwellings, which were sent by the Society of Antiquaries of Zurich. In the loan collection were a great many very fine specimens of stuffed fishes and aquatic birds and casts of fishes, the largest display being from the museum of the late Frank Buckland, at London. There was a good display, more than one hundred exhibits, of cured, packed, and preserved fish, principally from Scotland, but a large proportion from Norway.

A prominent feature was the exhibition of boats and implements used in fishing, including a number of models of boats of various classes, especially those adapted to herring fishing. The frequent losses of life that have occurred by the destruction of fishing boats off Scotland and neighboring coasts have made the substitution of safer vessels than those now in use of great importance, and the increased profits resulting from the use of steam trawlers has made the substitution of steam for sails on fishing craft generally a question of much practical interest.

Pisciculture has not received the attention in Scotland that might be expected from the importance here of the subject, but interesting displays of hatching and feeding apparatus were made from the hatcheries of Byram Littlewood, of Huddersfield, England; Sir James Gibson Maitland, of Stirling, Scotland, and Joseph J. Armistead, of Dumfries, Scotland. Mr. Littlewood also exhibited oysters produced by artificial contact of the sperm and ova in artificial sea water by a process of his invention. He claims that, while an American experimenter has succeeded in hatching the oyster, no one but himself has succeeded as yet in growing it beyond one of the earliest stages of development. He showed living specimens which he had kept in continuous growth from three to five months, which is as long as he has been experimenting in that direction, and expressed full confidence in the practicability of hatching and rearing oysters abundantly and profitably. Ten thousand fish about three weeks old were on exhibition by Constantine Muszynski, of St. Petersburg, Russia, which had been transported from there in a large glass bottle of his invention, with concave sides, without the loss of more than a dozen of the fry, and in excellent condition. A live sea anemone, *Actinia mesenbryanthemum*, was exhibited, which was taken from the east coast of Scotland in 1828, and has ever since been kept in the jar in which it was shown. It was at that time thought to be at least 7 years old. During a period of 20 years it produced 334 young. In 1851, after being unproductive for many years, it gave birth, in a single night, to 240 young, and last February it gave birth to 7 more, of which 3 were exhibited with it. It is kept in sea water, and is fed once a month with half of a live mussel, and on the following day the water is changed. A number of models of salmon ladders and fish passes were exhibited, those built around high falls in a river in Norway showing the greatest skill in overcoming natural obstacles.

The purification of the water, which, after use in factories, is returned to the streams in a condition fatal to fish, is a subject of great importance in connection with the preservation of the salmon and trout of this country. There were models of apparatus and samples of water exhibited showing the success that had been attained at several places in England and Scotland in separating the impurities in a condition suitable for reuse or merchantable for manure, and returning the water to the streams purified. The Native Guano Company exhibited living fish surviving in water from the factories of Aylesbury, England, which had been purified by this process. An exhibition of Balmain's luminous paint attracted a great deal of attention. The paint, which in the light looks like common white paint, has the peculiar quality of emitting a pale light (phosphorescent in appearance, though said to contain no phosphorus) when shown in a dark chamber, and it is claimed that vessels, buoys, or other objects painted with it may be plainly distinguished at a distance in the dark. A machine for fish-cleaning, the invention of John Ross, of Stonehaven, Scotland, was exhibited. It is claimed that by its use five girls can clean a hundred score of haddocks in three hours, and that the fish are less liable to be injured than by hand-cleaning. It consists of a series of stiff brushes, revolving on a cylinder. Among the nets, Thomas Davidson, of Aberdeen, Scotland, exhibited one called the jackal net, a long, narrow net, by dropping which from a boat it is claimed that it may be seen whether there are any herring under the boat and at what depth.

The exhibition was not only interesting as a collection of a great variety of articles well worth seeing, but there can be no doubt that it has well subserved the main object of its projectors, that of directing attention to the extent and importance of the fishing interest, which constitutes one of the most valuable industries of the country.

UNITED STATES CONSULATE, LEITH, *May* 18, 1882.

THE UTILIZATION OF LOCALITIES IN NORFOLK AND SUFFOLK SUITABLE FOR THE CULTIVATION OF MUSSELS AND OTHER SHELL-FISH.

By **CHARLES W. HARDING,**
Assoc. M. Inst. C. E., King's Lynn.

[Prize Essay, National Fisheries Exhibition, Norwich, 1881.]

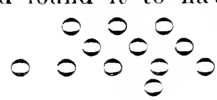
It may be fairly assumed that there is not a square yard of our coasts which has not been visited by the spawn or spat of the mussel (*Mytilus edulis*); and it would therefore appear that, in those places where mussels have not been found, nature protests, as it were, against them; some important conditions necessary for their development must be wanting in the water, soil, or temperature.

Mussel spat, which is free for a short time after extrusion from the parent, will not, as a rule, attach itself in any quantities on a barren sand, but will attach itself in large quantities on sands which contain cockles, although those sands may appear at first sight to be sterile. As the young mussels which have set on the cockle beds grow and become thicker, the cockles are choked and die; but this is a very insecure resting-place, as from the nature of the soil they are liable to be scattered and destroyed by the sea, unless the bed is well sheltered.

The most favorable locality for the permanent welfare of the embryo mussel is from five to fifteen feet above low-water spring tides, on a beach or shore consisting of sand well covered with clean sea-worn stones, varying from the size of a walnut to that of a cricket-ball and larger; this makes a hard, unshifting bed, not easily disturbed by the action of the sea, unless in very exposed localities.

I do not think it possible to demonstrate by maps where mussels can be best cultivated unless a general survey of the coasts of these islands is made, and such favorable localities delineated thereon.

Mussels may be found attached to various objects. Large quantities are found hanging to the piles of bridges, where the water is not too fresh. They are found in large quantities on buoys and vessels moored at sea, such as light-vessels; but, although they are found in such places, it does not follow that they can be best cultivated there.

In British waters, spatting usually takes place in the early spring, and does not appear to be at all dependent on warm weather. On December 7, 1877, I examined some of the undeveloped embryo taken from a spatting mussel, with a microscope, and found it to have a reddish appearance, and of the following shape,  and about the five-hundredth part of an inch in diameter. It would not polarize, so I conclude the shell was not formed. On December 12, 1879, I found large quantities of mussels to contain similar embryos, the weather at the time being very severe. On December 3, 1880, I found the same. The winters of 1879–'80 and 1880–'81 were exceptionally cold, so that it appears they are not dependent on "heat and tranquillity" for their proper development.

On May 25, 1879, after a very severe winter of about nine weeks' continuous frost, I found on one of the beds under my charge several acres of brood mussels, about the tenth of an inch in length. In the spring of the year 1879 and the spring of 1880 overwhelming quantities of brood were found on the scalps on the east coast of England, which might be measured by hundreds and thousands of acres.

Where mussels are found in thick and dense masses, they will be three years before they are what is called "sizable," that is, two inches in length; but instances are found near low-water mark where a few have become isolated, and have grown much more rapidly.

I do not think that mussels will spat, or rather that the spat will mature, in partially salt water. The only places where I have ever seen any young brood is where the water has the same degree of saltness as the outside sea, which, on the east coast of England, has a density of about 1026½, distilled water being 1000. Although it appears that salt water is necessary at their birth, brackish water is better adapted for fattening and growing, provided they are covered with the tide at high water. I find by experience that the most suitable degree of saltness of the water for fattening purposes is where the density of the water is about 1014. This likewise applies to the fattening of oysters.

To save the bulk of the spat when free is the great object of mussel culture, therefore it is imperative to have the ground of the natural sea bed as free from sand, weeds, and mud as possible, so that the young may have some clean hard substance to which it can attach itself. Ascidians and sponges are very destructive to the young mussel, as they cover the culch, which would otherwise be favorable for their attachment.

Mussels have a great many natural enemies, amongst which may be mentioned the star-fish or five-finger, the dog-whelk (*Purpura lapillus*), the sea-urchin or echinus, sea birds, Danish crows, and sometimes rats; but star-fish deal the most wholesale destruction. I have known ten acres of a thickly covered scalp to be almost denuded in a fortnight. Last summer I had carted from beds under my control between two and three hundred tons of this fish. The star-fish will always attack small mussels in preference to those of larger growth. It first grasps the mussel with its five fingers, and when the mussel opens slightly to breathe and feed, it inserts its stomach, or part of it, into the body of the mussel, when, I believe, digestion commences, and the mussel dies and opens its shell, and the star-fish withdraws its stomach with the meat of the mussel. This operation I have seen performed, in all its stages, thousands of times, upon oysters, mussels, and cockles.

The dog-whelk bores a hole in the shell of the mussel about the size of a small pin-head, and destroys it.

The sea-urchin also bores a hole in the shell of the mussel, but much larger than the dog-whelk, the hole being about the size of a sixpence. This very rarely occurs. I have only seen three instances, and that on large mussels near low-water mark.

Sea birds, Danish crows, and rats break the shell and devour the mussel.

I consider the best and only way that existing natural mussel beds can be properly cultivated and protected is to make them the actual property of some one. If they are allowed to be fished indiscriminately they will quickly become exhausted, as has been the case with hundreds of natural scalps on the coast.

Fifty years ago mussels were very prolific on the east coast of England, and almost every small harbor had its natural scalp outside, which fed the "lays" or fattening grounds inside, to the great profit of the owners of such lays. About that period some ill-starred individual discovered they were valuable for manure, when commenced a raid on the scalps, which is the origin of their present downfall. I can remember, as a boy, seeing hundreds and thousands of tons brought to land and sold to the farmers for manure, at three-halfpence a bushel.

An act was passed by Parliament in 1868, called "The sea fisheries act, 1868," which enables the board of trade to grant provisional orders to corporations and private individuals to regulate oyster and mussel fisheries; but the result, so far, has been very unsatisfactory. The reports of Mr. H. Cholmondeley Pennell and Mr. W. E. Hall, two of the inspectors of fisheries, on the oyster and mussel fisheries, at eighteen different stations, show the beds to be worked in a very unsatisfactory manner.

Mr. Hall reports in 1877 that the Boston corporation undertook to regulate the fishing in Boston deeps in the year 1870, so as to maintain the supply. The oyster beds, he states, remain in the state of denudation which characterized them in 1869. The supply of mussels, however, seems to be rapidly diminishing, from the persistent poaching of the fishermen and from want of power of the corporation under their "order" to close a sufficient portion of the ground every year. A similar "order" was granted to the corporation of King's Lynn in 1872. Mr. Hall reports on this "order" that the corporation system of management in regard to mussels is dangerous to the permanent welfare of the fishery, whilst as regards oysters the order is not carried into effect.

Under clause 4 of the order, the corporation is compelled to keep open for fishing two-thirds of the area of the oyster and mussel beds, thus leaving a large porportion of the whole in a great measure at the mercy of the fishermen; and Mr. Hall justly points out the danger to which the mussel beds of the wash are necessarily exposed from this provision.

When a mussel bed is opened by either of the above-mentioned corporations, a day is fixed and duly advertised, and at twelve o'clock at night scores of boats commence taking the mussels, some by tons and some only by a few bushels. The next day the markets are glutted with small mussels, and in some instances I have known them to be unsaleable. Even at the best they only make very small prices, whereas if they had been gradually sent to the various markets good prices would have been made. These provisional orders are simply a farce, as far as regards providing the long-line fishermen with mussels.

I am the lessee of about eleven miles of sea beach on the Norfolk coast, belonging to Hamon Le Strange, esq., whose title to the proprietary right descends from a grant made in the eleventh century by William II to William d'Albini, his butler.

The fishing on this beach consists of mussels, cockles, clams, 'winkles, and a few oysters.

When I hired the fishing, six years ago, there was not one ton of mussels on the whole eleven miles. I appointed watchers, enforced a close time, cleaned the ground, and endeavored to keep off poachers, but with very indifferent success. Mr. Le Strange, in 1879, applied to the board of trade for the grant of an order for the establishment and maintenance of a several oyster and mussel fishery, under the powers of "The sea fisheries act, 1868," so as to provide a better protection for the fishery. The board of trade sent an inspector down to hold an inquiry as to the proposed order, but from that day to this the order has not been granted.

If such an order could be obtained it would greatly benefit the long-line fishermen off the coasts of Northumberland and the south of Scotland, as I have special railway rates to all the ports on these coasts, and can afford, when I have any mussels, to deliver them at a reasonable price for bait. The importance of mussels for bait to these deep-sea line boats is incalculable.

Mr. P. Wilson, Her Majesty's fishery officer at Eyemouth, in Scotland, reports that in one week the boats from Burnmouth, Coldingham, and Eyemouth used for baiting their long lines 61 tons of mussels. They landed, with this quantity of mussels, 25,620 stone of haddocks, besides a considerable quantity of cod and whiting, and got for the fish 1*s.* 8*d.* per stone, equal to about £2,500. Observe, in one week alone 61 tons of mussels were used at these three fishing stations for bait, the cost of which was about £160, the produce in fish from which was 25,620 stone, worth £2,500. Mr. Wilson also reports that when the fishermen are unable to obtain mussels, they have had to bait their lines in many instances with bullock's liver, and be content with half a catch of fish.

The greatest trouble I have in protecting my mussel beds is from a class of men who call themselves fishermen, but who are half farm-laborers and half fish-hawkers, and are the scum of the villages bordering on the coast. I have lost from two to three thousand tons of mussels in one year by these men, which would otherwise have gone to Scotland to be used as bait by real fishermen. All of this might have been prevented had the board of trade granted a provisional order for this fishery when requested. I have read somewhere that the definition of the word "fisherman" is a man skilled in fishing, who proceeds to sea in a vessel, and by means of an engine catches fish. The men who rob me of my mussels do not proceed to sea, and have no skilled knowledge of fishing. They also rob the country of an enormous quantity of fish food, which would otherwise be caught and consumed. Taking Mr. Wilson's figures that sixty-one tons of mussels will catch £2,500 worth of haddocks, cod, and whiting, one thousand tons of mussels would catch about £41,000 worth of fish.

I consider that where natural beds of mussels have once existed and the ground has not altered, there new mussel beds may be established and cultivated; but the government must grant provisional orders to persons desirous and willing to take in hand the cultivation of mussels and oysters, and not allow the officials at the board of trade to prevent the granting of such orders. The orders must enforce heavy penalties on persons illegally taking the mollusks, and provide for the imprisonment of those people who are unable to pay the fines and costs, as the greatest amount of poaching is done by the impecunious inhabitants of the villages adjacent to the shore, and whose forefathers, a hundred years ago, were the wreckers and smugglers of that age; in fact, illegally taking oysters and mussels from a several fishery should be felony.

Mussels are largely cultivated on the Continent. The exports from Antwerp for Paris alone, as recorded in the "*Halles Centrales Statistics*," for the season of 1873, amounted to 7,000,000 francs (£280,000), which are the produce of natural beds and scalps unimproved by man's care.

In the town of St. Valery-sur-Somme, in France, artificial breeding, rearing, and fattening of mussels, upon principles akin to those which obtain in ostreaculture, is carried on, and the success attained is such as to be worthy of a record in the history of attempts made to utilize the unbounded wealth of food lying ready to man's hand along the seashore. Lines of wattled stakes, averaging 530 yards in length, are driven in the sand close to the fair-way, just above low-water mark. These *les bouchots de grand flot* extend over 25 acres. They serve for fixing the spat, which is floated up to them by the tidal currents, and constitute a collecting ground for brood, which are afterwards removed into shallow tanks of about 50 acres, dug out high on the strands between the tide marks. They are puddled with clay and fitted with sluice-gates. The salt water in these tanks is slightly admixed with soft river water. They also serve as nurseries for the young mussels, which hang in clusters and gather on wattles. When they attain proper size for transplanting they are removed into the *parc*, where they will grow and develop into marketable mussels. All this is being successfully carried out by M. Lemaire, who obtained from the French Government, in 1873, leave to appropriate a small strip of 40 acres of the foreshore fringing the low sandy estuary of the Somme. The success of this short experiment was so marked, that after an official visit paid by the minister of marine, Admiral Fourichon, and a number of *savants*, including M. Coste, who had predicted a failure, that the original concession was extended to 620 acres.

There are numerous other places on the continent of Europe where oyster and mussel culture is successfully carried on.

The secret of the whole matter is, that where mussel and oyster culture has proved successful, the person undertaking the same has obtained a concession from the government to work the beds exclusively himself, and has not been hampered by other persons claiming a right to fish on his grounds; in other words, fishings are worked in precisely the same way as farms on the land, where the farmer sows his seed and at the proper season reaps his corn.

In England the laws allow the seed to be sown and protected to a certain extent, and when the mollusks are a certain size, *i. e.*, 2½ inches for oysters and 2 inches for mussels, the whole world is free to come and fish on the beds by taking out a nominal license, which is at the rate of 3*s.* 6*d.* per ton on the burden of the smack for one year, or 9*d.* per ton per month. This applies only to fisheries worked under the "Sea fisheries act, 1868."

To make the oysters and mussels the actual property of some private individual or body corporate, appears at first sight to be rather hard on the so-called fishermen, but it must be borne in mind that any person who undertakes to properly cultivate a portion of the foreshore for the increase of oysters and mussels must be in a position to extend a certain amount of capital, and therefore he would not, very probably, do much manual labor, but confine his energies to the employment of watchers or water bailiffs, to the making of "lays" or "parcs," by digging large reservoirs between tide marks, and the various other expenses contingent upon the enterprise; so that the supply of mollusks would be greatly increased, and the fisherman or laborer employed would have more work than he has under the present exhausted state of things.

I wish this essay to be read in conjunction with my "Essay on the artificial propagation of anadromous fish, other than the salmon, and the restocking the tidal waters of our large rivers artificially with smelts, &c."

Under the "orders" granted to the corporations of Lynn and Boston for the cultivation of oysters and mussels, they have collectively jurisdiction over 229 square miles in the Wash, and I have no hestitation in saying that, if the mussel beds within this area were properly worked, they are capable of supplying the whole of the long-line fisheries of the country with bait.

MARCH, 1881.

MOVEMENTS AND CATCH OF MACKEREL.

By S. J. MARTIN.

[Letter to Prof. S. F. Baird.]

This year I have watched closely the movements of mackerel and made frequent inquiry about them of the fishermen as they daily arrive from their trips. It seems to be a very general opinion among the most experienced masters of the mackerel vessels that mackerel very seldom school in deep water; that is, in water over fifty fathoms in depth. They are rarely taken in water fifty fathoms deep, but so far this year they have been most abundant in from thirty to forty-five fathoms. About the 12th of June they were taken together with shad in Boston Bay in shoal water, but in no great abundance. Captain Melanson, in schooner Crest of the Wave, got 28 barrels of mackerel on the above date off Highland Light, and with the mackerel he took 8 barrels of shad. These were caught in 35 fathoms of water. Other vessels caught more or less of these mackerel as they moved eastward. They appeared to move quite close inshore until they reached the vicinity of Portland, about the 20th of June, when they disappeared. Since that date no quantity has been taken within 15 miles of the coast and but few within 40 miles. Trap-fishing for mackerel, as well as drag-net fishing, has been very unprofitable. This is very different from last year and the year before, when the trappers and netters made a good year's work, and the harbors were full of mackerel from the middle of June until late in July. The market boats last year found plenty of mackerel throughout July in Boston Bay, so that they could make short trips; but this year they have been obliged to go farther to the eastward, getting fare from Cashe's to the head of the Bay of Fundy. Where last year these vessels could make three trips a week they now seldom make more than one or two. More fresh mackerel have been taken to Portland this year than usual, that port being very much nearer the fishing grounds than Boston or Gloucester. In Portland these fresh fish are sold by the pound from the vessel, while in Boston and other ports they are sold by count.

The main body of the mackerel does not appear to have come inshore, but, coming from the southward, they have crossed South Channel, and have been very abundant on George's Banks, being seen by the cod fishermen in great schools, both in the northwest and southeast parts of the Banks, ever since the middle of June, in water from 35 to 50 fathoms deep. The fish that were schooling on the southeast part of George's seem to have struck across towards the Nova Scotia shore, where they were taken in abundance by the trap-fishermen at Barrington, Yarmouth, and other places. None of these have been taken by the trappers since about the 8th of July. Where they have gone to is a mystery to the fishermen. They were big fish, about two-thirds large, as is shown by some bought of the Nova Scotia trappers by two Gloucester vessels, the Joseph Story and J. J. Clark, that purchased about 300 barrels each and sold them in Gloucester about the 20th of June. Many of the fishermen think that these mackerel have gone up across the Gulf of Saint Lawrence, by Saint Paul's Island, towards the Labrador coast. It seems certain that they have not gone to the vicinity of Prince Edward Island, for none of any amount have yet been taken there, and very few taken at Magdalen Islands, and those of poor quality.

To return to George's, the mackerel seen on the northwest part of the bank moved toward Cashe's Bank, and from there to the eastward as far as Grand Manan. One trip, by schooner J. W. Campbell, was taken last week about 10 miles southwest of Grand Manan. This school did not go inshore on the coast of Maine, but kept at least 20 miles off, being taken 20 miles off Monhegan and Matinicus, and from 20 to 30 miles off Mount Desert Rock. Two vessels arrived about July 1, with trips taken on Seal Island ground, about 25 miles W. S. W. from Seal Island, Nova Scotia.

In moving from George's to the eastward they did not school in the deeper water between the banks, but only showed themselves when they reached Cashe's Bank in from 40 to 50 fathoms. Vessels fishing on Cashe's find that the mackerel show up every two or three days, and it is a general opinion that each lot is a different school coming from towards George's. The fish are still moving to the eastward, and it is impossible to tell where they will "bid up." I shall watch their movements with much interest.

The quality of mackerel thus far has been poorer than usual. Last year at this time half were No. 2's, but this year there are not more than one-third 2's. They are long enough, but not fat enough, and the fishermen think the leanness is owing to a scarcity of food. Earlier in the season some food was found in the fish, but now scarcely any is seen in them.

As the fish have been so far off-shore, I have not had much opportunity to observe their condition as regards spawning, but from what I can learn of the fishermen, they are spawning later this year than usual.

The mackerel fleet is very large, 140 sail from Gloucester alone, against about 120 last year, and at other ports there is also an increase in the number of vessels. The catch up to this time is much larger than at the same date last year, and bids fair to exceed any previous year. The price is higher than last year, and the business is now very prosperous. Nine sail of vessels, with 3,000 barrels of mackerel, arrived here this morning, and the fish were all sold before noon at $5.75 per barrel as they run, including the barrel. Barrels are in great demand, and sell readily at $1.15 each, and likely to increase in price. The first of the season they sold at 65 cents apiece. Five thousand arrived yesterday from Bangor by vessel.

GLOUCESTER, MASS., *July* 18, 1882.

NOTES ON THE FISHERIES OF GLOUCESTER, MASSACHUSETTS.

By S. J. MARTIN.

[Letters to Prof. S. F. Baird.]

The number of pounds of fish landed here during the month of May was as follows: George's cod, 2,170,000 pounds; George's halibut, 57,200 pounds; Western Bank cod, 4,381,000 pounds; Western Bank halibut, 33,500 pounds; Grand Bank halibut, 492,000 pounds; shore fish, 768,000 pounds; herring, 625 barrels; salt mackerel, 1,430 barrels. The shore fish consist of one-third cod, the balance pollock, hake, and haddock. The amount of Western Bank fish is the largest that ever was landed in Goucester in one month.

GLOUCESTER, MASS., *June* 4, 1882.

During the past week there were 35 arrivals from George's, with good trips; 11 from Western Bank, with good fares. The George's vessels average 22,000 pounds to a vessel. The Western Bank vessels average 40,000 pounds to a vessel. There have been 12 sail from shore fishing; 20 sail with small trips of salt mackerel; one vessel with fresh halibut. The fishermen are all doing well. Fish of all kinds are high.

GLOUCESTER, MASS., *June* 11, 1882.

Mackerel are plentiful. The vessels catch them from Noman's Land, 40 miles S. E. down to Mount Desert, and thence the whole length of the Nova Scotian coast as far as Cape Canso. There are no mackerel inshore. Last year at this time there were plenty of mackerel inshore, this side of Cape Cod. One vessel arrived last night with 320 barrels from Noman's Land. One vessel arrived from Mount Desert with 270 barrels, 30 miles S. E. from Mount Desert Rock. The farther east the better the mackerel. The mackerel caught off Noman's Land are small. Mackerel are low to-day—$5 per barrel, including the barrel. All the mackerel are sold out of pickle. A fortnight ago, when the first mackerel came along, there were some large shad mixed with them, and some small ones which the fishermen call "smutty-nosed shad," about the size of alewives. The others were large, weighing from 4 to 5 pounds. Some were caught with drag-nets, and some with seines, some of them being taken 8 miles from Cape Cod and some in Ipswich Bay. Six salmon have been caught in traps from Kettle Island to Portsmouth. The Western Bank vessels are bringing in good fares of codfish. The dogfish have struck all along the coast in large schools (driving the shore fishermen off the ground), in such large numbers that the trawls could not be used, as the fish eat them to pieces. One vessel belonging to Marblehead is fitting out to catch them.

GLOUCESTER, MASS., *June* 22, 1882.

Fishing has been good the past month. The mackerel catchers have done well. A large body of mackerel have been down the Nova Scotian coast. Three large fares arrived during the last two days: Schooner Leona, 540 barrels; schooner Henry N. Woods, 440 barrels; schooner I. E. Garland, 400 barrels. These three trips were caught 25 miles W. S. W. from Seal Island, Nova Scotia. Some of the vessels found plenty of mackerel S. E. 30 miles from Mount Desert Rock. When the mackerel get in that locality they seem to stop. Last year mackerel were on the same ground in the months of July and August. The largest mackerel I have seen this year were caught in the traps at Cape Sable. They were two-thirds large. Those now caught on the eastern shore are one-third large, and I think the body of large mackerel passed down the Novia Scotian shore. All the mackerel they have caught in nets from Cape Sable to Canso are large.

Mackerel sell as fast as they arrive. There were 2,000 barrels here this morning. All sold at 12 m. for $5 per barrel; $4 a barrel not rimmed; that is, barrel and all. The first school of mackerel came along the 1st of June; there were some shad mixed with them. Ten days ago, off Portland, some of the fishermen set nets for mackerel and caught some large shad and small ones. They have caught some in all the weirs along the coast. Mackerel and shad will go together; so will mackerel and herring. Two vessels set their seine around a school of mackerel; when they got the seine pursed up they were part herring and part mackerel. Some of the shad are large; some are small. I saw one taken from a trap at Kettle Island which weighed 5¼ pounds. Seven salmon have been caught in the traps at Kettle Island; three caught at Milk Island. The codfish on the shore ground are scarce. Hake are very plentiful. The oldest fishermen say they never saw hake so abundant as they were the first of June. A vessel catching 40,000 pounds salt fish gets two-thirds hake. Last year they would have two-thirds codfish.

The amount of fish landed here during the month of June was as follows: George's cod, 2,514,000 pounds; George's halibut, 99,300 pounds; Western Bank cod, 5,684,000 pounds; Western Bank halibut, 89,400 pounds; shore fish (mixed), 1,235,000 pounds; Grand Bank halibut, 460,000 pounds; received from Maine (mixed), 1,500 quintals; from British provinces (mixed), 3,200 quintals; mackerel, 25,960 barrels; mackerel (fresh to can), 735 barrels; herring, 80 barrels.

GLOUCESTER, MASS., *July* 5, 1882.

During the past week thirty-five schooners have arrived with full fares of mackerel, averaging 300 barrels per vessel. The vessels have done best on Cashe's. A week ago they did well in the Bay of Fundy; some of them doing very well on Cashe's. All the mackerel come across Cashe's. Schooner Eliza Abby set her seine around a school of mackerel, on Friday, on Cashe's, and got so many fish that the middle of the seine was torn away. The vessel arrived this morning with half the seine gone, and came near losing the boat. The captain says he thinks there were 500 barrels in the seine. Mackerel sold yesterday for $6.25 per barrel. I think they will be worth $7 per barrel next week. The last mackerel caught on Cashe's were of good quality. A trip of 330 barrels, packed there Friday, contained 30 barrels of No. ones, 150 barrels No. twos, and 150 barrels No. threes. The mackerel in the Bay of Fundy are not so fat as those caught on Cashe's; the mackerel caught on Friday, just referred to, being the best caught this year. The largest and fattest mackerel are sold as fast as they arrive.

Dried George's cod took a jump yesterday from $6 per quintal to $6.50. George's codfish are scarce. There have been twenty arrivals from George's during the past week, averaging 12,000 pounds to the vessel, selling their fares at $3.50 a hundred out of the vessel. That is the highest price paid for codfish since the war. Codfish are scarce on all the inshore grounds. Hake are plentiful. The fishermen say the hake have not been so abundant for twenty years. Dried fish of all kinds is high. George's cod will be sold for $7 a quintal next month.

I was much pleased, while rowing round the harbor yesterday, to see the name "Spencer F. Baird" on the stern of a new, handsome schooner. Capt. John Viber will command her.

GLOUCESTER, MASS., *July* 23, 1882.

Since Monday morning there have been 63 arrivals with salt mackerel, full fares, the vessels averaging 330 barrels each—the largest week's arrival of mackerel this year. The last sales were at $7 per barrel with the barrel. Two vessels, absent seven days, returned with 400 barrels. The mackerel have all been caught from Cashe's to Grand Manan Island, Bay of Fundy. They are all offshore.

The codfish on the eastern shore is a failure this season. Nothing but hake there. The cod were plentiful last season. The small boats on the eastern shore have not done anything this summer; no cod, no mackerel, no hake inshore. The vessels that fish on the George's Bank find the codfish scarce. Some vessels, absent two weeks, arrived with 4,000 and 5,000 pounds codfish. Codfish are high; sold green out of the vessel at $4.35 per hundred pounds. Dried George's cod sold at $7 a quintal. All kinds of fish are very high.

Schooner Martha C., which arrived last night, reports bluefish plentiful on the western part of Cashe's. There have been no bluefish on the eastern shore this summer inshore. Last Thursday night a large school of whiting, or Old England hake, came in the harbor. All the nets were full of them; two horse-cart loads were taken out of a small trap set in the harbor. Some of them were large and full of spawn.

The dogfish are abundant all along the coast. Captain Gill, in a small vessel, with four men, caught 3,000 in one day on trawls. They yielded 73 buckets of livers, which sold at 55 cents per bucket.

GLOUCESTER, MASS., *July* 30, 1882.

DISTRIBUTION OF GERMAN CARP BY THE UNITED STATES FISH COMMISSION.

By MARSHALL McDONALD.

The number actually sent out in 1881 was from six to eight thousand greater than appears from the subjoined table, many having been distributed through agents whose reports were not available when this table was made. There should also be added, the number of carp distributed in the spring of 1882, those being of the 1881 crop and amounting to five or six thousand. The crop of 1881 aggregated about 160,000.

Summary of carp distribution for the year 1881.

State.	Number of counties represented.	Number of applicants supplied by express.	Number of applicants supplied by messenger.	Total number of applicants supplied.	Total number of fish furnished.	Number of applicants remaining unsupplied.	Total number of applicants.
Alabama	38	28	60	88	1,856	70	158
Arizona	2	......	......	......	......	7	7
Arkansas	17	5	28	33	818	5	38
California	24	......	......	......	......	38	38
Colorado	9	1	......	1	20	18	19
Connecticut	8	21	71	92	2,220	14	106
Dakota	5	......	......	......	......	8	18
Delaware	3	16	42	58	2,100	1	59
District of Columbia	......	1	3	4	86	7	11
Florida	11	2	23	25	432	5	30
Georgia	94	30	380	410	7,681	133	543
Idaho	2	......	......	......	......	2	2
Illinois	62	23	139	162	2,844	24	186
Indiana	52	135	10	145	3,896	27	172
Indian Territory	1	......	16	16	317	......	16
Iowa	29	1	15	16	292	28	44
Kansas	45	5	105	110	2,366	17	127
Kentucky	70	7	489	496	9,732	84	580
Louisiana	24	1	51	52	1,276	6	58
Maine	6	6	......	6	116	5	11
Maryland	28	15	240	255	22,424	9	264
Massachusetts	10	24	3	27	745	21	48
Michigan	20	3	37	40	1,848	9	49
Minnesota	18	4	1	5	100	17	22
Mississippi	55	139	389	528	9,445	97	625
Missouri	50	2	208	210	4,126	54	264
Montana	2	......	......	......	......	2	2
Nebraska	11	6	1	7	120	8	15
Nevada	2	......	......	......	......	2	2
New Hampshire	6	6	......	6	140	5	11
New Jersey	19	49	21	70	1,352	11	81
New Mexico	3	......	......	......	......	6	6
New York	40	140	50	190	4,616	68	258
North Carolina	56	47	115	162	3,104	91	253
Ohio	62	172	35	207	4,258	89	296
Oregon	13	......	......	......	......	35	35
Pennsylvania	54	209	141	350	7,256	73	423
Rhode Island	4	5	20	25	1,140	2	27
South Carolina	26	9	236	245	11,884	11	256
Tennessee	46	34	165	199	4,200	55	254
Texas	112	15	926	941	16,580	9	950
Utah	5	5	......	5	130	5	10
Vermont	3	4	......	4	76	2	6
Virginia	68	172	304	476	11,669	30	506
Washington	......	......	......	......	......	11	11
West Virginia	21	35	41	76	1,935	6	82
Wisconsin	19	10	4	14	296	15	29
Wyoming	1	......	2	2	200	2	4
Total	1,256	1,387	4,371	5,758	143,696	1,244	7,002

WASHINGTON, D. C., *May* 5, 1882.

SHAD TAKEN IN MACKEREL GILL-NETS.

By CAPT. J. W. COLLINS.

[From a letter to Prof. S. F. Baird.]

A Friendship "mackerel dragger"—a 25-ton pinkey—while fishing with mackerel gill-nets in Ipswich Bay, about half-way from the Isle of Shoals to Halibut Point, on the night of June 9, took 27 full-grown shad, which would average $4\frac{1}{2}$ pounds each, besides about a bushel of small shad. The latter have a black tip to their nose, and are called smutty-nosed shad by the fishermen. They are about the size of large alewives, so Captain Martin tells me, who saw both the large and small shad taken by this vessel.

About the 12th of June Capt. David Malonson, of schooner Crest of the Wave, caught about 8 barrels of large shad, but no small ones, in a purse-seine, 8 miles northeast from Cape Cod light.

The shad were apparently mixed with mackerel, since 20 barrels of the latter fish were taken in the seine at the same time. There have been other instances of the capture of shad by the mackerel fishermen this spring, the particulars of which we have not yet fully learned.

GLOUCESTER, MASS., *June* 22, 1882.

TRANSPORTATION OF LIVE FISH.*

[From the official report of the International Fishery Exposition, Berlin, 1880.]

The following report relates mainly to the means of transporting live fish, exhibited in Class IV, with the exception of those destined for the transportation of young fry. With regard to these, competent pisciculturists who have a larger experience will report. It is only the transportation of large fish, such as are brought to market, are exhibited in aquaria, and are used for stocking ponds, of which I intend to speak in this report.

The comparatively small number of articles exhibited to illustrate the transportation of live fish—whilst nearly all other departments of the exhibition were well represented—showed clearly how little the development of means for transporting fish has advanced of late years. It certainly has not kept pace with the rapid development of general means of transportation. The great importance of fish, more especially of salt-water fish, as a popular article of food urgently demands that suitable means of transporting fish should be furnished. This applies particularly to transportation by railroad. For transporting fish by water the

* "*Transport lebender Fische*," from *Amtliche Berichte über die Internationale Fischerei-Ausstellung zu Berlin*, 1880. Translated from the German by HERMAN JACOBSON.

old method, to have perforated vessels, mostly in the shape of boats, fastened to boats, to be towed by them along the rivers, may be considered satisfactory as far as common vessels and fishing-boats are concerned, whilst it is not suited to transportation by steamers.

With regard to transportation by steamer, Messrs. Busse & Co., of Berlin, have taken a step in the right direction. This firm constructed some years ago a steamer specially arranged for transporting live fish, which carries regularly the fish accumulated at various points of the Swedish and Danish coasts (mostly eels) to Stettin, whence they are carried by water in perforated vessels to Berlin, which city is reached in about 60 hours. Berlin has, in consequence, become a considerable market for eels, and this trade is growing in importance from year to year. The above-mentioned firm alone sells annually about a thousand hundred-weight of eels.

Under No. 518, Messrs. L. Busse & Co. had exhibited a model of their steamer. The illustration of the steamer shows in the center the per-

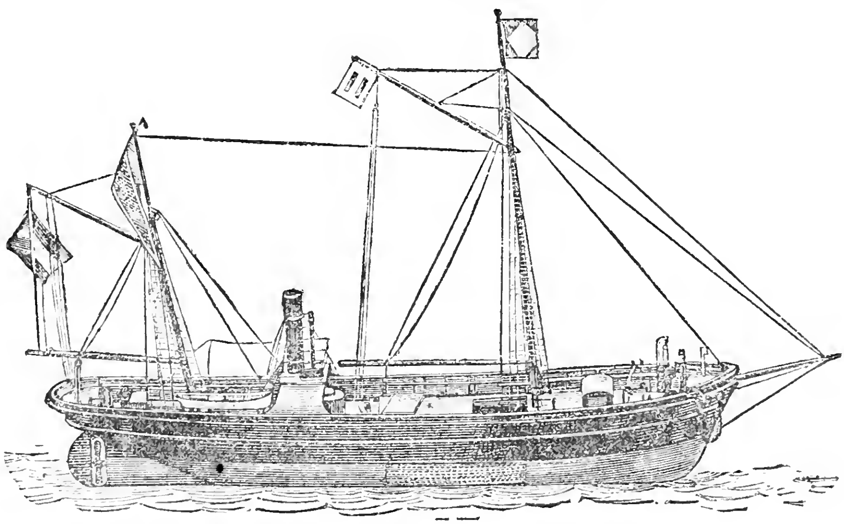


Fig. 1.

forated vessel for the fish, the cross walls of which are, of course, water-tight.

The eel, being accustomed to migrate from the rivers to the sea, and *vice versa*, can easily stand the transportation through salt and fresh-water.

Whilst this method of transporting fish by water has been very successful, transportation by railroad is still in an exceedingly backward condition. The difficulties to be overcome are, of course, much greater, because the natural conditions of transportation by water have to be artificially supplied. In addition to this, there is the extraordinary increase of the cost of transportation, owing to the quantity of water, which is in itself absolutely worthless, but is nevertheless necessary for live fish. Supposing I ship by railroad a barrel containing 10 per cent. fish and 90 per cent. water, and it will be seen that I pay the railroad company ten times the freight which I pay for other goods.

If I received by railroad ten pounds of meat, vegetables, or other articles of food, I get for the price of the freight the full weight, with the exception of the tare. Ten pounds of fish, however, demand, in the first place, 90 pounds of water, and, besides this, the tare weight of the cask or barrel, which is generally very heavy.

With some fish the proportion is still more unfavorable, thus especially with those which are brought to Berlin from distant seas for the purpose of stocking aquaria. In this case we can only count about 1 pound of fish to 100 pounds of water, so that nearly the entire freight is paid for absolutely useless matter, viz, water, and very frequently it happens that when fish arrive at their destination they are found to be dead! The transportation by railroad of live fish, therefore, offers difficulties which can hardly be overcome. As long as the railroad companies do not lower their rates for transporting fish, live fish, and more especially salt-water fish, will never be regularly shipped by railroad. The rates of freight are so high that only persons of means will be able to enjoy the luxury of fresh salt-water fish in inland towns.

For transporting other articles of food, live cattle, beer, &c., the railroad companies have everywhere provided special cars, whilst nothing has been done for the transportation of fish. In my opinion, however, it is absolutely indispensable that special cars should be provided for transporting live fish, if any trade in this article is to be built up, and if greater safety to the fish is to be guaranteed. It will hardly be possible to provide such cars by private means. The expense, the question where to keep them, the comparatively small use which the owner would have of them, the matter of rates, &c., all these are great difficulties, which, however, would be overcome at once if the government would make a beginning. As the state has of late years become the owner of nearly all our railroads, this would be the most natural solution of the problem. Years ago I entertained the idea of urging my company to procure a specially-constructed car for transporting fish for the Berlin Aquarium; but in consequence of the hard times, and in consideration of the fact that unless likewise used for some commercial purpose there would not be sufficient use for such a car, I gave up the idea. The exposition again revived the idea of having a special car constructed for the transportation of fish. In conjunction with the royal inspector of railroads, Mr. Bartels, I therefore drew up a plan, which I hope will be favorably received by the administration of railroads and be carried out by them. Quite recently an Austrian railroad official has got a patent for a specially-constructed car, which is principally intended for the transportation of fresh fish on ice, and of live fish.

Kretschmer's model of a specially-constructed railroad car, which was exhibited under No. 522, seemed impracticable and not sufficiently adapted to the purpose.

There is not the slightest doubt that the consumption of salt-water fish would increase very considerably if we could succeed in bringing them to the inland markets in a live condition. The prejudice of the general public against dead fish, if they be ever so fresh, is so deeply rooted that it would be utterly in vain to expect that it will be overcome very soon. During the hot summer season there is, moreover, great danger that salt-water fish will spoil during a journey of any length.

At present fresh-water fish are generally transported in kegs or barrels, two-thirds or three-fourths filled with water. The quantity of fish to each barrel depends on their kind, the season of the year, the temperature of the water, and the length of the journey. For short journeys no special arrangement is necessary, whilst for long journeys some precautionary measures are absolutely required. Fish need oxygen just as much as other animals, and this they find in the element in which they live. Water contains (though not in very great quantities) air—a mixture of oxygen and nitrogen. Consequently water contains oxygen, and receives new supplies of this element from the air with which it comes in contact. In water with little or no oxygen, fish will soon perish. The demand for oxygen is, of course, greater the more fish are contained in a comparatively small quantity of water. In rivers or in the sea the number of fish is so small as compared with the quantity of water that there will never be any lack of oxygen; but if fish are to be kept or transported in a limited quantity of water the introduction of air is absolutely necessary. During the journey the water in the vessel, which is not entirely filled, is in constant motion, and therefore presents a considerable surface to the air, so that during a short journey sufficient oxygen is in this manner introduced into the water. If the water stands for any length of time it must be agitated, or air must be introduced in some way. In shaking the vessels, however, the fish suffer, and it is therefore better to introduce air into the water direct. This may be done by filling with water a simple squirt or sprinkler, such as gardeners use for watering flowers, and by squirting this water into the vessels with some force from a short distance. The same end may be obtained by lashing the water by a vertically-placed fly-wheel, fastened to one part of the vessel, and separated from the other part by a perforated wall. Sometimes vessels are provided with a tube of turned iron or brass which has many small openings in the place where it rests on the bottom. This tube is connected with a pair of bellows or a rubber bag placed outside the vessel, and through it air is introduced into the water.

Mr. Schuster, mayor of Freiburg (Baden), has, in the transporting vessel exhibited by him, replaced this contrivance, which frequently needs repairing, by a simple but far more expensive air-pump, A, which consists of a metal vessel in the shape of a broad cylinder, with a leather lid or valve, the piston of which can be moved up and down with the hand. At the first pressure the tube is emptied and air enters into it, which at the second pressure enters the water through the openings in the tube, &c. At B there is a tin ice-box, which should not have any sharp edges, against which the fish might hurt themselves.

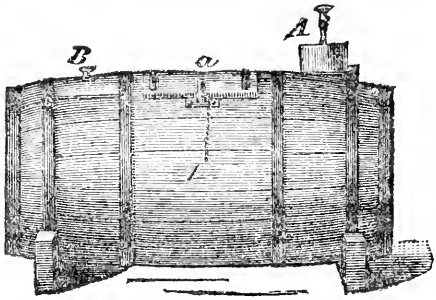


Fig. 2.

As regards fresh-water fish, it may be laid down as a general rule that they will keep best when transported in water of the lowest possible temperature. The colder the water the more oxygen will it absorb, whilst the quantity of oxygen consumed by the fish will decrease in proportion as the temperature gets lower. The lowering of the temperature, therefore, offers a twofold advantage, and the use of ice cannot, consequently, be too strongly recommended. To avoid any violent concussions, which might hurt the fish, the barrel may be placed on springs, as was shown in a transporting vessel from Velp, Holland.

Of the different methods of introducing air I prefer the one where air is introduced through tubes by means of an air-pump or bellows, because thereby the hurtful carbonic acid formed by the breathing process of the fish is more thoroughly expelled, and the vessel can be entirely filled with water. Beating or lashing the water is always injurious to the fish.

As long as specially-constructed railroad cars for transporting live fish are not provided, persons who ship live fish will have to resort to various more or less satisfactory means of transportation. For the use of the Berlin Aquarium I have constructed an apparatus which I consider as specially suited for transporting fish a considerable distance. It was exhibited under No. 514. It had been my object to meet the following conditions, which have to be considered more or less in transporting fish: 1, to provide sufficient air for the water; 2, to keep the water free from slime and other impurities; 3, to maintain a suitable temperature; 4, to prevent the beating or shaking of the water, and thus to protect the fish from injuries. Fish with broken scales or fins will not keep well.

This object I have reached in the following manner by connecting three vessels:

From the transporting vessel proper, No. 1 (see Figs. 3 and 4), as much water flows into vessel No. 2, on the same level, as is introduced from the raised vessel No. 3. Through the spigot *d* the water flows into an air-tight rubber tube connected therewith, which empties at the bottom of the vessel, or near it, at the place marked F, which is as far removed from the outlet as possible. At D some thin air-tubes are connected with the spigot (or rather soldered to it), through which a sufficient quantity of air is brought in from the water flowing through the tube, and rises and bubbles at F. The more powerful the current of the water, and the higher the pressure in vessel No. 3, all the more abundant will be the quantity of air which enters the water. The water flows out above a perforated inner lid, where at E a connection is made with the vessel destined for the outflowing water by means of a rubber tube. The water first of all flows into a perforated vessel containing

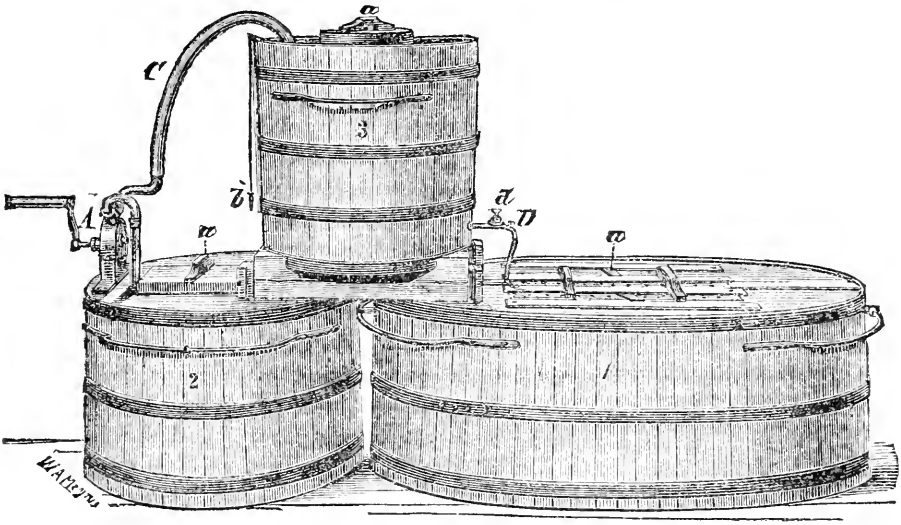


FIG. 3.

fine gravel—the filter—and thus enters the vessel No. 2 in a purified condition. By means of a simple suction and forcing pump, A, with the sucker B, the water is, through the tube C, pumped into the raised vessel. In the center of the firm outer lid there is a perforated stopper, *a*, and below it a large opening in the inner lid, which can also be closed by a perforated lid; this is intended for filling, removing, and observing the transporting vessel No. 1. A floating lid, *c*, in vessel No. 3 indicates the height of the water by a plummet, *b*, connected therewith. Through the lid *a* the quantity and temperature of the water in vessel No. 2 can be observed, and, if necessary, it can be cooled off by means of ice.

In this manner all the necessary conditions are fulfilled. The shaking of the water has been rendered impossible, as in consequence of the outlet-pipe, fastened between the upper and inner lids, the vessel is always entirely filled with water, and is still sufficiently provided with air. The introduction of water with the air at the bottom of the vessel serves to expel the carbonic acid and thus constantly renews the water. Whilst the raised vessel can be pumped full in 15 minutes, it takes the water several hours to flow out, so that the person in charge of the fish is not worked too hard. This apparatus has been very successfully used in the journey from Trieste to Berlin, which lasts 72 hours. Vessel No. 1 contains 24 hundred-weight, and the two others half that quantity. If there are enough persons to superintend and do the work, vessel No. 3 can be dispensed with by pumping water from vessel No. 2 into vessel No. 1 direct, through tube C, which should be *provided with air-tubes*, and which must reach to the bottom of the vessel. I prefer this method to the first-mentioned one, as in consequence of the greater pressure of the water, produced through the pump, larger quantities of air can be intro-

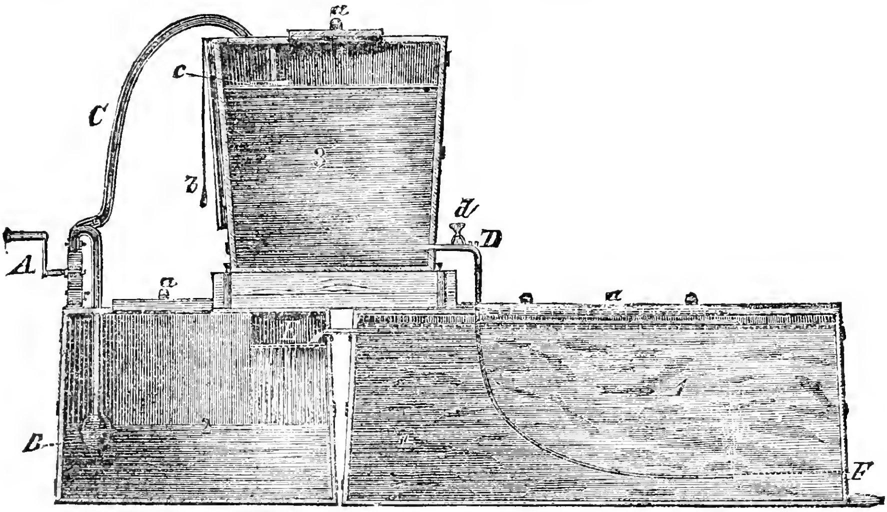


FIG. 4.

duced into the water. It is also possible to introduce air simultaneously into several vessels by one pump, by means of several narrow tubes, which must of course be furnished with air-tubes. In the projected railroad car for transporting fish the airing of the various transporting vessels is to be accomplished on this principle.

In transporting fish any considerable distance some precautions should be observed, which I must briefly mention in conclusion. If possible, only perfectly sound fish should be transported; these fish ought to be kept confined for some time prior to being transported; a few days before the journey is commenced no food should be given to them, so that there is no danger that the water becomes impure by the vomit or excrements of the fish. It is advisable, if any way possible, to change the water during the journey. This is of course easier with fresh-water than with salt-water fish, as it is nearly always possible to obtain good spring water during the journey. It is more difficult, but not impossible, to change sea water during the journey. For this purpose concentrated salt water, such as is for sale at the Berlin Aquarium, should be taken along, and to it should be added 6 times its weight of pure spring water. During the journeys from Trieste to Berlin the change of the salt water has several times been made at Vienna. For transporting marine animals artificial salt water is to be preferred to the natural salt water. The latter contains organic matter, especially a large number of animalcula belonging to the copepods, infusoria, &c., which soon die and make the water turbid and impure. No such danger need be apprehended if artificial salt water is used. I therefore strongly recommend the use of artificial salt water for transporting marine animals.

FISHING AND CONSUMPTION OF FISH IN NEWFOUNDLAND.

By M. HARVEY.

[From letter to Prof. S. F. Baird.]

Regarding the local consumption of fish of course it is only possible to form an estimate, as there are no returns. I have consulted with two or three persons well acquainted with the fisheries and the habits of the people, and taking their opinions into account, and what I myself know, I should judge that the consumption of codfish here might be safely estimated at a quintal and a half per head of the population, which is now about 180,000. This would give 270,000 quintals as the local consumption of cod.

As to the consumption of other kinds of fish it is so small as hardly to be worth taking into account. The salmon season lasts only six weeks, and in St. John's during that time there is a certain amount used fresh among the middle and upper classes, but the working people hardly ever use it. Where it is caught, which is only in comparatively few localities, a certain amount is used fresh by the catchers, who are few in number. Hardly any of it is used pickled; all is tinned or salted and exported.

Herring are not much used. The Labrador fishermen generally salt and bring home each a keg or half barrel for winter use. The whole does not amount to much, but I could give no estimate of the consump tion of either herring or salmon. Cod is the favorite food.

The seal fishery of this year is one of the very worst on record, owing to the enormous masses of heavy ice and prevailing easterly winds, driving it in on shore, so that vessels could not move about. The number of seals brought into St. John's was 139,222. All the returns are not in for other places, but the whole catch will not exceed 149,222. It is fortunate in one way, as it will help to save the seals longer from extermination, which on the present system is inevitable.

The increased value of the export of cod in 1881, arose largely from enhanced prices caused by failure of the Norwegian fisheries.

ST. JOHN'S, NEWFOUNDLAND, *June* 13, 1882.

CONNECTION OF ABUNDANCE OF MOSS AND OF BLACK FLIES WITH ABUNDANCE OF TROUT.

[From Scientific Farmer, May, 1878.]

It requires but very little imagination to connect the presence of moss growth with the pleasures and convenience of man, so close are the links of facts which join one circumstance with another. In the unsettled wooded regions we find the torment of black flies and mosquitoes, which oppress the inhabitants and render it difficult in the newly-cleared land of Maine to summer young stock. On the confines of the Arctic regions they are mentioned by voyagers as plagues of existence; and they are a serious drawback to the comfort of the tourist who seeks in the Gulf of Bothnia to see the midnight sun. Læstadius says that he will not affirm that they have ever devoured a living man, but that many young cattle, such as lambs and calves, have been worried out of their lives by them. All the people of Lapland declare that young birds are killed by them, which is not improbable, says our author. Wherever in Maine we find trout the most abundant, there we find the black fly, the gnat, and the mosquito in overpowering abundance; and as the country becomes settled these pests of man diminish and disappear; and, as angler-sportsmen note with grief, there is a diminution of the fish, which they ascribe usually to poaching, and to the destruction brought about by the rod, the spear, or the seine; and in cases of late years have endeavored to check this disappearance through the hatching of ova and the restocking of the waters. These gentlemen, however commendable their intentions, have overlooked the fact that there is a relation between the fish and its food; and with the destruction of the moss of the forests the breeding ground of the food insects is taken away, and the food supply thereby diminished. In the clearing of the land and the thinning of the forests are causes at work, through the diminution of the insects which furnish the food to the trout, by the destruction of the mosses, whereby the moisture essential for the development of the insect ova is retained, which acts more disastrously on the fish than the rod or the spear. In proof of this we offer our own experience that insects abound in greater abundance in mossy woods than in second growth; that trout brooks which flow through mossy woods are usually more prolific of trout than neighboring brooks whose flow is through cleared land or second growth; that artificially-stocked ponds and streams in settled regions are never equal to the support of as much trout-life as like streams in the backwoods of Maine; that fishing cannot exterminate trout in the region of the black fly. Let us illustrate by an opposite fact recorded by Williams in his History of Vermont. In a pond formed by damming a small stream, to obtain water-power for a saw-mill, and covering one thousand acres of primitive forest, the increased supply of food brought within reach of the fish multiplied them to that degree that at the head of the pond, where in the spring they crowded together in the brook which supplied it, they (trout) were taken by the hands at pleasure, and swine caught them without difficulty. A single sweep of a small scoop net would bring up half a bushel; carts were filled with them as fast as if picked up on dry land. The increase in size of the trout was as remarkable as the multiplication of their numbers.

We thus have indicated: Diminution of mossy woods; diminution of insect-life, upon which the young prey almost entirely and adult fish largely feed; diminution of fish. Could a more complete circumstantial chain of evidence be required?

Thus the mosses have an importance in supporting that prolificacy of life in the streams which exist in the far North; and the same pests which torment the Indian serve him in one remove as food; the same pests which trouble the frontiersman stock the streams with abundant life to serve him as food, and to attract the angler who employs him as a guide. As the mosses lose their supremacy the black fly disappears, the mosquito diminishes in number, and our streams dwindle in size, and even lose their flow in seasons of drought; and their capacity for supporting trout-life is sadly diminished. In overcoming the wilderness man is necessitated, through the infinite correlations of nature, to destroy the natural sources of food, and through art to sustain himself, less precariously, it is true, but with greater toil, from the land. He promotes vicissitudes of climate, and changed conditions which work to him injury, in order to realize the immediate gains which he desires; but is prone to overlook the causes of his acts, as nature acts through littles, which require thought to connect with their effects; and not the least of her littles are the humble mosses which exist so abundantly where coolness and moisture are to be found.

POISONED WATER IN THE GULF OF MEXICO.

[From the Sunland Tribune, Tampa, July 20, 1882.]

We learn from Capt. William Jackson, of the steamer "Lizzie Henderson," that on his trip from Cedar Key, Tuesday, he encountered a streak of poisoned water, covered with all varieties of dead fish, of more than a mile in extent, off Indian Pass, between Clear Water and Egmont Light. The captain says that a very offensive smell arose from it, and that a good many bottom fish, such as eels, were floating dead on the surface. We opine that this fact upsets the theory of some as to this poisoned water being fresh water from overflow on the mainland, impregnated with poisoned vegetable matter, as there are no streams of any size flowing into the Gulf near where these fish were found.

LIST OF FISHES COLLECTED AT MAZATLAN, MEXICO, BY CHARLES H. GILBERT.

By DAVID S. JORDAN and CHARLES H. GILBERT.

During the fall and winter of 1880–'81, Mr. Gilbert spent ten weeks at Mazatlan, on the west coast of Mexico, in making collections of fishes for the United States National Museum. The following is a list of the species obtained, and the numbers now borne by the specimens in the National Museum. Among the larger fishes, there is usually but a single specimen to each number, but in some cases, especially among the smaller fishes, many specimens are recorded under a single number. The popular names here given are those in use among the fishermen at Mazatlan. A very few species are included, specimens of which were examined in the field, but were not brought home. These are indicated by asterisks (*).

1. **Mustelus lunulatus** J. & G. (29211.)
2. **Carcharias æthalorus** J. & G. (28202, 29549.)
3. **Carcharias fronto** J. & G. (*Tiburon.*) (28167.)
5. **Scoliodon longurio** J. & G. (28306, 28330, 28331, 29541, 29551.)
6. **Galeocerdo tigrinus*** J. & G.
7. **Sphyrna tudes** (Cuv.) M. & H. (28160, 29520, 29540, 29641.)
8. **Sphyrna zygæna** (L.) Raf. (*Cornudo.*) (28134, 29645.)
9. **Ginglymostoma cirratum** (Gmel.) M. & H.
10. **Pristis perroteti*** Müller & Henle.
11. **Rhinobatus leucorhynchus** Gthr. (*Guitarro.*) (28205, 28206, 29547, 29602.)
12. **Urolophus asterias** J. & G. MSS. (28198, 28204, 29542, 29524, 29580.)
13. **Urolophus halleri** Cooper. (28263, 28264.)
14. **Trygon longa** Garman. (*Raia.*) (28188, 28203.)
15. **Pteroplatea crebripunctata** Peters. (28111, 28357, 28298.)
16. **Stoasodon laticeps** (Gill.) J. & G. (*Gavelan.*) (28201, 28278, 28346, 28348.)
17. **Manta birostris*** (Walb.) J. & G. (*Manta-raia.*)
18. **Ælurichthys pinnimaculatus** Steind. (28192, 28347.)
19. **Ælurichthys panamensis** Gill. (*Bagre.*) (28181, 28294, 29174, 29606.)
20. **Arius brandti** Steind. (*Bagre colorado.*) (28230, 29254.)
21. **Arius platypogon** Gthr. (28215, 28259, 28262, 28286.)
22. **Arius assimilis** Gthr. (28161, 28165, 28189, 28210, 28211, 28213, 28216, 28221, 28232, 28234, 28276, 28299, 28304.)
23. **Arius guatemalensis** Gthr. (28140, 28289, 28290, 29284, 29647.)
24. **Clupea stolifera** J. & G. (*Sardina.*) (28125.)
25. **Clupanodon thrissa** (L.) Lac.
26. **Opisthopterus lutipinnis** J. & G. (28126, 28209, 28320, 29224.)
27. **Albula vulpes** (L.) Goode.
28. **Elops saurus** (L.) (28148, 29544.)
29. **Chanos salmoneus** (Forster) C. & V. (*Sabalo.*) (28240, 28278, 28302, 28317, 28362, 29578.)
30. **Stolephorus macrolepidotus** (Kner & Steind.) J. & G. (*Sardina.*)
31. **Stolephorus lucidus** J. & G. (28121, 30884.)
32. **Stolephorus ischanus** J. & G. (29264.)
33. **Stolephorus curtus** J. & G. (29242.)

34. **Stolephorus exiguus** J. & G. (28120.)
35. **Stolephorus miarchus** J. & G. (28119.)
36. **Synodus scituliceps** J. & G. (28392.)
37. **Tylosurus fodiator** J. & G. (*Aguja.*) (28162, 28190, 28323.)
38. **Tylosurus sierrita** J. & G. (*Sierrita.*) (28265, 28378, 29227, 29377, 29378, 29562, 29564.)
39. **Hemirhamphus unifasciatus** Ranz. (*Pajarito.*) (28178, 28180, 29175, 29600, 29607.)
40. **Exocœtus californicus*** Cooper. (*Volador.*)
41. **Muræna pinta** J. & G. (*Anguila pinta.*) (28177, 28197, 28238, 28388, 29608.)
42. **Sidera dovii** (Gthr.) J. & G. (*Anguila pintita.*) (28311.) (Type of *Muræna pintita.*)
43. **Sidera panamensis** (Steind.) J. & G. (*Anguila prieta.*) (28246, 29535, 29591.)
44. **Ophichthys triserialis** (Kaup) Gthr. (*Anguila blanca.*) (28130, 29354.)
45. **Ophichthys zophochir** J. & G. (*Anguila blanca.*) (28277, 28280, 29220, 29239.)
46. **Pisodontophis xysturus** J. & G. (28142, 28247, 29642.)
47. **Muræncsox coniceps** J. & G. (*Anguila blanca.*) (28136, 28141, 29212.)
48. **Fistularia depressa** Gthr. (*Corneto.*)
49. **Hippocampus ingens** Grd. (*Caballito.*)
50. **Atherina eriarcha** J. & G. (29243.)
51. **Mugil albula** L. (*Liza: Macho.*)
52. **Mugil brasiliensis** Ag. (*Liza.*) (28175, 28332, 28338, 28372.)
53. **Chænomugil proboscideus** (Gthr.) Gill.
54. **Myxus harengus** Gthr. (*El Verde.*)
55. **Sphyræna ensis**† J. & G. MSS. (*Picuda.*) (28210, 28297, 28373, 29223, 29536, 29611.)
56. **Remora squalipeta** (Dald.) J. & G. (*Pega-pega.*) (29218.)
57. **Scomberomorus maculatus** (Mitch.) J. & G. (*Sierra.*) (28112, 28222, 28296.)
58. **Caranx vinctus** J. & G. (*Cocinera.*) (28343, 28365, 28366, 29553, 29597, 29649.)
59. **Caranx caballus** Gthr. (*Jurel.*) (28363, 28364, 28380, 29614, 29616.)
60. **Caranx fallax** C. & V. (*Toro.*) (29200, 29437, 29550, 29557.)
61. **Caranx hippos** (L.) J. & G. (*Toro.*) (28293, 29556, 29609, 29617.)
62. **Caranx dorsalis** (Gill) Gthr. (*Pompano.*) (28153, 28220, 28241, 28288, 29233.)
63. **Caranx crinitus** (Akerly). (28382.)
64. **Caranx speciosus** Lac. (*Mojarra dorada.*) (28151, 29592, 29625.)
65. **Selene setipinnis** (Mitch.) Lütk. (29216.)
66. **Selene vomer** (L.) Lütk. (*Caballo.*) (29588.)
67. **Selene œrstedi** Lütk. (28352.)
68. **Oligoplites altus** (Gthr.) Gthr. (*Monda.*) (28183, 28274, 28354, 28360, 29558, 29582, 29589.)
69. **Oligoplites occidentalis** (L.) Gill. (*Monda.*) (28359, 29208, 29209, 29225.)
70. **Trachynotus rhodopus** Gill. (*Palometa.*) (28110, 28233, 28329, 28353, 29633.)
71. **Trachynotus fasciatus** Gill. (*Palometa.*) (28137, 28325, 28326, 28381, 29555, 29605, 29628, 29786.)
72. **Nematistius pectoralis** Gill. (*Gayo.*) (28193, 28194, 28341, 28351, 28370.)
73. **Centropomus robalito** J. & G. (*Robalito, Constantino.*) (28102, 28128, 28132, 28150, 28310, 28321, 29228, 29562, 29564, 28395, 28334.)
74. **Centropomus pedimacula** Poey. (*Robalito.*) (28138, 28147, 28149, 28271, 29203, 29568, 29569, 29773, 29780.)
75. **Centropomus nigrescens** Gthr. (*Robalo prieto.*) (28101, 28156, 28249, 28376.)
76. **Centropomus undecimalis** (Bloch) Lac. (*Robalo: Robalo paleto.*) (28258, 28291, 28300, 28335, 29590, 29640.)
77. **Rhypticus xanti** Gill. (29234.)
78. **Epinephelus quinquefasciatus** (Bocourt) J. & G. (*Meron.*) (28283, 28307, 28318, 28358.)

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† *Sphyræna ensis* Jor. & Gilb. spec. nov. = *Sphyræna forsteri* Steindachner, Ichthyol. Beiträge, vii, 4, 1878, not *Sphyræna forsteri* Cuv. & Val.

79. **Epinephelus sellicauda** Gill. (*Cabrilla.*) (28104, 28324.)
80. **Epinephelus analogus** Gill. (*Cabrilla.*) (28235, 28256, 28314, 28356.)
81. **Trisotropis rosaceus** (Streets) J. & G. (28131.)
82. **Alphestes multiguttatus** (Gthr.) J. & G. (29235.)
83. **Serranus maculofasciatus** Steind. (28207, 29221, 29620.)
84. **Serranus calopteryx** J. & G. (28123.)
85. **Lutjanus guttatus** (Steind.) J. & G. (*Flamenco.*) (28144, 28152, 28199, 28224, 28227, 29202, 29603, 29604, 29766.)
86. **Lutjanus argentivittatus** (Peters) J. & G. (*Pargo amarillo.*) (29652, 29627, 29658, 29777, 29781, 29785, 29794.)
87. **Lutjanus novemfasciatus** Gill. (*Pargo prieto.*) (28196, 28231, 28384, 29567, 29779, 29787) (types of *Lutjanus prieto*).
88. **Lutjanus colorado** J. & G. (*Pargo colorado.*) (28261, 28305, 28383, 28386.)
89. **Lutjanus aratus** (Gthr.) J. & G. (*Pargo raizero.*) (28145, 28159, 28238, 28272, 28393, 29576, 29585.)
90. **Hoplopagrus güntheri** Gill. (*Pargo.*) (28115, 28164, 28367, 29581, 29531, 29629.)
91. **Calamus bajonado** (Bl. & Schn.) Poey. (*Mojarra garabata.*) (28135, 28312, 28374, 29206, 29572, 29624, 29646.)
92. **Pomadasys virginicus** (L.) J. & G. (28266, 28301, 28339, 28350.)
93. **Pomadasys dovii** (Gthr.) J. & G. (28251, 29533, 29626.)
94. **Pomadasys interruptus** (Gill) J. & G. (*Mojarron.*) (28169, 28170, 29593, 29637.)
95. **Pomadasys cæsius** Jor. & Gilb. (28158, 28333, 29632, 29771.)
96. **Pomadasys panamensis** (Steind.) J. & G. (28114.)
97. **Pomadasys macracanthus** (Gthr.) J. & G. (*Burro prieto.*) (28279, 29565, 29548, 29635, 29638, 29639, 29764, 29796.)
98. **Pomadasys branicki** (Steind.) J. & G. (29205, 29222, 29237, 29238, 29797.)
99. **Pomadasys elongatus** (Steind.) J. & G. (*Burro blanco.*) (29543, 29559, 29586.)
100. **Pomadasys leuciscus** (Gthr.) J. & G. (*Burro blanco.*) (29227, 29539.)
101. **Pomadasys nitidus** (Steind.) J. & G. (*Burro blanco.*) (28179, 28185.)
102. **Pomadasys axillaris** (Steind.) J. & G. (*Burro blanco.*) (28191, 29227, 29554, 29579, 29594.)
103. **Pomadasys chalceus** (Gthr.) J. & G. (29207, 29217, 29241.)
104. **Diabasis sexfasciatus** (Gill) J. & G. (28103, 28308.)
105. **Diabasis scudderi** (Gill) J. & G. (*Mojarra prieta.*) (28242, 28282, 29219, 29224, 29523, 29534, 29537, 29575, 29631, 29772.)
106. **Diabasis steindachneri** J. & G. (28172, 29226, 29634, 29759, 29778, 29795.)
107. **Diabasis flaviguttatus** (Gill) J. & G. (28173, 28212, 29758, 29767, 29770, 29776, 29791.)
108. **Pimelepterus analogus** Gill. (*Chopa.*) (28168, 28174, 29583, 29622.)
109. **Cynoscion xanthulum** J. & G. (*Corbina.*) (28109.)
110. **Cynoscion reticulatum** (Gthr.) J. & G. (*Corbina.*) (28250, 28327, 28303, 29236.)
111. **Larimus breviceps** C. & V. (*Chiri.*) (28285, 28309, 28313, 29230.)
112. **Sciæna icistia** J. & G. (*Corbineta.*) (28182, 28275, 28228, 28368, 29613, 29566, 29615, 29775, 29790.)
113. **Sciæna vermicularis** (Gthr.) J. & G. (*Corbineta.*) (28385, 29229, 29638.)
114. **Micropogon ectenes** J. & G. (*Corbina.*) (28295, 28361, 28336, 29538.)
115. **Umbrina xanti** Gill. (*Codorniz.*) (29419, 29430, 29636.)
116. **Umbrina dorsalis** Gill. (*Codorniz.*) (28105.)
117. **Menticirrus elongatus** (Gthr.) J. & G. (*Caiman.*) (28146, 28155, 28315.)
118. **Menticirrrus panamensis** (Steind.) J. & G. (*Caiman.*) (28107.)
119. **Menticirrus nasus** (Gthr.) J. & G. (*Caiman.*) (28176, 28287, 28292, 29584.)
120. **Upeneus grandisquamis** Gill. (*Chirito.*)
121. **Polynemus approximans** Lay & Bennett. (*Raton.*) (28184, 28344, 29552.)
122. **Polynemus opercularis** (Gill) Gthr. (*Raton.*) (28219, 28389.)

123. **Cirrhites rivulatus** Val.
124. **Holocentrum suborbitale** Gill. (30880.)
125. **Gerres gracilis** (Gill) J. & G. (*Mojarra cantileña.*) (29788.)
126. **Gerres californiensis** (Gill) J. & G. (*Mojarra cantileña.*) (28106.)
127. **Gerres cinereus** (Walb.) J. & G. (*Mojarra blanca.*) (28217, 29215.)
128. **Gerres peruvianus** C. & V. (*Mojarra china.*) (28108, 29232, 29532, 29595, 29598, 29774, 29784.)
129. **Gerres lineatus** (Humboldt) C. & V. (*Mojarra china.*) (28281, 29209, 29214.)
130. **Julis lucasanus** Gill.
131. **Pseudojulis notospilus** Gthr.
132. **Platyglossus dispilus** Gthr.
133. **Scarus perrico** J. & G. (*Perrico: Loro.*) (28328.)
134. **Pomacentrus rectifrænum** Gill. (*Pescado azul.*)
135. **Pomacentrus flavilatus** Gill.
136. **Glyphidodon saxatilis** (Bloch) Lac.
137. **Glyphidodon declivifrons** (Gill) Gthr. (28186, 29204, 29643.)
138. **Pomacanthus zonipectus** (Gill) Gthr. (*Muñeca.*) (28139.) (Type of *Pomacanthus crescentalis* J. & G.)
139. **Chætodon humeralis** Gthr. (*Muñeca.*) (29596, 29612, 29618.)
140. **Chætodipterus faber** (Brouss.) J. & G. (29570, 29601, 29610.)
141. **Acanthurus tractus** Poey. (*Barbero: Cirujano.*) (28116.)
142. **Gobius soporator** C. & V.
143. **Gobius sagittula** (Gthr.) J. & G.
144. **Gobiosoma zosterurum** J. & G. (29245.)
145. **Dormitator maculatus** (Bloch) J. & G. (28163, 38394.)
146. **Culius æquidens** J. & G. (28268, 29240.)
147. **Scorpæna plumieri** Bloch. (28154, 28226, 28236, 29621.)
148. **Gobiesox adustus** J. & G. (29249.)
149. **Gobiesox zebra** J. & G. (29250.)
150. **Gobiesox erythrops** J. & G. (29248, 30885.)
151. **Gobiesox eos** J. & G. (29247, 30889.)
152. **Isesthes brevipinnis** (Gthr.) J. & G.
153. **Salarias atlanticus** C. & V. (29231.)
154. **Salarias chiostictus** J. & G. (28117.)
155. **Tripterygium carminale** J. & G. (28118.)
156. **Clinus zonifer** J. & G. (28122.)
157. **Clinus xanti** (Gill) Gthr. (28349, 29648, 29650, 29789.)
158. **Cremnobates integripinnis** Rosa Smith.
159. **Fierasfer arenicola** J. & G. (29244.)
160. **Dinematichthys ventralis** (Gill) J. & G.
161. **Paralichthys adspersus** (Steind.) J. & G. (*Lenguado*) (28319, 29577, 29619.)
162. **Citharichthys panamensis** Steind. (*Lenguado*) (28208, 28187, 29573, 29545, 29573, 29587, 29623, 29630, 29798.)
163. **Citharichthys spilopterus** Gthr. (*Lenguado.*) (28210, 28243, 28342, 29225.)
164. **Hemirhombus ovalis** Gthr.
165. **Etropus crossotus** J. &. G. (28124.)
166. **Achirus mazatlanus** (Steind.) J. & G. (*Teipalcate.*) (28166, 28171, 28248, 28316, 28379, 29574.)
167. **Malthe elater** J. & G. (28127.)
168. **Balistes mitis** Benn. (*Pez puerco.*) (29176, 29201.)
169. **Balistes polylepis** Steind. (*Pez puerco.*) (28157, 28337, 29530, 29560, 29561.)
170. **Tetrodon politus** Ayres. (*Pateta.*) (28195, 28200, 29563, 29599.)
171. **Diodon hystrix** L. (*Puercespino.*) (28267.)
172. **Mola rotunda*** Cuv.

LIST OF FISHES COLLECTED AT PANAMA BY CHARLES H. GILBERT.

By DAVID S. JORDAN and CHARLES H. GILBERT.

The greater part of the months of February and March, 1881, were spent by Mr. Gilbert, at Panama, in making collections of fishes for the United States National Museum. The following is a list of the species observed, with numbers now borne by the specimens on the register of the museum. Many of the smaller fishes have not yet been entered on the register.

1. **Mustelus dorsalis** Gill. (29497.)
2. **Carcharias æthalorus** J. & G.
3. **Sphyrna zygæna** (L.) Raf. (29289.)
4. **Urolophus asterias** J. & G. MSS. (29318.)
5. **Urolophus aspidurus** J. & G. (29307, 29410, 29454.)
6. **Ælurichthys panamensis** Gill.
7. **Ælurichthys pinnimaculatus** Steind. (29447, 29456, 31016.)
8. **Arius brandti** Steind. (29262.)
9. **Arius kessleri** Steind. (29252, 29413.)
10. **Arius planiceps** Steind. (29417, 29500.)
11. **Arius platypogon** Gthr. (29257.)
12. **Arius insculptus** J. & G. (29415.)
13. **Arius elatturus** J. & G. (29408.)
14. **Arius osculus** J. & G. (29476.)
15. **Arius assimilis** Gthr.
16. **Arius dovii** (Gill) Gthr. (29529.)
17. **Arius dasycephalus** Gthr. (29400, 29478.)
18. **Arius hypophthalmus** Steind. (29436, 29508.)
19. **Clupanodon thrissa** (L.) Lac. (29428, 29458, 29509.)
20. **Pellona panamensis** Steind. (29303, 29334, 29168.)
21. **Pellona fürthi** Steind. (29505.)
22. **Albula vulpes** (L.) Goode.
23. **Elops saurus** (L.).
24. **Stolephorus panamensis** (Steind.) J. & G. (29178, 29396.)

24 (*b*). **Stolephorus macrolepidotus** (Kner & Steind.) J. & G.

25. **Synodus scituliceps** J. & G. (29449.)
26. **Pœcilia elongata** Gthr. (29166, 29172.)
27. **Tylosurus scapularis** J. & G. (29427, 29435, 29438.)
28. **Tylosurus pacificus** (Steind.) J. & G. (29297, 29300.)
29. **Hemirhamphus brasiliensis** (L.) C. & V. (29448.)
30. **Exocœtus calopterus** Gthr. (29517, 29521.)
31. **Myrophis punctatus** Lütken.
32. **Murænesox coniceps** J. & G. (29288, 29346, 29450.)
33. **Ophichthys triserialis** (Kaup) Gthr.
34. **Fistularia depressa** Gthr. (29325.)
35. **Myxus harengus** Gthr.
36. **Chænomugil proboscideus** (Gthr.) Gill. (29263.)
37. **Mugil brasiliensis** Ag. (29251, 29525.)

38 **Mugil incilis** Hancock. (29414.)

39 **Sphyræna ensis** J. & G. (29333.)

40. **Scomberomorus maculatus** (Mitch.) J. & G.
41. **Oligoplites altus** (Gthr.) J. & G.
42. **Oligoplites occidentalis** (L.) Gill.
43. **Chloroscombus chrysurus** (L.) Gill. (29165, 29278, 29285, 29343.)
44. **Selene vomer** (L.) Lütken. (29412, 29426.)
45. **Selene setipinnis** (Mitch.) Lütk. (29162.)
46. **Caranx dorsalis** (Gill) Gthr.
47. **Caraux speciosus** Lac.
48. **Caranx hippos** (L.) J. & G. (29280.)
49. **Caranx fallax** C. & V. (29279, 29342.)
50. **Caranx caballus** Gthr.
51. **Caranx atrimanus** J. & G. (29341.)
52. **Caranx crumenophthalmus** (Bloch.) Lac. (29431.)
53. **Centropomus unionensis** Boc. (29457, 29492, 29327, 29485.)
54. **Centropomus armatus** Gill. (29161, 29308, 29435, 29512, 29514, 29527.)

54 (*b*). **Centropomus robalito** J. & G. (29391, 29471.)

55. **Centropomus pedimacula** Poey.
56. **Centropomus nigrescens** Gthr.
57. **Centropomus undecimalis** (Bloch) Lac.
58. **Rhypticus nigripinnis** Gill. (29277, 29283, 29421.)
59. **Alphestes multiguttatus** (Gthr.) J. & G. (29291, 29510, 29519.)
60. **Epinephelus analogus** Gill. (29284, 29301.)
61. **Epinephelus quinquefasciatus** (Bocourt) J. & G.
62. **Hypoplectrus lamprurus** J. & G. (29651.)
63. **Diplectrum radiale** (Quoy & Gaim.) Streets. (29163, 29302, 29347.)
64. **Xenichthys xanti** Gill. (29173 [18 specimens: types of *Xenichthys xenops* J. & G.], 29513.)
65. **Lutjanus guttatus** (Steind.) J. & G. (29434.)
66. **Lutjanus argentivittatus** (Peters) J. & G.
67. **Lutjanus novemfasciatus** Gill.
68. **Lutjanus aratus** (Gthr.) J. & G. (29329.)
69. **Pomadasys virginicus** (L.) J. & G.
70. **Pomadasys dovii** (Gthr.) J. & G. (29308.)
71. **Pomadasys interruptus** (Gill) J. & G.
72. **Pomadasys pacifici** (Gthr.) J. & G. (29473, 29337, 29445, 29451, 29453.)
73. **Pomadasys panamensis** (Steind.) J. & G. (29320, 29344.)
74. **Pomadasys branicki** (Steind.) J. & G. (29441.)
75. **Pomadasys macracanthus** (Gthr.) J. & G.
76. **Pomadasys elongatus** (Steind.) J. & G.
77. **Pomadasys leuciscus** (Gthr.) J. & G. (29332.)
78. **Pomadasys nitidus** (Steind.) J. & G. (29483, 29405, 29331, 29397.)
79. **Pomadasys chalceus** (Gthr.) J. & G. (29345, 29265.)
80. **Diabasis sexfasciatus** (Gill) J. & G. (29452.)
81. **Diabasis scudderi** (Gill) J. & G. (29282, 29270, 29516.)
82. **Diabasis flaviguttatus** (Gill) J. & G. (29295.)
83. **Diabasis steindachneri** J. & G. (29305, 29387.)
84. **Diabasis maculicauda** (Gill) J. & G. (29256, 29274, 29350.)
85. **Lobotes surinamensis** (Bloch) Cuv. (29799.)
86. **Pimelepterus analogus** Gill.
87. **Pimelepterus ocyurus** J. & G. (29395, 39397, 29725.)
88. **Cynoscion reticulatum** (Gthr.) J. & G. (29290, 29467.)
89. **Cynoscion album** (Gthr.) J. & G. (29292, 29522.)
90. **Cynoscion stolzmanni** (Steind.) J. & G. (28143, 29293, 29723.)
91. **Cynoscion phoxocephalum** J. & G. (29296, 29339, 28389, 29724.)
92. **Larimus argenteus** (Gill) J. & G. (29287, 29314, 29330, 29491.)
93. **Larimus breviceps** C. & V. (29317, 29322, 29323.)

94. **Ancylodon jaculidens** C. & V. (29294, 29722.)
95. **Isopisthus remifer** J. & G. (29169, 29312, 29324, 29336, 29429.)
96. **Nebris microps** C. & V. (29170, 29260, 29335, 29721.)
97. **Odontoscion archidium** J. & G. (29266, 29480, 29518.)
98. **Sciæna ensifera** J. & G. (29316, 29442, 29464, 29526.)
99. **Sciæna armata** (Gill) J. & G. (29461, 29465.)
100. **Sciæna chrysoleuca** (Gthr.) J. & G. (29793.)
101. **Sciæna vermicularis** (Gthr.) J. & G. (29337, 29499, 29490, 29269, 29275.)
102. **Sciæna imiceps** J. & G. (29432, 29481, 29489.)
103. **Sciæna ophioscion** (Gthr.) J. & G. (29171, 29546, 29493, 29398, 29399, 29321.)
104. **Sciæna fürthi** (Steind.) J. &. G. (29392.)
105. **Sciæna ericymba** J. & G. (29338, 29433, 29466, 29477, 29479, 29494.)
106. **Sciæna oscitans** J. & G. (29258, 29299, 29319, 29326.)
107. **Genyonemus fasciatus** Steind. (29164, 29268, 29311, 29313, 29315, 29455, 29498.)
108. **Micropogon altipinnis** Gthr. (29348, 29462.)
109. **Umbrina xanti** Gill. (29419.)
110. **Menticirrus panamensis** (Steind.) J. & G. (29259, 29446.)
111. **Menticirrus nasus** (Gthr.) J. & G. (29159, 29406.)
112. **Apogon dovii** Gthr.
113. **Upeneus grandisquamis** Gill. (29160, 29511.)
114. **Polynemus opercularis** (Gill) Gthr. (29328, 29420.)
115. **Polynemus approximans** Lay & Bennett.
116. **Holocentrum suborbitale** Gill.
117. **Acanthurus tractus** Poey. (29286.)
118. **Chætodipterus faber** (Brouss.) J. & G. (29276.)
119. **Chætodon humeralis** Gthr. (29179, 29273, 29482, 29501, 29504.)
120. **Pomacanthus zonipectus** (Gill) Gthr.
121. **Gerres gracilis** (Gill) J. & G. (29390, 29571.)
122. **Gerres dovii** (Gill) Gthr. (29281, 29495.)
123. **Gerres aureolus** J. & G. (29487.)
124. **Gerres peruvianus** C. & V. (29459, 29460, 29469.)
125. **Glyphidodon saxatilis** (Bloch) Lac.
126. **Pseudojulis notospilus** Gthr.
127. **Scarus perrico** J. & G.
128. **Scorpæna plumieri** Bloch. (29298, 29394.)
129. **Batrachoides pacifici** (Gthr.) Gill. (29267, 29306, 29349, 29475.)
130. **Gobius soporator** C. & V.
131. **Gobius sagittula** (Gthr.) J. & G.
132. **Gobius paradoxus** Gthr.
133. **Gobius seminudus** Gthr.
134. **Lepidogobius emblematicus** J. & G.
135. **Isesthes striatus** (Steind.) J. & G.
136. **Cremnobates monophthalmus** Gthr.
137. **Dinematichthys ventralis** (Gill) J. & G.
138. **Cerdale ionthas** J. & G. (29664.)
139. **Microdesmus retropinnis** J. & G. (29665.)
140. **Paralichthys adspersus** (Steind.) J. & G. (29264, 29309.)
141. **Citharichthys spilopterus** Gthr. (29271, 29340, 29507.)
142. **Citharichthys panamensis** Steind. (29272, 29264, 29304, 29411.)
143. **Hemirhombus ovalis** Gthr. (29422.)
144. **Hemirhombus latifrons** J. & G. (29255, 29416, 29425, 29496.)
145. **Etropus crossotus** J. & G. (29177.)
146. **Aphoristia elongata** (Gthr.) J. & G. (29418, 29424.)
147. **Balistes polylepis** Steind. (29261.)
148. **Tetrodon testudineus** L. (29409.)

INDIANA UNIVERSITY, *August* 1, 1882.

LIST OF FISHES OBSERVED AT PUNTA ARENAS, ON THE PACIFIC COAST OF CENTRAL AMERICA.

By CHARLES H. GILBERT.

During a stay of a few hours in the port of Punta Arenas, on the west coast of Central America, the following species of fishes were observed:

1. **Galeocerdo tigrinus** M. & H. (29515; from San Jose.)
2. **Ælurichthys panamensis** Gill. (29310; from Libertad.)
3. **Arius brandti** Steind. (*Bagre colorado.*)
4. **Pellona panamensis** Steind. (29167, 29393.)
5. **Mugil brasiliensis** Agass. (*Liza.*)
6. **Centropomus nigrescens** Gthr. (*Robalo.*)
7. **Centropomus undecimalis** (Bloch) Lac.
8. **Centropomus pedimacula** Poey.
9. **Epinephelus quinquefasciatus** (Boc.) J. & G. (*Merou.*)
10. **Lutjanus colorado** J. & G. (*Pargo colorado.*)
11. **Lutjanus novemfasciatus** Gill. (*Pargo prieto.*)
12. **Lutjanus aratus** (Gthr.) J. & G.
13. **Pomadasys macracanthus** (Gthr.) J. & G. (*Roncador.*)
14. **Pomadasys leuciscus** (Gthr.) J. & G.
15. **Hoplopagrus güntheri** Gill.
16. **Lobotes surinamensis** (Bloch) Cuv.
17. **Sciæna ensifera** J. & G. (29506.)
18. **Sciæna armata** (Gill) J. & G. (29253, 29367.)
19. **Sciæna vermicularis** (Gthr.) J. & G.
20. **Larimus breviceps** C. & V.
21. **Umbrina xanti** Gill.
22. **Polynemus approximans** Lay & Bennett.
23. **Gerres peruvianus** C. & V.
24. **Citharichthys panamensis** Steind.

SECOND ANNUAL APPEARANCE OF YOUNG COD HATCHED BY THE UNITED STATES FISH COMMISSION IN GLOUCESTER HARBOR IN THE WINTER OF 1879-80.

By E. H. HASKELL.

[Letter to Prof. S. F. Baird.]

You will be pleased to hear that the results of your attempts to propagate cod on our coasts are very gratifying. My own boy, fishing from one of the wharves in the inner harbor, a few days ago, caught thirteen as handsome specimens of young cod as have ever been landed, varying from 10 to 14 inches; and this right in the harbor. I understand they are very plenty, and growing fast. If something could be done to induce those who fish to let them grow, it would be better; but they are so plenty that I suppose it would be difficult. I shall be glad to look into this matter further for you, and will advise you.

BOSTON, MASS., *June* 30, 1882.

SUCCESSFUL PROPAGATION OF BLACK BASS.

By MAJOR ISAAC ARNOLD Jr., U. S. A.

[From letters to Prof. S. F. Baird.]

I have in a small pond at this arsenal about 40 black bass (large and small mouthed), that are weighing from 2 to 4 pounds apiece. I have had them in this pond for three years. Last year they produced a large number of small fry, nearly all of which were destroyed by sun-perch. I have had the pond cleaned this spring and the sun-perch removed. As the bass are in fine condition, I expect there will be thousands of the young fry this season.

INDIANAPOLIS ARSENAL, INDIANAPOLIS, IND., *April* 22, 1882.

This morning I discovered the fish were nesting. They have refused food for the past week, indicating they have been on the nest during that time. I have removed all the sun-perch from the ponds, so there will be no danger to the small fry from that source. My pond is fed with water from the city water-works, and is taken from White River. I have an overflow. All the bass, with one exception, appear healthy.

INDIANAPOLIS, IND., *May* 16, 1882.

The black bass are hatching out very fast. I have partitioned off one end of the pond, so as to protect the small fry from the large fish; have some trouble in catching the small fry as they come off the nests, but should think there are 25,000 or more in the part of the pond partitioned off. We are putting in more as fast as they are caught.

INDIANAPOLIS, IND., *June* 2, 1882.

The black bass hatched out by the thousand, and I think there will be more in a few days. The young fish are all healthy, but they eat each other. Yesterday my foreman, in less than fifteen minutes, saw nine of the young fry swallowed by fish of apparently the same size. The large-mouths seem to do the greater part of this work. I have stopped transferring the small fry into an inclosed space, thinking they will do better in the large pond. I have about 400 fish that are one year old, in fine condition, and believe, if you can remove them, the final result will be more satisfactory. They are from 3 to 6 inches in length, all strong and hardy. Each day the number of this year's small fry grows less, as the strong ones destroy the weaker. The first hatching are now nearly three-fourths of an inch in length, and can probably protect themselves.

INDIANAPOLIS, IND., *June* 16, 1882.

I think I must have had, one week ago, at least 100,000 young fry, and there were four or five large fish on the nests whose eggs had not hatched. This morning I discovered the inclosed place at one end of the pond was nearly destitute of small fry, but I found a great many in the large pond, the exact number of which would be hard to determine, but should think I saw several thousand. I made one haul with a minnow-net and transferred probably a thousand or more to the inclosed space. At one end of the inclosed space I have dug a shallow ditch some 10 feet long and 2 feet wide, in which the water stands about 10 inches deep; have covered the bottom of this ditch with sand and gravel; it forms the outlet for the surplus water, and is provided with a wire screen to prevent the escape of the young fry. I am in hopes the running water will prove to be beneficial to the young fry; they like it, and are constantly going in and out. I do not find many dead fish or notice any that appear sick. They have all increased in size wonderfully, and to-day I have not noticed any cannibalism; think they are getting large and strong enough to protect themselves. I am trying to protect the fry in the large pond from the old fish by making brush protection along the shores of the pond, and keep the old ones well supplied with food, which they usually take very freely, but have not taken at all for the past week. The upshot of the whole is that I am in hopes there will be enough of the young fry left to pay you for the trouble of taking them away, but every day makes it more uncertain; there will be no danger of losing any of the year-old bass, and I would advise the whole lot be removed as soon as possible. Although there are to-day several thousand young fry in the pond, I do not believe there is the tenth part of what there was two weeks ago, and I am afraid of making any experiments for their protection, as they might not be successful. I should think 1,500 to 2,000 young fry have disappeared from the inclosed space since the afternoon of the 24th. There is a mystery in the loss, always occurring during the night, that still remains unexplained. There are still quite a large number of young fish in the main pond.

INDIANAPOLIS, IND., *June* 23, 1882.

I made small openings through the partition in my ponds this morning, large enough to allow the free passage of the small fry from one part of the pond to the other—too small for the mature fish to pass through. In less than half an hour several thousand of the young fry had collected near the outlet of the pond and were trying to find a passage through the screens. After watching the fry for a couple of hours, it occurred to me they might bruise themselves by rubbing against the wires, and I had a wooden trough made, with a wire screen about 12 by 12 inches, fastened across an opening in the bottom near one end so that the water passing out of the pond goes through the screen in a vertical instead of a horizontal direction. The trough is nailed to four posts, driven into the bottom of the pond, and is placed so as to have about 3 inches of water covering the screen at all times. It effectively prevents the wedging and jamming of the young fry. They have already learned the road backward and forward through the partition. I notice the young fry have an invariable tendency to follow the outward current, and do not collect at the inlet of the pond. If you have room, in constructing your ponds, to have an overflow from the breeding-pond to a smaller one, all the young fry will naturally collect in the smaller pond without handling, and thus save considerable trouble.

INDIANAPOLIS, IND., *June* 29, 1882.

It is usually the case that thousands of small black bass are taken with hook and line near here in the fall of the year. I think they are fish two years old, and shall give instructions to one of my corporals to catch all he can and put in my ponds; besides, if the streams get very low, as they usually do in the summer months, they may be able to get quite a large number of small fry with the minnow-net. It would do your eyes good to see the yearlings feed upon small minnows and angleworms. They are great pets, and afford me much pleasure.

INDIANAPOLIS, IND., *June* 30, 1882.

I placed the bass in the pond for the sole purpose of noticing them during the breeding season, but the water in the pond was so crowded with a growth of algæ that my observations have not been satisfactory. I think the female prepares the spawning ground or bed, after which the male joins her. Whilst the female is preparing the bed the males fight with each other for possession. (The fish alluded to in my letter of May 15 died from effects of injury received in a free fight; he was injured about the head, and in a few days was covered with a white fungus, which proved fatal.) The male presses the roe from the female by a series of bites or pressures along her belly with his mouth, the female lying upon her side during the operation. The male ejects the milt upon or over the roe from time to time, and the spawning process lasts for two or three days.* When the spawning is over the male disappears from the scene, and the female remains upon the nest extremely pugnacious, allowing nothing to approach until the eggs have hatched and the young fry are a week or ten days old. The young fish commence at once to prey upon each other and continue until they are two or three weeks old, when cannibalism ceases and there is no more danger from that source. The shallow ditch was a good arrangement; by covering the ditch with a layer of brush the young fry were well protected from all kinds of birds. I think frogs destroy a great many young fish, and should always be destroyed as far as possible. I am satisfied that with the final arrangement adopted, that of having one end of the pond partitioned off, with openings so that the small fry can pass freely back and forth, and with the trough-screen for overflow, better results can be reasonably expected. If I remain at the arsenal I intend to repeat the experiment.

HADDAM, CONN., *September* 21, 1882.

*I first advanced this idea in Forest and Stream, in an article signed "Gringo," and afterwards saw a confirmation of the same by Mr. Geo. C. Rixford, of Rixford, Fla.

REMOVAL OF BASS FROM INDIANA TO NORTH CAROLINA BY THE UNITED STATES FISH COMMISSION.

By CHAS. W. SMILEY.

Although the Fish Commission has not undertaken to propagate game fish, nor to stock streams with predaceous fishes, it is, nevertheless, constantly receiving applications for bass and for information upon the subject. Upon the receipt of the very courteous offer of Maj. Isaac Arnold, U. S. A., to donate the fish alluded to in the preceding article, Professor Baird directed that a messenger be sent for them. Accordingly Mr. Ellis left Washington July 5, reaching Indianapolis on the 7th. In the absence of Major Arnold, Captain Rexford arranged to have a seine drawn, so that at 3 p. m. on Saturday, the 8th, Mr. Ellis started away with 5,000 small bass in five 15-gallon cans, and 300 yearlings and a few two-year-old bass in five other cans of the same capacity. About half the lot were black bass and the other half green bass. This did not exhaust Major Arnold's supply of bass, for, as the messenger reported, "there appeared to be a plenty left in the ponds."

After a wagon-ride of two miles, the train was reached at 4.30 p. m. ice was procured, and, the weather being very warm, plenty of fresh water was required. Mr. Ellis reached Washington Sunday, July 9, at 9 p. m., and upon transferring the fish to the tanks of the Central hatching station, found that but 6 large and 30 small fish had died in transit. After remaining at the hatching station in Washington a few days, during which time a considerable number of the fry made their way through the wire screens and were devoured by the older bass, the lot was forwarded in charge of the same messenger to Mr. W. J. Green, of Fayetteville, N. C., who, on the 17th of July, wrote, "The consignment of bass arrived in remarkably good condition on the 15th; I do not think there were over half a dozen dead ones in the whole lot. I divided them among three of my ponds well adapted for their propagation and development."

There are still eight or ten applications on file in this office for black bass, but the Commission is not able to enter upon this field of fish culture at present. The experience in bass propagation by Major Arnold, and the transfer from Indiana to North Carolina, are placed on record as an encouragement to private or State enterprise.

U. S. FISH COMMISSION, *Washington, D. C., October* 10, 1882.

THE SCOTCH HERRING FISHERIES IN 1882.*

[From *Fiskeri Tidende*, No. 1, January, 1882.]

As the annual yield of the Scotch fisheries is not published till some months after the close of the year in question, a few data respecting last year's fisheries, gathered from the most reliable sources, may prove of interest. The weather, all during the fishing season, was unusually changeable, and the loss of life and apparatus was above the average. Whenever the weather permitted the boats to approach the fishing-stations, the fisheries, with hardly an exception, proved successful, and large quantities of herring were caught at the fishing-stations nearest the coast, where for a number of years but few fish had been caught.

As a general rule the quality of last year's herring was very good, and, as they were salted under very favorable circumstances, the salters did a very good business and could prepare a superior article. The number of barrels bearing the government mark was, in proportion to to the number of fish caught, much larger than in 1880, as they amounted to 500,000 out of a total catch of 643,000 crans, whilst last year they numbered 689,286 out of a total catch of 835,807 crans.

The following table shows the number of boats engaged in the fisheries and the number of crans caught on the east coast of Scotland, from Berwick to the Shetland Islands, during the last ten years:

Year.	Boats.	Crans.
1871	4,557	516,722
1872	4,369	524,737
1873	4,081	641,277
1874	4.153	663,864
1875	4,092	615,706
1876	4,034	393,740
1877	4,087	487,199
1878	4,144	567,927
1879	4,267	456,406
1880	4,486	835,807
1881	4,579	634,000

The average catch per boat this year was, therefore, 138 crans against 186 in 1880, and 107 in 1879. The earnings of the fishermen may be estimated at £650,000, the value of their boats at £450,000, and of their nets about £500,000. The number of fishermen exceeded 28,000, whilst the number of persons engaged in preparing fish, or in some other way employed in this great national industry, far exceeds that number. A peculiar phenomenon is the constant decrease in the number of herring exported to Ireland from the east coast of Scotland. Not many years ago Ireland was the principal market for Scotch herring, but dur-

* *Det Skotske Sildefiske i* 1881.—Translated from the Danish by HERMAN JACOBSON.

ing the last few years only a few ship-loads of herring from the northern stations have gone to Ireland, whilst by far larger numbers are exported to Germany. Even the Eyemouth district, which in former years found a ready market for its fish in England, has, in 1881, exported a very considerable quantity of herring to Germany, whilst Aberdeenshire and Moray Firth send all their prepared herring to the Continent.

LIST OF FOOD-FISHES BROUGHT FROM KEY WEST, FLA., INTO THE MARKETS OF HAVANA.

By FELIPE POEY.

[The following is a translation of a portion of a letter received from Professor Poey, in response to a request from me for information as to the species of fishes sent by Key West fishermen to the Havana market.—D. S. JORDAN.]

I have received from an old fisherman (now dealing in fishes in the Havana market) the following list of fishes which are received in Havana from Key West, either living or preserved in ice:

1. CHERNA = *Epinephelus morio* (C. & V.).
2. PARGO GUACHINANGO = *Lutjanus campechianus* Poey.
3. PEZ PERRO = *Lachnolæmus suillus* C. & V.
4. AGUAJI. The name of Aguaji is given to two species, both of which grow to a large size, viz: *Trisotropis brunneus* Poey and *Trisotropis aguaji* Poey. The species here meant I believe to be the former.
5. JALLAO = *Hæmulon album* C. & V.
6. BAJONADO = *Calamus bajonado* (Bloch).
7. RABIRRUBA = *Ocyurus chrysurus* (Bloch).
8. BIAJAIBA = *Lutjanus synagris* L. (*uninotatus* C. & V.)
9. CABALLEROTE = *Lutjanus cabellerote* Poey (vide Poey, Enumeratio, in Anal. Soc. Esp. de Hist. Nat. IV, 100).
10. CABRILLA. The name of *Cabra* (*Cabra mora*) is given to *Epinephelus punctatus* Bloch (Syn. *maculatus*, *atlanticus*, *nigriculus*, *pixanga*, *impetiginosus*: vide Poey Anal. Soc. Esp. Hist. Nat. IV, 91). There is also a *Cabrilla* (diminutive of Cabra), *Epinephelus lunulatus* (Syn. *catus* Val). I do not know which of these two may be meant.
11. SIERRA = *Cybium caballa* C. & V.
12. SARGO. There are several Sargos. I believe that the one here intended is *Sargus caribæus* Poey.

Besides these, I have myself observed the following:

13. *Promicrops guasa* Poey.
14. *Trisotropis falcatus* Poey.
15. *Trisotropis petrosus* Poey.

HAVANA, CUBA, *March* 9, 1882.

DREDGING STATIONS OF THE UNITED STATES FISH COMMISSION STEAMER FISH HAWK, LIEUT. Z. L. TANNER COMMANDING, FOR 1880, 1881, AND 1882, WITH TEMPERATURE AND OTHER OBSERVATIONS.

Arranged for publication

By RICHARD RATHBUN.

In the summer of 1880, the headquarters of the United States Fish Commission were established at Newport, R. I., and the steamer Fish Hawk, then newly constructed, made its dredging and trawling trips from there, whenever the weather permitted. The field of explorations for the summer included Narragansett Bay, Sakonnet River, and the regions to the northward, eastward, and southward of Block Island. In September and the first part of October, three trips were made by the Fish Hawk to the inner edge of the Gulf Stream slope, between latitudes 40° 05′ 42″ N. and 39° 46′ N., and longitudes 70° 22′ 06″ W. and 71° 10′ W., in depths of 64 to 487 fathoms, resulting in the discovery of a new and exceedingly rich fauna, both as regards fish and marine invertebrates. On her passage to Washington in November, the Fish Hawk also trawled off the mouth of Chesapeake Bay, in depths of 18 to 300 fathoms.

During the summers of 1881 and 1882, the headquarters of the Commission were at Wood's Holl, Mass. As the shallow waters of this region had been quite fully explored by the Commission in 1871 and 1875, very little time was expended in work near land; but advantage was taken of all pleasant weather to still further investigate the rich faunal region of the Gulf Stream slope, discovered the previous year. Seven trips were made to this region, in 1881, between latitudes 39° 40′ N. and 40° 22′ N., and longitudes 69° 15′ W. and 71° 32′ W., in depths of 43 to 782 fathoms. A line of dredgings and trawlings, at intervals of about four miles, was made from off Noman's Land to the Gulf Stream slope, in order to connect the inshore with the offshore stations; and a few trips were also made in Vineyard Sound, Buzzard's Bay, and off Chatham, Cape Cod, on, and in the vicinity of, Crab Ledge. Cod trawl-lines were set on most of the outside trips, for the purpose of catching fish that would not enter the beam-trawl.

In 1882, five deep-water trips, were made to the same region, extending the area of dredgings considerably beyond its former eastern and western limits. A few hauls of the dredge and beam-trawl were taken in Vineyard Sound, and one trip was made to the one-hundred fathom line, off the eastern side of Cape Cod. The most eastern haul on the Gulf Stream slope for 1882, was in latitude 40° 08′ N. and longitude 68° 45′ W.; and the most western in latitude 39° 31′ N. and longitude 72° 06′ W.; the deepest haul was in 787 fathoms. Cod-trawls were set on two of the trips only.

The temperatures of the air were taken, in part, with a Jas. Green, in part with a Signal Service, thermometer; the temperatures of the bottom and surface waters were obtained by means of Negretti and Zambra deep-sea thermometers. The bearings are all magnetic. As the bearings and latitudes and longitudes indicate only the points at which the dredge or trawl was lowered upon the bottom, the direction of the drift of the vessel and the distance gone over in dredging and trawling have been given in most cases, to show the extent of the hauls. The figures in the column of "Drift" indicate the distance of the drift in miles. The abbreviations in the column of "Apparatus used" have the following significations: D., dredge; R. D., rake-dredge; O. D., oyster-dredge; T., trawl; O. T., otter-trawl; B. T., Blake-trawl; Tan., tangles; C. T., cod-trawl.

The New York fishing schooner, Josie Reeves, Capt. F. M. Redmond, employed by the Fish Commission to look for the tile fish (*Lopholatilus chameleonticeps*) in the neighborhood of the one-hundred fathom line, south of Martha's Vineyard, made five stations in that region, which for convenience sake have been given numbers in the regular series from 1145 to 1149, inclusive. She used cod trawl-lines and lobster-pots.

Dredging stations of the steamer Fish Hawk for 1880, 1881, *and* 1882.

Serial number.	Date.	Hour.	Latitude N. ° ′ ″	Longitude W. ° ′ ″	Locality.	Drift.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Temperatures. Surf.	Temperatures. Bottom.	Apparatus used.
	1880.				Narragansett Bay:							
770	Aug. 6	10 a. m.			Beaver Tail Light, SE. by S., ⅞ mile		8¼	Sand and shells	68.0	66.5	62.5	D.
771	Aug. 6	10.30			Beaver Tail Light, SE. ¼ S., ¾ mile		8¼	...do	68.0	66.5	62.5	T.
772	Aug. 6	11.35			Beaver Tail Light, S. by E., 1¼ miles		8	...do	72.0	69.5	67.0	D.
773	Aug. 6	11.45			Beaver Tail Light, S. by E., 1⅓ miles		8	...do	72.0	69.5	67.0	T.
774	Aug. 6	1 p. m.			North end Dutch Island, south, ⅓ mile		10½	Sand, mud, shells	72.0	72.0	69.0	D.
775	Aug. 6	1.[illegible]5			North end Dutch Island, south, 1 mile		12	Gravel, sand, mud	79.0	72.0	68.0	T.
776	Aug. 7	9.45 a. m.			Fort Dumpling, NW. by W. ½ W., ⅝ mile		27½	Sand, shells	72.0	67.5	58.5	D.
777	Aug. 7	10.20			Fort Dumpling, NW. by W. ½ W., ⅝ mile		27½	Sand, shells, gravel	72.0	67.5	58.5	T.
778	Aug. 7	10.40			Fort Dumpling, N. ¾ E., 800 yards		26	Gravel, sand, broken shells	76.0	70.0	58.5	T.
779	Aug. 7	11.05			Fort Dumpling, NE., 1¼ miles		22⅓	Gravel, sand, shells	78.0	68.0	57.5	D.
780	Aug. 7	11.30			Beaver Tail Light, west, 1 mile		18	...do	79.0	69.0	57.5	T.
781	Aug. 7	12 m.			Beaver Tail Light, W. NW., 1 mile		16	Sand	75.0	69.0	57.0	T.
782	Aug. 12	9.30 a. m.			Beaver Tail Light, W. ¾ N., 1¼ miles		16	Sand, gravel, broken shells	68.0	70.0	60.0	D.
					Off Newport, R. I.:							
783	Aug. 12	10.15			Brenton's Reef Light-ship, N. by E., 1 mile.		17½	...do	70.0	70.0	55.0	T.
784	Aug. 12	10.50			Point Judith, W. ½ S., 4¾ miles		20	Fine sand and broken shells.	71.5	71.0	53.5	D.
785	Aug. 12	11.30			Brenton's Reef Light-ship, N. ½ W., 2½ miles.		19½	Sand	72.0	71.0	54.5	T.
786	Aug. 12	2.35 p. m.			Brenton's Reef Light-ship, NW. ⅓ W., 4⅓ miles.		19	Mud and fine sand	74.0	71.0	53.5	D.
787	Aug. 12	3			Brenton's Reef Light-ship, N. NW. ½ W., 4 miles.		19	...do	74.0	71.0	53.5	T.
788	Aug. 13	10.40 a. m.			Brenton's Reef Light-ship, N. NW. ¾ W., 6 miles.		18	Fine sandy mud	70.0	71.0	54.0	D.
789	Aug. 13	11.05			Brenton's Reef Light-ship, N. NW. ¾ W., 5¼ miles.		17½	Sand and scallops	70.0	71.0	54.0	O. T.
790	Aug. 13	11.55			Point Judith, W. NW. ¾ W., 8⅓ miles		16	Fine sand	70.0	71.0	54.5	T.
791	Aug. 13	1.10 p. m.			Point Judith, W. NW., 12½ miles		20	Fine sandy mud	72.0	71.0	60.0	D.
792	Aug. 13	1.50			Point Judith, W. NW., 12 miles		18	...do	72.0	71.0	54.0	D.
793	Aug. 14	9 a. m.			Point Judith, W. NW. ½ W., 6 miles		19	Sand and broken shells	71.0	69.0	63.0	D.
794	Aug. 14	9.45			Point Judith, W. NW. ½ W., 5 miles		19	Sand	70.0	69.0	53.0	T.
795	Aug. 14	10.25			Point Judith, W. NW. ½ W., 4 miles		19	Fine sandy mud	71.0	69.0	53.0	D.
796	Aug. 14	11.00			Point Judith, W. NW., 3¼ miles		19	...do	70.0	69.0	53.0	T.
797	Aug. 14	11.40			Point Judith, NW. by W. ¾ W., 2¼ miles		16½	Soft mud and coarse sand	70.0	68.5	55.0	D.
798	Aug. 14	12.10 p. m.			Point Judith, NW. by W. ¾ W., 1¼ miles		12½	Sand, gravel, few large stones	71.0	66.0	59.0	D.
799	Aug. 14	12.30			Point Judith, W. ½ N., 1¾ miles		13	...do	70.0	67.0	61.0	D.
					Narragansett Bay:							
800	Aug. 16	11.35 a. m.			Poplar Point Lights, N. NW. ¾ W., 2¼ miles.		4	Sand	63.0	70.0	69.5	T.

Dredging stations of the steamer Fish Hawk for 1880, 1881, *and* 1882—Continued.

Serial number.	Date.	Hour.	Latitude N.	Longitude W.	Locality.	Drift.	Depth in fathoms.	Nature of bottom.	Temperatures.			Apparatus used.
									Air.	Surf.	Bottom.	
	1880.		° ′ ″	° ″	Narragansett Bay:							
801	Aug. 16	12.20 p.m.			Poplar Point Lights, W. by N., 2¼ miles		4½	Mud	65.0	71.0	68.0	T.
802	Aug. 16	2.15			Halfway Rock, W., ¾ of a mile		12½	...do	68.0	70.5	62.0	T.
803	Aug. 16	3.25			Halfway Rock, N. by E. ¼ E., 2⅝ miles		20	Fine sandy mud	67.0	69.0	60.0	D.
					Off Newport, R. I. (Brown's Ledge):							
804	Aug. 17	11.15 a.m.			Cuttyhunk Light, NE. by E., 8¾ miles	NW. by W., ¼ mile.	11¼	Rocks and sand	68.0	66.0	59.0	D.
805	Aug. 17				Close to No. 804		11¼	Fine gravel				D.
806	Aug. 17	12.00 m.			Cuttyhunk Light, E.NE., 7¾ miles	W.SW., ½ mile	14	...do	69.0	67.0	56.0	Tan.
807	Aug. 17	12.50 p.m.			Cuttyhunk Light, NE. by E., ¾ E., 7¾ miles.	SW. by S., ¼ mile.	12¼	Fine gravel and stones	70.0	67.0	60.0	D.
808	Aug. 17	1.20			Cuttyhunk Light, NE. by E. ½ E., 8 miles	SW. by S. ½ S., ¼ mile.	13	...do	70.0	67.0	60.0	D.
					Off Newport, R. I.; SW. of Brown's Ledge:							
809	Aug. 17	1.55			Cuttyhunk Light, NE. by E., 12 miles	W. ½ S., ¼ mile	21¼	Fine sand	70.0	67.0	52.0	D.
810	Aug. 17	2.15			Cuttyhunk Light, NE. by E., 12½ miles	W.NW., ¼ mile	21	Fine sand and gravel	70.0	67.0	52.0	T.
					Off Newport, R. I.; W. of Brown's Ledge:							
811	Aug. 17	2.20			Cuttyhunk Light, NE. by E., 12½ miles	SW., ¼ mile	19¼	Fine sandy mud	69.0	67.0	53.0	D.
					Off Block Island:							
812	Aug. 18	11.30 a.m.			Block Island Light, N.NW. ¼ W., 20 miles.	NW., ½ mile	28½	Sand	70.0	66.0	46.0	D.
813	Aug. 18	11.55			Block Island Light, N.NW. ¼ W., 20 miles.	SE., ¼ mile	28½	...do	70.0	67.0	46.0	T.
814	Aug. 18	1.00 p.m.			Block Island Light, N.NW. ⅝ W., 18 miles.	SW., ¼ mile	27½	Sand and gravel	72.0	72.0	46.0	T.
815	Aug. 18	2.15			Block Island Light, NW. by N., 17 miles	SW., ¼ mile	29	Fine sand	72.0	72.0	48.0	R.D.
					Narragansett Bay:							
816	Aug. 23	10.25 a.m.			Brenton's Reef Light-ship, E. ¾ S., 2¾ miles.	SE., ¼ mile	8½	Sand and broken shells	71.0	69.0	66.0	D.
817	Aug. 23	11.00			Brenton's Reef Light-ship, E. ½ N., 3 miles.	SE., ¼ mile	10	...do	72.0	68.0	63.0	D.
818	Aug. 23	11.20			Brenton's Reef Light-ship, E. ½ N., 3¼ miles.	SE., ¼ mile	9½	...do	72.0	68.0	65.0	D.
819	Aug. 23	1.00 p.m.			South end Hope Island, SE. by E. ½ E., ½ mile.	W. SW., ¼ mile	6	Mud and broken shells	74.0	73.0	70.0	T.
820	Aug. 23	1.40			South end Hope Island, N.NE., ¼ mile	W. by S., ¼ mile	5½	...do	76.0	72.0	70.0	T.
821	Aug. 23	2.15			South end Hope Island, N. by E., ½ mile	SW. ¼ mile	5	...do	78.0	72.0	70.0	T.
822	Aug. 23	3.00			South end Hope Island, NE., ⅛ mile	W., ¼ mile	4½	...do	78.0	71.0	70.0	T.
					North of Block Island:							
823	Aug. 24	12.35			North Light of Block Island, W. ½ S., 1½ miles.	NW., ¼ mile	15½	Sand	74.0	65.0	60.0	D.
824	Aug. 24	12.50			North Light of Block Island, SW. ½ W., 1 mile.	NW., ¼ mile	13	...do	74.0	65.0	67.0	T.

825	Aug. 24	1.30			North Light of Block Island, W. SW. $\frac{3}{4}$ W., $1\frac{1}{4}$ miles.	NW., $\frac{1}{2}$ mile	13	...do	73.0	67.0	60.0	O. T.
826	Aug. 24	2.40			North Light of Block Island, W. NW. $\frac{1}{2}$ W., $2\frac{1}{2}$ miles.	S. SW., $\frac{1}{4}$ mile	22	...do	73.0	67.0	57.0	D.
827	Aug. 24	3.05			North Light of Block Island, W. NW. $\frac{1}{2}$ W., $2\frac{1}{2}$ miles.		$20\frac{1}{2}$	...do	71.0	67.0	57.0	B. T.
828	Aug. 25	12.40			North Light of Block Island, SW. by W. $\frac{3}{4}$ W., $2\frac{1}{2}$ miles.	E. NE., $\frac{1}{4}$ mile	15	...do	70.0	66.0	60.0	D.
					Mouth of Sakonnet River, R. I.:							
829	Aug. 27	10.45 a. m.			Cormorant Rock, NW. by N., $\frac{1}{4}$ mile	S. by E., $\frac{1}{4}$ mile	9	Gravel and stones	63.0	66.0	65.0	D.
830	Aug. 27	11.15			West Island, SE. by E. $\frac{1}{2}$ E., $\frac{3}{4}$ mile	NE. $\frac{1}{2}$ E., $\frac{1}{4}$ mile	$10\frac{1}{2}$	Sand and gravel	64.0	66.0	65.0	D.
					Sakonnet River, R. I.:							
831	Aug. 27	12.30 p. m.			North end of Gould Island, SW. $\frac{1}{4}$ W., 350 yards.	S., $\frac{1}{4}$ mile	6	Dark, soft fetid mud	68.0	71.0	71.0	D.
832	Aug. 27	12.45			North end of Gould Island, W., 150 yards	S., $\frac{1}{4}$ mile	9	...do	70.0	71.0	71.0	D.
833	Aug. 27	1.00			South end of Gould Island, W., 100 yards	S., $\frac{1}{4}$ mile	$6\frac{1}{2}$	...do	70.0	71.0	71.0	R. D.
834	Aug. 27	1.30			McCurry's Point, W. SW., $\frac{3}{4}$ mile	N. by E., $\frac{1}{4}$ mile	11	...do	63.0	73.0	71.0	R. D.
835	Aug. 27	1.50			McCurry's Point, N. $\frac{1}{4}$ E., $1\frac{1}{4}$ miles	N., $\frac{1}{4}$ mile	$3\frac{1}{2}$	Soft mud and broken shells	68.0	73.0	71.0	R. D.
836	Aug. 27	2.25			Black Point, W. $\frac{1}{4}$ N., $\frac{1}{2}$ mile	S. SW., $\frac{1}{4}$ mile	5	Sand	66.0	71.0	71.0	R. D.
837	Aug. 27	2.45			Black Point, NW. by W. $\frac{1}{2}$ W., $\frac{1}{2}$ mile	S. by E., $\frac{1}{4}$ mile	5	...do	69.0	71.0	71.0	T.
838	Aug. 27	3.15			Wood's Castle, W. by N., 1 mile	S. by E., $\frac{1}{4}$ mile	$5\frac{1}{2}$	...do	66.0	70.0	68.0	T.
					Narragansett Bay:							
839	Aug. 31	9.50 a. m.			Dumplings, NW. $\frac{1}{2}$ N., 300 yards	SW., $\frac{1}{4}$ mile	$27\frac{1}{2}$	Gravel and sand	67.0	67.0	61.0	D.
840	Aug. 31	10.05			Dumplings, N. by W. $\frac{1}{2}$ W., 100 yards	SW., $\frac{1}{4}$ mile	$20\frac{1}{2}$	...do	67.0	67.0	61.0	D.
841	Aug. 31	10.45			Goat Island Light, NE. by E. $\frac{3}{4}$ E., $\frac{7}{8}$ mile.	S., $\frac{1}{4}$ mile	21	Mud, sand, large stones	68.0	67.0	60.0	D.
842	Aug. 31	11.00			Goat Island Light, E. NE. $\frac{1}{2}$ E., $\frac{1}{2}$ mile		8	Sand	69.0	67.0	67.0	D.
843	Aug. 31	12.00 m.			North end Dyer's Island, NE. $\frac{1}{2}$ E., $\frac{3}{4}$ mile.	N., $\frac{1}{4}$ mile	$14\frac{1}{2}$	...do	69.0	69.0	63.0	T.
844	Aug. 31	12.30 p. m.			North end Dyer's Island, SE. $\frac{1}{2}$ E., $\frac{1}{4}$ mile.	W. SW., $\frac{1}{4}$ mile	$11\frac{1}{2}$	...do	70.0	69.0	63.0	T.
845	Aug. 31	1.00			Prudence Light, N. $\frac{1}{2}$ W., $\frac{3}{4}$ mile		$14\frac{1}{2}$	Gravel	70.0	69.0	64.0	T.
846	Aug. 31	1.35			Prudence Light, N. by E. $\frac{3}{4}$ E., $1\frac{1}{2}$ miles	E. NE., $\frac{1}{4}$ mile	$14\frac{1}{2}$	Sandy mud and broken shells	70.0	68.0	63.0	R. D.
847	Aug. 31	2.15			Half-Way Rock, N. $\frac{1}{4}$ W., 1 mile	N. NE., $\frac{1}{4}$ mile	$12\frac{1}{2}$	Mud	70.0	68.0	62.0	T.
848	Aug. 31	3.00			Bishop's Rocks, E. $\frac{1}{2}$ mile	N., $\frac{1}{4}$	$15\frac{1}{2}$	Mud	69.0	68.0	62.0	T.
849	Sept. 1	9.20 a. m.			Fort Dumpling, W. NW. $\frac{1}{2}$ W., $\frac{1}{4}$ mile	SW., $\frac{1}{4}$	20	Sand, gravel, stones	67.0	67.0	63.0	R. D.
850	Sept. 1	9.40			Fort Dumpling, E. NE. $\frac{1}{2}$ E., $\frac{1}{2}$ mile	S. SW., $\frac{1}{4}$	$14\frac{1}{2}$	Sand and shells	67.0	67.0	63.0	R. D.
851	Sept. 1	10.00			Beaver Tail Light, SW. $\frac{1}{4}$ W., $1\frac{3}{4}$ miles	S., $\frac{1}{4}$	$12\frac{1}{2}$	Sand and gravel	66.0	67.0	66.0	R. D.
852	Sept. 1	10.35			Beaver Tail Light, S. SW. $\frac{3}{4}$ W., $2\frac{1}{8}$ miles	S., $\frac{1}{4}$	$2\frac{1}{2}$	Sand	67.0	67.0	66.0	T.
853	Sept. 1	10.50			Beaver Tail Light, SW by S., 2 miles	S., $\frac{1}{4}$	$4\frac{1}{2}$	Sand	68.0	67.0	67.0	T.
854	Sept. 1	11.10			Beaver Tail Light, SW. $\frac{1}{4}$ S., $1\frac{3}{4}$ miles	S., $\frac{1}{4}$	6	Sand	69.0	67.0	67.0	T.
855	Sept. 1	11.40			Beaver Tail Light, SW. by S., [illegible] miles	S., $\frac{1}{4}$	$3\frac{1}{2}$	Sand	70.0	68.0	68.0	T.
856	Sept. 1	12.05 p. m.			Beaver Tail Light, SW. $\frac{1}{2}$ W., $1\frac{3}{8}$ miles	S. SE., $\frac{1}{4}$	11	Sand, gravel, shells	69.0	68.0	67.0	R. D.
857	Sept. 1	12.35			Beaver Tail Light, W. SW. $\frac{3}{4}$ W., $\frac{6}{10}$ mile	SE., $\frac{1}{4}$	19	Sand	69.0	63.0	66.0	R. D.
858	Sept. 1	1.05			Beaver Tail Light, W. NW. $\frac{1}{4}$ W., $\frac{1}{2}$ mile	E., $\frac{1}{4}$	14	Coarse sand, broken shells	69.0	63.0	66.0	R. D.
					Vineyard Sound:							
859	Sept. 3	11.20 a. m.			Cuttyhunk Light, N. $\frac{1}{2}$ W., 3 miles	W., $\frac{1}{4}$	$17\frac{1}{2}$	Sand and mud	68.0	66.0	63.0	R. D.
860	Sept. 3	11.55			Cuttyhunk Light, N. $\frac{1}{2}$ W., 3 miles	W., $\frac{1}{4}$	$17\frac{1}{2}$	...do	70.0	66.0	64.0	R. D.
861	Sept. 3	12.20 p. m.			Cuttyhunk Light, N. $\frac{3}{4}$ W., $3\frac{3}{4}$ miles	S., $\frac{1}{4}$	17	Sand	69.0	66.0	61.0	T.
862	Sept. 3	12.55			Cuttyhunk Light, N., 4 miles	S., $\frac{1}{4}$	17	...do	68.0	66.0	64.0	T.
863	Sept. 3	1.40			Cuttyhunk Light, N. $\frac{1}{8}$ E., $3\frac{3}{4}$ miles	S., $\frac{1}{4}$	18	Sand and mud	70.0	67.0	65.0	R. D.
864	Sept. 3	3.00			Gay Head Light, S. SW., $\frac{7}{8}$, W., $5\frac{6}{10}$ miles	S., $\frac{1}{4}$	13	Sand and broken shells	70.0	67.0	61.0	D.

Dredging stations of the steamer Fish Hawk for 1880, 1881, *and* 1882—Continued.

Serial number.	Date.	Hour.	Latitude N.	Longitude W.	Locality.	Drift.	Depth in fathoms.	Nature of bottom.	Temperatures.			Apparatus used.
									Air.	Surf.	Bottom.	
	1880.		° ′ ″	° ′ ″	Atlantic Ocean:							
865	Sept. 4	5.40 a. m.	40 05	70 23	Off Martha's Vineyard	E.NE., ¾	65	Compact fine sand and mud	71.0	73.0	68.	T.
866	Sept. 4	6.30	40 05 18	70 22 18	......do	NE. by E., ½	65	Fine sand and mud	73.0	73.0	68.5	T.
867	Sept. 4	7.04	40 05 42	70 22 06	......do	E.SE., ¾	64	Compact hard sand and broken shells.	75.0	73.0	53.0	R. D.
868	Sept. 4	8.23	40 01 42	70 22 30	......do	NW., ¾	162	Fine sand and black specks.	75.0	75.0	47.0	T.
869	Sept. 4	9.27	40 02 18	70 23 06	......do	N.NE., ¾	192	Fine sand	80.0	76.0	50.0	T.
870	Sept. 4	10.59	40 02 36	70 22 58	......do	W. by N., 1	155	Mud and fine sand	80.0	77.0	......	T.
871	Sept. 4	11.40	40 02 54	70 23 40	......do	N.NW., ¾	115	Mud and fine sand	84.0	76.5	49.0	T.
872	Sept. 4	12.45 p. m.	40 05 39	70 23 52	......do	NW. by N., ½	86	Sand, gravel, shells, and sponge.	81.0	77.0	50.5	T.
873	Sept. 13	5.36 a. m.	40 02	70 57	......do	NW. by N., ½	100	Soft sticky mud	68.0	69.5	51.0	T.
874	Sept. 13	6.26	40 00 00	70 57 00	......do	NW., ½ mile	85	.. do	70.0	70.0	51.0	T.
875	Sept. 13	7.51	39 57 00	70 57 30	......do	NE., ½ mile	126	....do	70.0	70.0	53.0	T.
876	Sept. 13	8.45	39 57 00	70 56 00	......do	N., ¾ mile	120	... do	68.0	70.0	53.0	T.
877	Sept. 13	9.40	39 56 00	70 54 18	......do	N.NW., ¾ mile	126	... do	71.0	71.0	57.0	T.
878	Sept. 13	11.00	39 55 00	70 54 15	......do	NW., ¾ mile	142½	Mud	72.0	71.0	52.0	T.
879	Sept. 13	1.20 p. m.	39 49 30	70 54 00	......do	N. by W., ¾ mile.	225	Sand and blue mud	73.0	71.5	42.0	T.
880	Sept. 13	3.12	39 48 30	70 54 00	......do	W. by N., ¾ mile.	252½	Mud	74.0	71.5	43.0	T.
881	Sept. 13	5.00	39 46 30	70 54 00	......do	W.NW., ½ mile	325	....do	70.0	71.0	42.0	T.
					Narragansett Bay:							
882	Sept. 17	10.56 a. m.	....	....	Halfway Rock, N. NE. ¼ E., 2⅜ miles	SW., ¼ mile	12½	Mud	68.0	65.0	67.0	T.
883	Sept. 17	11.35	....	....	Halfway Rock, NE. by N., 2¼ miles	SW., ½ mile	13	.. do	70.0	65.0	63.5	T.
884	Sept. 17	2.10 p. m.	....	....	Hope Island, NE. ⅛ E., 200 yards	SW., ¼ mile	5	.. do	72.0	65.0	63.5	R. D.
885	Sept. 17	3.15	....	....	Gould Island, N. by E. ¾ E., ⅜ mile	S., ¼ mile	16	Mud and shells	71.0	69.0	65.0	O. T.
					Off Block Island:							
886	Sept. 21	12.49	....	....	South Light of Block Island, N. ¼ E., 5¾ miles.	N., ¼ mile	19	Shells and coarse gravel	67.0	64.0	62.0	D.
887	Sept. 21	1.30	....	....	South Light of Block Island, N. ½ W., 5¾ miles.	W., ¾ mile	19	....do	67.0	64.0	62.0	T.
888	Sept. 21	2.00	....	....	South Light of Block Island, N. by E., 6 miles.	W., 1½ miles	19	....do	68.0	64.0	62.0	T.
889	Sept. 21	3.50	....	....	South Light of Block Island, W. ¼ S., 5 miles.	W.SW., ½ mile	11	Hard sand and rocks	68.0	64.0	61.5	D.
890	Sept. 21	4.15	....	....	South Light of Block Island, W. ¼ S., 4¾ miles.	W.SW., ½ mile	11	....do	68.0	64.0	61.5	D.
891	Oct. 2	6.00 a. m.	39 46 00	71 10 00	Atlantic Ocean, off Martha's Vineyard	N., ½ mile	480?	Soft, brown mud	60.0	67.0	......	T.
892	Oct. 2	8.46	39 46 00	71 05 00	......do	N.NE., 2 miles	487	Soft, brown mud and small stone.	64.0	65.0	......	T.
893	Oct. 2	11.23	39 52 20	70 58 00	......do	N., 1 mile	372	... do	63.0	64.0	40.0	T.
894	Oct. 2	1.10 p. m.	39 53 00	70 58 30	......do	N., 2 miles	365	... do	63.0	64.0	40.0	T.

895	Oct. 2	3.17	39 56 30	70 59 45	......do	N., 1½ miles	238	Soft mud	62.0	65.0	42.0	T.
896	Nov. 16	9.20 a. m.	37 26 00	74 19 00	Atlantic Ocean, off mouth of Chesapeake Bay.	W.NW., ½ mile	56	Sand, shells	52.0	62.0	55.0	T.
897	Nov. 16	10.10	37 25 00	74 18 00	......do	W., 1 mile	157½	Sand, mud	62.0	62.0	48.0	T.
898	Nov. 16	11.25	37 24 00	74 17 00	......do	W., 1 mile	300	Mud	60.0	62.0	44.0	T.
899	Nov. 16	1.55 p. m.	37 22 00	74 29 00	......do	SW., ¼ mile	57½	Sand	58.0	61.0	54.0	T.
900	Nov. 16	4.00	37 19 00	74 41 00	......do	W., ½ mile	31	Sand	55.0	59.0	56.0	T.
901	Nov. 16	7.15	37 10 00	75 08 00	......do	W., ⅓ mile	18	....do	53.0	60.0	......	T.
902 } 916 }	......	....	....	....	Shallow water dredgings on the oyster beds, off Point Lookout, Potomac River, Virginia, by the Fish Hawk.							
	1881.											
917	July 16	4.10 a. m.	40 22 00	70 42 00	Atlantic Ocean, off Martha's Vineyard	NE., ¾ mile	44	Green mud	66.0	63.0	42.0	T.
918	July 16	5.33	40 20 24	70 41 30	......do	N. NE., 1 mile	46	....do	67.0	63.0	42.0	T.
919	July 16	7.00	40 16 18	70 41 18	......do	NE., 1 mile	53	....do	70.0	66.0	42.5	T.
920	July 16	8.20	40 13 00	70 41 54	......do	W. by S., 1 mile	63	....do	72.0	66.0	49.0	T.
921	July 16	9.40	40 07 48	70 43 54	......do	W., 1 mile	67	....do	75.0	70.0	52.0	T.
922	July 16	10.57	40 03 48	70 45 54	......do	N. by W., 1 mile	71	Green mud and sand	76.0	72.0	52.0	T.
923	July 16	12.27 p. m.	40 01 24	70 46 00	......do	W. NW., 1½ miles	98	Sand	74.5	72.0	52.0	T.
924	July 16	1.52	39 57 30	70 46 00	......do	NW., 2 miles	164	....do	74.5	71.0	44.5	T.
925	July 16	3.35	39 55 00	70 47 00	......do	NW. by W., 1½ miles.	229	Sand and mud	74.0	71.0	42.0	T.
926	July 16	5.24	39 56 00	70 46 00	......do	NW. ½ N., 2½ miles.	199	....do	74.0	71.0	44.0	T.
					Vineyard Sound:							
927	July 20	10.47 a. m.	....	....	Menemsha Bight; Gay Head Light, W. by S. ⅜ S., 2¼ miles.	W. NW., ½ mile	11	Sand	68.0	62.0	59.0	T.
928	July 20	11.30	....	....	Gay Head Light, W. ¾ S., 2⅜ miles	W. by N., ½ mile.	10	....do	69.0	62.5	60.0	T.
929	July 20	12.35 p. m	....	....	Off Quick's Hole; Gay Head Light, S. by W., 4½ miles	SE. by S., ¾ mile.	10	....do	66.0	63.0	62.0	D.
930	July 20	1.10	....	....	Gay Head Light, S. by W., 4¾ miles	S. ½ E., ½ mile	12	Sand and shells	65.0	63.0	62.0	D.
931	July 20	1.42	....	....	Off Robinson's Hole; Gay Head Light, SW. by S. ½ S., 5¼ miles.	S. ½ W., ½ mile	16	... do	65.0	63.0	62.0	D.
932	July 20	2.43	....	....	Off Lackey's Bay; Tarpaulin Cove Light, W. by S. ½ S., 3 miles.	NW. by W., ¼ mile.	14	Rock	67.0	66.0	66.0	D.
933	July 20	3.30	....	....	West Chop Light, S. ¾ E., ¾ mile	E.NE., 2½ miles	14	Stones	68.0	65.0	64.0	D.
934	July 20	4.10	....	....	Nobska Light, W. ¾ S., 1¾ miles	N.NW., 1 mile	9	Sand and gravel	68.0	67.0	67.0	T.
					Atlantic Ocean:							
935	Aug. 4	8.14 a. m.	39 45 00	69 44 45	Off Martha's Vineyard	NW. ½ N., 2½ miles	782	Green mud and sand	72.0	70.0	39.5	T.
936	Aug. 4	10.43	39 46 30	69 47 00	......do	NW. ⅜ W., 2 miles	716	Green mud	78.0	71.0	39.5	T.
937	Aug. 4	12.45 p. m.	39 49 25	69 49 00	......do	N., 2½ miles	616	Green mud and sand, with lumps of clay.	75.0	72.0	40.5	T.
938	Aug. 4	2.44	39 51 00	69 49 15	......do	N.NW., 2 miles	317	Green mud and sand	80.0	72.5	42.0	T.
939	Aug. 4	4.25	39 53 00	69 50 30	......do	N.NW., 1½ miles	264	....do	78.0	73.0	47.0	T.
940	Aug. 4	5.30	39 54 00	69 51 30	......do	N.NW. ½ W., 2 miles.	134	Hard sand and sponges	76.0	72.0	52.0	T.
941	Aug. 4	7.45	40 01 00	69 56 00	......do	W. NW., 1½ miles	79	Hard sand and mud	74.0	71.0	52.0	T.
942	Aug. 9	6.15 a. m.	40 01 00	71 12 30	......do	SW. by W., 2 miles.	138	....do	72.0	69.0	50.0	D.
943	Aug. 9	7.10	40 00 00	71 14 30	......do	NW. by N., 2½ miles.	157	Mud, sand, and shells	76.0	70.0	49.0	D.

Dredging stations of the steamer Fish Hawk for 1880, 1881, *and* 1882—Continued.

Serial number.	Date.	Hour.	Latitude N.	Longitude W.	Locality.	Drift.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Temperatures. Surf.	Temperatures. Bottom.	Apparatus used.
	1881.		° ′ ″	° ′ ″	Atlantic Ocean:							
944	Aug. 9	8.27 a. m.	40 01 00	71 14 30	Off Martha's Vineyard	NW. by N., 1½ miles.	128	Mud, sand, and shells	78.0	70.0	51.0	T.
945	Aug. 9	12.05 p. m.	39 58 00	71 13 00	......do	NW. by N., 2 miles.	207	Green mud and sand	75.0	71.0	44.0	T.
946	Aug. 9	2.00	39 55 30	71 14 00	......do	NW. by W., 1½ miles.	247	....do	75.5	71.0	47.0	T.
947	Aug. 9	4.00	39 53 30	71 13 30	......do	W.NW., 3 miles.	319	Sand and mud	75.0	70.0	44.0	T.
					Buzzard's Bay:							
948	Aug. 13	5.20			Penikese Island east, 2 miles	W.SW., 1 mile	7	Black mud and shells	76.6	67.0	66.0	T.
					Atlantic Ocean:							
949	Aug. 23	4.20 a. m.	40 03 00	70 31 00	Off Martha's Vineyard	N.NW., 2 miles	100	Yellow mud	68.0	66.0	52.0	R.D.
950	Aug. 23	5.50	40 07 00	70 32 00	......do	N.NW., 1½ miles	71	Sand, shells, and mud	69.0	65.0	52.0	T.
951	Aug. 23	9.40	39 57 00	70 31 30	......do	N., 1½ miles	225	Mud	78.0	67.5	41.0	T.
952	Aug. 23	11.28	39 55 00	70 28 00	......do	NE. by N., 1½ miles.	396	Yellow mud and sand	82.0	68.0	40.0	T.
953	Aug. 23	2.30 p. m.	39 52 30	70 17 30	......do	N.NW., 1½ miles.	724	Mud	77.0	68.0	39.5	T.
954	Aug. 23	4.50	39 53 00	70 18 30	......do	N.NW., 2 miles	651	Sand and mud	74.5	68.0	39.5	T.
					Buzzard's Bay:							
955	Aug. 26	10.50 a. m.			Nye's Neck, E. by S., ¼ mile	W. by S. ¼ S., ½ mile.	7	Sand	69.0	67.5	68.0	T.
956	Aug. 26	11.26			Nye's Neck, S.SE. ¾ E., ⅛ mile	W. by S., ¼ mile.	5¼	....do	71.0	69.0	68.0	T.
957	Aug. 26	11.45			Nye's Neck, S.SE. ¾ E., ⅛ mile	W. ¾ N., ¼ mile	6	Sand and stones	73.0	69.5	68.0	T.
958	Aug. 26	12.20 p. m.			Nye's Neck, S. by E. ¼ E., ⅓ mile	W.SW., ⅓ mile	5	Sand, stones, shells	75.0	70.0	68.0	T.
959	Aug. 26	12.40			Nye's Neck, S., ½ mile	West, ½ mile	5	....do	72.0	69.0	68.0	T.
960	Aug. 26	1.10			Nye's Neck, S. ¾ E., ½ mile	SW. by W., ½ mile.	4½	....do	72.5	69.5	68.0	T.
961	Aug. 26	1.52			Nye's Neck, NE. ¾ E., 2¾ miles	W. by S., ¾ mile	8	Black mud	71.5	69.0	68.0	T.
962	Aug. 26	3.10			Woepecket Island, NE. ¾ E., 1¼ miles	W.NW., ½ mile	8	Black mud, sand	71.0	68.0	66.0	T.
963	Aug. 26	3.40			Woepecket Island, SE. ½ S., 1 mile	W.SW., ¾ mile	8½	Brown mud	70.0	68.0	66.0	D.
					Off Chatham, Cape Cod (Crab Ledge):							
964	Aug. 30	7.50 a. m.			Chatham Lights, NW. ½ W., 5 miles	S.SE., ⅓ mile	10	Sand, gravel	65.0	61.0	55.0	D.
965	Aug. 30	8.15			Chatham Lights, NW. by W., 6 miles	SE. by E., ⅓ mile.	15	....do	65.0	61.0	53.0	D.
966	Aug. 30	8.40			Chatham Lights, NW. by W. ¼ W., 6¼ miles	SE., ⅛ mile	16	Sand, small stones	65.0	61.0	52.0	D.
967	Aug. 30	8.50			Chatham Lights, NW. by W. ¼ W., 6¾ miles	SE., ⅙ mile	16	Sand, gravel	66.0	61.0	52.0	D.
968	Aug. 30	9.00			Chatham Lights, NW. by W. ¾ W., 7¼ miles.	NW. by W., ⅛ mile.	18	Gravel	66.0	61.5	50.5	D.
969	Aug. 30	9.10			Chatham Lights, NW. by W. ¾ W., 7 miles.	SE., ¼ mile	18	Sand, pebbles	66.0	61.5	51.0	D.
970	Aug. 30	9.43			Chatham Lights, W.NW. ¾ W., 6 miles	W.NW., ⅛ mile	13	....do	67.0	61.0	54.0	D.
971	Aug. 30	10.05			Chatham Lights, W. ¾ N., 4¼ miles	S.SE., ¼ mile	11	Sand, gravel, pebbles	67.0	61.5	54.0	D.

972	Aug. 30	10.48	....	....	Chatham Lights, NW. by W. ⅞ W., 7½ miles.	NE., ⅛ mile	16	Sand, gravel, stones	67.0	62.0	52.0	D.
973	Aug. 30	11.10	....	....	Chatham Lights, W.NW., 6¾ miles	W.SW., ⅛ mile	17	...do	67.0	62.0	51.0	D
974	Aug. 30	11.30	....	....	Chatham Lights, W.NW. ½ W., 6½ miles	W.SW., ⅛ mile	16	...do	67.0	62.0	51.0	D.
975	Aug. 30	11.45	....	....	Chatham Lights, W.NW. ¼ W., 6¼ miles	S., ⅛ mile	16	...do	68.0	63.0	52.0	D.
976	Aug. 30	12.00 m.	....	....	Chatham Lights, W.NW. ⅜ W., 6 miles	S. SW., ⅛ mile	16	...do	69.0	63.0	52.0	D.
977	Aug. 30	12.20 p. m.	....	....	Chatham Lights, W.NW., 6¼ miles	W. by N., ¼ mile	17	...do	70.0	64.0	52.0	D.
978	Aug. 30	12.30	....	....	Chatham Lights, W.NW., 6 miles	W. by N., ⅛ mile	17	...do	70.0	64.0	52.0	D.
979	Aug. 30	12.40	....	....	Chatham Lights, W.NW. ¼ W., 6 miles	W. by N., ⅛ mile	16	Sand	70.0	64.0	52.0	D.
980	Aug. 30	1.00	....	....	Chatham Lights, NW. by W. ¼ W., 5¾ miles.	SW., ⅛ mile	14	Sand, stones, pebbles	70.0	62.0	53.0	D.
981	Aug. 30	2.10	....	....	Chatham Lights, W.NW., 16 miles	S. ¼ W., 1½ miles	43	Sand, gravel	65.0	63.5	49.0	T.
982	Aug. 30	2.45	41 36	69 35	Off Chatham, Cape Cod	S.SW., 1½ miles	42	...do	65.0	63.5	41.5	T.
983	Aug. 30	3.23	41 33	69 32	......do	S. by E., ½ mile	36	Sand	64.5	64.0	42.0	T.
984	Aug. 30	4.07	41 31	69 28	......do	S. ½ W., ½ mile	33	Mud and sand	64.0	63.5	41.5	T.
					Atlantic Ocean:							
985	Sept. 7	12.55 p. m.	41	70 49	Off Martha's Vineyard	SW. by S., 1¼ miles.	26	Sand	73.0	66.0	50.0	T.
986	Sept. 7	2.00	40 55	70 48	......do	S. ½ W., 1 mile	28	...do	73.0	67.0	49.0	T.
987	Sept. 7	2.28	40 54	70 48 30	......do	S., ½ mile	28	...do	73.0	67.0	49.0	R.D.
988	Sept. 7	3.30	40 49 30	70 47	......do	S., ½ mile	30	...do	73.0	67.0	49.5	R.D.
989	Sept. 7	4.00	40 49	70 47	......do	S., ¾ mile	30	...do	73.0	67.0	49.5	T.
990	Sept. 7	5.08	40 44	70 47	......do	S. ½ W., ¾ mile	34	Green mud and sand	71.5	66.0	47.0	T.
991	Sept. 7	6.05	40 39	70 46	......do	S. ¼ W., ¼ mile	34	...do	70.0	66.0	47.5	T.
992	Sept. 7	7.30	40 33	70 45	......do	S., ⅛ mile	36	...do	69.0	65.0	48.0	T.
993	Sept. 7	8.20	40 28	70 44	......do	S., ⅝ mile	39	Mud	69.0	65.0	46.5	T.
994	Sept. 8	4.50 a. m.	39 40	71 30	......do	W.NW., 2 miles	368	...do	72.0	68.0	40.5	T.
995	Sept. 8	6.32	39 40 30	71 31	......do	W.NW., ½ mile	358	Yellow mud and sand	72.0	68.0	40.5	T.
996	Sept. 8	7.35	39 41	71 31 37	......do	NW., ⅛ mile	346	...do	75.0	67.5	40.0	R.D.
997	Sept. 8	9.03	39 42	71 32	......do	N. by W., 1 mile	335	Yellow mud	75.0	67.5	40.0	T.
998	Sept. 8	10.34	39 43	71 32	......do	N., 1¼ miles	302	Green mud	74.0	68.0	40.0	T.
999	Sept. 8	11.48	39 45 13	71 30	......do	N. NW., ¾ mile	266	...do	73.0	68.0	......	R.D.
1000 } 1024 }	....	....	....	....	(Dredgings by steamer Lookout. Nos. 1006 to 1013, close off Gay Head; 1014 N. of Lucas Shoal, Vineyard Sound.)							
					Atlantic Ocean:							
1025	Sept. 8	1.05 p. m.	39 49	71 25	Off Martha's Vineyard	N. ¼ E., 1 mile	216	...do	71.0	69.0	45.0	T.
1026	Sept. 8	2.55	39 50 30	71 23	......do	N. by E., 1½ miles	182	Green mud, sand	69.0	69.0	47.5	T.
1027	Sept. 14	7.23 a. m.	40 00	69 19	......do	N., ¾ mile	93	Fine sand	61.0	65.0	48.5	T.
1028	Sept. 14	9.01	39 57	69 17	......do	N. NE., ½ mile	410	Yellow mud	66.5	66.0	41.0	T.
1029	Sept. 14	12.13 p. m.	39 57 06	69 16	......do	NE. by N., 1 mile.	458	Yellow mud, sand	72.0	68.0	40.0	T.
1030	Sept. 14	1.52	39 58 30	69 15	......do	N. by W., 1½ miles.	337	Yellow mud	65.0	66.0	41.0	R.D.
1031	Sept. 14	2.54	39 57	69 19	......do	NW. by N., 1½ miles.	255	...do	64.0	65.0	46.0	T.
1032	Sept. 14	4.00	39 56	69 22	......do	NW., ¾ mile	208	...do	65.0	65.0	46.0	T.
1033	Sept. 14	4.55	39 56	69 24	......do	N. NW., 2 miles	183	Sand, gravel	66.0	63.0	......	T.
1034	Sept. 14	5.55	39 56	69 26	......do	N. NW., ½ mile	146	Sand and yellow mud	66.0	62.0	46.5	T.
1035	Sept. 14	6.56	39 57	69 28	......do	N., ¾ mile	120	Sand	65.0	62.0	47.0	T.
1036	Sept. 14	7.54	39 58	69 30	......do	N. NW., 1½ miles	94	...do	62.0	61.5	51.0	R.D.

Dredging stations of the steamer Fish Hawk for 1880, 1881, *and* 1882—Continued.

Serial number.	Date.	Hour.	Latitude N.	Longitude W.	Locality.	Drift.	Depth in fathoms.	Nature of bottom.	Temperatures.			Apparatus used.
									Air.	Surf.	Bottom.	
	1881.		° ′ ″	° ′ ″	Off Gay Head, Martha's Vineyard:							
1037	Sept. 15	8.00 a. m.			Gay Head Light, NE. ¾ N., 4 miles		16	Sand				T.
					Atlantic Ocean:							
1038	Sept. 21	6.55	39 58	70 06	Off Martha's Vineyard	N. by E., 1 mile	146	Sand and shells	67.0	67.0	47.0	T.
1039	Sept. 21	9.35	39 59	70 06	do	N. by E., 2 miles	130	do	66.5	67.0	50.0	T.
1040	Sept. 21	10.43	40 00	70 06	do	N. by E., 2 miles	93	do	64.0	68.0	66.0	D.
					Vineyard Sound, Mass.:							
1041	Sept. 22	12.35 p. m.			West Chop Light, E. ½ N., 1¾ miles	W.SW., ¾ mile	9	Sand and gravel	63.5	65.0	65.0	T.
1042	Sept. 22	1.17			West Chop Light, E. ½ N., 1½ miles	W. by N., ½ mile	6	do	63.5	65.0	65.0	T.
					Atlantic Ocean:							
1043	Oct. 10	7.17 a. m.	38 39	73 11	Off the Capes of Delaware	NW. by N., 1¾ miles.	130	Sand	63.5	65.5	49.0	T.
1044	Oct. 10	8.15	38 37	73 12	do	W.NW., ½ mile	224	Gray mud	65.0	66.0	42.5	T.
1045	Oct. 10	9.32	38 35	73 13	do	W. ¾ N., ¾ mile	312	do	67.0	66.0	40.0	T.
1046	Oct. 10	11.14	38 33	73 18	do	W.NW., ¾ mile	104	Sand	66.0	66.0	51.0	T.
1047	Oct. 10	12.15 p. m.	38 31	73 21	do	NW., 1½ miles	156	do	69.0	66.0	49.0	T.
1048	Oct. 10	1.55	38 29	73 21	do	W., 2 miles	435	Mud	71.0	66.0	40.0	T.
1049	Oct. 10	3.30	38 28	73 22	do	N.NW., 2 miles	435	do	68.0	66.0	40.0	T.
	1882.				Chesapeake Bay:							
1050	Feb. 27	2.00 p. m.			Point No Point, N.NE., 1½ miles		3½	Mud, shells, gravel	50.0	41.0		O. D.
1051	Feb. 27	2.15			Point No Point, N. by E., 1 mile		2	Mud, grass	50.0	41.0	40.0	O. D.
1052	Feb. 27	2.30			Point No Point, N.NE., ¾ mile		1¾	do	50.0	41.0	40.0	O. D.
1053	Feb. 27	2.45			Point No Point, N. by E., 1½ miles		2¾	Mud, shells, oysters	50.0	41.0	40.0	O. D.
1054	Feb. 27	2.50			Point No Point, N. by E., 1¼ miles		2¾	do	50.0	41.0	40.0	O. D.
					Patuxent River, Maryland:							
1055	Feb. 28	10.40 a. m.			Drum Point, NE., ½ mile		6	Brown mud, shells	46.0	40.0		D.
1056	Feb. 28	10.55			Drum Point, N.NE., ½ mile		6	do	46.0	40.0		R.D.
					Chesapeake Bay:							
1057	Feb. 28	12.00 m.			South end Barren Island, E. by S., 1¾ miles.	W.NW., ½ mile	17–20	Brown mud	49.0	40.0	40.0	T.
1058	Feb. 28	12.10 p. m.			South end Barren Island, SE. by E. ½ E., 2 miles.	W.NW., ¾ mile	3–25	do	49.0	40.0	40.0	T.
1059	Feb. 28	12.30			South end Barren Island, SE. ½ E., 2 miles	W.NW., ¾ mile	2¾–25	do	49.0	40.0	40.0	T.
1060	Feb. 28	4.40			Smith's Point, S.SW., 2 miles	SE. by S., ¾ mile	7	Brown mud, shells	46.0	41.0	40.5	T.
1061	Mar. 2	11.20 a. m.			Smith's Point Light, S. by W. ½ W., 1½ miles.	S., ½ mile	11–16	do	48.0	41.5	41.5	D.
1062	Mar. 2	11.40			Smith's Point Light, SW. ½ S., 1¼ miles	S. by W., 1 mile	16–9½	do	48.0	41.5	41.5	T.
1063	Mar. 2	1.35 p. m.			South point Tangier Island, N. by E. ¾ E., 2¼ miles.	NE. by E., ½ mile	10	do	50.0	44.0	42.0	R.D.
1064	Mar. 2	2.17			South point Tangier Island, N.NW., 1 mile.	NE. by E., ½ mile	20–9½	do	50.0	42.0	42.0	R.D.

1065	Mar. 6	9.00 a. m.			Cherrystone Light, E. by N., 2 miles		25–12	Sand	56.0	45.0	46.5	T.
1066	Mar. 6	9.20			Cherrystone Light, E. by S., 3 miles		12–25	....do	56.0	45.0	45.0	T.
1067	Mar. 6	9.10			Cherrystone Light, SE. by E ¼ E., 3 miles		12–20	....do	56.0	45.0	47.0	T.
1068	Mar. 11	9.50 a. m.			Thomas Point Light, W.SW. ½ W., 2 miles		14–9	Black mud	49.0	42.0	41.0	T.
1069	Mar. 11	10.30			Thomas Point Light, SW. by W. ¾ W., 2¼ miles.		18	....do	51.0	42.0	40.0	T.
1070	Mar. 11	10.45			Thomas Point Light, W. by S., 2 miles		15–10	....do	45.0	42.0	42.0	T.
1071	Mar. 11	11.22			Thomas Point Light, W.NW. ½ W., 2¼ miles.		14–13	....do	49.0	42.0	40.0	T.
1072	Mar. 11	12.00 m.			Thomas Point Light, NW., 2¼ miles		16	....do	50.0	42.0	42.0	R. D.
1073	Mar. 11	12.25 p. m.			Thomas Point Light, NW. by N., 2¼ miles		13	Black mud, shells	50.0	42.0	42.0	R. D.
1074	Mar. 11	1.10			Thomas Point Light, N. by W. ½ W., 4¼ miles.		18–11	Black mud	51.0	43.0	41.0	T.
1075	Mar. 13	9.45 a. m.			Sandy Point Light, N. by W. ¼ W., 3½ miles.		14–11	Mud	45.0	43.0	40.0	T.
1076	Mar. 13	10.15			Sandy Point Light, N. by W. ¼ W., 3½ miles.		15	....do	45.0	43.0	40.0	T.
1077	Mar. 13	10.55			Sandy Point Light, NW. ¼ W., 2¼ miles		11–12	....do	49.0	43.0	40.0	T.
					Off Cape Cod:							
1078	Aug. 2	7.50 a. m.			Nausett Lights, NW. ½ N., 10 miles	S. by W., ½ mile	55	Green mud, fine sand	72.0	63.0	37.0	T.
1079	Aug. 2	8.40			Nausett Lights, NW. by W. ½ W., 8¼ miles	E.SE., 1 mile	61½	Fine sand	69.0	63.5	37.0	T.
1080	Aug. 2	9.40			Nausett Lights, NW. by W. ½ W., 6½ miles	W.NW., 1 mile	55	....do	69.0	61.5	37.0	T.
1081	Aug. 2	10.50			Nausett Lights, W. by S., 5½ miles	NW. by N., 1 mile.	33½	Coarse gravel and pebbles	69.0	59.0	39.0	T.
1082	Aug. 2	11.45			Cape Cod Light, NW. ¾ N., 11½ miles	NW. by N., ¼ mile.	28	Coarse gravel	70.0	59.0	40.0	T.
1083	Aug. 2	12.45 p. m.			Cape Cod Light, W. by N., 15 miles	W.SW., ½ mile	83½		77.0	64.0	38.0	T.
1084	Aug. 2	2.20			Cape Cod Light, W.NW. ¾ W., 8 miles	W.SW., 1 mile	37½	Coarse sand	78.0	62.5	38.0	T.
1085	Aug. 3	6.15 a. m.			Race Point Light, S. 73° E., 2 miles	S. by E., 1 mile	34½	Fine sand, green mud	67.0	64.0	39.0	T.
1086	Aug. 3	7.00			Race Point Light, S. 20° W., 2¾ miles	S., ¾ mile	34	Fine sand	74.0	64.0	39.5	T.
1087	Aug. 3	8.30			Cape Cod Light, S.SW., 7 miles	W.SW. ½ mile	44	Gray sand	81.0	62.5	39.0	T.
1088	Aug. 3	9.50			Cape Cod Light, SW. ¾ W., 9½ miles	NW., 1½ miles	90	Coarse sand	82.5	62.0	38.0	T.
1089	Aug. 3	11.10			Cape Cod Light, SW. ¾ W., 14 miles	NW. by W., ¾ mile.	110	Gray mud	78.0	63.0	38.5	T.
1090	Aug. 3	11.50			Cape Cod Light, SW. ¾ W., 13¾ miles	W.SW., 1 mile	110	....do	81.5	62.0	38.5	T.
					Atlantic Ocean:							
1091	Aug. 11	5.30 a. m.	40 03	69 41	Off Martha's Vineyard	NW. by W., ½ mile.	65	Gray sand, broken shells	77.0	75.0	46.0	T.
1092	Aug. 11	6.54	39 58	69 42	....do	N.NW., ¾ mile	202	Gray sand	79.0	75.0	41.0	T.
1093	Aug. 11	8.35	39 56	69 45	....do	N.NW., 1 mile	349	Blue mud, sand	82.0	75.0	40.0	T.
1094	Aug. 11	10.10	39 57	69 47	....do	NW. by N., 1 mile.	301	Blue mud	84.0	76.0	40.0	T.
1095	Aug. 11	11.55	39 55 28	69 47	....do	N.NW. ½ W., ¾ mile.	321	Soft green mud	82.0	76.0	40.0	T.
1096	Aug. 11	1.19 p. m.	39 53	69 47	....do	NW. ½ N., ½ mile	317	....do	78.0	75.5	40.0	T.
1097	Aug. 11	3.10	39 54	69 44	....do	N. ½ W., ½ mile	158	Fine sand	76.0	75.5	45.0	T.
1098	Aug. 11	4.35	39 53	69 45	....do	N. by E., ½ mile	156	....do	78.0	75.0	43.5	T.
					Vineyard Sound:							
1099	Aug. 18	11.05 a. m.			Nobska Point Light, W.SW. ¼ W., 1⅜ miles.	NE. by N. ½ mile	6	Sand, gravel	76.0	72.0	71.5	T.
1100	Aug. 18	11.47			Nobska Point Light, W.SW. ¼ W., 1¼ miles.	NE. by N. ½ mile	4¼	Sand, gravel, shells	77.0	72.0	71.5	T.

Nov. 4, 1882.

Dredging stations of the steamer Fish Hawk for 1880, 1881, *and* 1882—Continued.

Serial number.	Date.	Hour.	Latitude N.	Longitude W.	Locality.	Drift.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Temperatures. Surf.	Temperatures. Bottom.	Apparatus used.
	1882.		° ′ ″	° ′ ″	Vineyard Sound:							
1101	Aug. 18	12.15 p. m.	......	......	Nobska Point Light, W. by S. 1½ miles	NE., 1 mile	5	Sand, gravel, shells	78.0	72.0	71.0	T.
1102	Aug. 18	1.10	......	......	East Chop Light, NW. ¾ W., 2½ miles	E. by S., ½ mile	5	Coarse sand	73.0	70.0	69.0	T.
1103	Aug. 18	1.42	......	......	East Chop Light, NW. by W., 2¾ miles	E. by S., ½ mile	5	...do	72.0	70.0	69.0	T.
1104	Aug. 18	2.12	......	......	East Chop Light, W.NW. ½ W., 4 miles	N. by W. ¾ W., ½ mile.	8½	Shells	79.0	70.0	69.0	T.
1105	Aug. 18	3.00	......	......	Cape Poge Light, S. by W., 4 miles	NE. by E. ½ E., 2 miles.	10	Coarse sand	80.0	72.0	71.0	T.
1106	Aug. 18	3.35	......	......	Cape Poge Light, S. by W. ½ W., 5½ miles	NE. by N., ¼ mile	5	Sand, shells	80.0	72.5	72.0	T.
					Atlantic Ocean:							
1107	Aug. 22	6.00 a. m.	40 02	70 35	Off Martha's Vineyard	NW., 1 mile	116	Gray mud	69.5	71.0	48.0	T.
1108	Aug. 22	6.55	40 02	70 37 30	...do	NW., ¾ mile	101	Gray mud, fine sand	69.5	71.0	48.0	T.
1109	Aug. 22	7.55	40 03	70 38	...do	N.NW., 1 mile	89	Gray sand	70.5	71.0	49.0	T.
1110	Aug. 22	9.16	40 02	70 35	...do	N. by W. ½ W., 1 mile.	100	Green mud, fine sand	75.0	72.0	47.0	T.
1111	Aug. 22	10.45	40 01 33	70 35	...do	N.NE. ½ E., 1 mile.	124	Fine sand	76.0	72.0	47.0	T.
1112	Aug. 22	12.43 p. m.	39 56	70 35	...do	NW. by N., 1 mile.	245	Green mud, sand	72.0	72.0	43.0	T.
1113	Aug. 22	1.45	39 57	70 37	...do	N., 1 mile	192	Green mud	75.0	72.0	43.0	T.
1114	Aug. 22	2.40	39 58	70 38	...do	N. by W., 1 mile	171	...do	74.0	72.0	43.0	T.
1115	Aug. 22	3.28	39 59	70 41	...do	W. by N., ¾ mile	146	Green mud, sand	75.0	72.5	45.0	R. D.
1116	Aug. 22	4.20	39 59	70 44	...do	NW. by W., 1 mile.	111	...do	77.0	72.0	46.0	T.
1117	Aug. 22	5.30	40 02	70 45	...do	N. by E., 1 mile	89	Fine sand	78.0	72.0	48.0	T.
1118	Aug. 22	6.20	40 03	70 45	...do	N.NW., ¾ mile	70	...do	74.0	72.0	49.0	T.
1119	Aug. 26	6.32 a. m.	40 08	68 45	...do	NE. ½ N., ¾ mile	97	Sand, broken shells	68.0	65.0	48.0	T.
1120	Aug. 26	7.41	40 05	68 48	...do	NW., 1½ miles	194	Fine sand, stones	69.0	65.0	43.5	T.
1121	Aug. 26	9.05	40 04	68 49	...do	W.NW., 1 mile	234	...do	65.0	65.0	41.5	T.
1122	Aug. 26	10.28	40 02	68 50	...do	NW., 1 mile	351	...do	70.0	67.0	40.5	T.
1123	Aug. 26	12.00 m.	39 59 45	68 54	...do	N.NW., 1 mile	787	Fine sand, green mud	70.0	69.0	39.0	T.
1124	Aug. 26	1.01 p. m.	40 01	68 54	...do	NW. by N., 1 mile	610	Fine sand, green mud, limestone nodules.	65.0	65.0	39.0	T.
1125	Aug. 26	5.45	40 03	68 56	...do	NW. by W., 1 mile.	291	Sand, mud	65.0	64.0	40.0	T.
					Vineyard Sound, Menemsha Bight:							
1126	Aug. 28	1.46 p. m.	......	......	Gay Head Light-house, W.SW., 2¾ miles	SE. by E., ¾ mile.	11	Sand, black mud	72.0	66.0	63.5	T.
1127	Aug. 28	2.30	......	......	Gay Head Light-house, W. by S., 3 miles.	E.SE., ½ mile	10	Gray sand, mud	66.0	......	64.0	T.
1128	Aug. 28	3.10	......	......	Gay Head Light-house, W. ¾ S., 2¾ miles	S. by E., ¼ mile	9	...do	69.0	66.0	65.0	D.
					North of Nomen's Land:							
1129	Sept. 2	2.00	......	......	Fishing Village, S., ½ mile	NE. by E., ½ mile.	4	Sand, stones	72.0	65.0	62.0	D.
1130	Sept. 2	2.13	......	......	Fishing Village S. ½ E., ½ mile	NW. by N., ½ mile	4	...do	72.0	65.0	62.0	D.
1131	Sept. 2	2.29	......	......	Fishing Village, SE. by E., ½ mile	E. by N., ¼ mile	4	...do	72.0	65.0	63.0	D.

1132	Sept. 2	2.45	....	....	Fishing Village, SE. by E., ¼ mile	N.NE., ½ mile	4	....do	72.0	65.0	62.0	D.
1133	Sept. 2	3.10	....	....	Fishing Village, SE., ¾ mile	E. by S., ¾ mile	4	....do	72.0	65.0	62.0	D.
					Vineyard Sound, Menemsha Bight:							
1134	Sept. 6	1.26 p.m.	....	....	Gay Head Light., W.SW. ¾ W., 2¾ miles	NW. by N., ½ mile	9½	Sand, mud	76.0	66.0	64.0	T.
1135	Sept. 6	2.20	....	....	Gay Head Light., W. ½ S., 3 miles	NE., ¼ mile	7½	do	71.0	66.0	64.0	T.
1136	Sept. 6	3.50	....	....	Gay Head Light., W.SW. ⅞ W., 3 miles	NE., ¼ mile	10	Mud	70.0	66.0	63.0	D.
					Atlantic Ocean:							
1137	Sept. 8	6.00 a.m.	39 40	71 52	Off Martha's Vineyard	N.NW., ½ mile	173	Fine sand, pebbles	68.0	70.0	46.0	T.
1138	Sept. 8	7.24	39 39	71 54	......do	NW., 1 mile	168	....do	72.0	71.0	46.0	T.
1139	Sept. 8	8.48	39 37	71 55	......do	NW. by W., 1½ miles.	291	Mud	74.0	72.0	44.0	T.
1140	Sept. 8	10.35	39 34	71 56	......do	N., 1 mile.	374	Fine sand, soft mud, pebbles	78.0	73.0	40.0	T.
1141	Sept. 8	12.27 p.m.	39 32	71 57	......do	W. by N., ½ N., 1 mile.	389	Sand and mud	80.0	74.0	40.0	T.
1142	Sept. 8	1.52	39 32	72 00	......do	W. by S., ½ mile.	322	Mud, with sand and pebbles.	80.0	74.0	41.0	T.
1143	Sept. 8	3.36	39 29	72 01	......do	NW., 2 miles	452	Soft mud	80.0	74.0	40.0	T.
1144	Sept. 8	6.00	39 31	72 06	......do	N., 1 mile	386	... do	75.0	74.0	41.0	T.
1145*	Sept. 21	....	40 03	70 28	......do	....	135–160	....	.....	.....	.....	C. T.
1146	Sept. 21	....	40 02	70 41	......do	....	130–150	....	.....	.....	.....	C. T.
1147	Sept. 22	....	40 01	71 02	......do	....	125	....	.....	.....	.....	C. T.
1148	Sept. 23	....	39 54	71 22	......do	....	100–125	....	.....	.....	.....	C. T.
1149	Sept. 23	....	39 50	71 25	.... do	....	110	....	.....	.....	.....	C. T.
1150	Oct. 4	6.35 a.m.	39 58	70 37	..... do	E., ½ mile	140	Sand	65.0	62.0	47.0	T.
1151	Oct. 4	7.45	39 58 30	70 37	......do	E., 2 miles	125	... do	66.0	62.0	48.0	T.
1152	Oct. 4	8.42	39 58	70 35	.... do	E., 1½ miles	115	....do	68.0	62.0	48.0	T.
1153	Oct. 4	10.45	39 54	70 37	......do	N., ½ W., 1½ miles	225	Sand and mud	70.0	62.5	44.0	T.
1154	Oct. 4	12.10 p.m.	39 55 31	70 39	......do	N. by W., 1½ miles	193	do	62.0	62.5	.....	T.
1155	Oct. 4	4.06	39 52	70 30	......do	N. NW., ½ mile	554	Soft mud	64.0	63.0	40.0	T.

* Nos. 1145–1149 indicate the stations of the fishing schooner Josie Reeves, using cod trawl-lines.

SCARCITY OF BLACKFISH—MORTALITY OF CODFISH.

By CHAS. C. LESLIE.

[From letter to G. Brown Goode.]

For the past four or five years we have noticed the scarcity of blackfish in the summer, and especially this summer. The smacks here have not made their expenses for the past two months. I have just seen Capt. S. M. Corker, one of our expert blackfish fishermen, who has been in the business for thirty years. He tells me that he has never seen them so scarce as they are at present, and that in former years the fishermen were accustomed to catch enough to pay expenses during the summer. Captain Corker also tells me that about June 1 a vessel came into this port, and, according to the statement of her captain, she sailed through acres of codfish, floating belly up, between Hatteras and Cape Henry. The fish were not dead, but very weak.

CHARLESTON, S. C., *June* 29, 1882.

SHAD FISHING ON THE SAINT JOHN'S RIVER.

By JOHN H. OSBORN.

[From a letter to Prof. S. F. Baird.]

The past winter was very poor; the river was quite low and everything favorable for a good run of shad. I fished from January 12 until February 25. This is my sixth and last winter on the Saint John's. Our average catch nightly was 13 during January; during February it was 20. We had a good many northeast winds and many very cold nights, both of which stopped shad from running.

Several fishermen on the lower river have quit the business. Messrs. Melton & Tote, the largest fishery near Jacksonville, running 30 nets, did not pay expenses. Shad sold in Palatka and Jacksonville for 50 cents apiece. We sold a l we could catch at Sanford and Orange City. Could have sold ten times as many if we could have caught them. In the winter of 1876 I caught, on an average, 200 shad per night, with a 300-foot net, 20 meshes, 2½ inch mesh, rigged 3 meshes to a 5-inch span. Shad have gradually decreased since, and last winter I fished a 400-foot net, 25 meshes deep, 2¼ inch mesh, rigged to 3 meshes on a 4-inch span. My net was rigged to catch fish and she did catch them, except shad, from a 5-inch herring up to 40 pound catfish and gars.

SORRENTO, FLA., *June* 5, 1882.

REPORT OF AN EXPLORING TRIP OF THE STEAMER FISH HAWK IN CHESAPEAKE BAY IN THE EARLY SPRING OF 1882.

By Lieut. Z. L. TANNER, U. S. N.

We left the navy-yard at 12.50 p. m., Saturday, and arrived at Point Lookout at 10.45 p. m., where we anchored for the night. At 12.30 p. m., before leaving Washington, we received 1,000,000 cod eggs in artificial sea water; about 75 per cent. of them seemed to be alive. Upon our arrival here they were put in three cones and a glass jar, and the hatching process commenced. The water was 40° at the surface and 41° in the cones; specific gravity 1.0070, that of sea water being from 1.0240 to 1.0290.

The eggs sunk at once to the bottom, and were, in consequence treated as shad eggs. About 60 per cent. were apparently alive on Sun, day morning, but the development had entirely ceased; in fact, the germinal disc seemed to have contracted. On Monday morning there were but few eggs alive (about 1 in 500), and no development since they were placed in the water of Chesapeake Bay. The germinal disc was much distorted. It was difficult to find a live egg in the evening, and the few discovered presented the same abnormal appearance. We have found no live eggs this morning (Tuesday). Those that survived the longest were strangely distorted, indicating, I think, that the trouble was with the water.

Nets were set Sunday evening in five fathoms opposite Point Lookout, but no fish taken. We went to Saint Jerome's Creek early Monday morning, and landed the lumber shipped for that place. At noon we ran over to Barren Island, where the cutter was left, to set a gang of nets; this vessel then went to the Patuxent, where another lot of nets were set. The latter have been taken up, but no fish caught. At 9.45 p. m. the cutter returned with a few menhaden, taken near the bottom in 20 fathoms water—no other fish in the nets. I propose using the dredge and trawl here, then off Barren Island, and will set the nets off Tangier Sound to-night; Cherrystone, to-morrow night; York River, the following day, and then return to the Potomac. This programme will depend on the weather.

STEAMER FISH HAWK, *Patuxent River*, *February* 28, 1882.

My report of February 28 closed at 9.45 a. m. At 10 a. m. we commenced dredging in the deepest water at the mouth of the Patuxent River to ascertain what life, if any, could be found in the bed of the stream. We found it to be absolutely barren, and the towing net failed to produce anything from the surface.

Three hauls of the trawl were then taken off Barren Island in the deepest water of the bay, 25 fathoms, the only results being a few young menhaden, young herring, and another small fish, perhaps another variety of herring, a few shrimp, one craw-fish, and a few small shells.

Having examined this locality to my satisfaction, we started for Tangier Sound, but finding it would be late in the evening before we could arrive, I set four nets off Smith's Point and two off Point Lookout, anchoring at the latter place for the night. A thick fog shut down before the last nets were out, and the weather generally had an unsatisfactory appearance.

At 4 a. m., March 1, it was blowing a gale from southeast with thick fog and rain. Our anchorage being exposed to winds from that direction, we soon had a heavy swell. The steam cutter was down and thrashing about in the most lively manner, and the ship was somewhat uneasy, so much so that I did not consider it prudent to attempt to take the cutter on board. I ordered steam raised as soon as things began to get uncomfortable, and when ready we got under way; felt our way around Cornfield Point with the lead and anchored off Smith's Creek, where we found comparatively smooth water till about 10 a. m., when, the fog lifting, we went into Smith's Creek for a harbor. The wind moderated during the afternoon, and went round to northwest during the night. To-day the weather has been simply perfect.

We were under way soon after daylight this morning, and started for our nets, which had been out since the evening of the 28th ultimo. In passing the oyster beds off Smith's Creek, I observed that they were entirely abandoned by the dredgers, and as we had done some work there last season (finding oysters plentiful) I was curious to know the reason. A few hauls of the dredge demonstrated the fact that they were practically exhausted, our average being but a bushel to a haul, and these of a small size. We found the nets off Point Lookout in good condition, but no sign of fish in them, the only catch being a good quantity of bryozoa, medusæ, and grass. They stood the gale in their exposed condition remarkably well. Those at Smith's Point, on the contrary, were entirely demoralized, one end having broken adrift from its anchor, we found the entire lot in a "snarl" around the lee moorings, no sign of fish having been near them. Two of the four nets out at this place are *expended;* the others will be repaired.

The dredge and trawl were used in deep water off the point, but the waters were barren as usual.

Arriving off the Sound early this afternoon we used the rake dredge in order to see if there was anything burrowing in the sand and mud of the bottom. We found nothing but half a dozen common worms, a few shrimp, and dead oyster shells.

We are at anchor for the night in Cod Harbor, and our nets are set across the entrance to the Sound.

March 3.—We took the nets up at daylight. There were no fish in them, but they were loaded with great masses of grass, bryozoa, &c. As soon as the nets were on board, we got under way and started for Fortress Monroe for supplies. It seems that the stewards trusted somewhat to the resources of the places we expected to visit when laying in stores, and now find themselves running short.

We will go either to York River or Cherrystone to-night, being governed by the weather. We can do nothing with nets at the latter place, unless it is calm and smooth, as they are to be set in the open bay.

Should we find anything in York River it will be an inducement to try our fortune in Mob Jack Bay; if not, it will hardly be worth while.

Our present plan is to spend about three or four more working-days in the bay and Lower Potomac, and then return to Washington.

1.45 *p. m.*—Arrived at Fortress Monroe. Will leave about 2.30 for Cherrystone.

STEAMER FISH HAWK, *Tangier Sound, March* 2, 1882.

PRELIMINARY NOTICE OF SOME POINTS IN THE MINUTE ANATOMY OF THE OYSTER.

By JOHN A. RYDER.

There is a spacious segmentation cavity developed in the embryo which becomes the subdivided body cavity (schizocœl) of later stages.

Between the ecto- and entoblast the mesenchymal or mesoblastic tissue is developed, apparently, and for comparative embryological reasons, from the two former by proliferation, whereby the segmentation cavity becomes in part obliterated.

The mesoblast of the embryo, formed as above stated, is the tissue from which the mesenchyme or connective tissue of the adult is developed.

The blood channels, or canals, are developed in the mesenchyme; no specialized endothelial lining cells are ever differentiated, the mesenchymal cells form their immediate walls. An exception to this is found only in the structure of the anterior and posterior aortæ, the heart, and branchio-cardiac vessels, which have proper walls.

In some places the mesenchymal tissue is found to be spongy, its cells being built around complex anastomosing spaces for the blood. There is, therefore, a true schizocœl developed in the oyster; it has been formed as the mesenchyme has grown into the segmentation cavity, which has been subdivided in this way into hæmal canals and spaces as development proceeded.

The heart, as in the embryo fish, develops in the blastocœl or segmentation cavity, the pericardiac space being a remnant of the latter. (See Davaine. Recherches sur la Génération des Huitres. Mém. de la Soc. de Biologie IV, Paris, 1853. The foregoing statement is made upon the evidences afforded by the observations of the author above cited, on the development of the heart.)

The adductor of the shell and the radiating muscles of the mantle, as well as those of the heart, are derived from the mesoblastic or mesenchymal structures of the animal. The radiating muscular bundles of the adult lie just beneath the ectoblast, or epithelium, on the outer sides of the mantle leaves.

The muscular fibers of the walls of the heart are not striated, and decussate in every direction. The cavity of the heart is crossed in various directions by muscular bands, and a more or less complete muscular septum divides the ventricle in the median line. The heart is therefore approximately four-chambered.

The mesenchymal or mesoblastic tissues compose the great bulk of the body of the animal, and extend out into and form the greatest proportion of the thickness of the mantle, and also down into the branchiæ, where it forms thick transverse vertical septa between the outer compoundly ribbed walls of the branchial pouches lined with ectoblast. The mesenchyme also gives support to all the viscera, the stomach, liver, intestines, and reproductive organs being embedded in it.

The branchial blood-channels are also limited by the mesenchyme.

The mesenchymal cells are large, and will average $\frac{1}{500}$th of an inch in diameter. They inclose, in all cases, both in winter and summer, a large irregular nucleus, from which a complex network of intracellular fibrils radiate in all directions through the enveloping cellular substance. At one side of the nucleus there are always one or more accessory bodies perfectly globular. The mesenchymal elements are not fat cells, as has been erroneously supposed by Brooks.

The mesenchymal cells are probably very hygroscopic, which explains why it is that oysters may be much swollen by osmose in a short time by immersion in water of less specific gravity than the sea-water in which they grew.

The mesenchyme may be regarded as the connective tissue of the animal. It corresponds morphologically to that structure in other types.

There is an apparent atrophy of the mesenchyme in the body-mass and mantle during the spawning season, with a great concomitant development of the reproductive follicles or tubules. In winter the reproductive follicles atrophy, when the mesenchyme again increases in bulk in the body-mass and mantle. These facts appear to show that the reproductive elements are derived from the mesenchyme by a transformation of its substance in which their follicles are embedded.

It is the great development of the mesenchymal substance in the autumn and winter, when the reproductive function is in abeyance, that constitutes the condition of the animal known to oystermen as "fatness." This word expresses the condition well enough, practically, but it is scientifically incorrect, since there is scarcely any fatty substance in the animal at any time.

In summer, when the reproductive organs are gorged with their products, their follicles are crowded together into contact; in winter, in their atrophied condition, they lie embedded in the superficial portion of the mesenchyme of the body-mass the same as in summer, but are much less developed, so as to appear in sections like a very open network of strands of very small nucleated incipient embryo cells, the connection of which may be traced into the now collapsed and internally ciliated branches of the oviducts. All the parts of the reproductive apparatus are therefore present in winter, but in an undeveloped condition.

The oviducts branch and spread over each side of the body-mass just external to the stratum of reproductive follicles and immediately beneath the mantle. They do not ramify through the substance of the reproductive organ, but lie externally to it. Their principal openings on each side of the body-mass pour their contents into the suprabranchial chambers on each side just below the muscle.

The liver is a diverticulum from the entoblastic walls of the stomach. The great bile ducts pass outward from the cavity of the stomach, and subdivide again and again, and end blindly in spacious ovoidal hepatic follicles, the simple walls of which consist of hepatic cells. The function of the liver is in all probability both excretory and secretory, and takes an all important share in the processes of digestion.

The entoblastic wall of the intestine is folded inwards at one side for its entire length in a peculiar way, so that its lumen is more or less crescentic in cross section.

There are neither annular nor longitudinal muscular fibers in the wall of the intestine; the sole motive force in the propulsion of the ingested food appears to be exerted by the ciliary covering which clothes the internal surface of the alimentary tract from the mouth to the anus.

The words ento- and ectoblastic as applied to the adult, correspond to the embryonic epi- and hypoblast; mesenchyme to the mesoblast. I have adopted the terms from a paper on the mesoblastic layers of embryos by R. and O. Hertwig, in the *Jenaische Zeitschrift* (XV, 1st Hft., 1881), in which they discuss for the first time what they designate as the *Cœlom theory*, as applied to an explanation of the origin and typical forms of mesoblast as derived from the gastrula stage, typical of all metazoan development. The body of facts which is brought forward embraces the results of the work of the principal embryological authorities, and, although they had already been interpreted in a somewhat similar way by Huxley and McAlister, are for the first time connectedly stated so as to be of fixed value in embryological studies. They have given us a topography of the embryonic layers of the greatest value, which enables us to decipher with the greatest ease the relations and genesis of the parts of a form as comparatively undifferentiated as the adult oyster. In that they have considered *Chiton* as a member of their second subdivision of the *Metazoa*, the *Pseudocœlia*, characterized by the genesis of the mesoblast by proliferation from the epiblast and hypoblast, a massive, soft, and unsegmented, bilaterally symmetrical body, it is clear from what has preceded that the oyster is also typical, and a member of this group.

THE CODFISHERIES ON THE COAST OF NORWAY.

[From *Fiskeri Tidende*, No. 1, January, 1884.]

Codfish are very common all along the coasts of Norway. A peculiar variety of the codfish, the "*skrei*" (winter, spring, or sea-cod), however, keeps away from the coast the greater part of the year, visiting it only at certain seasons, but then in very large numbers. It is principally caught near the Vestfiord, where it gives rise to the Loffoden fisheries, whilst between Stat and the Trondhjems fiord, especially near Söndmöre it gives rise to the so-called Romsdals fisheries. At all these places the "*skrei*" makes its appearance from the end of January till the beginning of April, for the purpose of spawning on the coast banks whose water has been warmed by the currents of the sea. The spawn floats about near the surface of the water, where the young fish are also hatched. Other sea-cod fisheries, the Capelan fisheries, are annually carried on along the coasts of Finmarken. The cod caught here are not spawning fish, but approach the coast for the purpose of eating the capelans (hence the name), a fish of the trout family which comes near the coast about this time for the purpose of spawning. The fisheries are carried on from March to May, and about 66,000 persons gather annually at the fishing stations during the season, partly for the purpose of fishing and partly to buy and prepare fish.

FISHING FOR SHAD IN SOUTH AMERICAN WATERS.

[From Gloucester Telegraph, June 25, 1842.]

The "Fountain," Captain Norwood, arrived on Sunday, and the "Delta," Captain Marchant, on Tuesday, each with 290 barrels of shad. These vessels sailed from Gloucester for Buenos Ayres in the early part of October last, and have been absent about eight months and a half. They were obliged to be idle in the La Plata River full forty days before they could obtain permission to fish; had this not been the case, they would undoubtedly have done well—at least they would have made saving voyages.

NOTES ON THE SHRIMP AND PRAWN FISHERIES OF THE UNITED STATES.

By RICHARD RATHBUN.

1. THE EDIBLE SPECIES OF SHRIMP AND PRAWNS.

At least six species of shrimp and prawns are used as food on the coasts of the United States. They are as follows: *Crangon vulgaris*, *Crangon franciscorum*, *Penæus setiferus*, *Penæus brasiliensis*, *Pandalus Danæ*, and *Pandalus*, sp. *Crangon vulgaris* is common to the sea coasts of both sides of our continent; but the two species of *Penæus* are confined to the Atlantic and Gulf coasts of the Southern States, and *Crangon franciscorum* and both species of *Pandalus* to the Pacific coast. Three other species of prawns—*Pandalus leptoceros*, *P. Montagui*, and *P. borealis*—occur in great abundance in the deeper waters, off the coasts of Middle and Northern New England, and the British Provinces, and, although not now fished for, are available as food. In addition to the above, there are two species of fresh-water or river shrimp, common to the Mississippi River and its tributaries, which occasionally find their way into some of the interior markets. They are *Palæmon Ohionis* Smith, and *Palæmonetes exilipes* Stimpson. The common little shore prawn of the eastern coast of the United States, *Palæmonetes vulgaris*, although extremely abundant, is too small to answer as an article of food for man. All of our shrimps and prawns are eagerly sought after as food by many of our coast fishes.

THE COMMON SHRIMP. *Crangon vulgaris*, Fabr.

Crangon vulgaris is one of the most widely distributed of all of the shrimps, occurring on both sides of the North Atlantic and on the Pacific coast of North America. Its bathymetrical range is also great, extending from low water to a depth of 60 or 70 fathoms. On the Atlantic coast of North America, it has been recorded from North Carolina to Labrador, and on the Pacific coast, from Point Conception to Alaska (Mutiny Bay). It is eaten in Europe as well as in this country.

"It is found in greatest abundance in shallow, and on sandy or weedy bottoms, but occurs also on muddy, shelly, and rocky bottoms." It varies much in coloration, imitating to a great extent the color of the bottom on which it lives. "It needs all its powers of concealment, for it is eagerly hunted and captured by nearly all the larger fishes which frequent the same waters. Fortunately it is a very prolific species, and is abundant along the entire coast, from North Carolina to Labrador, wherever sandy shores occur." [Verrill.]

The young swim free at the surface, for a considerable period after hatching. On the Southern New England coast, the eggs hatch during

May and June, but further south, as in Chesapeake Bay, the spawning season is somewhat earlier. This species attains a length of over two inches, exclusive of the feelers, but generally occurs much smaller than this. So far as we are aware, it is not captured for food south of New York, although it has been found in extreme abundance and of good size in Chesapeake Bay and elsewhere south, by the U. S. Fish Commission. In its favorite haunts it frequently occurs in vast numbers, and may be readily captured in marketable quantities.

On the California coast, according to Mr. W. N. Lockington, *Crangon vulgaris* occurs, associated with another species of the same genus (*Crangon franciscorum*), which excels it in size and generally in abundance. The average length of specimens there is said to be about 2¼ inches; a length of over 3 inches is sometimes attained. It is distinguished from *Crangon franciscorum* in having a darker-colored tail and a larger proportion of black markings upon the body, as well as by the different form of the hand or larger claw. From its black coloring it has received among fishermen the name of black-tailed crab.

THE CALIFORNIA SHRIMP. *Crangon franciscorum*, Stimpson.

This species, according to Mr. Lockington, is the shrimp *par excellence* of the San Francisco markets, where it is sold during nearly every month of the year. It averages in length from 3 to 3½ inches. The characters by which it is distinguished from *Crangon vulgaris* have already been enumerated. Its range, so far as determined, is very limited, being from Puget Sound to Point Conception. In San Francisco and Tomales Bays it is very abundant, frequenting especially the sandy coves along the shores. It is fished for mainly by the Chinese, both for consumption in California and for shipment to China.

A third species of shrimp, *Hippolyte brevirostris*, of a uniform light crimson or scarlet color, occurs in small quantities in San Francisco Bay, and is frequently captured along with the two species of *Crangon* and sold with them.

THE SOUTHERN SHRIMPS AND PRAWNS. *Penæus setiferus*, M.-Edwards; *Penæus brasiliensis*, Latr.

These two closely related species compose the bulk of the large supplies of shrimp or prawns consumed in New York and the southern coast cities. They frequently occur associated together in the same localities, and, being so nearly alike in appearance, are not distinguished apart by the fishermen and dealers. *Penæus setiferus* is supposed to be the more abundant species; it attains a length of 6 or more inches, exclusive of the feelers, and may measure more than three fourths of an inch in depth and breadth, in the front or body part. Strangely enough these useful crustaceans are known both as shrimps and prawns to the fishermen who take them, as well as in the markets, the distinction being made with reference to size only. According to Prof. Lewis R. Gibbes, of Charleston, S. C., the larger individuals of both species are termed prawns or sprawns, and the half-grown ones, shrimps. The prawns appear in shallow water generally in March, or, in very open springs, as early as the latter part of February, and remain in season for two or three months, after which the supply diminishes, and they retire for a time, apparently to spawn. Their spawning localities are not known, and Professor Gibbes adds, that he has never seen an individual carrying eggs. He suggests that they may ascend the rivers to spawn. In June and the succeeding months of summer, the half-grown individuals or "shrimps" are in season, and "for tenderness of flesh and delicacy of flavor are preferred to the prawns." In the autumn, they disappear from the coast and move into deeper water, or farther toward the south.

Penæus brasiliensis has been found as far north as the Croton River, at Sing Sing, N. Y., and from that point ranges southward along the entire Atlantic and Gulf coasts of the United States. It also extends to the coast of Brazil, and has been doubtfully identified from the California coast by Mr. Lockington. *Penæus setiferus* has not been recorded from northward of Norfolk, Va., but its southern range corresponds with that of the other species, at least so far as the coast of the United States is concerned. Neither of these species has been found in sufficient abundance north of North Carolina, however, to warrant a fishery for them.

Mr. T. E. Fisher, of Fernandina, Fla., who has had much experience in this fishery, furnishes the following notes on the shrimp and prawns of his region, which he distinguishes from one another, as Professor Gibbes has done above. "It is my opinion," he says, "that the shrimp (smaller individuals) move into deeper water at the beginning of winter, and there remain until about the full moon of March or thereabouts, when they return to the bays and rivers in great quantities, as prawns, and ascend the rivers and creeks, I think to spawn. This is the time when they are taken as food. After spawning, or about May or June, they return to the sea. From May to August the so-called shrimp, which then appear, are quite small, and used principally as fish bait. From August to December they grow quite rapidly. September and October are the best shrimping months of the year, and May and June are the only months when shrimp are scarce, excepting during the colder months of winter, when they leave the coast for a time." The shrimping seasons of the South Carolina and Florida coasts, therefore, correspond approximately, being somewhat longer for the latter region, probably because of its milder climate.

According to Mr. Silas Stearns, of Pensacola, Fla., shrimp are abundant on all parts of the Gulf coast, and especially so on the coasts of Louisiana and Texas. They live on the grassy and sandy flats, and among the weeds on the bottoms of bayous and lagoons, in both salt and brackish water. Barataria Bay, of the Louisiana coast, and Galveston and Matagorda Bays, of the Texas coast, are notable places for the shrimp fishery. Shrimp of marketable size average about four inches in length. The habit of schooling among shrimp is common, especially in the fall, upon the Louisiana and Texas coasts. The shrimping season extends through the year, excepting the winter months.

THE CALIFORNIA PRAWN. *Pandalus Danæ* Stimpson.

This is a moderately large species, which finds its way into the San Francisco markets from the open ocean, between the Farallone Islands and Point Reyes, where it is very abundant. It attains a length of five inches, exclusive of the feelers. Fresh specimens are finely marked with transverse zigzag lines of white, separated by bands of red. The known range of this species is from Queen Charlotte's Island, British Columbia, to Point Conception, California. It has been noticed with spawn in November, December, and January, but the entire length of the spawning season is unknown. This species has only recently been added to the market supplies of San Francisco, from the shrimp fishermen now venturing farther out to sea than formerly.

Another and smaller species of *Pandalus*, of a uniform light pink color, occurs associated with the above and is captured with it. Specimens of a species of *Penæus*, resembling *Penæus brasiliensis* of the east coast, are occasionally brought to the San Francisco markets and sold as prawns. They sometimes measure seven inches in length.

THE NEW ENGLAND DEEP-WATER PRAWNS. *Pandalus leptoceros*, *Montagui*, and *borealis*.

These are three closely related species of prawns, inhabiting the deeper waters of Massachusetts Bay, the Gulf of Maine, and other areas off the coasts of New England and the British Provinces. *Pandalus borealis* attains much the largest size, while the two other species are quite uniform in this respect, and only distinguishable from one another by a close examination. The only differences which the fisherman would observe are those of size, and he would, therefore, naturally recognize a larger and a smaller prawn, the former being *Pandalus borealis*, and the latter consisting of the other two species.

These three prawns have not yet found their way into the markets. They occur in very much the same kind of localities, are frequently associated together, but never approach near to the shore, and cannot be taken in the ordinary fishing nets and traps used upon our coast. They are known to the lobster fishermen of some part of the New England coast, from the fact of their occasionally entering the lobster pots in deep water. When their haunts, great abundance, and fine flavor, as well as the proper methods of capturing them, become known to the fishermen, it is fair to suppose that they will give rise to an important industry. Such a fishery must necessarily be more difficult than the shrimp and prawn fisheries of the Southern States, and would require more capital, in the start, for the purchase of larger boats and more extensive nets; but there is every reason to believe that it would repay the outlay to, at least, a limited number of fishermen, for many important markets are close at hand.

These prawns are so readily recognized as such, in the regions to which they belong, that a description of their appearance is unnecessary here. We abstract the following notes, mainly bearing upon their distribution, from recently published observations of Prof. S. I. Smith.

Pandalus borealis attains a length of 7 inches. The body is thickly sprinkled with small red stellate spots, which, from closer aggregation, make the tail deeper in color than the rest of the body. The eggs are ultramarine blue. Females with spawn were taken in August and September, 1877 and 1878, in Massachusetts Bay and off Cape Ann. The following list of localities, from which this species has been recorded, will give an idea of its distribution: Massachusetts Bay, off Salem, 45 to 50 fathoms, very abundant on muddy bottoms; Gulf of Maine, 40 to 160 fathoms, muddy bottoms, very abundant in many places. In the Gulf of Maine, it was found to be especially common in a region about 14 miles southeast of Cape Ann, in depths of 50 to about 100 fathoms. It was also encountered 20 to 30 miles off Cape Sable, Nova Scotia, in depths of 59 to 88 fathoms, and 30 miles off Halifax, in 85 to 110 fathoms. In foreign waters, this species has been recorded from Greenland, Norway, and Behring Sea.

Pandalus leptoceros and *Montagui* differ from *Pandalus borealis*, among other characters, in the coloration of the body, the red being more intense and arranged in clearly defined markings, of which those upon the carapax and abdomen form conspicuous, obliquely transverse lines or bars, while the color upon the rest of the body, and upon the appendages, is collected in distinct specks, blotches, or annulations. The length attained by these species is about four and a half inches, though the bulk of the specimens examined have measured somewhat less. Their range is from Eastern Long Island Sound to Greenland, in the West Atlantic, and from the British Islands northward, on the European coast. They are much more abundant than *Pandalus borealis*, though smaller in size, and occur in shallower water, as well as in the same places with the latter. South of Cape Cod, they are much less abundant than to the north of it, and average smaller in size; they occur in depths of 25 to 30 fathoms and deeper. In Massachusetts Bay, they inhabit depths of 22 to 48 fathoms, where the bottom is gravelly, sandy, and muddy, and have also been found on Stellwagen's Bank. In the Gulf of Maine, they are widespread and exceedingly abundant in many localities, being often associated with *Pandalus borealis* on muddy bottoms. They live on all kinds of bottom and in all depths of water, from 10 fathoms downward, having been found just to the eastward of George's Bank in a depth of 430 fathoms. In the Bay of Fundy, they occur in depths of 10 to 77 fathoms; off Nova Scotia, in depths of 16 to 75 fathoms; in Bedford Basin, Halifax, in depths of 26 to 40 fathoms; in the Gulf of Saint Lawrence; on the coast of Labrador, &c.

The distribution of these three species of prawns, as above described, was mainly traced out by the United States Fish Commission, which, in its explorations with the dredge and trawl along the New England coast, during the past ten years, has constantly come upon immense schools of them, sometimes two or three of the species being associated together, at others occurring separately. It has been no uncommon occurrence for a peck or more to come up in a single haul of the beam-trawl, and several such hauls have been made in a single day. These prawns apparently swim in schools from place to place; they are active in their movements, and can, therefore, be seldom taken in the dredge. There are many witnesses among the members of the Fish Commission who can testify to the superior quality of the deep-water prawns as an article of food.

The lobster fishermen of Biddeford Pool, Maine, who set their pots in the winter from 4 to 6 miles from land, occasionally capture a few specimens, and the same is true of other localities. It is very difficult to suggest a proper style of apparatus for taking these prawns in quantity for food. The beam-trawl employed by the United States Fish Commission, which is a modification of the beam-trawl used by English fishermen, would probably answer as well as anything. The net used by the Chinese, on the California coast, for catching *Pandalus Danæ* would, perhaps, answer the same purpose for the same genus, in moderate depths on our eastern coast; but the writer has no practical knowledge of its workings. It is possible, though not probable, that these prawns would seek bait in traps, constructed somewhat like the lobster pots, but with a finer mesh. The beam-trawl or some adaptation of it would, however, seem to approach nearest to the requirements of the case.

We do not wish it to be understood that we suggest the fitting out of boats and nets by the wholesale, for this proposed new fishery. Should any one become interested in it, he had best begin in a small way, and in the course of a season or two he could determine its practicability, and the additional outfit he might require.

THE RIVER SHRIMPS. *Palæmon Ohionis*, Smith, and *Palæmonetes exilipes*, Stimpson.

These are the only species of fresh-water shrimps so far described from the Mississippi River, its tributaries, and the rivers to the eastward of it, although others may sooner or later be brought to light. They do not appear to be used much as food, but the former species is occasionally taken for that purpose at some of the inland towns. At New Orleans the *Palæmon* is sold in the markets, and is probably canned in connection with the Gulf species. Both species have a considerable range, and have been recorded from over a wide area. *Palæmon Ohionis* attains a length of at least three and one-fourth inches. *Palæmonetes exilipes* is a much smaller species, adult specimens measuring only about one and one-half inches long, and, on account of its small size, would probably never become an article of food.

THE COMMON PRAWN OF THE EASTERN UNITED STATES. *Palæmonetes vulgaris*, Stimpson.

This species of prawn approaches more closely in structure the English prawn than any other upon our coast; but, although it is very abundant and inhabits the shore region, its small size (about one and one-half inches) precludes its ever being used as food by man, at least to any extent. The English prawn measures in length from three to five inches. *Palæmonetes vulgaris* ranges from Massachusetts Bay to Northern Florida, and is most common among eel-grass. It also occurs in pools and ditches on the shore, even in brackish water, and on muddy and sandy bottoms in shallow water.

2. THE SHRIMP AND PRAWN FISHERY OF THE EASTERN COAST OF THE UNITED STATES.

THE NEW ENGLAND AND MIDDLE STATES.

None of the New England States can lay claim to a regular shrimp fishery, although a few shrimp are occasionally taken in various localities, mainly for use as bait. As already pointed out, the small species of prawn (*Palæmonetes vulgaris*), so common everywhere along this section of the coast, is too small to be put to any practical use, although it serves as an important article of food for some species of fish. From many inquiries regarding the true shrimp (*Crangon vulgaris*), it appears that this species is favorably regarded by amateur sportsmen as a bait for several of the game fishes, such as the sea-bass, &c. For this purpose it is taken in small quantities at Wareham, Mass., and along the eastern shore of Buzzard's Bay. Farther east than this it is also used to some extent by the same class of fishermen, and occasionally by small boys fishing from the wharves. About New Bedford, Mass., there is a small and irregular fishery, lasting from May to October, from one quart to four gallons being sometimes taken daily, though not for any length of time. The greater portion of this catch is used in the vicinity as bait, but a small quantity is sent as food to Providence and New York, the shipments, which are always small, being made in boxes, with a packing of seaweed, moss, or sawdust. In Narragansett Bay a few shrimp are taken nearly every season, for consumption in, and about, Newport. The largest daily catch brought to our notice was about one peck.

New York City uses a small amount of this species of shrimp every year, the supplies coming mainly from Bay Ridge, Long Island, and the season lasting from March until the middle of May. The demand for this shrimp in Fulton Market appears to be increasing, and many more were sold there in the spring of 1882 than in the same season of 1880. In the latter year, Bay Ridge supplied New York with about 3,000 gallons of shrimp, valued at about $1.50 per gallon. During July and August of every year, about 1,000 gallons of fresh shrimp are used in the vicinity of Bay Ridge, as bait for hook-and-line fishing.

The fishery for *Crangon vulgaris* is conducted mainly by means of dip or scoop nets. At Bay Ridge the nets are hauled every morning. Before being shipped to market the shrimp are boiled in brine and then dried. The average sales per day in New York during the season are about 50 gallons.

A very small quantity of shrimp are sent to New York from the New Jersey coast, where they are reported to be very abundant. They are also said to be extensively employed in the same region as bait for hook-and-line fishing, and for that purpose are regarded by many as superior to any other kind of bait. The shrimping season extends from May until about November.

THE SOUTHERN STATES.

The shrimp fishery has already attained considerable development in some sections of the Southern coast, but there is still ample material for greatly enlarging this industry. In Delaware a few shrimp are used as bait by the fishermen, but the yearly catch is comparatively small. Shrimp are very abundant on the Virginia coast, but, as in Delaware, they are taken only in small quantities for bait, or are captured incidentally in seines while hauling for fish. At Norfolk and Hampton they are occasionally eaten, and at the former place they are especially esteemed as bait for the "rock." The season extends through the spring, summer, and fall, but the shrimp are said to be most abundant in the latter part of the year. Prices vary greatly, and range from ten cents a quart, when very abundant, to twenty-five cents a dozen, in times of scarcity. The shrimp of Virginia probably includes both the *Crangon vulgaris* and one or both species of *Penæus*, but we have not been able to determine from observation which species is most utilized.

North Carolina appears to be the northernmost of the Southern States which offers especial inducements for shrimp-fishing, but no regular fishery has as yet been established there, except a small one at Wilmington. It can be safely asserted that the commercial shrimp of the Carolinas and succeeding Southern States consists of one or both of the species of *Penæus*. While the *Crangon* probably occurs there its small size, in comparison with the other species, renders it very inconspicuous to the fishermen.

Shrimp are very plentiful in Pamlico Sound; but in Croatan, Roanoke, and Albemarle Sounds they have never been observed in great abundance. They are also abundant about Beaufort and Morehead City. At all of these places, where the shrimp occur in considerable numbers, they are frequently taken incidentally by the fishermen in their fish seines; but, finding no market for them, they are generally thrown away. The ordinary fish seines, on account of their coarse mesh, are not adapted to the shrimp fishery, and yet there are numerous accounts of large catches of shrimp, by this means, on the coast of North Carolina. The fishermen of New Berne, who work their large seines along the banks of the Neuse River, are said to often secure from 30 to 40 bushels of shrimp at a single haul; and again we hear of the capture of from 5 to 10 barrels at a time, by the fishermen of Beaufort. In addition to the fish seines being unsuited to the catching of shrimp, the fishermen also generally visit those shores which are less frequented by the shrimp, and might find them more abundant by looking for them elsewhere. According to all accounts, there seems to be every opportunity for the establishment of a successful shrimp fishery at several points on the North Carolina coast; but whoever engages in it must be provided with the proper nets and the means of preparing his catch for shipment. The fishermen of North Carolina complain that they have no market for shrimp, but New York city derives the most of its supplies from points still farther south, and that market is seldom, if ever, overstocked with shrimp. In the fall of 1879, a small shipment of fresh shrimp, packed in ice, was made to New York. The weather was warm and the shrimp spoiled on the way, but the receivers at Fulton Market state that they were of large size and fine appearance, and could have been readily sold had they been in good condition. The fault consisted in not boiling the shrimp in brine and then drying them before shipping, as is the rule elsewhere. The inhabitants along the coast of North Carolina do not appreciate the shrimp as food, and seldom eat them, and, therefore, nearly all that are taken are left on the beaches to decay. The New Berne marketmen have refused to buy them from the fishermen, even at the low rate of fifty cents a bushel, which must certainly have discouraged the latter parties.

The sounds and bays about Wilmington, N. C., abound in shrimp and prawns from the last of May until November. These crustaceans inhabit the brackish as well as the salt waters of this region. They are taken in shrimp seines, which were introduced at this locality in 1872, and also in skim and cast nets, which have been in use for a much longer period. The shrimp seines measure from 30 to 40 yards in length, and from 6 to 10 feet in depth, and have a half-inch mesh. In 1880, four seines, with eight seiners, were employed, while about 50 additional shrimpers used the skim and cast nets. The seines are owned in Wrightsville, or Middle Sound. The season's catch for each seine is about 500 bushels, making a total of 2,000 bushels for the four seines in use. The season's catch for the 50 additional shrimpers amounted to about 3,000 bushels. Not over one-half of this catch was marketed as food or bait, the larger specimens only being selected for these purposes. The remainder were used for fertilizing, or were thrown away. Fishing is carried on in the daytime, but not with any precise regularity, on account of the limited demand. The shrimp are boiled in brine, in kettles holding from 10 to 50 quarts, and are then spread out to dry. They are shipped to market in baskets. Prior to 1878, no shrimp were shipped away from Wilmington, but since then a limited trade has sprung up with neighboring towns, and with New York and Philadelphia.

South Carolina.—One of the most important fisheries of the vicinity of Charleston is that for shrimp and prawns. From March to July, the larger prawns alone are taken, but later the smaller shrimp replace them entirely. The fishery continues from the last of March, or first of April, until the middle of November, and is carried on mainly within 15 miles of the city, and during the two or three hours of low tide of each night. The boats return to the city before daylight, so as to supply bait to the boat fishermen, after which the shrimp remaining are sold in small lots to men, women, and children, who vend them through the city. During the first of the season (1880), some 6 to 8 seine boats, with crews of about 6 men each, are engaged in this fishery. The catch is variable, being sometimes better in one locality and again in another; and often from 10 to 20 bushels may be the result of a night's seining by one or more boats, while the remainder will obtain only 4 or 5 bushels each. Prawns are considered to form one of the best baits for whiting, which are in season at the same time, and for this purpose the greater part of the catch is frequently sold. The shrimpers sell the prawns by the plateful, each containing from one to one and a half quarts, the customary price being about 50 cents per plate. The price sometimes rises to one dollar per plate, or at the rate of about two cents for each prawn. During the first few weeks of the prawn fishery, it is one of the most profitable of all of the fisheries in this section. Early in May the prawns become more abundant, and the seines are abandoned for cast-nets, the number of persons engaging in the fishery also increasing at the same time. During the height of the season, at least 75 cast-nets are in use, and, in June, the daily catch per boat exceeds one hundred plates.

The prawns are replaced by the shrimp early in July, and the latter continue near the shore until November. The difference in size between these two is roughly stated to be about as follows: that while only about forty prawns are required to fill a plate, a plateful of the shrimp will contain from fifty to sixty individuals. The number of shrimpers continues about the same as the prawn-catchers, in June, until near the close of the season; but the price soon falls to 25 cents, then to 15 cents, and finally to 10 cents per plate. The retail venders, who sell through the city, are all blacks, and begin their rounds early in the morning. As there are no city laws restricting their business, they compose a numerous body. Shrimp and prawns have come to be considered a standard article of food in Charleston. The greater part of the catch is sold at home, only a few hundred bushels being shipped away annually.

Georgia.—The shrimp and prawn fishery of Georgia is of great extent and value, and during the height of the season gives employment to about 400 men. The season is the same as for the South Carolina coast. Many shrimp are sent every year from Savannah to the New York markets.

Florida.—Prawns appear in the shallow water about Fernandina, and elsewhere along the Florida coast, about the full moon in March, and enter the bays, rivers, and creeks in large numbers, as it is thought, to spawn. About May or June they are succeeded by the shrimp, which remain until December, or, if the winter be very mild, until the following spring. The best shrimping season is during September and October. The fishing grounds are on both muddy and sandy bottoms, in from 6 inches to 4 feet or more of water; and the fishing is done mainly during the night, when the shrimp or prawns are more abundant than in the daytime. Cast-nets only are used, as they are preferred to the seines. They measure from 10 to 15 feet in diameter. Two men go in each boat—one to row, the other to manage the net. The average daily catch per boat for the entire season would amount to about two bushels. Before shipping, the shrimp are washed clean, boiled about 10 minutes in a very thick brine, and then allowed to steam in a covered basket or barrel, after which they are spread out and dried on a platform of boards.

The shrimp fishery was well inaugurated at Fernandina several years prior to 1880; but for the want of patronage it did not succeed, and was, therefore, soon abandoned, not, however, from a lack of material, which is said to be exceedingly abundant and easy to obtain. Successful shipments have been made to New York, Philadelphia, and many Southern cities, but now the fishery is limited to supplying the home demand.

A small shrimp fishery is carried on at Saint Augustine, Fla., during the months of July, August, September, and October. The men use cast-nets, measuring from 4 to 5 feet long, and with a half-inch mesh, and make about three trips weekly, fishing at low tide during the night, or at early dawn. An average daily catch per boat is about 4 bushels. The entire season's catch, which in 1880 amounted to about 600 bushels, is used locally, either for food or bait. The price is about 10 cents per quart, in the beginning of the season, but at a later period it falls as low as 15 cents per peck.

Gulf coast.—The shrimp fishery of the Gulf coast is mainly confined to Louisiana and Texas, although shrimp may possibly occur in equal abundance in other sections. The greater part of the supplies come from Barataria Bay, Louisiana, and Matagorda and Galveston Bays, Texas. Both seines and cast-nets are used by the shrimpers, who station themselves along the shores in the shrimping region. The season extends, more or less, throughout the entire year; but fishing appears to be conducted mainly from October to April. New Orleans is an important shrimp center, and derives the greater part of its salt-water supplies from the grassy bottoms of Barataria Bay. Three varieties of shrimp are recognized in the New Orleans markets: the Gulf shrimp, above referred to; the lake shrimp, found in the lakes and inclosed bays inside of the Gulf coast; and the river shrimp, from the banks of the Mississippi. The lake shrimp are obtained only during the equinoctial seasons; and the river shrimp, in small quantities, during the warmer half of the year. The latter species is caught by means of cane baskets, sunk to the bottom near the banks. Shipments are made to New Orleans from the coast in steamers or luggars, without ice. The prices paid to the fishermen on the Louisiana coast are about 3 cents per pound, and on the Texas coast about 25 cents per bucket. Fresh shrimp are very much esteemed as food in New Orleans, and large quantities are canned both in New Orleans and Galveston, for shipment throughout the United States and to Europe.

Shrimp canning.—In 1880, there were only two establishments in the United States for the canning of shrimp. One was located at New Orleans, the other at Galveston, and both were then doing a successful business; they did not, however, confine themselves entirely to the preparation of shrimp. The process of canning shrimp is similar to that for crabs and lobsters, as practiced at the North. The season includes about five months of the fall and winter. Over two hundred persons, mainly women and girls, are employed at this time. The shrimp are put up in one and one-half pound tins, the production for 1880 amounting to about 310,000 such cans.

3. THE SHRIMP AND PRAWN FISHERY OF THE PACIFIC COAST.

The shrimp and prawn fisheries of the Pacific coast are mainly confined to the vicinity of San Francisco and Tomales Bays, California, and are controlled almost entirely by the Chinese, who export the greater part of their catch to China. A small quantity is also shipped by them for the use of their countrymen in the Sandwich Islands. *Crangon franciscorum*, being the larger species of true shrimp, and also generally the more abundant one, figures most conspicuously in the fishery, but *Crangon vulgaris* forms a large percentage of the quantity taken and disposed of. These two species are fished for mainly in the deeper waters (12 to 20 fathoms), near shore, of the two bays above mentioned. The two species of *Pandalus* are found associated together in moderate depths of water off San Francisco Bay, between Point Reyes and the Farallone Islands, and during the two years prior to 1880 were more commonly seen in the San Francisco markets than formerly. The reason assigned for this fact was that as the supply of fish in the bay began to greatly diminish about that time, the fishermen were driven to the more open waters of the ocean, where the prawns abounded.

A species of *Penæus*, closely resembling *Penæus brasiliensis* of the east coast, if not identical with it, has been recognized by Mr. Lockington in the markets of San Francisco, and is said by him to occasionally visit the bay of San Francisco. Being much larger than any of the other species of shrimps or prawns on the California coast, it commands a higher price; but some years it appears to be entirely absent.

For the capture of shrimp and prawns the Chinese use a conical, bag-shaped net, about 20 to 25 feet long and 10 feet across at the larger end, which is the mouth. From this end the net tapers toward the other, where there is an opening only about a foot across, to permit of emptying the contents of the net. One side of the mouth, or larger end, is furnished with a line of weights and the other with a line of floats, to hold it open while in use. The opening at the smaller end closes by means of a "sphincter," or puckering string. The mesh of the net measures from one to one and one-fourth inches at the mouth, and gradually diminishes to about one-fourth of an inch at the smaller end. The boats employed in working these bag seines are from 12 to 25 feet long, rather narrow and sharp at the ends, and with flat bottoms and thick, heavy sides. They are built by the Chinese, of redwood lumber.

After the day's fishing is over, it is the usual custom to carry the fresh shrimp to the Vallejo-street Market in San Francisco, in live-baskets, covered with a netting, which has a hole in the center, closed by means of a puckering string. At the market, the fresh shrimp are sold at the rate of about ten cents a pound, and those remaining unsold are carried back to the Chinese settlement and put at once into boiling brine. The kettle for boiling the shrimp is a rectangular iron tank, 6 feet long by 4 wide and 2 deep, with a fireplace underneath. After sufficient boil, ing, care being taken to prevent overcooking, the shrimps are taken out and spread to dry upon level plats of hard ground, which have been previously stripped of grass and rendered perfectly smooth. They are spread out, and turned occasionally, by means of a hoe-like broom. After four or five days' time, or when they are perfectly dry, they are crushed under large wooden pestles, or trod upon by the Chinese in wooden shoes, for the purpose of loosening the meats from the outer chitinous covering; after which the entire mixture is put through a fanning mill, for the actual separation of the meats from the shells.

This fanning mill, which is rather a crude affair, is constructed of wood, by the Chinese themselves, on the same principle as the one used for winnowing grain. The entire structure measures about 8 feet long by 5 high, and consists of a square box, divided in the inside for the passage through of the separated meats and shells, with a hopper above, and a large fan wheel, worked by a crank at one end.

The meats are partly consumed at home, or at the various inland Chinese settlements, but are mostly shipped to China. They are worth

5 cents a pound in San Francisco. The shells are utilized as manure, to some extent, about San Francisco; but, like the meats, are mostly sent to China, where they serve as a fertilizer for rice, the tea plant, &c. In San Francisco they sell at about 25 cents per hundred-weight. Both the meats and shells are shipped to China in sacks. The trade is entirely in the hands of Chinese merchants, who ship by way of Hong Kong. The meats are eaten by all classes, but are cheaper and less esteemed than the native shrimps, which are said to be comparatively scarce.

It is estimated that about 200,000 pounds of shrimps, valued at about $20,000, are annually sold in the San Francisco markets. The total exports of shrimp meats and shells to China and the Sandwich Islands for 1880 were estimated by Mr. Lockington at above $100,000. These are at present the most important food invertebrates of the Pacific coast of North America.

The greater part of the Chinese who engage in the shrimp fishery devote nearly all of their time to this industry. They live mainly in small, scattered colonies in San Francisco and Tomales Bays, and number several hundred in all. The more important colonies are at Bay View and along the shores of San Mateo, Santa Clara, Marin, and Contra Costa Counties.

There is no law regulating the shrimp fishery in California, and fishing is carried on more or less continuously throughout the year. It seems quite probable that the consumption of shrimps in the vicinity of San Francisco exceeds their rate of increase, and that a marked decrease in the supply will soon result, as has happened in the case of the food fishes in the bay of San Francisco. No such decrease has, however, been yet observed.

SHAD IN PUGET SOUND.

By JAMES G. SWAN.

Mr. G. M. Haller, of Seattle, Wash., announces the taking by fishermen in a net of a shad, August 26, 1882, in Puget Sound. The Seattle papers also mention it and say that it was preserved by Mr. Levy for the Young Naturalists Society of Seattle. This specimen must have come from the Columbia River or have found its way north from San Francisco Bay. I think it was quite small—say 8 or 10 inches long—but I have not seen the dimensions accurately given.

PORT TOWNSEND, WASH., *August* 29, 1882.

THE PROPOSED INTRODUCTION OF AMERICAN CATFISH INTO THE RIVERS OF BELGIUM.

By ALFRED LEFEBVRE.

[From dispatch No. 41 of the vice-consul of the United States at Ghent, Belgium, to the State Department, transmitted to the United States Fish Commission.]

When Mr. Wilson was consul at this port he interested himself in a project for the improvement of the pisciculture of the country. The industries of Flanders, and especially of Ghent, concentrated, exhibited as they are in large manufacturing establishments, situated on the banks of the rivers and discharging their refuse into the water, render it unhealthy for the fish, and has resulted in their decreased numbers, if not entire disappearance in some neighborhoods. Mr. Wilson compared its situation to the rivers of Delaware and Schuylkill in the neighborhood of the city of Philadelphia, and expressed a belief that the catfish so common there would thrive here. He conferred with Prof. S. F. Baird, who confirmed him in this belief, and in the correspondence which took place between them, the feasibility of stocking these rivers with these fish seems to have been agreed upon.

Mr. Wilson opened a correspondence with the authorities of Flanders (which has been continued by me since his departure), and it, with other causes, attracted official attention to the subject and created much interest in it. Parliament took it up; a new law for the protection and propagation of fish is about to be passed (a copy of which I will send to the department as soon as it shall have been printed), and a committee appointed having general charge of the subject. Hon. E. Willequet, member of Parliament from Ghent, is a member of this committee; and, not wearying you with uninteresting details, I come to the immediate object of this dispatch, which is, that the committee desire to put Mr. Wilson's and Professor Baird's scheme into operation, and have, through Mr. Willequet, requested me to communicate through the department with Professor Baird and secure his aid and co-operation.

Mr. Wilson and myself have had many conversations with Mr. Willequet, the governor of the province, and other authorities, who are all in favor of the attempt. I inclose a translation of Mr. Willequet's notes, that they and a copy of this dispatch, if needed, may be transmitted to Professor Baird.

Arrangements have been made with the Red Star Line of steamers for shipment of the young fish from New York to Antwerp, if they can be put on board, and I will see that they are taken care of on their arrival. As you will perceive by Mr. Willequet's letter of the 22d July, if he only can know when the fish will arrive he will have everything in readiness to receive them.

As to the work on pisciculture or ichthyology, alluded to, I would like Professor Baird to indicate one of the best, and I will procure it for the committee of which Mr. Willequet is a member.

GHENT, *July* 26, 1882.

TRANSLATION OF A LETTER OF MR. WILLEQUET, DATED 1ST JULY, 1882, TO THE UNITED STATES CONSUL AT GHENT.

I have the honor to belong to the committee which has charge of elaborating the rules to append to the new law upon fisheries.

In the meeting of yesterday the committee received communication of the letters sent by your predecessor at Ghent, Mr. Wilson, to the governor of the province. These letters, among other obliging things, make the offer to supply our province and our country with the eggs or live young fish of an American species which, according to Mr. Wilson, would thrive wonderfully in the rivers of our provinces.

Mr. Wilson has been called to another post. I dare to hope that the United States consulate will preserve for our country, and especially for our Flanders, the good will shown until now, and I shall be very happy to be the medium to convey this kindness.

TRANSLATION OF LETTER OF MR. WILLEQUET, DATED 22D JULY, 1882, TO THE UNITED STATES CONSUL AT GHENT.

I hasten to answer your letter, and will begin by thanking you and the Government of the United States for the courtesy shown in this instance. I have taken notice of the communications of your predecessor, sent to the committee for the elaboration of the rules upon fisheries, and I am personally convinced of the efficacy of the indicated means to new-stock our rivers.

As soon as these rules shall be published, and this will be, along with the law, in about five or six weeks, I will take care to send you a few copies of both.

You will render good service to the public, first, by asking your government to let us have the young catfish of which you speak, and then, by letting me know the exact time of their arrival in Belgium, as it will be necessary to prepare for them, and this has to be done with care. I will make in this matter all necessary communications to the Government of Belgium.

It would be fortunate, also, if you could indicate a work upon pisiculture or ichthyology, which would allow us to study the question from the American point of view.

THE PROPOSED USE OF STEAMERS IN THE MACKEREL FISHERY.

By CHAS. W. SMILEY.

During the second week of July quite an excitement was created at Gloucester, Mass., by the announcement that Capt. Daniel T. Church, of steamer Jemima Boomer, Tiverton, R. I., had ordered of Messrs. H. & G. Lord a mackerel seine, and that menhaden being so scarce he proposed to turn his steamer to good account by catching mackerel. The Cape Ann Advertiser, of July 14th, contained an article entitled, "Threatened innovation of the mackerel fishery," in which it said, "The doings of this steamer will be watched with a great deal of anxiety by the captains of the one hundred steamers formerly engaged in the menhaden fisheries, as well as by the large number who depend upon mackerel fishing for employment and for the investment of capital. It is not difficult to anticipate the result, if this class of steamers engage in this branch of the fisheries. There is no reason to doubt their ability to catch almost or quite as many mackerel as they have formerly caught menhaden. Several of them are large, capable of carrying 2,800 barrels of fish in bulk. They carry a double gang of men and apparatus to correspond. During moderate weather, when mackerel generally school the best, and sailing vessels find it difficult to move, these steamers can play around the fleet of schooners, and catch almost every fish that shows itself."

Having thus described the vast superiority of steamers over sailing vessels in this business, and proceeding upon the supposition that the mackerel when caught would be used for oil and guano as had the menhaden, it continues, "Can we afford to take the risk of having such a valuable fishery destroyed and have this vast industry, giving employment to thousands and delicious fish-food to millions, diverted from its proper channel? Is it economy; is it justice to manufacture into oil and guano millions of barrels of the best food-fishes we have?" It then calls for legislation "to prevent the catch of mackerel for the purpose of manufacturing oil and guano."

A correspondent of the Boston Advertiser, writing from Gloucester, July 10, briefly stated the same facts, and added: "The employment of these steamers has undoubtedly broken up and driven off the menhaden, and the same effect will be produced upon the mackerel. The general feeling is that some stringent laws should at once be enacted for the protection of the mackerel fishery."

The same day Capt. J. W. Collins wrote to Prof. S. F. Baird stating that he had been requested by certain persons largely interested in the fisheries to bring the matter to his attention, and stating the fear that the proposed innovation will soon practically deprive us of one of the most valuable food-fishes of the American coast.

To all the reports concerning the use to be made of the mackerel so caught, Mr. Church replied in the Boston Herald that no steamer was being fitted to take mackerel for that purpose, and he showed the unreasonableness of such an expectation by stating that he is offered for the mackerel for food purposes $3 per barrel as they come from the water, while the market value of a barrel of mackerel after being rendered into oil and guano is $1 per barrel.

The Cape Ann Bulletin took a hopeful view in its issue, July 12. It admitted that schooner fishing for mackerel was endangered, but declared that Gloucester fishermen would not be long in fitting out steamers of their own if that method of fishing gave indications of success. As to steamers destroying the menhaden fishing, it said, "This is an open question. The fish have always been more or less variable in their visits to the coast, and it is by no means improbable that the investigations of the United States Fish Commission will discover the haunts of the menhaden and assign reasons for their change of locality. To wholly destroy any variety of fish by the hand of man is declared by competent authority to be practically impossible, since what is taken from them is but a drop in the bucket compared with what are destroyed by other means." This accords with Mr. Church's defense, in which he says, "It is a fact well known to all who have taken the pains to study the history of fish that live and multiply in the sea, that they have periods of being plenty and scarce, and that man, in his puny efforts of capture, is as nothing in comparison with the destruction by blue-fish, sharks, bonitas, and other fish of prey. Prof. Baird estimates that the blue-fish in four months destroy on the coast of New England 150,000,000 barrels of fish. When we add to the above the destruction by sharks, whales, etc., and add to that the whole coast from Maine to Mexico, and take twelve months' destruction instead of four, we see that man's influence is about the same as a fly's would be in trying to stop the steamer Bristol's engine by lighting on the end of the walking-beam when it was running wide open, with all the steam the law allowed."

Concerning the use of steamers, Mr. Clark, writing from Gloucester, says: "Gloucester mackerel men do insist that the ordinary use of the purse-seine does not appreciably decrease the stock of fish. Capt. Sol. Jacobs, the famous mackerel-catcher, says that one steamer can catch as many fish as ten sailing vessels; that steamers cannot make a business of carrying fresh fish to market, for lack of ice-houses and means of keeping fish fresh enough for food. If bailed into the hold the fish would be fit for nothing but guano on reaching port. Steamers have not the facilities for carrying barrels and salt, nor deck room to use in splitting, salting, and packing fish. Being entirely unfit for preserving mackerel, all that remains is to carry them to oil and guano factories. The time required to dress mackerel is at present a safeguard against an over-catch; but were all hands to pitch in and see how many fish could be scooped up, regardless of their preservation, it is probable that the business would soon become a thing of the past.

On mackerel vessels the mackerel pocket is useful in saving the fish alongside until they can be dressed and stowed down, besides its use in saving the seine from damage by dog-fish. The pocket would be of little use to steamers, for the reason that there is no difficulty in quickly bailing the catch from the seine into the hold." He, too, calls for legislation.

To all these considerations Professor Baird made the following philosophic reply:

"If the menhaden men catch an abundance of mackerel, can they afford to convert them into oil and guano? Will not these fish, however small, bring better prices for canning? There is a demand, apparently, for ten times as many mackerel as are produced. What can the mackerel men do in the matter? These fisheries are prosecuted more than three miles from shore. Hence neither State nor Federal authority can do anything to prevent any foreigner from coming on the same grounds and fishing in any way he may deem best. When the fish are landed, the State can interfere; and, if it is considered that a wasteful application of the fish is being made, State laws can be enacted. They can say, for instance, that a menhaden man shall not have a mackerel in his possession, just as the same authorities declare that no man shall be found with a trout in his possession during the closed season. The dilemma is that if Massachusetts passes prohibitory laws the fish will be transferred to States not so restricted, and it will be found difficult to produce concurrent action in all the States. The fishermen cannot object to legitimate competition. If the fish are caught and sold for food, so much the better for the country. I do not believe that steam-seining for mackerel will be kept up very long, in view of the comparatively small returns. The menhaden men, while fishing for mackerel, will, of course, utilize the new mackerel pocket and all the other devices."

The status at the present time thus appears to be about as follows:

I. It is proposed to catch mackerel by the use of steamers and the various novel appliances whereby all concede that very much larger numbers may be taken.

II. The rumor that men formerly engaged in making oil and guano from menhaden will convert the mackerel to the same purpose is met with prompt denial, and with the fact that the fish will bring three times as much for food as for oil.

III. As a safeguard, laws are invoked to prohibit manufacture of mackerel into oil; to which it is replied that the Federal Government has no jurisdiction, and that the States could hardly be induced to all unite upon a common prohibition, and especially while any foreigner can catch the fish on the high seas and do as he pleases with them.

IV. It was greatly feared and confidently predicted in 1878 that introduction of purse-seines would ruin the mackerel fisheries, but to day the

Gloucester fishermen insist that although in general use no diminution is appreciable and the catch has greatly increased since 1878.

V. It is now feared that steam fishing will exhaust the mackerel fisheries, as some allege it already has the menhaden fisheries. To this it is answered that menhaden fishing was always variable, that the present absence may be but temporary, and that if permanent it was caused, not by steamers over-fishing, but very likely by great oceanic causes, such as variation in temperature, destruction of their food, &c. It is also declared that all man can do is as nothing compared with the destructive agencies of predacious fish and natural enemies.

VI. The innovation, if it proves a success, is but another illustration of the advance of man in conquering the earth and bringing all its resources within his control, and if he sees the mackerel fisheries in danger of exhaustion he will find a way to propagate them and replenish the seas.

THE COTTBUS CARP TRADE.

[From *Deutsche Fischerei-Zeitung*, vol. v, No. 30; Stettin, July 25, 1882.*]

The Report of the Cottbus Chamber of Commerce contains some information relative to the carp trade, and gives the contracts between the large Berlin fish-dealers and the presidents of the Lusatia fishery associations, which were made last year for the first time, and which probably will also in the future form the basis for all business transactions in the fish trade, making of course due allowance for the variations in price caused by different circumstances. By the terms of these contracts 33 carp of the first quality were allowed to the hundred-weight, and 34 to 43 of the second quality. In order to make these terms less harsh, many bargains were, in 1881, concluded in the following manner: For a hundred-weight of carp (delivered free at the railroad station), containing 43 to 50 fish, 60 marks ($14.28) were paid; for 3 fish more or less to the hundred-weight, 1 mark (23.8 cents); therefore for a hundred-weight of 40 carp, 61 marks ($14.51); for one of 37 carp, 62 marks ($14.75); and, on the other hand, for a hundred-weight of 53 carp, 59 marks ($14.04); and for a hundred-weight of 56 carp, 58 marks ($13.89).

The sums paid are calculated according to the average of carp per hundred-weight of the entire quantity of carp sold. The importance of the Cottbus Carp Exchange for the fish trade may be gathered from the fact that nearly 250,000 kilograms of carp are, as a general rule, bespoken by large fish-dealers, and do not enter the general market. The yield of the carp ponds in the Cottbus district alone amounted to 75,000 kilograms in 1881. As the Report of the Chamber of Commerce remarks, the conditions of sale are just both to the producers and buyers, and will in all probability remain in force for a long time.

* *Vom Cottbuser Karpfenhandel.* Translated from the German by HERMAN JACOBSON.

A CONTRIBUTION TO OUR KNOWLEDGE OF THE DEVELOPMENT OF THE OYSTER (OSTREA EDULIS L.).

By DR. R. HORST.*

During the past summer, as our zoological station was then established in the vicinity of the oyster banks in the Eastern Schelde, I busied myself for several weeks with the study of the history of the development of the oyster. Even though this investigation is still incomplete, I think, however, that the following communication may contribute to an increase of our still very fragmentary knowledge of the embryology of the bivalve mollusca. These investigations were carried on in the station at Wemeldinge,† where, during my stay, I experienced many disinterested and important favors at the hands of MM. Zocher and De Leeuw. The study of the history of the development of the oyster is beset with peculiar difficulties, to which the French zoölogist, M. Lacaze-Duthiers, alludes as follows: "The oyster is certainly one of the most difficult of the species of the group of acephalous lamellibranchs to study, both in relation to its organization as well as its development."‡ While in the case of most of the lower animals the sexes are confined to distinct individuals, and the sexual products, when mature, freely escape from the body, the fertilization taking place outside the latter, with the oyster this is not the case. Not only do the embryos pass through their first stages of development within the mantle cavity of the adult, and impregnation occurs internally instead of externally, but it may also be said that the eggs and spermatozoa come into contact in their passage out of the generative glands. If it is desired to observe the first changes of the fertilized egg, it is therefore impossible to resort to artificial impregnation as in the case of most other lower animals, and one is obliged to trust to finding individuals which are full of brood, which may be opened for the purpose. If a mother oyster is opened in the usual way, that is, by cutting through the adductor muscle, the animal soon dies, and the normal development of the brood which it contains is also disturbed; for one may keep the embryos alive in an aquarium for several days, though abnormal conditions soon make their appearance, if the development itself does not come to a complete standstill. Lacaze-Duthiers observes that he kept oyster larvæ alive in aquaria longer than a month, but he affirms that during all of this time slow changes of organization occurred, which it is safe to say were not nor-

* Bijdrage tot de Kennis van de Ontwikkelingsgeschiedenis van de Oester (Ostrea edulis L.), door Dr. R. Horst, in Utrecht. Extracted from *Tijdschr. d. Ned. Dierk. Vereen*, dl. vi, 1882. Translated by J. A. Ryder. Abstr. in Zoolog. Anzeiger, 3d April, 1882.

† See the 6th yearly report (Jaarverslag) of the zool. station.)

‡ Mém. sur le développement des acéphales lamellibranches. (Comptes rendu, cad. Sc., Paris, t. xxxix, p. 1197.)

mal. In one instance I was successful in making an opening at the edge of the shell of an adult, by which means the animal was very slightly, if at all, injured, and which enabled me to introduce a pipette into the mantle cavity in order to obtain embryos and to follow the undisturbed development for a couple of days; but this method was not long available, since every time embryos were detached artificially great numbers would escape from the parent, so that all of the brood was soon lost. It is, therefore, impossible to obtain an unbroken series of the different stages of development, but it is necessary to resort to the method of comparison of the observed stages, and in that way endeavor to form an idea of the mode of development. It is also a fact that one cannot always distinguish by external marks those adults which contain brood; the relaxation of the adductor muscle and the less energetic closure of the shell consequent upon that condition is a pretty sure indication that the oyster is full of embryos, but this does not remove our doubts as to the age of the brood and how soon it will be set free. I also obtained many more mother oysters containing old than young brood, and I would state here that in consequence of this fact the first stages of segmentation are in great part unknown to me, a hiatus which I hope to have the opportunity to fill up next season.

Davaine* has figured several of the first stages of the segmentation of the egg of *Ostrea edulis;* if these are compared with the stages observed by me, as in Figs. 1 and 2, and with those observed by Brooks† in his account of the development of *Ostrea virginiana*, there remains little doubt that the first stages of segmentation of the egg of the oyster take place in a manner similar to that of the eggs of other lamellibranchs. From the beginning of development onwards there is already a decided difference between the lowermost (vegetative) and the uppermost (animal) portion of the egg, so that after repeated cleavage the lowermost pole consists of a large granular cell, from which the entoderm (and mesoderm?) develop, while at the upper pole lie numerous smaller and clearer cells, which enter into the formation of the ectoderm (Fig. 1). These animal or ectoderm cells multiply by repeated fission and grow down over the vegetative pole more and more, until they finally close over and include it. Now the large entoderm cell or sphere also begins to divide, at first into two great round cells (Fig. 2), later into a number of cylindrical cells (Fig. 4); at the same time the embryo loses its spherical form, and after an invagination of the entoderm of the lower pole it assumes a slightly reniform shape, as seen from the side in Fig. 3, in which the uppermost pole is represented as directed upwards. If an older stage is now observed in longitudinal section (Fig. 4), it is seen that the entoderm cells are slightly invag-

* Recherches sur la génération des Huîtres, Pl. II.

† The development of the American oyster (*Ostrea virginiana* List.). Studies from the Biological Laboratory of the Johns Hopkins University, No. IV, 1880, Pls. 1, 2, and 3.

inated, and that in this way a true gastrula stage has been developed. It is plain, however, that no true gastrulation takes place, since it is not possible to demonstrate a true cleavage cavity; indeed it appears to be, as it were, a transition form between a gastrula formed by embolic invagination and one developed by the epibolic downgrowth of the ectoderm over the entoderm. This last form appears to be common to other marine lamellibranchs. Indeed Rabl * has already pointed out that these apparently and fundamentally different modes of the formation of the gastrula are connected together by a series of transition forms, and that both may be referred to essentially the same process.

The embryo oyster at this stage is remarkable in that there is not only an invagination at the vegetative pole, but that there is also visible a distinct transverse groove formed a little below the apex of the opposite pole. When the embryo is viewed from the side the latter invagination immediately becomes apparent (Fig. 5, *sk*), and an optic section (Fig. 4) teaches us that it has originated from a mass of ectoderm cells which have been pushed inwards towards the center of the embryo. In the course of further development (Figs. 7 and 8), a sack with a narrow cavity is developed from this invagination, the walls of which are formed of long, cylindrical cells; the blind end of the sack is now directed towards the dorsal side of the embryo, whilst the direction of its cavity is parallel with the longitudinal axis of the latter. Without doubt, as we see in the case of older stages, this sack or invagination is nothing more than the shell gland. The assertion of Fol † that the shell gland in the embryos of *Ostrea* is not a true invagination, but that it is merely an ectodermal thickening, slightly hollowed out, is thus seen not to be very just, and apparently rests on what is observed in the older stages, where, as in other embryo mollusks provided with an external shell, the invagination becomes gradually shallower. As is well known, this organ was first observed in the *Cephalophora*, and was afterwards met with by Ray Lankester ‡ and Hatschek § amongst the lamellibranchs (*Pisidium* and *Teredo*); in comparison with the genera just named, the shell gland of the oyster appears very early in embryonic life.

The first investigators who studied the development of the oyster, Davaine and Lacaze-Duthiers, speak of "une échancrure" and "une dépression" from the presence of which the embryo becomes heart-shaped when viewed from the side; this invagination therefore appears to have been known to the older authors, although its significance was not understood by them. According to the investigations of Brooks, the embryo of *Ostrea virginiana* also has a deep depression or groove on

* Entwickelung der Tellerschnecke. Morph. Jahrbuch, Bd. V, p. 601.

† Études sur le développement des Mollusques. Arch. de Zoologie expér., T. vi, p. 186.

‡ On the developmental history of Mollusca. Philos. Transac. Roy. Soc., 1874.

§ Ueber Entwickelungsgeschichte von Teredo. Arbeiten aus dem Zool. Inst. Wien., T. III.

dorsal side, which he considers the external opening of the gastrula—the blastopore. If, however, we compare his Fig. 32 (*op. cit.*) with my figures 5, 6, and 8, then I believe that we may infer with great probability that the structure regarded as the blastopore by Brooks is nothing more than the external opening of the shell gland. This view is further sustained by the fact that he observed that at a later period the shell began to develop at this point, regarded by him as the opening of the blastopore. Such a mode of development of the shell of lamellibranchs has hitherto been observed only by Rabl* in *Unio*, and is so entirely opposed to the observations which have been made on the development of other lamellibranchs that, as has been capably observed, the matter should be more closely reinvestigated.

Returning to the embryo represented in Fig. 6, we see that the entodermal field or area, which in an earlier stage (Fig. 4) presents as yet little more than a slight depression, has now acquired the form of a deep invagination with a tubular cavity, the true gastrula form (protogaster); behind the mouth of the gastrular opening lie a pair of large cells, which may apparently be regarded as the first mesodermal cells, although their mode of origin as well as their further development I have failed to discover. In the embryo of the following day (Fig. 8) one already encounters mesoderm cells on the dorsal side of the rudimentary intestine. The ventral portion of the embryo which lies below the mouth now begins to be pushed out, so that a foot-like prominence is developed, whereby the embryo assumes some likeness to a young gastropod. The blastopore is still very distinctly visible, and has a peculiar triangular form, as seen from the anterior end, as in Fig. 7. As far as I have been able to make out, the blastopore does not close, but is transformed directly into the permanent mouth. For even in those forms in which the blastopore closes, the œsophagus as well as the permanent mouth is formed by an invagination of the ectoderm and also in those in which the blastopore does not close, the ectoderm cells have a share in building up the anterior portion of the alimentary canal.

During the further growth of the embryo, great internal as well as external changes take place; which is true in the first place in regard to the shell gland, which gradually loses its original character of a glandular invagination; its walls are reflected outwards, so that it again becomes merely a shallow depression, with a thickened floor of long conical cells (Fig. 9, *sk*). A cuticular membrane, *s*, the product of the secretion of these cells, represents the primitive foundation of the shell, and upon this point, in the full grown animal, rests the hinge. Accordingly, the representations of Davaine, who remarks, "Un trait transparent * * * * c'est le premier indice de la charnière," are fully borne out. The bivalve shell of the oyster is thus plainly seen to develop from

* Ueber die Entwickelungsgeschichte der Malermuschel. (Jen. Zeitschrift, XI., 1876.)

a simple unpaired rudiment, in opposition to the observations of Lacaze-Duthiers, according to whom both halves of the shell originate, "par deux boursouflements de l'enveloppe", (?) which afterwards unite to form the hinge. Brooks, in discussing this point recently in regard to the American oyster, observes that the shell from the first consists of two distinct halves, which develop from a small, irregular, transparent tract which lies in and athwart the dorsal groove or depression—his blastopore.

If it is also borne in mind, as I have before observed, that the peculiar character of this groove and the true blastopore have apparently escaped the observation of the last-named author, then we may be justly allowed to entertain some doubts as to the correctness of his interpretation. On the other hand, the description given by Hatschek of the first appearance of the shell in *Teredo*, agrees perfectly with that observed by me in *Ostrea*, and we may, as it appears to me, with safety assume that *the development of the shell in all mollusks takes place in the same way.* This admits of no question; and, as the last-named investigator very justly observes, it is a weighty argument in support of the position so ably defended by Von Jhering, viz, the theory of the monophyletic descent of the Mollusca.

Meanwhile, the ectoderm frees itself over almost the whole circumference of the embryo from the entoderm, so that now, for the first time, a body cavity (segmentation cavity) becomes apparent; a crown of cilia is also developed above the mouth, and the velar area (included by the ciliary girdle) is composed of columnar cells (Fig. 9). The entoderm has, meanwhile, enlarged and includes a spacious stomach cavity, from which a sac-like outgrowth is developed below, which still ends blindly, but which will afterwards be fused with the ectoderm to form the anal end of the intestine.

In the stage of development attained by the next day (Fig. 10), the shell has grown considerably in size. It now covers a large portion of the body, and, as indicated by treatment with acids, is already in part composed of lime carbonate. After the application of dilute acetic acid there remained only a tough membrane of conchioline. The ectoderm cells, which lie below the shell, have by this time become extremely flattened and transparent, so that one can no longer make out their contours, and with difficulty their highly refringent nuclei. The larva (Fig. 11), which now takes in nourishment, moves about with a lively motion and begins to grow slowly; the velum now forms a prominent portion of the body, which will be entirely covered by the shell as the latter grows larger. The velar area, which is included by the ciliary crown of the velum, is already slightly thickened in the center, the rudiment of the velar plate. A funnel-shaped œsophagus passes into the wide pear-shaped stomach which communicates posteriorly with the exterior through the intermediation of the intestine.

After the appearance of pigment on various parts of the body (velar plate, œsophagus, and blind saccular portion of the stomach), the brood begins to assume a gray or bluish color. The dimensions of the valves are now $0^{mm}.16$ (about $\frac{1}{156}$ of an inch); their form is almost circular, except the hinge border, which is straight. As already noted by Lacaze-Duthiers, the hinge at this stage is already provided with teeth. One may now note that the whole animal is withdrawn within the shell from time to time. This is effected principally by the help of a dorsal and a ventral muscle, *ds* and *vs*, which originate near the hinge border, and are inserted at the base of the velum. These muscles are formed of branched, attenuated, mesodermal cells, the branches of which traverse the body cavity in various directions. Several of these cells, which extend across from the left to the right half of the shell, have been aggregated into a group, and form a distinct adductor muscle, *sp*. Whenever the larva swims it thrusts the head or velar end of the body out of the shell, and partly turns it outwards over the edges of the latter anteriorly. The preoral ciliary crown consists of a double row of long cilia. If the velar area is viewed from above, the cilia will be found implanted upon two nearly approximated rows of almost rectangular cells. From each of these cells two cilia arise, which in stained preparations may be traced for some distance into the cellular protoplasm. I was unable to detect a postoral ciliary band, although the cephalic extremity of the embryo behind the preoral band is clothed with cilia. The velar area now consists in great part of a single layer of very much flattened cells, which can scarcely be defined even when aided by the presence of their stained nuclei; only in the center is there a marked thickening, which projects inwards, composed of distinct layers of ectodermal cells (*tp*). This is the structure which we have heretofore been designating by the name of velar area (*topplaat;* German, *Scheitelplatte*), and from which the supraœsophageal ganglion is developed. A longitudinal groove appears to divide this area superficially into two halves, but in consequence of a black pigment which is usually developed in this region, I could not make it out distinctly. Peripheral nerves, which pass outwards from the central velar thickening, such as were observed in the larvæ of *Teredo* by Hatschek, were not encountered by me. The above-mentioned ectodermal thickening appears to have been noticed in the larval oyster by Davaine, as well as by Lacaze-Duthiers, but was at first regarded by both as the oral opening—an error which was afterwards rectified by the last-named investigator.

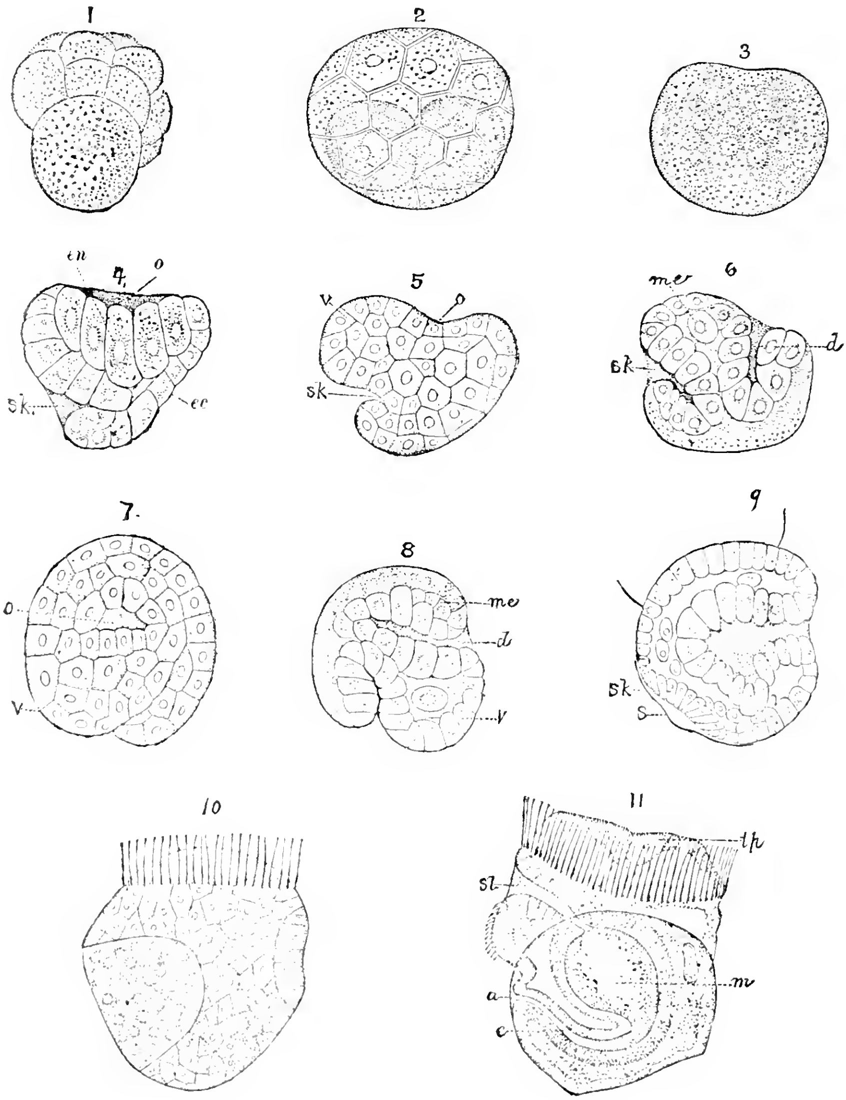
Together with the other parts of the body the intestinal canal has also progressed in development, the œsophagus, which has been pigmented with a brown color, has grown longer, and its anterior portion has been widened, and become funnel-shaped. The cavity of the stomach has grown in length, and a constriction divides it into an upper and a lower portion. From the upper portion on the left and right sides a large round blind sac (*l*) has been developed, which constitutes the rudiment of the liver, while at the level of the constriction the intestine arises, making a couple of bends upon itself before opening into the mantle cavity (*mh*). The entire internal surface of the alimentary canal is clothed with cilia, with apparently the exception of the hepatic diverticulum (*l*), the internal surface of which it is difficult to observe in consequence of the presence of a black pigment.

At the point where the rudimentary foot was formerly developed, a thickening of the ectoderm is now formed, of the same character as that already described as arising in the center of the velar area. This mass also contains a large number of nuclei; but whether the pedal ganglion is developed from it, I have not been able to make out, nor could I discover the presence of auditory vesicles, though Lacaze-Duthiers claims to have seen them. Nor was I more fortunate in detecting the presence of excretory organs, although I made special efforts to discover them; otherwise the numerous points of agreement, of the larva (trochophora) of the oyster with those presented by *Teredo*, were complete, with only these slight exceptions. Perhaps renewed investigation would show that the segmental organs also are not wanting. Older stages than that represented in Fig. 12 I was unfortunately not able to investigate, so that regarding the length of the period which intervenes between the time when the larvæ are set free, and the time at which they fix themselves, as well as the changes which they undergo during this period, I am unable to affirm anything.

The difficulties encountered in distinguishing the young oyster, immediately after it has attached itself, I believe I have entirely overcome: and instead of using the ordinary collector for this purpose, which is covered with a mixture of lime and sand, a collector should be used which is covered with an even coat of clean lime; for the numerous little asperities due to the presence of the sand grains; make it difficult even for the sharp-sighted oyster fishermen to distinguish the shells of the young oysters on the collectors of the usual form. In order to have the surface as even as possible, I used panes of glass instead of the usual form of collector, though this is not positively necessary. After one of these panes of glass had been immersed in the water for eight days, several young oysters were found to be attached; of these the largest measured $0^{mm}.85$ (about $\frac{1}{30}$ inch), and the smallest scarcely $0^{mm}.57$ (about $\frac{1}{43}$ inch) in diameter, though the latter was already visible to the naked eye.

The experiments instituted by Dr. De Leeuw and myself, in order to learn if the young oysters would fix themselves in inclosed basins, have not yet been completed.

Before closing, I would call attention in this place to a probable enemy of oyster brood. In my aquarium, in which a mother oyster was placed, and which every now and then threw out a great quantity of brood, there were also a couple of actiniæ of the same species which is very often observed attached to oyster shells. It occurred to me that the quantity of brood was diminishing too rapidly, and upon making an investigation of the matter I found a number of small bluish-gray pellets, a couple of millimeters in diameter, floating about in the water. Just then I saw one of the actiniæ eject a similar pellet from its mouth. Upon investigating one of these pellets microscopically I learned that it consisted of nothing else than the empty shells of young oysters, the remains of the ingested food of the actinia. Although I do not believe that the actiniæ, under ordinary natural conditions, have the opportunity to destroy as many larvæ as noted above, they may, however, be able to destroy great quantities, as they are present in great numbers, attached to the old oysters at the sea bottom.



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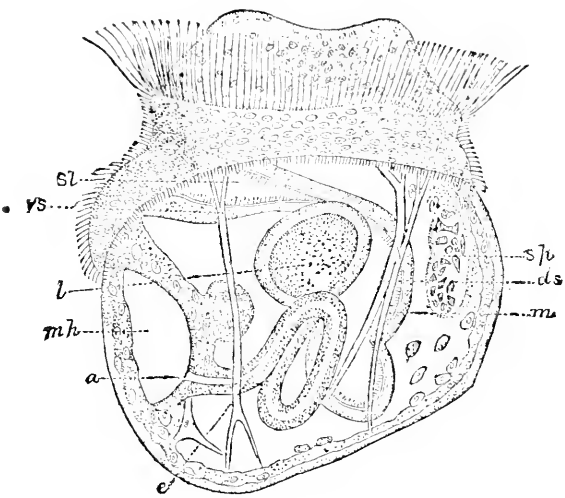


Explanation of the Plate.

FIG. 1.—Segmented egg showing the large vegetative cell below, and the numerous animal cells above.

FIG. 2.—Older stage, seen from above, showing the two entodermal cells shimmering through from below.

FIG. 3.—Embryo seen from the side, showing the commencement of the gastrular invagination.

FIG. 4.—More advanced stage, seen in optic section, showing the entodermal invagination and the commencement of the shell gland; *ec*, ectoderm; *en*, entoderm; *o*, gastrula mouth—blastopore; *sk*, shell gland.

FIG. 5.—Still older embryo, seen from the side; *v*, foot; the other letters with the same signification as before.

FIG. 6.—The same stage seen in optic section; *me*, mesoderm; *d*, gastrula cavity or archenteron.

FIG. 7.—Embryo one day older, seen from the anterior end, showing the triangular opening of the blastopore.

FIG. 8.—The same stage in optic section.

FIG. 9.—Embryo one day older, seen in section, with ciliary crown (vellum), stomach cavity, and rudiment of the shell developed; *s*, shell.

FIG. 10.—A more advanced stage seen from the side, with the shell further developed.

FIG. 11.—Larva still more advanced, with velar disk or area developing, the central thickening of which, *tp*, is apparent; *a*, anus; *e*, rectal end of intestine; *m*, stomach; *sl*, œsophagus; *tp*, rudiment of supraœsophageal ganglion.

FIG. 12.—More advanced larva with a double preoral girdle of cilia, hepatic sac, muscles, and rudiment of supraœsophageal ganglion developed; *ds*, dorsal pallial muscle; *rs*, ventral pallial muscle; *sp*, adductor muscle; *l*, hepatic sac or diverticulum of the stomach; *mh*, mantle cavity. The remaining letters have the same signification as in previous figures.

CARP PROPAGATION AND BLUE CARP.

BY GEORGE ECKARDT.

[From a letter to Prof. S. F. Baird.]

I am here to construct spawning ponds in Forest Park for the Missouri Fish Commission. The success it had last year in those park ponds is not satisfactory, but good enough to fill all the applications. We have carp six months old from 4 to 14½ inches long and in very fine condition, only not of the right shape. I have to go to Germany, *militaria causa*, and will bring over some adult blue carp for the Missouri Commission next February. The blue carp is just the fish for the country, because it likes warm climate better than the other, and is only spawning when they have a good summer in Germany.

ST. LOUIS, MO., *December* 8, 1882.

FEEDING CARP WITH INDIAN CORN.

By CARL NICKLAS.

[From "Deutsche-Fischerei-Zeitung," vol. V, No. 38, Stettin, September 19, 1882.*]

What would be the proportion of nutritive matter in 1 kilogram of boiled Indian corn if mixed with 1 kilogram of "meat-flour?"

According to Professor Wolff, "meat-flour" contains: 68 per cent. of digestible albumen, no hydrates of carbon, and 11.2 per cent. of fat; Indian corn, 8.4 per cent. of albumen, 60.6 per cent. hydrates of carbon, and 4.8 per cent. of fat. The proportion of nutritive matter in "meat-flour" is, therefore, Nh : Nfr = 1 : 0.4; and in Indian corn 1 : 8.6; consequently the proportion in Indian corn is 21.5 times greater than in "meat-flour." In 1 kilogram (1,000 grams) "meat-flour" there are contained 689 grams albumen, no hydrates of carbon, and 112 grams fat; in 1 kilogram Indian corn: 84 grams albumen, 606 grams hydrates of carbon, and 48 grams fat. Even if one were to suppose—which, however, is hardly possible—that, in feeding carp, the proportion of nutritive substances is immaterial, and that only the quantity of albumen is essential, it would take 8 kilograms of albumen to reach the same quantity of nutritive substance as 1 kilogram "meat-flour," because the quantity of albumen in 8 kilograms Indian corn is about the same as that contained in 1 kilogram "meat-flour." Indian corn is, therefore, among the most irrational and expensive articles of food for carp. Boiling does not change this, but only tends to make the Indian corn a little more digestible. If you boil 1 kilogram Indian corn with 3.5 kilograms *dry* blood, so that the fluid is entirely absorbed by the corn, you will get the right proportion of nutritive substances, viz: about 1 : 0.6. It is preferable to make a paste of corn-meal and blood in the above mentioned quantities.

* "Fütterung der Karpfen mit Mais." Translated from German by H. Jacobson.

THE FIRST DECADE OF THE UNITED STATES FISH COMMISSION: ITS PLAN OF WORK AND ACCOMPLISHED RESULTS, SCIENTIFIC AND ECONOMICAL.

By G. BROWN GOODE.*

There are nine departments of the government devoted, in part or wholly, to researches in pure and applied science—the Geological Survey; the Coast and Geodetic Survey; the Naval Observatory; the National Museum; the Department of Agriculture; the Entomological Commission; the Tenth Census, with its special agencies for the study of the natural resources of the country; the Smithsonian Bureau of Ethnology, and the Commission of Fish and Fisheries. The Smithsonian Institution, established upon an independent foundation, should also be mentioned, as well as the Medical Museum of the Army, and the various laboratories under the control of the Army and Navy Departments.

The Geological Survey is not now carrying on any of the schemes of zoological and botanical investigation engaged in by its predecessors.

The work of the Entomological Commission and that of the census, though of extreme importance, are limited in scope and duration, while that of the Agricultural Department is necessarily, for the most part, economical.

The work of the National Museum is chiefly confined to the study of collections made by government surveys or individual collectors and sent in to be reported upon.

The work of the Fish Commission, in one of its aspects, may perhaps be regarded as the most prominent of the present efforts of the government in aid of aggressive biological research.

On the 9th of February, 1874, Congress passed a joint resolution which authorized the appointment of a Commissioner 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 Commissoner 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

*Read before the American Association for the Advancement of Science, Boston, August 28, 1880.

been created. Professor Baird, at that time assistant secretary of the Smithsonian Institution, was appointed and entered at once upon his duties.

The summer of 1880 marks the tenth season of active work since its inception in 1871. The Fish Commission now fills a place tenfold more extensive and useful than at first. The present essay aims to show, in a general way, what it has done, is doing, and expects to do—its purposes, its methods, its results.

The work is naturally divided into three sections:

1. The systematic investigation of the waters of the United States and the biological and physical problems which they present. The scientific studies of the commission are based upon a liberal and philosophical interpretation of the law. In making his original plans the Commissioner insisted that to study only the food-fishes would be of little importance, and that useful conclusions must needs rest upon a broad foundation of investigations purely scientific in character. The life history of species of economic value should be understood from beginning to end, but no less requisite is it to know the histories of the animals and plants upon which they feed or upon which their food is nourished; the histories of their enemies and friends and the friends and foes of their enemies and friends, as well as the currents, temperatures, and other physical phenomena of the waters in relation to migration, reproduction, and growth. A necessary accompaniment to this division is the amassing of material for research to be stored in the national and other museums for future use.

2. The investigation of the methods of fisheries of past and present, and the statistics of production and commerce of fishery products. Man being one of the chief destroyers of fish, his influence upon their abundance must be studied. Fishery methods and apparatus must be examined and compared with those of other lands, that the use of those which threaten the destruction of useful fishes may be discouraged, and that those which are inefficient may be replaced by others more serviceable. Statistics of industry and trade must be secured for the use of Congress in making treaties or imposing tariffs, to show to producers the best markets, and to consumers where and with what their needs may be supplied.

3. The introduction and multiplication of useful food-fishes throughout the country, especially in waters under the jurisdiction of the general government, or those common to several States, none of which might feel willing to make expenditure for the benefit of the others. This work, which was not contemplated when the commission was established, was first undertaken at the instance of the American Fish Cultural Association, whose representatives induced Congress to make a special appropriation for the purpose. This appropriation has since been renewed every year on a more bountiful scale, and propagation is at present by far the most extensive branch of the work of the commis-

sion, both in respect of number of men employed and quantity of money expended.

Although activity in this direction may be regarded in the light of applied rather than pure scientific work, it is particularly important to the biologist, since it affords opportunities for investigating many new problems in physiology and embryology.

The origin of the commission, its purposes, and methods of organization, having been described, it now remains to review the accomplished results of its work. In many departments, especialy that of direct research, most efficient services have been rendered by volunteers; in fact, a large share of what has been accomplished in biological and physical exploration is the result of unpaid labor on the part of some of the most skillful American specialists. Although it would be interesting to review the peculiar features of the work of each investigation, the limits of this paper will not allow me to do so, or even to mention them all by name.

Since the important fisheries center in New England, the coast of this district has been the seat of the most active operations in marine research. For ten years the commission, with a party of specialists, has devoted the summer season to work at the shore, at various stations along the coast, from Connecticut to Nova Scotia.

A suitable place having been selected, a temporary laboratory is fitted up with the necessary appliances for collection and study. In this are placed from ten to twenty tables, each occupied by an investigator, either an officer of the commission or a volunteer. From 1878 to 1879, important aid was rendered by the Secretary of the Navy, who detailed for this service a steamer to be used in dredging and trawling, and this year the steamer built expressly for the commission is employed in the same manner.*

The regular routine of operations at a summer station includes all the various forms of activity known to naturalists—collecting along the shore, seining upon the beaches, setting traps for animals not otherwise to be obtained, and scraping with dredge and trawl the bottom of the sea, at depths as great as can be reached by a steamer in a trip of three days. In the laboratory are carried on the usual structural and sys-

* The number of dredging and trawling stations on record is as follows:

1871.	Wood's Holl	345
1872.	Eastport, 200 by hand, 35 by steamer	235
1873.	Portland	149
1874.	Noank	223
1875.	Wood's Holl	169
1877.	Salem	378
	Halifax	
1878.	Gloucester	
1879.	Provincetown	
	Total in round numbers	1,500

The number of seine hauls is about 600.

tematic studies; the preparation of museum specimens and of reports. Since the organization of the commission, the deep-sea work and the investigation of invertebrate animals has been under the charge of Professor Verrill, who had for many years before the commission was established been studying independently the invertebrate fauna of New England.

In addition to what has been done at the summer station, more or less exhaustive investigations have been carried on by smaller parties on many parts of the coast and interior waters. The fauna of Grand Rapids, and other off-shore fishing grounds, has been partly explored. In 1872, 1873, and 1874, dredging was carried on from the Coast Survey steamer Bache, by Professor Packard and Mr. Cooke, Professor Smith, Mr. Harger, and Mr. Rathbun. In 1879 Mr. H. L. Osborn spent three months in a cod schooner collecting material on the Grand Banks, and Mr. N. P. Scudder as long a time on the halibut grounds of Davis' Straits.

A most remarkable series of contributions have been received from the fishermen of Cape Ann. When the Fish Commission had its headquarters at Gloucester, in 1878, a general interest in the zoloogical work sprang up among the crews of the fishing vessels, and since that time they have been vieing with each other in efforts to find new animals. Their activity has been stimulated by the publication of lists of their donations in the local papers, and the number of separate lots of specimens received, to the present time, exceeds eight hundred. Many of these lots are large, consisting of collecting-tanks full of alcoholic specimens. At least thirty fishing vessels now carry collecting-tanks on every trip, and many of the fishermen, with characteristic superstition, have the idea that it insures good look to have a tank on board, and will not go to sea without one. The number of specimens acquired in this manner is at least fifty or sixty thousand, most of them belonging to species unattainable. Each halibut vessel sets, twice daily, lines from ten to fourteen miles in length, with hooks upon them six feet apart, in water twelve hundred to eighteen hundred feet in depth, and the quantity of living forms brought up in this manner, and which had never hitherto been saved, is very astonishing. Over thirty species of fishes have thus been added to the fauna of North America, and Professor Verrill informs me that the number of new and extra-limital forms thus placed upon the list of invertebrates cannot be less than fifty.

A permanent collector, Mr. Vinal N. Edwards, has been employed at Wood's Holl and vicinity since 1871, and many remarkable forms have also been discovered by him.

No dredging has yet been attempted by the commission south of Long Island, though much has been done in shore work, especially among the fishes, by special agents and friends of the commission, and by the parties stationed here and there in the work of fish culture. Mr. E. G.

Blackford, of Fulton Market, New York, by carefully watching the market slabs, has added at least ten species of fishes to the fauna of the United States. Mr. F. Mather is studying the fish of Long Island and the Sound. Dr. Yarrow, Mr. Earll, and others, have collected from Cape May to Key West. The Gulf States coast was explored last winter by a party conducted by Mr. Silas Stearns, who spent nine months in studying the food-fishes and apparatus for the census. The entire Pacific Coast has been scoured by Professor Jordan for the commission and the census, and the ichthyology of that region has been enriched by the discovery of sixty species new to the fauna, forty of them being new to science. A similar investigation on the great lakes has been carried over a period of several years by Mr. Milner and Mr. Kumlien. The ichthyology of the rivers of the country has received much attention from the many experts employed by the commission in the fish-cultural work.

In addition to these local studies may be mentioned the general explorations such as are now being carried on for the oyster, by Mr. Ernest Ingersoll and Mr. John A. Ryder, for the shad by Colonel McDonald, for the smelt and the Atlantic salmon by Mr. C. G. Atkins, and the quinnat salmon by Mr. Livingston Stone.

A partial indication of what has been accomplished may be found in the number of species added to the various faunal lists. Take, for instance, the cephalopod mollusks of New England. In Professor Verrill's recently published monographs twenty species are mentioned, thirteen of which are new to science. Ten years ago only three were known.

I am indebted to Professor Verrill for the following estimate of the number of species added within the past ten years to the fauna of New England, mainly by the agency of the Commission:

	Family known.	Additions.	Now known.
Crustacea	105	193	298
Pycnogonida	5	10	15
Annelida	67	238	305
Vermes	....	....	....
Mollusca	....	....	....
Echinodermata	....	....	....
Anthozoa	....	....	....
Tunicata	26	25	51
Polyzoa	56	91	147
Brachiopoda	5	....	5
Sponges	10	80	90
Acalephæ	....	....	....
Total in round numbers	800	1,000	1,800

It is but just to say that many of these species were obtained by Professor Verrill in the course of his independent explorations in Maine and Connecticut previous to 1871.

A similar estimate for the fishes indicates the discovery of at least one hundred species on the Eastern Atlantic coast within ten years; half of these are new to science. Forty species have been added to the fauna north of Cape Cod; sixteen of these are new and have been found within three years; seventeen have been described as new from the Gulf of Mexico; sixty, and more, have been added upon the West coast. The results of the summers' campaigns are worked in winter in the Peabody Museum of Yale College, under the direction of Professor Verrill, and by the specialists of the National Museum.

One of the important features of the work is the preparation of life histories of the useful marine animals of the country, and great quantities of material have been accumulated relating to almost every species. A portion of this has been published, more or less complete biographical monographs having been printed on the bluefish, the scup, the menhaden, the salmon, and the whitefish, and others are nearly ready.

Another monograph which may be referred to in this connection is that of Mr. Starbuck on the whale fishery, giving its history from the earliest settlement of North America.

The temperature of the water in its relation to the movements of fish has from the first received special attention. Observations are made regularly during the summer work, and at the various hatching stations. At the instance of the Commissioner, an extensive series of obervations have for several years been made under the direction of the Chief Signal Officer of the Army, at light-houses, light-ships, life-saving and signal stations, carefully chosen, along the whole coast. This year thirty or more fishing schooners and steamers are carrying thermometers to record temperatures upon the fishing grounds, a journal of the movements of the fish being kept at the same time. One practical result of the study of these observations has been the demonstration of the cause of the failure of the menhaden fisheries on the coast of Maine in 1879—a failure on account of which nearly 2,000 persons were thrown out of employment.

Another important series of investigations carried on by Commander Beardsley, of the Navy, shows the error of the ordinary manner of using the Casella-Miller deep-sea thermometer; still another series made by Dr. Kidder, of the Navy, and to be carried out in future, had for its object the determination of the temperature of the blood of marine animals.

Observations have also been made by Mr. Milner upon the influence of a change from sea water into fresh water and from fresh water into sea water upon the young of different fishes.

Mr. H. J. Rice carried on series of studies upon the effect of cold in retarding the development of incubating fish eggs.

A series of analyses have been made by Professor Atwater to determine the chemical composition and nutritive value of fish as compared with other articles of food. This investigation is still in progress.

In connection with the work of fish-culture much attention has been paid to embryology. The breeding times and habits of nearly all of our fishes have been studied, and their relations to water temperatures. The embryological history of a number of species, such as the cod, shad, alewife, salmon, smelt, Spanish mackerel, striped bass, white perch, and the oyster, have been obtained under the auspices of the commission, by Messrs. Brooks, Ryder, Schæffer, Rice, and others.

The introduction of new species in water in which they were previously unknown is of special interest to the student of geographical distribution. Through the agency of the commission the German carp has already been placed in nearly every State and Territory, although the work of distribution has only just begun, and the tench (*Tinca vulgaris*) and the golden orfe (*Idus melanotus*) have been acclimated; the shad has been successfully planted in the Mississippi Valley and on the coast of California, and the California salmon in the rivers of the Atlantic slope. The maraena, or lake whitefish, of Europe has been introduced into a lake of Wisconsin. It is not my purpose to speak of the great success in restocking with shad and salmon several rivers in which the supply was almost exhausted, and in planting the Schoodic salmon in numerous lakes. As an act of international courtesy California salmon have been successfully introduced into New Zealand and Germany. The propagation work has increased in importance from year to year, as may be seen by the constant increase in the amount of the annual appropriation. A review of the results of the labors of the commission in increasing the food supply of the country may be found in the annual reports, the rude appliances of fish-culture in use ten years ago have given way to scientifially devised apparatus, by which millions of eggs are hatched where thousands were, and the demonstration of the possibility of stocking rivers and lakes to any desired extent has been greatly strengthened. This work was for six years most efficiently directed by the late Mr. James W. Milner, and is now in charge of Maj. T. B. Ferguson, also commissioner for the State of Maryland, by whom has been devised the machinery for propagation on a gigantic scale, by the aid of steam, which is now so successfully in use.

The investigation of the statistics and history of the fisheries has perhaps assumed greater proportion than was at first contemplated. One of the immediate causes of the establishment of the commission was the dissension between the line and net fishermen of Southern New England with reference to laws for the protection of the deteriorating fisheries of that region. The first work of Professor Baird, as Commissioner, was to investigate the causes of this deterioration, and the report of that year's work includes much statistical material. In the same year a zoological and statistical survey of the great lakes was accomplished, and various circulars were sent out in contemplation of the preparation of monographic reports upon the special branches of the fisheries, some of which have already been published.

In 1877, the Commissioner and his staff were summoned to Halifax to serve as witnesses and experts before the Halifax Fishery Commission, then charged with the settlement of the amount of compensation to be paid by the United States for the privilege of participating in the fisheries of the provinces. The information at that time available concerning the fisheries was found to be so slight and imperfect that a plan for systematic investigation of th esubject was arranged and partially undertaken. The work was carried on for two seasons with some financial aid from the Department of State. In 1879 an arrangement was made with the Superintendent of the Tenth Census, who agreed to bear a part of the expense of carrying out the scheme in full. Some thirty trained experts are now engaged in the preparation of a statistical report on the present state and the past history of the fisheries of the United States. This will be finished next year, but the subject will hereafter be continued in monographs upon separate branches of the fisheries, such as the Halibut Fishery, the Mackerel Fishery, the Shad Fishery, the Cod Fishery, the Herring Fishery, the Smelt Fishery, and various others of less importance.

Hundreds and even thousands of specimens of a single species are often obtained. After those for the National Museum have been selected, a great number of duplicates remain. These are identified, labeled and made up into sets for exchange with other museums and for distribution to schools and small museums. This is in accordance with the time-honored usage of the Smithsonian Institution, and is regarded as an important branch of the work. Several specialists are employed solely in making up these sets and in gathering material required for their completion. Within three years fifty sets of fishes in alcohol, including at least ten thousand specimens, have been sent out, and fifty sets of invertebrates, embracing one hundred and seventy-five species and two hundred and fifty thousand specimens. One hundred smaller sets of representative forms are intended for educational purposes, to be given to schools and academies, are now being prepared.

The arrangement of the invertebrate duplicates is in the charge of Mr. Richard Rathbun; of the fishes, in that of Dr. T. H. Bean.

Facilities have also been given to many institutions for making collections on their own behalf.

Six annual reports have been published, with an aggregate of 5,650 pages. These cover the period from 1871 to 1878. Many papers relating to the work have been published elsewhere—particularly descriptions of new species and results of special faunal exploration.

AN EPITOME OF THE HISTORY OF THE COMMISSION.

1871.

The Commissioner, with a party of zoologists, established the first summer station at Wood's Holl, Mass., other assistants being engaged in a similar work at Cape Hatteras and the Great Lakes. He also personally investigated the alleged decrease of the fisheries in Southern New England, taking the testimony of numerous witnesses.

1872.

This year the summer station was at Eastport, Me., particular attention being paid to the herring fisheries. The survey of the Great Lakes was continued. Dredging, under the direction of Professor Packard, was begun on the off-shore banks. At the instance of the American Fish Cultural Association, Congress requested the Commissioner to take charge of the work of multiplying valuable food-fishes throughout the country. Work was begun on the shad, salmon, and whitefish, and the eggs of the European salmon were imported.

1873.

The summer headquarters were fixed at Portland, Me. The opportunities for research were greatly increased by the aid of the Secretary of the Navy, who granted the use of an eighty-ton steamer.

Exploration in the outer waters between Mount Desert and Cape Cod were carried on in the United States Coast Survey steamer Bache. Operations in fish-culture were carried on upon an extensive scale.

1874–1875.

In 1874 the zoological work centered at Noank, Conn. The attempt was made to introduce shad into Europe. In 1875 the station was for a second time at Wood's Holl, where a permanent seaside laboratory, with aquarium, was now established. The number of investigations this year were about twenty. The increase in the propagation work was proportionately much larger.

1876.

This year the Commissioner was unable to take the fishes and useful invertebrates in behalf the commission field for fishery investigations, having been instructed to exhibit, in connection with the Philadelphia International Exhibition, the methods of fish-culture and the American fisheries. Much, however, was accomplished by single investigators in various localities. The propagation work continued. This year the first carp were introduced from Germany.

1877.

The field of investigation was resumed at Salem, Mass., and later at Halifax Nova Scotia. A larger steamer of 300 tons made deep-sea research possible. The Commissioner and his staff served as experts before the Halifax Fishery Commission. The propagating work was on the increase, and the government carp ponds were established in Washington.

1878–1879.

In 1878 the summer station was at Gloucester, Mass.; in 1879 at Provincetown. These centers of the fishing interests were selected that more attention might be devoted to studying the history, statistics, and methods of the sea fisheries. A plan for the systematic investigation which seemed yearly more necessary in view of the dissensions between the Governments of the United States and Great Britain. In 1879 a combination was formed with the Superintendent of the Tenth Census, by which the Commissioner was enabled to carry more rapidly forward this branch of the work. Specialists were dispatched to all parts of the country to study the biological, statistical, and practical aspects of the fisheries. In 1878 the breeding of cod and haddock was accomplished at Gloucester. In 1879 the propagation of the oyster was accomplished by co-operation with the Maryland Commission, under the direction of Major Ferguson, and the distribution of the carp throughout the country was begun.

1880.

The summer station is at Newport, R. I. The Fish Hawk, a steamer of 484 tons, constructed expressly for the work of the commission, lies at the wharf, now equipped for scientific research, later to be employed in the propagation of the sea fish, such as the cod and the mackerel. Over fifty investigations are in the field in the service of the commission. The season was opened by the participation of the commission in the International Exhibition at Berlin. The first-honor prize, the gift of the Emperor of Germany, was awarded to Professor Baird, not alone as an acknowledgement that the display of the United States was the most perfect and most imposing, but as a personal tribute to one who, in the words of the president of the Deutscher Fischerie Verein, is regarded in Europe as the first fish-culturlist in the world.

SCARCITY OF BLACKFISH IN THE SOUTH.

By CHARLES C. LESLIE.

[NOTE.—In view of the immense and unusual abundance of the sea bass or blackfish, *Serranus atrarius*, on the coast of Southern New England, the following note from Mr. C. C. Leslie to G. Brown Goode possesses much interest:]

We have noticed for the past four or five years the scarcity of blackfish in the summer, and especially this summer. The smacks here have not made their expenses for the past two months. I have just seen Capt. S. M. Corker, one of our most expert blackfish fishermen, who has been in the business for thirty years. He states that he has never seen them so scarce as they are, and that in former years they could catch enough to pay expenses during the summer. Captain Corker told me also, about the first of June, a vessel came into this port; her captain reported that he sailed through acres of codfishes floating belly up between Hatteras and Cape Henry. The fishes were not dead, but very weak.

CHARLESTON, S. C., *June* 29, 1882.

OBSERVATIONS ON THE ABSORPTION OF THE YELK, THE FOOD, FEEDING, AND DEVELOPMENT OF EMBRYO FISHES, COMPRISING SOME INVESTIGATIONS CONDUCTED AT THE CENTRAL HATCHERY, ARMORY BUILDING, WASHINGTON, D. C., IN 1882.

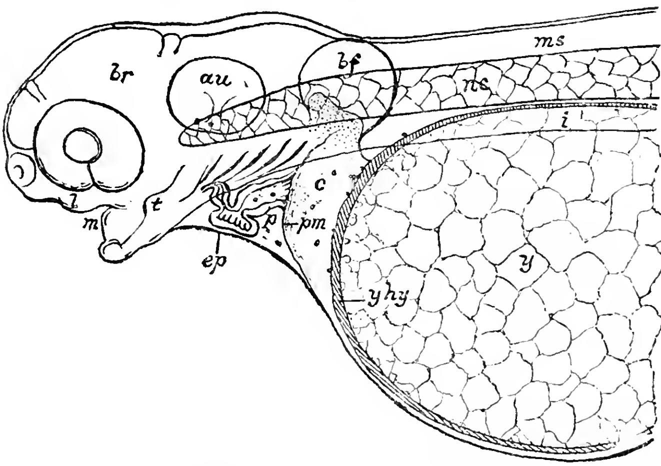
By JOHN A. RYDER.

I.—OBSERVATIONS ON THE MODE OF ABSORPTION OF THE YELK OF THE EMBRYO SHAD.

The manner in which the yelk of fish ova is absorbed or incorporated into the body of the young fish, especially in those forms in which no vessels traverse the yelk bag, was for a long time a puzzle to me. The yelk in all cases diminishes in bulk progressively, not suddenly. This fact indicated that the process of absorption probably occupied a considerable time, and that if a careful watch was kept up it might possibly be that the observer would be rewarded by the discovery of the manner of its accomplishment. With this object in view, the writer carefully observed young shad which had but recently left the egg, and in which it was to be inferred that the blood was about to be developed. My reason for choosing this stage of development was this: I knew, for example, that in species in which there was a complex system of vessels traversing the surface of the yelk sac, the substance of the latter seemed to be absorbed by those same vessels in the form of corpuscles, which, as in the case of *Tylosurus*, were unquestionably derived from the store of protoplasmic matter embraced by the yelk bag. Aided as I was by previous observations, which led me to undertake the investigation, the result proved that I was right in my anticipations regarding the manner in which the yelk of the young shad was absorbed, and that the heart, practically the vascular system here, was one of the principal agents in the process, notwithstanding the fact that no true vitelline vessels are ever developed in this species.

In order that the process may be made clear to the reader, I have represented the anterior portion of an embryo shad in the accompanying figure, in which the relation of the heart to the yelk is shown as distinctly as possible. The sketch represents the head end of the embryo with the greater part of the yelk bag within the field of view, the whole being treated as a transparent object enlarged about 35 times. In order to understand the process of yelk absorption, to be hereafter described, it will be necessary for us to know the relation of the yelk to the rest of the embryo. The great mass of the yelk in the shad embryo at the present stage of development is composed of coarse, irregular masses of very clear protoplasmic matter, *y*.

These irregular masses in turn seem to be separated from each other by a material which occupies the fine interstices between them. It, again, is a protoplasm optically different in character from that of the masses which it envelops. The relation of the clear masses to the mesh work in which they are involved is shown in the figure. At the surface of the yelk mass, and next to the homogeneous wall *yhy* of the yelk sac proper, the clear masses become smaller, and in sections, if they may be implicitly trusted, they sometimes present the appearance of minute spheres or corpuscles. The immediate superficial envelope or covering of the yelk sac *yhy* is homogeneous, both in the living embryo viewed as a transparent object, and also when examined in carefully prepared sections. This superficial layer is different, again, in optical appearance from the clear masses and their matrix, already described, so that the organization of the yelk is found to be quite complex. This layer also covers the whole yelk, which is, therefore, truly a closed



EXPLANATION OF FIGURE.—Head and fore part of yelk sac of young shad, just hatched, enlarged 35 times. *y*, clear yelk masses involved in a protoplasmic mesh-work; *yhy*, palish amber yelk hypoblast, which forms the innermost covering of the yelk; from its anterior portion blood-cells are observed to be budding off into the segmentation cavity *c*; some are also noticed in the pericardial space *p*, and in the heart; *pm*, the posterior pericardial membrane joined to the heart and fused with the external layers *ep* a little way below *pm*; *i*, intestine; *nc*, notochord; *t*, rudiment of tongue, seen through the transparent walls of the cheeks; *m*, mouth; *l*, margin of upper lip; *br*, brain; *au*, ear; *bf*, breast fin; *ms*, spinal cord.

sac or vesicle. In color this yelk covering is palish amber, quite different from the clear body of the yelk, and at the anterior portion of the sac it is usually thicker than at any other point. In fact, just behind the heart, which is inclosed in the space *p*, this superficial layer is often heaped up in the form of a conical prominence, thus becoming several times thicker at this point than at any other place. On the upper or dorsal aspect of the yelk vesicle there is a longitudinal depression or furrow, along which the superficial yelk envelope is depressed. In this depression lies the cylindrical fore-gut *i*, which, for the most part, afterwards becomes the œsophagus of the more advanced conditions of development. There is no connection of any kind between the intestine and the yelk sac at any time, such as has been described as connecting the yolk and the intestine in some embryo sharks. The general form of the yelk vesicle, as may be seen in the figure, is ovoidal, slightly flattened on its upper side, with a depression or furrow traversing the flattened portion lengthwise. It is entirely surrounded, on all sides, by a space filled with a serous fluid. At the anterior end of the yelk vesicle this space, in the stage of development here described, is most capacious, and comprises all that cavity marked by *c* between the posterior pericardial membrane *pm* and the yelk envelope *yhy*. This space *c* I have identified with the segmentation cavity, for reasons which it will not be necessary to present in detail in this place. If the heart does not actually develop within this cavity, its immediate connection with this space is an incontestable fact. Practically the heart develops within it, as we have elsewhere described. In the cod (*Gadus*) the mesoblast from which the heart is developed lies upon this space, and as development proceeds each step of the heart's evolution may be watched most satisfactorily. At most, the only separation between the pericardial space *p* and the heart is effected by the development of the posterior pericardial membrane *pm*, which is usually of extreme tenuity in the stage of development here described. In fact, I am not sure that the membrane *pm* may not be perforate, for the reason that blood corpuscles are almost always found in the pericardial space at about this stage of development. In *Tylosurus* I am quite sure that the pericardial cavity is not shut off from connection with the homologue of *c*, because in that genus it is crowded, in some stages, with blood corpuscles, which vibrate in unison with the pulsations of the heart in the fluid in which both are immersed.

In the shad, as in other species, the membrane *pm* is continuous with the splanchnopleural or peritoneal layer. As the venous end of the heart, just above *p*, pulsates, the membrane *pm* is pulled back and forth by the action of pulsation. Moreover, the membrane *pm* is continuous with and joined to the venous end of the heart, just above *p*, and in front of *c*. In fact, the heart opens freely into the cavity *c*. Free communication is thus established between the cavity of the heart itself and the segmentation cavity, or the serous space which surrounds the yelk vesicle.

We are now ready to comprehend in a measure the manner in which the material of the yelk is generally broken up into small spherules or corpuscles and sucked up out of the space *c* by the heart, and carried into the body of the embryo to be appropriated in the processes of further development. On the surface of the structureless membrane *yhy* careful observation will reveal the fact that minute spherical prominences are developed. If one will be content to observe patiently for a couple of hours, these bodies will finally be seen to free themselves from all further connection with *yhy* and to drop freely into the surrounding fluid. These corpuscles are quite colorless and present the irregular globular appearance of the white blood cells found in human blood. Owing to their continual vibration in the serous medium in which they are found, on account of the persistent pulsation of the heart, I found it was impossible to ascertain whether they manifested any amœboid movements or changes of form such as may be observed in the colorless blood cell. In the figure I have exaggerated the number visible at one time at this stage in order to show more clearly the steps of the process. In the embryo shad they are formed sparingly at first, but at a later period of development they become more plentiful. In *Tylosurus* they are, however, formed in such myriads at about this same stage that it would be quite impossible to count them, the serous fluid surrounding the heart being charged with vast numbers, which are in this instance, however, already reddish in color, which is not the case with the shad, where the red coloring matter of the blood appears to be developed at a later stage. It is a singular general truth that, in those species in which the pigmentation of the body takes place early or while the embryo is still within the egg, the blood cells become reddened much earlier than in those in which the pigmentation is delayed or retarded. In fact, it also appears to be generally true that the first lines of pigment cells are developed along the courses of the great blood vessels and in the neighborhood of specialized sensory organs.

This, however, is leading us away from the subject in hand. As the yelk vesicle or sac diminishes in bulk it tends to become pointed anteriorly. The external layer of the yelk *yhy*, which, as we saw, affords the material for new supplies of blood cells, becomes thickened anteriorly, and sometimes even appears to be extended into a conical point directed towards the venous and open end of the heart. This would indicate that the yelk was being consumed from its anterior extremity. The anterior conical end of the yelk vesicle sometimes presents a granular, or rather corpuscular, appearance after two-thirds of the whole has been absorbed. This condition is in keeping with what we observed at an earlier stage, where, as in the figure, we saw the outer layer of the yelk gradually break up into corpuscles or spherules, which were taken up by the heart, although as yet there was no evidence of a complete circulation. Together with this diminution in the volume of the yelk vesicle, the membrane *pm* is drawn back, at its outer attached border, becoming more funnel-shaped; into this infundibuliform backward prolongation of the posterior pericardial membrane the conical anterior extremity of the yelk mass extends. Gradually the bulk of the yelk diminishes still more until it remains as a fusiform mass which is no longer prominent on the ventral side of the body of the young fish. Meanwhile the liver of the young fish has been more developed and the portal vein makes its way over the dorsal aspect of the yelk towards the venous end of the heart. It appears probable that what now remains of the yelk may be taken up in part by the portal vein, but of this I am not well assured, further than to state that the portal vessels or channels appear in part to traverse what was formerly the segmentation cavity *c*.

The peculiar, homogeneous protoplasmic wall of the yelk vesicle *yhy* persists to the last, as I have learned from sections prepared from embryos in which the yelk sac was almost entirely absorbed. It would therefore appear that the central clear portion of the yelk *y* was by degrees transformed into the superficial palish amber layer which forms the covering of the vesicle or sac. Of the forces at work in effecting this transformation, we know nothing more than of the efficient cause of development itself.

Thus far we have discussed the absorption of only that part of the yelk which remained after the embryo shad had left the egg. As we know that the volume of the embryo previous to hatching is greatly in excess of the volume of the germinal disk, it is fair to infer that in addition to the mode of yelk absorption here described there must be another which will account for the growth of the embryo before its heart has developed enough to be an active agent in the process of yelk incorporation. This second method of yelk absorption has been called *intussusception*, and is the primary or initial mode. It supposes that the embryo appropriates a part of the yelk during the early stages of development by a direct process of incorporation without the aid or intervention of a blood vascular apparatus, as rudimentary even as that which we have ascribed to the embryo shad. The body of the embryo, superimposed as it is upon the yelk, is supposed to derive portions of material for further growth as these are needed from an "intermediary layer" (Van Bambeke), which probably corresponds to our palish amber yelk envelope which covers the clear yelk material in the shad. This layer, called the *couche hæmatogéne* by Vogt in his embryological history of *Coregonus palæa*, therefore appears to play an important part in the development of the blood at all stages both before and after the functional development of the heart. Under whatever name we know it, it is undoubted that in this layer a process of cell and blood-cell differentiation takes place. This statement is grounded on two sets of facts; namely, the observation of free nuclei in this layer by embryologists, and the undoubted circumstance of the origination of blood cells from its surface. Blood cells, especially white ones, are known to be nucleated, and no others are at first formed in the shad; it therefore follows that the nucleation must occur in the layer here understood. Kupffer* has alluded to a similar process, but from what I have been able to gather from his writings he does not seem to have been clear in his understanding of the layer, confounding it with the true hypoblast. This opinion I was also led to adopt in my essays on the Spanish mackerel and silver gar, but I am now in doubt whether this view can be justified. My main reason being that I have been unable to discover any evidence that the intestine of the shad originates from this yelk envelope in sections prepared from such stages

*Beobachtungen über die Entwickelung der Knochenfische. Arch. für Mik. Anat., iv, 1868.

as ought to have exhibited it. In fact, the tract from which the intestine originates is independent of this outer yelk wall from the first. The rudiment of the intestine, before the development of its internal cavity, is merely a flat band of cells somewhat thicker in the middle line than at its edges, and lies just below the tract in which the aorta and cardinal veins are afterwards excavated. Upon referring to some of my notes, bearing the date of February 27, 1882, in regard to the structure of the yelk sac of the land-locked salmon, I find the following recorded: "As to the structure of the yelk sac, in making a dissection of a lively embryo, in a neutral salt solution, the epithelial (epiblastic) layer was found to be quite free from the yelk, so that it could be stripped entirely off from the surface of the latter." It evidently was not continuous with the subjacent layer traversed by the complex blood-vessels of the yelk, but between the two there was an exceedingly thin serous space. "On the ninth day after hatching, large numbers of red blood corpuscles were still found in the pericardiac space. Later, in diseased, or rather in what were probably injured specimens, numbers of which were kindly brought me by Mr. Fred Mather for study, I found large quantities of blood-cells in the serous space between the external or epiblastic and somatopleural covering of the sac and the vascular layer. In some cases the posterior portion of the former was abnormally much distended, so that a large cavity was developed." To continue the reproduction of my notes, however, I further stated: "Beneath the outer layer and forming the inner wall of the serous space around the yelk, came the vascular hypo-blastic stratum in which the vitelline network of blood-vessels was developed. This, like the outermost layer, could be removed entire from the contained yelk. The segmentation cavity, with which I identify one of the serous spaces so resulting, may be either between the epiblast and vascular splanchnopleural layer, or between the latter and the yelk." But the homologue of the segmentation cavity is probably the latter. Inside of the vascular layer I encountered the yelk vesicle proper, comparable with the palish amber layer of the shad. In its superficial portion I find the oil spheres immersed. This stratum in fact is the "*couche hæmatogéne*" of Vogt, which is as well developed in the embryos of *Coregonus albus* of our lakes as in the European species, studied by the versatile naturalist of Geneva. Here as in many other species there is a tendency of the blood channels to present the appearance of irregular wide passages over the yelk, somewhat lacunar in nature. This feature is observed, however, only in such as have a vitelline circulation, as, for example, in embryos of *Apeltes*, *Tylosurus*, *Carassius*, *Idus*, *Fundulus*, *Esox*, *Goarces*, *Salmo*, etc., and not in *Alosa*, *Cybium*, *Parephippus*, *Pomolobus*, *Gadus*, which are without a vitelline vascular system. But these two types run into each other, for in some the intestinal or portal or else the median subintestinal system of vessels may hereafter be found to take a share in the process of blood development.

I have elsewhere* alluded to the researches of Gensch,† who investigated the development of the blood of *Zoarces* and *Esox*. He observes that the blood originates in these forms by budding from the hypoblast, and credits Kupffer with having been the first to call attention to the fact. I cannot help thinking, however, that what he means by the hypoblast is really the equivalent of the palish amber envelope of the yelk of the shad, and in no sense anything but a temporary and evanescent structure, which vanishes completely when the contained yelk material has been absorbed. It may be proper, perhaps, to designate this structure by the name of *yelk hypoblast*, but beyond the name it is doubtful whether it is proper to imply more, because I have yet to learn, after careful investigation, that it ever enters into the formation of any of the organs or membranes of the body cavity in which it is actually inclosed.

Before concluding, however, I wish to call attention to one more difference between the embryo of fishes with a vitelline circulation and those without it. In those forms in which the blood-vascular network covering the yelk is well developed the hypo-blastic vascular layer is relatively thick and distinct in cross-sections. In those in which there is no vitelline circulation the reverse is the case. When we come to examine cross-sections, the epiblast, mesoblast, and the true hypoblast are so intimately united and their combined thickness so slight that it is with great difficulty that they are resolved with the microscope. In the young shad, directly after hatching, the outer covering of the yelk is extremely thin, and measures about $\frac{1}{2000}$ of an inch in thickness. Immediately beneath it and separate from it lies the homogeneous wall of the yelk vesicle. This structure, which we have chosen to call the yelk hypoblast above, is, on the contrary, often ten times as thick as the outer and external yelk envelope which comprises, as we saw, all of the embryonic layers, but which have been reduced to the greatest tenuity.

From the foregoing recital of facts we are led to a somewhat clearer understanding of the method of yelk absorption as observed in young fishes. We cannot help admiring the simplicity and efficiency of the apparatus. Whether the space identified by me as the segmentation cavity in fishes must be considered equivalent to the pleuroperitoneal space in the embryos of birds, I am unable to state; this is, however, probable. Practically, there is very little difference between the mode of yelk absorption, as manifested in the chick and in the fish. If by a large license, as it seems to me, we admit that the yelk vesicle of the shad is really its hypoblast, the origin of the blood and the incorporation of the yelk substance are similar in birds and fishes. In the latter the nature of the hypoblast may be so obscured that I may have fallen into error in not regarding the yelk wall as hypoblastic; however, that

*Notes on the development, spinning habits and structure of the four-spined stickleback *Apeltes quadracus*. Bull. U. S. Fish Commission, 1881, pp. 24–29.

†Die Blutbildung auf dem Dottersack bei Knochenfischen. Arch. für Mik. Anat., xix, pp. 134–136.

a structure which disappears so entirely as not to leave behind any organ which may be with certainty traced to it as its source of formation, I am loath to regard as one of the primary embryónic layers. The yelk is entirely included within the abdominal cavity in fishes as soon as the blastoderm has closed over it. In this regard it widely differs from the chick, a point to be borne in mind in this discussion. The serous space around the yelk in the shad represents the body cavity. Looking again, during the present writing, at sections made from embryos shortly after the inclusion of the yelk by the blastoderm, I am convinced more forcibly than ever of the correctness of the view herein maintained. I cannot persuade myself, even while examining this early stage, that the yet thin and incipient yelk wall is continuous, or likely to have been with any of the embryonic layers, except during the very earliest stages of development and before the differentiation of the layers. The yelk hypoblast, therefore, has only a physiological and mechanical function to perform, which ends with the final and complete absorption of the yelk out of the serous abdominal cavity.

Immediately after the heart is formed, as soon as it begins to pulsate, and long before hatching, it seems to open directly into the serous cavity already described. In this condition and even much later it seems to the observer almost like an independent being within the embryo, sucking up the yelk; an appearance which, at this time, is of course illusive, as the breaking down of the yelk by the help of germination and the circulation probably does not begin until about the time the embryo is free from the egg. Previous to that time the appropriation of the yelk material probably goes on by intussusception, as already mentioned. The communication of the heart with the serous cavity surrounding the yelk, as stated before, is direct, but as soon as the Cuvierian ducts are developed, its venous end is almost entirely fed by them from the cardinal veins, the serous cavity in front of the yelk only communicating imperfectly with the heart. In four or five days the bulk of the yelk is absorbed, some remnants of it sometimes remaining for a long time afterwards, or up to the tenth day or even later. The rate of yelk absorption is profoundly influenced by temperature, which is no more than was to be expected.

The diminution in the bulk of the yelk is accompanied by a gradual collapse of the outer sac, the diminution of the capacity of one seeming to keep pace with that of the other. This is the case with the shad, and in fact with most embryo fishes. The most notable exception to this rule being the very remarkable phenomena first observed by the writer in the embryos of *Cybium* and *Parephippus*, where the collapse of the yelk mass in its vesicle, as absorption goes on, is not followed by an immediate and equivalent diminution of the capacity of the external sac. It follows from this state of affairs, in these species, that the serous cavity around the yelk becomes remarkably enlarged. The question, then, also arises, how does the extra water find its way into this serous space, unless by a purely physical process of transudation, or osmosis of water from without, which keeps pace with the collapse of the yelk, the absorbed water taking the place of the latter as it diminishes in volume?

II.—NOTICE OF AN EXTRAORDINARY HYBRID BETWEEN THE SHAD AND STRIPED BASS.

A number of young fish which had already lost their yelk sacs, in consequence of which it is to be supposed that they were already several days old, were received from Havre de Grace at the central station on the evening of June 13. They were immediately placed in an aquarium, but many of them died in a day or two after, save about fifty, which were transferred by the writer to one of the smaller of the carp ponds in charge of Dr. Rudolph Hessel, where, as Professor Baird had suggested, they might possibly find some food suited to their wants and grow large enough for us to learn something of their future history. The case is an extraordinary one, as the possibility of interbreeding members of such very distinct families as that of the Clupeoids and Percoids, unless the impregnation took place under the very eyes of the naturalist, might well be doubted, as even such a thing as the successful impregnation of the ova would naturally be doubted by those familiar with the recorded facts related of hybrids in general. The evidence in favor of the fact in this case is, however, too strong to be passed over, and until we know more of the later history of this singular hybrid, the following notes on the differences which were presented by the embryos as compared with those of the true shad must suffice. The striped bass was the male and the shad the female parent.

Teeth more numerous and more hooked on the lower jaw; at least three pairs, only two pairs in shad of same age. Lower jaw itself longer, with gape of mouth much wider; ear capsule proportionally much larger than in shad larvæ of same age, and otoliths much larger. Tail a little more fan-shaped than in shad of same age, and pigment and fine cellular radii of fins slightly more developed than in the latter. Intestine much more slender, that is, its lumen is much less spacious than in *Alosa* or *Clupea*. Liver in about the same position as in larval *Alosa*, but gall-bladder and eye relatively and perceptibly larger; Meckel's cartilage a fourth longer. General form that of the larval *Alosa*, but head more prolonged and acuminate anteriorly. The preponderance of characters appears to be towards the female parent, and appears to be an undoubted hybrid. The eggs were taken by some of the crew of the steamer Fish-hawk, at Havre de Grace, and were impregnated with the milt of the "rock" or striped bass, because no ripe shad milters happened to be at hand.

III.—CAUSE OF THE NON-DEVELOPMENT OF FUNGUS ON THE EGGS HATCHED IN THE McDONALD JAR.

The development of fungus on shad eggs, as far as we are able to judge, has always been due to the conditions under which they were placed. When any imperfection existed in the current of water flowing through the cones, the eggs which would collect on some spot on the bottom screen which had been partially choked up with sediment, caused both dead and live eggs to collect in a mass over such places. The fungus, on account of its very rapid development, when once started amongst such lots of eggs, would soon mat them together in large masses, which had to be removed with the small "skim net." The absence of any current amongst masses of ova seems to be the one favoring condition under which the egg-fungus grows most advantageously. The mycelium, once established on the membranes of a lot of eggs, soon attacks those which some movement may bring into contiguity with those already infested. The plant possesses all the features of a parasite converting the material of the egg into its own substance. Its reproductive activities are also developed very early, and its germs are produced in vast numbers, which are very minute motile bodies which escape from their receptacles on the parent plant to pollute the surrounding water. It is easy on this account to understand that any apparatus from which it is impossible to effectually remove dead eggs, and in which there is an imperfect circulation of water amongst the latter, would favor the development of fungus and the destruction of many ova. Formerly the Bell and Mather cone was disposed, if not carefully watched, to favor the development of fungus. Recently this objectionable feature seems to have been overcome to a certain extent. No "cone" yet devised is, however, as good as any one of three different forms of glass apparatus; the Chase, the Clark, or the McDonald jar offer advantages over any form of metal apparatus. These systems of glass-hatching vessels can be kept so thoroughly free from dead eggs without a skim net, and the circulation can be so perfectly regulated so as to keep every egg in continuous movement, thus preventing any fungus spores from lodging on the eggs. The continuous and gentle attrition of the ova in the glass jars effectually prevents any fungoid germs from adhering to the membranes of the ova; the pest, which is in this way prevented from obtaining a foothold, never causes any serious trouble.

Another advantage offered by the glass jars is the ease and accuracy with which the number of eggs may be estimated by graduating the jar into inches or into intervals indicating the spaces occupied by single thousands of eggs, or by measuring the height of the column of eggs in the jar with a graduated rule indicating similar quantities. This also enables the person in charge to estimate very closely the number of dead eggs which accumulate on the surface of the live ones in a layer of nearly even thickness. This is impossible in the metal cones, and the estimate of losses has hitherto been little better than guesswork. In the glass vessels the estimate is very nearly accurate and very easily made.

In hatching white perch or other adhesive eggs, if the strings with ova adhering to them were hung into the McDonald jar, into which a quantity of shad ova had also been introduced, I think it altogether probable that the attrition of the shad eggs against the perch eggs would prevent the latter from becoming infested. The shad ova in their rolling movements over the others would tend to prevent the lodgment of fungus spores, as already pointed out in my discussion of shad ova.

In the English edition of Maout and Decaisne's Botany, p. 975, I find the following account of the egg fungus or alga as it is indifferently called by different authorities. In order to disseminate a fuller knowledge of its life history I will here reproduce what these distinguished writers say of it:

"These singular vegetables are considered to be fungi by some botanists; they live, in fact, on organic matters in a state of decomposition in water, where they act upon oxide of iron by decomposing the carbonic acid, absorbing the oxygen, and thus setting free the sulphuretted hydrogen, which destroys the vegetables or animals near it. [This indicates the great importance of at once removing from the hatching vessels any masses of fish ova which have become infested.] Notwithstanding the significance of these biological phenomena, several physiologists who have carefully studied *Saprolegnieæ* do not hesitate to class them amongst Algæ. '*Saprolegnia ferax*,' says Thuret, 'is usually found on the bodies of drowned animals, which it covers with a whitish down; it even attacks live fish. Nothing is easier than to procure this singular *Alga*. Let a vase be filled with water from a garden tub, and some flies be thrown into it, and it will usually be developed in a few days. The body of the fly becomes covered with hyaline filaments, which radiate around it, enveloping it with a whitish zone. Under a miscroscope, these filaments are seen to be continuous, simple, or scarcely branched, and to contain minute granules, which show a motion resembling that which is seen in the hairs of Phænogams. These granules are very numerous, especially towards the upper extremity of the tube, to which they give a gray, somewhat russet tint. This portion soon becomes isolated from the rest of the filament by the formation of a diaphragm. Then the contained matter coagulates in small masses, which become more and more sharply defined, and end by forming so many zoöspores. These phenomena succeed each other very rapidly; often in less than an hour the granular matter becomes condensed at the top of the filament, the septum forms, and the zoöspores appear. Finally the tube, which has a small protuberance at its extremity, bursts there, and the zoöspores escape, the first with impetuosity, the others more slowly; they are turbinate in shape, and furnished with two hairs. This is not the only mode of reproduction possessed by *Saprolegnia*; another phenomenon succeeds. The filaments emit small lateral branches, the extremities of which swell into sacs of a blackish hue, due to the condensation of their granular contents. Soon a septum forms, isolating the sacs from the little tubes which serve as pedicels to them. After some time the granular matter divides into several masses, which at first adhere to the walls of the sac, but which later become free and spherical. Sometimes there is only one of these masses; sometimes the same sac contains fifteen or twenty. I have fancied that I could recognize on their periphery little *mamillæ* resembling regularly arranged opercula.' The sacs have been termed by Pringsheim *oosporangia*. The oosporangia require fertilization to enable them to produce fertile spores. It is obvious, therefore, that *Saprolagnieæ* have a double mode of reproduction, similar to that of *Vaucheria*; the one asexual by means of zoöspores; the other sexual, producing *oogonia* arising from the fertilization of a sporangium (*oosporangium*)."

The tubes alluded to in the first portion of this quotation, when developed on the surface of a dead shad-egg, stand out in all directions like a vast number of rays; to make a vivid comparison, the infested egg looks very like a seed-head of the common dandelion, with all of its slight, tufted seeds still adherent to the receptacle. The zoöspores alluded to as possessing two hairs or filaments have these latter endowed with a power of movement; these filaments in turn propel the body of the spore about, so that in this way the noxious germs of the plants are widely distributed through the water.

IV.—EXPERIMENTS WITH CARBOLIC ACID TO KILL THE FUNGUS ON LARGE FISHES.

Several hybrid gold-fish in the aquaria in the central station became badly infested with fungus, probably because too large a quantity of dead shad-eggs was thrown into the water to serve for their food, which, instead of being immediately consumed, remained lying on the bottom of the tank until the fruiting condition of the egg fungus was developed on them. These spores from the egg fungus then lodged upon the skin of the fishes and commenced to grow, showing the mode in which the fungoid infection might be conveyed from the eggs to the adult fish.

Knowing the fungicidal properties of carbolic acid, it occurred to me to try a very weak solution in water to see if it would kill the fungus on the fish. A badly infested fish was placed in a glass aquarium holding nearly four gallons of water; in the first trial ten drops of a concentrated No. 4 solution of carbolic acid was dropped into the water, with little more effect than to make the fish exceedingly restless. The next trial was made by doubling the quantity of acid used, which in the course of ten minutes showed that the fish was suffering and would probably die if fresh water was not immediately turned into the aquarium to replace that in which the acid had been dissolved. In a day or so afterwards the fish experimented upon died from the inroads of the fungus, showing apparently that the acid was not the cause of its death.

Mr. Livingston Stone has recommended the use of a strong solution of common salt to kill fungus, which he has found quite effectual. Mr. Behler, of the Druid Hill hatching house, says a saturated solution of salt water is effectual; and he also states that if young salmon infested with the fungus are dipped bodily into asphalt, the fungus will be killed and the young fish come out all right and healthy, the asphalt gradually peeling off of their bodies. This last statement seems almost incredible, but it has been stated to me in good faith by the experimenter himself.

V.—DISTURBANCE OF THE BALANCE OF CONDITIONS, AND ITS INFLUENCE ON THE CRUSTACEAN FOOD OF THE SHAD.

In conducting the experiment of feeding the young shad, vast numbers of minute Daphnidæ were caught, which were put in the glass aquaria with the young fish; sometimes the number of these minute crustaceans captured at one time was so great that when closely packed they would almost equal a solid quart in bulk. Great mortality was noticed among them soon after being placed in the aquarium with the fish, which would indicate that they had been subjected to a fatal change of surroundings. Various reasons might be assigned as probable causes of this mortality. It may be that the rapid circulation of water in the aquarium was one of them, or it may be supposed that when taken from the stagnant water of the carp ponds and transferred to water of a considerably lower temperature in the hatching house the change was too great. A still more probable cause may be the fact that the crustaceans, when removed from amongst the water plants in the pond, were deprived of their natural food, and as a result starved to death.

Whatever may have been the cause of this phenomenon, however, we may be assured of this fact, that in supplying live food to shad larvæ we must also be careful to attend to the vital conditions required by the former. If it is desired to keep this living food in a healthy state, so as to multiply in the aquaria, it is probable that water plants must be supplied for the purpose of furnishing the requisite conditions for the protection and multiplication of the food of the living shad-food. Until recently we have not been able to supply quite the proper conditions for the nutrition of the young shad, and in feeding the latter it becomes evident that we must take care to feed the food, which may be done by providing the conditions for the propagation of protozoa, algæ, &c., in the aquaria or shad nurseries.

VI.—A MEANS OF DEMONSTRATING CARTILAGE IN FISH EMBRYOS.

Knowing the potency of potassic hydrate in dissolving protoplasm, it occurred to me to try its efficiency as a means of getting rid of the tissues and membranes which envelop the trabeculæ cranii, hyoid, and branchial cartilages of the shad. A 5 per cent. solution it was found would rapidly dissolve the dermal, neural, and muscular tissues, leaving only the rudimentary, aponeurotic membranes and matrices of fasciæ between the muscular segments and the notochordal sheath. The head cartilages remained undestroyed and could afterwards be stained. The method is useful, however, only where fresh material is at hand, as it is almost impossible to mount a specimen satisfactorily for permanent preparation. In staining, it is desirable to wash out the alkali as much as possible, and afterwards to investigate the arrangement of the cartilages of the skeleton under gentle pressure under a Fol's compressor.

VII.—METHODS OF HANDLING WHITE PERCH OVA.

The egg of the white perch is notoriously adhesive, and for this reason is one of the most troublesome to deal with practically. The eggs were taken upon cotton yarn, which was drawn up through a funnel, into which the eggs and milt had been squeezed from the spawning fish. The cord, covered with the adhering eggs, was then wrapped upon a wooden reel and sent under cover of damp cloths to the central station, where they arrived in fine condition, almost every egg being impregnated. This system, devised and carried out under the superintendence of Colonel McDonald, was really another adaptation of the dry method of carrying the ova of the shad.

After reaching the central station, the cotton cord, with the adhering eggs, was cut into lengths of 10 to 12 inches and suspended in the glass hatching jars. The development progressed normally as long as not interfered with by the growth of saprolegnious fungus. There being no attrition between eggs, as amongst shad ova, when incubated in the jar, fungus soon established itself, and grew until the whole brood was practically destroyed. Another mode was to introduce the wooden reel, with the eggs adhering to the cord, into a wide aquarium. These also were attacked by fungus, but slightly more favorable results were obtained. With the water at 58° F. to 60° F., the ova hatched out in six days. The water in the jars, for some of the time, stood at 51° to 55° F., and rose but little above this point.

The use of narrow strips of glass or mica might, it seems to the writer, be used to advantage, or even glass plates would be convenient, upon which the eggs might be allowed to adhere. It was discovered this spring by the writer that where the eggs were allowed to stick to the string in several layers, the uppermost strata seemed to smother or prevent the respiration of the lowermost layers, which were killed in consequence. This is opposed to the experience of Mr. Clark with the Atlantic herring, and also to that of Capt. Z. L. Tanner with the Branch herring. Both of these experimenters found that great masses of the eggs would hatch with scarcely any loss, although it was scarcely possible to understand how it was possible that there should be any circulation of fresh water through such large clumps of adherent ova.

The nature and origin of the material by which adherent ova are made to stick fast to foreign bodies and to each other is an interesting inquiry. It appears to be a mucous substance, derived, possibly, as a peculiar secretion either from the ovarian follicles or some special glandular structures within the ovary. Its remarkable property of hardening under water I find to be characteristic of the material in all the species with adhesive ova which I have yet had the opportunity of examining.

VIII.—NOTES ON SMALL FISHES AND WATER ANIMALS WHICH PREY ON FISH LARVÆ.

Recently (June 1882) some four-spined sticklebacks (*Apeltes quadracus*) in spawning condition were received at the Central or Armory hatching station of the United States Fish Commission from Mr. W. P. Seal, of Philadelphia, who, in his letter announcing their shipment, informed me that they would not accept dead food, but must be supplied with small living insect or crustacean prey, which they would themselves capture. The specimens were mostly males, and would measure an inch and three-eighths in length; some were smaller. Mr. Seal's opinion as to their feeding habits was soon verified, as it was found that dead food had not the slightest attraction for them, but as soon as live food was offered them they exhibited a vivacity and alertness in its capture which was truly surprising. I obtained a supply of this from the government carp ponds by skimming the surface of the water amongst a rank growth of aquatic plants with a fine net, where it was found that *Daphiniidæ*, neuropterous, and coleopterous larvæ abounded, as well as numerous brown aphides, which had blown on to the surface of the water from the taller plants fringing the pond. These creatures were transferred to the aquarium containing the sticklebacks, when the work of destruction was at once commenced. The lively little ichthian marauders would poise themselves in the water, roll their eyes, and when one of their victims was within sure range they would pounce upon it, rarely missing their mark, in spite of the fact that the latter, as in the case of the Daphnids, might happen to be quite minute. Hard-shelled coleoptera and bugs were not accepted, nor did the larger neuroptera seem to attract their serious attention. The smaller, softer-bodied animals seemed to be most palatable. Upon observing this, it occurred to me to try them upon shad larvæ. About twenty-five of these, three days old, were then put into the jar; no sooner than they had made themselves conspicuous by their active wriggling movements through the water, the keen eyes of the sticklebacks perceived them; their destruction was completed in about half an hour by the half-dozen individuals of *Apeltes*. The experiment was repeated with a similar result, showing the destructive capacities of *Apeltes* when brought to bear upon helpless shad larvæ. Gunther has noticed the voracity of Gasterosteus in his "Study of Fishes."

It has been maintained by some writers that fish larvæ, which in the case of many species are very transparent, are protected by this transparency, which renders them to a great extent invisible in water. The transparency of the larval shad is notorious, and with the exception of the glittering iris and two dark lines of pigment cells above and below the intestine, would be almost invisible in the water; yet it is evident from our experience that this transparency affords little or no prtection from so sharp-sighted an enemy as the stickleback. And if it could be shown that one stickleback under natural conditions could devour a dozen shad larvæ in an hour in the weedy flats of rivers, where the naturally spawned young of *Alosa* may be supposed to abound, the destruction of such larvæ during a season must be enormous in respect of numbers. The foregoing observations tend to show, it would appear to the writer, that the transparency of larval fishes is practically of no avail in the presence of the predaceous species of their own class. If shad larvæ are visible to sticklebacks, there is no valid reason why they should not be equally so to young predaceous fishes of a dozen other species, and if, as we may suppose with good reason, not unsupported by observation, that young fishes will be attracted to weedy flats on account of the insect prey which there abounds, we may be almost equally certain that any very young fish larvæ, although still transparent, will not escape the vigilant eyes of their finny enemies, and consequent destruction.

The larvæ of many neuropterous insects which undergo their transformations in water, as well as those of certain coleoptera, such as *Dytiscus*, are noted for their predaceous habits. I have seen the larvæ of the dragon-fly capture and devour a young salamander almost or quite as large as itself. These gourmands of both the neuropterous and coleopterous order are probably not exceiled in rapacity by any small fishes, though their rapidity of movement is probably not as great as that of the latter. Now as to the facts of the case, I find upon trial that both neuropterous and coleopterous larvæ are capable of destroying young shad, but to what extent I am not assured, as a sufficient number of observations are wanting.

The main point at which we have been aiming is, however, clear. Transparency is no safeguard from either active vertebrate or invertebrate enemies, and now the question arises as to the point already urged in a former paper by the writer, as to the expediency of setting shad larvæ free in weedy shallows in rivers where it is found that their natural food abounds, together with their enemies. The only answer that seems possible under the conditions as we now know them is the following: That it is best to put the larvæ where they will soonest find food, although they be at the same time brought into the presence of the greatest number of enemies. The chances of survival seem to me to be greater where the food is most abundant, for the following reason: Notwithstanding the fact that many enemies may be present, the chances to obtain food in such places are so much more favorable, so that the growth and vigor of the larvæ will be soonest enhanced, thus enabling them to grow faster, become more vigorous, and the more readily able to escape their enemies.

IX.—OBSERVATIONS ON THE FOOD OF THE YOUNG JAPANESE GOLD-FISHES.

Professor Baird, noticing that the young fish in the carp ponds appeared to be feeding very actively upon something, requested me to investigate the contents of their stomachs and intestines. On the 6th of June I opened a specimen 30 millimeters long, in the intestine of which I found the following:

Dirt and particles of quartz-sand:

Branchiopoda.
Lynceus.
Daphnia.
Ostracoda.
Cypris.
Rhizopods.
Arcella.
Cyphoderia.
Rotifers, tests of.
Statoplasts of polyzoa.
Desmids, several species.
Copepoda; *Cyclops*, *Canthocamptus.*

Woody and vascular vegetable tissue, with spiral bands in the cellular walls.

Cellulose membranes of the cells of the leaves of *Anacharis* and *Lemna*, &c., some still containing chlorophyl, rendering the color of the intestinal contents green.

Pine pollen.
Filaments of *Spirogyra.*
Palmellaceous algæ.
Diatoms.

In the stomach of the same specimen I found the following:

Green spores of algæ; some in the zoögloear condition.
Spirogyra.
Chitinous remains of dipterous larvæ.
Cyclops, *Daphniæ*, &c.
Rotifers.
Also a minute six-legged mite-like creature.
Stellate hairs from the leaves of some tree in the vicinity.

In another specimen, besides the foregoing, I found the following:

Siliceous spicules of a fresh-water sponge.
Oscillatoriæ.
Ova of Daphnids.
Hair.

In still another specimen I found both the dermal and flesh spicules of a fresh-water sponge and the remains of a portion of a tracheal tube of an insect.

A more exhaustive examination of the fish, which I did not care to sacrifice to any great extent, would have shown that in feeding they had probably laid the entire fauna and flora of the pond under contribution; at any rate, the foregoing list shows that there was no want of variety in the make-up of the bill of fare consumed by these young Cyprinoids.

X.—EXPERIMENTS IN SUPPLYING THE PROPER FOOD FOR LARVAL SHAD.

It was suggested to me by Professor Baird in 1880 to try to discover the kind of food upon which the young shad normally feeds, and if possible to collect or breed the food in quantities large enough to afford a supply of nutriment for the larvæ. My investigations upon the intestinal contents of the adults during that season taught me approximately what I might expect to find to be the food of the young. Investigations which I conducted in the latter part of the season of 1880, upon the young which had been kept for fourteen days at the navy-yard at Washington by Mr. F. N. Clark, showed that my surmises had been correct. As already discussed in my paper, published in this Bulletin, entitled "On the Protozoa and Protophytes as the Primitive Source of the Food of Fishes," the young shad, under favorable conditions, soon prey upon other minute organisms. The mouth is not open widely enough immediately after hatching to take food, nor can the mouth be opened and closed at this time, but by the time the yelk sac is fairly absorbed, or in four to five days after hatching, the young fish will already take food, as observed by us this season in the aquaria at the central station. At first the mouth is on the under side of the head, and it is only after the jaws and gill-arches have grown longer that the mouth is widely enough open to seize food with the four conical, hooked teeth with which the lower jaw is armed; this condition of development is attained when the yelk sac has been mostly absorbed.

It was a problem with me for some time as to how the food of the young shad, which consists mostly of Copepoda, Ostracoda, &c., was to be got in sufficient quantity to make artificial feeding a success. Knowing the favorable conditions which existed in the carp ponds in Washington for the multiplication of these crustaceans, I took a fine net to the ponds and found a locality where I could skim them out from water, amongst dense growths of *Anacharis*, by the many thousands. The skimming was continued until a large number of Copepoda and Daphniidæ were obtained, which were turned out amongst the young fish into the *collectors* used by Colonel McDonald in connection with his hatching-jar. The young shad in the collector aquarium, having vast numbers of their favorite food all about them, which could not escape on account of a fine screen which was placed over the outlet from the collector, soon began to feed. In a half hour afterwards, I should think fully ten per cent. of the young fish which had already lost their sacs had begun to feed. The evidence of this was the presence of their crustacean food in the intestine, in which it could be readily seen with the naked eye through the transparent walls of the abdomen. It would tend to accumulate just behind the origin of the liver and air-bladder, which marks the origin of the larval stomach.

These experiments were instituted on the 11th day of June, and daily supplies of Copepoda were afterwards sent to the Arm ory by Dr. Hessel from the carp ponds, where the latter gentleman also found other localities where these crustaceans were still more abundant than those originally visited by me. The mortality amongst the young fish, even in the presence of their natural food, was very great—not less than 75 per cent.; but it was shown that it would be practicable to furnish the required food, and as I hear since I left Washington, from Colonel McDonald, the young fish continue to feed, growing rapidly and giving every promise of surviving until an advanced condition of growth is reached. Some of these young shad, according to my last advices from the central station, must now, July 6, be nearly a month old.

Since the above was written some time has elapsed, and the survivors of the lot of young shad which gave such promise of continuing to grow have either been captured for preservation in alcohol or have escaped from the aquarium in which they were confined. The last surviving specimen of the lot lived to be forty-two days old, when it accidentally escaped into the sewer-pipe before it was possible to recover it. Those in charge at the time inform me that this individual was about one and a quarter inches in length at the time of its escape. This would be about the length it would have reached at the age mentioned above, judging from some specimens which were submitted to me for examination from North Carolina; these having had the good fortune to survive to the age of three weeks, when they measured 22 millimeters long, or about seven-eighths of an inch. The Armory specimens, I am told by Mr. J. E. Brown, fed quite ravenously upon the living Copepoda, which were supplied to them to the last.

XI.—MECHANICAL CONDITIONS AFFECTING THE DEVELOPMENT OF FISH OVA.

There is a class of facts met with in embryological observations which have a significance which, I think, have not received the attention they deserve. They relate more especially to what may be termed the *mechanism or construction of ova*, and to the peculiarities of development which grow out of conditions of construction as necessary results thereof.

Holoblastic ova, for instance, are very differently conditioned from the mesoblastic. Practically, we can scarcely say of the former type that it ever develops a blastoderm, but rather that the whole of it at once becomes blastodermic in morphological character. Nor do holoblastic ova even behave similarly to each other. Even in the progress of development the *gastrula* stage is sometimes so modified or interfered with by the mechanical accidents of the construction of the ovum as to be almost wholly obscured or suppressed. Such occurs in a few cases like *Eucope* and *Stephanomia*, where a gastric cavity is formed without gastrulation before the oral opening is broken through, so that the fact of gastrulation is not universally a preliminary to the formation of the archenteric cavity; formerly, in its positive form, an embryological doctrine which observed facts have shown to be untenable when universally applied. Again, it is certain that the blastopore which results from the closure of the outermost layers of the ovum over the innermost ones, or over the yelk, does not always correspond either to stomodeum or proctodeum, or to mouth or vent, but that it is sometimes an evanescent structure of little or no morphological significance. This is the case with what is probably the true blastopore of the Teleostean ovum.

The mechanical relation of germ disk or blastoderm to the yelk in the Teleostean ovum is a peculiar one and has not hitherto received the attention which its importance has deserved. The peculiar mode of development which has grown out of this relation is in the highest degree interesting as compared with other forms. After the disk has been formed by the amœboid aggregation of the germinal protoplasm, a series of phenomena present themselves during segmentation which will well repay attention. As soon as the segmentation is fairly under way, so that the rudiment of the embryo's axis begins to be apparent at the edge of the blastoderm, it is found that a shallow, crescent-shaped cavity has appeared underneath the central portion of the disk not immediately embraced by the embryo. This space extends beneath the blastoderm and grows laterally with the growth of the disk. It is, in fact, a space filled with a film of fluid over which the disk may spread without friction on the underlying yelk. It remains until the blastoderm finally closes over the yelk entirely, when it may still be seen as a space, in some species separating the membranes of the embryo all round from the true yelk sac within. This arrangement, of course, causes the development to present some peculiar features, since the development of the embryo is perfectly sessile on the yelk. Later on, the heart communicates directly with this cavity, as in *Alosa* and *Pomolobus*, and yelk corpuscles are budded off directly into it and sucked up by the heart, to be carried directly into the vascular system. Nor is this the only feature of novelty; at the tail, the rim of the blastoderm closes and forms what I have denominated the *caudal plate*, which afterwards enters into the development of the tail. The whole of the blastodermic rim (*ringwulst*) is thus absorbed, and no similarity remains to make the Teleostean embryo comparable in this respect with the Elasmobranch, in which the rim of the blastoderm is not incorporated in this manner. In the region of the caudal plate a solid neural cord or rod is continuous with the notochord and rudiment of the hind-gut below, so that the gastrula is practically but obscurely realized by means of a strand of cells which connects the neurula and hind-gut. From Balfour's account I infer that the development of *Lepidosteus* is essentially similar. The hind-gut develops from behind forwards, and almost immediately after the tail commences to bud out the vent appears beneath the latter. The gut has absolutely no connection in any part with the yelk-sac, and the liver appears as an enteric thickening at first, and afterwards as a ventral diverticulum of the intestine, lying upon the upper and hinder aspect of the yelk. The air-bladder is a dorsal outgrowth of the intestine, which originates a little way behind the origin of the liver, from what may be termed the anterior duodenal region. The heart develops as a simple tube in the pericardiac region, and almost from the first communicates with the segmentation cavity. The body up to the time of the closure of the blastoderm grows from behind forwards from the edge of the latter, adding somite to somite behind with the progress of development. In some cases the rim of the blastoderm commences to segment into muscular somites even before the closure of the blastoderm.

Comparing this form of development with that of the Amphibian and Marsipobranch, we find that we are forced to look upon the blastoderm of the Teleost, exclusive to the yelk, as their complete morphological equivalent, and that the Marsipobranch justifies the comparison in the peculiar way in which the body of the latter grows from behind forwards out of the caudal mass, just as the embryo Teleost grows from behind forwards from the edge of the blastoderm; so that, although in other respects there are some essential differences, such as in the relation and homologies of the neurula, hind-gut, and the blastopore, otherwise there is an evident similarity, which may give us a key to the comprehension of why it is that the embryo Teleost develops at and from the edge of the blastoderm.

It was not my intention, however, to enter into an embryological discussion in this place so much as to show that the development of the teleost was peculiarly conditioned mechanically in consequence of the peculiar organization of the egg, and that that had much to do in determining its mode of development. The real cause of some of its singularities appears to be the presence of the relatively enormous yelk which must be included by the blastoderm in order to be absorbed. The process of yelk-absorption itself in the teleost offers some strong contrasts with that described by writers on the absorption of the yelk of birds and Elasmobranchs, as we shall see in another place.

A few words more on the mechanical conditions presented by the ova of several genera of fishes, and I have done with this part of the subject. I am familiar with the ova of four genera of salmonoids; *Salmo*, *Salvelinus*, *Coregonus*, and *Osmerus;* all are characterized by an abundance of oil drops embedded in the vitellus, but most abundantly just immediately under the germinal disk, where indeed most of the oil seems aggregated in the species studied by me. This oil behaves like oils in general, even in the live eggs, *i. e.*, its specific gravity is less than water, in consequence of which the aggregation of oil drops underneath the disk tend to keep the latter directed constantly upward. If the egg is turned, the buoyancy of the oil drops at once turns the vitellus within the egg membrane, and brings it to rights with the germinal disk looking upwards. This contrivance, if one may so call it, for righting the egg is perfectly automatic. Later, when the embryos are hatched, the presence of the oil drops in the upper part of the yelk-sack helps to keep them in the natural position.

Another totally different type of eggs is that of the cusk, crab-eater, Spanish mackerel, and moon-fish. In all of these forms the egg is buoyant in consequence of the presence of a single large oil sphere. This oil sphere is always situated at a point in the egg almost exactly opposite the germinal disk. In consequence of this arrangement the germinal disk is constantly inverted; that is, it is carried on the lowermost face of the vitellus, the whole of the latter lying above it. It will be seen that in this case the buoyant oil drop of the egg acts in a manner just the reverse of what we noted in the eggs of the salmonoids. Even after the young have escaped from the egg membrane they are at first unable to right themselves, but swim for a time upside down. This is due to the presence of the oil drop in the yelk-sack to the ventral wall of which it is permanently fixed.

The egg of the cod, strange to say, is wholly without the oil drop, but the specific gravity of the vitellus is so slight that it behaves precisely like the foregoing, and has the germinal disk constantly directed downwards, floating in this position.

The egg of *Morone americana*, or white perch, is another special case. Here the egg is adhesive and fixed, and embedded in the vitellus there is a very large oil sphere. In consequence of the fixed character of the egg membrane, the oil-drop controls the position of the vitellus and keeps the disk inverted and on the lower side of the vitelline globe, while the free, uncovered portion of the latter is always directed upwards, at least during the early stages.

The egg of the shad is another special case, and here there is an unusually large water space all around the vitellus between the latter and the egg membrane, but the egg is non-adhesive, and its specific gravity is greater than that of the water in which it is immersed. The peculiarity about the behavior of the egg is the constant disposition of the germinal disk to arrange itself at the side of the vitellus when viewed from above, though there is no oil whatever present in the vitellus to influence the position of the vitellus or germ.

Again, the egg of the plectognath, *Aleuteres*, is green, with a cluster of oil droplets embedded in its yelk or deutoplasm at one side. Its germinal matter or protoplasm is relatively large in amount.

In *Fundulus* and *Syngnathus* the oil drops appear uniformly distributed and embedded in the superficial portions of the yelk next to its external surface. This brings the deposits of oily matter in close proximity to the vessels traversing the vitellus. The function of these oils, aside from their buoyant tendencies, as in these last cases, is not clear, and, beyond the fact that they are evidently absorbed together with the remainder of the yelk, we know little of their nutritive properties. Perhaps, in the process of physiological decomposition, these oils of fish embryos develop heat. If we are to judge by what may be observed in the absorption of the single oil drop of the Spanish mackerel, for example, it is one of the last portions of the vitellus to be absorbed. In fact, it dwindles progressively, the drop continually growing smaller, while it retains its globular form as it disappears.

The remarkable differences here noted in regard to the organization and behavior of fish eggs are noteworthy, too, as showing that the statement so often and unwarrantably made, even by very distinguished biologists, to the effect that ova in general have the same physical constitution, differ in no respect from each other, &c., has no foundation in fact. Indeed, the more intimately we know the various forms of ova of the various animal species, the more evident does it become that some time, when our knowledge is more complete, we shall perhaps be able to distinguish the species apart by the eggs alone, just as botanists have used the characters presented by seeds to distinguish plants. It is also evident that such striking diversities of organization must, to a certain extent, be reflected in the mode of development of the various species; that independently of the action of the principle of *acceleration and retardation*, pointed out by Professor Cope (the effects of the working of which are frequently very evident), the morphological character of the egg reacts upon the manner of development, as proved by the one fact that with the variation in the bulk of the yelk there is a corresponding variation in the length of the arc embraced by the body of the embyro as it lies on the sac before the tail begins to bud out. When once the body is segmented, and the *primary somites* are distinguishable, as we may call those proper to the body, which are formed before the caudal somites, the amount of matter used up in carrying the development to this stage in different species will of course vary; the yelk itself also varies in dimensions; hence, as a natural result, the arc on the great longitudinal circumference of the latter, embraced by the embyro, must in like manner vary, so as to comprise one-third, one-half, or three-fourths of that circumference, as may be noted in different forms. These are not the only consequences of structure, as we learn upon making a still wider survey of the various forms of fish ova, some of which have been alluded to elsewhere, though we may here note the fact that the number of primary somites varies in the embryos of different genera. So great is this difference at the same relative stage in different species, that we find as many as seventy-five pairs of somites developed in *Tylosurus* and only eighteen to twenty in *Alosa*. (The terms somites as here used is that now generally applied to designate what was formerly implied by *proto-vertebræ;* these embryonic segments represent the rudiments of the paired muscular plates on the opposite sides of the body of the adult.) The remarkable variation in the number of segments developed in embryos of different genera, as pointed out a little way back, is also partly explained by the difference in the number of muscular segments in the parent fishes of the different species. This brings us to the recognition of the influence of that remarkable organic force, *heredity.*

XII.—SPECIFIC CHARACTER OF PROTOPLASM.

Beginning with that very remarkable substance designated by the name of *protoplasm* by Von Mohl, *sarcode* by some writers, and *the physical basis of life* by Huxley, from a nearly homogeneous state in some protozoan types or in the yelks of some eggs, we pass in ascending steps from one type to another until we find that out of it various tissues serving diverse uses have been differentiated. In the most undifferentiated forms, in this remarkable *substance* there inheres a power to feel and to distinguish objects which are fit for food from those which are not fit. The near presence of food appears to determine the lines along which the conscious living matter will travel, although anything like visible sense organs are entirely wanting.* The rude and primitive apparatus of movement before us in the amœba foreshadows what is possible with co-ordinated combinations of such elements in more differentiated organisms. In the latter, similar minute lumps of the living matter, the cellular elements, no longer retain in all parts of the organism, of which they are at once the servants and members, the power of feeling and moving, of being at one and the same time nerve and muscle. Only in some degree do all the histological elements of organisms retain this independent characteristic; it is probably this hereditary legacy from the protozoan grade which constitutes what is known to physiologists as the *vis medicatrix naturæ*, *nisus formativus*, or inherent remedial power. From the cœlenterata, some of which may be cut in two and yet mutually reproduce the severed parts, up to the warm-blooded mammalia where the powers of reparation are reduced to a minimum, such as the healing of wounds and the knitting together of broken bones, and where a highly complicated and very fixed and special structure has put an end to the possibility of any power to multiply parts by budding except in early embryonic states, but which rarely reach perfection of development except in the case of minor and unimportant parts. This part of the subject has been more ably and more fully discussed in Darwin's Variation of Animals and Plants under Domestication, and is only introduced here to illustrate the varying germinating and reparative power of protoplasm in the various grades of the animal kingdom.

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* See some remarkable cases described in Leidy's *Rhizopods of North America.*

The physical character of the organic matter is extremely variable. Protoplasm may be colorless, black, yellow, orange, red, brown, green, violet, blue, purple, amethystine, pinkish, or amber-colored, with tints and tones as various as the species examined. Many of these colors are no doubt due to peculiar coloring matters, but it is evident that in many instances such is not the case, but that it is a part of the substance of the body in itself. Such differences become very apparent to the student of embryology, who sees usually either the pure protoplasm of the holoblastic ovum or the protoplasm together with added yelk or dentoplasm. Such marked differences of color as are often observed indicates an undoubted difference of constitution as indicated by the specific gravity of the eggs of various species of fishes. The reddish ovoidal blood-cells of *Arca pexata*, first observed by me, are presumably colored by some ferrous compound, such as tinges the mammalian blood-disk. In some species of fishes (*Alosa*), when death takes place, the egg becomes lighter in water; in *Tylosurus* the death of the egg in sea-water makes no apparent difference in its specific gravity, still falling to the bottom the same as the healthy egg. Then the healthy cod egg floats in sea-water, while the egg of *Tylosurus* sinks, though both are without oil spheres. On the other hand the eggs of *Elecate*, *Parephippus*, and *Cybium* float in sea-water, and have a single large oil drop embedded in the yelk opposite the germinal disk. The egg of the shad, without oil drops, sinks in fresh water, while the eggs of the salmon family, inclosing many large and small oil droplets, also sink in fresh water, while the oil which they contain floats in the same medium. Besides their differences, those of color are equally well marked in the protoplasm of the germ, the latter being much darker in some than in other species. The distinctly corpuscular character of the yelk in some, the ovoidal form of these corpuscles in others, as in *Amia*, for example, compared with its almost perfect homogeneity in *Cybium* and *Elecate*, seems to me to indicate a want of identity which cannot be covered by the one same term. As tacitly implied by the conditions of the hypothesis of pangenesis of Darwin, and that of the perigenesis of the plastidule as proposed by Haeckel, we ought, I believe, to regard the protoplasm of distinct species as specifically distinct from other protoplasm, as the species from which it was derived is from all others, but itself in turn capable of modification under changed conditions of relation to the environment.

Jevons (Principles of Science, p. 764) has the following: "Protoplasm may be chemically the same substance, and the germ-cell of a man and of a fish may be apparently the same as far as the microscope can decide, but if certain cells produce men, and others as uniformly produce a species of fish, there must be a hidden constitution determining the extremely different results. If this were not so, the generation of every living creature from the uniform germ would have to be regarded as a distinct act of creation." Now it is just this "uniform germ" doctrine which I wish to point out the fallacy of from another point of view.

We are informed by very high authorities that man, for instance, is developed from an ovule about the 125th of an inch in diameter, which differs in no respect from the ovules of other animals. Even within the limits of the mammalia, the phrase "differs in no respect from the ovules of other animals" is obviously inaccurate if a careful and just comparison of the figures of the ova of various genera and their dimensions, &c., as given by specialists, are compared together. That hackneyed comparison of the gill arches of the various groups of vertebrates, indicating as it does, and as every one will be ready to admit, an important morphological law, namely, community of descent, we cannot help but be incredulous when it is asserted, as it often is, that at a certain stage it is nearly or altogether impossible to distinguish an embryo human being from a fish or dog of the same relative stage of development. If some of the most enthusiastic defenders of this type of evolution run mad had stuck conscientiously to the word "nearly" in order to qualify their assertion of the appearance of identity which they have mostly discovered upon comparing the embryological figures of careful laboratory investigators, we should not feel called upon to write the present paragraph. Of such an identity, perfect in detail, I defy any honest investigator to produce proof. It would, on the other hand, be an easy matter for specialists to produce abundant evidence that even within the limits of small and restricted groups specific differences already make their appearance with the first steps of segmentation, leaving out of account all other purely morphological differences, which, conscience knows, are sufficient in themselves to break up the foundations of the doctrine of identity so glibly retailed by these careless writers. It has been noted that the segmentation of their germs will serve to mark the genera and species. I will go a step further and assert that there are numerous features, properly *characters*, which will serve the same purpose at various stages, and that at no stage can it be said that there is a positive identity even in closely allied genera or strongly marked species. Embryological differences have not been well enough studied in slightly marked varieties or species, to say much of these. But genera ought, in all conscience, to be close enough together to refute the validity of the "uniform germ theory." Here we find in every case great numbers of characters which may be stated in words, and many of these even become the most positive differentiæ when a certain embryo is compared with the embryos of something else. Vast numbers of details must be considered as affecting this too readily assumed identity, not the least of which is form; perhaps this latter is really the most important. So long, then, as the *somewhat similar* germs of different animals produce *different* species, we shall or ought to hold to the doctrine that the protoplasm of which a man is made is different from that of which the body of a dog or a fish is composed.

I do not wish to be understood as denying the possibility of variation in the nature of the protoplasm of different germs which have been derived from the same parent. I might cite facts to show that a single laying of eggs may produce individuals which differ from each other in many minor details; this variability is very marked in the plumage of broods of domestic birds, and I am informed by Mr. T. R. Peale that he has met with remarkable instances amongst butterflies, broods of which he had reared artificially from the eggs of a single parent. These well-known facts indicate that still another principle should not be lost sight of; namely, that the hidden constitutions of different germs of the same parent are variable; that the living matter of the germ-producing organs themselves is not similar in its developmental tendencies. It follows from this, that when I say that in the protoplasm of the shad there inhere specific properties which are transferred to and embodied in its germs, I do not mean to say that the living matter of all parts of the body is alike, but that the protoplasm of its parts when compared with the same parts of other species must be unlike the latter. To put the same idea in other phraseology, I would say that not only is the protoplasm of the species specific, but also that, if we consider the facts of variation, the different as well as the same parts of the body of one and the same species must be variable in their hidden and transmissible constitutions. In following out such a train of thought, it is almost impossible not to trench upon Darwin's Hypothesis of Pangenesis, as we have done above; but it is to be borne in mind, if one is faithful to the showings of right reason, that it is scarcely possible to escape such a coincidence.

THE MICROSCOPIC SEXUAL CHARACTERISTICS OF THE AMERICAN, PORTUGUESE, AND COMMON EDIBLE OYSTER OF EUROPE COMPARED.

By JOHN A. RYDER.

In the issue of Forest and Stream of November 30, just past, in an article by the writer, page 351, middle column, it is remarked: "I regard Davaine's observations upon the histology of the reproductive organs [of the European oyster] as of little value, being made before the introduction of improved methods of investigation. His figures of the finer structural details have apparently been made from crushed fragments." In passing this judgment upon Dr. Davaine's work, I have been severer than the state of the case demanded, as will be seen in the sequel, though I do not yet admit that his methods of research were what they should have been, for until now we have had no adequate description of the structures in question. Until recently I have maintained with reservations that the sexes in the European oyster were probably separate as in the American; more recent investigation with more refined methods have proved to me that in this I am in error. In my article in Forest and Stream I also took occasion to refer to a statement in Gegenbaur's Elements of Comparative Anatomy, English edition, p.

380, where he says: "In the oysters we find an intermediate step toward a separation of the sexes, inasmuch as these organs are not active at the same time in the same individual; but the male and female organs alternately so." The writer in commenting upon the above then wrote: "This quotation tacitly admits the unisexuality of the European oyster to which it evidently refers. The last part of the remark, however, is founded upon the slenderest kind of evidence; in fact, upon no evidence except a surmise, as such an alternate activity of the two parts is improbable [for obvious reasons]; besides, it is not possible to demonstrate such an alternation of sexual activity in the same individual. As every one knows, the soft parts of an oyster cannot be examined without opening the shell, which necessarily makes the needed second observation to confirm this alleged alternation of sexual activity a physical impossibility." I am now in a position to go still further and to assert that the first part of the quotation from Gegenbaur is also erroneous, because we may find both eggs and spermatozoa in the same follicle at the same time.

What, then, is the true state of the case? This query we propose answering, but before we set out it will be necessary to give some account of the methods of investigation used in order to arrive at a definite conclusion. Thin sections of those portions of the animal in which the reproductive structures are lodged are of the first importance. After trying various methods, which were found for the most part unsatisfactory, the preparation of sections was finally conducted as follows: After the soft parts were removed from the shell they were thrown into a chromic acid solution of one to two per cent., in which they were allowed to remain for several days, and in some cases the hardening solution was even renewed. This was done in order that the hardening agent might act upon the whole of the soft parts and harden them throughout; unless the chromic acid is allowed some time to act upon the entire animal it will not be uniformly hardened, the center of the body remaining soft. After hardening, the animals should be thoroughly washed and soaked in water for a couple of days to remove all traces of the acid before they are finally put into alcohol for permanent preservation. Hardened material so preserved will make good sections months afterwards.

Portions of the body mass of different individuals should then be cut out; it is best to cut up the body into thick slices or blocks in a transverse direction, large enough to be conveniently held between the fingers. It was also found advisable to take such thick slices of the hardened body mass from several individuals, since it was discovered that scarcely any two had the reproductive glands developed to exactly the same degree of maturity. This point is important, as it has enabled us to follow up the development of the reproductive organs in the connective tissue which invests them. After considerable experiment and disappointment in the effort to imbed these thick, hardened slices so as to cut sections with the microtome, the method of imbedding was abandoned altogether. The thick blocks or slices were entirely freed from alcohol by soaking in water for a day; then removed, after drying them off as much as possible with blotting paper or a soft linen cloth, to a thick solution of gum arabic, in which it is best to allow them to remain twenty-four to forty-eight hours so as to be thoroughly saturated. The superfluous gum may then be poured off and the blocks of tissue, soaked as they are with the gum, covered with strong alcohol. In twenty-four hours the blocks will be found hard enough to cut. The blocks of hardened tissue are simply held between the thumb and forefinger, and the sections made with a section-knife with the free hand. When cutting sections, it is necessary to keep the knife well wetted with alcohol so that the sections may readily slide off on the upper side of the blade. Water should not be used to wet the knife, as it would get on the block of tissue, dissolve the gum, and soften the surface to be cut, and injure the succeeding sections. The sections are lifted from the knife as fast as cut, with a camel's hair pencil, and thrown into a dish of water, in which the gum will dissolve out in a few minutes. The sections are then ready to be stained, and in order to clearly differentiate the hermaphroditic character of the reproductive glands of *ostrea edulis* a special staining reagent must be used. The one which gives the best results and acts most quickly will be given here. Equal parts of dense alcoholic solutions of safranin red and methyle green* are poured together and diluted with about eight times their combined volumes of water, producing a dark purplish solution of about the color of claret wine. Into this the sections may be thrown and allowed to remain until com pletely saturated with color or until they are opaque; they may remain in the staining fluid from one hour to a day, but two or three hours is a sufficient length of time. When removed from the staining fluid they are too deeply stained to be mounted at once, and must therefore be transferred to 95 per cent. or absolute alcohol and stirred about in it until the safranin red is no longer given off in clouds from the sections; but it is important to note that if the sections remain in the strong alcohol too long the whole of the safranin will be washed out. In order to prevent this, when it is seen that the section has acquired a rosy red hue, combined with a bluish-green tint in the parts stained by the methyle green, the object should at once be removed from the alcohol and thrown into oil of cloves and mounted in balsam or damar. The extraction of the superfluous color requires from five to fifteen minutes, according to the thickness and character of the section, and should on no account be allowed to proceed too far; if it does, the peculiar and important staining effect of the safranin is lost. As first pointed out by Flemming, it has the peculiar property of staining the nucleus and its contents, while it may be totally removed from other parts of the cell; in

*These are both aniline colors; the first is hard to obtain, except from dealers in dyers' colors.

fact, as in the oyster egg, it may be entirely removed from the nucleus and left only in a part of the nucleolus. The methyle green, on the other hand, does not tend to stain the eggs, but rather the spermatozoa and the cells from which they are derived, and it is one of the most astounding facts known to histological chemistry that, although both of these dyes, to begin with, are intimately mixed together in the staining fluid, the different histological elements of the section exert some kind of selective power by which they absorb and hold mainly the one color only. This peculiar property of the two colors, even when mixed together, enables one to distinctly map out the relations of the sexual elements in the reproductive follicles, the nuclei of the ovarian ova being stained red by the safranin, and the heads of the spermatozoa bluish green by the methyl green. The foregoing is mainly the method to which I have had recourse in working out the sexual characteristics of *Ostrea edulis*. Simpler staining methods suffice in the case of *Ostrea virginica* and *Ostrea angulata*. A single color used in staining sections of *O. edulis* is liable to lead to error in consequence of the peculiar mode in which the spermatozoa are packed together in oblong clusters, which are often of about the size of the ovarian ova. This egg-like appearance of the masses of unripe spermatozoa in the follicles of the reproductive organs of the common oyster of Europe misled me when examining sections stained only with eosin or carmine. The monochromatic effect produced by one color only gave no hint as to the real relations of ova and spermatozoa in the follicles until high powers were used with special manipulation of the light.

The characteristics of the reproductive organs of *Ostrea edulis*, *O. virginica*, and *O. angulata* are sufficiently marked to be very precisely described and figured so as to enable any person to appreciate the differences, especially between the first and last two. *O. edulis* is essentially hermaphroditic in the structure of its reproductive organs, while the other two are as distinctly monœcious or unisexual. A marked difference is also to be noted in the relative size or caliber of the reproductive follicles in the hermaphroditic and in the unisexual species. In *O. edulis* the caliber of the generative tubules appears to be relatively much greater than in *O. virginica* and *O. angulata*, nor are the tubules so densely crowded together as in the latter species. Up to this time this difference appears to me to be so marked that I think it would be possible to distinguish sections of *O. edulis* from those of the other two species by means of this one character. In other respects the history of the development of the reproductive tissues in both species appears to be similar. In all the sexual tissue arises as a linear, interstitial differentiation between the coarse, connective-tissue cells of the animal, only that in *O. edulis* the rudimentary network does not form quite so close a meshwork as in the other two forms here considered. The tubules have a more extensive anastomosis with each other in the unisexual species than in the hermaphroditic. In all the forms fine vessels pass off from the dorsal and ventral somatic arteries, which tend to branch into vessels of a capillary fineness amongst the productive follicles. Thus the glandular portions of the reproductive organs are effectively nourished by supplies of blood passing from the great vessels given off by the heart. These are the principal characteristic features of the reproductive follicles in the hermaphroditic and unisexual forms which are noticed upon comparing the two together. The most important differences between the two forms are to be found, however, in the mode in which the generative elements are produced in each type, which we will now consider.

In *O. edulis* the reproductive glands when well developed show in many cases a lining of large nearly mature ovules or ovarian eggs, at intervals, and insinuated between them large coarsely granular bodies may be observed, in which large, irregular, nuclear bodies are often embedded. These nuclear bodies are further distinguished from those of the ovules by their oval or oblong and often irregular form, and by containing a dense mass of granules which absorb safranin in such quantity as to become opaque. This granular *chromatin*, as it would be designated by Flemming, is usually aggregated at the center of the nuclear or cellular mass, whichever it may be, and is furthermore apt to conform to a certain extent to the external outline of the body which contains it. From these bodies the rounded granular cells appear to arise, which fall into the cavity of the tubule or follicle, there to undergo further segmentation, and finally break up into spermatozoa with spherical heads and filiform tails or flagella. Even in some cases, where no spermatozoa are as yet revealed by the methyl green, these rounded spermogens or spermatoblasts are to be seen free in the center of the follicles. Usually, however, the spermatoblasts have been crowded towards the external end of the tubule where they have undergone differentiation into spermatozoa. The spermatozoa are often on this account so crowded together at the outlet of the tubules, passing even into the superficial ducts, so that when acted upon by the methyl green they are revealed as a dense, almost opaque, dark, bluish-green mass. The ovules, on the other hand, which may be quite nearly mature, remain unstained, except their spherical clear nucleus and nucleolus, which is double, as if formed of two conjoined spherules. If the safranin has been washed out of the nucleus the one spherule of the nucleolus only is apt to retain the color. The peculiar nucleus of the ovules at once distinguishes them from the elements, which later break up and become the spermatozoa. Apparently every phase of the spermatogenetic process is under way in the follicles, while more or less nearly mature ovules may be adherent to the walls of the same tubules. In some specimens I find the tubules to contain nothing but ova, with little or no trace of spermatoblasts; in others, again, both classes of products may be present in about the same condition of maturity. In still others little else but spermatozoa are to be found, but, adherent to the walls of the follicles, cells are to be found which have the nucleus so characteristic of the more mature ovules. These, I am inclined to believe, are the representatives of what will later become ova, and not the representatives of spermatoblasts. It is a singular fact that the spermatozoa have a tendency in *O. edulis* to cling together in masses of about a uniform size. Though the spermatic particles which comprise these masses are somewhat separated from each other, if compressed together they would evidently form a body about the size of the spermatoblasts from which they were derived. Later they tend to break up and form a more homogeneous, granular mass at the outlet of their parent tubule, where the latter joins the outgoing efferent duct. While it is true that some sections of *O. edulis* show little evidence of the presence of anything else but the product of one sex, it appears to me that there is sufficient evidence of the hermaphrodite character of the generative glands of the species presented by a pretty large series of sections taken from about fifty individuals from different localities along the coasts of Wales, Scotland, England, France, Holland, and Germany. Sometimes a portion only of a section will be hermaphroditic, showing that different parts of the generative glands of the same animals may be of different sexes. The result of this arrangement is that it is scarcely possible for the eggs to escape impregnation by the milt generated alongside of them, and we may, I believe, fairly assume that *Ostrea edulis* is a self-fertilizing hermaphrodite.

The condition of things in the generative tubules of *Ostrea virginica* and *angulata* is very different, as may be gathered from the following account. In the first place I have never found any evidence of hermaphroditism either in the living animal or in sections of the reproductive organs. The mode of pressing out the spawn from the gland and ducts of *O. virginica*, and the physical test used to determine the sex of the products in practical work during the last season, afford the most positive demonstrations of the unisexuality of that species. Examining sections, however, we never find either in the reproductive follicles of *O. virginica* or of *O. angulata* any evidence of the coexistence of ovules and spermatozoa. In fact, the mode of spermatogenesis in the unisexual species is very different from that of the hermaphroditic. As indicated in Brooks' figure of a part of a section of a male oyster, the spermatozoa are peculiarly arranged in the follicle or tubule. Upon applying a high power (500 to 800 diameters) I find that the heads of the spermatozoa show a very marked tendency to be arranged in rows like beads and not in oblong clusters, as in the hermaphroditic species. Moreover, the walls of the generative tubules are lined by relatively very much smaller spermatoblasts than those found free in the reproductive follicles of the hermaphrodite form. This spermatogenetic layer is often very marked in the males of the unisexual species, and even at an early stage of the functional activity of the testicular organs presents much the same structure that it does later. The rows of spermatozoa already alluded to also have a tendency to be bent towards the outlet of the tubules, giving rise to a fringe-like appearance on either side of follicle with a clearer space between the edges of the fringe-like masses of spermatozoa. In fact it is plainly to be seen that the spermatozoa are being budded off from the spermatogenetic layer, and that the appearances just described are a result of that process. It results from this that the structural peculiarities of the testicular tubules are very characteristic, so that once recognized they will never afterwards be confounded with the arrangement observed in the ovary of the female, where, as in the hermaphrodite species, the ova may be seen in different stages of development, though where the majority of the ovules have attained nearly full development, it may happen that few of the nascent ovules closely adherent to the walls of the follicles are visible.

The distinction between *Ostrea edulis* and the American and Portuguese species is therefore very marked and important. Möbius, Der Auster und die Austernwirthschaft, Berlin, 1877, page 19, says of their species: "Oysters are hermaphrodites. In the largest number of individuals, in the whole reproductive organ, I found only spermatozoa, but no eggs. In seven oysters which carried blue brood in the beard, the sexual gland contained only spermatozoa. Three oysters with younger white embryos in the beard had no spermatozoa in the sexual gland. In the most of the brood-bearing oysters the sexual gland contained neither eggs nor spermatozoa. Of 309 oysters, which were taken, on the 25th May, from four different banks east of the island of Sylt and afterward examined from May 26 to June 1, 18 per cent. were hermaphroditic, and of the remaining 82 per cent. one-half were egg-bearing, the other half sperm-bearing. In none were the sexual products completely mature. From these observations I conclude that the eggs and spermatozoa do not develop simultaneously but successively in the sexual gland; that spermatozoa may be developed very soon after the discharge of the ova, and that probably one-half of the oysters of one locality during a breeding period produce only eggs, and the other half produce only spermatozoa." To the same effect are the statements of Lacaze-Duthiers; but Davaine seems to have first noticed the peculiar aggregations of spermatozoa in oval masses in *Ostrea edulis*. Brooks thinks "Gerbe's statement, that among 435 European oysters one year old he found 35 with young, 127 with ripe eggs, and 189 with ripe semen, seems to be sufficient to show the incorrectness of Lacaze-Duthiers' conjecture that the functionally male condition precedes the functionally female condition."

This is about the state of the controversy at present in regard to the breeding habits of *Ostrea edulis*. The only authority, as far as I am aware, who distinctly takes the ground that eggs of this species are fertilized in the reproductive organs is Horst, who says: "Not only do the embryos pass through their first stages of development within the mantle cavity of the adult, and impregnation occurs internally instead of externally, but it may also be said that the eggs and spermatozoa come into contact in their passage out of the generative glands." It is barely possible, indeed probable, if my memory serves me rightly, that Davaine has put similar observations upon record. Horst also distinctly asserts that the normal development of the embryos of *Ostrea edulis* cannot take place outside of the parent. Mr. Berthelot, according to Mr. Brandely, has discovered that the fluids in the mantle cavity of *O. edulis* contain albumen in a notable proportion, upon which the young are supposed to be nourished. Mr. Brandely has found by direct experiment, that in the case of *O. angulata* it is possible to artificially impregnate the eggs. His attempts to fertilize the eggs of *O. edulis* with the milt of *O. angulata* and *vice versa* were unsuccessfully repeated at different times for the last two years. I am now also uncertain in regard to the identity of the species of which Lieutenant Winslow succeeded in artificially impregnating the eggs at the mouth of the St. Mary's River, in the Bay of Cadiz, Spain, which he says were natives, the variety having existed and flourished in the bay for as far back as could be remembered. I quote his description of the specimens he used in his experiments as follows: "In appearance they were quite similar to the American species (*Ostrea virginica*), having long shells of from one to three inches in length, rougher and thicker than is usually the case with the European oyster." This remark raises the question whether the experimenter was not really working with *O. angulata* instead of *O. edulis*. The locality where he got his specimens and where he conducted his experiments also makes it not improbable that he was in reality working the native unisexual species, *O. angulata*.

To return to the question of the breeding habits of *Ostrea edulis*, it appears to me that we cannot very well question the authority of Möbius, Lacaze-Duthiers, and Horst, in regard to the bisexual state of the reproductive organs. My investigations also give some countenance to the fact of a preponderance either of eggs or of spermatozoa in different individuals; in fact, in some cases the one or other seems to be almost exclusively the mature product. But we are not yet in a position to arrive at a conclusion in this matter because of the scantiness of the observations which have hitherto been made. The hypothesis that the spermatozoa are drawn from without into the generative ducts by the ciliary action of the gills and mantle may be dismissed with the remark that microscopic investigation, to my mind, has effectually disposed of the probability of any such a state of affairs. We may see the spermatozoa in course of development in the same follicle with the ova, which is conclusive proof that the milt has not been derived from without, from the water into which it had been discharged by neighboring individuals. In truth, we find in some cases the spermatozoa present so deep down in the utmost ramifications of the generative follicles that it is not conceivable that they should have been drawn in from without.

As to the alternate activity of the organs in producing ova and spermatozoa there is a possibility that such is the case, but as stated at the outset there is as yet no conclusive proof of the fact. Certain it is, that I have yet to see sections of *O. edulis* in which both ova and spermatozoa are not present in some condition of development at the same time. If the one be not present in a fully developed state, developing traces of it may be discovered, or even a very minute quantity of developed milt or a few developed eggs may be present in some one follicle, while in the others there are perhaps exclusively eggs or exclusively milt in a developed condition. I am aware that this view of the matter is opposed to the current doctrine that nature provides against continuous interbreeding, but when we find the eggs and milt about equally advanced in development in the same follicle, what is there to prevent self-fertilization; in fact, what else can be the mode of reproduction?

In some of the sections of *O. edulis* examined by me the ovules already measured $\frac{1}{250}$th of an inch in diameter, showing them to be about twice the size of the ripe eggs of *O. virginica* and *O. angulata*, in both of which the ova are of about the same size when mature. Estimates which I have made, based on the figures of the eggs of *O. edulis* given by M. Davaine, show them to be $\frac{1}{130}$th of an inch in diameter. Estimates based on the figures of Lacaze-Duthiers give $\frac{1}{270}$th of an inch, while Möbius and Horst give the size of the young fry at $\frac{1}{156}$th of an inch in diameter. The spherical heads of the spermatozoa of the three species here discussed measure about the same or approximately, $\frac{1}{13000}$th of an inch in diameter. The clusters of spermatozoa of *O. edulis* measure approximately $\frac{1}{750}$th of an inch in diameter. The spherical unsegmented spermatoblasts which break up into spermatozoa in *O. edulis* measure $\frac{1}{1500}$th of an inch in diameter. The nucleus of the ovarian eggs of *O. edulis* measure not quite $\frac{1}{750}$th of an inch in diameter. The nucleus of the ovarian egg of *O. angulata* measures approximately $\frac{1}{1333}$rd of an inch in diameter, which is about that of the nucleus of the egg of *O. virginica*. The large spherule of the nucleolus of the egg of *O. edulis* measures $\frac{1}{2750}$th of an inch in diameter; the small spherule, which is stained red by the safranin, measures $\frac{1}{4250}$th of an inch; the long diameter of the conjoined spherules is $\frac{1}{1750}$th of an inch. The long diameter of the nucleolus of the egg of *O. angulata* and *O. virginica* is about $\frac{1}{4000}$th of an inch. A slide in my possession containing some of the brood of *O. edulis* shows that, even after it has acquired both valves of the shell within the beard of the mother oyster, the brood varies greatly in size. I find, for example, that such fry measures from $\frac{1}{110}$th of an inch down to as small as $\frac{1}{150}$th. This brood, like that of the American oyster, has not yet acquired any umbonal prominences at the hinge end of the valves. Before this occurs in the American oyster embryo considerable growth has taken place, but when the shell already covers the body the whole embryo, contrary to what is found in the European species, measures little, if any, more in diameter, than the egg, or about $\frac{1}{500}$th of an inch. Later, when the embryo has grown considerably and when it is on the eve of attaching itself permanently, it measures from $\frac{1}{80}$th down to $\frac{1}{90}$th of an inch in diameter. The mode of fixation of the fry of both species is probably the same, but the mode of incubation—the one in the mother, the other in the open water—we see is widely different, differing as greatly in this respect as do the eggs in size and details of construction, as shown by the measurements which I have given. It must not be forgotten, however, that the material from which I prepared my sections was received from Europe, in January and March, when it is to be supposed that the reproductive organs were not yet fully developed, and that consequently the dimensions of the ovarian ova as found by me are rather to be considered as being below than above their true ones when fully developed at the height of the spawning season.

It is a very remarkable fact that one finds individual specimens of oysters in which the reproductive organs have undergone total atrophy or wasting away at the completion of the spawning season. Examining sections through the body-mass of spawn-spent oysters taken from their native waters in August last, I find that the whole of the connective tissue subjacent to the mantle, and between the latter and the liver, especially over the sides of the body-mass, has disappeared, together with all traces of the reproductive organs, including the superficial branches of the efferent ducts. At the first bend of the intestine there is still some of the connective tissue remaining; but even here and in the mantle it has changed its character entirely, and become very spongy and areolar, instead of solid, and composed of large vesicular cells, such as are met with when the animal is in a better condition of flesh. In fact, it appears as if this mesenchymal or connective tissue substance had been used up and converted into reproductive bodies—generative products—in the case of the spawn-spent and extremely emaciated individuals. In sections from individuals in various conditions from that in which the rudimentary network of generative tubules has just appeared in the connective tissue, on up to those in which the reproductive tissues are enormously developed in bulk and proportion to the mass of the remaining structures, there is a perfect gradation from their complete absence to their full development. This would appear to be very strong evidence in support of the theory that the reproductive follicles, or tubules, are developed anew each season directly from the specialization of certain strings or strands of connective tissue cells.

Many animals manifest a periodic development of the glandular portions of the reproductive organs; but I know of no form in which there is any such presumptive evidence that these organs are annually regenerated and finally altogether aborted as seems to be the case with the oyster. Together with the changes here described, the most remarkable changes in the solidity and consistence of the animal take place. The shrinkage of a spawn-spent oyster in alcohol or chomic acid solution is excessive, and will, when complete, reduce the animal to one-tenth of its bulk while alive. This shrinkage is due to abstraction of the water with which the loose, spongy tissue of the exhausted animal is distended. A so-called "fat" oyster, on the other hand, will suffer no such excessive diminution in bulk when placed in alcohol or other hardening fluid. In consequence of this variable development of the reproductive organs as well as that of the connective tissue of the body-mass, the amount of solid protoplasmic material contained in the same animal at different times under different conditions must vary between wide limits. And, inasmuch as the nutritive and reproductive functions of animals are notoriously interdependent, it follows in consequence of the enormous fertility of the oyster that a vast amount of stored material in the shape of connective tissue must be annually converted into germs and annually replaced by nutritive processes. Plentitude or dearth of food are also to be considered; but it now becomes a little easier to understand the physiological interdependence of the reproductive function and the so-called fattening process.

To a great extent what has been remarked in the preceding paragraphs of the wasting away of the reproductive organs in *Ostrea virginica*, seems to apply also to *O. edulis* and *O. angulata*. The last species has an extraordinarily thick body-mass with the stratum of reproductive follicles of remarkable thickness, averaging a much greater development than I have ever seen in any other form. When the contents of this great mass of tubules has been discharged a diminution in the bulk of the body-mass must naturally ensue, probably accompanied by a wasting away of the connective tissue and tubules such as apparently occurs in the American species. From what I have seen of the generative tubules of *O. edulis* in sections, they are evidently regenerated much as in *O. virginica*. In a few specimens I find them almost entirely gone, or present only in an extremely rudimentary state.

BRINGING WHALE OIL FROM THE PACIFIC TO NEW YORK.

By FREDERICK HABERSHAW.

[From letter to Prof. S. F. Baird.]

I am bringing the Northwest Pacific whale oil, which is now delivered by whalers at San Francisco, to the Atlantic by bulk cars instead of by Cape Horn route, as formerly. The total amount coming thus by rail is 21 cars this year, averaging 3,300 gallons each, or 69,300 gallons.

San Francisco has become the whaling depot of the Pacific, for the fitting up and discharging of whalers; it is only a question of time when all this product will be brought to the Atlantic by rail. Probably in a few years all the manufacturing will be done there instead of at New Bedford.

113 MAIDEN LANE, NEW YORK, *January* 30, 1883.

OCCURRENCE OF FUR SEALS IN MID-OCEAN.

By LIEUT. Z. L. TANNER, U. S. N.

[Letter to Prof. S. F. Baird.]

At your request I send you the following extracts from my remark book during a passage from Yokohama to San Francisco in the Pacific mail steamer City of Peking:

June 25, 1878.—Latitude at noon, 42° 55′ 53″ north, longitude 162° 14′ 45″ east. During the morning passed branches of a tree; saw a couple of seals, several ducks, albatross, and large numbers of jelly-fish.

June 26.—Latitude noon, 42° 53′ 17″ north, longitude 167° 16′ 30″ east A. M.—Several pieces of driftwood seen; ducks, whales, and whale birds in sight occasionally. P. M.—Passed several pieces of driftwood —two pine trees 60 to 80 feet in length.

June 28.—Latitude noon, 42° 43′ 22″ north, longitude 177° 43′ 06″ east. A. M.—Several seals and ducks seen.

June 30.—Latitude noon, 43° 05′ 18″ north, longitude 167° 41′ 06″ west. A. M.—Passed a pine tree 1½ foot diam., bark gone, surface clean.

July 1.—Latitude noon, 43° 01′ 14″ north, longitude 161° 23′ 30″ west. A. M.—Whales, seals, puffins, &c., seen during the day.

NOTE.—Puffins mentioned in this day's remarks are the ducks of previous days.

July 2.—Latitude noon, 43° 05′ 12″ north, longitude 155° 26′ 37″ west. A. M.—Whales seen during the day. P. M.—A large school of fish seen during the evening.

NOTE.—Uncertain as to kind of fish; last called them skip-jacks.

July 3.—Latitude noon, 43° 02′ 06″ north, longitude 145° 41′ 30″ west. A. M.—Porpoises seen during the morning. P. M.—A large school of fish resembling herring seen during the afternoon. Passed a large drift log covered with barnacles at 5.30 p. m.

July 4.—Latitude noon, 43° 05′ 56″ north, longitude 144° 16′ 00″ west. Whales and a small number of Portuguese men-of-war (vellala) were seen during the day. P. M.—Whales seen during the afternoon.

July 5.—Latitude noon, 42° 41′ 52″ north, longitude 138° 30′ 15″ west, A. M.—Whales and a small number of vellalas seen during the day. The usual number (3) of gonies following the ship.

NOTE.—The three gonies referred to were usually with the ship, until we approached land at either end of the route. Other birds were seen almost daily, but it seldom happened that those mentioned above were absent for any length of time.

I have no doubt seals, &c., were seen on other voyages, but my books are not at hand to-day.

U. S. F. C. STEAMER ALBATROSS,

NAVY YARD, WASHINGTON, D. C., *December* 29, 1882.

ACCOUNT OF OPERATIONS AT THE McCLOUD RIVER FISH-BREEDING STATIONS OF THE UNITED STATES FISH COMMISSION, FROM 1872 TO 1882, INCLUSIVE.

By LIVINGSTON STONE.

[Written by request of Professor Baird, for the London Exhibition, 1883.]

The United States salmon-breeding establishment on the McCloud River, California, which afterwards became the largest of its kind in the world, arose from small beginnings. A rough board cabin 12 feet by 14 feet, and a small set of hatching-troughs, resting on the ground, without a roof over them, constituted the McCloud River salmon-breeding station of the United States in 1872, the first year of its history. Three white men, including the writer, with the help of one or two Indians, did all the work. Our one room answered the purpose of office, kitchen, dining-room, and bed-room for all of us. Thirty thousand salmon eggs, matured for shipment, which afterwards dwindled down to 9,000 living ones at the end of their overland journey, constituted the results of the season's work. We even actually suffered, at times, for want of means. More than once my remittances from Washington being unexpectedly delayed, we were obliged to sell part of our clothing and some of the cooking utensils to obtain money for our immediate necessities. Our force was so small that we were repeatedly in danger of being robbed and murdered, and it often became necessary for the same man to work all day and two-thirds of the night to complete the day's work. From these small beginnings and straitened circumstances sprung the McCloud River salmon-breeding station, which a few years afterwards employed forty or fifty men, and distributed in one season nearly 14,000,000 salmon eggs, which went not only to various parts of the United States, but to several foreign countries, of which New Zealand was the most remote.

The results of the season's work, however, small as they were, were enough. They were sufficient to establish the important facts that salmon eggs could be procured in California, could be matured for shipment, and, what was more gratifying than all, could be sent alive across the North American Continent.

To settle the points just mentioned was a matter of no small consequence. Every one of them was regarded as extremely doubtful before the expedition set out, while at the same time every one of them was absolutely indispensable to success. The whole project, indeed, of getting salmon eggs on a large scale on the Pacific coast, and transporting them alive to the Atlantic coast, had been looked upon with great distrust. It was considered very doubtful whether the California salmon eggs could be procured in large quantities. It was considered doubtful whether, under the changed conditions of the Pacific slope, salmon eggs could be brought to the shipping (packing) age in a healthy state; and finally it was generally thought to be decidedly impracticable to transport them alive a distance of over three thousand miles from one ocean to the other, in which latter view the writer to some extent shared.

It will be seen, therefore, that to settle these doubtful points was no small achievement, and the fact that they were settled makes the results of this first season, insignificant as they were in magnitude, of the utmost importance in point of fact.

At all events, the United States Commission felt authorized by the results to continue the work another year, and each successive year more and more clearly vindicated the wisdom of this decision. Perhaps, as ten years have elapsed since that time, I may be pardoned for recalling some of the reminiscences of that first year at the fishery, so full of novelty, of anxiety, and of interest to those who were engaged in the work.

I arrived in California on the 8th of August, 1872, with instructions from Professor Baird, United States Commissioner of Fisheries, to find a suitable place for procuring the eggs of the Pacific coast salmon on a large scale, and if practicable to obtain and forward some to the Eastern States that year. As the salmon with which I was familiar—the *Salmo salar* of the Atlantic coast—does not deposit its spawn until October, I did not feel at all uneasy on account of not having time enough. I nevertheless spared no pains to gather information as to where the Pacific coast salmon spawned, and as to what would be the best location for procuring their eggs on a large scale.

I expected to be informed at once where the spawning grounds of Sacramento salmon were.

Reared in New England, where almost every square foot of ground has been explored, I supposed that almost any one who had given attention to the matter could tell where the salmon spawned. To my very great astonishment, not a man could be found in California who could give the desired information.

The fishermen at Sacramento, and between Sacramento and San Francisco, knew all about catching salmon, but none of them knew where the salmon spawned. The State fish commissioners, although they had collected valuable information of other kinds, had not yet learned the location of the spawning grounds of the Sacramento salmon. As I was about giving up in despair, Hon. B. B. Redding, secretary of the California fish commission, introduced me to Mr. W. W. Montague, the chief engineer of the Central Pacific Railroad, who gave me the first clew I had yet received to the much-desired information in regard to the spawning of the California salmon. Mr. Montague said that he had seen Indians spearing salmon on the McCloud River, and was quite sure that he had seen the ripe spawn coming from the fish that had been speared. Here was a clew to work from. I lost no time in taking conveyance to the McCloud River. I arrived on the river on the 29th of

August, and with my own eyes saw proofs of the correctness of Mr. Montague's statements. Indeed, the Indians were there actually spearing salmon, with the ripe spawn coming from them. Here, at last, was found one at least of the spawning grounds of the salmon of the Sacramento River. There was no doubt about that, but it was associated with another fact that filled me with dismay, and that was that the salmon were at this very time engaged in depositing their spawn, and I had no net, no hatching-house, no hatching apparatus, and indeed nothing whatever, to enable me to avail myself of the facilities presented right here of securing the salmon eggs, that in thousands upon thousands were now being deposited by the parent fish. Every one knows that it is as impossible to procure salmon eggs after the salmon-spawning season is over, as it is to pick a dish of blackberries after the blackberry season is over. In either case no amount of money or zeal is of any avail. Our dismay can perhaps be imagined, then, when it is known that we discovered that the spawning season was nearly at its height, that it must necessarily soon be over, while we had not the means to mature a single egg. It should be remembered also that we were in an unsettled wilderness, 50 miles from a railway and telegraph station, and about the same distance from a saw-mill. The situation called for the most energetic measures, and no pains were spared nor a moment lost in bringing lumber to the spot that I had selected for the hatching works, and in getting some system of fishing under way for procuring a regular supply of salmon eggs. Our party worked so industriously, and were so favored by circumstances, that on the 16th of September we had on a brook near by, a set of hatching-troughs established, in good running order, and had also built a small cabin of rough boards, where we could sleep at night and keep our tools and other valuables. I was also prepared to draw a seine regularly in the river for parent salmon.

It was none too soon, for now the spawning season was very near its end, and by far the larger proportion of salmon in the river had spawned. By dint of persevering labor, which sometimes involved working night and day, we obtained the eggs of about twenty salmon and placed them in good condition in the hatching-troughs.

Our trials were, however, by no means at an end. In California there are many bands of hogs running in a half-wild state in the woods and hills. One hot day a number of these hogs refreshed themselves by bathing and wallowing in the little brook that supplied the hatching-troughs with water; in a few minutes the water was as roily as the Missouri River and in half an hour the eggs in the troughs were covered with mud. This was both discouraging and alarming, but we finally cleaned the mud off the eggs, drove away the hogs, and restored everything to its normal condition. From this time until the season was over we had to "watch out" for the hogs and drive them off, and notwithstanding our vigilance we were several times compelled to clean the hatching-troughs of the mud which the hogs had stirred up when they found us off our guard. This was not all. To our great alarm we found that on very hot and dry days the brook which fed the troughs would shrink by nightfall to one-half or one-fourth of its size in the morning, owing to evaporation and leakage. However, we did not take enough eggs this season to cause even this much-reduced water supply to become insufficient, and we consequently did not suffer much from this cause; but the climax of our troubles was reached when, one hot afternoon, on trying the thermometer in the brook, we found that it stood at 84° F., and on looking at the salmon eggs we found every one white and dead. This was indeed a dark day for the young salmon-hatching station. Still there was one hope left. We could perhaps obtain a few more eggs before the last straggler among the breeding salmon had deposited its spawn, and the cooler weather of the fall being now near at hand there was some chance of the water not getting hot enough to kill the eggs. On this frail hope and chance we went to work again, although heavily handicapped in spirit and energy by this last almost fatal discouragement. This time we succeeded, by hook and by crook, by resorting to every possible means of securing spawning fish, in obtaining thirty thousand more eggs. These were safely laid down, and succeeded in running the gauntlet of all the dangers that threatened them, and in sixteen days showed the welcome eye-spots. The sight restored our failing courage. Half the battle was over. It was now proved that salmon eggs could be procured and developed to the proper stage for shipment.

But a still greater difficulty loomed up before us; this was to transport the eggs alive from these foot-hills of the Sierras to the waters of the Atlantic coast where they were wanted. I confess I had but a very feeble hope that this could be done. However, it was attempted. I sent 50 miles to Mount Shasta for moss for packing, packed the eggs as well as I could, and, wishing them a God-speed for their long journey, sent them on the stage to the nearest railway station, from which the cars took them more than 3,400 miles to their destination in New Jersey. I did not expect to ever hear of them alive again, but in a week or two came the joyful news that about a third of them had arrived on the Atlantic coast in good condition. The other half of the battle was now won; it was settled beyond a doubt that the eggs of the Pacific coast salmon could not only be obtained and matured for shipment, but could be sent alive across the North American Continent.

This is a summary account of the first beginnings of the United States salmon-breeding establishment of California; but though it was small and weak at first, it grew every succeeding year in strength and efficiency, and soon in capacity and actual results eclipsed all other similar establishments in the world.

At the close of this report will be found a diary of the more important events of its history, illustrating its growth and development from year to year.

I will now leave the chronological order of events, and take up in succession the various subjects connected with the carrying on of this station which seem to present themselves most prominently, and will speak first of its advantages of location.

ADVANTAGES OF LOCATION.

There are several tributaries of the Sacramento in California that the salmon formerly ascended for the purpose of depositing their spawn. With three exceptions, all of these rivers, as, for instance, the Feather River, the Yuba, the American Fork, have long ago been completely ruined as spawning grounds, in consequence of the immense deposit of mud in them, caused by the hydraulic mining operations on these rivers. Not a salmon ever enters these streams now. Except possibly at a time of very high water, these streams are so thick with mud that it would kill any fish attempting to ascend them. The three exceptions mentioned are the Pit River, the Little Sacramento, and the McCloud, which is really a tributary of the Pit River. Now of these three rivers, the Pit above its confluence with the McCloud becomes too warm for salmon in the summer, and the Little Sacramento is rapidly losing its salmon owing to mining operations which have been carried on there during the last few years. It will consequently be seen that the McCloud remains the only stream tributary to the Sacramento that furnishes good spawning grounds for the Sacramento salmon. Up this river the great body of the Sacramento River salmon go to spawn, and on this river, 2 miles from its mouth, is built the salmon-breeding station of the United States Fish Commission.

Advantageous as this situation is for its abundance of salmon, it would be of little use as a distributing point for the eggs if it had no convenient lines of communication with the rest of the world; but fortunately the California and Oregon stage route—the only direct through road but one in the country, connecting Oregon and California—follows the north bank of the McCloud for a short distance, and it is just where the stage road coming south touches the river that the salmon-breeding station is built. It was a most happy combination of circumstances that this through line happened to strike the point where, of all others, the California salmon could be most abundantly obtained. The consequence is that we have had, during our whole ten years there, a daily mail north and south and all the incidental advantages, which are very great, of living on the great thoroughfare between the two States.

Besides these advantages just mentioned, this station has another, which, though of a negative character, is nevertheless indispensable to its existence. It is that the geological formations of the river do not indicate the presence of gold-bearing ground on its banks. This has saved the river from the miners and still protects it, and it is the only thing that does protect it; for had gold been found in any abundance on the river, the McCloud would have gone the way of its fellows, the Yuba, the

Feather, and the American, and nothing could have saved these magnificent spawning grounds from entire destruction.

The river itself also possesses some great advantages. Being supplied chiefly by springs, the largest of which is formed by the melting snow of Mount Shasta, it is not subject to fluctuations, but remains at the same height all through the egg-taking season, seldom rising or falling even an inch during the whole time. As the parent salmon are taken in the river, and we build a dam across the river to stop the salmon in front of the fishery, and as we take the river water into the hatching house to hatch the eggs with, it will be seen at once what a desirable thing it is to be situated on a river that never rises or falls during the working season. The size of the river is also an advantage, it being large enough to attract vast numbers of salmon up its channel, and at the same time not being so large as to be unmanageable when the bridge is being built and the parent salmon are being caught. The temperature also of the river seems to be just right for bringing forward healthy embryos, and hatching hardy fish, which, however, is only what one would expect from a stream which furnishes the natural and favorite spawning grounds of the salmon of a great river.

I will conclude the enumeration of the advantages of location possessed by the McCloud River station, by the mention of one more, viz, the presence of the native Indians. This at first sight seems perhaps a doubtful advantage; but what could we have done without the Indians? They helped us in our extremity during the first season when we could get no other help. They helped us the next year and every succeeding year in building the dam across the river when the water was too cold and deep and swift for white men to work in it. They have been invaluable, when the spawning season came, for handling the parent salmon, both when the seine is drawn in and during the operation of taking the eggs; and we have never found any one who could take the place of the Indian women in picking over the salmon eggs in the hatching troughs, which is done every day to separate the dead ones from the live ones. The Indians have also been of the utmost service in times of emergency, and on occasions of alarming accidents, as, for example, on the memorable 18th of September, 1881, when the large current wheel, which furnished the whole supply of water for the hatching house, went to pieces, and the Indians saved our seven million salmon eggs by bringing water from the river in buckets from eleven o'clock one morning until four o'clock the next morning without taking any rest. Indeed, I think I may safely say that the white men at the station would have had a very hard time to do their work without the assistance of the Indians, if indeed they could have done it at all, and to make a success of it as they have for ten consecutive years.

THE NATURAL HISTORY OF THE CALIFORNIA SALMON.

Passing now to the salmon themselves, a few words about their characteristics and history may not be out of place.

The California salmon was formerly known as "*Salmo quinnat.*" It is now called "*Oncorhyncus chouecka.*" It is, when prime, a handsome silvery fish, resembling very much in shape and general appearance the salmon of the Atlantic coast of both America and Europe (*Salmo salar*), except that it has dark spots on its back and sides that do not belong to *Salmo salar*. The Sacramento salmon, which is the same fish which is found in the Columbia and other rivers on the Pacific coast in great quantities, averages in weight in the Sacramento River from fifteen to twenty pounds, and is found in that river every month of the year, being in best condition during the three winter months, and in the greatest abundance, probaly, in March, April, and August. When the salmon enter the Sacramento from the ocean they are, as just mentioned, handsome, silvery fish, but they fall off in looks and quality every week after they leave tide-water and enter upon their journey up the river to their spawning grounds. When we take them full of ripe eggs, in September, at the hatching station, they are mostly of a dark-olive color, the females being distended with spawn, and the males often very thin and deep, sometimes almost black, and frequently having a broad red band on their sides extending their whole length from head to tail. After spawning, and sometimes before, both sexes become emaciated, weak, and covered with white spots. At this stage the salt water of the ocean is the only thing that will revive them; and those that do not reach it in season, and this includes about all that go up the McCloud River, die of sickness and exhaustion.

METHOD OF CAPTURING PARENT SALMON.

Our methods of capturing the parent salmon and confining them, for the purpose of securing their eggs, have been various.

The first year, besides hauling the seine for them, we obtained what we could from the fish-baskets of the Indians. This latter method furnished only a meager and precarious supply, and was entirely abandoned after the first season.

The second year I had to adopt some means of keeping the salmon in confinement after they were caught, because, in order to secure a large number of eggs, I began fishing several weeks before the beginning of the spawning season. I hoped, by catching the salmon early in the season and confining them, to have a large number on hand when the spawning season came. This plan, however, only led to a succession of disappointments; for wherever we put the salmon they would die in a week or two. We put them in large plank boxes anchored in the river, with great apertures in them to insure a good circulation of water. We built capacious pens in the river by driving stakes into the bed of the stream; we built ponds on shore, supplied with a constant stream of river water, and we tried every expedient we could think of to keep them alive in confinement, but all to no avail. The imprisoned fish would spend their whole time in efforts to escape, and in not many days would be found dead in their pens, in most cases, probably, in consequence of their bruises. Day after day and week after week they died. The more we caught the more we lost; until at last about as many died daily as we succeeded in catching, and though we took that year about two million eggs, we should probably have taken nearly, if not fully, as many if we had not drawn the seine at all until the spawning season began.

THE BRIDGE AND DAM ACROSS THE RIVER.

The evident impossibility of ever successfully confining the parent salmon in ponds or pens made the necessity imperative of devising some sort of means for collecting the spawning fish together in large numbers. The object of this station was to take salmon eggs on a large scale, and if only two million could be secured at a season the enterprise would be virtually a failure. Besides this, the immense amount of labor and expense that was incurred in 1873 in getting the two million eggs of that year seemed exceedingly disproportionate to the number of eggs obtained. At this critical juncture a new idea suggested itself, which was to put a dam across the river at the fishery, which would prevent the salmon from ascending the river any higher. Their irrepressible instinct to push up the stream would, it was thought, prevent them from going down the river, and the dam keeping them from going up any further, it was believed that the salmon would collect in great quantities in front of the fishery. This idea was carried into practice in the season of 1874, and it fulfilled our highest expectations. The impassable dam was built, the river closed to the ascent of the breeding salmon in July, and before the spawning season commenced, to our great delight, they were collected in vast quantities below the dam. The great problem of securing salmon eggs on a large scale was solved. We experienced the great relief which comes when the prospect of assured success takes the place of the prospect of failure. During the spawning season of that year we took 5,750,000 eggs. The crisis was so important and the effect of our project so novel and interesting, that perhaps I may be excused for quoting something relating to the subject from my report of operations for the year 1874:

"With the time and men at my command, the construction of the bridge and dam was an undertaking of no small magnitude. The point selected for the purpose was just below the hatching-tents, where the river begins to break over a series of rapids. It was necessary to do the work here or at some similar place in order to avoid the deep holes and irregularities of the river-bed which prevailed everywhere in the channel. This necessity, however, involved the disadvantage of having very swift water to work in—so swift indeed that a boat could not be held for a moment along the whole line of the bridge without being made fast to the shore. This disadvantage was the more serious because the snow-water which forms the river is so cold that the men working in it, as they were obliged to, a great deal of the time up to their waists and often up to their necks, could not endure it long without severe suffering. Fortunately, I had with me a force of resolute men who were daunted at nothing, and through their courage and resolution these and all other obstacles were overcome. The space to be bridged over was one hundred and five feet, or, with the corral extension, one hundred and fifty feet. The line was made across the river at nearly right angles with the current. The water was from four to eight feet deep, and running with tremendous force. The river-bed was of loose, detached rocks, varying from a pound to half a ton in weight. We began the work by felling logs in the woods, cutting them into twelve-foot lengths and hewing off the ends square. Three of these lengths were then laid together horizontally and in the form of a triangle, and the ends firmly pinned together with wooden pins. Another similar triangle was then made and placed over the first, then another and another, and so on till the structure reached the required height to support the bridge at a suitable distance above the surface of the water. When this was finished the men waded out with it, with great labor, to its place in the river and fastened it there with cables till it was banked up with rocks, and the hollow space inside was also filled with rocks. When this was done, we had a solid stone pier, resting on the bottom of the river, which the current was unable to move. Another similar pier was then built and placed, and then another and another at suitable intervals, till the other side of the river was reached. The tops of the piers were then connected with logs hewn square and pinned to the piers with strong wooden pins. This completed the bridge. When it is remembered that we had neither horses nor derricks, but relied entirely on our physical strength to do all the work, it will be seen that it was no trifling undertaking. Nothing was yet accomplished, however, in arresting the passage of the salmon, as the space below the bridge was, of course, except at the piers, entirely open to them. It, therefore, now remained to dam the rapid and powerful current so that the salmon could not pass. After some deliberation it was decided to make this dam of poles about two inches in diameter, placed nearly vertically in the river, with the upper ends resting on the side of the bridge, and the lower ends against the bottom of the river. To facilitate the work of placing the poles, we concluded to make a regular fence of them, laying poles side by side about one inch and a half apart, and inserting both ends of each pole into a strong cross-piece of hewn timber running at right-angles with the poles. This having been decided on, the next thing was to get the poles. We required a thousand. The nearest that could be found in any quantity were in a forest four miles off, over a rough mountain trail. I immediately fitted out an expedition with axes, blankets, and provisions for four days. The thermometer was ranging at that time between 100° and 110° in the shade. In the sun it was hot enough to cook eggs. This made the work of lumbering rather severe; but at the end of the four days the expedition returned, having procured several hundred poles. These the choppers packed on their shoulders to the nearest point on the stage-road, whence they were brought to camp by the mule-teams returning from Oregon. I continued sending to this spot for poles until they reported the stock exhausted. We then scoured the woods in the immediate neighborhood of the camp and gathered in all the scattering ones that could be found until these were gone. There were still many more needed, which were obtained from various quarters and packed into camp on the shoulders of the men employed.

"The poles having been secured, the fence which was to form the dam was constructed on shore in sections, which when completed were taken to the bridge and dropped into the water at an angle of perhaps thirty degrees with the perpendicular of the bridge. The upper side of each section being now firmly spiked to the timbers of the bridge, the current striking it at the angle mentioned forced the bottom of the fence very tightly against the river-bed. All the sections being thus placed, rocks were then piled up around the bottom of the fence and thrust into any crevices which the salmon might get through; and this work having been extended entirely across the river, the bridge and dam were rendered complete.

"About four o'clock in the afternoon, a few days after, the passage of the salmon was obstructed, and before the corrals were made, it was announced that the salmon were making their first assault upon the dam. The whole camp collected on the bridge to witness the attack. It was a sight never to be forgotten. For several rods below the bridge the salmon formed one black, writhing mass of life. Piled together, one above another, they charged in solid columns against the bridge and dam, which trembled and shook continually under their blows. Not daunted by their repeated failures, they led attack after attack upon the fence, one column succeeding as another fell back. Encouraged by their number, and urged on by their irrepressible instinct, they entirely disregarded the observers on the bridge, and struggled at their very best to pass the unwonted obstruction. Finding the fence impassable, many fell back a little and tried to jump the bridge. This several succeeded in doing, sometimes violently striking the men on the bridge in their leaps, and sometimes actually jumping between their feet. For an hour and a half this fierce assault continued, when, exhausted by their efforts and discouraged by many failures, they fell back to the deep hole just below the rapids, arrested, for the first time since the McCloud formed its channel, in their progress up the river. The Indians, who were watching their movements, were wild with excitement over this scene, which, even after a residence of centuries on the river, was new to them."

We had no difficulty after this in obtaining all the salmon that were wanted. The subsequent season, having made the dam or fence a little closer and higher, so that no salmon whatever could get by, we took 8,000,000 eggs, and in 1878 we took 14,000,000, and could have taken probably 20,000,000 if necessary. We always after this adopted the same plan of putting a barricade across the river, and by that means collecting the parent salmon opposite the fishery, and the plan was always followed by the same magnificent results.

TAKING AND MATURING THE EGGS.

I will now pass from the capture of the fish to the taking of the eggs. About the middle of August we are in the habit of hauling the seine every two or three days to examine the condition of the breeding salmon. During the third week in August we generally find one or two ripe females, and usually more than that number of males, but it is almost always a week after this that the ripe fish appear in sufficient numbers to warrant our beginning on the work of collecting eggs. There is an extreme variation of about ten days in the time of the beginning of spawning season proper, in different years, but by the first week in September we are always fairly under way. Several days before this time arrives we build, just above where the net is drawn, and extending over the water's edge, a commodious brush house, which is simply a framework of sufficient size, covered and inclosed with green boughs. In this house the work of taking the salmon eggs is done. The covering with green boughs is accomplished by Indians and is always an admirable piece of work, and the whole structure answers its purpose to perfection. A few feet out in the river from the water's edge are sunk three large covered wooden corrals or pens, for holding the parent salmon when taken from the net preparatory to spawning. A plank floor is built out from the shore to the corrals, the whole being covered by the green boughs. When the seine is drawn ashore, six or eight men immediately proceed to examine the fish to see if they are ripe. The unripe ones are thrown back into the river. The ripe fish are put in the corrals, one sex in one compartment, the other in another one. We continue to haul the seine till it is thought that enough ripe fish have been secured, and then the fishermen if at night haul off and retire; if in the daytime, they proceed to take the eggs. After I got this part of the work systematized we took a million eggs a day with great ease, and could have taken many more if necessary. So well is the work arranged now and so thoroughly does every man understand and perform his part, that the spawning gang will sometimes fill sixty pans, that is spawn sixty females, in sixty minutes. Any fish breeder reading this will appreciate the rapidity and efficiency with which the work must be done to accomplish this result, especially when it is added that every particular about the taking and impregnating is minutely and carefully attended to, so that scarcely an egg in the whole sixty pans is lost from injury or from undue lack of impregnation. When the eggs have stood a sufficient length of time, they are taken to the hatching house in buckets, and after being measured are put in the hatching troughs.

As I have already mentioned, our first and primitive hatching works in

1872, put up in the hurry of the moment, consisted only of a set of hatching-troughs under the open sky, without a roof, and with only a board over each trough to protect the contents from the rays of the sun. The next year (1873), in order to afford shelter to the hatching troughs, which had now been removed to the bank of the McCloud River and much extended, I put up two large tents over the troughs. Under these tents the eggs were matured for several years till 1876, when I built a large and substantial hatching house in which the work of bringing forward the eggs was performed, until it was carried away by the great floods of February, 1881. In the following summer (1881) a new, large, and very convenient hatching house was erected on higher ground, and still remains the central structure of the McCloud River salmon-breeding station. To this hatching house we now bring the impregnated salmon eggs, and pour them into the deep wire trays now in use there. These trays or baskets easily hold thirty thousand eggs apiece.

The hatching apparatus used is that which is commonly called the Williamson trough, the principle of which is to force the water up through the eggs instead of flowing the water over the eggs as was formerly done. By adopting this principle the eggs can be put in the trays or baskets several layers deep. Our baskets are six inches deep and we fill them nearly three-quarters full of eggs. The eggs appear to suffer no injury from being piled upon one another to such an extent, owing probably to their being buoyed up by the water which is being forced upwards through them. They do not suffer at all from suffocation, for the same reason.

We can put over 30,000 in a tray, and consequently are enabled to mature several million in a comparatively small space. In illustration of this I will say that in the hatching house at the McCloud station there have been at one time as many salmon eggs in process of hatching as would have covered, with the old method of shallow trays, two acres of ground.

All fish culturists know that as soon as fish eggs are laid in the hatching troughs the daily examination of them and the removal of dead eggs must begin. With the small force of experienced hands at our command during the earlier history of the station, I found some difficulty in getting the eggs picked over in a satisfactory manner, the work being of such a delicate character that hardly any one could be found careful enough and of sufficiently delicate touch to go through the daily picking over of the eggs without killing them; beginners sometimes causing more dead eggs to appear each day than they had removed on the previous day. In this emergency the Indian girls and women came to the rescue and furnished precisely the kind of work that was wanted. From that time we had no more trouble about getting the dead eggs picked out. The delicate fingers and patient natures of the Indian women accomplished the work to perfection. These Indian women come regularly to the fishery every year when the proper season arrives and pick over the eggs daily until the season for hatching arrives or the eggs are sent off for distribution. Some of them, I think, have picked over the eggs every year of the ten years that the station has been in existence on the river, and the station could hardly get through the picking season without them.

The eggs develop rapidly, and very soon after the hatching troughs begin to fill up, it becomes necessary to prepare for packing them. The packing of a few thousand salmon eggs is not a very laborious task, but the packing of a million for a journey across the North American continent is a considerable undertaking. In 1878 8,000,000 eggs were packed and forwarded from this station, entirely filling two large freight cars. No little preparation is required for packing eggs on so large a scale. Strange to say, no suitable moss for packing is to be found within 50 or 60 miles of the fishery, and the only moss that I know of, even as near as that, is found at the base of Mount Shasta, and nowhere else. Accordingly, we have to get our packing moss gathered at this great distance, and brought to the station on mule teams. As soon as it arrives it is washed and twice picked over very carefully, after which it forms an excellent packing material. A suitable outside packing around the box of moss and eggs, to protect them from changes of temperature, has always been an important desideratum with us. Sawdust is practically unattainable, the cost of getting it to the station being too great. The first year (1872) we used hay. The second year (1873) we also used hay, and with the comparatively few eggs distributed those years, the expense was not very burdensome, but when we came to pack 4,000,000 eggs the next year (1874) it became essential to look around for some material for the outside packing less expensive than hay, for which we then paid $60 a ton. The Indians again came to the rescue in this emergency. Armed with knives of every description that they could find, they went out into the hills, and cut down several tons of the ferns which grow abundantly about the fishery, and brought them into camp. These ferns made an excellent packing material, and the cost was nothing like the cost of hay. We have used the ferns every year since, to pack and crate the boxes of eggs in.

In 1874, the first year that salmon eggs were packed on a large scale, another emergency connected with the packing developed itself. It arose from the fact that so many eggs must be forwarded at once. A car-load must be got ready and packed at *one* time. No plan that I had hitherto adopted would accomplish the packing of so many eggs in so short a time. So this year a division of labor was effected, and a system adopted substantially as follows: At the upper end of the hatching-house four packing-boxes are placed side by side, and at each box stands a man who packs the eggs in the box, and opposite him another man who helps spread the moss. At each end of the line of packers are seated four Indian girls with nippers to pick out the dead eggs. Just below the packers are two large tubs, kept full by a constantly-running stream of water, at each of which is stationed a man with a gauged dipper to measure the eggs in. Besides these, there are two other men in the hatching-house, whose business it is to bring the eggs to the measurer at the tubs, and two or three others on the other side of the packers to keep them supplied with moss and mosquito bar for packing. There is also one other man, who sits on one of the rafters overhead, looking down on the whole, and who keeps count of the number of layers of eggs that are put in each box. When everything is ready to proceed with the packing, the two men in the hatching-house bring the eggs to the measurers and pour them into the tubs. Here the stream of water running through the tubs cleanses them, and they are dipped out with long-handled tin measures into pans of water, which are placed on a bench in front of the Indian pickers who pick out the dead ones. When the pans have been thoroughly freed from dead eggs, they are placed on another bench, within reach of the packers, who take them up and strew their contents very skillfully and neatly over the bottom of the packing box, a layer of moss and one thickness of mosquito bar having previously been carefully placed in the box for the eggs to rest on. The packers immediately cover up this first layer of eggs with another piece of mosquito bar and a layer of moss, and, having placed a piece of mosquito bar over the moss, they proceed as before with another pan of eggs, and so on till the requisite number of layers of eggs have been packed, when the box is removed and another empty one substituted in its place, and the packing goes on.

By the method just described we were enabled to pack the eggs very rapidly, *three quarters of a million of eggs having frequently been packed in an hour*, and after this we had no trouble in getting a car-load of eggs ready in a very short time.

THE WATER SUPPLY.

The supply of water which was furnished by the little brook on which we operated the first year was of course wholly inadequate for the maturing of salmon eggs on a large scale, besides being unsuitable for the purpose in consequence of its occasional high temperature and liability to disturbances. I therefore gave up all thoughts of using it another year, and resolved that the next season I would use the river water for the hatching-house, raising it to the necessary height by some device not yet determined upon. Accordingly the next summer I moved the cabin and hatching-trough and all our belongings from the brook where we spent the first season to the north bank of the McCloud River, close to the water's edge. The device which I finally concluded upon for raising water from the river was a current wheel. The first wheel we built was only 12 feet in circumference and raised the water only about 7 feet, but by erecting the hatching-troughs on a low bar not many inches above the level of the river's surface, we made this height (or fall) answer our purpose very well. The wheel worked admirably, and I cannot too highly recommend it for similar uses in a stream that is free from driftwood during the hatching season, and is not subject to too great fluctuations. I have used a current wheel to supply the hatching-house with water at this station for ten successive seasons without a failure.

The water supply furnished by the wheel this second season (1873) was ample and constant, and, being taken directly from the very spawning grounds of the salmon themselves, was eminently adapted to its purpose. Words can hardly describe the immense relief it was to be freed from the annoyances and constant anxiety caused the year before by trying to do our work on the little, warm, muddy brook which furnished the water for the hatching-troughs. Not a drawback of any serious character once occurred in the maturing of the eggs this year, but as soon as they were sent off, it now being the beginning of the rainy season, we had to take down the tents which covered the hatching-troughs and remove tents, troughs, and all to higher ground for the winter, to save them from being carried away by the rising river, which soon came up many feet over the rocky bar where they had stood. In the mean time the wheel which was erected on two stationary piers in the river had to be abandoned to its fate, and was soon carried by the swift torrent out of sight.

The next two years, 1874 and 1875, the water supply was obtained and the hatching of the eggs conducted as in the season of 1873. Both years were a great success as far as the main object of the station was concerned, viz, the obtaining and maturing of salmon eggs, but each season's operations involved the labor and expense of tearing down our hatching apparatus every fall and re-erecting it the next spring, which seemed, and which was, unnecessary.

The considerations that had caused me to submit to it were these: If a permanent hatching-house were built, it would be necessary to place it, of course, high enough above the water to prevent its being carried away by the rise in the river, which occurs every year during the rainy season. I had thought that a current wheel large enough to raise the water to this height might be unmanageable, but the next year (1876) I resolved to try it. Accordingly, having selected a level spot 15 feet above the summer level of the river, I put up a permanent and very substantial building upon it for a hatching-house, and built a wheel 27 feet in diameter, in a current several rods above the house. This raised the water high enough to supply the hatching-house, and so far all went very well, but a sudden rise in the river during the next rainy season carried off the wheel and a new one had to be built the next year. The loss of so many wheels demonstrated pretty effectually that some change ought to be made, so the next year I put the wheel on two large flat-boats, or rather between two flat-boats, with the ends of the shaft resting on standards erected on the boat. This seemed to solve the question of a water supply for the present, and it did practically, although after the salmon-breeding station was carried away by the flood of 1881, it became necessary to build the new hatching-house on still higher ground than the old one, This in time necessitated the building of a correspondingly larger wheel in order to raise the water to the increased height now demanded. The wheel that was then constructed is now running and furnishes the water for the hatching-house. It is 32 feet in diameter and rests on boats 36 feet long and 8 feet wide. Its lifting capacity is 50,000 foot-pounds a minute.

RESULTS OF OPERATIONS AT SALMON-BREEDING STATION.

In the eleven years since the salmon-breeding station has been in operation, 67,000,000 eggs have been taken, most of which have been distributed in the various States of the Union. Several million, however, have been sent to foreign countries, including Germany, France, Great Britain, Denmark, Russia, Belgium, Holland, Canada, New Zealand, Australia, and the Sandwich Islands.

About 15,000,000 have been hatched at the station, and the young fish placed in the McCloud and other tributaries of the Sacramento River. So great have been the benefits of this restocking of the Sacramento that the statistics of the salmon fisheries on the Sacramento show that the annual salmon catch of the river has increased 5,000,000 pounds during the last few years.

UNITED STATES TROUT PONDS.

In July, 1879, I received instructions from the United States Commissioner of Fisheries to establish a station on the McCloud River, for taking and distributing the eggs of the black spotted McCloud River trout (*Salvelinus iridea*). After a careful and thorough exploration of the McCloud for 17 miles from its mouth, a suitable place was found near the mouth of a creek on the west side of the river, 4 miles above the salmon fishery. This creek is fed by a spring, and furnishes a large supply of cold water in the hottest and dryest time in summer. A trout-breeding station was built here in the fall of 1879, from which 388,000 trout eggs were distributed during the next spawning season (January–May, 1880). An immense deal of labor was expended here this year (1880) in catching parent trout for the ponds, and we were so well rewarded for our pains that by Christmas there was gathered here the finest collection of live trout in America, and probably in the world, consisting of 3,000 full-grown fish, averaging in weight 3 pounds apiece, all in good health and in fine condition. In February, 1881, just as the trout were beginning to spawn, there came the great flood of that year and washed such enormous quantities of mud into the ponds that many trout were killed, and Mr. Myron Green, who had charge of the station, was unable to send away more than 261,000 eggs.

During this year (1881) the losses among the parent trout were made up as far as possible by persistent fishing in the river, and at the next spawning season 337,500 more eggs were distributed.

The fishing for parent trout in the river is now being continued, in order to add to the stock already in the ponds, which probably contain at present about three tons weight of healthy and fine-looking fish.

I will conclude this report by giving an annual record of the most important events at the two stations of the United States Fish Commission on the McCloud River, from the beginning of operations (1872) up to the present time (1882).

ANNUAL RECORD OF OPERATIONS AT THE FISH-BREEDING STATIONS OF THE UNITED STATES FISH COMMISSION ON THE MCCLOUD RIVER.

1872.

The spawning grounds of the Sacramento salmon discovered in the McCloud River. A small station for taking salmon eggs, temporarily established on a stream on the west side of the McCloud.

Operations were begun too late in the season to accomplish any considerable results this year, but 30,000 eggs were sent to the Atlantic coast, and the very important fact was established that salmon eggs could make the overland journey to the Atlantic in safety.

1873.

Salmon-breeding station moved to the bank of the McCloud River. Hostile demonstrations were made by the natives to prevent the work from going on. Referring to this, my report for the year says:

"Our attempt to locate a camp on the river bank was received by the Indians with furious and threatening demonstrations. They had until this time succeeded in keeping white men from the river, with the exception of one settler, a Mr. Crooks, whom they murdered a few weeks after our arrival. Their success thus far in keeping white men off had given them a good deal of assurance, and they evidently entertained the belief that they should continue, like their ancestors before them, to keep the McCloud River from being desecrated by the presence of white men. Their resentment was consequently very violent when they saw us bringing our house and tents and camp-belongings to the edge of the river, and they spent the whole day in resentful demonstrations, or, as Mr. Woodbury expressed it, in trying to drive us off. Had they thought they could have succeeded in driving us off with impunity to themselves, they undoubtedly would have done so, and would have hesitated at nothing to accomplish their object; but the terrible punishments which they have suffered from the hands of the whites for past misdeeds are undoubtedly too fresh in their memories to allow them to attempt any open or punishable violence. So, at night, they went off, and seemed subsequently to accept in general the situation."

Raised the water for the hatching-house from the river by means of a current-wheel 12 feet in diameter. Endeavored unsuccessfully to keep salmon alive in corrals and pens and artificial ponds. Used a large tent for a hatching-house. Enlarged the dwelling-house. Hatched some eggs in boxes floating horizontally in the river. Took and distributed 2,000,000 eggs.

1874.

Used deep trays exclusively in maturing the salmon eggs. Built a bridge and rack across the river just above the seining ground to obstruct the ascent of the salmon. This experiment proved very successful and resulted in a yield for the season of 5,750,000 eggs.

1875.

Built large dwelling-house this year and made various improvements. Took 8,610,000 eggs. In December of this year President Grant made a United States reservation of the fishery premises by public proclamation.

1876.

Abandoned the use of tents and built a permanent hatching-house, 100 feet long by 26 feet wide. Erected a current-wheel 17 feet in diameter. Salmon eggs abundant. Took 1,000,000 eggs for the hatching-house in one day; took 7,500,000 eggs in all.

Salmon eggs were sent this year to New Zealand and to the Sandwich Islands. The eggs shipped East this year were forwarded in a freight car filled with ice, and traveling with passenger trains. The result was very successful, the loss in transportation across the continent being extremely small.

1877.

Used floating flat-boats to support the wheel instead of stationary piers. Result very favorable, the wheel rising and falling with the river, and consequently free from the danger of being carried away by high water. Had a guard of soldiers on the McCloud River this year.

Took 7,000,000 salmon eggs, of which some were sent to England, France, Germany, Holland, Russia, Australia, and New Zealand. Only 2½ per cent. loss in transportation to the Atlantic States. Two million young salmon returned to the tributaries of the Sacramento. The Columbia River salmon-hatching establishment was built this year on the Clackamas River, Oregon, by the writer.

1878.

A post-office was established here this year and named Baird, and the post-office building built. A breakwater was constructed from the river to the high land behind the buildings to protect them from high water. A second hatching-house was built at a spring near the river.

Salmon very abundant this year. In July the salmon, about sunset, were jumping in the river in great numbers. One hundred and forty-five were counted jumping in the space of a minute. There was an Indian war in Idaho this year. Dangerous threats of burning the fishery were made by neighboring Indians. All our men were furnished by the War Department with rifles and ammunition. 14,000,000 salmon eggs were taken and two car-loads sent East.

1879.

The McCloud River trout-pond station was established this year. 7,000,000 salmon eggs were taken, of which 2,000,000 were hatched for the Sacramento, and the remainder sent to the Eastern States, Europe, and Australia. The Indian war being over, the Indians were friendly again.

1880.

This was an uneventful year at the salmon fishery. Seven and a half million salmon eggs were taken. At the trout-breeding station 338,000 trout eggs were taken and a great number of large parent trout were caught in the river and added to the stock in the pond. Salmon were very abundant indeed in the McCloud River this year.

1881.

The flood of February 3 carried away almost the whole of the salmon-breeding station. During the night of February 2 the rain, which had been falling in torrents for several days, seemed to increase in volume, and the river rose at the rate of a foot an hour. Long before midnight the water had risen above the danger mark, and at half past two on the morning of February 3 the large dwelling house toppled over with a great crash and was instantly swept down the river by the irresistible current, followed soon after by the other buildings. Nothing of any consequence was left. My report for the year says:

"The men's house, where the workmen had eaten and slept for nine successive seasons, and which contained the original cabin, 12 by 14 feet, where the pioneers of the United States Fish Commission lived during the first season of 1872; the hatching house which, with the tents that preceded it, had turned out 70,000,000 salmon eggs, the distribution of which reached from New Zealand to St. Petersburg; the large dwelling house, to which improvements and conveniences had been added each year for five years, these were all gone, every vestige of them, and nothing was to be seen in the direction where they stood except the wreck of the faithful wheel which through summers' suns and winters' rains had poured a hundred million gallons of water over the salmon eggs in the hatchery, and which now lay dismantled and ruined upon the flatboats which had supported it and which were kept from escaping by two wire cables made fast to the river bank.

"The river continued to rise the next forenoon, until it reached a maximum height of 26 feet and 8 inches above its summer level. This, of course, is not a very extraordinary rise for a slow-moving river, but when it is remembered that the McCloud is at low water a succession of cascades and rapids, having an average fall of 40 feet to the mile, it will be seen at once what a vast volume of water must have been poured into this rapid river within a very short time, and with what velocity it must have come to have raised it 26 feet when its natural fall was sweeping it out of the cañon so swiftly. Those who saw this mighty volume of water at its highest point, rushing through its mountain cañon with such speed, say that it was appalling, while the roar of the torrent was so deafening that persons standing side by side on the bank could not hear each other talk.

"It must be over two centuries since the McCloud River rose, if ever, as high as it did last winter. There is very good evidence of this on the very spot where the fishery was located, for just behind the mess-house, and exactly under where the fishery flag floats with a good south breeze, is an Indian graveyard, where the venerable chiefs of the McClouds have been taken for burial for at least two hundred years, and there is no knowing how much longer. One-third of this grave yard was swept away last winter, and the ground below was strewn with dead men's bones. Now the fact that the Indians have been in the habit of burying their dead in this spot for two centuries proves that the river has never risen to the height of last winter's rise within that time, for nothing could induce Indians to bury their fathers where they thought there was the least danger of the sacred bones being disturbed by floods.

"When the waters subsided, it became apparent what a clean sweep the river had made. Here and there the stumps of a few posts, broken off and worn down nearly to the ground by the drift wood rubbing over them, formed the only vestiges whatever to indicate that anything had ever existed there but the clean, rocky bar that the falling waters had left."

An appropriation was made by Congress for rebuilding the station, and the work of restoration began in May and was completed in September, the newly erected buildings being much better than those that were destroyed. Seven and a half million salmon eggs were taken this year.

At the trout ponds many parent fish were killed by the mud which was carried by the very heavy rains into the ponds. Only 261,000 trout eggs were distributed this year. During the year many very large trout were caught in the river and put alive in the ponds.

1882.

The appropriations came so late this year that very little was done at the salmon-breeding station. Four million salmon eggs were taken, and all hatched for the Sacramento River.

At the trout ponds 337,500 eggs were taken, most of which were shipped east.

FIVE AMERICAN SALMONIDÆ IN GERMANY.

BY HERR VON BEHR.

[From Circular No. 8, 1882, of the German Fishery Association, Berlin, December 2, 1882.*]

Since it became my honorable and highly appreciated duty, seven years ago, to attend to the current business of the German Fishery Association, I have given my undivided attention to the question of benefiting our waters by introducing valuable fish from abroad. It was evident from the very beginning that this would have to be done cautiously. Fish-of-prey—if I may use this expression—were, at least in North Germany, found in sufficient number, and there was therefore no necessity for introducing such as the *Salmo hucho*. Such a foreigner might spread too easily and rapidly, and injure those fish which we prize highly. My endeavors to introduce foreign fish have frequently been criticised. Shall I simply pass these attacks in silence? I prefer to give, in brief outline, the causes of my endeavors and the thoughts which have guided me.

The principal consideration has been the great benefit which has accrued to our country from the introduction of other foreign animals and plants. I simply refer to the two well-known books, "K. W. Volz, *Beitrag zur Kulturgeschichte*" (contributions to the history of culture), and "V. Hehn, *Kulturpflanzen und Hausthiere, &c.*" (cultivated plants and domestic animals, &c.). Both these works report a long series of highly valuable plants and animals introduced into Germany from foreign countries, and when reviewing the material gathered in these two works, it may well be said that the majority of our cultivated plants and domestic animals have been introduced from foreign countries, either by ourselves or by our ancestors. This process of introducing foreign plants and animals was much slower and more difficult in olden times than now, when, thanks to steam and electricity, time and space offer no obstacles.

Let us briefly enumerate a few of these introductions.

Our present improved breed of horses is said to have come originally from the Kirgisè steppes and the vast pasture lands of Central Asia; the history of the introduction of the merino sheep is well known; the goat comes from Asia; the chickens from India; the turkey has been introduced from America at no very distant time, for in 1561 a member of the wealthy family of Fugger for the first time had a roast turkey grace his festive board; the pheasant is said to come from Mingrelia, and the rabbit from Spain. And can it be said that Germany has any

* "Fünf Amerikanische Salmoniden in Deutschland." Translated from the German by HERMAN JACOBSON.

reason to complain of having these animals introduced from foreign countries?

All that has been said applies still more to the vegetable kingdom. It is doubtful whether rye and oats are indigenous in Germany; but wheat and barley have certainly been introduced from abroad; the lupine was probably introduced into Greece from Media at the time of Alexander the Great; pease and lentils are assuredly of foreign origin; but instead of enumerating all these plants it would simply have sufficed to utter the single word "potato."

Here—where we speak specially of useful plants—would not be the place to mention the innumerable beautiful flowers which our gardens have received from foreign countries; but we cannot dismiss this subject without mentioning the number of magnificent trees which we have introduced from abroad; thus quite recently from the Caucasus: *Pinus nordmanniana;* from America: The *Wellingtonia*, *Abies Douglasii*, *Abies nobilis*, &c. We have even gone so far as to work out an elaborate plan for planting and cultivating foreign trees in the Prussian Government forests; there has also been some talk of a history of plants, which is to give, in systematized shape, the changes which plants have undergone in their local conditions.

And should fish be excluded from being artificially transported to and acclimatized in countries far from their home, at a time when we have learned how to safely transport the tender fish-eggs great distances?

In Germany fish have for a long time been transported from one province to the other. During the middle ages this was frequently done by the monks, who never failed to make exceedingly practical fish-ponds near their beautifully and favorably situated monasteries; these ponds were so well arranged that even in our days their work has still been used. In South Germany especially the history of the spreading of many choice fish, such as the Saibling and the Zander (*Amaul*), is closely interwoven with the history of the monasteries.

As far as I know, no fish have of late years been introduced from any great distance into foreign countries.

If, as I expect to show in the following, I was successful in introducing five new kinds of fish, I shall at once give the honor to whom it belongs, my excellent friend *in piscibus*, Prof. Spencer F. Baird, of Washington. He is not only at the head of the United States Fish Commission, but also presides over the noble Smithsonian Institution, whose grand object is to increase and diffuse knowledge among men. Truly Professor Baird has fulfilled the duties of his two great offices with this object in view, and our heartiest gratitude is herewith expressed. I am also under great obligations to the North German Lloyd, in Bremen, which has never refused its aid, and which, in the most liberal manner, has gratuitously carried numerous fish and fish-eggs between New York and Bremen. Who, finally, does not know from the circulars of the German

Fishery Association in what an incomparable manner our friend, Fred. Mather, has packed all these fish-eggs?

I shall now proceed to give some details relative to the introduction of different kinds of fish, for all of which I am under deep obligation to Professor Baird.

I. First of all he sent, in October, 1877, eggs of the *California salmon*. The United States and Canada have on their Atlantic coasts a salmon which is identical with our Rhine salmon, *Salmo salar*. Nevertheless millions of eggs of the *Salmo quinnat* have, at the suggestion of Professor Baird, been gathered and hatched at the Sacramento River, in California. These fish ascend the rivers of the Pacific coast, even as far as the last branches of their mountain tributaries. This salmon is highly prized in America, on account of its greater vitality and more rapid growth than is possessed by the salmon of the Atlantic coast, and attempts have been made to introduce it in all those rivers of the Eastern States which, on account of the warm temperature of their water, do not agree with the *Salmo salar*. This is not the place to enter fully on the important subject of the conditions of existence of fish as regards the degree of temperature of the water. For the case in hand, it may suffice to state that the California salmon can, in the streams of its own country, stand a degree of warmth in the water which would be fatal to our Rhine salmon.

The first batch of California salmon eggs* arrived about the same time that an important aid was given to the German Fishery Association by an annual grant from the imperial treasury. As soon as this grant had been secured, it became our duty to give some attention to South Germany, especially the Danube and its tributaries. It was a tempting thought to introduce into this great river, which possesses no migratory salmon, California salmon, and thus to bring the vast fish food of the Black Sea to the beautiful Danube country changed to delicious salmon. The journey which the salmon would have to make, as far as Sigmaringen, would not be much longer than that of the California salmon in its home, not to mention the numerous tributaries of the Danube. If the Lower Danube is, during summer, as "hot as hell," as we are told, the California streams, where they flow into the sea, are certainly not much cooler. As the Rhine salmon is not suited to the Danube, it was worth while to attempt the introduction of the California salmon.

Some five years ago, about 350,000 or 400,000 young California salmon were placed in the Danube and its tributaries from Sigmaringen to Hungary. Quite recently a well developed California salmon has been caught in the river Isar. So far, however, we have not heard that any salmon returning from the Black Sea has been caught; nor is this to be expected for the present, as this would require from four to five years, as during the first years when these attempts were made there were but few fish at our disposal, and as very probably the strange

* See detailed account in circulars 1877, p. 200.

fish would hardly attract any attention in the regions of the Lower Danube. Is this a reason why we should be discouraged or discontinue these attempts? As long as our faithful friend across the water lends us a helping hand, and as long as I am privileged to serve the German Fishery Association, my motto shall be "Persevere!" It may here be stated that the California salmon in the piscicultural establishment of Mr. Schuster, at Radolfszell, thrived so well, that he succeeded in obtaining from them many thousands of young fish; and Mr. Schuster speaks very highly of the healthy and rapid growth of these young fish. Why should we then discuss the question whether the California salmon has been definitely acclimatized in Germany. Its value to us, I must repeat it, is principally based on the hope to supply thereby the Danube and its tributaries with a migratory salmon.

II. We may, without the shadow of a doubt, state that the second fish which has been introduced from the United States, the *Salmo fontinalis*, has been thoroughly and permanently acclimatized in Germany. Eggs of this fish I have received at different times and from different sources. The eggs, with which Mr. Livingston Stone surprised me in January, 1879, developed very successfully, as I stated in circular 1879, pp. 24, 25; as also a quantity of eggs which were sent to me last winter by Professor Baird. As regards these last-mentioned eggs Counselor Bruhns, of Eutin, Director Haack, of Hüningen, Messrs. Schuster, Freiburg, and Staudinger, of Munich, can testify; and they cannot speak too highly of the young fish obtained from these eggs. Mr. Schuster—and if anybody is an authority in these matters, it is he—writes me: "The young of the *Salmo fontinalis* thrive very well, and grow even more rapidly than the California salmon; and we shall be eminently successful with these fish." Similar results can also be reported of the first-mentioned batch of eggs which were hatched in Von dem Borne's establishment. Several hundred of these young fish were placed in the establishment of Count Arnim, of Boitzenburg, and developed so successfully in that favorably located and well-conducted establishment, that as early as the autumn of 1881 several thousand eggs were obtained and impregnated. A short time ago I had the great pleasure of seeing thousands of these young fish at Boitzenburg, as also a large number of large fish, almost four years old, which for this coming autumn promise such a rich harvest of eggs that, thanks to the liberality of Count Arnim, I shall be able to supply a considerable number of piscicultural establishments with such eggs. I may, therefore, well say that *Salmo fontinalis* has been permanently acclimatized in Germany.

Is this to be considered a gain? I am firmly convinced of it, for the *Salmo fontinalis* is a "saibling," and, as I expect to show presently, a "saibling" possessing the ability to spread to an astonishing degree. If I am not mistaken, it is this fish, which we at first took for a kind of brook-trout, and which was found to be a "saibling" by Director

Haack, and that the "saibling" is a most valuable fish will be most enthusiastically affirmed by our South German friends. How much more valuable must be a "saibling" which is not confined to lakes, as is the case with our *Salmo salvelinus?* Mr. Charles G. Atkins, an assistant of Professor Baird, was kind enough to furnish, at my request, the following account of the *Salmo fontinalis:*

"A. NAME.—Our best authorities now count the *Salmoofntinalis* as belonging to the genus *Salvelinus* (Richardson). This fish is, with us, known everywhere by the common designation 'brook-trout.' In some localities, where—in lakes—this fish reaches a large size, it is known by the popular name of 'salmon-trout.' By this last-mentioned name the fish is also known in some parts of Canada, where it goes into the sea, and is often caught in salt water.

"B. LOCALITIES WHERE THIS FISH IS FOUND.—It is very generally found in the Northern States of the Union east of the Rocky Mountains, and in all the streams of British America which flow into the Atlantic Ocean or into the Hudson Bay. Farther south this fish is found in the mountainous regions, as far south as Georgia.

"C. WATERS IN WHICH THIS FISH LIVES.—It is found in all fresh waters which furnish suitable spawning-places, and do not contain too many predaceous fish, such as pike, perch, &c. These last-mentioned fish prevent the occurrence of the *Salmo fontinalis* in most of our rivers and streams, with the exception of their more northerly, and therefore colder, portions; but it is found in nearly all brooks and in the higher parts of the United States, *e. g.*, the Adirondack Mountains in New York, the Rangely Region in Maine, &c., where it is more numerous than any other fish.

"D. HABITS.—The *Salmo fontinalis*—no matter where it lives, in rivers, lakes, ponds, or in the sea, invariably selects for spawning, in autumn, gravel bottom in clear fresh water. In the forty-fourth degree of northern latitude it spawns late in October, about three or four weeks before the small lakes are covered with ice.

"E. FOOD.—Insects, crustaceans, and small fish form its food. It seems to prefer the two former.

"F. SIZE.—In the brooks the *Salmo fontinalis* generally remains small, weighing less than half a pound; in rivers and lakes it often reaches a weight of 3 pounds; in large lakes, where the conditions for its development are particularly favorable, it reaches a weight of 6 to 7 pounds, sometimes even 10 pounds. Fish weighing 10 pounds, however, have only been found in the Rangely Lakes in Maine; and even there they are of rare occurrence. The fish from the Rangely Lakes are, in all the stages of their growth, distinguished by their greater strength above the fish living in brooks; even their eggs and embryos are stronger.

"As a general rule the size of the eggs of the salmon corresponds with that of the fish; only with the comparatively small 'land-locked' salmon of the Schoodic Lakes we find larger eggs than with the larger migratory salmon (*Salmo salar*), although our ichthyologists maintain that these two fish are identical."

III. The land-locked salmon, which was introduced into Germany about a year ago, is the third American salmonidæ which we possess. Last winter Professor Baird sent us 10,000 eggs of this fish. From all I had heard about the land-locked salmon, I determined to choose deep mountain lakes in Bavaria for this fish; but I also sent 1,500 eggs each to Freiburg and Hüningen for experiments and observations. So far only the healthy development of the young fry has been reported, and further results are still to be looked for.

I meanwhile take the liberty to give the following report of Mr. Atkins, relative to this fish, which, unfortunately, reached me later than the above-mentioned eggs, and which suggests the propriety of scattering the eggs more in future. Mr. Atkins writes:

"I am not able to give you the exact depth and area of the lakes where the land-locked salmon is found; but among them there are certainly lakes which have a depth of less than 100 feet and an area of less than 1,000 acres. The largest lake in which this salmon is found, and after which it is generally called, Lake Sebago, has an extent of 50 square miles. The lakes in which these salmon are found in large number are surrounded by a flat country. Lake Sebago is situated in a flat sandy country, and on the great lake in the Schoodic Hills there is no hill higher than 600 feet over the surface of the lake. None of the lakes in question is located in a mountainous region.

"There are altogether only about twenty lakes, located in four not very extensive river regions in Maine, where this salmon (which does not migrate) is found. Relatively speaking it is, therefore, a rare fish, for Maine has hundreds of lakes.

"In the Schoodic Lakes this salmon reaches a weight of 5 pounds, and in Lake Sebago 12 pounds. In exceptional cases it reaches a weight of 10 pounds in the former lakes, and from 18 to 20 pounds in the latter. This fish is prized more highly in the United States than any other kind of salmonidæ.

"These fish commence to spawn in October, and their principal spawning-season is from November 1 to 20. Like *Salmo fontinalis*, they spawn in running streams. In small artificial basins they do not grow as rapidly as *Salmo fontinalis*. They are generally caught in May and June, but also in July, September, and during the winter months.

"The usual bait in May is the skin of salt pork; in June, artificial flies; and in winter, some small live fish."

IV. For two winters large numbers (250,000 to 300,000) of eggs of the white fish, *Coregonus albus*, have been successfully shipped to Germany from the United States; and we, therefore, possess in this fish a fourth salmonidæ.

The artificial hatching of this fish, which is highly prized in the

United States, and which, in our opinion, is closely related to our "Maräne," has in America reached a very high degree of perfection. Enormous numbers are hatched in numerous piscicultural establishments, the one at Northville, under the direction of Mr. Frank N. Clark, annually producing 15,000,000 to 20,000,000. The watching of the exceedingly small *coregonus* eggs, and the separating of the spoiled eggs from the healthy ones, has hitherto been an almost insurmountable difficulty with us; but in America this is managed in the most ingenious manner, the never-resting inventive genius of the Americans having produced a series of apparatus—one more ingenious than the other—which leaves the separating of the spoiled from the healthy eggs to the gentle force of an exactly regulated current, a self-picking system.

Quite recently Messrs. McDonald & Brown have taken out a patent for such a self-picker, which will be described in a future circular. It is well-known that our honored friend Von dem Borne has also invented a self-picking apparatus, which is constantly gaining greater favor in Germany for hatching coregonus eggs. As Raveret-Wattel reports, the highly-prized whitefish is now—thanks to the large number of young fry furnished by the hatching establishments—found in very large numbers in many lakes in the United States, where formerly it was unknown; not only in the Eastern States, its proper home, but as far as California. According to the same author, the whitefish in some lakes reaches a weight of 20 to 40 pounds, whilst in others it only has an average weight of 2 pounds.

The report of Raveret-Wattel contains much interesting matter with regard to pisciculture in the United States. The publication of the "Societé d'Acclimation" in Paris, containing this report, is to be found in the library of the German Fishery Association.

It has been mentioned as an advantage which the whitefish possesses over our "Maräne," that it is an excellent fish for hook and line fishing. Its flavor is very delicious, and of a kind that one does not easily tire of. It is, therefore, not to be wondered at that I gladly accepted the offer of eggs of this fish.

The success of shipping these eggs, during both winters, has been almost miraculous. Thanks to the excellent manner in which they were packed, there was hardly any loss during the voyage, and the young fry developed very successfully. The eggs were divided between the Lake of Constance, the Walchen Lake, and Ammer Lake in Bavaria, and the Madue Lake, the Schaal Lake, and some lakes in Mecklenburg, all very deep; and it is to be hoped that in three to four years we shall reap a rich harvest of these fish. Further particulars as to the distribution of these eggs are contained in Von dem Borne's reports in our circulars for the years 1881 and 1882.

V. The fifth salmonidae which has been successfully introduced into Germany from the United States, is the *Salmo iridea* (rainbow-trout).

Even in the illimitable territory of the American Union this fish (which so far I have not been able to consider as anything else but a genuine trout) may be termed a "recent discovery." Its home is in California. Since it has been more closely observed, it has been found to possess a rapid growth, a degree of vitality, and fecundity without a parallel among the salmonidæ, and people vied with each other in spreading it as far as possible throughout the Union. Doubts have been expressed, however, whether it has always been the same fish which has thus been spread, or whether different kinds of fish have not been spread under this name. Years ago Professor Baird had promised me eggs of this fish, but various hinderances and accidents prevented him from fulfilling his promise. It was not till the spring of this year that we received a small quantity. Of the 2,000 eggs a great many were spoiled, so that at the present time we have hardly 400 young fish of this kind in Freiburg, Hüningen, and Starnberg.

These eggs are difficult to obtain even in America, and their transportation is endangered by the circumstance that it must occur in April and May, instead of in the cold months, as is the case with the other salmonidæ.

Mr. Haack writes me, under date of September 7 last, relative to these trout: "The young fish obtained from the few eggs of *Salmo iridea* which I received have proved wonderfully successful. I have not lost a single little fish; and even now they are at least twice as large as the European trout which are five months older, and much larger than the California salmon which are six to seven months older. I have never seen anything like it." Thus writes this experienced pisciculturist.

Also in America there seems to be but one opinion as to the enormously rapid growth of *Salmo iridea*. Of late years, however, some fault has been found with the *quality* of the fish. It is alleged that its meat is not as delicate as that of *Salmo fontinalis*, and that it soon grows soft. It is even said that—in spite of the rainbow colored stripe on the sides—the appearance of the fish is not beautiful, because the spots on the sides of the fish are not red or of any other bright color, but black.

As I have mentioned above, experiments as to the value of this new fish are being made in three prominent German piscicultural establishments. If Professor Baird, as I sincerely hope, again makes an attempt to send me some eggs of this fish next spring, they, too, will be tested in these same excellent piscicultural establishments as to the value of this fish for Germany. Caution will have to be exercised *where* to place this new kind of trout. It will be wiser, for the present at least, not to allow them to share our most highly-favored brooks with our fine trout—just as little as we would place perch or pike there. If, however, as has been stated, the *Salmo iridea* is content with any kind of water, and develops successfully in places where *Salmo fontinalis* could not flourish, it would be proper to make the experiments in such places, therefore in lakes and in the lower course of rivers. In the rivers of the Western States of the Union these fish frequently reach a weight of 20 pounds. The dispute as to the value of this "hot-blooded and pugnacious" fish waxes hot in the American journals. In California *Salmo fontinalis* is being introduced, and the fish-dealers in New York doubt whether, with its ugly appearance, *Salmo iridea* will fetch the same price as *Salmo fontinalis*. In short, it is wise to exercise some caution. But Mr. Atkins, whom I consider as high authority, writes me: "*Salmo iridea* is a species of fish which promises well." It may be true that it is more advantageous to introduce "land-locked salmon" and *Salmo fontinalis*, but our prominent pisciculturists will doubtless soon have gathered sufficient experience to enable them to decide as to the true value of this fish.

We have, therefore, at present in Germany five of the best known and most highly valued American salmonidæ. It may seem somewhat hasty to propose names for them, and ask all German pisciculturists to adopt these names, before we know whether these fish have become permanently settled with us. Nevertheless, I shall venture to do this, with the view of preventing the adoption of different names which when once in use are difficult to abolish. It seems best to me to adopt the following names:

1. For *Salmo quinnat*, "*Californischer Lachs*" (California salmon).
2. For *Salmo fontinalis*, "*Bach-saibling*" (brook trout).
3. For *landlocked salmon*, "*Amerikanische Seelachs*" (American lake salmon.)
4. For *Coregonus albus*, "*Amerikanische Maräne*," (American marâne).
5. For *Salmo iridea*, "*Regenbogen-Forelle*" (rainbow trout).

Of all these names I like "Seelachs" (lake salmon) least because it is not near as expressive as the term "landlocked salmon," which much better had be translated by "firmly-nailed wanderer." I shall be glad to receive any propositions of new names for "Seelachs." All the more I am delighted with the short name "Bach-saibling," used in contradistinction to our German "saibling," which, properly speaking, only lives in deep lakes, whilst—according to Atkins and others—*Salmo fontinalis* seems, as regarding its distribution, to take exactly the place of our "Bach-forelle" (brook-trout).

So much for our American importations.

Another very fine salmon—the *Carpione*—has recently been introduced in Germany from Lake Garda in Italy; and several hundreds of these fish are, at the present time, found in excellent health and spirits, in the Starnberg establishment. The eggs of this fish were sent to us from Torbole last summer. There are in Lake Garda *Carpione* which spawn in summer, and others which spawn in winter. Why should we not try the experiment and see whether this delicate salmon-trout could be acclimatized in our waters? Another batch of eggs has been ordered for the coming winter.

There are other problems which have to be solved, relating to the sterlet and the shad. The last-mentioned fish may well be termed "the old flame of the German Fishery Association," and it must be said that the attempts to transplant the shad from American to German waters have been carried on in the most energetic manner. Quite recently Col. M. McDonald, one of Professor Baird's most active assistants, seems to have shown his intention of making new experiments in transporting shad to Europe. I look to his experiments with great confidence in the fact that the proud English adage "where there's a will there's a way" is nowhere better understood and practiced than in the United States.

Does it seem probable that the above-mentioned fish exhaust the list of those which could be introduced with us to advantage? I can hardly suppose this to be the case; for I think that even on this field of human knowledge we can serve our country still more in the future. As long as I am privileged to serve the German Fishery Association my eyes shall be open in this direction and my zeal shall not grow cold.

SCHMOLDOW, GERMANY, *November* 3, 1882.

CATCHING DOGFISH FOR OIL AND GUANO.

By B. FRANK GALLUP.

[Letter to Prof. S. F. Baird.]

Allow me to call your attention to a new industry started this season on this coast upon scientific principles, and which promises to be a success, providing there is a bounty allowed to the fishermen. I refer to the catching of Dogfish and making them into oil and guano. I have paid this season $1 per 100 fish, and the fishermen claim that the price is too low, yet it is all that I can afford to pay for them—in fact all they are worth. My views are that if the fishermen received a bounty in addition to the above price, that many more would engage in the business, and add their mite to ridding the ocean of these destructive fish.

I have this season converted the Pogie factory, formerly owned by Gallup & Holmes into using the fish, and can handle during their stay here say 1,000,000 fish, besides being instrumental in destroying twice that number in the young fish nearly matured.

EAST BOOTHBAY, ME., *September* 26, 1882.

METHOD AND RESULTS OF AN EFFORT TO COLLECT STATISTICS OF THE FISH TRADE AND CONSUMPTION OF FISH THROUGHOUT THE UNITED STATES.

BY CHAS. W. SMILEY.

In July, 1879, it was proposed by Gen. F. A. Walker, Superintendent of the Tenth Census, and Prof. Spencer F. Baird, Commissioner of Fish and Fisheries, to ascertain something of the extent and nature of the fish trade and consumption of fish throughout the entire United States. In consequence there was prepared a three-paged circular with blanks for answers, and containing eighteen brief but comprehensive questions, such as:

1. Do fish constitute an important article of diet in your town and in the adjacent country?

2. Where is the supply obtained?

3. Check on the following list the kinds commonly to be seen in the markets: (list given.)

4. What is the average retail price per pound?

5. What kinds of fish are taken from your ponds and streams? Check on the following list: (list given.)

8. Are salted and smoked fish sold?

9. What kinds? Check on the following list: (list given.)

11. Are oysters brought to your place? How are they brought—in shell, in tubs, in cans? What is the usual price?

16. Answer same questions for clams and lobsters.

18. Is fish guano in its various forms used by your farmers?

With this was sent to every postmaster in the United States a circular letter asking the assistance of himself or some one familiar with the facts, and accompanied by a circular from the Postmaster-General, instructing postmasters to furnish such information as could be given "without prejudice to the duties of their offices." An addressed return envelope accompanied each circular.

The result of this sending in general terms was as follows:

Forty-one thousand five hundred and seventeen postmasters were addressed, from whom inside of two hundred days 16,996 replies were received, or 41 per cent. At the expiration of two hundred days it was deemed best to send again, to those who had not answered, precisely the same matter as had been sent before. This was done with a very gratifying result. Twenty-four thousand five hundred and twenty-one postmasters were addressed from whom, inside of two hundred days, 13,233 replies were received. In the six hundred and eighty days that have since elapsed, but 155 more replies have arrived. This is much less than one per cent. The net result of two sendings was to get 73 per cent. of the reports desired:

Sending.	Circulars sent out.	Returns within 200 days.	Per cent. of the sending returned.	Per cent. of desired reports received.
I	41,517	16,996	41	41
II	24,521	13,233	54	32
Total	66,038	30,229	....	73

I should have preferred a third sending at the expiration of two hundred days from the second. I estimate that a third call on the remaining 11,133 offices might have produced about 6,000 more replies, and brought the per cent. of results up to 86 per cent. of what was desired.

I have taken two hundred days as the limit of returns. The number that arrive after that is very insignificant. But it will be valuable to know what results to expect earlier. Taking the total of 16,996 replies which came in the first two hundred days, the percentage which came in each of the ten twenty-day periods was as follows:

Twenty-day periods.	Number of returns.	Per cent. of all.	The days that had elapsed from the time of sending.	Per cent. of what was destined to come, which had arrived each twenty-day period.
First	9,680	57	20	57
Second	4,711	27	40	84
Third	1,313	8	60	92
Fourth	604	3½	80	95½
Fifth	314	2	100	97½
Sixth	165	1	120	98½
Seventh	72	½	140	99
Eighth	65	½	160	99½
Ninth	42	¼	180	99¾
Tenth	30	¼	200	100
	16,996	100	200	100

The return within one hundred days of 97½ per cent. of all that would arrive within two hundred days, shows that when subsequent calls are to be made one hundred days is a very good limit to fix at which to send again. The receipts under the second call were even more precipitate than the first, being augmented slightly by the driblets from the first call. It was as follows:

Twenty-day periods.	Number of returns.	Per cent. of all.	The days that had elapsed from the time of sending.	Per cent. of what was destined to come which had arrived at each twenty-day period.
First	7,862	59½	20	59½
Second	2,796	21	40	80½
Third	998	7½	60	88
Fourth	790	6	80	94
Fifth	338	3	100	97
Sixth	238	2	120	99
Seventh	112	1	140	100
Eighth	33	......	160	....
Ninth	11	......	180	....
Tenth	3	......	200	....

The case under consideration was a semi-official call upon all the States and Territories, and the effect of the call upon the different sections was very different. While the total yield of returns was 73 per cent. of the offices addressed, 95 per cent. of the Dakota offices answered, and but 61 per cent. of the Louisiana offices answered. The per cent. of answers for each State or Territory was as follows:

	Per cent.		Per cent.
Dakota	95	New Jersey	77
Indian Territory	89	Illinois	77
Washington	88	Ohio	76
Wyoming	88	Colorado	75
Idaho	87	New Mexico	73
Rhode Island	87	Missouri	72
Utah	86	Indiana	71
Massachusetts	85	North Carolina	70
Vermont	83	New York	70
Oregon	83	West Virginia	69
Michigan	82	Maryland	69
Kansas	81	Arizona	68
Maine	81	Arkansas	68
Nevada	81	Pennsylvania	67
New Hampshire	81	Delaware	66
Wisconsin	80	Tennessee	65
Connecticut	80	Kentucky	65
Minnesota	80	Georgia	65
Montana	80	Mississippi	64
Florida	79	South Carolina	63
California	78	Alabama	63
Iowa	78	Virginia	62
Nebraska	78	Louisiana	61
Texas	78		

It was to be expected that States would answer according to their degree of education and intelligence, and this is no doubt an element, but some other element has entered in here to place five Western Territories ahead of the best States. My own opinion is that the semi-official indorsement of the Postmaster-General had a far greater influence upon the new sections of the country than upon the older; that new officers answered partly because of the official indorsement, and that old ones have become somewhat accustomed to disregard such indorsements. But why Dakota exceeded Arizona 27 per cent., and the

Indian Territory exceeded New Mexico 16 per cent., I am unable to suggest, except the possibility of the loss of mails in transit, by fire, wrecking, robbing of mail coaches, etc.

A grouping of the geographical sections yields some interesting results:

New England.	Per cent.
Rhode Island	87
Massachusetts	85
Vermont	83
Maine	81
New Hampshire	81
Connecticut	80
Average	82

Great Plain Region.	Per cent.
Dakota	95
Indian Territory	89
Wyoming	88
Idaho	87
Utah	86
Montana	80
New Mexico	73
Arizona	68
Colorado	65
Average	82

Pacific Coast.	Per cent.
Washington	88
Oregon	83
Nevada	81
California	78
Average	81

The Northwest.	Per cent.
Michigan	82
Kansas	81
Minnesota	80
Wisconsin	80
Iowa	78
Nebraska	78
Illinois	77
Ohio	76
Indiana	71
Average	78

Middle States.	Per cent.
New Jersey	77
New York	70
Pennsylvania	67
Delaware	66
Average	69

The Southwest.	Per cent.
Texas	78
Missouri	72
Arkansas	68
Kentucky	65
Tennessee	65
Mississippi	64
Alabama	63
Louisiana	61
Average	68

The Southeast.	Per cent.
Florida	79
North Carolina	70
Maryland	69
West Virginia	69
Georgia	65
South Carolina	63
Virginia	62
Average	67

RECAPITULATION.

	Offices addressed.	Answers received in 680 days.	Per cent. which answered.
New England	3,176	2,616	82
Great Plain Region	1,381	1,137	82
Pacific Coast	1,528	1,236	81
The Northwest	13,157	10,239	78
Middle States	7,074	4,905	69
The Southwest	8,622	5,865	68
The Southeast	6,579	4,386	67
Total	41,517	30,384	73

For quantity, these results were entirely satisfactory. The quality of the replies was of all grades. A very large per cent., however, bore internal evidence of truthfulness. A wise discretion was needed in the compilation, but with skilled compilers excellent results could be produced. A discussion of methods of compilation, eliminating errors, etc., would be interesting, but cannot be included in this paper.

Let it not be supposed that these excellent results can be obtained only by government machinery. The official nature of this correspondence was a great aid, but I have obtained even better results from college men upon matters relating to their colleges and from specialists concerning their specialties. I therefore feel free to protest against the careless and inefficient work of this sort so often done by both public and private enterprise. Patience and perseverance in wise methods may not be all the qualifications that are necessary for good statistical work, but these are indispensable. Some of the suggestions to be made for success in collecting material are the following:

I. Make the questions very clear, concise, and as few as possible. (Better send twice than totally break down by too long requests.)

II. If but one class of persons can be addressed from each of whom an answer is especially desirable, send to all a first issue, to all who do not answer in 100 days a second issue, and to all who do not answer in 100 days more a third issue.

III. If more than one class of persons can give the facts, address all of each class, and after about seventy-five days address the delinquents a second time.

IV. Do not vary the matter sent the second time. Let it be an exact duplicate, and be sent just exactly as if it had not been previously issued.

V. Leave blank lines between the questions, so that no other paper is needed for reply, and if it can be put on a postal furnish it, more for the sake of uniformity even than for inducing people to reply.

VI. Always inclose an addressed envelope or postal for reply, and provide that there be no expense to the respondent for postage.

VII. Remember that more or less of your circulars will be misdirected, lost in transit, fall into wrong hands, arrive during the absence or sickness of your correspondents, be crowded aside for later answer, or to get some needed information, and then inadvertently overlooked, and so, do not loose faith in human nature, but rather rejoice that amid so many contingencies you can get the material at all.

Statistics are frequently laughed at, usually pushed aside as "dry" and sometimes analyzed to the serious discomfort of the author. At other times they are extolled and made the basis of the most important action. I am quite sure that these various treatments are usually just. Accurate and truthful statistics are very scarce, and, when found, very valuable. Figures often do misrepresent terribly, notwithstanding the charitable maxim that "figures never tell lies."

Whoever has prepared statistics or tested them knows that the great and fruitful cause of bad statistics is in bad methods of collecting the data. The methods are not revealed on the face of the results, and hence the insidiousness of this cause. Mailing circulars does not constitute the most effective method, but if rightly managed it is cheapest. It is especially economical in government bureaus where postage costs nothing. The most effective method is by personal visitation of skilled agents. This, from its expense, is usually out of reach of private institutions, and often out of reach of government officers. The method of personal visitation I could extol very highly from personal experience and from close examination of results of that kind of work performed by others, but the present purpose has been to treat solely of the collection of material by mail.

U. S. FISH COMMISSION,
Washington, D. C., December 10, 1882.

NOTES ON THE MENHADEN FISHERY.

By OSCAR O. FRIEDLAENDER.

[Letter to Prof. S. F. Baird.]

Very large bodies of menhaden appeared on the Long Island coast between Fire Island and Rockaway Inlet last week, and all the boats did well. They were evidently driven in by sharks, as all the steamers caught lots of them. On Wednesday our steamer, the Leonard Brightman, caught 11 sharks, none less than 8 feet long, among 180,000 menhaden. We must have had last week not less than 350 sharks at the works. The destruction of these ferocious fish by the menhaden fleet during the season must be between 20,000 and 50,000, which should not be lost sight of. Steamers fishing between Barnegat and Harrifurt report fish all along the coast. I shall be pleased to furnish you a full report of catches at the close of the season.

My theory that the menhaden leave one locality for another to find better feeding ground seems now generally adopted. Between Cape May and Harrifurt, where the largest bodies of fat fish are found, they remain in spite of great numbers of steamers going there regularly to load up. Captain Church's steamers, especially the Humphrey, had a regular harvest there, loading up twice a week for three or four weeks past. If you determine to issue a circular regarding the seines, it strikes me that you may include not to commence fishing before May 15. Some opponents of the menhaden interest seem to believe that the spawning season commences about April 1 and extends to June. I differ with these gentlemen on that score on account of the poor quality of the menhaden caught early in May, but to satisfy these gentlemen and not to hurt our interests too much I do not doubt but all northern factories would submit to a recommendation from you not to open before May 15.

36 BROADWAY, NEW YORK, *September* 11, 1882.

LIFE IN THE SEA.*

By J. B. MARTENS.

[Teacher of natural sciences at the Seminary of St. Nikolas, Belgium.]

Though the land is inhabited by thousands and thousands of different kinds of animals, differing in shape, size, and mode of life, life in the sea shows still greater abundance and variety. To further establish this assertion shall be our object in a few plain remarks based upon natural history.

I.—THE LARGEST ANIMALS LIVE IN THE WATER.

The water surpasses the land in more respects than one. It occupies by far the larger portion of our globe; so great, in fact, is the extent of water over its surface that it much rather deserves the name of "water globe" than that of terrestrial globe. If we could leave our earth and, floating through the vast expanse of the heavens, take a bird's-eye view of it, it would, seen from a certain point, show hardly anything but the water. Not only does the water occupy a greater portion of our globe than the land, but the animals living in it are also larger. This agrees with a remarkable law of nature, according to which the size of the larger species of animals is proportionate to the extent of territory limited by nature. You will pardon me if we leave the sea for awhile to take a cursory view of the land; and I hope you will become convinced of the actual existence of this law of nature.

The Old World, comprising Europe, Asia, and Africa, is the largest continent rising from the water; and here we also find the largest quadrupeds; the gigantic elephant, the heavy rhinoceros, the stout hippopotamus, the long-necked giraffe, whose head is eighteen feet above the ground, the camel, so useful to travelers in the arid desert, and the horse, so strong and at the same time so docile in man's hand.

The next largest continent is America. It was no misnomer when this continent, upon its discovery, received the name of the New World, for everything was new; and the eyes of the astonished Europeans beheld plants and animals differing from anything they had seen hitherto. Here the large animals of the Old World were wanting; not one was found as large as the horse or the ox. To-day all this is changed, for these useful animals, long since introduced into America, are numerous throughout all parts of the New World. In South America they even

* *Het Leven in de Zee. Eene Voordracht door J. B. Martens, Kanunnik, leeraar van natuurlijke wetenschappen aan het Klein Seminarie, te Sint-Nikolaas (Waas).* 24mo., pp. 48. Translated from the Dutch by HERMAN JACOBSON.

NOTE.—I have omitted numerous quotations of Scripture from the translation.—EDITOR.

live in a wild condition in herds of many thousands; but they are all descended from horses and cattle originally introduced from Europe. The largest animals of the New World, living there when it was discovered, is the tapir, or water-hog, which in its appearance really resembles the hog somewhat, and the llama, or camel-sheep, so called because it seems to be a cross between the camel and the sheep. As regards the size of these two genuine American animals, they can only be compared to the donkey.

We will now pass from the New World to Australia, the largest island of our globe, entirely surrounded by water, but as large as Europe, which forms such a small portion of the continent of the Old World. On this island—if such a name may properly be applied to so large an extent of land—we find horses and cattle, but they have been introduced there by man. The largest animal peculiar to this country is the kangaroo, a most remarkably shaped animal. Its fore feet are so short as to be entirely useless for walking; but all the longer and stronger are its hind feet, which it uses for leaping an almost incredible distance. As regards its size the kangaroo is surpassed by the American tapir and llama.

One of the largest islands of our globe—next to Australia—is Madagascar, near the eastern coast of Africa, but as regards large animals peculiar to it, it is far surpassed even by Australia. Among the small islands of Oceanica, which in large number are scattered throughout the vast Pacific Ocean, there are some whose inhabitants know only birds and the water animals found near the coast. Land animals were unknown to them until the arrival of foreign navigators. The first animals thus introduced were unfortunately such as could easily have been spared—rats and mice—which often are very numerous in vessels, and which during the unloading of the cargo were brought on shore with some of the boxes or barrels. These examples will suffice to prove that the wider the natural limits of a land, the larger are the animals peculiar to it.

In making a general comparison between land and water, we shall find another corroboration of this rule. In the ocean, which in extent far exceeds the land, life appears in much more colossal shape. The largest of all animals are the monsters of the deep. Man feels overawed on seeing for the first time the enormous elephant; but what is the elephant compared to the whale, measuring from sixty to a hundred feet in length, and correspondingly thick? This animal, although outwardly entirely resembling a fish, can, nevertheless, not be classed among the fish. It gives birth to live young ones, whilst fish lay eggs, from which the young come forth after some time. Fish breathe under the water through gills, whilst the whale has lungs, and therefore must, from time to time, come to the surface to breathe; if it remained under the water, it would either pine away or suffocate, like other animals which are accustomed to live in the open air. The head of the whale is disproportionately large, for it takes up one-third of its entire body. The mouth resembles a cave in which a company of twelve persons could easily find room. It may well be imagined what a strong current is reated in the water when the whale opens its mouth, carrying myriads of living beings into the open jaws of the monster.

There are different kinds of whales. They are found in nearly all parts of the ocean, and everywhere they appear quick in their movements. It is of course understood that they do not live in the immediate neighborhood of the coast, for such monsters require a great deal of space; and in shallow waters they are as much exposed to the danger of foundering as ships. Whenever such an event takes place, it gives rise to a terrible spectacle. The whale begins to struggle violently in order to get free; the water is lashed into a seething foam by the desperate tossing of its tail; and for a great distance the air resounds with the loud noise of the struggle. All these endeavors have frequently no other result than to cast the unfortunate animal still higher on the shore, where it falls into a sort of torpor and finally dies.

Under the skin of the whale there is a thick layer of fat, from which, by pressure or warmth, an oily liquid flows. This liquid, known as train-oil, is used for many purposes, and from a single whale sometimes a hundred and twenty tons of train-oil are obtained. No wonder that these animals are so eagerly sought after, dangerous though this chase will always be! How great is man in creation! He engages in combat with this powerful monster, which, by a single blow with its tail, can cast a boat with all its crew high up into the air like a ball. "To me," man says, "belongs this immense animal with its huge body and all the oil it contains! The monster may crush my boat like a nut-shell, if it has the chance; but in spite of this I shall approach it so close that my hand shall deal the blow which ends its life!" And thus it really happens.

II.—The sea is more densely populated than the land.

So far we have only given attention to large animals; but if we examine every living being we must say that, as far as the number of its inhabitants is concerned, the water by far surpasses the land. Is there among the land animals any which are found in as large numbers as the herring and the codfish, which for centuries and centuries have been caught by hundreds of millions without any apparent diminution of their number?

The farther north we go the fewer is the number of living beings on land; the faculty of growth seems to diminish, the plants shrink, and gradually animals become scarcer and scarcer. The sea, on the other hand, is always full of life; and in latitudes where the soil, frozen nearly all the year round, does not yield any harvest to man, he finds ample compensation for this in the fisheries, for the water which laves these northern shores contains such an abundance of provisions that it can never be exhausted.

We must here state a remarkable observation relative to the animal kingdom, from which it will be seen how great a difference exists between the population of the land and that of the sea. The large carnivorous animals, like the lion, the tiger, &c., hardly ever live in herds; as a general rule one only finds a couple of them occupying a considerable extent of territory. "This is our own exclusive kingdom," say the lion and lioness; "whoever hunts here is a poacher, and will have cause to regret his presumption. Here there is never too much game for us and our young ones."

In the sea we find still greater carnivorous animals than the lion and the tiger. Among these we must mention the different kinds of dolphins, which, from a scientific stand-point, must be classed with the whales, because they also have lungs, and are obliged to come to the surface to breathe. Although not as large as the whale, the dolphin must nevertheless be classed among the large sea animals, for its length varies from eight to twenty and even forty feet. In olden times the dolphin was considered a friend of man. It was even said that the dolphin could show affection; but, to tell the truth, its only love is for prey, and the dolphins are in reality barbarous gluttons, which make said havoc among the inhabitants of the sea. This bloodthirsty animal does not live in couples like the carnivorous land animals, but they are found in large herds or schools. Could this be possible, if those animals on which these pirates of the sea live did not increase in extraordinary numbers?

The whale also lives on live animals, but these are necessarily small, for its narrow throat is utterly disproportionate to its immense body. It may well be imagined in what enormous numbers, and how close together, these little marine animals must swim, if they are to satisfy the appetite of a monster like the whale.

In passing from the whales and dolphins to the real fish, we find that they too, with hardly an exception, are carnivorous. It may truly be said that the water is an enormous battle-field, where life is only maintained by constant slaughter. It is very easy to observe the cruel and gluttonous character of the fish. Put some of the little fish—for example, sticklebacks, so common in all our brooks—in a large glass full of water. As they are very lively, they will, in the beginning, afford more pleasure than gold fish, which please the eye by their beautiful red color, but which are so slow in their motions that one might think they are pining away or are sick. If a little worm has the misfortune to attract the attention of the sticklebacks, it is made the object of violent attacks, and is soon devoured. If you put in the glass small fish, hardly a few days old, and not any larger than little worms, not one of them will escape these greedy gluttons. So greedy are these little wretches after flesh that if properly fed they can easily be tamed. As soon as some small pieces of flesh are thrown into the water they will approach rapidly, and by repeating this experiment four or five times, they can be made to come to the surface as soon as they see the hand stretched out over the water. This spectacle, however, is soon followed by another pitiable one. The sticklebacks, confined within the narrow limits of the glass, do not find food enough, and begin to attack each other, and soon a desperate civil war is waging in the glass. The stronger pursue the weaker, and although they are not able to swallow them entire, they nevertheless inflict terrible wounds on them. Soon some of the fish may be observed which are hindered in their movements, because their tail has been bitten off either entirely or in part. The wound soon grows worse, and the poor little animal pines away and dies; but even in its death agonies it is assailed by its cruel enemies. The fish continue this war until only two are left, which retire each to a different corner of the glass. Here they sit and watch each other with eyes full of hatred and envy; and if one of them is bold enough to enter the domain of his adversary the result is a mortal combat.

If this is the way the little sticklebacks act, what can we expect from the greedy pike, the scourge of the fresh water, or the dangerous shark, which reaches the size of the large dolphins and is continually roaming about the sea, devouring everything that comes in its way? Woe to the unfortunate sailor who falls overboard in waters where there are sharks.

If we consider that nearly all fish are carnivorous and live by robbing and murdering, we must confess that the population of the sea must be infinitely larger than that of the land, for otherwise fish would not find food enough.

III.—A QUERY AND ITS ANSWER; FURTHER OBSERVATIONS.

After the foregoing the reader will perhaps be tempted to say: "If that is the way things are carried on in the water, I am inclined to believe that life in the water must eventually die out. How can any race of animals exist when such a continuous slaughter is going on? How is it that the larger of these insatiable animals have not long ago entirely destroyed the smaller ones, finally to die themselves of starvation, leaving nothing but their skeletons floating in the waters of the ocean which has by that time become a howling wilderness?" Those animals which are intended to serve as a prey to others have greater fecundity; they produce more young ones than those animals which live on them; the carnivorous animals are therefore never in want of food, which consists of weaker animals, and still the races of the latter do not die out.

It will readily be seen how life in the water does not become extinct, in spite of all the scenes of murder which are there enacted, if we remember that, as a general rule, the water animals increase much more than the land animals. There are animals which are destroyed in innumerable quantities, both by their natural enemies and by man. Such are the herring and the codfish, whose number does not seem to have materially decreased in the course of centuries. This will easily be understood when we state the fact that a single herring produces 60,000 eggs, whilst the codfish matures as many as 2,000,000. It should also be remembered that the young fry hatched from these eggs grows up without any great difficulty. Young fish know how to take care of themselves the moment they leave the egg, and father and mother need not look after them. The work of the codfish would be truly enormous if, like the birds, it had to feed its innumerable young.

The sea is not only enormously rich in fish, but also in other animals. In its depth there live and thrive a very large number of different kinds of animals, all differing from each other in size and shape, and frequently of such curious form that the limits of a brief lecture would not suffice even to give a mere enumeration of them. We must, however, devote a few words to the crustaceans, some kinds of which, like the lobster, the shrimp, and the crab, are well known to every one, because they form common articles of food.

The crustaceans are a war-like race, encased in a coat of armor from head to heel. This armor consists of a thick, chalky skin, whose joints are both strong and flexible. Besides this they are furnished with different weapons of attack. Some have shears, which in the larger kinds may even prove dangerous to man; others have a long and spear-like protuberance in front of their body; and all have powerful jaws, composed of many sharp and notched pieces.

These rascals, fully armed and almost invulnerable, do not do as much harm as might be expected, for they prefer to feed on dead bodies, even such as have already begun to decompose. Do not let us criticise this morbid taste too harshly. The crustaceans and some other animals have the duty to keep the shores of the sea clean, and for this very reason they are possessed of this desire for decaying flesh. Everything which the waves of the sea cast on the shore, and which the action of the atmosphere decomposes, falls a prey to the swarms of crustaceans, which can live out of the water for a considerable length of time.

It sometimes happens that the waves cast the dead body of a whale ashore. What great injury might be caused thereby? The air, for a great distance, becomes impregnated with the mephitic exhalations arising from this enormous mass of decaying flesh. There is danger that the entire region may become uninhabitable, for contagious diseases may be bred by the foul miasma.

But all such fears are ungrounded. The crustaceans are on hand; and on these very occasions it will best be seen in what enormous numbers they are found in the sea, especially near some of the northern coasts. From all directions they come marching in dense columns, and so great is the number of these gluttons, and so eager are they to get their fill, that all danger of the air becoming foul is speedily averted, and soon nothing is left of the enormous bulk but the skeleton. All this flesh, which had begun to putrefy, has gone into the stomachs of numberless crustaceans, and is, in part at least, to be transformed into live, healthy flesh.

IV.—What was thought in former times of the habitableness of the deep.

Ought we not, in our discourse, to make a difference between the surface of the sea and its depths? "It may be," some one will say, "that life is richer in the sea than on land; this may apply not only to the shallow waters near the coast, but also to the surface of the open sea; but in the great depths life cannot exist, or at least it cannot be varied in form and number. Physics teach us that an animal thrown into the water must bear the weight of the entire quantity of water which rests upon it. For this reason the pressure, at a depth of 500 meters, is 50 kilograms per square centimeter. Is it possible that any living being can stand such a pressure without being crushed? And what is 500 meters compared with the immeasurable depth of the ocean? Depths of 3,000 and 4,000 meters are common, and there are even some of 8,000 and more meters.

"It is true that light will penetrate the water, but not without losing some of its strength; and one generally calculates that a layer of water 100 meters thick is sufficient to entirely intercept the light. The sunshine, therefore, only acts on the surface of the sea, and a short distance below the surface everything is shrouded in impenetrable gloom. In that dark abyss no plants can grow and no animals can live; in its depths the ocean is nothing but an unmeasured, dark, and dead desert."

Thus scientists talked hardly five and twenty years ago, and this idea was then very generally entertained. Experience had not taught this, for scientists had not descended into this dark abyss with a lantern to examine it. They had not gone to sea and let down nets into the depths for the purpose of seeing what they would bring to light; for in those days suitable instruments for making such observations were unknown.

Little more had been done than to sound a few depths with a lead weight covered with glue, so that objects at the bottom of the sea might stick to it, and thus be brought to light. This way of sounding was moreover so tedious a work that it was but rarely undertaken. The plummet must be tolerably heavy, for otherwise the current will not allow it and its interminable line to reach the depths. To let the plummet down was easy enough, but to haul it up again was a labor at which even sailors could easily work themselves weary.

No, it was assuredly not from experience that scientists derived their idea that the depths of the sea were a dark desert; they only reasoned so from speculations, to engage in which they need not leave their comfortable studies. In our time it has been shown how deceptive such speculations may be, and how necessary it is to examine nature herself, and, so to speak, catch her in the very act, if you wish to learn her mysteries. Because we know that the animals of the upper world live under such and such conditions, we do not have the right to conclude therefrom that the depths of the sea remain uninhabitable.

V.—The first investigations of the depths of the sea.

About a quarter of a century ago hardly anything was known regarding the bottom of the sea. In 1855 the first serious attempt was made to study this subject, when it was proposed to connect England and America by means of a telegraph wire, which was to be laid across the depths of the Atlantic Ocean. To enter upon this important undertaking with some chance of success it became necessary to commission competent men to investigate the dark cavern of the sea with the view of finding suitable places where the cable could rest on even ground and avoid sharp rocks, where the motion of the water might cause it to wear out and break.

These investigations were made from both sides of the Atlantic by the two countries mainly interested in the undertaking, England and the United States. The vessels sent out on this expedition were supplied with all the latest and most improved instruments, especially with an entirely new kind of plummets for deep-sea soundings. These consisted of a hollow stem, with a lid at the lower end, allowing mud and other matter from the bottom to pass in, but safely retaining everything that had passed in. This is much better than the glue which was formerly put on the plummet. This stem is not heavy. In order that it may sink perpendicularly, weights are attached to it in such a manner as to cause them to drop off the moment the plummet touches the bottom. This, of course, renders the hauling up much easier, but care should be taken to have a good supply of these weights on board, as they can only serve once. It is hardly necessary to add that nowadays steam is employed in this work.

"This is all very well," people will say; "but this will not aid in solving the question whether there is any life in the depths of the sea. It would be the same as if a blind man wanted to assert that no birds fly in the air, because he does not happen to catch any in his outstretched hands."

Let us not judge rashly. The first observations showed that the bottom of the ocean was sufficiently even for the object in view. The soundings also showed that the bottom was covered with very small shells, exceedingly thin and brittle. This circumstance raised the question: How did the little animals to which these shells belonged live? Did they live near the surface, enjoying the light of the sun, and had these shells, therefore, slowly sunk to the bottom after the death of the animals? Or had they lived in these dark depths where their remains had been found? That this latter supposition might be true, was shown by the fact that starfish and other creeping animals were brought up by the plummet, animals which certainly must have lived on the bottom. These starfish, when brought up, were alive, and in their stomachs shellfish were found in an almost complete condition. It was then that scientists felt that the old belief of the uninhabitableness of the sea was giving way.

About the same time some Swedish and Norwegian naturalists began to penetrate as far as possible into the depths of the sea with the common fishing implements. They reached a depth of about 100 meters below the surface. According to the old established opinion they ought, at that depth, not to have met with a single living being. But they found, on the contrary, that at this depth life was by no means wanting; the animals which were brought up, moreover, were of strange kinds, and differed materially from those living near the surface.

A new, and hitherto entirely unknown, world seemed to open out. No time was lost in gaining further knowledge of this interesting subject, and it was not merely a thirst for knowledge which urged men to pursue these observations. The laying of the submarine cable between England and America had been accomplished, and new cables were being laid in many other parts of the sea; it was therefore important to know in what company these expensive cables found themselves at the bottom of the ocean.

It is well known that they consist of copper wires inclosed in gutta-percha tubes. Along these wires the electric spark was to travel, and there was a possibility that the tube might be injured. There might be among the inhabitants of the deep some which, attracted by the gutta-percha, could lay the metal wire bare, and thus render it useless. This suspicion was well founded, for, among the very large number of well-known marine animals, there were some which could bore holes not only in the wall of a vessel, but even in the hard rock. It was therefore necessary to learn what sort of animals lived at the bottom, and keep a strict watch over them.

English naturalists directed the attention of their government to this important subject, and requested its aid in solving this problem. Their request was granted, and a man-of-war, the Lightning, was in 1868 placed at their disposal. This was an unfortunate selection, for the Lightning was a small vessel, entirely unsuited for the purpose which it was to serve. Nevertheless Mr. Carpenter and Mr. Wyville Thomson went on a cruise of two months in this vessel between Scotland and the Faroe Islands. Everything seemed to go against them; the weather was very stormy nearly all the time, and there were but few days when they could progress with their labors; and still they succeeded in this short time in recording some important and interesting observations. They endeavored to extend their observations to greater depths than their Scandinavian colleagues. Although the sea in those parts has a depth of more than 1,000 meters, they found an abundance of life at the bottom, and the animals, which at that depth swam or crept about, did not only belong to the simple kinds, but were of many different kinds; among them also some fish.

Like the Scandinavian scientists before them, they found that the animals of the deep have quite a peculiar character, and differ in many respects very materially from those usually found near the English coasts; they seemed to be closer related to those antediluvian animals known to us by the many petrefactions dug out from the earth.

These observers expected to find the water in these depths to be nearly ice-cold, as it would be the nature of this water—being more compressed—to weigh heavier, and therefore sink to the bottom. But, on the contrary, they found sometimes cold and sometimes warm water in all different depths, according to the places from which the currents came. They found even parts of the water which, though in close proximity to each other, differed widely in their temperature, and were consequently inhabited by entirely different kinds of animals.

The results of this expedition, although undertaken under very unfavorable conditions, seemed so remarkable that the English Government resolved to continue these investigations, and during the two following years (1869 and 1870) placed another man-of-war at the disposal of the scientists. This was the Porcupine, much better adapted to the purpose than the Lightning. The naturalists also had the good fortune to meet with much more favorable weather than during the preceding year. They eagerly pursued their investigations of the mysterious world of the deep, and did not only see all their former observations corroborated, but also added many new ones. During the former expedition they had only penetrated to a depth of about 1,000 meters, but this time they reached a depth of 2,000, 3,000, and 4,000 meters, and yet did not find the uninhabitable desert which they had expected to find. At the depth of nearly a mile they found many kinds of invertebrates. If one takes into consideration the circumstances that these soundings of the deep have to be made in entire darkness, it must be confessed that, if by blindly groping about in the deep animals are constantly brought up, life in these depths can by no means be scarce, but seems on the contrary to be exceedingly abundant.

VI.—The Challenger scientific voyage round the world.

It may well be imagined with what eager attention all the naturalists of Europe followed these first observations on an entirely new field. Even the public, which is constantly taking greater interest in the progress of science, was surprised at these unexpected discoveries. From all sides the desire was expressed not to stop at these first attempts, but to continue the investigation of the world under the sea.

So far, however, soundings had only been made in the neighborhood of the European coasts. Important as the result had been, it must be confessed that all these endeavors were but trifling compared to the illimitable extent of the field. An expedition carefully prepared for exhaustive observations of the depths of the ocean all over the globe would undoubtedly prove of immense interest to science. And what nation was better fitted to take the matter in hand than England, which proudly "rules the waves," and therefore, more than any other nation, would derive benefit from a thorough knowledge of the ocean?

The English statesmen were fully aware of the vast importance of this subject, and with the consent of Parliament they opened the door of the treasury wide. A fine frigate of the Royal Navy, called the Challenger, was selected for this expedition; the guns were taken out, and she was fitted out anew, with the special view of taking observations. The vessel was manned by picked officers and men, and a number of prominent naturalists became members of the expedition, at the head of which was Mr. Wyville Thomson, who had had charge of the first observations mentioned above.

Toward the end of the year 1872 the Challenger departed on her voyage around the world, cruising in all directions in the Atlantic and Pacific. The expedition occupied three years, and on its return the Challenger had sailed more than 20,000 miles. The observations had been directed to different subjects: the temperature of the water from the surface to the bottom; the depth of the sea in various places; the nature of the bottom and the animals inhabiting it; whether the water was stationary or whether there were currents, the direction and swiftness of these currents, &c. With the excellent instruments plummets were hauled up from great depths, among them one of 8,363 meters. This was the greatest depth which was sounded, which of course does not imply that there are no greater depths in the sea, for it can hardly be expected that by chance the plummet would sink into the greatest depth of the sea.

And what do we learn, regarding this very interesting subject, from the expedition of the Challenger. The naturalists made everywhere the same observations which they had made in the first waters examined by them. Nowhere did they find a lack of living beings, and at the bottom of the sea they found all kinds of invertebrates. They also hauled up some fish which were evidently intended to live at the bottom, and which could not live anywhere else. When the fish were brought up their air-bladders protruded from their mouths, and their eyes protruded from their sockets; nothing but the great pressure existing in these depths is able to keep these organs in their places.

From the depth crustaceans were brought up as well formed as those of the surface waters, but they were either entirely blind or had no eyes at all. "No wonder," people will say, "for these organs are entirely useless in the dense darkness prevailing in these depths." Granted; but what do those animals which have eyes, and which also live in the depths, do with those organs? Are we certain that there is in these depths an entire absence of light? A remarkable statement made by the naturalists of the Challenger seems to make this matter somewhat doubtful. Who does not know the glow-worm, which shines so brightly in the darkness? Such light-giving animals are also found in the water, some of them even in such vast quantities as to make the entire surface of the sea to shine. Polyps have been brought up from the deep, small animals which grow fast to the bottom, and are there found in enormous numbers, outwardly resembling a vegetable product. To illustrate this, imagine every grain in an ear of corn to be a living animal, and imagine even the stalk full of them. These polyps also give out light when they are touched. Behold here the living corn fields of the deep! If a fish swims over them his track is marked by a streak of light. Might it not be possible that, under certain conditions, these submarine living corn fields could throw out light and thus banish darkness from these depths?

Another question has also attracted the attention of the naturalists, "On what do the animals of the deep live?" We have spoken above of the large number of carnivorous animals in the sea, but all these animals cannot possibly live in this same manner; some kinds, which become a prey to others, must necessarily find their food in the vegetable kingdom. This kingdom is represented in the sea, but only near the surface; it does not, like the animal kingdom, extend into the depths. What food, therefore, is found in the depths on which those primitive animals, which serve as food for other higher animals, could feed? To this the naturalists reply that the water of the sea contains nutritive matter, originating from the rivers which empty into the sea, from the waters of the surface, from the numberless decaying animals, &c. The water must, therefore, be considered as the food and drink of some animals.

The naturalists of the Challenger were the first to confess that they are still far from possessing a complete knowledge of the ocean. Astronomers assert that the human race, even after a thousand centuries, shall not have exhausted the study of the heavenly bodies. Who would, therefore, maintain that the same cannot apply to the animals of the sea? How can we ever expect to finish the observations of the illimitable deep if a single glass of water from any of our ponds, when viewed through the magnifying glass, shows enough living beings to occupy the lifetime of a man.

We know, however, enough of the sea and its bottom to conquer the prejudice which only twenty-five years ago was very widespread, viz, that the sea—inhabitable near its surface—presented in its depths nothing but a dark, dead, and eternally silent desert.

A BILL PROPOSED TO THE MARYLAND LEGISLATURE AT THE SESSION OF 1876, AND ENTITLED "AN ACT TO REGULATE THE CATCHING AND TO PROVIDE FOR THE PRESERVATION OF FISH IN THE WATERS OF THE STATE AND OF THE POTOMAC RIVER."

By MR. KNIGHT.

SECTION I. *Be it enacted by the general assembly of Maryland,* That no person shall catch or take shad or herring in the waters of the State and in the Potomac River before the fifteenth of March or after the first day of June in each year.

SEC. II. *And be it enacted,* That during the season for fishing for shad and herring, as above provided, no person shall take or catch with seine, fyke-net, gill-net, or net of any kind, or with weir or fixed apparatus of any kind or description, any fish between the hours of twelve o'clock m. on Saturday and twelve o'clock midnight on Sunday in each week.

SEC. III. *And be it enacted,* That no person shall fish for or take or catch any kind of fish with seine, fyke-net, or gill-net, or net of any kind or description, or with weir or other fixed apparatus of any kind or description, without first having obtained a license therefor, as hereinafter provided.

SEC. IV. *And be it enacted,* That the comptroller of the treasury shall issue, through the clerks of the several circuit courts of the State, or the clerk of the court of common pleas of Baltimore City when the person applying is a resident of Baltimore City, to a person who is a bona fide resident of the county or city where the application is made, a license to commence on the first day of March and to hold good for one year, to fish, and to take and catch fish with seine, gill-net, fyke-net, or net of any other description, or with weir or other fixed apparatus, in any of the waters of this State, subject to the exceptions and provisions in this act.

SEC. V. *And be it enacted,* That every license to fish as aforesaid shall state the name and residence of the person to whom the same is granted; the description of the seine, net, or other apparatus to be used; the number of square yards of seine, net, or other apparatus when rigged, and that he is the bona fide owner of the same; but no such license shall be granted unless the person applying for the same shall make oath before the clerk of the court authorized to issue the same, or before some justice of the peace of the same county or city, upon whose certificate that such oath has been made the clerk may issue such license that the facts required to be stated in said license are strictly true, and that he will comply with all the laws of this State regulating the time and manner of catching fish.

SEC. VI. *And be it enacted,* That the clerks of the several circuit courts of this State, or the clerk of the court of common pleas of Baltimore City, as the case may be, shall collect before granting such license one cent per square yard for every square yard of haul-seine of one-inch mesh, and one quarter of one cent in addition thereto for every square yard for every quarter of an inch decrease from one inch in size of mesh, and one-eighth of one cent less for every square yard for every increase of one quarter of an inch over one inch in size of mesh.

SEC. VII. *And be it enacted*, That every person applying for a license to fish with a gill-net shall pay for the same one cent per square yard for every square yard of net whose mesh is less than one and one-half inches, and three-quarters of one cent per square yard of net whose mesh is over one and one-half inches and less than two and one-half inches, and one-half of one cent per square yard for every square yard of net whose mesh is over two and one-half inches.

SEC. VIII. *And be it enacted*, That every person applying for a license for a weir, fyke-net, pound-net, or fixed apparatus, or apparatus of any kind for fishing, other than a haul-seine or gill-net, shall pay one cent per square yard for every square yard of fence or leader, and shall also pay in addition for every square yard of the bowl or pocket of the said weir, fyke-net, pound-net, or other apparatus, at the rate, and as prescribed in this act for haul-seines.

SEC. IX. *And be it enacted*, That for the purposes of this act, the meshes of all seines and nets of every description whatever shall be measured by the length of the side or bar of the mesh.

SEC. X. *And be it enacted*, That no license shall be required for any seine which is hauled and emptied exclusively in such inclosures as are commonly known as "ponds:" Provided, however, that if the owner or owners of such seine shall haul and empty the same in any other manner, he or they shall, unless licensed as hereinbefore provided, be deemed guilty of fishing with a seine without license, and liable as hereinafter provided for such offense.

SEC. XI. *And be it enacted*, That the clerks of the several courts as aforesaid shall each account to the comptroller of the treasury, in his next quarterly return, for all funds obtained from licenses granted under this act, and such return shall contain a statement of the number of such licenses issued, to whom issued, and the size and character of the fishing apparatus for which each license was issued, and all funds which come into the State treasury from such licenses shall be placed to the credit of a fund to be called the "State fishery fund," and the same shall be paid out upon the warrant of the comptroller, to be issued upon the requisition of the commission of fisheries, subject to the approval of the governor, and to be used in purchasing or leasing sites, erecting and providing implements, equipments, and ponds for fish breeding, and for payment of the salaries of the fish wardens.

SEC. XII. *And be it enacted*, That no fish-pot or fish basket shall be licensed except for the Susquehanna River, but the same shall be deemed a nuisance to be abated by any citizen or resident of the State, and it shall be the duty of the fish wardens and the State fishery force, to demolish and remove the same wherever found, except those licensed in the Susquehanna River as herein provided for, after the expiration of three months from the passage of this act, and no person shall use or take or catch any fish in a fish-pot or fish-basket in the Susquehanna River without first having obtained a license therefor as herein provided, for which license he shall pay two cents for every foot of wall-fence or ladder attached to or connected with such fish-pot or fish-basket, and no license shall be issued to construct or use, or to take or catch any fish in, any fish-pot or fish-basket whose slats shall be less than —— inches apart, and any person using a fish-pot or fish-basket, or taking fish therefrom, in the Susquehanna River, without first having obtained such license, shall be fined fifty dollars for the first offense and one hundred dollars for each and every subsequent offense; and it shall be the duty of the fish wardens to inspect frequently the said fish-pots or fish-baskets in the Susquehanna River during the season in which they are operated, and see that they are constructed and operated in accordance with the provisions of the license, and any person or persons found violating the terms of the license shall be deemed guilty of fishing without a license.

SEC. XIII. *And be it enacted*, That if any person shall fish for or take or catch any kind of fish with seine, gill-net, or net of any kind or description, or with weir or any kind of fixed apparatus without first having obtained a license as hereinbefore provided, he shall forfeit his boat or boats and apparatus for catching fish so being used, and shall also be fined fifty dollars.

SEC. XIV. *And be it enacted*, That if any person shall fish for or take or catch any shad or herring before the fifteenth day of March or after the first day of June in any year, such person shall be fined fifty dollars, and shall also forfeit his boat or boats and fishing apparatus.

SEC. XV. *And be it enacted*, That no person, whether licensed, as hereinbefore provided, or not, shall be allowed to take from any river or stream any fish which have been introduced into such river or stream by the Commission of Fisheries, and which were unknown in such river or stream before their introduction therein by the said commission, until after three years from the time of the introduction of such fish, and any person offending against the provisions of this section shall be fined five dollars for each fish so taken.

SEC. XVI. *And be it enacted*, That no person shall be allowed to take or catch the fish known as "black bass" in any of the waters of this State or in the Potomac River in any manner whatever except by angling, and any person offending against the provisions of this section shall forfeit his boat and fishing apparatus, and shall also be fined five dollars for each fish so taken.

SEC. XVII. *And be it enacted*, That no person shall haul, drift, or fish any seine or gill-net within the water bounds or berths of any regular fishing landing in this State and in the Potomac River, nor opposite to any part of the shore of the owner or occupier of any such landing, within hauling distance from such shore, between the fifteenth day of March and the first day of June in each year without the permission of the owner or occupier of such fishing landing, and any such person so offending shall be fined not less than fifty nor more than one hundred dollars for the first offence, and for the second offence he shall be fined one hundred dollars, and shall also forfeit his seine, gill-net, boat, and all his fishing apparatus.

SEC. XVIII. *And be it enacted*, That the owner or owners of all dams erected now or hereafter in or across any of the rivers of this State, or streams running into such rivers, or the Potomac River, or streams running into said river, shall make and keep in repair, properly constructed fish ladders or fishways, to be placed on said dams so as to afford to the fish in said rivers or streams, free course up and down said river or streams, and if any owner or owners of such dams shall fail to comply with this provision within six months from the passage and approval of this act, he or they shall be deemed guilty of a misdemeanor, and upon conviction thereof in the court of the county where such owner resides, or in the criminal court of Baltimore city, shall be fined not less than three, nor more than five hundred dollars, and such dam shall be deemed a nuisance and liable to be abated as other nuisances under the laws of this State.

SEC. XIX. *And be it enacted*, That no person shall catch, take or fish for any fish from off or on any fishways or fish ladders in any of the waters of this State, or of the Potomac River, and any person offending against this provision, shall be fined one hundred dollars, and shall forfeit all his fishing apparatus.

SEC. XX. *And be it enacted*, That if any person during the season for fishing for shad and herring as hereinbefore provided for, shall take or catch with seine, gill-net, fyke-net, or net of any kind or description, or with weir or fixed apparatus of any kind or description, any fish of any kind between the hours of twelve o'clock m., on Saturday, and twelve o'clock midnight, Sunday in each week, he shall be fined one dollar for every fish so taken.

SEC. XXI. *And be it enacted*, That from and after the passage of this act it shall not be lawful for any person to take, capture or destroy any fish by seine, gill-net, or net of any kind or description, or by fish-basket, fish-pot, weir, or any fixed apparatus of any kind or description, except as is herein provided in the case of the Susquehanna River, or to destroy or capture any fish by shooting or striking them on the ice anywhere beyond one mile above tidewater in any of the waters of this State, or of the Potomac River: *Provided*, That it may be lawful to use without having obtained a license therefor, a dip-net for landing large fish in angling, and for taking to be used as bait the small fish commonly used for this purpose by anglers, and any one violating the provisions of this section, shall, upon conviction, be fined not less than ten nor more than fifty dollars.

SEC. XXII. *And be it enacted*, That upon information given upon oath to any justice of the peace, accessible or convenient to the place where the offence is committed, of any violation of any of the provisons of this act, the said justice shall forthwith issue his warrant for the arrest of the offender or offenders, and for the seizure of the seine, net or other apparatus, and of the boat or boats and other fishing outfit, which shall be directed to the sheriff, or any constable of the county where the said justice of the peace resides, or of Baltimore city, if said justice resides in Baltimore city, or to any of the commanders of the State fishery force, and it shall be the duty of the sheriff, or other officers to whom such warrant may be directed, to arrest the person or persons named in the warrant, and also to seize the seine, net or other apparatus, and boat or boats, and to bring the offender or offenders before the justice issuing the said warrant, and upon conviction of the said offence, the justice shall impose the fine or fines provided by this act, and shall decree a forfeiture of such seine, net or other apparatus, and boat or boats, and upon the failure of the said offender or offenders to pay the fine or fines imposed, the justice shall commit him or them until such fine is paid.

SEC. XXIII. *And be it enacted*, That if the name of the offender is unknown, he may be arrested as above provided, on a warrant describing him as the person committing the offence, without stating his name in the warrant.

SEC. XXIV. *And be it enacted*, That it shall be the duty of the sheriff or other officers authorized to serve a warrant issued by a justice of the peace, for a violation of any of the provisions of this act to arrest, with or without warrant, any person or persons found violating any of the provisions of this act, and to seize the seine, net or other apparatus, or boat or boats, in cases where forfeiture of the same is provided, found being used in violating any of the said provisions, and to bring such person or persons before some justice of the peace, convenient or accessible to the place where such offence was committed, whereupon such justice shall proceed as is herein provided for cases where such person is brought before him under a warrant issued upon oath.

SEC. XXV. *And be it enacted*, That if any person or persons shall, by threat, menace, or otherwise, attempt to deter or prevent any sheriff, constable, fish warden, or any other persons from enforcing or carrying into effect this act, or any part thereof, he or they so offending shall be guilty of a misdemeanor, and on conviction thereof shall be punished with a fine not exceeding one hundred dollars, or by imprisonment not exceeding three months, or either or both, at the discretion of the court before which such offender or offenders shall be convicted.

SEC. XXVI. *And be it enacted*, That all seines, nets, or other apparatus, or boat or boats, condemned to be forfeited under the provisions of this act, shall be delivered by the sheriff, or other officer making the seizure, to some constable of the county, to be selected by the justice before whom the matter was tried, and shall be by him sold at public sale on ten days' notice, given by written notice to be set up at three of the most public places in the neighborhood of the seizure, and the proceeds of sale after deducting the expenses thereof shall be paid to the school fund of the county where the offence was committed.

SEC. XXVII. *And be it enacted*, That all fines collected for a violation of any of the provisions of this act shall be paid, one-half to the informer and the remainder to the school fund of the county where the offence was committed.

SEC. XXVIII. *And be it enacted*, That every person convicted under the provisions of this act shall have the right of appeal to the circuit court of the county where the offence was committed, or to the criminal court of Baltimore City, if the offence was committed within the limits of Baltimore City, but executions of the judgment of the justice of peace shall not be stayed unless the party appealing shall give bond to the State of Maryland for double the amount of fine imposed and value of the property decreed to be forfeited, with security approved by the justice rendering the judgment, with condition to prosecute his appeal with effect, or to pay the fine imposed, with all costs, and also to deliver up to the sheriff or other officer making the seizure the property decreed to be forfeited.

SEC. XXIX. *And be it enacted*, That if any person applying for a license as hereinbefore provided shall swear falsely to any of the facts required to be sworn to by him, he shall be deemed guilty of perjury, and liable to be proceeded against by indictment and otherwise, as in other cases of perjury, and shall also forfeit his seine, bet, or other apparatus, and be fined fifty dollars, the same to be enforced as other fines and forfeitures under the provisions of this act.

SEC. XXX. *And be it enacted*, That the State of Maryland hereby declares her assent and approbation to the passage by the State of Virginia of a law containing the general provisions of this act, to regulate the taking and for the preservation of fish in the Potomac River; and in the event of the passage of such a law by the said State, and the assent and approbation of the said State duly declared being given to the passage of the act, then nothing herein contained shall be construed to prevent a resident of Virginia holding a license issued under such law from fishing in the waters of the Potomac River, subject to the other provisions of this act.

SEC. XXXI. *And be it enacted*, That in case the State of Virginia shall enact a law similar in its general provisions to this act, and shall give her assent and approbation to this act with reference to fishing in the Potomac River, then citizens of either State when arrested for a violation of any of the provisions of this act, or of such act to be passed by the State of Virginia relating to the said river, by any officer of either State authorized to arrest therefor, shall be delivered up for trial to such officer of the State of which the offender is a citizen, as may be authorized to arrest under the law of such State, unless arrested for hindrance or disturbance of the fisheries on the shores of the other State, in violation of any of the provisions of this act, in which case he shall be tried in such other State; and persons who are not bona fide residents of either State, who may be arrested for a violation of any of the provisions of this act relating to the Potomac River, shall be tried in the State of the officer making the arrest, and in all questions of citizenship the burden of proof shall be on the offender.

SEC. XXXII. *And be it enacted*, That the commissioners of fisheries, and such other persons to whom the said commissioners may give authority in writing, shall be allowed at all times, and in any manner, to take any fish in any of the waters of the State, or in the Potomac River, for purposes of propagation and for scientific purposes.

SEC. XXXIII. *And be it enacted*, That nothing herein contained shall prevent any person from taking fish on his own shores for family use during the seasons, and between the periods allowed by this act, and subject to the provisions relating to such fish as have been introduced into the waters of this State by the commissioners of fisheries.

SEC. XXXIV. *And be it enacted*, That the commissioner of fisheries, be, and the same are hereby declared to be, members ex officio of the board of commissioners of the State fishery force, and it shall be the duty of the said board thus constituted, and especially of the several commanders of the vessels used in the said force, to enforce all laws of this State relating and regulating the catching of fish in the navigable waters of this State, and of the Potomac River, as well as those relating to the catching of oysters.

SEC. XXXV. *And be it enacted*, That the governor shall, upon the recommendation of the commission of fisheries, appoint not more than twelve persons to serve as fish wardens in certain limits and localities to be assigned each by the commission of fisheries, and the said wardens shall be charged with the enforcement of the laws relating to and regulating the catching of fish in the waters of the State and of the Potomac River, and more particularly in those waters beyond the reach of vessels of the State fishery force, and they shall frequently visit the fishing shores and grounds, especially during the fishing season, and such persons so appointed shall receive, in addition to such sum as he may become entitled to as informer, as a salary, a sum not exceeding one hundred dollars per annum, to be paid out of the fund herein provided for, to be known as the State fishery fund; and such wardens shall be removable at any time by the governor upon the recommendation of the commission of fisheries, and in the event of such removal they shall be paid at the rate of not more than one hundred dollars, and only for the time of their actual service.

SEC. XXXVI. *And be it enacted*, That all acts and parts of acts, whether of the public general or public local laws, inconsistent with the provisions of this enactment, be and the same are hereby repealed.

SEC. XXXVII. *And be it enacted*, That no non-resident shall take any fish in any of the waters of this State, except by angling or with hand-line, and nothing in this act shall be so construed as to exempt any one from the operation of the several local laws of this State, where and to the extent that such local laws superadd to the requirements of this act.

SEC. XXXVIII. *And be it enacted*, That this act shall take effect from the time of its passage.

EELS (ANGUILLA ROSTRATA) IN NEW BEDFORD WATER PIPES—MACKEREL ABUNDANT IN AMHERST RIVER.

By WILLARD NYE, Jr.

[Letter to Prof. S. F. Baird.]

I send by express several eels that came out of the water-supply pipes of this place. Now, it struck me that they might be the descendants of the salt-water eels that ran up the Amherst River and got caught there when the water-works dam was made, over ten years ago, and that they had taken what they thought the shortest way back to salt water. They were first noticed in the pipes soon after the nights began to be chilly, and the most trouble from them was in the lower part of the city near the salt water, where they took over thirty out of one pipe. The one in the jar that got stuck in a pipe shows how anxious they were to get along.

This year mackerel have struck into our rivers in great quantities, and they ran higher than I have ever seen them here before. There were three sizes, viz, about seven, ten, and a few fourteen inches long, and they must have been driven in here by some kind of fish, as a large per cent. of them showed marks of teeth on their sides, and they did not look like blue-fish bites. I thought it might be of interest, as there has never since I can remember been one-tenth as many mackerel in our rivers in any season, and when they were here they were of the small size.

NEW BEDFORD, MASS., *October* 27, 1882.

NOTES ON THE MOVEMENTS, HABITS, AND CAPTURES OF MACKEREL FOR THE SEASON OF 1882.

By CAPT. J. W. COLLINS.

The mackerel fishery ranks among the most important of our great food-fisheries, and in some respects—especially that of international consequence—it takes precedence of all others. Nearly all of the claim made by the Canadian Government against the United States at Halifax, in 1877, was based upon the supposed advantage derived by American fishermen from having the privilege of catching mackerel in British waters. And for this concession our government paid $5,500,000. In view of this fact, therefore, it seems desirable that some record should be kept of the most interesting and strongly-marked features of the mackerel fishery, especially of the movements and habits of the fish, so far as these can be ascertained. If this is done from year to year, we shall soon be in possession of much information on a subject concerning which somewhat indefinite ideas have prevailed in the past. With this object in view these notes are presented. They have been gathered from various sources, but chiefly from some of the most reliable and intelligent men engaged in the mackerel fishery, with whom I had an opportunity of conversing during my stay at Gloucester the past summer and autumn (1882).

The mackerel appeared at the usual time off the coast of the Middle States, and in about the same locality in which they have generally been found in early spring. The first fare of fresh mackerel for this season was brought to New York on April 1, by the schooner Nellie N. Rowe, which, according to Mr. W. A. Wilcox, secretary of the Boston Fish Bureau, had taken 50 barrels of large-sized fish, averaging 11 to 15 inches each in length. The first catches were made between the parallels of 36° and 39° north latitude, and the meridians of 72° and 75° west longitude.*

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* The following list of the early catches of mackerel on the southern coast from 1878 to 1881, inclusive, taken from the History of the Mackerel Fishery, will show with much exactitude and clearness when and where these fish are first met with as they approach the coast in the spring:

EARLY CATCHES OF MACKEREL, 1878 TO 1881.

The earliest catches of the past three years are shown in the following notes:

EARLY CATCHES OF MACKEREL IN 1878.

March 30.—Schooner Lillian, of Noank, Conn., Captain Latham, off Chincoteague.

April 16.—Schooner Sarah M. Jacobs, of Gloucester, Capt. Solomon Jacobs, caught her first mackerel in latitude 36° 10′ N., longitude 74° 45′ W.

April 18.—Schooner Alice, of Swan's Island, Me., Capt. Hanson B. Joyce, master, caught her first mackerel 25 miles southeast from Cape May.

 April 19, 1883.

In connection with first catches of mackerel by the schooners off our southern coast, it may not be out of place to allude to the fact that many individuals of this species were found in the stomachs of cod taken off the New Jersey coast several weeks before the commencement of the mackerel seining season. Capt. F. M. Redmond, master of smack Josie Reeves, of New York, who for many years has been engaged in the winter cod fishery, says that nearly every spring, for the past six or seven years, he has found mackerel, both large and small, in the stomachs of cod two or three weeks before the capture of any mackerel by seiners. He states further that in the latter part of February, 1882, he found a great many mackerel inside the cod which he took 10 or 12 miles off Egg Harbor, N. J., in 12 to 15 fathoms of water. Nor, according to the same authority, was it an uncommon occurrence to find from 15 to 25 mackerel in the bottom of each dory, these fish having been thrown out by the cod with which the boats had been loaded. Captain Redmond also says that frequently menhaden are found in the stomachs of codfish several weeks before the former are seen in schools off the coast. In nearly every instance these expectorated fish, menhaden or mackerel, were in a perfectly fresh condition, which would indicate that they had been swallowed but a short time. Whether these mackerel had been eaten by the cod at some distance from the coast or on their regular feeding grounds, where the cod are caught, is a question which must be settled by future investigations. It seems only reasonable, however, to suppose, as above stated, that the mackerel had been swallowed but a short time, as otherwise they would, when thrown up, have been in a very decomposed state. We are, from these facts, led

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April 25.—Schooner John Somes, of Swan's Island, Me., Capt. J. S. Staples, master, caught her first mackerel 50 miles southeast from Cape May.

EARLY CATCHES OF MACKEREL IN 1879.

April 12.—Schooner Sarah M. Jacobs, of Gloucester, caught first mackerel in latitude 36° 35′ N., longitude 74° 50′ W.

April 13.—Schooner Augusta E. Herrick, of Swan's Island, Me., Capt. William Herrick, caught first mackerel (130 barrels) in latitude 37° 37′ N., longitude 74° 23′ W.

April 13.—A few fish taken by schooner S. G. Wonson, of Gloucester, 75 miles south-southeast from Cape Henlopen.

April 14.—Schooner Charles Haskell, of Gloucester, caught first mackerel in latitude 38° 8′ N., longitude 73° 57′ W.

April 19.—Schooner Alice, of Swan's Island, Me., caught first mackerel (140 barrels) in latitude 37° 50′ N., longitude 74° 3′ W.

EARLY CATCHES OF MACKEREL IN 1880.

April 1.—Schooner Edward E. Webster, of Gloucester, Capt. Solomon Jacobs, caught the first mackerel of the season in latitude 35° 30′ N., longitude 74° 15′ W.

EARLY CATCHES OF MACKEREL IN 1881.

March 20.—Schooner Edward E. Webster, of Gloucester, caught the first fish of the season, and the earliest on record, in latitude 37° 10′ N., longitude 74° 5′ W. A second fare was caught by the same vessel on April 18, in latitude 38° 38′ N., longitude 74° W.

to infer that stragglers from the main body reach the coast several weeks in advance of the main schools, which are sought and captured by the seiners.

For a few days after the first appearance of the mackerel this season, there was nothing remarkable in their movements; but, as they passed towards the north, the principal body of the fish, according to Capt. Henry B. Thomas, of Gloucester, came much closer to the shore than usual, moving along the New Jersey coast in water averaging 15 to 25 fathoms deep, while good catches were also made inside of the light-ship on Five Fathom Bank, off the mouth of the Delaware, as well as between the shore and the light-ship lying off Sandy Hook, at the entrance to New York Harbor. It is a somewhat rare occurrence for mackerel to be taken so near the shore in spring. At the same time, however, according to Captain Thomas, some of the fishing schooners met with large schools of small-sized mackerel some 70 miles off-shore, in a direction about south-southeast from Sandy Hook. Several large fares of these were obtained.

The main body of the mackerel, composed of the largest fish, exhibited such a decided tendency to keep close to the shore during the spring, that it was predicted by the fishermen that the schools would "play in" near the coast when north of Cape Cod. This, however, proved to be a mistaken opinion, for, as a rule, the chief part of the mackerel after entering the Gulf of Maine, kept far off-shore, while only scattering schools were met with on the shoal grounds near the land, which are generally the favorite haunts of the species in summer.

During the last few days of May and the early portion of June, the movements of these fish presented some peculiar phases which have been rarely noticed in former years. A large body of mackerel, passing through the South Channel, moved on between Cape Cod and George's Bank in a northeasterly direction. From its left wing scattering schools reached in near the land, extending, in some cases, as far as Massachusetts Bay and the shores of Cape Cod; while from the right flank other schools passed across George's Bank and gathered in great masses about the western part of Nova Scotia, in which locality the fish appear to have remained for a much longer period than usual. This detention in the waters of Nova Scotia may probably be accounted for by the fact that, for many weeks previously and at that time, great quantities of ice had been collected about the eastern coast of that peninsula, off Newfoundland, and on the Grand Bank, from March until well into June. Frequent mention of this fact was made by the press.* This

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* As an instance, the two following paragraphs appeared in the Boston Herald of June 10:

"SAINT JOHN'S, NEWFOUNDLAND, *June* 10, 1882.—It is reported that the schooner Ripple is imbedded in an ice-pack 20 miles off Fogo Island, and her crew of twenty-two men are starving. The steamers Vola and Benacre are also in the ice. The steamer Hercules has been sent to their assistance. Bark Petunia, from Cadis, regreat accumulation of ice would naturally lower the temperature of the ocean so much along the eastern coast of Nova Scotia as to deter the mackerel from making their spring migrations in that direction at the usual time.

The numerous pounds and fish-traps about the western part of Nova Scotia, especially from Yarmouth to Barrington, profited by this halt of the fish, and caught larger quantities of mackerel, in some instances, than the weirmen could properly care for. These fish were said to be, for the most part, remarkable for their large size, being, according to several statements, much larger than any mackerel caught elsewhere during the season. I cannot, however, vouch for the verity of this statement, as from my examination of several barrels which were brought thence by a Gloucester schooner, I failed to note anything remarkable regarding their size, though it is true a majority were above 13 inches long. While these schools were filling the waters between Cape Cod and Cape Sable, there was yet another body of mackerel bringing up the rear in the waters off Noman's Land. These, however, were smaller fish than those which first went north.

The following mention of arrival of vessels at Gloucester, with mackerel caught between June 9 and June 20, in different localities, may give some idea of the area covered by these fish. Capt. S. J. Martin, in his Journal of Gloucester Fisheries, records that some mackerel were caught off Cape Cod on June 9, and that about that time good hauls were made by the seiners 10 miles southeast from Noman's Land. It appears that mackerel continued to be abundant at the latter place for several days after the 10th of June. The Cape Ann Advertiser of June 16 contained the following mention of a good fare from that point:

"The schooner Madawaska Maid, of this port, took a large haul of mackerel off Noman's Land last week, and arrived at New York Thursday with 300 barrels."

The captain of the schooner Martha A. Bradley, which arrived in Gloucester on June 23 with a fare of 303 barrels, told me that he caught them from June 15 to June 18, inclusive. The fish were small, ranging from 9 to 11 inches in length. The first day's catch was obtained 20 miles southeast from Block Island, and the fish moved so rapidly to the eastward that those which were taken four days later were caught 20 miles to the southwest of the light-ship on the South Shoal of Nantucket.

On June 11 some fish were taken by seiners 40 miles east-southeast from the high land of Cape Cod; and five vessels, with fares ranging from 300 to 350 barrels, arrived in Gloucester on June 14, having caught the greater portion of these fish eastward of the Cape. On

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ports seeing eight ocean steamers working their way through the ice-fields between latitude 44° and Cape Race."

"SAINT JOHN'S, NEWFOUNDLAND, *June* 10, 1882.—Fishing schooner P. L. Whitton arrived last evening. She reports stormy weather, and that it is impossible to fish on the Grand Banks, owing to numerous icebergs. Advices just received from the northward say that the bays are again packed with ice. Six sailing vessels are jammed some distance northeast of Cape John."

June 13 one schooner took 140 barrels 30 miles southeast of Cape Ann. On June 15 the schooner Joseph Story arrived at Gloucester with 290 barrels of mackerel from the pounds near Pubnico, N. S.,* while on the same day the schooner Charles Tappan came in with a fare of 300 barrels, reported to have been taken on George's Bank.

The Port Mulgrave correspondent of the Cape Ann Advertiser, writing under date of June 9, states that mackerel had made their appearance on the eastern coast of Nova Scotia, "Captain Rood, of the steamer M. A. Starr, reporting that he passed through large schools between Halifax and Canso. Captain Harding, of schooner Keetsca, of Lockeport [N. S.], made the same report. What had been caught in nets were of large size."

From the foregoing it may be seen that early in June mackerel in greater or less abundance were met with all along the coast, from Block Island on the south to Cape Canso on the north, a distance, in a straight line, of about 500 miles. Their abundance off the New England coast is apparent from the unusually large captures made at this period, to which reference has already been made, and when we consider the enormous area which they covered it is difficult to form any accurate estimate of the quantity of these fish which swarmed in our waters, and from which our fishermen were gathering a bountiful harvest.

Before proceeding further in the discussion of the movements of the mackerel, I shall pause to consider some facts in connection with their spawning habits. It has generally been supposed by close observers that mackerel spawn on the New England coast soon after the 1st of June; in the summer of 1882, however, this operation took place later than had ever before been recorded. On June 23 I opened thirteen mackerel, caught the preceding evening at Rockport, Mass. Their average length was 12 inches. In nine of them (males) the milt was nearly ripe. One was a spent male, and the remaining three had been eviscerated, so that no determination as to sex or condition was possible. According to some of the most experienced Gloucester fishermen, the mackerel on the off-shore grounds had not finished spawning until a month or more later than the above date. Captain Thomas says that the height of the spawning season this year (1882) occurred from about the middle of July to August 1. The majority of the fish taken during that interval appeared to be partially spent, the ovaries and spermaries being somewhat shrunken. They contained, however, more or less eggs and milt in a ripe condition, which ran from the fish when they were handled. A portion of the mackerel had finished spawning and were fatter than the half-spent fish taken from the same school. As a rule, in previous years, it had been noticed that the mackerel sank during the season of reproduction, rarely appearing in schools at the surface, and for a space

* On the following day the schooner J. J. Clark arrived with a full fare from the same locality, and other vessels came in later which had obtained loads of mackerel from the Nova Scotia pounds.

of two or three weeks comparatively few fish could be taken. According to Captain Thomas, the mackerel "showed up" during the spawning season of 1882 better than the records indicate for any previous year, and great numbers were caught in the deep water about 15 to 40 miles to the east of Cashe's Ledge. The late occurrence of the spawning season this year was perhaps due to a probable lower temperature of the water than is common, caused by the masses of ice to the eastward, reference to which has already been made. My brother, Capt. D. E. Collins, says that as late as May 15 the ice on the southern coast of Nova Scotia extended as far west as Whitehead, and even at a later date vessels were blockaded in the harbor of Cape Canso, nor was passage through the straits of Canso possible. Very few scientific observations, so far as I know, have as yet been made concerning the degree of water temperature at which mackerel prefer to spawn, and for this reason any intelligent theoretical discussion of the subject is impossible.

Returning, then, from this digression to a further consideration of the movements of the mackerel, we find that about the middle of June, as has already been stated, they were massed in four large divisions, with here and there additional straggling schools. The two largest and most important bodies were those of which the first was found between Cashe's and George's Banks, and the other off the coast of Maine and about the mouth of the Bay of Fundy. A third body of mackerel which, pursuing its way along the southern coast of Nova Scotia, subsequently entered the Gulf of Saint Lawrence was of much less importance than the two last mentioned. The fourth division, the capture of which was comparatively unremunerative by reason of the small size of the fish, was found off Noman's Land and near the South Shoal off Nantucket.*

One of the most important features to be noted in connection with the mackerel that swarmed in such abundance in the Gulf of Maine, during the summer, is that they remained in unusually deep water and much farther from the coast than these fish generally occur.

From early in June until the last of July, mackerel were very abundant between Cashe's and George's, playing in the deep water immediately east of the former bank. According to Captain Martin, a large portion of the mackerel which were brought into Gloucester between the above dates was taken in that locality. On July 13 he records the arrival of the schooner Reporter (a haddock-catcher), whose captain testified to having sailed through schooling-mackerel for a distance of 50 miles

* From the fact that the schools of mackerel found off Noman's Land and Nantucket Shoals, in June, were composed of such small individuals, none of the vessels sought them after about the 20th of June. For this reason no reliable data can be obtained concerning the movements of these fish, though there is every reason to suppose that they entered the Gulf of Maine—between Cape Cod and the Bay of Fundy—in July, since schools of small mackerel were occasionally captured in those waters during the latter part of the summer and throughout the fall. For the above reasons, no further allusion to the movements of this body of fish will be made.

between Brown's and Cashe's Banks. The western edge of this body of fish extended to within 10 miles of the latter bank. Captain Thomas says: "Nearly all mackerel fishermen know that in June and July the chief part of the fish was caught in the deep water between Cashe's and George's Banks in depths ranging from about 100 to 200 fathoms." Captain John W. McFarlane, of the schooner William F. Gaffney, which arrived in Gloucester on June 23, with a full fare, told me that he caught the larger portion of his fish in the deep water 40 miles southeast from Cashe's and that when the fish failed to "show" at the surface there, he "stood in" toward Cape Ann. When about 30 or 40 miles distant from the land, in the deep water lying in an east-southeast direction from the Cape, he fell in with numerous schools, capturing enough in one day to complete his load. Mr. Silas Calder, one of the crew of the schooner W. H. Wellington, of Gloucester, states that from July 1 to July 20 there was a large fleet of mackerel schooners fishing from 90 to 100 miles southeast by south from Monhegan Island. He thinks that a very large percentage of the mackerel caught by the New England fleet, during the period above mentioned, was taken in that locality, namely, the deep water between Cashe's and George's Banks, where also the Wellington, which left Gloucester on her first trip June 28, returning in twelve days, caught her fare of 400 barrels. The whole fleet did well, many vessels securing large fares in a few days.*

Captain Hurlburt, formerly of the United States Fish Commission, and others who have been engaged during this season in the mackerel fishery, concur in this statement. Captain Hurlburt is one of the crew of the schooner Wildfire, which arrived from a mackerel trip on August 7, after an absence of twelve days, with 535 barrels of fish. He says that 400 of the above were taken in the deep water 35 miles east-southeast from the shoal water of Cashe's. These were all fine fish.

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*The following chronological record of arrivals of mackerel schooners with full fares caught, for the most part, between Cashe's and George's, from July 20 to July 29, inclusive, is obtained from Captain Martin's journal:

July 20.—Seven schooners arrived, two of which averaged 360 barrels each, after an absence of only six days, while the total aggregate brought in by the whole was 2,390 barrels.

July 21.—Two schooners, with an aggregate catch of 370 barrels.

July 22.—Two schooners, with an aggregate catch of 490 barrels.

July 24.—Nine schooners, with an aggregate catch of 2,404 barrels

July 25.—Seven schooners, with an aggregate catch of 2,225 barrels.

July 26.—Eleven schooners, with an aggregate catch of 3,150 barrels.

July 27.—Eight schooners, with an aggregate catch of 2,835 barrels.

July 28.—Fifteen schooners, with an aggregate catch of 5,398 barrels.

July 29.—Fifteen schooners, with an aggregate catch of 4,965 barrels.

This gives a grand total of 24,227 barrels of mackerel taken by seventy-six schooners.

In corroboration of the above, the Cape Ann Bulletin of August 2, 1882, contained the following:

"Last Thursday there was an immense arrival of mackerel, one vessel bringing 500 barrels, another 400 barrels, another 375, and another 350. The best mackerel are of extra good quality, most of them being taken between George's and Cashe's."

As soon as the schools disappeared and could no longer be found in this region, most of the fleet, numbering about eighty sail, went to other grounds. The Wildfire ran to the eastward, and the remainder of her fare, 135 barrels, was taken 25 miles west by south from Bryer Island, N. S. Capt. George M. McClain, master of this schooner, says that before the middle of August he caught no fish in shoal water. It is not possible to say with any degree of certainty why the mackerel, as a rule, exhibited such a disposition to remain off-shore and in deep water. Their presence and long continuance to the eastward of Cashe's may, however, be due to the abundance of food which could be obtained there, though the same reason cannot so positively be assigned for their presence elsewhere. The fishermen during the month of July reported that the mackerel caught in the vicinity of Cashe's were "full of feed," while those taken along the Maine coast and in the Bay of Fundy had little or no food in their stomachs. It is very probable that the unusual disinclination of the main body of the mackerel to approach close to the coast may be attributed to a remarkable scarcity, along the shore, of the forms of life upon which they feed. The fact that the fish which were caught nearest the coast were rarely found gorged with "seed"—indeed, the opposite being generally the case—would indicate that there was little to attract them in-shore, and consequently they remained a long distance from the land, where the chances for obtaining food were better. But even on the off-shore grounds a decrease in the abundance of mackerel "feed" was noticeable about the 1st of August, and this may have influenced the subsequent movements of the fish found thereabout.

At any rate the mackerel, which were so abundant to the eastward of Cashe's during June and July, apparently left that locality early in August, since by that time they were no longer accessible in large numbers to the fishermen, and during the remainder of the season only a few scattering schools were found in those waters. It is possible that during the period of abundance on Cashe's the schools were in reality on their way to the east coast of Maine, the mouth of the Bay of Fundy, or to Seal Island Ground, passing along slowly in an eastward or northeasterly course. That the fish did move in one of these directions, about the last of July or the 1st of August, there can be but little doubt. Further reference will be made to this matter in a subsequent paragraph.

Passing, now, to the consideration of the schools of mackerel which were found near the coast of Maine, I will say that with rare exceptions they kept off in deep water at distances from the land varying from 15 to 40 or 50 miles; and, according to the statements of the fishermen, their method of schooling differed in some respects from that followed by the mackerel on Cashe's. Captain Martin also records, under date of July 24, the following facts relative to this matter:

"The mackerel, which are in large bodies, when they go across Cashe's appear to be more scattered, and break up into small *pods* when they reach the Bay of Fundy."* Perhaps the greatest quantities of mackerel taken on the coast of Maine during June and July were caught in the vicinity of Mount Desert Rock, at distances therefrom of 15 to 30 miles, and usually in a southeast direction. Mr. Calder told me that the Wellington, while on her second trip, took the greater portion of her fare in the deep water† 45 miles south from Mount Desert. He also states that at the end of July and the beginning of August, a fleet of 50 to 85 sail was fishing in those waters. At the same time, good catches were made from 15 to 25 miles from Matinicus and Monhegan Islands."‡

Indeed, mackerel had never been more plentiful on the American coast from the commencement of the spring fishing to the middle of August, nor had vessels ever made larger captures, than during this period.§ In August, however, a decided change took place in this fishery, the receipts of mackerel at the principal fishing ports falling off considerably.

* By the Bay of Fundy, Captain Martin may be understood to mean the waters extending from Monhegan Island to Grand Manan.

† The term *deep water*, as used here, may be taken to mean a depth varying from 60 to 200 fathoms, but generally more than 80 fathoms.

‡ The following record of arrivals with full fares taken in this region is gathered from the journal of Captain Martin:

June 22.—Arrival of four mackerel schooners, one of which fished off Mount Desert.

June 26.—Arrival of ten mackerel schooners. Most vessels report catching their fish off the coast of Maine.

June 27.—Arrival of four mackerel schooners from 20 miles southeast of Matinicus.

June 29.—Arrival of four mackerel schooners, one of which caught its fish 30 miles east of Mount Desert Rock.

July 16.—Schooner S. A. Campbell arrived with 360 barrels, reported to have been caught 10 miles from Grand Manan Island.

August 2.—Five fares of mackerel arrived on previous day, one of which was caught 40 miles southeast from Mount Desert Rock, one 35 miles southeast from Matinicus, and a third 35 miles to the southward of Monhegan Island. The other two fares were caught on Cashe's.

August 8.—Six arrivals of mackerel fares, some of which were caught 30 miles northwest from Yarmouth, N. S., and the others 25 miles southeast from Mount Desert Rock.

It is worthy of notice that quite all of the localities mentioned here by Captain Martin are those where there is deep water, or at least where the depth is more than 50 fathoms. Indeed, the area is very small off the coast of Maine where a depth of less than 50 fathoms can be obtained outside of 15 miles from the land.

§ The following extracts from the Cape Ann Advertiser of July 7, 1882, bear testimony to this statement:

"Schooner Carl Schurz, belonging to Messrs. Rowe & Jordan of this city, landed 850 barrels of mackerel in two trips between 6th and 30th ultimo, June."

"Schooner Augusta E. Herrick, of Swan's Island, has landed 850 barrels in fourteen days."

"Schooner Henry N. Woods, Captain McEachran, seined 500 barrels of mackerel off Seal Island inside of two weeks."

"Schooner Edward E. Webster, Captain Solomon Jacobs, sailed from Boston on Monday and was back there Thursday with 250 barrels of mackerel, seined off Mount Desert Rock, stocking $1,300."

This decrease was due in a great measure to the prevalence of dense fogs which hung over the waters frequented by the mackerel fishermen, and often rendered fishing impracticable. It is also possible that the comparative scarcity of the fish which occurred at this time may have been caused by a remarkable discoloration of the sea-water, which appeared about the 1st of August along the coast of Maine and in the Bay of Fundy. Mackerel fishermen, returning from the Bay of Fundy and the coast of Maine, August 10, reported that for ten or twelve days previous the water off Monhegan and Mount Desert had presented a most singular appearance, its color resembling that of diluted milk. This whitish streak was 30 or 40 miles wide. and extended some 65 or 70 miles in a northeasterly direction from Monhegan Island, its inner edge varying from 5 to 25 miles distant from the land. The line of demarkation between this colored water and the blue sea was very conspicuous and as regular as a wall. During this period the white water was semi-transparent, so that the fish, to which was imparted a reddish tinge, could be seen beneath the surface at a great distance. Some men stated that mackerel passing from blue to white water appeared to be peculiarly affected by the change, apparently becoming wild and rushing madly to and fro. Others, however, did not notice any of these peculiarities in the movements of the fish, merely stating that the mackerel rarely schooled at the surface. The semi-transparency of the water, however, enabled the fishermen to see the schools so far beneath the surface that, in consequence, they could be inclosed in the purse-seines as well as if they were inclined to swim closer to the top of the water. For a couple of weeks after the appearance of this phenomenon many schools of mackerel were captured in the "white water," though the best fishing was beyond its limits about the western part of the Nova Scotia coast, off Yarmouth, and on the Seal Island Ground. At the same time, however, the market boats, and occasionally the salt fishermen, made some large hauls in the waters around and inside of Monhegan, which were, at the time of the phenomenon, within the area of discoloration. It is difficult to define precisely the influences which this "white water" may have exerted on the movements of the mackerel, but it certainly is the general opinion of the fishermen that one effect produced was a sudden and almost total disappearance of the main body of the fish from the coast. Though it is probable that the discoloration was due to an unusual accumulation of some form of animalcula or crustacea in the water, it is nevertheless true that little or no food suitable for the mackerel occurred within its limits. All of the mackerel fishermen with whom I have conversed on this subject agree in saying that without exception the fish taken in the "white water" had little or no food in their stomachs. It is not probable that there was any chemical change in the sea, yet many of the most intelligent and observing fishermen are of the opinion that the schools of mackerel were peculiarly affected by the "white water," or at least acted queerly within its limits. Capt. George H. Martin, of Gloucester, assured me that the fish appeared less shy and could be captured far easier than when in blue water, not attempting to escape from the seine by "diving," as is so frequently the case under ordinary circumstances. This is all the more remarkable since the wonderful clearness of the water, previously alluded to, made it possible even for the fishermen to see the bottom of their seine which was sunk a depth of from 18 to 25 fathoms.

The occurrence of heavy fogs, as has already been stated, during the month of August and the beginning of September, and the fact that the main body of mackerel was at that time found on the Seal Island Ground* and Brown's Bank, where strong currents and heavy tide-rips occur, rendered it extremely difficult for the fishermen to capture the fish which were found in that region. The result, therefore, of these combined adverse influences was a great decrease in the catch of fish by the mackerel fleet. It seems altogether probable that the mackerel caught on the Seal Island Ground and about Brown's Bank were the same fish which occurred earlier in the season in such abundance between Cashe's and George's Banks, and which, as has previously been stated, probably moved to the eastward from the above-mentioned locality. What direction this body of mackerel took after leaving Brown's Bank cannot be absolutely determined, but it is the opinion of most of the experienced fishermen that the fish, continuing their outward course from the shore, swept off by the southern edge of George's instead of passing inside, as is their usual habit when making their regular fall migration. This irregular movement was anticipated as early as July, for on the 8th of that month Captain Martin wrote: "If no other school of mackerel comes along the catch will be light during the latter part of the season. I do not think the mackerel on the Seal Island Ground will go into the Bay of Fundy." The fishermen at that date, too, reported an abundance of mackerel on George's, and Captain Martin, on June 28, 1882, noted the arrival, in Gloucester, of two fares of mackerel from that bank. Although a few fares may have then been taken on George's, it seems probable that in most cases, there was a slight error in the reports of the skippers; for, to my knowledge, several of the Gloucester vessels which visited George's on the strength of these statements failed to find any mackerel in that locality. These failures may have been due to some extent to the prevalence of dense fogs which covered the bank much of the summer, and rendered it next to impossible for the skippers to keep their position on this ground, where the tides sweep with great velocity. Therefore it seems probable that most of the fares which were reported on several occasions to have been caught on George's Bank were in reality taken in the near vicinity, north of the bank, or farther east, on Brown's Bank.

Little more can be said relative to the movements of the mackerel on the New England coast during the season of 1882, except to speak of the scarcity of fish throughout the remainder of the season, which was

*Catches of mackerel were also made on this ground as early in the season as the latter part of June.

in remarkable contrast to their abundance in the early part of the year. It is true that a few of the vessels—the "lucky ones"—succeeded in making many good catches during the late summer and fall, but the majority of the fleet averaged small fares. I am, indeed, assured that some vessels took less than 100 barrels each from the first of August until November. The mackerel which still remained near the coast, appearing in somewhat scattered schools—and for the most part of small size—began their fall migration at about the usual time, that is, late in September or early in October. About this date the vessels, many of which had been fishing on the off-shore grounds, having lost trace of the fish there, collected near the coast and pursued the mackerel as they moved in a westerly course from the shores of Maine towards Massachusetts Bay and contiguous waters. The fall catch of mackerel, which, even with favorable weather, would probably not have been very large, was seriously affected by the prevalence of strong easterly winds, and no doubt the departure of the fish from the coast was somewhat hastened by the same cause.

An interesting and somewhat remarkable feature of the mackerel fishery during the fall should be mentioned. When the mackerel reached the waters about Cape Ann and Massachusetts Bay, comparatively few catches were made in the daytime; the phosphorescence exhibited at night, however, aided the work of the seiners. The fish rarely schooled by daylight, and even when they did they were, according to the statements of several parties, so shy as to render their capture very difficult and often impossible. Most of the fish taken were caught at night, and, as I was assured by some of the fishermen, so small was the probability of seining mackerel in the daytime that on many of the vessels no one was kept on the lookout for schools. Dark, moonless nights are, under such circumstances, best for the capture of mackerel, since at such times the movements of the fish may be known and traced by the phosphorescence thrown out from the schools. Notwithstanding, however, that every effort was made both night and day, the vessels, as a rule, did so poorly that the majority of the mackerel fleet had "hauled up" before the 1st day of November. A few very fair catches were, however, made in Barnstable Bay and about Cape Cod on subsequent dates.

Before closing these remarks it may be well to refer again to the schools of mackerel which, detained beyond their usual period of migration along the Nova Scotia shore, eventually found their way into the Gulf of Saint Lawrence. Whether any of the fish, which under other conditions might have gone to the Gulf of Saint Lawrence, were hindered from doing so by the accumulation of ice about the eastern part of Nova Scotia, can only be conjectured. According to the reports of the Boston Fish Bureau, mackerel have never within the memory of man been so scarce in the Gulf of Saint Lawrence as during this season. The catch of the boat-fishermen at Prince Edward Island has been unusually small, while not a single fare, so far as can be learned, was taken by either American or Canadian vessels, if we except a small trip caught in gill-nets by an American schooner on the Labrador coast. Indeed, it is a fact that one Provincial vessel, at least, the Festina Lente, Capt. Andrew Hammond, of Lockport, Nova Scotia, was engaged during the past season in mackerel seining on the New England coast. It seems only proper to allude to this fact in this connection because it goes to prove that the claims made by the Canadians concerning the superiority of the mackerel fisheries in their waters is wholly without foundation. There is every prospect that in future years a fleet of Canadian vessels will be engaged in mackerel seining on our coast, instead of our fishermen being compelled to resort to Provincial waters, as was the case when hand-lining was the principal means of capture. In this connection, and as a fair demonstration of the importance and prosperity which the mackerel fishery has reached at the present day on our coast, should be mentioned the remarkable and unparalleled stocks which have been realized by some of the vessels from the sale of their fish. The following extracts from the Cape Ann Advertiser give a statement of the most important stocks made by the vessels engaged in the mackerel fishery during the season when this species can be taken, namely, from April 1 to about the middle of November:

"Two of the largest mackerel stocks ever landed at this port or in New England have been made by the schooners Nellie N. Rowe, Capt. Eben Lewis, and the Edward E. Webster, Capt. Solomon Jacobs, the past season, comprising eight months of time actually employed. The net stock of the Rowe was $35,537, and of the Webster $34,229. The average share of the Webster's crew was $959.75, and the steward, Mr. Warren Fowles, with his extra pay of $160, made for his season's work, $1,129.75."—(Cape Ann Advertiser, November 17, 1882.)

"The following good stocks are reported in the mackerel fishery by vessels hailing from this port: Schooner J. H. French, Capt. John Chisholm, net stock about $20,000, crew shared $615; schooner Leona, Capt. Willard Pool, net stock $19,715.72, crew shared $582; schooner Carl Schurz, Capt. Jed. Warren, net stock since June 6, $15,608, crew shared $468—stock for the year, $23,222, crew sharing $733.86; schooner John D. Long, Capt. Charles Hardy, net stock $18,500, crew shared $571; schooner Helen M. Crosby, Capt. Joseph Swim, net stock $18,020, crew shared $596; schooner Ivanhoe, Capt. James Crowley, net stock $16,945, crew shared $525; schooner Golden Hind, Capt. Solomon Reed, net stock $16,323, crew shared $594; schooner John S. McQuin, Capt. Henry G. Coas, net stock $16,035.57, crew shared $517."—(Cape Ann Advertiser, November 24, 1882.)

It should be borne in mind that the above figures, large as they may appear, represent only the *net* stock made by the several vessels, and that to get a more correct idea of the value of the fish taken we must add to the stock of each schooner from two to three thousand dollars. This will give us, approximately, the amount for which the fish were sold.

CATCH OF FISH IN NEWFOUNDLAND AND LABRADOR IN 1881.

By JOS. S. HAYWARD.

[From letter to Prof. S. F. Baird.]

I enclose a memorandum showing the exports of the product of this colony for the year ending July 31, 1882. It gives the catch of fish for the year 1881, as at the date the memorandum was made up all the fish caught in that year was exported.

The catch for the present year is not so large, but the prices have considerably increased.

STATEMENT OF EXPORTS FROM NEWFOUNDLAND AND LABRADOR FOR THE YEAR ENDING JULY 31, 1882.

	£	*s.*	*d.*
1,463,439 quintals dried codfish, at 20*s*	1,463,439	00	0
1,457 quintals green codfish, at 6*s*. 6*d*	473	10	6
200,500 sealskins, at 5*s*	50,125	00	0
5,548 tuns seal oil, at £31	171,988	00	0
116 tuns whale oil, at £27	3,132	00	0
4,254 tuns cod oil, at £29	123,366	00	0
147 tuns refined cod-liver oil, at £48	7,056	00	0
1 tun other oil, at £25	25	00	0
3 tuns cod dregs, at £12	36	00	0
83 tuns cod blubber, at £3 10*s*	290	10	0
3,825 tierces pickled salmon, at £6	22,950	00	0
313,000 pounds frozen salmon, at 6*d*	7,825	00	0
10,000 pounds preserved salmon, at 7*d*	291	13	4
4,330 barrels frozen herrings, at 5*s*	1,082	10	0
63,943 barrels pickled herrings, at 17*s*. 6*d*	55,950	02	6
1,716 barrels pickled trout, at 40*s*	3,432	00	0
1 barrel pickled mackerel, at 15*s*		15	0
10 barrels cod roes, at 15*s*	7	10	0
721 quintals dried haddock, at 13*s*	468	13	0
22 barrels pickled turbot, at 40*s*	44	00	0
557 barrels dried caplin, at 2*s* 6*d*	44	12	6
62 packages cod sounds and tongues, at 5*s*	15	10	0
1,265,224 pounds preserved lobsters, at 5*d*	26,358	16	8
9 tons whale pitchings, at £18	162	00	0
2,379 pounds whalebone, "local," at 3*d*	29	14	9
5,948 pounds whalebone, "Arctic," at 10*s*	2,974	00	0
18,729 tons copper ore, at £5	93,645	00	0
155 tons regulus ore, at £12	1,860	00	0
Unenumerated articles	20,000	00	0
	2,057,072	18	3
	or $8,228,291 65		

CUSTOM HOUSE, ST. JOHNS, NEWFOUNDLAND,

February 17. 1883.

NOTES ON THE HERRING FISHERY OF MASSACHUSETTS BAY IN THE AUTUMN OF 1882.

By CAPT. J. W. COLLINS.

The herring fishery prosecuted in Massachusetts Bay and contiguous waters during the fall of 1882 has presented some phases which are of special interest. The peculiarities exhibited are:

I. The apparent disinclination of the fish to approach as close to the shore as was formerly their custom.

II. The accidental capture of many schools of herring, in the night, by the purse-seiners, at various distances from land.

Before entering into a discussion of these topics I shall allude, briefly, to the arrival of spawning sea-herring in several distinct schools on the coast of Maine, during the spring and summer; and to the marked degree of consistency and regularity which these fish exhibit in making their annual visits to certain localities. I designate them as *sea herring* in contradistinction to the smaller fish which frequent the shores during the greater part of the year. The large herring come inshore apparently only for the purpose of reproduction, for I have never known any of them to make their appearance on the coast except when they were in a gravid condition. At other times they are usually found only on or near the outer fishing-banks from 30 to 150 miles from the coast.

In the spring, during April and May, the schools of herring, which are found in the vicinity of Eastport, generally come to deposit their ova. In the latter part of July and beginning of August, spawning herring are abundant about Boisbubert Island, near Millbridge, on the coast of Maine, and many small vessels resort to that locality and obtain their fares with gill-nets. I have been told by several of the old residents of Isle au Haut that for many years previous to 1850, two distinct schools of large spawn-herring visited the shores of that island with an almost undeviating regularity. One of these schools made its appearance about the middle of July, and remained one month; the other came in about two months later, staying about the same length of time. A remarkable circumstance, in this connection, was that these bodies of fish occupied different spawning grounds which were distant from each other about four or five miles. The summer fish visited the western part of the island, and those which came later struck in at the eastern end. Since 1850 the appearance of these herring has been very uncertain. Sometimes they would come in great abundance, but more frequently would not be seen at all, yet within the past ten years vessels have occasionally obtained full fares of these large spawn-herring at Head Harbor on the western part of the island. For the last few years schools of spawn-herring have been found in Castine Harbor, and also at Crabtree Point, the southernmost extremity of North Haven, in Penobscot Bay. The fish have usually been found at the latter locality some two weeks after they occurred at Castine, at which place the school struck in two or three weeks after the height of the fishing at Boisbubert was over. The next school of herring of importance that visits the coast of Maine is the one which has for a number of years regularly been found at Wood Island, and the vicinity, on the coast of Western Maine. These fish approach the shore usually from the 10th to the 15th of September, some two weeks, or more, after the herring have left the waters of Penobscot Bay. So regular has been the appearance of herring at Wood Island for a number of years, and so great is their abundance during a period of two or three weeks, that large numbers of small vessels with gill-nets resort to that harbor about the middle of September, to engage in the capture of these fish. The next school which visits our coast for the purpose of spawning is that which strikes the northern shores of Massachusetts Bay and adjacent waters a short time after the first appearance at Wood Island. This latter body is the one which is now especially under consideration. The foregoing remarks in regard to other schools of this species are intended merely to give a general idea of the several bodies of herring which spawn on our shores during the spring and summer.

Whether the herring that visit Massachusetts Bay are the same or a portion of the same school that strike in at Wood Island, is, perhaps, an open question; but it seems probable that while they may possibly not be the same school they are nevertheless the left wing, so to speak, of the great army which approaches the coast at that season, the right wing reaching Wood Island, where, after the act of reproduction is consummated, they leave the coast. Ordinarily the herring which come in for the purpose of spawning move with regularity and precision directly for the shores, where they deposit their eggs. There is no doubt but that their movements, at this particular time, are dependent, for the most part, on the temperature of the water, and their close approach to the coast may be accelerated or retarded by an unusual variation of the temperature from its normal condition. From the observations which have been made it appears that they prefer to spawn along the coast when the temperature of the sea-water has fallen to about 35° or 40° F. Captain Martin tells me that for the three years previous to 1882, the fall school of herring did not approach the shore at Cape Ann until the temperature was down to 35° F.; but that during the present fall (1882) the fish came in on the 18th of September, at which time the temperature was 50°. It is worthy of remark, however, in this connection, that notwithstanding the fact that a few schools of herring came in close to the shores, the greater part of the main body of the fish appeared to keep off at a distance of several miles from the coast. According to Capt. William B. Parsons, of Rockport, Mass., the herring-catchers began fishing in Ipswich Bay, near Rockport, about the first of October, but the catch was very small for the first week, and the few fish taken were sold principally for bait. Captain

Parsons thinks that there were not more than 500 barrels of herring caught during the first seven or eight days, and after that little or nothing was done, the school evidently having passed by Rockport on its way to the westward. Notwithstanding the fact that so few herring were taken at Rockport, Mr. Parsons is of the opinion that there has rarely been seen such a heavy body of this species on our coast. He says that the fish did not seem inclined to come inshore, but kept off too far to be taken in the gill-nets which are usually set near the land. The herring, after passing to the westward of Thatcher's Island and entering Massachusetts Bay, apparently still kept at some distance from the land (at least the greater part of the schools), and many of the fish deposited their spawn on rocky "spots" of bottom several miles from the shore. Many of the Gloucester boat fishermen report that their anchors and anchor-lines would frequently be covered with herring spawn in twenty-five fathoms of water on the codfishing grounds offshore. In consequence of this disinclination of the herring to approach the coast the fleet of small vessels (numbering from 75 to 100 sail, or more, which engage in gill-netting at this season and make their headquarters at Gloucester Harbor) met with poor success. In regard to this matter the Boston fish bureau reports on October 20 as follows: "Our offshore catch of herring is proving a failure; not much has been received from it, and few, if any, more fish are now looked for."

The following notices of arrivals at Gloucester of herring vessels, and of the captures of herring in gill-nets by the small vessels which make their rendezvous at that port, are taken from Captain Martin's journal of the Gloucester fisheries, and may, perhaps, give an idea of the fishery of this fall:

October 5.—Schooner Wave, gill-netter, arrived from Wood Island with 150 barrels.

October 6.—Fifty barrels of large spawn-herring were caught in Gloucester harbor by the fleet of boats and small-vessels. Seventy-five barrels of smaller fish were taken on the same day off Milk Island.

October 7.—Schooner Mary Elizabeth, gill-netter, arrived from Wood Island with 140 barrels of herring. On the same date 25 barrels were caught in gill-nets in Gloucester harbor, and 20 barrels in a fish-trap off Milk Island.

October 9.—Two hundred and twenty barrels of herring were landed, part of which were taken with seines off-shore.

October 10.—Fifty barrels of herring were caught in gill-nets in Gloucester harbor.*

October 11.—Captain Martin reports that 75 small vessels were lying in the outer harbor of Gloucester engaged in fishing for herring with gill-nets. He also says there were 450 nets set at that date off Norman's Woe and Eastern Point, in which 75 barrels of herring were caught.

*The gill-nets, as a rule, are set near Eastern Point, Norman's Woe, and westerly to Kettle Island.

While these exceedingly poor returns were being obtained by the gill-net fishermen near the shore, herring occurred, as has been previously mentioned, in extraordinary abundance in the deeper waters at some distance from the land, and many were captured in purse-seines at night; the schools of these fish having been mistaken for mackerel. These captures of herring in purse-seines, though not especially important in themselves, are nevertheless interesting in so far as they demonstrate the adaptability of purse-seines to the capture of herring as well as other species which school at the surface, and suggest the feasibility of their profitable employment in European waters. It is well known that one of the most important as well as the most valuable fishery of Europe is that for herring, which have heretofore been taken at sea exclusively by the use of gill-nets; but the advantage of using purse-seines in the European herring fishery cannot be doubted when we take into consideration the large catches made by our mackerel fishermen during the present fall, and this, too, without any special effort having been made. Indeed, it is a fact that whenever the fishermen were assured that the fish they saw at night were herring, they invariably desisted from the pursuit.

The following are a few of the many captures of herring in purse-seines:

October 1.—The schooner A. R. Crittenden, arrived in Gloucester with 150 barrels of large spawn-herring which she caught in a purse-seine, the night before, eight miles southeast of Thatcher's Island.

According to the report of the Boston Fish Bureau, one of the mackerel fleet arrived at Boston on Thursday, October 5, with 200 barrels of fresh herring, caught in a purse-seine between Boston and Minot's Ledge light-house.

On October 6, the following vessels arrived at Gloucester with fresh herring caught with purse-seines the previous night:

The Florence E. Nightingale, of Swampscott, with 50 barrels; the A. C. Newhall, of Gloucester, with 60 barrels; Magellan Cloud, of Gloucester, with 120 barrels. October 7, the schooner Rushlight, of Gloucester, arrived with 80 barrels of herring caught the previous night five miles east of Thatcher's Island.

More instances might be cited of the capture of herring by mackerel-schooners; but this, doubtless, is sufficient to show what might be accomplished in the herring fishery by the use of purse-seines.

The price of herring in our markets, however, is rarely high enough to offer any inducement for the purse-seiners to engage in this branch of the fishery; and, as previously stated, no attempt would be made to surround the schools if the fishermen knew they were composed of herring. I have been assured that in some instances, herring, after having been inclosed in the seine, have been allowed to escape, in order that the fishermen might not lose their time, which would, perhaps, be more profitably employed.

CORRESPONDENCE RELATIVE TO THE PROCUREMENT OF CERTAIN FISHERY IMPLEMENTS FOR THE GOVERNMENT OF NEW SOUTH WALES.

By CAPT. J. W. COLLINS.

[Letter to Prof. S. F. BAIRD.]

I have the honor to submit the following report of the correspondence relative to the procurement of fishery apparatus for the Government of New South Wales.

On the 5th of September, 1881, I received from Sir Saul Samuel, the agent-general of the New South Wales Government, the following letter, dated 5 Westminster Chambers, Victoria street, S. W., London, August 22, 1881:

"I have the honor to inform you that I am anxious to procure for my government the undermentioned, namely:

"A purse-seine, such as is used in the menhaden fishery on the Maine coast, North America.

"A bultow or set-line, such as is used by the French fishermen at Newfoundland.

"I learn from Mr. Spencer Walpole, the inspector of English fisheries, that I may possibly purchase them of you.

"Should you be able to furnish me with these articles, and will have the goodness to forward them to Messrs. R. W. Cameron & Co., 23 South William street, New York, properly packed for transmission to Sydney, I shall be much obliged to you.

"By this post I write to Messrs. Cameron & Co., directing them to receive the goods and to pay all charges that may be incurred by you.

"If you should be able to comply with this request, will you please render your account to Messrs. Cameron & Co. accordingly."

To this I replied from Washington, under date of September 7, 1881, as follows:

"Your favor of August 22, requesting me to obtain and transmit to your government, through your New York agents, a purse-seine and line-trawl, is at hand.

"I shall take pleasure in executing the commission you have honored me with, and the matter will receive my close attention.

"With the seine and line I shall send certain articles which are indispensable for their proper management, and which, I have no doubt, will be well appreciated by the people of New South Wales.

"Any future service you may require will be most cheerfully given."

On the 6th of September I received the following letter from R. W.

Cameron & Co., the New York agents of the New South Wales Government, and dated 23 South William street, New York, September 5, 1881:

"We are informed by Mr. Yardley, secretary of the New South Wales Government agency, London, that the fishery instruments mentioned below have been ordered from you for shipment to Sydney, New South Wales, through us. We are also instructed to pay for the same, and will be pleased to know when you can forward the goods, for the cost of which we will have pleasure in sending you our check.

"A purse-seine, such as is used in the menhaden fishery on the Maine coast.

"A bultow or set-line, such as is used by the French fishermen of Newfoundland."

I immediately corresponded with parties in Boston and Gloucester relative to the construction of the apparatus required, and had the satisfaction of engaging the well-known firm of H. & G. W. Lord, of Boston, to make the seine, and Capt. George Merchant, jr., an experienced fisherman, of Gloucester, to construct the trawl-line and prepare the necessary attachments.

Soon after this an attack of illness rendered it necessary for me to leave Washington and go to Gloucester, where I might profit by the cool sea air.

After reaching Gloucester I wrote, under date of September 13, 1881, the following letter to Messrs. R. W. Cameron & Co., the New York agents, relative to the procurement of certain articles not specified in the letter of the Agent-General of New South Wales, but which I thought indispensable:

"I think it quite important that a set of seine-boat fittings, such as those named in the inclosed list,† should be sent with the seine to Sydney, New South Wales. My opinion is fully indorsed by those having the widest knowledge of the American fisheries. All the articles marked with a (*) are indispensable for the management of a purse-seine, while the rowlocks and sockets, though not absolutely necessary, are nevertheless the result of many years' experiments, and will no doubt be valuable to those to whom the seine is sent. * * * The whole cost delivered in New York would scarcely exceed $31.

"With the trawl I am also anxious to send a roller and nippers, all of which will cost only about $3.50. They are exceedingly valuable, and not obtainable in any other country.

"Before deciding fully to send these articles, I wish to consult you

† The following is the list referred to in the letter: *1 pursing davit; *1 davit guard and step; *1 pair large pursing blocks; *1 pair small pursing blocks; *1 set of cleats; *1 set of oar-holders; *1 set (6) of eye-plates; 1 set of rowlocks and sockets; *steering rowlock and socket.

about the matter and get your opinion of what I ought to do. The seine and trawl are now in course of construction, and will probably be completed and ready for shipment in three weeks."

In reply the following, dated 23 South William street, New York, 16th September, 1881, was received:

"We are in receipt of your favor of the 13th instant, in regard to extra fittings for fishery apparatus ordered for the Government of New South Wales. As these extras are important, we authorize you to procure them, and beg to thank you for your interest in having everything in order. We note that you think the goods will be ready for shipment in three weeks."

This matter having been settled, another of even greater importance engaged my attention. This was the question of what should be applied to the purse-seine as a preservative. It is well known that our fishermen have their seines almost exclusively prepared with coal tar, but this method of preserving netting, though a most excellent one where the seine can be kept in brine, or thoroughly salted in the open air, would not answer for a net that was to be closely packed for months and stowed in a ship's hold for a long sea voyage across the tropics. Even if spontaneous combustion did not occur—and there was reason to fear that it might—the seine would soon become overheated and the twine impaired to such an extent as to render it utterly worthless. The other common method of preserving netting, that of barking or tanning, is not a good one for purse-seines, and is rarely resorted to by our fishermen. From conversations with Capt. George Merchant, jr., and other experienced seine fishermen, I learned that an application of tar and tan might obviate any difficulties likely to occur from using either one of these preservatives alone. I therefore wrote, under date of Gloucester, September 28, 1881, to the Messrs. Lord as follows:

"Some of the most experienced fishermen here say that a barked or tanned seine will not last more than one season at most. They think a net might first be lightly tarred and then tanned, and be transported with less risk than if either tar or tan was wholly used, providing the tar was thoroughly dried before the tan was applied. Such a method they think would preserve the seine as well or better than any other, and without much risk. Your long experience in the manufacture of nets and seines will enable you to judge as to the merits of these suggestions, which I submit for your consideration.

"I shall be pleased to hear how the seine is progressing, and also to have your opinion as to the method of preservation mentioned above."

To this letter I received the following reply, dated Boston, September 29, 1881:

"Your favor of yesterday received and contents noted. The seineweb is completed and ready to color. We are aware that coloring is not the proper thing for a menhaden seine, and would not have proposed it except in case of emergency. We have prepared netting in the way you propose, and think it lessens the risk very much. We think the fishermen's experience is worth considering, and in giving your assent, as we understand you do, we have concluded to tar and tan in the manner suggested. In this process we shall endeavor to be particular and leave nothing undone towards preserving the seine, so that it will be a week or ten days before it is ready for shipment. We will notify you at Gloucester, unless otherwise ordered, when ready, or shortly before."

On the 4th of October I wrote to Messrs. Cameron & Co., New York, acquainting them with the progress that was being made in the preparation of the seine and trawl, and also informing them of the method of preparing the seine which I had decided to adopt. In reply, they wrote, under date of October 5, 1881, as follows:

"We duly received your favor of yesterday's date, the contents of which we have perused with much interest, and would again express our warm appreciation of the interest you are taking in the apparatus for the New South Wales Government.

"We regret to hear that your health is so poor, and sincerely trust it may improve, and so enable you to prepare the drawing you refer to, which the honorable the agent-general would certainly appreciate, and which would also greatly assist the folks in New South Wales."

The seine was completed and shipped to New York October 18. The acknowledgment of its receipt there is contained in the following words, transmitted under date of October 22, 1881:

"We have pleasure in advising you of the arrival here of two bales, containing the nets for New South Wales Government, and of their shipment on board the bark Ingleside, for Sydney.

"We hope your health has improved, and would be pleased to receive bill for cost of the apparatus, and also any suggestions you may think necessary as to its use."

Although the state of my health was such that I was confined indoors, I was nevertheless able to write quite a long letter to the Messrs. Cameron & Co.; a copy of which I neglected to keep. Replying to me and acknowledging the receipt of the articles from Gloucester, they wrote October 28, 1881, as follows:

"We duly received your esteemed favor of the 24th instant, copy of which we forward to-day to the agent-general for New South Wales, in

London, informing him at the same time that you would send to him a more detailed account, with diagram, &c.

"The two cases from Gloucester arrived here yesterday, and were this morning shipped on board of our Sydney vessel. * * * We were much pleased to hear that your health is improving, and again thank you for your attention to the interests of the New South Wales Government."

On the 5th of November I wrote to the Sir Saul Samuel, agent-general for New South Wales, in London, sending him at the same time a rough diagram and some published illustrations of a seine-boat, in order that the use (as well as the position they should occupy) of the seine-boat fittings might be more easily understood. The following is the language used November 5, 1881:

"I have the honor to inform you that the purse-seine and set-line you desired to purchase of me, in your letter of August 22, have been completed and forwarded to R. W. Cameron & Co., New York, according to your instructions.

"Being fully aware of the possible advantage to be derived by the people of New South Wales from the introduction of these improved forms of fishing apparatus, I have felt that it was very important that each article should be constructed in accordance with the most recent and approved methods. Nothing that experience could suggest has been omitted to insure the completeness of the apparatus.

"Much care has also been taken in packing the goods in water-proof coverings to insure, so far as possible, their safety during transportation.

"As brief descriptions of the seine and line may be of interest, I will give them here, together with some suggestions as to the use, care, &c., of the apparatus, which I hope may be of service.

"The purse-seine which has been sent to Sydney, New South Wales, a rough diagram of which is inclosed, is of the same size as those most generally used in the menhaden fisheries, namely, 185 fathoms long and about 8½—600 meshes—deep when hung. The size of the mesh is 2⅝ inches in the wings, and 2½ inches for the remainder of the net. The plan, though incorrect so far as the relative proportions of the net are concerned, will serve to give an idea of the several sections and their position. The dimensions of the divisions, each of which is made of different-sized twine, the two wings having the smallest, the bunt the largest, while intermediate sizes are used for other sections, and has a technical name, are more clearly shown by the following figures: Wings, each 3,150 meshes long, 600 meshes deep; bunt, 500 meshes long, 300 meshes deep; top of bunt, 300 meshes long, 30 meshes deep; sides, each 100 meshes long, 300 meshes deep; under, 700 meshes long, 300 meshes deep.

"The loops, and line passing across their ends, represent the bridles and purse rope, which are attached to the bottom of the seine, and by means of which it is drawn into a purse or bag. In this place I will remark that, on account of its bulk, it was found necessary to pack the seine in two bales. One bale contains one wing of the net, five-eighths of the purse rope, &c., while the other holds the remainder of the seine and rope. Both parts of the apparatus are hung, and one at all familiar with netting will find no difficulty in joining the two sections together; suitable kinds of twine have been packed in the bales for this purpose.

"Though it was easy enough to decide upon the size and other general details of construction, the kind of preservative to be applied to the seine was in this case an important matter, demanding the most careful consideration. If a mistake should be made in this particular the implement might be ruined before it reached its destination. On the other hand, an inferior method of preparation would not protect the net from decay when in use even if it arrived safely in Sydney. Coal tar, heated by steam, is almost universally applied to seines which are to be used here, though it is well known that when so prepared they can be transported only short distances, the heat of the tar causing the net to rot. The manufacturers suggested tanning with catechu in this case. I was not sure but what this method would have to be adopted, although seines so prepared will not usually last more than one season of six months, while those that are tarred will wear three or four summers. I learned, however, from one of the most experienced seine fishermen of this port, one who is also an expert in the preparation of netting, that by first tarring lightly and then tanning the net it might pass without injury through the heat of the tropics, the long sea voyage, and still retain the strength and wearing qualities that seines have here. I was shown a bundle of netting which had been prepared in a similar manner in 1876, and which still retains its strength notwithstanding it has been lying in a compact mass ever since in a place where it has been exposed to a high degree of heat in summer. The evidence of the superiority of this method of preparing netting which must be transported long distances appearing indisputable, I wrote to the manufacturers in regard to it. They replied as follows:

"'We are aware that coloring (tanning) is not the proper thing for a menhaden seine, and would not have proposed it except in case of emergency. We have prepared netting in the way you propose and think it lessens the risk very much. We think the fisherman's experience is worth considering, and in giving your assent, as we understand you do, we have concluded to tar and tan in the manner suggested. In this process we shall endeavor to be particular and leave nothing undone towards preserving the seine.'

"This method of preparation delayed the completion of the net for about two weeks. I hope, however, that it may arrive in good condition in Sydney, and that the extra care, time, and labor may not have been misspent.

"Mention has been made that the average length of time a tarred seine can be used is about three or four years. Much, however, depends on the care observed, any neglect on the fishermen's part soon resulting in ruined apparatus. The bunt of a seine will rarely last more than one season, it being exposed to much more wear than the other sections of the net.

"Since the proper care of a seine is a matter of some importance in a pecuniary sense, it may not be out of place to mention here the methods most commonly employed by the American fishermen. During the fishing season, which continues from March or April to November, the seines are kept constantly damp except when they are taken on shore for repairs. Whether they are stowed in the boat or on the vessel's deck, they are *always* salted during the process of stowing except they are to be used immediately. The salting is done soon after the seine is taken from the water. The quantity of salt used varies from one-half to two barrels, more, of course, being required for a dirty net than for one comparatively clean. Strong brine is also put on in addition to the salt if necessary. Seines are occasionally salted to keep over winter, but the ordinary method is to wash and dry them thoroughly, after which they are taken to repairing lofts, mended, and then stowed away until the following spring.

"As a rule seines are tarred anew at the beginning of the second season, and again about the middle of the third summer. The tar is heated by jets of steam which issue from a perforated pipe. This pipe extends diagonally across the bottom of the kettle or tank containing the tar. For a new seine the liquid is heated to about 110° or 120° F. As the net grows older a greater degree of heat is required. After being immersed in the steaming tar the twine is passed between two large rubber rollers which remove all superfluous tar, while at the same time spreading it evenly on the net, which is then dried on a field.

"With the seine, but in a separate package, has been sent a set of seine-boat fittings; these include the pursing gear, without which a purse seine cannot be managed. Knowing how important it was that these articles should be sent with the seine, I sought the advice of Prof. Spencer F. Baird, Commissioner of Fisheries, and of Prof. G. Brown Goode, about the matter. They both thought it would be much to the advantage of the people of New South Wales to send the things. I therefore sought and obtained permission from Messrs. R. W. Cameron & Co. to purchase the articles, each piece of which has its name attached, while the position it should occupy in the boat is shown on the rough diagram, and the accompanying plate, which I send with this. The diagram and plate will give a very fair idea of the shape and relative proportions of the seine boat, the largest of which are 36 feet long, though those of 35 feet in length are most generally preferred, and are well adapted for any kind of purse-seine fishing. Indeed, it may be said without exaggeration that much of the success of the American purse-seine fishery, especially that for mackerel, is due to the excellence of these boats, which are justly celebrated for their many good qualities.

"The capture of fish with a purse seine has been so fully discussed in the 'History of the American Menhaden' by Prof. G. Brown Goode, that it will not be necessary for me to speak of it here, since, without doubt, the Government of New South Wales is in possession of several copies of the above work.

"The set-line or bultow which has been sent to Sydney is the same in size and general construction as those which are used on the first-class American schooners engaged in the cod fisheries. Two men manage a line of this kind, though it is divided into sections for greater convenience in handling, and, if desirable, two or more set-lines may be made of it. In regard to the apparatus used by the French at Newfoundland, it is, perhaps only necessary to say that for several years past they have adopted the same kind as is employed by the Americans, though, as a rule, the former are not so particular in rigging their gear as the latter, so far as neatness and completeness are concerned. The set-line has been constructed of the best materials and in the most thorough manner. It comprises the following parts, namely: Ground line, nearly 11,150 feet long; 2,000 hooks attached to the ground line by small lines called gangings*, each 3 feet long (the hooks are placed 5½ feet apart); two small anchors, two keg buoys to mark the position of the line, two buoy lines, each 100 fathoms long, two flags for the buoys, and a 'trawl roller' and two pairs of 'nippers.'

"The set-line itself, with its several parts of anchors, buoys, &c., is so well understood by the fishermen of most countries that I will not presume to say anything here of it or of its use. Of the trawl roller and woolen nippers, articles which are not well known to any but American fishermen, I will speak more at length. These, like the seine-boat fittings, are 'extras,' but since they are considered indispensable by our fishermen, and the cost is trifling, I sent them with the bultow. The latter can be handled much quicker and with far more ease with the assistance of these articles than it could possibly be otherwise. The trawl roller is secured to the gunwale of the boat, near the bow, in such a manner that the line passes over it as the bultow is pulled in by the fishermen. The woolen nippers are held on the hands of the fisherman (one on each hand), who is thus enabled to grasp the line firmly and to pull with all his strength, an impossible feat for a bare-handed person. Herr von Behr, President of the *Deutsche Fischerei Verein*, assured me that, though simple in contrivance, and comparatively insignificant in appearance, the woolen line-nippers, in his opinion, deserved to rank among the most important of the American exhibits at Berlin.

"My interest in the success of the attempt to introduce the purse-seine and set-line into the fisheries of New South Wales is my only excuse for incurring the additional expense necessary to guard against

* The second "g" is pronounced soft like "j"; thus găn-gings.

failure, and no better apology can I give for the liberty I have taken in writing you this long letter. I humbly hope that my action in this matter may meet with your approval, as well as that of the government.

"Assuring you that I shall be happy to render you any future service, I have the honor to be, your obedient servant, &c."

The reply to the foregoing was dated 5 Westminster Chambers, Victoria street, S. W., London, December 1, 1881, as follows:

"I have the honor to thank you for your interesting letter of the 5th November last in reference to the purse-seine and set-line which you have been good enough to procure for transmission to Sydney, through Messrs. R. W. Cameron & Co., of New York.

"I shall have pleasure in sending a copy of your letter to my government for their information, and I tender you my best thanks for the trouble and attention you have been pleased to bestow on this matter."

About the middle of June, 1882, I received the following letter, dated New South Wales Government, 5 Westminster Chambers, Victoria street, southwest, June 1, 1882, and inclosing a copy of one from the Colonial Secretary of New South Wales:

"I have much pleasure in forwarding herewith a copy of a dispatch received by me from the Colonial Secretary of New South Wales, requesting me to convey to you the thanks of the Commissioners of Fisheries of New South Wales for your courtesy and the trouble you have taken in regard to certain fishery implements asked for by them."

NEW SOUTH WALES,
COLONIAL SECRETARY'S OFFICE,
Sydney, March 31, 1882.

SIR: Referring to your letters, dated respectively the 18th November and 2d December last, regarding the transmission of certain fishery implements by Captain Collins, of the United States Fishery Commission, and Herr Wallem, of Bergen, Norway, I have the honor to request that you will be so good as to convey to the above-named gentlemen the thanks of the Commissioners of Fisheries for New South Wales for their courtesy and the trouble they have taken in the matter.

I have the honor to be, sir, your most obedient servant,

JOHN ROBERTSON.

The AGENT-GENERAL FOR NEW SOUTH WALES, *London.*

I have been unable to learn anything of the condition in which the apparatus reached Sydney, a matter in which, for reasons already explained, I felt much interest.

Replying to a letter of mine asking for information relative to this subject, Mr. S. Yardley, secretary for the New South Wales Government agency, writes under date of November 10, 1882, as follows:

"Sir Saul Samuel has not received any communication from the government in regard to the fishery implements that you were kind enough to collect and transmit to Sydney, and he fears that possibly they have all been destroyed in the disastrous fire at the Garden Palace."

GROWTH, SPAWNING, EDIBLE QUALITIES AND MANNER OF COOKING GERMAN CARP RECEIVED FROM THE UNITED STATES FISH COMMISSION IN 1880.

By W. VAN ANTWERP.

[From letter to Prof. S. F. Baird.]

To-day I can go to my ponds and catch carp of 7 pounds weight, which were planted two years ago the 19th of this coming December. Several ponds have young fry in them to the amount of many hundred thousand each. I went personally and put them into shallow water lying fair to the sun, with brush, stumps, and old roots to make places for spawning. I have sown rice and transplanted water lilies, &c., to make shade and concealment for them. We have caught quite a number to test their edible qualities which all pronounce not excelled by any of our indigenous fishes.

I always instruct the cook to clean them nicely; then wrap the fish in a linen towel, have a large kettle of water boiling, coil the fish neatly in the kettle and boil fifteen minutes, then turn off the water, remove to a baking pan without marring and put in the oven, bake and then baste with butter gravy. A nice dressing could occupy the interior of the fish and the space around the sides. If properly done it makes a dish fit for a king, or a hungry fisherman.

MOUNT STERLING, MONTGOMERY COUNTY, KENTUCKY,
October 31, 1882.

GROWTH AND FOOD OF CARP.

By SAMUEL GILLESPIE.

[From letter to Prof. S. F. Baird.]

My fish surpass all expectations in growth. They are estimated by the most competent judges to weigh 4 pounds. When I received them from you, November 7, 1881, they were about 2 inches long. After putting them in the pond I never saw anything of them until the 15th of June. I then commenced feeding them twice a day on bread and potatoes. I continued this until the middle of July; then I commenced on sweet corn cut from the cob. They are very fond of this, and come as readily for it as my pigs. I still fed the scraps from the table, too, but corn is their favorite. On the 16th day of November they bade me adieu until next summer. They have caused quite an excitement, and people come miles to see them.

MILLVILLE, BUTLER CO., OHIO,
December 14, 1882.

REPORT UPON A CRUISE MADE TO THE TILE-FISH GROUND IN THE SMACK "JOSIE REEVES," SEPTEMBER, 1882.

By CAPT. J. W. COLLINS.

The area of sea bottom lying inside of the Gulf Stream, near the parallel of 40° north latitude, and between the meridians of 70° and 71° 20′ west longitude, in depths varying from about 90 to 125 fathoms, is where the tile-fish (*Lopholatilus chamælonticeps*) has been found abundant during the past three summers, and this locality is known as the "tile-fish ground," and here, as well as much farther south and west, dead fish of this species were seen floating in vast numbers at the surface of the ocean last March and April. The object of this trip was to ascertain by practical methods, and as complete a research as circumstances would allow, to what extent the tile-fish had been depleted by the mortality of last spring, or if they had been practically annihilated in the region where they have heretofore been known to occur. The investigation of this subject was therefore a matter of unusual interest, whether we look at it from a scientific standpoint or whether we take into consideration how much benefit might result to those engaged in the fisheries, should the tile-fish be found in anything like its former abundance, and its commercial value be established. This species has been pronounced a most excellent food-fish by competent judges, and there is reason to expect that its market value might have been fully equal to that of many of our choice fishes had sufficient numbers been taken to place it before the public as an article of food.

In obedience to the tenor of your orders that I should proceed to the tile-fishing ground and ascertain the presence or absence of the *Lopholatilus chamælonticeps*, I have the honor to submit the following report:

I left Gloucester September 15 (1882), to join the schooner Josie Reeves, which was then at Greenport, Long Island, waiting my arrival. I had previously forwarded the fishing apparatus, trawl lines, &c., that I had prepared for the trip. My intention was to have started on the 14th, but the prevalence of an easterly storm, accompanied by high winds, together with some difficulty I had in obtaining the lobster-pots, delayed my departure.

Going by the Fall River line, I reached New York on the morning of the 16th. On arriving at the city I went at once to the office of Mr. E. G. Blackford, Fulton Fish Market, in order that I might learn of him whether all the tanks, jars, and other materials for preserving specimens (which articles were sent to his care), had been forwarded to the smack. All of these details had been carefully attended to by Mr.

Blackford; and I learned from him that, besides the provision made for the preservation of material in alcohol, there was sufficient ice on board of the schooner for the refrigeration of our bait and any number of fish we were likely to capture.

Having ascertained these facts, I went by the afternoon train (the first one leaving New York) to Greenport, where I arrived at 6.40 o'clock in the evening. Mr. Barnet Phillips, who accompanied us on the cruise and who had joined the smack in New York, and Captain Redmond, the skipper of the Josie Reeves, met me at the depot. I went with them on board the schooner then lying at the wharf where the menhaden steamers rendezvous when in port.

I learned from Captain Redmond that all the material for the trip, with the exception of the lobster-pots which I had sent from Gloucester, had been received and was snugly stowed away on board of the smack. However, owing to the prevalence of rough weather during the preceding four or five days, no menhaden had been caught, and therefore it had been impossible to procure a supply of bait for the cruise. It is true, perhaps, that bait might have been obtained from the weirs in the vicinity of Sandy Hook when the smack left New York, but to have taken it then, with a storm of uncertain length impending, would have been very unwise, since the probabilities were that it might be unfit for use before a chance offered to go to sea. Under the circumstances, there was nothing to do but to wait until Monday.

Captain Redmond thought our best chance of obtaining bait would be from the weirs in the vicinity of Greenport. Therefore, on the next day, the 17th, we procured a team and drove to all the fish traps which could be reached. We found, however, that the prospect of getting "bunkers" from the pounds was not good, for most of the pounds had been either torn up or so badly injured by the storm that there was little chance of securing enough menhaden to answer our purpose. The only thing that could be done under the circumstances was to wait until the fishermen went out in the Sound, when, if the fish "played" well, we might get bait from the seining gangs.

At daylight on Monday, the 18th, there was a smart southerly breeze with indications of rain. The steamers had started between midnight and dawn, and the sailing gangs, which were out early, looking for fish, finding the wind too strong down Gardner's Bay, began working up by Greenport under reefed sails, towards the more sheltered waters of the Great Peconic Bay. Altogether the prospect of getting a supply of bait was not promising for that day. Towards noon, however, the appearance of the weather changed very much, and the afternoon was fine, with a moderate southwesterly wind.

We were reluctantly compelled to wait for our lobster-pots until the arrival of the steamer from New London at 11.30 o'clock a. m. We then got under way, but seeing no indications of the presence of menhaden as we ran down Gardner's Bay, we decided to work up the Sound, feeling confident that we should have a better chance there to meet the fleet of steamers that had gone in that direction; there was also a probability of getting menhaden from the pounds on the Connecticut shore. When off Cornfield light-ship we saw several "bunches" of "bunkers," but as there were no seiners in sight we kept on our way. The pounds along the shore, which we approached quite closely, had met with the same fate as those at Greenport, being rendered unfit for fishing by the late gale. At about 8 o'clock in the evening, having reached the vicinity of Guilford, where there is an oil and guano factory, we came to anchor near Falkner's Island, expecting to have an opportunity the next morning to secure bait from some of the fishing gangs which were thought to be at that place. Another reason for our anchoring was that the tide had turned against us, and, the wind being light, we could not hold our own under sail.

The morning of the 19th was calm and fine, and after daylight we saw numerous "bunches" of menhaden playing at the surface near where we lay anchored. At that time there were the two sloops of a "sailing gang" lying at anchor close in shore, but they did not get under way until some time after sunrise, when they began working off shore, taking what advantage they could of the occasional "cat's-paws," which, later, became more steady, though the wind continued very light. The boats gained little, however, and feeling anxious to secure their assistance in procuring bait, and fearing that they might go in some other direction if the wind breezed up, I, with two of the smack's crew, started to board them in one of our dories. We had about two miles to row, but the distance was soon passed over, and we boarded the larger of the sloops—the one having the fishing gang on board—the other being the carryway boat.

Having first told the captain of the gang that there seemed to be an abundance of fish near our vessel, I asked him if he would sell us bait enough for our trip, telling him for what purpose the cruise was undertaken. Though entirely willing to furnish us with bait, so far as he was personally concerned, the captain explained that he was not permitted to sell any menhaden for such a purpose, but said that if I would go ashore and get the consent of Captain Fowler, one of the proprietors of the factory, and who, we were told, is president of the Oil and Guano Association, he would most gladly supply us with bait. Accordingly we went to the factory, but learned that Mr. Fowler had just driven off to "town" (Guilford) and would not return for the day. The foreman in charge of the factory, to whom we explained why we landed, thought there would be no objection to our procuring bait, but was not disposed to assume any responsibility.

As nothing further could be done we returned to the Josie Reeves, and, the wind having breezed up slightly in the interim, we got under way and stood in the direction of the sloop we had boarded, and which at this time had worked off on the ground a little over a mile distant from us. Soon after filling away we saw the boats out, setting the seine, and the breeze being too light to gain much in the vessel, I started off again with two of our men to buy what bait we needed if the seiners succeeded in making a good catch. A fair-sized "bunch of fish" had been surrounded, and our men helped to gather in the twine during the "drying in" process. The "boss" of the gang thought he had from 15,000 to 20,000 fish in the net, and there was every prospect of securing the entire lot, when, just as the men were ready to "bail out" the fish, a large hole was torn in the seine (due to the rottenness of the twine, or the bite of a shark or dog-fish), and the bunkers went streaming out through the "tear," leaving only a few—perhaps one-tenth of the whole—which were hastily gathered in one corner of the bunt, and scooped on board of the carryway boat. The skipper had consented to supply us with bait, on condition that I should write a letter to the owners of the factory explaining the purpose for which it was obtained.* The failure to get this school was as much a disappointment to us as to the fishermen themselves, possibly even more so, for we were very anxious to improve the favorable wind to run down the Sound, and also felt some uncertainty about getting bait before night.

However, another set was made by the crew of the sloop, but the result added but little to the first catch, the whole amounting to only 2,200 fish, which we took on board and packed in ice. By this time it was getting late in the afternoon, the fish had stopped schooling, the sailing gang manifested a disposition to go in harbor, and a loaded steamer, bound to Greenport, which we unsuccessfully tried to head off, paying no attention to our signals, there seemed little probability of getting the rest of our bait before night. But a sharp lookout was kept for homeward-bound bunker steamers, and at 5 o'clock p. m. we were fortunate enough to meet with the William A. Wells, on her way to Greenport with a cargo of menhaden. The captain, who knew the Josie Reeves, and understood why she was there, very kindly stopped his boat and sold us 2,000 fish at five dollars per thousand. He also took our mail.

We then filled away and ran down the Sound with a brisk southerly breeze, carrying all of our light sails. At 8.40 p. m. passed Little Gull Rock and at 10.30 p. m. Montauk Point light bore SW. by W. about 5

*This letter was written and addressed to Messrs. Fowler & Colburn, Guilford, Conn., as follows: "Being in want of menhaden for bait wherewith to make a fishing trip to the grounds lying inside of the Gulf Stream, in the interest of the United States Fish Commission, we have applied to the captain of the sloop 'Fanny,' who has kindly consented to furnish us with a supply on condition that I shall write this letter of explanation to you. I trust you will commend his action in this matter, since we have been prevented from obtaining bait for several days on account of the recent rough weather, and because of the importance of this investigation, which might be much delayed, if not rendered abortive, should we be unable to procure bait now."

miles distant. At that time we hauled to, steering a S.SE. course, and as there was some head sea and the wind had freshened, we took in the balloon jib and staysail.

The morning of Wednesday, the 20th, was fine, with a brisk breeze from S.SW. About 8 o'clock, however, it was foggy, but soon after it cleared off, and the weather continued fine throughout the day, though the wind was somewhat variable, backing southerly for two or three hours at a time, and then hauling back again.

At sunrise all hands were called, and we began making preparations for setting the gear, and during the forenoon we baited a cod and haddock trawl, each having 1,000 hooks. We thought it possible in the morning that we might get to the tile-fish ground early enough to make a set with the trawls, but the wind being moderate and variable in the afternoon we did not reach deep water until 3.55 p.m., when we sounded in 118 fathoms, our position at that time by dead reckoning being 40° 4′ north latitude and 70° 30′ west longitude, about a mile from the position where the Fish Hawk found tile-fish abundant August 23, 1881. The day was too far advanced, however, for us to set the trawls, so we hove to for the night.

A short time before reaching deep water (shortly after 3 o'clock) we saw several fin-back whales. A little after 4 o'clock we noticed three or four schools of small fish, which were apparently about the size of a large mackerel. At times they showed a ripple like mackerel or herring, and very frequently many of them would spring from the water together, making long dolphin-like jumps. We ran for the schools in hopes to approach them near enough to find out what species the fish were, but they sank before we got close enough to them, and a troll-hook which we put out failed to catch any.*

The evening was fine, with brisk SS.W. wind. We lay to under mainsail and jib with head to the eastward during the first half of the night, after which we jogged the opposite way.

Thursday morning, the 21st, was overcast, with a moderate SS.W. breeze, but after sunrise the weather cleared off beautifully with a slight increase of wind.

At daylight we set the trawls under sail, beginning in 160 fathoms and running the gear northwardly towards shoaler water. After the trawls were out we sounded at the lee ends, getting a depth of 135 fathoms, the bottom being mud, sand, and broken shells. Our position was latitude 40° 3′ north and longitude 70° 28′ west. Captain Redmond went in one of the dories (as he did during the whole time we were on the ground), leaving me to manage the smack with the assistance of the cook, while Mr. Phillips busied himself in taking notes on this method of fishing, which he now saw for the first time.

Being entirely unacquainted with the strength of the current in this

* It is probable that the fish we saw were mullet.

locality, we put four buoys on each trawl—two on an end—to make sure that the gear should not be lost by the submergence of the kegs. We found, however, after the trawls were set, that there was only a moderate tide setting to leeward in a northeasterly direction, and apparently only at the surface.

We began hauling the trawls at 8 o'clock a. m., and picked up the last dory at 10.15. Only three fish were caught. These were a hake (*Phycis*), a grenadier (*Macrurus*), and a whiting, or silver hake (*Merlucius*).*

After getting the boats on board we ran to the westward, the men in the mean time being busy in baiting the trawls, which we set again at 2.30 o'clock p. m. in from 130 to 150 fathoms,† our position being latitude 40° 2′ north, longitude 70° 41′ west.

The gear was hauled late in the afternoon. We caught about 20 hake (*Phycis*), four or five silver hake (*Merlucius*), several skates (*Raia*), of which we saved two specimens, and three handsome fish of a species which I had not previously seen,‡ besides a limited number of invertebrates. All of the largest fish were iced, as well as one of the rare ones, which we were in hopes might prove of special interest, and which we preferred to keep in ice so that it would retain its color. The other two were put in alcohol, as also were the invertebrates.§

Owing to the fact that we were uncertain about the strength of the current in the morning, and had so little time for the afternoon set, we did not put out any of the lobster pots. It is, perhaps, proper to remark here that, fishing as we were under sail, and exerting ourselves to the utmost to make as many trials as possible in a given space of time, little could be done with lobster pots in deep water, though it is entirely reasonable to suppose that they might be set from a vessel at anchor on hard bottom with excellent results. When making "flying sets," to "try the ground," it is desirable that the gear shall sink as soon as possible, in order that it may soon be hauled in again. Lobster pots, of the ordinary pattern, are somewhat unwieldy and sink slowly, and the necessity for speedy action when fishing under sail makes it

* These, with the exception of the first, were put in jars, with other material (invertebrates), and labeled "Lot No. 1."

† In all cases the trawls were set at right angles to the trend of the ground, which here extends nearly east and west, sloping quite rapidly to the southward, so that a trawl, being nearly a mile long, might be in 150 fathoms where its southern end lay, while at the northern extremity there would not be more than 120 or 130 fathoms. It seemed desirable to place the gear so that, as far as circumstances would permit, various depths might be reached, since it often happens that some species of fish which may occur in great abundance at a depth of, say, 130 fathoms or more, can be rarely taken in shoaler water, while other kinds would be found most plentiful where it was not so deep.

‡ This species has since been identified as the *Sebastoplus dactylopterus*. Immature specimens had previously been found on our coast, but no adults had been taken. It also occurs in the Mediterranean and at Madeira.

§ This collection was labeled "Lot No. 2."

desirable to pull them in again before they have been sufficiently long on the bottom to secure the best results.*

After hauling our trawls we ran to the westward about 10 miles and hove to for the night, with the "jib to the mast."†

During the day the wind had backed easterly, and at sunset was southeast, blowing a moderate breeze. The weather at that time was fine, but the sun "setting in a bank" gave us reason to suppose that it might be less favorable on the next day.

Friday morning, the 22d, there was a fresh southeast breeze, with indications of stronger wind and, possibly, rain before night. Orders had been given the previous night to exercise considerable care to keep our position, and so well was this attended to that at daylight we sounded in 140 fathoms. At this time the men were called out to bait the gear. One man was sick, therefore we set only one string of trawl, which we put out at 8.30 a. m., in 125 fathoms, latitude 40° 1′ north, longitude 71° 2′ west, by dead reckoning.

We hauled the gear at noon, three men going in the dory. At this time there was a strong and increasing wind with a choppy sea going. As there was little probability of its moderating enough to set again in the afternoon, we took the dory on deck, took care of the catch, and stowed the trawls below.

On this occasion ("Lot No. 3") we caught twenty-five or thirty hake, several silver hake, and eleven specimens of the remarkable red fish which we had first seen the day before. One of the latter was so badly eaten by slime eels that it was thrown away. Several of the finest specimens were put on ice, while the rest, with the exception of two, which we ate, were put in alcohol. Mr. Phillips, believing the species might be new to science, and deeming it an important matter to determine its qualities as a food-fish, suggested that we should eat one, as no one could say when another opportunity might offer to obtain fresh specimens. Fully concurring in his opinion, I had two of them cooked, and we found them most delicious, with firm crispy flesh, and a delicate flavor that would be hard to equal.

In the lobster pot only slime eels were taken. These were placed in alcohol.

It is perhaps worthy of remark that in all the fish which were eviscer-

*On the ground where we were fishing it would probably have made little difference, for the slime eels (*Myxine*) were so plenty that they invariably consumed the bait when the pots were set at a later date, and it is very likely that their presence in such great numbers would have prevented the entrance of other and more desirable species, which might otherwise have been captured.

†This is a favorite method of heaving a vessel to on the fishing ground among the market fishermen from New York to Portland, Maine. The jib is trimmed flat so that its clew is nearly amidships, or it is held in about the same position by a "tail rope" from the weather bow. The helm is then secured in such a manner that the vessel, by lying first on one tack and then on the other for greater or less time, will hold her position much closer than would be expected. However, to accomplish this successfully, requires the peculiar knowledge of these vessels, and the skill to manage them possessed by the fishermen, and which only long experience can give.

ated not the least trace of food was found, and I am at a loss to know why species so voracious as the hake, whiting, and others, which we took, should be found in a locality where there is evidently little food to be obtained.

The scarcity of sea-birds might be cited as an indication of a limited amount of small fishes, or other forms near the surface. However, an occasional hag (*Puffinus*) was seen, and several varieties of jaegers, which appeared more common in this region than other forms.

At 1 o'clock p. m. we kept off and ran to the westward 15 miles by the log.* At 3.45 p. m. we sounded, and having got a depth of only 50 fathoms, let the vessel jog under mainsail and jib, on the port tack, slowly head-reaching to the southward. At sunset there was less wind and occasional light showers. By the exercise of much care, and sounding frequently during the night, the vessel was kept on the edge of the ground so closely that at 5 o'clock on Saturday morning, the 23d, we were in 150 fathoms. At this time there was a moderate S. S. E. breeze, but considerable ground swell, which increased somewhat later in the day. The sky was overcast with broken clouds, though there was no appearance of thick weather.

All the men were called to bait the trawls at dawn. Being anxious to make two sets during the day, and knowing that we could not if we set two trawls at once, we baited only one string—a thousand hooks—which we set between 8 and 9 o'clock a. m. in from 100 to 125 fathoms; latitude 39° 54′ north, longitude 71° 22′ west. After the trawl was set we left one of the dories fast to the lee end, since the ground swell rendered it difficult to see a buoy flag any distance. We began hauling the gear at 11 o'clock, a dory going to each end of the trawl, and shortly after noon the men had finished the work. But little was taken on this haul—"Lot No. 4"—it consisting of a few hake, three dogfish (*Squalus*) and a few invertebrates on the trawl, and nearly a bucket full of slime eels (*Myxine*), and a single crab in the lobster pot, which we had fastened near one of the anchors.

As soon as we had finished hauling we kept off southwest by west and ran a little over 5 miles on that course, when, having got a depth of 110 fathoms, we set one of the trawls, which we had baited during the forenoon while the first one was out. The position of this set was, latitude, 39° 50′ north; longitude, 71° 25′ west. The trawl was hauled at 4.30 p. m., by three men, who went in one of the dories. This was necessary, as one of the crew was ill, and also because at this time the increasing wind and sea made the hauling of the trawl a matter of some difficulty for two men to accomplish. The catch, which contained nothing of interest, consisted of about thirty hake, and a single specimen each of dogfish (*Squalus*) and monkfish (*Lophius*), all of which we iced.

*I take this occasion to mention that the captain of the yacht "Madeline," which lay in winter quarters at Greenport, kindly lent us the yacht's patent log, which we found very serviceable. The log was returned through Captain Redmond, with a letter of thanks and acknowledgment of the favor conferred.

The investigation having now continued uninterruptedly for three days, and 50 miles along the edge of the ground having been tried over, with not the slightest indication of the presence of the tilefish, to search for which was the object of the trip, and the appearance of the weather being such that strong winds and a rough sea might be expected for the next two or three days at least,* I concluded that nothing could be gained by staying longer on the ground. One reason for this decision was that our bait, though we had had it on board only five days, had already begun to show signs of deterioration, and it was obvious that, should we have rough weather for three or four days, which was very likely to occur at this season, the menhaden would be entirely unfit for use, and the cruise would have to be given up then even if there should be a return of fine weather. The chances, therefore, were that a longer stay would only add to the expense of the trip without the attainment of any additional results. Other important business, which required my attention, also made it extremely desirable that no time should be wasted. Besides all this the time for which we had chartered the smack had nearly expired, and Captain Redmond was very desirous of resuming his business of lobster carrying, since he feared his trade might be injured by a longer absence.

I had hoped to continue the investigation for eight or ten days, at least, and to have prosecuted the research some distance farther south, though the probabilities are that little more could have been accomplished, so far as catching tilefish is concerned. Nevertheless, it would have been more satisfactory if the weather had permitted us to stay long enough to settle all doubts as to the presence or absence of the *Lopholatilus* within certain limits. However, this not being practicable for the reasons given above, it was decided to run for the land. Accordingly we kept off at 5 o'clock p. m. The wind at that time blew fresh, and continued strong and steady through the night. At 2 o'clock Sunday morning, September 24, we made Block Island light. After getting nearly abreast of the island we hauled up more, and, passing through Buzzard's Bay and Quick's Hole, reached Wood's Holl about 9 o'clock a. m., just in time to escape a dense fog which, coming in from sea, completely obscured all but the nearest objects. The apparatus which we had on board of the Josie Reeves, and as much of the collection as was considered valuable, was landed during the day, and Captain Redmond was left free to proceed to New York as soon as the weather permitted him to sail, which he did on the following morning.

Before closing this report it is proper that mention should be made of the efficient aid rendered by the captain and crew of the Josie Reeves in the prosecution of this investigation. The cheerfulness with which

*The spell of rough easterly weather that began at this time continued uninterruptedly for eight days, and there is little probability that the least chance would have offered to set trawls, especially when we consider that a large fleet of mackerel schooners was kept in harbor during all this time, and many vessels engaged in the cod and halibut fisheries were prevented from sailing by the same cause.

they engaged in the most arduous labor, and the zeal they exhibited in collecting and in doing all that pertained to the work we had to perform, was certainly commendable, and rendered my duty much pleasanter than it otherwise would have been.

I would also improve this opportunity to acknowledge the obligations I am under to Mr. Phillips for suggestions which were valuable and well timed.

REPORT UPON THE MANAGEMENT OF GERMAN CARP BY A MISSISSIPPI CORRESPONDENT.*

By JOHN YOST.

[From a letter to Prof. S. F. Baird.]

About the middle of December, 1881, I received at Jackson, Miss., in good order, twenty Carp from the United States Fish Commission. Unfortunately the pond intended for their reception was stocked with other fish, such as Sun-fish, Bream, and Cat-fish. I undertook to drain it, and having procured a dry-goods box about two and one-half feet square by twenty inches deep, I bored a number of small holes to allow the free circulation of the water running from a spring. I put a rock in it to hold it down, also a few shovels of dirt. Then I put the Carp in the box. They remained there eight days. I fed them on crumbs of corn bread. I could see some of them every day and supposed they were doing well, but when I had drained my pond and it was ready for their reception, I was surprised in taking them out to find ten of them under the rock and dead. That left me but ten live fish, and two of them were sick. When I turned them loose in the pond they swam slowly off into deep water, and have not been seen since. I have two ponds side by side, with but a few feet of earth to separate them. Into the one where the box was was sunk I put the common fish. While taking the Carp from the box one of them accidentally fell in with the Cats and Bream. I had not seen any of the Carp until the first day of the present month, when a boy fishing for the common fish caught the Carp that had accidentally got among them. The bait used was a worm. I measured his length, which was 12 inches from the nose to the parting of the tail. When put in the pond about December 26 they were each of them about 3 inches long. In the case of this one it shows a gain of 9 inches in length in six months. Of course, I put him with his own kind. I have not seen them, however, since they were put in, December 26, 1881. I suppose they are doing well from the condition in which I found that one. For food I give them cabbage leaves, lettuce, tomatoes, peaches, apples, and corn bread. I discover small fish in their pond. I would like to know at what age they breed.

BRANDON, FRANKLIN COUNTY, MISSISSIPPI, *July* 30, 1882.

* Had this gentleman followed instructions to have his pond in entire readiness, and free from all other fish, his success would doubtless have been greater.—EDITOR.

NOTES ON THE HALIBUT FISHERIES OF 1881-'82.

By CAPT. J. W. COLLINS.

The importance of the fishery for fresh halibut, the apparently rapid diminution of the species wherever it has been sought, causing thereby more changes in this industry than are noticeable in the other food-fisheries, seems to make it desirable that a record of the leading events connected with this business (so far at least as relates to the abundance of fish on certain grounds) should be kept. Two events of a remarkable character, and which seem worthy of special mention, have occurred during the seasons of 1881-'82. These are (1) the discovery of a new fishing ground, and (2) the occurrence, at a season when it was least to be expected, of halibut in almost unequalled numbers in a well-known and long-frequented region. The following account of the events alluded to is based on such facts as could be gathered from the halibut fishermen during my stay at Gloucester this summer (1882), and though not at all exhaustive may possibly prove of some interest.

As a rule, during most of the season of 1881, and particularly in the fall, halibut were scarce on the more frequented fishing grounds along the edge of the outer banks. Consequently the inducement was great for the skippers to seek new and untried fields, where, perhaps, fish might be found in undisturbed abundance. With this end in view, Capt. George H. Johnson, of the schooner Augusta A. Johnson, in the autumn of 1881, crossed the Grand Bank and fished in the deep water on its eastern slope, where, so far as I know, no systematic research had previously been made.* Anchoring in 110 fathoms—latitude 43° 55′ north, longitude 49° 08′ west—he found halibut abundant, and made large catches on trawls set to the eastward of his vessel and in somewhat deeper water. In six days' fishing he secured a fare of between 50,000 and 60,000 pounds of halibut, most of which were large "gray" fish.† The same schooner on her next trip—this time commanded by another man—revisited the new ground, but the winter

* I was told by an acquaintance several years ago that a vessel had looked for halibut along the eastern edge of the Grand Bank as early as 1877, but had failed to find any, the skipper reporting that the bottom declined so suddenly that it was impracticable to attempt to anchor or set trawls. The late researches have shown that the statement was entirely wrong, and give reason to doubt the probability of the vessel having visited the deep water on the east side of the Bank.

† It is somewhat remarkable that when halibut are found on grounds not previously fished a large percentage of the catch are generally "gray" fish, and with rare exceptions these are above the average size. Instances are somewhat uncommon where medium sized "white" halibut have predominated on newly tried fields, but such instances have, however, occasionally occurred. After several years' fishing in one locality the quality of the halibut generally improves, the fish being of smaller size and in finer condition.

season had then so far advanced that there was a constant succession of furious gales. The prevalence of strong northerly winds caused an unusually rapid flow of the polar current (which often sweeps down by the eastern side of the Grand Bank with such velocity as to render fishing nearly impracticable), and in consequence of this combination of unfavorable circumstances, very little was accomplished. In the spring of 1882 Captain Johnson went to this place again and had remarkable success. His good fortune was soon noised abroad, whereupon many of the other halibut schooners made similar ventures, the result being that the eastern side of the Grand Bank was pretty thoroughly "tried over" from latitude 43° 15′ to 44° 30′ north, in depths varying from one to three hundred fathoms. At many points along this stretch halibut were abundant, but a strong polar current caused the fishermen much loss of gear, whilst the prevalence of dense fogs, together with the proximity of numerous icebergs, rendered fishing in that locality so hazardous that the majority of the skippers were glad to resort to other grounds, even where, perhaps, the prospect of finding large numbers of fish was not so good. Several of the vessels lost most of their trawls before they had secured a full fare, and few that fished on the eastern side of the bank returned to port without having met with some damage to their gear.* The icebergs sweeping down from the north, borne along by the swiftly running currents, were a source of great danger to the vessels lying at anchor. Huge mountains of ice would often appear suddenly out of a dense fog so close to the schooners that the startled crews were frequently almost compelled to cut their cables to prevent collision. Captain Johnson told me that on one occasion he counted twenty-eight bergs within sight of his vessel, and one of the number lay grounded for nearly a week—all the time he remained at anchor—not more than a mile distant, in water probably not less than 125 fathoms deep. It is scarcely necessary to say that in a rough sea one blow from such a monster would crush a fishing schooner as though it were an egg-shell.

The fact, however, of halibut having been found in abundance off the eastern, or rather, perhaps, the southeastern side of the Grand Bank, is a matter of more interest than would appear at first glance, since it permits us to form a better idea of the winter habitat of certain schools of this species, and also to judge more intelligently concerning the spring and fall migrations, about which, heretofore, only indefinite and uncertain ideas could be formed. For several years previous to the discovery of the deep-water fishing-grounds, it was noticed by the fishermen that, during the winter and early spring—from about the

* Where strong currents prevail in deep water the buoys which mark the position of the trawl-lines are dragged beneath the surface of the water by the great strain on the buoy-line. These buoys, being generally soft wood kegs, are broken by the pressure of the water, when they have been submerged to any considerable depth, and the result is that there being nothing to support the buoy-line—the only means by which the trawl can be recovered—the apparatus is lost.

middle of January to the last of April—the schools of halibut found on the body of the Grand Bank, between 43° 30′ and 45° north latitude, appeared to come from the east or southeast side of the Bank, and almost invariably moved slowly but steadily across the ground in a westerly or northwesterly direction. A vessel might obtain remarkably good fishing for two or three days, perhaps for a shorter time, but the halibut would suddenly disappear and none could be taken. It frequently happened that on such occasions a change of position—the schooner moving 5 or 6 miles in the direction which the fish were known to be going—might result in the school being overtaken again, and in the capture of a full fare. In some instances a skipper might be able to "keep run" of the fish for several days, and while they were passing over a distance of 20 to 30 miles, and many statements could be cited of a character to verify this assertion, though it would probably be superfluous to do so, since these matters have been quite fully discussed in the account of the halibut fishery, where, perhaps, they more properly belong. As it may be a source of wonder to many how any intelligent idea could be formed by the fishermen of the direction in which the halibut were moving, the following explanation should be offered:

The custom is for the Grand Bank halibut schooners to fish with trawls, each more than a mile long. These are set out from the vessel, from which, as a center, they radiate in the form of a star, stretching out in six long lines like the tentacles of the nautilus. A school of halibut approaching from the east would first be caught in great abundance on the lines set in that direction, while the trawls on the west side of the vessel would get comparatively few fish. On the next set the catch might be pretty equally divided, while succeeding hauls would show that the fish had moved so far that only the "tail end" of the school could be reached by the farthest ends of the western trawls. As soon as this occurred, any intelligent skipper, understanding the habits of the species, could form a tolerably definite theory as to how fast the halibut were moving and also the course they were pursuing. Notwithstanding it was apparently well known that the halibut were migrating at such times, only the most vague and indefinite ideas were formed as to the place from which they came or whither they went. No one seems to have entertained the thought that they "hung around" the edges of the Bank in deep water after leaving the body or shoaler portions of the ground. That the halibut came from some undiscovered bank to the eastward and passed across the Grand Bank on their way north and west towards Newfoundland, the Gulf of Saint Lawrence, Labrador, etc., was, I think, the general belief of the fishermen, at least, of such as took the trouble to formulate any theory. The discovery of halibut along the east side of the Grand Bank seemingly settles this question, and it is undoubtedly a fact that the great schools of this species, which for many years have been known to migrate northwesterly in the spring, make their winter residence on the eastern slope in depths varying from 100 to probably 400 fathoms.

Fortunately, halibut were discovered in remarkable abundance in the early summer on another and well-known fishing-ground, thus rendering it unnecessary for the fishermen to be longer exposed to so many losses and perils as they had experienced on the east side of the Bank.

On the deeply submerged plateau which extends in a northwesterly direction from the northwest prong of the Grand Bank to Saint Peter's Bank, forming a sort of border to the southern end of Green Bank—by which name this stretch of bottom is usually called by the fishermen—in depths varying from 112 to 250 fathoms, halibut of the finest quality, and in extraordinary numbers, were found. This locality has been famous for the abundance of halibut in the spring of the year since the discovery of the deep-water fishery in 1875. In April of that year the vessels, driven off the shoaler parts of the Grand Bank by immense masses of field-ice, sought to catch fish in deeper water, and halibut were found exceedingly abundant off the northwest prong of the Grand Bank in depths varying from 100 to 200 fathoms. During the whole season—even as late as September—these fish were caught at about the same depths nearly the entire length of the slope extending from the northwest prong to Saint Peter's Bank. And in such numbers did they occur that few vessels fishing in the locality failed to get full fares, while most of the fleet made extraordinary catches. Since 1875, however, notwithstanding the fact that large schools of this species have been found off Green Bank almost every spring, it has appeared from the movements of the fish that they were migrating to more northern regions, and that they were only passing over these grounds, pausing slightly, perhaps, in their course, or, at least, moving slowly.*

For a period of four to six weeks, generally in March and April, large fares were obtained between the northwest prong of the Grand Bank and Saint Peter's Bank. After that interval, however, the fish became scarce, and rarely did it happen that they were sufficiently plenty during the summer for vessels to obtain good fares there.† This

* On several occasions the movements of these fish have been pretty definitely traced along the southwestern side of Saint Peter's Bank and into the deep water between this bank and the shores of Newfoundland. Without doubt a portion of the Green Bank spring school is found in summer on the west coast of Newfoundland in pursuit of capelin close into the shore.

† In this connection it may be well to mention that in the summer of 1878 the schooner "Gwendolen" found a new fishing-ground some 20 miles to the southwest of Saint Peter's Bank, in a depth of about 200 fathoms, where no soundings are laid down on the chart. She succeeded in taking several large fares, but other schooners, learning of her good fortune, resorted in such numbers to the same grounds, that in September of that year the school had been broken up, nor has any large catch of halibut been made on that ground since. Allusion to this fact is made here because the locality is not far from that region off Green Bank now under discussion, and also because, with this exception, halibut have rarely been found abundant in the summer in its immediate vicinity since 1875, until the present year.

season has, however, been a marked exception to the general rule, and the fact of the abundance of halibut at that point during the present year is all the more remarkable, inasmuch as when the schools have been broken up on other fishing grounds, or the fish forced to leave their favorite resorts during a portion of the year, they rarely return to stay in such abundance. From early in June until late in October the species has occurred in almost unprecedented numbers off the southern part of Green Bank in depths ranging from 100 to 250 fathoms; whereas, in former years, even when halibut have been most plentiful, a dearth has usually occurred on all the halibut grounds in the latter part of September and in October and November. During those months, however, of this year (1882) wonderful catches have been made, several fares of from 40,000 to 75,000 pounds having arrived at Gloucester. The following are a few of the many instances of large captures made on Green Bank during this season: One of the first fares to arrive from that locality—possibly the first—was brought in by the schooner Isaac A. Chapman, which reached Gloucester on June 25, 1882. She had on board above 80,000 pounds, four-fifths of which were "white." The following detailed account of the amount and value of her fare appeared in the Cape Ann Advertiser of June 30, 1882:

"Schooner Isaac A. Chapman, Capt. Augustus G. Hall, arrived from a Grand Bank trip on Sunday, bringing in 81,000 pounds of halibut and 5,000 pounds of codfish, stocking $4,303.66, the crew sharing $145.30. She was absent nineteen days, of which time two days were spent in Nova Scotia ports waiting for bait."

Captain Hall told me that these fish were caught at a depth of 112 fathoms in latitude 45° 04′ north, longitude 54° 59′ west. He fished for eight days altogether, during the first two of which he was in shoaler water, and caught only 4,500 pounds of halibut, so that 76,000 pounds were taken in six days.

September 11 the schooner Gertie E. Foster arrived home from Green Bank, bringing in a fare of 78,625 pounds of halibut. Captain Olsen, who commanded her, told me that he had made several unsuccessful attempts to catch halibut on the Western Bank and Banquereau.

On the 4th of October the schooner Willie M. Stevens arrived with about 80,000 pounds of halibut, caught near Green Bank at a depth of 250 fathoms. The vessel, however, lay anchored in 220 fathoms, her position, according to Captain McInnis, being latitude 44° 58′ north, longitude 54° 33′ west.

A few days later the schooner Grace L. Fears arrived with a "big trip," caught near the same locality, the following notice of which was published in the Cape Ann Advertiser of October 13, 1882: "Schooner Grace L. Fears arrived from a Bank trip on Monday (October 9) with 70,220 pounds fresh halibut, which were sold to the Atlantic Halibut Company for $3,606.61, her crew sharing $119.39."

On October 28, the Augusta A. Johnson arrived in Gloucester from Green Bank with a fare reported to be between 50,000 and 60,000 pounds of fresh halibut.

In conversation with the captains of several halibut schooners I learned that many attempts have been made during the summer and fall to catch halibut along the southern edge of the Western Bank and the southwest prong and eastern edge of Banquereau, but these have rarely been successful. The captains of these schooners were induced to make these trials because the greater portion of the fleet had resorted to the vicinity of Green Bank, where the vessels lay close together, fishing on a small area of sea-bottom. As a result of this crowding there was much loss of gear, which rendered the trips far less profitable than they otherwise would have been. With scarcely an exception, however, so far as I have been able to learn, the vessels, after making the attempts already alluded to, were obliged to go to Green Bank in order to complete their fares. It may be interesting to note that, whereas in former years the halibut taken in the region under discussion (Green Bank) were nearly always of large size, the "gray" predominating, this year the reverse is the case, for the fish caught there have nearly all been of medium size and of much finer quality, averaging from two-thirds to seven-eighths "white." Mention should be made here of the capture of halibut along the southwest part of the Grand Bank, during the first part of this year (1882). Several fine fares were obtained on the western slope of that Bank in depths ranging from 150 to 300 fathoms between the extreme southern point of the Bank and 44° north latitude. Much difficulty has, however, been experienced in fishing off the southern peak, as well as on the eastern side of the Bank, from the strong polar current, though this is not generally a source of trouble on the western side of the Bank, north of lat. 43° 20′. It appears, however, that halibut were scarce along the southwest slope of the Bank during the summer months, though occasional fares were possibly taken in that locality since the spring. From information derived from the most reliable sources, however, it appears that nearly all the vessels engaged in halibut fishing have resorted to Green Bank since July. It is undoubtedly true that the small number of vessels engaged in this fishery has been favorable to their obtaining large fares throughout the entire season. Had the fleet, as in 1878 and 1879, been composed of forty or forty-five, instead of only fourteen or fifteen sail, there is no doubt but that the school of halibut on Green Bank would have been broken up after two or three months' fishing. And, if not, it is certain that the accumulation of lost gear on the fishing gounds would have rendered profitable fishing in that locality a practical impossibility.*

* When a large number of vessels are fishing on a small piece of ground the result is that the trawls of one vessel are generally set over those of another, until, in some cases, the gear of several schooners is piled, so to speak, in inextricable confusion on the bottom. This method of setting renders it difficult, if not impossible, for any

GRATIFYING RESULTS OF PROPAGATING GERMAN CARP-BREAM AND CARP IN PONDS TOGETHER—TABLE QUALITIES OF CARP.

By H. B. DAVIS.

[Letter to Prof. S. F. Baird.]

I constructed a small fish-pond in February, 1880. For this purpose I drained a valley below a spring of water, clear as crystal, and which flowed into a small creek. Leaving a portion of the undergrowth for shade and feeding-ground, I put into this pond thirty-two carp. A part of them were of the scale variety and some leather. Soon after, as I wrote you on a previous occasion, the dam broke and I lost all except five, four of which were scale carp. When the dam gave way in June of 1880 the five fish averaged 11 inches in length. They were about 3 inches long when received three months previously. So much for carp raised partly in northern waters (say, nine months) and partly in southern waters (say, four months). Well, on or about June 1, 1881, I examined this pond which had contained the five carp. Only four large carp were found, three scale and one leather. These measured 18 inches in length. There were several hundred young carp, all about 3 inches in length. I was delighted with this, and went to work to construct other ponds. I built two ponds on a small stream, both fed from a cold clear spring; the upper was a small deep one, and the lower pond covers a considerable space, though very shallow, not averaging more than 15 inches deep. In April or May of this year I examined these ponds (stocked with the young carp mentioned above) and discovered a great difference in the growth of the fish in the two ponds, and yet it was the same water and the same kind of bottom. The fish in the small deep pond were only 6 or 7 inches in length, while those in the pond below covering about twice the space were 12½ inches long. The bottoms of these ponds were partly sand on the edges and in the center black mud, or swamp muck, as some term it. Both ponds, as in the case of the

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one to recover the whole of his trawls. The trouble is increased, too, because each one of the fishermen, on account of this mixing up of the apparatus, finds his labor—severe enough under the most favorable circumstances—much added to, and, feeling resentful and aggrieved thereby, rarely hesitates to cut any trawls that he may haul up, and which do not belong to the vessel he does. This "slaughter of gear" if once begun, goes on increasing from day to day, each one, prompted by a spirit of retaliation, soon seeking, rather than evading, the opportunity to destroy the apparatus of rival vessels. It is true that this is not always the case, but it is easy to see that with the utmost forbearance there must, under such circumstances, be a great loss of trawls, and the result is that the ground soon becomes so covered with a mass of lines and hooks that it is next to impossible to recover a trawl that has been set on it. The hooks of the trawls, drawn over the bottom by the current or the struggles of the fish, catch in the lost gear and become so entangled that it rarely happens all can be hauled back. As, however, the lines decay very rapidly on the bottom, the ground, if deserted for a few weeks, will be found "clean" again.

first, were only partly cleared of trees and bushes, so that the carp could have plenty of shade and feeding-ground.

Now comes the most interesting part of my experiments. In the latter part of February or the first of March of this present year, I constructed another pond some distance from the others, they being very near my house. It covered more space than any of the others, but was very shallow, not over 6 inches deep in the deepest part. I transferred six carp from one of the above ponds to this new pond, and in addition put in one hundred and sixty bream. At that time the carp were not over 4 inches long. To-day, after finding that the spring had failed and the pond was fast drying up, I let off the water and transferred the fish to a new pond just finished. I was surprised at the large growth of the carp as well as the slow growth of the bream. The largest of the six carp, now one year and three or four months old, measured 17 inches in length and weighed full 2½ pounds. The bream were only a little larger than when put in. These carp in six months had grown from 4 inches in length to 17, and had not been fed once. I forgot to mention that the fish in the small deep pond had been fed while those in the pond below, where the fish grew to more than twice the size, had not been fed. In this pond that I drained to-day I find plenty of young bream, but what puzzles me is that I find any quantity of small fish about three times their size.

I would think these were young carp if it were not for the following reasons: First, the carp that would have spawned them are only a little over one year old. Second, the mouth resembles the carp in shape, but does not have the thick lips of a carp; on the contrary, the lip is very thin. I have never seen anything like them here, and it may be that they are carp. These large carp taken from this pond, as you will see from reading above, are only a fraction smaller than my carp when they spawned last year, though they were two years old. I have secured several specimens and placed them in a large basin of water to await further developments.

My conclusions briefly are as follows: First, that in southern waters it makes no difference whether the water is clear or muddy. Second, that it matters not whether the bottom is muddy or not. Third, that if they are not crowded, or, in other words, have plenty of feeding-ground, it is not necessary to feed them. Fourth, that they do not, in my judgment, "kettle" in the winter in this latitude. Fifth, that they will certainly spawn in two years if properly cared for. Sixth, that they are not full of bones, and do not taste of mud, as some would have us think, but, on the contrary, are very free from small bones, and are a most excellent table fish, to which several who have dined with me will testify.

MACON, BIBB COUNTY, GEORGIA, *August* 26, 1882.

REPORT RELATIVE TO THE GENERATION AND ARTIFICIAL FECUNDATION OF OYSTERS, ADDRESSED TO THE MINISTER OF THE MARINE AND THE COLONIES.*

By M. BOUCHON-BRANDELY,

SECRETARY OF THE COLLEGE OF FRANCE.

Since the creation of the ostracultural industry, the administration of the marine has not ceased by divers means, grants of money, missions, etc., to encourage all attempts having for their object the development of this industry. It is undoubtedly to this that ostraculture owes its present prosperity and the constant progress it has realized, a progress which was shown in so worthy a manner at the exposition at Bordeaux.

Faithful to this tradition, you have been good enough, monsieur, to authorize us, under your auspices and with your encouragement, to make the investigations of which we herewith present an account.

These researches commenced in the College of France in 1880, in the laboratory of comparative embryogeny, under the direction of M. Balbiani, the eminent successor of M. Coste, who has aided us with his counsel, have been pursued in this same laboratory and upon different points of our coast, and they relate to:

1. The sexuality of the French oyster (*Ostrea edulis*) and the Portuguese oyster (*Ostrea angulata*).
2. The fecundation, the incubation, and the development of the eggs and embryos of both species.
3. The possibility of interbreeding [crossing] them.
4. The artificial fertilization of the Portuguese oyster.

This outline report does not permit us to give the questions which we have studied that extended consideration which they deserve, so as to touch upon all their aspects; we will have the honor, however, of shortly presenting to you a more complete report on this subject. We now occupy ourselves more particularly with our experiments in the artificial fecundation of the Portuguese oyster; these are what appear to us to be of the most immediate interest.

THE PORTUGUESE OYSTER.

The mollusk known under the name of the Portuguese oyster has not existed upon our coast for more than thirty years. The Museum Delessert, Lamarck collection, possesses the only specimen which we

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* *Rapport relatif à la génération et à la fécondation artificielle des huîtres, adressé au ministre de la marine et des colonies, par M. Bouchon-Brandely, secrétaire du Collège de France. Journal officiel de la République Française.* December 16 and 17, 1882, pp. 6762–6764 and 6778–6782. Translated, with notes, by JOHN A. RYDER.

have. Its introduction and acclimation into our waters are due entirely to an accidental cause. A vessel coming from Portugal brought back a cargo. Entering the Gironde after a long voyage, the captain thinking the oysters were dead had the whole ship-load thrown into the water, on an old bed called the Banc du Richard. Having found in the Gironde a medium almost identical with that from whence they came, and the conditions favorable to their propagation, they have there multiplied in such proportion that from the Pointe de Grave to beyond Banc du Richard, that is for an extent of nearly 30 kilometers, they form a vast bed, the extent of which will soon be limited only by the banks of the river.

The natural history of this mollusk has been imperfectly known, and the accounts of it are very vague. We may compare them with the common oyster, from which they differ as follows: 1, in their form; 2d, in the taste of their flesh; 3d, in their habits; 4th, in respect to their sexuality.

It is superfluous to here describe their external form, in that it does not recall that of *O. edulis.*

As to the taste or flavor, no confusion is possible to a palate in the least experienced. As to their habits, we know that they delight in brackish and muddy waters, and that there they multiply in preference to all other situations. We find them, in fact, in the Gironde, in the approaches to the Île d'Oléron, at the mouth of the Charente, where the waters have a specific gravity of between 1½ to 3 degrees (1.009 to 1.020). They still multiply in the Basin of Arcachon but meagerly, and only in such places where they are sensible of the influence of fresh water. It is fitting in this connection to allude to a singular phenomenon at that place; it is, that the oyster of the Tagus there becomes infertile after a certain length of time, to such an extent that they soon disappear in the basin if a complement of sexually mature individuals are not brought there at intervals to perpetuate the species.

In respect to sexuality, the difference between these two mollusks is very great; most radical. *Ostrea edulis* is hermaphrodite; *O. angulata* is unisexual or diœcious. We have opened more than 10,000 in all phases of reproductive activity, and we have not seen a single one of the latter of which the sex was doubtful. They were all either exclusively male or exclusively female.

No less marked is the difference in the mode of reproduction. The eggs of the common oyster are fecundated within the valves of the parent, apparently within the openings of the oviducts; those of the Portuguese species on the bosom of the waters. The first cannot develop outside of the incubatory cavity of the parent; the second undergo their development in the open currents. The larvæ of *O. edulis*, in order to live, develop and attain the errant or pelagic stage of their existence, are dependent upon the albuminous liquid secreted by the mother; those of *O. angulata*, more vigorous, more independent, and altogether more active, transport themselves into the living waters to there take up the nutritive matters which are necessary to transform them into spat.

HYBRIDIZATION.

There are, therefore, great differences between the Portuguese and common oyster of our coasts, not only from a conchological point of view—that is to say, in respect of external form—but also as regards their malacological and embryological peculiarities. The characters of each are so well marked that the question of hybridization, which has so alarmed our maritime population, would not have needed to be raised. We understand that, according to a preconceived theory of certain culturists, these two rival species of oysters are susceptible of crossing.

The Portuguese, on the one hand, tending to abase the purity of our race of oysters; on the other, on account of its fecundity and vitality to replace the common oyster, to invade our banks, to ruin our propagating parks. This prediction has happily not been realized, and our oysters, also those of Arcachon, those with the fine and nacreous shells of some of the rivers of Bretagne, the green oysters of Marennes, the deep-water oysters grown on the sands of d'Olonne, have lost nothing of their purity and primitive qualities. We consider it useless in this place to state the weighty reasons which impel us to combat this theory.

We would simply remark in this place that it is now nearly thirty years since the Portuguese oyster has been introduced into the waters of Arcachon. If they have exercised the influence which has been supposed upon the native oysters of the basin, we cannot find any evidence at this ostracultural station of a single individual which shows the effect of hybridization.

On the other hand, not a single bed can be cited where they have caused ruin and diminution of fertility. Have they injured the oysters of Arcachon? The marshes not transformed into parks; the canals of the basin, are they less productive than in times past? The banks of Brittany, still so rich (the Portuguese oysters have been cultivated in the rivers of Auray and La Trinité), have they suffered in the least? Does the dredger of to-day encounter many Portuguese or hybrid oysters? No. These fears, we repeat, are not justified, and this for the reason already stated, that the two rival bivalves live and are adapted to entirely different environments. Moreover, the following experiments demonstrate scientifically the inanity of the doctrine of hybridization.

The surest means of discovering if cross-fertilization would take place consisted in bringing into contact the generative elements of the two species participating, or supposed to, in this act. It is in this way also that we should proceed when we would learn if the individuals of allied species or varieties of the same species are susceptible of concurring in the production of a being. Very often, when closely allied species or varieties of the same species were used, the cross-fertilization would not end in the production of living embryos. The elements sometimes blended properly and fecundation took place; sometimes also the ovule would segment and attain a more or less advanced degree of development, etc.; but when these same elements were brought into immediate contact they remained unchanged, and ended in absolute sterility.

This is precisely what we have observed in the course of direct attempts at hybridization which we have made during the past two years—last year and this.

At different times and under different conditions we have brought the eggs of the Portuguese oyster and the milt of the common oyster into contact, and *vice versa;* never under these experimental conditions, the sexual elements not being brought into contact naturally, has there been a trace of evidence of successful fertilization or of development.

ATTEMPTS AT ARTIFICIAL IMPREGNATION.

When after two years we had learned for a certainty that the sexes of *Ostrea angulata* were confined to separate individuals, we immediately conceived that it was possible to artificially fertilize the eggs of this mollusk. We were likewise encouraged by the experiments which Brooks, of the Johns Hopkins University of Baltimore, had made upon *Ostrea virginica*, likewise unisexual, and which had enabled him to follow the development of the embryos to the formation of the shell.

We began some experiments in the laboratory of embryogeny of the College of France, which, without being conclusive, indicated none the less the path to be pursued, and the manner in which our experiments were to be conducted. In the course of the same year these experiments were repeated at Arcachon without much success. Last year we obtained mobile larvæ for the first time. The observation much surprised us; we had not long to wait, for after an incubation of only twelve hours, a precocious outward manifestation of life was apparent, for already in this phase of their evolution these larvæ presented an appearance which left no doubt as to their definitive form.

On the other hand, we have found nothing in what has been published on the subject of the incubation and transformation of the eggs of *Ostrea edulis* which recalls the aforementioned phenomenon of precocious movement which had not, we believe, been observed before.* The advanced state of the season where we were, and the difficulties which we had to procure Portuguese oysters at Arcachon in a condition fitted for spawning purposes, did not permit us to continue the

*At the time when they occupied themselves busily with the artificial fecundation of fish ova, the two Vosgian fishermen, Gehin and Rémy, sought to discover, or had stated that it would be possible to treat the eggs of the common oyster, the only native species known at that time, by the same methods. But the hermaphroditism of the mollusk having been demonstrated, they were obliged to abandon this hope. Moreover, had the artificial fecundation been possible, it would have been of no consequence industrially, for the reason that the eggs and embryos of *Ostrea edulis* cannot develop outside of the incubatory cavity of the parent.

experiments profitably, nor to settle those questions which were still obscure. At the end of last season we little thought, considering the slowness with which our studies had progressed, that we would be able in a single campaign to solve the problem of artificial fertilization applicable to the ostracultural industry; we were also not at first assured of our ability to produce the manifestation of the phenomena which we have observed with so much interest and upon which rested our hope of final success.

In recommencing the work we were obliged to make choice of a convenient station for our experiments. The station of Verdon, situated on the left bank of the Gironde, at a distance of several kilometers from the mouth of the river, seemed to us to combine all the desired advantages. We were assured of finding there the oysters fitted for spawning, as well as suitable water. In fact, the first attempt which we made in artificial impregnation in fourteen hours afterwards resulted in the production of mobile larvæ, notwithstanding that the season for the fry had not yet arrived, commencing at least a month later.

M. Tripota, one of the veteran ostraculturists, and at the same time one of the most competent, very willingly, at the request of the commissioner, M. Jouan, placed at our disposal, with a grace and disinterestedness for which we are under great obligations, two beautiful unsubmersible claires which received fresh water for several days during the spring tide, and which were soon arranged for our use by means of some slight internal alterations. Separated from each other by a straight, massive wall of earth, these two ponds, with an area of about 100 meters each and an average depth of 80 centimeters to 1 meter [27 inches to 3 feet], were placed in communication by means of a pipe, which was closed at either end by a sponge to keep out any sediment in suspension in the water. In this manner all doubt as to the origin of the spat which was collected was guarded against.

For the outlet, an apparatus consisting of a wall of fine sand confined by boards permitted the water to percolate through it, but prevented the embryos from escaping with it. The lowermost claire only was utilized in our experiments. The uppermost claire, in which we stored the water whenever it was possible, served as a reservoir from which to decant, the supply-pipe allowing nothing to pass into the experimental claire except clear water.

This arrangement completed, the products of artificial fecundation, impregnated in various ways, were poured into the experimental reservoir. This took place in the second week in June.

According to our belief, we hoped to find some spat on the collectors placed in the experimental claire at the end of the same month or by the beginning of the month of July. M. Tripota, who had taken an active part in the work, and who took my place in my absence, continued to supply the claire with fertilized eggs and mobile embryos.

The time assigned for experimental proof having arrived, the collectors were examined, but they did not bear any apparent trace of spat. This was a deception. Meanwhile, thinking that the season for the fry had not yet begun in the Gironde, we expected happier results from our final experiments. The claire was emptied, and some modifications were introduced in the management of the water, and from day to day mixtures of the generative products were again poured into the claire

On the 24th July the tiles were examined. This time all had spat attached. It was therefore evident that the first experiments had not been as unsuccessful as we had supposed. In fact, each of the tiles immersed had young oysters attached to the number of twenty or thirty, measuring about a centimeter [two-fifths of an inch] in diameter. This spat was evidently derived from the spawn put out during the end of June or the commencement of July; but their small size had prevented us from seeing them when the inspection was made at that time. On the 24th July we had specimens about a month old. This fact was all the more remarkable, in that, up to that same time, the collectors placed in the Gironde, in the very center of the spawning beds, did not show a sign of spat.

The problem which we had put before ourselves had accordingly received, from a scientific and practical point of view, a solution in conformity with our hopes. It was possible to obtain spat by means of artificial fecundation and to capture it in confined waters. And we no longer had the slightest reason to doubt the identity of that which had caught on our tiles, nor to suppose that it came from the waters without, since there was as yet none apparent in the Gironde, and the tiles in the upper claire, which served to feed the experimental claire, were completely exempt.

If in forcing nature's processes we arrive at the same result, that is, provoke the birth of the young before the time of the normal emission of the spawn, there is all the more reason for us to suppose that we have an excellent means to aid and favor her.

In pursuing our researches in the establishment of M. Tripota, we did well to vary our means of investigation whenever the same bore upon the industrial aspects of the work.

On the rights [parks] along the Canal du Conseiller, and fed by it, there exist old salt marshes, for the most part abandoned, or used for other purposes than formerly, some of which have been transformed into reservoirs for fishes. Those which we appropriated were about two kilometers from the river and from the locality chosen at Verdon, and received fresh supplies of water during the spring tides. They consisted of numerous compartments, varying in depth and communicating by wide trenches cut into the banks separating them from each other. Their total extent somewhat exceeded a hectare. During the new and full moon the gate controlling the supply was opened to allow the fish carried by the current to enter and to renew the water. This maneuver was repeated many times during the tide. On account of the situation occupied by this marsh along the exposed shores of the Gironde the water is never stagnant, even at the time of the neap tides. The sea-breezes and winds which follow the course of the river aerate it perpetually and agitate its surface. Those which we had chosen measured 5 to 6 feet in depth at the center and 2 to 3 along the margin. Stakes placed at intervals supported the fragments of tiles suspended with iron wire.

From the beginning of July to the end of August, M. Gassiau, schoolmaster at Verdon, who assisted us during the entire campaign, with an intelligence, zeal, and devotion worthy of the highest praise, took care to pour into the inclosures, several times a week, the products of the artificial fecundations which he prepared with rare skill and certainty. Three hundred oysters only were used in these experiments.

On the 8th of August he visited the collectors, and observed on all of them, without exception, hundreds of young oysters, measuring one-half to two millimeters in diameter [$\frac{1}{50}$ to $\frac{1}{12}$ of an inch]. The spat grown from each of the successive lots of fertilized spawn could be distinguished by its size, which corresponded to its age. Having the curiosity to know how many fixed themselves to one tile, we counted more than eight hundred on a single piece of tile, of which the size was one-fifth that of an entire one. This time our success was complete.

Up to the end of August, the time when the oysters had nearly all spawned, the spat continued to attach itself just as abundantly to all kinds of collectors with which it came in contact indiscriminately, fragments of tiles, pieces of wood, boards, &c.

Doubt was no longer possible. The pessimists asked whether our nurslings would grow and develop equal to those which were naturally collected on the banks of the Gironde. We responded to this objection by sending some of the tiles to be placed in the parks at Arcachon, where they remained for a month and a half.

These tiles and fragments of tiles figured at the end of September in the exposition at Bordeaux by the side of those which had been brought by MM. Tripota and Gassiau.

We also found that the spat born in the beginning of July, in the closed claire, measured from three to four centimeters in diameter, and that which was collected in the salt-marsh by the end of July and during the month of August had attained the dimension of one centimeter [two-fifths of an inch] in diameter. Finally, during the early part of October, we had the honor of presenting to the minister of marine a tile upon which two thousand young oysters could be counted, measuring from one to two centimeters [two-fifths to four-fifths of an inch] in diameter.

It now remained for us to make a final demonstration. It was necessary to prove that the spat which was collected did not primarily emanate from the banks in the Gironde, but was the result of the artificial fecundations practiced under our care. This proof was evidently superfluous after what had taken place in the closed and poorly aërated waters of the claire where we had in the first place established ourselves. We knew, in fact, that the person who cultivated the marsh had attempted in vain, two or three years before, to collect spat. But, in undertaking this counter-experiment, we had a two-fold object in view, viz, to clear up all doubts, if such still existed, as to the value and advantages of the method of artificial fecundation, and that of creating a sentiment in its favor. This proof had to be conclusive.

At the entrance to a fish-pond close to the one used by us, of nearly the same extent, similarly arranged and receiving water from the same canal, had been placed the tiles upon which it was thought the spat coming from the river would not fail to attach itself. At that time the oysters were in the height of reproductive activity; the collectors in the Gironde were being charged with spat, and ours in the other pond were being covered as fast as and in the proportion that they were immersed. We expected to find some young oysters on the collectors put down as a test. There was nothing on them, however; these collectors remained completely free of all traces of spat.

THE METHODS OF ARTIFICIAL FERTILIZATION.

Imperfect and incomplete as our methods of artificial fertilization still are, we think it useful to make them known. In fact, there is no better way perhaps to aid in bringing them to that perfection of which they seem to be susceptible. After many trials and experiments, we have found the following to be the most practicable:

It is easy, after a little practice, to determine the sex of the Portuguese oyster with the naked eye. A small portion of the matter contained in the genital gland is taken and placed on a plate of glass and diluted with a quantity of sea-water many times in excess of the volume of the portion of spawn.

When the subject is female, the liquid appears granular, and upon examining it with care we see the ovules which the water has set free or separated. If it is a male, the mixing of the water with the seminal fluid is more difficult, and the liquid remains opaque and milky. With the aid of a pocket lens the distinction is very easily made.

The choice of spawning individuals is not, we have reason to think, a matter of indifference to the success of the operation. We would reject for this purpose oysters from shallow water or such as are frequently uncovered by the tide.* We have never obtained good results

* Our belief as to the sterility of certain brood-oysters rests upon two very important observations made at the island of Oléron. It was in vain that we attempted to fertilize the spawn of oysters taken from the higher levels of the oyster grounds of the island, while at the same time, under the same conditions, in the same medium, with the same water, and under the same external influences, the experiments resulted in the formation of mobile embryos, if spawners were used from the same shore, but from deeper water. We would, however, make certain reservations in this regard.

with them. The fecundation is effectual, cleavage sometimes proceeds to an advanced stage, but all at once the development is arrested, the eggs undergo alterations, and their membrane ruptures.

To avoid all inconveniences of this kind it is best to use spawners taken from active and deep waters. It is also important to assure one's self that the sexual products used are quite mature. In the absence of any means of verification by means of the microscope, an instrument possessed by few ostraculturists, the following methods are to be resorted to: First, by an inspection of the genital gland. If it is transparent at one point, it shows that the evacuation of the generative products has commenced, and that consequently those elements are mature. (This remark applies to the gland of the male as well as to that of the female.) Secondly, by freeing the eggs from the ovary. If the eggs are easily detached, by simply stroking with a fine camel's-hair pencil, we may consider them fitted for fertilization. It seems, however, that infertile ovules detach themselves easily from the gland, but that this does not take place unless the spawning oysters have been injured.

Finally we find that the seminal liquor seems to act most efficiently when it mixes readily with the water.* This disposition noted, and after having prepared a vessel one-half or one-third full of sea-water, an incision is made in the ovarian gland, and we detach the eggs by means of a soft, flexible brush or pencil, from which they are deposited in the vessel as fast as they are removed. We find that their impregnation is facilitated if they are subjected to a washing at this time.

This operation purges them of impurities which are still adherent, and brings about the dissociation of those which still stick together. With this object we shake the contents of the vessel with the hand or stir them with the pencil, when the liquid is allowed to settle. In one-half to one hour afterwards the uninjured ova have settled at the bottom of the vessel; that which remains in suspension in the water; vitelline matters, ruptured membranes, injured eggs, &c., is to be poured off. It is of advantage to repeat this process of decantation.

The seminal liquor [milt] is obtained by the same means as the eggs, but there is no necessity for any preliminary preparation. It is simply

*The microscope is now of the greatest utility, if we wish to assure ourselves of the quality of the fertilizing element. This element, in order that it may serve its purpose satisfactorily, when examined with a sufficiently strong magnifying power, it is necessary that the animalcules of which it consists should appear segregated, independent, and active. During cold weather they are often immobile, but they are often only benumbed; it is then only necessary to expose them to warm air or place them in water at a temperature of 22° C. to 25° C. (71° F. to 77° F.), in order to cause them to vibrate and display activity. Segregation of the spermatic particles may be produced under certain circumstances by the same process. Cases of infertility of the milt are generally very rare. [The segregation or dissociation of the seminal particles or spermatozoa by diluting the sperm with water is an important fact, and one that has thrust itself upon the notice of the translator in observing the fresh milt of both oysters and fishes. It seems quite inactive in some cases before dilution; its activity is then at once provoked by the addition of water.—TR.]

poured into the same vessel with the latter, impregnation taking place at once.*

From that moment the successive phenomena of development are not easy to follow under the microscope. We find, after the generative elements are brought into contact, that the egg, which was at first pear-shaped, becomes more and more nearly round; the germinative vesicle is effaced and disappears totally, the polar globules appear at one point on the periphery, the egg segments into two, three, and four parts, the number of which goes on increasing until it finally assumes the mulberry or morula form. In order to clearly describe the transformations of the egg, it would be necessary to have illustrations appended. In the course of seven or eight hours of incubation, according to the temperature, the embryos begin to move, and a mobile larva appears.†

The mobility of the larva is manifested in accelerated movements of rotation or by sudden starts across the field of view in which they are observed. Sometimes they rotate as if on a pivot, sometimes they remain quite immobile; but if we examine them with care we find that the vibratile cilia with which they are provided continually manifest their peculiar motions. Arrived at this period of their existence, and in consequence of their small size, they become difficult to observe.‡ We have observed the rudiment of the shell at about the seventh day of development. [This is sometimes formed in twenty-four hours in the American species.—Tr.]

Fertilization will succeed without conforming rigorously to the directions which we have given. The determination of the sexes, for example, is not absolutely necessary, for, in operating with a certain number of sexually mature adults, it is certain that both males and females will be found amongst them. The same remark applies to washing the eggs; but we would insist that it is a useful precaution which has real advantages and facilitates the study of the phenomena of development.

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* According to the observations made in the laboratory of M. Balbiani by M. Henneguy, the egg of *Ostrea angulata* appears to be provided with a micropyle at its point of attachment to the follicle, that is to say, at the extremity of its pedicle.

† At Verdon we have obtained mobile embryos seven hours after the fecundation, with the water at a temperature of 22° C. (71° F). [The eggs of the American oyster, with the water at 78° F. to 80° F., will hatch in five hours.—Tr.]

‡ The volume of the larva is about equal to the egg. Now, the egg of *Ostrea angulata*, if we suppose it to be perfectly spherical, and we take the smallest diameter of this sphere, measures 52 millimeters [$\frac{1}{480}$th of an inch]; the volume is consequently .0073584th of a cubic millimeter.

For the sake of comparison, measurements of the following species are appended:

The unisexual oyster of Dackar; diameter of the egg, 43 millimeters.

The hermaphroditic oyster of Toulon (*Ostrea plicatula*): diameter of the egg, 95 millimeters.

The common oyster (*O. edulis*), hermaphroditic; diameter of the egg, 122 millimeters.

We would add, in conclusion, that the generative elements may be preserved for some hours, without being brought into contact, and not lose any of their vital properties. Our collaborators have obtained the best results when the generative products were not mixed together for one or two hours after they were removed from the glands.

We will close this part of our essay with allusions to some observations relative to, first, the influence apparently exercised by the density of the water on the process of fertilization; secondly, artificial incubation. The water employed at Verdon had a density of about two and a quarter to three degrees, measured by the hydrometer [or an indicated specific gravity of about 1.014 to 1.020 of Baumé's scale, the one probably used.—Tr.]

At Cette, the waters of the Mediterranean were successfully used; the specific gravity in this case was nearly 4 degrees [or nearly 1.027].

In the present condition of our researches it is difficult to reach any conclusion in regard to the facts just recorded, particularly the two preceding. It does not seem any the less certain that if the oysters will not be able to become sexually active in very saline waters, it does not appear that such waters are inimical to fertilization and development. [This was not the experience of the translator with the spawn of the American oyster. It was found in fact that water of a markedly higher specific gravity than that from which the spawning adults was taken was injurious, especially to the milt.—Tr.]

In respect to the attempts at artificial incubation, we would say that we have employed [temperature] methods similar to those used in incubating birds' eggs. The eggs of the oysters placed in water maintained at a uniform temperature of 20° C. [68° F.] were hatched in six and a half hours. It would be profitable to make experiments in this direction; for, if the method of artificial incubation is successful as applied industrially, it would be carried on at all times, except during cold, stormy weather, which kills both the eggs as well as the larvæ. With our present processes the incubation as well as the fertilization are not very successful, except when the weather is warm and fair.

APPLICATION OF ARTIFICIAL FECUNDATION.

Is it necessary to have recourse to the economy of artificial methods, in view of the evidence in favor of its advantages, opening up, as it does, a new field in the ostracultural industry?

The Portuguese oyster is endowed with surprising fertility.* If all of

*A cubic centimetre of ovary yields:

	Ova.
By the method of dissociation	2,500,000
By the method of section	5,200,000
Total	7,700,000

(Mean, 3,850,000.)

The volume of the ovary of an oyster of medium size varies between 6 and 8 cubic the eggs annually produced by the innumerable individuals to which the Gironde affords protection would hatch out, and if also the waters of the river contained sufficient food to nourish them, the adjacent portions of the sea would soon be filled up. The causes of the destruction are numerous and powerful, for the crop of fry is always abundant, and either in consequence of inclement weather or during high winds, tempestuous waves disperse and destroy the legions of larvæ which are in process of incubation. Now, the methods which we extol would enable us to escape some of these evils, and would assure those who put them in practice of a certain crop, by protecting the fry from the fluctuations of the temperature, and by this means persisting bad weather would not compromise the regular abundance.

We have already remarked that it is not a single crop of fry which we have each year, but two, and perhaps three. In fact, the season for the fry lasts for at least three months. This interval is sufficient, we have learned with certainty, at Verdon, to permit us to place the collectors three times in the same claire, when the fry will adhere each time.

The localities adapted for the hatching establishments are not wanting; they are to be found near the mouths of most of our rivers. Two conditions only are necessary: the waters should be brackish and have a specific gravity of 1.014 to 1.020, and be readily renewed.

Perhaps it would serve us much better to show up the advantages of our system by borrowing some data from fluvial fish-culture.

We know with what success we now treat the eggs of fishes by methods of artificial fertilization, of which M. Coste determined and stated the laws. The cause of the depopulation of the waters is the want of proper economy; and it may be said that in every European state the question of fish-culture is the order of the day, and takes the first rank amongst those economical questions claiming prompt solution. To this end special laboratories for the practice of fish-culture have been established in Switzerland, Germany, England, Russia, Norway, etc. Artificial fertilization is the *raison d'être*, and is the basis of their operations. These have given results much superior to those which are obtained by allowing nature to have her own way. For example, of 1,000 eggs fertilized artificially and cared for in hatching boxes, 980 hatch perfectly, while of those left to themselves in the open waters it is estimated that 90 per centum are lost.

We admit that the eggs of the salmonoids are much better adapted, on account of their large size, to artificial treatment, than those of *Ostrea angulata;* but even if this comparison is hardly fair, the diminished losses which would result from the application of artificial

centimetres. There are consequently about 20,000,000 eggs discharged annually by an oyster three to four years old.

In the case of the common oyster (*O. edulis*) this number is reduced to 1,200,000 to 1,500,000 eggs.

methods to the eggs of the unisexual oysters would none the less be a fruitful operation. We see what occurs under natural conditions. The mother oyster discharges its eggs in considerable numbers. But how many are there of those which in the immensity of the surrounding waters find favorable conditions for their life? The estimation of the losses is difficult, but if we base our calculation upon the proportions indicated above, we will find that of the twenty millions of eggs produced during one season but two millions ever attain the condition of mobile larvæ.

Once brought to this phase of transformation, how many attach themselves to the collectors? There is little hope that more than a tenth part escape the manifold dangers by which they are constantly surrounded. In the closed claires it is otherwise. We at once guarantee the impregnation of all the fertilizable eggs, placed as they are in forced contact with the fecundating element. There is thus suppressed the prime cause of the destruction of germs, without doubt the most important. We also escape a second and also serious cause of mortality, in protecting the embryos in the closed reservoirs, where, sheltered from dangers of all kinds to which they are exposed without, they pass undisturbedly through the period of their pelagic existence, till the time when they find themselves in need of the collectors, which they will readily find, and to which they will fix themselves.

Figures will be more eloquent than many arguments; *one hundred fertilized eggs have produced eighty mobile larvæ.* This is the mean result of our experience at Verdon. Considered in its industrial relations, the system of capturing the fry in closed waters would be infinitely more economical than the present system.

The only collectors suitable for great depths are the tiles, which, on account of their weight, oppose a resistance to the currents; boards, slates, and other light bodies have been successively abandoned. But the tiles are raised with difficulty after they are disposed in nests on the beds. They are put out only when the fry is abundant, or when it is being discharged during certain tides and favorable times.

In confined waters [claires] we could put down or remove the collectors at any phase of the moon, no matter what might be the state of the sea, without incurring the risk of breaking them. Nor would it be necessary to fix them to the bottom. Moreover, we would not employ tiles exclusively, for, while the tile is an excellent collector, it also has its disadvantages, especially on the shores of the Gironde, where this mode of rearing the oyster is not in favor. Since their great weight renders their transportation costly, they remain in position only till the spat may have reached the size necessary for *detrocage* [or detachment], from which cause the growth of the spat is delayed for a year.

Not to neglect any of the aspects in which ostraculture may perhaps be viewed, permit us to say that the following methods appear practicable: Firstly, the introduction and acclimation in our waters of unisexual species of oysters, like those of Dakar, America, etc.; secondly, the establishment of beds at different places known to be favorable along our coast.

This work of colonization would present no very great difficulties, nor would it entail a very heavy expense. This might be carried out at the mouth of one of our rivers—the Charente or Adour, for example, the mouths of which are known to be well adapted as breeding and hatching basins. In these reservoirs during three months we would pour the fertilized products of thousands of oysters, and allow the resulting embryos to disperse themselves freely in the river. If the collectors, tiles, stones, or shells were then spread on the bed of the river, a bank would soon be formed; and if they repeat this operation for two or three years, this bank will be sufficiently important to become an object of regular and productive improvement.

CULTURE.

Our experiments in propagation have for their necessary complement the study of the question of culture. We are now assured of no lack of the spat of the Portuguese oyster. The culturists of Verdon who furnish it need have no anxiety about finding sale for what is collected during the spawning season. Arcachon will take a large quantity, and we need scarcely observe that its employment will render it possible to utilize lands supposed to be unproductive, and also abandoned parks which have been found not adapted to the culture of the common oyster. Their cultivation is still practiced in some places on the island of Oléron, and in some of the claires of the Seudre and of La Rochelle. But the area devoted to this special industry is necessarily very limited, because, in spite of the favorable reports on the culture [*education*] of the oyster of the Tagus, the culturists do not appear disposed, at present at least, to abandon, in preference to the latter, the culture of the French oyster.

It is now important to find suitable fields for the exercise of the energies of the maritime population; to find sites suitable for the establishments of which we are in need.

We have extended our survey in part over our sea-coast, where portions of the beach still remain unused, and in part along the shores of the Mediterranean, where we encounter a vast chaplet of lagoons, which are separated from the lake of Berre, where they do not terminate, however, and after a short interruption of continuity end at the lake of Le Cauet.

At the sea-shore we would designate some places along the Charente and Adour, and particularly certain plains in the valley of the Gironde, where, as at Verdon, the industry is almost entirely neglected. The opinion of the inhabitants of this coast is, that the culture of the oyster is there neither possible nor advantageous. This opinion has no foundation in fact, because it is not possible to doubt that the Portuguese oyster will thrive in any medium favorable to it. Such an opinion would be contrary to the teachings of natural history. We believe also that, in the Lower Medoc district, they will at some future time collect their spat in the Gironde. Meanwhile the intelligent culturists are boldly immersing on the beds in the river thousands of collectors, which are rapidly covered with young oysters. This example is bearing fruit. This year the park-culturists of Verdon have put down 120,000 tiles. Next year their imitators will be more numerous.

It would be the same with the rearing (*élevage*) of the oyster, and if some one would make an initial attempt, with the proper means, it would be found that the grounds of Verdon, the nature of which is similar to those of Arcachon, where the Portuguese oyster, after detachment from the collectors, grows to an edible size in a year and a half, would produce oysters equal to those of the latter place in size and fatness. Up to the present the oyster industry of Verdon has simply limited itself to the following: To fish and dredge up every year whatever of oysters have accumulated on the beds and concessions, and transport them as promptly as possible to the cultural stations.*

It is true that the attempts at culture, in the manner urged by us, have not here given the best results. The oysters do very well at first in the claires and marshes, but if their stay is prolonged, they soon sicken. What is the cause of their decline? All those who have had experience in ostraculture would say, the want of fresh water and the renewal of the sea-water; in a word, the absence of oxygen and food in a sufficient quantity to nourish the oysters contained in the rearing ponds.

We would mention, as relating to this subject, a very remarkable fact. On the Canal de Rambaud there is a park, constructed under the direction of the municipality of Verdon, into which the scattered oysters gathered along the coast are deposited. The oysters which here find an asylum grow so rapidly that we have been enabled to present to the administration of the marine some specimens of them which in the space of less than three months had grown from 3 centimeters [1⅛ of an inch] to 8 and 9 centimeters [3 to 3½ inches] in diameter.

The explanation of this phenomenon is as follows: The municipal claire, whose aquatic inhabitants no epidemic has ever disturbed, is situated at the level of the canal, receiving water from it twice a day, the water at most remaining stagnant only two or three days.

We have expressed the wish, and commended the matter to the en-

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* We would here make an exception in favor of M. Bouchotte, who has established some very well managed cultural parks at Pointe de Grave. But these parks are not of the sort which we would see established. Another exception we would note, in M. Tripota, who himself instituted a series of very instructive and interesting experiments; and also in M. Peponnet. These are the only ones who may have established claires for artificial culture.

lightened attention of the minister of marine, that the work of deepening and cleaning the canals of Rambaud and Le Conseiller be undertaken. The realization of this idea, giving to the honest and interesting population along the Gironde an opportunity for which they have long waited, would permit them to practice oyster-culture on the spot at Verdon, and would have the effect of yielding up hundreds of hectares to industrial enterprise.

We will turn our attention to the Atlantic coasts and the shores of the Mediterranean. We are here brought into the presence of immense beaches and lagoons which no one has ever attempted to reclaim. Would it not, therefore, be found that the ponds of Berre, Caronte, Le Gloria, Mauguio, Palavas, Frontignan, Thau, Sigean, and Leucate are suitable for an enterprise of this kind? Does it not seem as if human industry might put an end to their sterility? The aquicultural industry, for example, for which they seem to have been designed, would it not be able to there establish and develop itself? We have studied the southern coast in detail, the aridity of which presents an afflicting spectacle, and in passing from one to another of the stations along these shores we have been convinced that they might become a field for active industry and a source of national prosperity.

This conviction I have endeavored to cause the members of the senatorial commission, in charge of the restocking of our waters, to share with me, in making the report to them of the investigation with which they had the honor to charge me in 1880.

The plan of the present report was limited exclusively to a single branch of aquiculture, having put aside everything which relates to marine pisciculture and myticulture [culture of mussels] in order to devote ourselves exclusively to the subject of the culture of the oyster. We may ask why the grand movement under the direction of the maritime administration and M. Coste, which determined the inauguration of the oyster industry on the shores of the ocean, did not extend to the French coasts of the Mediterranean. Are the waters not adapted to the precious mollusk; would they not be able to nourish it? Yes, most assuredly. The oyster is no stranger to our southern ocean. They were formerly to be had at Port de Bouc, at Cette, on the Rocher-d'Agde, at Narbonne, &c. We still find fine ones, not to speak of the French coast, at Toulon and in salt-water ponds in Corsica. Furthermore, we have seen magnificent beds established in the roads [bay] of Toulon, well ordered and managed, and which have nothing to envy in the splendid cultivations established on the shores of the ocean.

At Cette, in the canal connecting the lagoon of Thau with the sea, the cultivators have established floating parks of small dimensions, for the largest will not exceed forty square meters in area, on which they pile up and fatten more than a million oysters annually. We find, therefore, that the waters of the Mediterranean possess the qualities necessary to the growth and prosperity of the oyster.

The principal reasons why the ostracultural industry has not yet established itself on our southern coast are, in the first place, the ignorance of the art of aquiculture, for want of an example to follow, on the part of the maritime population of those districts; in the second, the poor success of the attempts already made; and, finally, the greater success of all those who devote themselves to the culture of the vine, the silk-worm, and madder. Times are now changed; different scourges have visited our southern provinces and ruined their secular industries. A more marked exodus of the population has now manifested itself for some years; the inhabitants with regret leave the land where they were born—they no longer yield them what will suffice for the needs of existence. This emigration would be arrested the day that a new industry came to furnish a field for their activities. Do we not know that oyster culture alone on our ocean shores regularly gives the means of existence to more than 200,000 persons? What immense resources would they not yield if the shores of the south could be taken up and developed in proportion to the extent to which they are capable?

But if it is necessary to cite the example of the western coasts, where the cultivation of the oyster has always been practiced, in an imperfect manner it is true; if the citation of this example were necessary, we repeat, to illustrate the splendid results which we would record, there is all the more reason why the southern coasts should be cultivated, where the people have always ignored the very first principles of oyster culture.

The examples of Toulon and Cette are too much isolated, and their influence extends over too restricted an area to provoke extensive imitation. It is asked if the success met with at those places could be as readily achieved in the Gulf of Marseilles, in the lagoon of Berre, and in those of Languedoc and Rousillon. Conscious of the utility of the efforts which have been made on the Mediterranean coasts, we have been authorized by the administration of the marine to make some experiments in the lagoon of Thau, in some of the estuaries of Languedoc, in the Gulf of Fos, and the lagoon of Berre, which have related especially to the artificial reproduction of the Portuguese oyster and its culture.

The work of artificial fertilization, using spawning adults which came from the Gironde, has, after some uncertainty, been clearly successful. M. Hardy, deputy of the administration of the marine at Cette, whom we instructed in our methods, wrote us, three weeks after our experiments were commenced, that the artificial fertilizations conducted by him resulted in producing mobile embryos in sixty-five cases out of a hundred. This was nearly the average attained at Verdon. All that was needed was to disseminate these larvæ in a favorable medium and to place collectors in proximity. The rock of Rouqueyrol, situated in the center of the lagoon of Thau, seemed to be favorable, and we had the tiles coated with lime placed around it; but we did not consider the poachers, who, profiting by the cover of the night, destroyed and broke up our tiles and apparatus.

It did not seem worth while to repeat our experiments, seeing that the spawning season was already well advanced when the foregoing occurred. We no longer doubt, after what we have seen and the experience which we had in these matters, that the oyster will soon be propagated in the waters of the Mediterranean by the method employed by us. In regard to rearing, we have remarked that the Portuguese oyster adapts itself very readily to the waters of our southern coasts; but we have not noted with exactitude the rate of their growth, having protected our stock in a cage, a mode of culture which would appear adapted to these shores, where those deadly enemies of the oyster, the boring whelks, are found in multitudes.

Our conclusion it is easy to foresee. In conformity with what has been stated, we must acknowledge that the oyster industry may be developed and prosper on the French coasts of the Mediterranean.

We cannot close this report without considering the mollusk which has been under discussion in respect to its edible and commercial qualities. We know, however, that this species of oyster has its detractors. At one time these had reached the point of demanding its total extermination. The pretext was, as we have said, the pretended danger that it would interbreed with and affect the purity of our native oyster, but the true reason was the fear that it would replace the French oyster in the esteem of the consumers; in a word, it was a rival. We have shown what justice there was in this pretext. As to the real reason, that has no foundation. Has the sale and exportation of the indigenous oyster (designating by that name the flat oyster [*O. edulis*], for the oyster of the Tagus may now also be considered indigenous) diminished since the appearance of its rival? This does not appear to be the fact. Have our ostracultural establishments been encumbered by products which they could not dispose of? Not at all. The business is perhaps now less remunerative than formerly, because the number of dealers and producers is much greater; but all of the oysters that are reared or gathered are sold either in France or to other countries; and it is the same with the celebrated establishments, which find it impossible to supply the demand made upon them from all sides.

If the Portuguese oyster becomes the object of an important trade, and if it now contributes largely to the public food-supply, it will not be to the detriment of our native species. Because, relatively abundant, it is better known, and, because of its cheapness, it is procurable by those of slender means. These are the causes which make for it many partisans. Moreover, would the reasons urged justify the interdiction of what is to-day an important ostracultural industry? Is it necessary to reduce to misery, on account of some particular dissatisfied interests, so many honest people who, thanks to this mollusk, feel, perhaps for the first time in a long while, that their condition has improved?

Is it necessary to reduce the unproductive lands which they have converted into fertile parks to their primitive sterility? Is it necessary to arrest that progress which seems destined to bring oyster culture into favor on those parts of the French coasts where it is not yet developed? And, from the point of view of political economy, would it not be most unreasonable to interfere with the production of a food-supply, under cover of the singular pretext that it interfered with and ruined the sale of a more delicate rival? Do we need to defend the harvesting of rye because wheat is better? Yes, it has been said that the Portuguese oyster was very much inferior to its rival in respect to flavor. This is possible, but this is a point to be decided by the consumer. The administration should have no preference, nor be orthodox in the matter of the flavor of oysters.

Do they not tell us that Americans have not the proper delicacy of taste because they relish the oyster of Virginia, which these persons would esteem but little more than *Ostrea angulata?* But it is not only in America that that species is relished, but all over Europe; in France, in England, and in the whole of Northern Germany, where it is brought both in the fresh state and canned.

We have no fears regarding the propagation of the Portuguese oyster in our waters, because, seeing the facility with which it is reared and its rapid growth, it occupies an important place as a food product, in consequence of which it will always find a ready market. If our ostracultural establishments would but produce a much larger quantity they might be exported in lieu of the American oyster, with the additional advantage that they would be fattened in the parks before they were taken to market. But in the present state of the industry we are not able to supply the demands of home consumption. Each year, vessels go in search of cargoes of them in the Tagus; but, in spite of this, they have great difficulty in obtaining them for our ostracultural stations, so that the important dealers in common or flat oysters, in view of this condition of things, have not agreed to supply more than a certain percentage of Portuguese oysters.

We are conscious, moreover, that the detractors of this species are becoming less numerous; that, as the culture of this mollusk tends to become general and cultivators devote themselves to it, they will not be of those who will realize the least of its benefits. Here, then, the new method is unfolded. We should not forget that we now occupy the first place in Europe as regards oyster culture; we should not neglect maintaining it.

In conclusion, it remains my duty to express my thanks to the functionaries of the marine for the enlightened and hearty assistance they have rendered me at all times, especially M. de Choisy, chief of the service at Bordeaux, and MM. Jouau, commissary at Pauillac; l'Hopital, commissary at la Teste; Allégu, at commissary Martigues; and, finally, to M. the commissary Sénès. We would also express to M. Hardy, at Cette, our sincere thanks for the zeal he has shown and pains he has taken to aid and second us in our efforts. Our thanks are also due to M. Curet, captain; to M. Blanchereau and M. Dutemple.

APPENDIX.

ANALYSES OF THE PORTUGUESE AND COMMON OYSTER.

Portuguese oysters, originally from Arcachon, or having been imported there at least a year.	Iodine ... Bromine.. Chlorine .	.105 gram in every 100 grams of the soft parts of the animal.
Native Portuguese oysters of Verdon.	Iodine ... Bromine.. Chlorine .	.11 gram in every 100 grams of the soft parts.
Common or French oysters (*O. edulis*) from the basin of Arcachon.	Iodine ... Bromine.. Chlorine .	.057 gram in every 100 grams of the soft parts.

NOTE BY THE TRANSLATOR.—The resemblance of the Portuguese and American oysters is in some respects most striking. In both, the impressions of the adductors are dark purple, while in *O. edulis* it is almost invariably colorless. The muscle of both of the first-mentioned species is much more tender and evidently more readily digestible than that of the latter. *O. edulis* is smaller, and in every way inferior to both of the unisexual species.

The Portuguese oyster differs, however, considerably from the American in the form of the shell. The lower valve of the former is much more concave internally than that of the American, and the upper valve is often singularly bent to fit it. The internal-hinge border of the lower valve also frequently overhangs the cephalic end of the internal concavity of the latter to an extent rarely, if ever, met with in our species.

The body-mass is a very conspicuous portion of the soft parts of the Portuguese oyster. It is relatively much thicker from side to side than in any other species I have seen. The stratum of generative tissue is also of an extraordinary average thickness, actually far exceeding in proportional volume the same layer in either the American or common oyster of Europe.

It appears that the spat of *Ostrea angulata*, like that of the American species, grows much more rapidly than that of *O. edulis*. For data respecting the rate of growth of the spat of the American oyster, see my report, pp. 60–62, in the appendix to the Annual Report of the Commissioner of Fisheries of Maryland for 1881.

ON THE SEXUALITY OF THE COMMON OYSTER (O. edulis) AND THAT OF THE PORTUGUESE OYSTER (O. angulata). ARTIFICIAL FECUNDATION OF THE PORTUGUESE OYSTER.*

By M. BOUCHON-BRANDELY.

Twenty or twenty-five years ago the Portuguese oyster, indigenous to the Tagus, did not exist on the coasts of France. It was acclimated in our waters altogether accidentally. A vessel from Portugal discharged its cargo so as to repair some damages it had sustained. The oysters which it carried were thrown into the Gironde, on the old Banc de Richard; here having met with the conditions favorable to their propagation, they have multiplied in such numbers that, from the Point de Grave to Richard, for a distance of 25 to 30 kilometers, they form a vast bed, the extent of which will soon be limited only by the banks of the river.

The sexuality of this oyster differs essentially from that of the other kinds common in our waters, the most widely diffused of which is *O. edulis.* The latter is hermaphrodite as established by Lacaze-Duthiers, Coste, Davaine, Möbius, Eyton, Hart, and others. Is it a self-sufficing hermaphrodite? With respect to this nothing has yet been demonstrated. It is highly probable that they are not self-fecundating, if we take into account the fact that the genital gland rarely presents the two sexes at the same degree of maturity.

The Portuguese oyster, on the contrary, is unisexual. This fact is incontestable. We have opened a great number, taken at all phases of the reproductive period, and all were exclusively male or exclusively female.

On the other hand, and contrary to that which occurs in the common oyster, where fecundation is accomplished in the interior of the valves, in the Portuguese oyster the eggs are expelled from the shell into the water outside, where they meet with the fertilizing element. Never, in fact, did we find either ova or embryos in the mantle of *O. angulata.* A fact which also goes far to prove this is the following: The eggs and embryos of the Portuguese oyster develop in pure sea-water, while those of the common oyster, at least during the whole of the period of gestation of the egg to the moment when the embryo abandons its maternal shelter, cannot live outside of the liquid contained in the shell, a liquid which, according to an analysis made in the laboratory of M. Berthe-

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* *De la sexualité chez l'Huître ordinaire (O. edulis) et chez l'Huître portugaise (O. angulata). Fécondation artificielle de l'Huître portugaise. Note de M. Bouchon-Brandely, présentée par M. Berthelot. Comptes rendus hebdomadaires des Séances de l'Académie des Sciences. Vol. XCV, No.* 5 (31 *Juillet* 1882), pp. 256–259. *Paris,* 1882. Translated by JOHN A. RYDER.

lot, *contains albumen* in a notable proportion. It was in vain that we attempted to preserve the embryos of *O. edulis* in renewed and aerated sea-water until their complete development, even though they had attained the state of white or that of gray fry. The white embryos died after two or three days, the gray embryos after twelve or fifteen days, although they were in the presence of collectors to which they could attach themselves.

These facts show the essential differences between the two species of oysters, and exclude all idea of interbreeding and make us reject the preconceived theory of hybridization entertained by some ostraculturists. We have, moreover, made direct experiments in hybridization which gave only negative results. In this manner, in several attempts last season and this, we have brought together the eggs of the Portuguese oyster and the zoosperms of the common oyster, and reciprocally; never, under the conditions where we have experimented, the sexual elements not being brought together naturally and instinctively, was there a sign of fecundation or of development.

The sexual elements of *O. angulata* being, as one might say of them, clearly separated, we have conceived the possibility of achieving their artificial fecundation. The example of Brooks, of the [Johns Hopkins] University of Baltimore, who had made successful attempts in the artificial fecundation of *Ostrea virginiana*, was, to say the least, encouraging.

Here is, after numerous experiments, the mode of fecundation which we have adopted. It is easy, after some experience, to distinguish the sexes of the adults with the naked eye. We detached the eggs from the ovary by means of a camel's hair pencil, and they were then placed in a vessel filled with sea-water—a vial, for example. To separate them and free them from the foreign matters with which they are surrounded, we shook the vial for a few moments, when the liquid was allowed to stand. The eggs which are fit for fecundation then fall to the bottom of the vessel; that which remains in suspension is to be thrown away. Decanting the latter we renew the water in the vessel, and it is sufficient to add a small portion of seminal liquor, upon which the eggs are immediately surrounded and rolled by the mobile zoosperms; the first phases of fecundation commence soon afterward.

The ova and spermatozoa retain their vital properties for several hours, without being in contact, in water. Our most successful experiments were made with elements which were not brought into contact until two or three hours after their extraction from the genital glands.

We will not describe the first phases of development of the eggs, but we think there deserves to be mentioned a fact which has not hitherto been observed, viz, that the embryos of *O. angulata* commence to swim, according to temperature, at from seven to twelve hours after fecundation. At Verdon we have had them to do so in seven hours, the water having a temperature of 22° [C. 71° F.] Their movements of translation are of a rotatory, gyratory character; at times they turn about a point as upon a pivot; at other times they change place rapidly and traverse the field view in which they are observed.

The shell is formed about the sixth or seventh day after impregnation.

Artificial fecundation presents no difficulties, and results four times out of five in the formation of mobile embryos, if good spawn is used. Oviposition proceeds gradually in the Portuguese oyster, and sometimes for several weeks. When the genital gland becomes transparent at one point it shows that the sexual products are ripe, and that they may be used to advantage.

Because of what has just been said, and in view of the exceptional fecundity of the oyster of the Tagus* [*O. angulata*], we have attempted to make some practical applications. With this object, we have arranged at Verdon a claire of 100 square meters in area, into which we have poured the animated products of diverse artificial fecundations.

The difficulty to be overcome was to prevent the escape of the embryos and assure the renewal of the water. We have attained these ends by making the water pass in and flow out through a bed of fine sand.

After a month of repeated experiments our efforts were crowned with success. We have had the satisfaction to find some spat fixed upon each of the tiles placed in our experimental claire. This is all the more remarkable, since, up to this time, the past week, there has been no spat attached to the innumerable collectors immersed upon the oyster banks of the Gironde—that is to say, in the very center of the reproductive area.

A HYBRID PLAICE—PLATESSA VULGARIS WITH RHOMBUS MAXIMUS.†

By K. E. H. KRAUSE.

On the 21st day of August, of this year, a remarkable-looking plaice was shown to me, and the question arose whether it was not a turbot. It had been sold by the fishwoman Hävernick of Warnemünde together

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* One cubic centimeter of the ovary contains:

	Eggs.
By the method of dissociation	2,500,000
By the method of sections	5,200,000
Mean	3,850,000

The volume of the ovary of an oyster, of medium size, varies between 6 and 8 cubic centimeters.

† *Ein Schollen-Bastard. Platessa vulgaris* × *Rhombus maximus. K. E. H. Krause, in: Archiv des vereins der Freunde der Naturgeschichte in Mecklenberg* (1881). May, 1882, pp. 119–120. Translated by H. G. DRESEL, U. S. N.

with other "Maischollen," *Platessa vulgaris* Cuv., and a small Kleist,* *Rhombus lævis* Rond. The vender asked me the name of the "Scholle," which was unknown to the fisherman who had caught it. The boats had gone out farther than usual, where at times they catch fish with which they are unacquainted. Her attention had been called to the *Rhombus*, because it was smooth and spotless, and because its head was like that of a Steinbutt, but less tuberculated, and the eyes were on the left side. The above-mentioned plaice, 32^{cm} long, had a head like that of the turbot; the eyes, also, on the left side, with the tubercles not so prominent as those of the ordinary plaice. The yellow spots common to the plaice were present; but on the head and upon the upper left side, especially along the curved lateral line, were small epidermal ossifications which were rather numerous just behind the gill coverings. These protuberances were not so large as to produce bony areas on the head, but they were considerably larger and more prominent than the small roughness of *Platessa flesus* L. The anal fin did not extend so close to the caudal fin as it does in the turbot; the body was also more elongated than that of the latter, or that of the plaice. The teeth were somewhat sharp, but not so sharply pointed as those of the turbot. The meat, in the firmness of the muscular tissue and in taste, approached that of the plaice.

There is no doubt but that the specimen, which unfortunately could no longer be obtained, was a bastard. The shape of the head and the curve of the lateral line totally exclude the possibility of a cross between *Platessa vulgaris* and *Platessa flesus;* accordingly there only remains the possibility of a cross between *Platessa vulgaris* and *Rhombus maximus*. Both of these parent forms are considerably smaller in size in the Baltic Sea than in the North Sea.

Several years ago a fisherman named Ritgart, of Warnemünde, spoke to me of a kind of flat fish, which he called Blender, which was caught farther out in the sea. At that time, from his incomplete description, I took this species to be *Rhombus lævis*, but perhaps it may have been a bastard like the above; at least, the name points that way.

ROSTOCK.

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*Along the Elbe coast, in Stade and in Hamburg, *Rhombus lævis* is commonly called Kleis, m. Kleist f. Kleise; along the Weser (Bremen) it has received the name Tarbutt, probably from the English "turbot," which, however, is the name of the Steinbutt.

The fishermen of Travemünde name *Rhombus lævis* "Margretenbütt," while "Kleis," "Kleishe," and "Plattdisen" are their names for *Platessa limanda*, called "Shäning" by the Warnemünde fishermen. Compare Lenz in Wittmack, Beitr. zur Fischereistatistik, 1879.

RESEARCHES ON THE GENERATIVE ORGANS OF THE OYSTER (O. edulis.)*

By P. P. C. HOEK.

Last year the administrative commission of the zoological station of the Netherlands Society of Zoology took the initiative in the prosecution of researches relating to the anatomy, embryology, and biology of the oyster.

The anatomical portion of these investigations fell to my lot. My work was done in a small wooden building, the station of the society, which was in operation during the last two years in the vicinity of Bergen-op-Zoom. This town, situated on the northernmost arm of the Escaut, is also, so to speak, the center of oyster-culture in Holland.

My investigations from the first have related to the generative organs of the oyster. At the end of the first season I published a summary of the work done, in the sixth annual report of the zoological station. Up to the present time, after having again devoted some months to these studies, my results are so far developed that I publish herewith a summary of my investigations up to the end of the year. It will be published simultaneously in French and Dutch.

The most remarkable result of my researches during the past year has been to learn that the generative organs do not consist of localized glands, but that they extend over nearly the whole of the body mass; and also that they do not correspond in structure to the usual definition of such organs (lobulated or botryoidal glands) usually met with in lamellibranchiates. They are not separated on either side of the body from the integument, which in these regions is at the same time the mantle, consisting of a thin layer of connective tissue; at the fore part of the pericardiac cavity the dorsal and ventral portions, the right and left halves of the organ are in communication. Everywhere we meet with its branched ducts, which communicate with each other, and of which the inner walls are produced into cul-de-sacs directed towards the interior and vertically to the surface of the body. The epithelial cells of these cul-de-sacs are metamorphosed into eggs as well as into spermatogenetic cells. Therefore it is the same cul-de-sac which produces at one time spermatozoa and ova.

The past year I had no luck in finding the generative openings. With the exception of M. Lacaze-Duthiers all the authors who have investigated this question have met with the same difficulty. To attain better results than my predecessors, I had employed the method of sections; I isolated portions of the ventral process of the body mass, where

* *Recherches sur les organes génitaux des Huîtres. Par* M. P. P. C. HOEK. *Comptes rendus des séances de l'Academie des Sciences, Paris. Novembre* 6, 1882. Translated by JOHN A. RYDER.

the orifice is found which was observed by M. Lacaze-Duthiers. Unfortunately, the first series of sections very plainly showed the longitudinal cleft near the nervous commissure, which goes from the branchial ganglion to the branchiæ, the opening observed by M. Lacaze-Duthiers; but the series of sections was interrupted before this opening was prolonged into the genital canal. In another series, each preparation contained a section of the genital canal, which, however, resembled in every respect the branches (ducts) of the reproductive organ, but of which the special value was not recognized by me. It was from this that I was led to doubt the accuracy of the observation of M. Lacaze-Duthiers.

The investigations of the past summer demonstrated to me that it was not M. Lacaze-Duthiers, but myself, that was in error. The longitudinal cleft is prolonged as a duct, which is nothing else than the genital canal; this canal commences to branch very near its external orifice; these are the branches, which again divide and spread over nearly the whole surface of the body.

There is no trace of a genital papilla; the position of the genital opening is exactly the same on either side of the body, and it is also this same opening which serves for the organ of Bojanus; thus it is necessary to regard it as the urogenital opening. The efferent canals of the genital organs and the organ of Bojanus meet together near the common opening. We are, therefore, able to assert, with the same right that the efferent duct of the organ of Bojanus ends at that of the genital organ, or the contrary. Analogy has forced us rather to accept the latter view.

On the organ of Bojanus of the oyster, the literature is silent. In the excellent work of M. Lacaze-Duthiers (Ann. des Sciences Nat., 4e sér., t. IV, 1855) the common oyster has not been studied in this regard, and Von Jhering in 1877 (Zeitschr. Wiss. Zool.), in reviewing what had been published upon the organ of Bojanus in the mollusca, states that our knowledge is null upon this point as regards the oyster. My researches also led me to study this organ.

The organ of Bojanus is not developed as a very clearly marked structure; it is composed of membranous folds communicating with each other and with a cavity paved with ciliated epithelial cells, itself opening by a fine canal in the urogenital orifice. The cells of the wall of the canal are provided with vibratile cilia longer than those of the cells of the cavity. This cavity appears to be the same as that which, in the *mussel*, has been called the collecting canal by M. Sabatier. In the wall of this cavity commences a straight canal, which is continued nearly parallel to the genital duct and ends by opening into the so-called pericardiac cavity. This canal is clothed by cells bearing very long vibratile cilia which meet in the center and guard the passage against any object no matter how small. The membranous folds of the organ of Bojanus extend on to the walls of the pericardiac cavity, and upon the posterior part of the sides of the body, then into that part of the mantle which joins the adductor muscle on its ventral side. In my report I will give a detailed description of the organ of Bojanus of the oyster.

If there is still the slightest doubt as to the hermaphroditism of the oyster, my researches have shown that, at the time when an oyster is sexually mature, it always functionates as a male as well as a female; it is, therefore, physiologically diœcious. And when the eggs of one oyster are fecundated by the spermatozoa of another, we need not be surprised if the contact of the eggs and spermatozoa takes place in the interior of the animal. Likewise the fact observed by M. Lacaze-Duthiers and by other authors, that the egg of the oyster is nearly always fecundated at the time of laying, is not surprising. The large number of males also, that is to say, individuals functionating as males, as stated by M. Davaine and M. Lacaze-Duthiers, explains itself. In the case of the oyster, as with most other lamellibranchs, the spermatozoa move and encounter the egg; "the water carrying the sperm in the currents produced by the ciliary movements of the internal surface of the mantle reaches the eggs;" that is, it gets into the genital duct.

I think this view of the question is the only one which gives a rational explanation of the facts.

NOTE ON THE ORGAN OF BOJANUS IN OSTREA VIRGINICA, GMELIN.

By JOHN A. RYDER.

In March, 1882, I first noticed what I supposed might probably be the organ of Bojanus of the American oyster, but I could not then investigate the matter, so that it was allowed to rest for the time being until a more favorable opportunity should occur to carry out more detailed researches. In November, 1882, I first began to make preparations to study the subject by means of sections, the only method by which it was believed possible to arrive at any valuable conclusions. Although I have not yet traced the structure in question in its relation to the pericardiac cavity and the openings of the generative organs, my sections show essentially much the same details of structure as have been described by M. Hoek. As that author observes, the literature of the subject is silent in regard to this structure in the oyster, and of the few allusions to the matter, one is by Huxley,* who says: "In *Ostrea* and *Teredo* the renal organ seems to be present in only a very rudimentary form." He then alludes to the researches of M. Lacaze-Duthiers. That it is present in a rudimentary form is the fact, as an examination of the structure in question has proved. In *Bronn's Klassen u. Ordnungen des Thierreichs, III, Malacozoa*, by Keferstein, on page 388, it is remarked, in effect, that the organ of Bojanus in *Ostrea* is present as a mere appendage of the ventricle. In "Forest and Stream," under date of No-

*Anat. Invertebrates, p. 411, New York, 1878.

vember 30, 1882, I described this organ in the following terms: "Besides, no anatomist, to my knowledge, has very definitely located the organs of Bojanus or quasi-renal apparatus of the animal, or indicated the apparently close relation of this paired organ to the openings of the generative ducts. It is true these structures are very rudimentary, but seem to be present in a slightly developed condition, in somewhat the same relation to the great adductor as in *Pecten*, only that they lie close against the mantle at either insertion of the muscle and on its ventral side. Their extent is sometimes marked by brownish tissue in their walls."

In order to see these structures at all it is necessary to open the animal with the greatest possible care, in order that the mantle and the underlying delicate tissue of the organs of Bojanus which lie close against the lower side of the muscular insertion be not lacerated beyond recognition. The body-mass, which is prolonged backwards below the adductor and containing the first bend of the intestine, lies just below the organ, and in fact a suspensor membrane connects the two. This suspensor has the same structure as the mantle. The form of the organ of Bojanus in the oyster, taken as a whole and viewed from the side, is somewhat sickle-shaped, and clasps the opposite ends of the adductor next the mantle on either side for an extent of about three-quarters of an inch, and rarely extends a very little way forward upon the floor of the pericardiac chamber. In section through its most enlarged part it is somewhat triangular or trihedral, and its inner non-canaliculated portion involves more or less completely at this point the parieto-splanchnic ganglia, as is shown by my sections. It is a paired organ, and the portions of opposite sides are about equally developed. Their dimensions, as compared with the same organs in *Unio*, are very meager indeed.

When examined under the microscope, sections from the mid-region of the organ show several large canals, six or seven, the walls of which are clothed with an epithelium provided with very long cilia, which hang freely into their cavities. These larger canals are placed near the center of the trihedral body of the organ. Around the larger canals numerous smaller canals and induplicatures of membrane are aggregated, which are clothed with a less conspicuously ciliated internal epithelium. These smaller canals evidently communicate with the larger ones, and are probably the secretory portions of the organ, but no crystalloidal bodies in the form of urates were detected, such as may be seen in the renal organ of *Arca pexata*, for example. The smaller ducts and canals of the organ encroach upon the connective tissue of the adjacent portion of the mantle to some extent. The color of the tissue of the organ in life is frequently dark-brown, so that its extent may be clearly made out in an oyster which has been very carefully opened. Oftener, however, the organ can scarcely be distinguished from the neighboring structures, except by its richer yellowish color. Its greatest development is attained at the lower side of the adductor muscle, just where the posterior sickle-shaped column of white fibers comes into contact with the larger grayish oval anterior column. Just in the angle formed by these parallel muscular columns the organ is most massive, and just here too lies the parieto-splanchnic ganglionic masses of nervous matter, which are more or less enveloped by the external and perhaps indifferent portions of the organ.

As before stated, I have not taken the pains to demonstrate the opening of the organ into the pericardiac cavity and the generative canals, but as already hinted in my article in "Forest and Stream," which was written before I had seen M. Hoek's paper, I believe such a connection altogether probable from what is known of the relations of the homologous organs in other lamellibranchs. Just below the vicinity of the thickest portion of the organ are situated the external openings of the generative ducts, which, as observed by M. Hoek, are not marked by papillar elevations.

M. Hoek's observations on the generative ducts of *Ostrea edulis* agree with my own on *O. virginica*. From the openings of the ducts forward over the sides and dorsal and ventral surfaces of the animal, beneath the mantle-layer, they branch over the greater portion of the body-mass, receiving the generative products from the underlying follicles, which have a generally vertical direction, and stand at right angles to the courses of the ducts and their ramifications.

The sexual characteristics of *O. edulis*, *O. angulata*, and *O. virginica* have already been discussed by me in another essay which has preceded this, so that there is no need of a further elaboration of that matter here. More recently two notices by M. Bouchon-Brandely have been placed in my hands by Professor Baird, which discuss this matter from still another point of view than my own, viz, the microscopical and histological aspect of the subject.

WASHINGTON, D. C., *December* 25, 1882.

A SIMPLE TEST TO LEARN IF FISH OVA ARE IMPREGNATED.*

By PROFESSOR NUSSBAUM.

The development of the eggs of game fishes [salmonoids], as is well known, is relatively far advanced before the fish-culturist is positively assured that embryos are developing normally in the egg. A method, therefore, which would enable us to shorten this period of probation would not only be desirable, but also of value under certain circumstances, since it is certainly annoying, after having had them in water

* *Ein einfaches Verfahren zur Erkennung der gelungenen Befruchtung von Fischeiern, von Professor Nussbaum in Bonn. Deutsche Fischerei-Zeitung*, VI, No. 5, Jan. 30, 1883. Translated by JOHN A. RYDER.

for four or five weeks, spending time and care over them, to eventually find, when the "eye-spots" do not develop, that all our trouble was wasted and that no development at all took place.

It is true one may, with proper preparations and with the help of the pocket-lens or microscope, follow the development while there may be no external signs of the process evident. This method of making the test is, however, not adapted to the purposes of the practical fish-culturist, who will have better success by the following method:

If fertilized fish ova are placed in a 50 per cent. solution of wine vinegar [Any ordinary vinegar will probably be found to answer just as well—Tr.] the embryo, even during the very first stages of development, will become apparent to the eye lying on the transparent yelk. The acetic acid contained in the mixture, one part water to one part wine vinegar, causes the material of the embryo proper to coagulate while the yelk remains clear.

A short time after the ova are laid in this mixture, and during the first week after impregnation, a white circle at one pole of the egg should become apparent, and in the course of the second week a cylindrical white streak running from the edge of the circle towards its center should be evident. If these features are not developed by the test, the eggs have not been fertilized, and are, therefore, worthless.

We will not complicate the application of the method by describing other details of the development, but would merely suggest that when a lot of ova are fertilized a small portion should be left unimpregnated. These could then be tested in comparison with the fertilized ova from day to day, using say three eggs at a time of each lot. The observant culturist could by this means construct for himself a scale of development covering the period embraced by his experiments. At a lower temperature the development is slower than at a higher one. The difference of appearance between fertilized and unfertilized ova treated by the method will demonstrate its utility. Whoever does not trust to the method for the evidence of death of the eggs until after five weeks subsequent to impregnation, must of course wait.

Director Tiefenthaler, of Kölzen, has had the kindness to test the method practically, and finds it useful to fish-culturists.

[A very little practice, it seems to the translator, would serve to enable any person of ordinary intelligence to apply this method or several others which might be suggested. Other substances which would answer the same purpose would be dilute solutions of picric or chromic acid, of not more than one to one-half per cent., or one part to two hundred of water. Vinegar or acetic acid of the shops may also be used; the last to be diluted in the proportions of about one part in ten of water. The acids cited will coagulate and cause the germ disk to turn white or yellow in a few hours. Chromic is better than picric acid, as it coagulates the yelk also, but turns the latter much darker than the embryo or embryonic disk.—Tr.]

NOTES ON THE LAMPREYS—PETROMYZONTIDÆ.

By G. BROWN GOODE.

In the fresh and brackish waters of the United States occur several species of the lamprey family.

The habits of this group of fishes are not well understood, and in the present discussion we shall be obliged to rely to a considerable degree upon the observations of European zoologists. In the United States these fishes, of whatever species, are generally known as "lampreys" and "lamper-eels," these names being also in use in England, where one of the smaller species, *P. branchialis*, is also known as the "pride," "prid," or "sandpiper." The name "nine-eye" is also common in England, a name which reappears on the continent in the "neun-äuge" and "neun-äugel" of Germany and Austria, and the "nejon ögon" of Scandinavia. This curious name has its origin in the eye-like appearance of the circular branchial openings, of which a considerable number appear on either side of the head. In the common "nine-eye" of England, however, there are really only seven, and, even if the eye be counted, only eight eye-like circles upon each side. In Germany the name most commonly in use is "pricke" or "bricke," while in France "lamproie" is their usual appellation, and in Italy "lampreta."

The lampreys are among the lowest and least specialized of fishes; although in form resembling the eels, they belong to a very different group, which, by Gill and others of our best authorities, has been considered a distinct class, and are not even entitled to be called fishes. So slight has been the progress in the scientific study of the lampreys that but little can be definitely stated about their geographical distribution, excepting that they occur in the fresh waters and along the coasts of the temperate regions of both hemispheres. The largest and best known species, and the only one which has at present any commercial value, is *Petromyzon americanus*, by most authorities believed to be identical with the *P. marinus* of Europe,* which occurs in the streams and estuaries of our eastern coast from Nova Scotia as far south at least as Cape Hatteras.

The key to the habits of the lampreys is found in the peculiar arrangement of their great suctorial mouth. In *P. marinus*, according to Émile Blanchard, this is completely circular, and forms a great sucker enormously capacious, surrounded by a fleshy lip studded with tentacles and supported within by a cartilaginous framework. This mouth is covered over its entire interior surface with strong teeth, arranged in concentric circles—some single, others double—the larger occupying the central portion, and the smaller forming the exterior rows. A large

* Günther's Catalogue Fishes of the British Museum, 8, p. 501.

double tooth, situated above the aperture of the mouth, indicates the situation of the upper jaw; a large cartilage, supporting seven or eight great teeth, represents the lower jaw. The tongue also carries three large teeth, deeply serrated upon their edges.

The structure of the intestine, which, as in the sharks, is provided with an extensive spiral valve, indicates that these animals are chiefly carnivorous in diet. They are said to feed upon worms, insects, and decaying animal matter.

Dr. Benecke, of Königsberg, Germany, and others have found their stomachs full of fish eggs. The structure of the mouth, however, would teach us, even in default of observations upon their customany mode of feeding, that they are semi-parasitic in their habits, attaching themselves to large fish by suctorial action, and, while attached, tearing the flesh of the fish with their marvelous mincing machine, which is composed of the teeth within the circular mouth, while they suck the blood of their victim. They are often found attached to the larger fishes, such as shad, sturgeon, and sharks.

Captain Atwood states that small lampreys of a bluish color are found attached to various species of fish in Massachusetts Bay, such as cod, haddock, and mackerel. They cling to the side of the fish beneath the pectoral and suck their blood until the flesh of their prey seems as white as paper.

There can be but little doubt that to the lampreys may be credited an immense destruction of the various food-fishes which enter estuaries and rivers. It is by no means uncommon for fishermen to find them attached to halibut and other large species caught at sea. Lampreys are found far inland, ascending most of the creeks and rivers of Central Europe and of temperate North America far toward their sources. In fact the distances from the sea, at which the so-called sea-lamprey of Europe is constantly found, are so great, when their feeble powers of locomotion are considered, that Dr. Günther in his essay on the fishes of the Neckar was induced to advance the theory that they are carried from the sea to the river sources by the shad, salmon, and other fish to which the lampreys attach themselves. This view is combated by De La Blanchere, who claims that no one has ever seen lampreys attached to salmon. If I am correctly informed, salmon are largely annoyed by lampreys in the United States, but it seems hardly necessary at present to accept Günther's theory in the fullest extent, since the lamprey is apparently not much inferior to the eel in powers of locomotion, and the eel, it is well known, accomplishes long migrations without apparent inconvenience.

It has been customary among writers upon fishes to class the lampreys among the migratory fishes, and to describe the migrations of the sea-lampreys as beginning in the spring, when they are supposed to ascend the rivers for the purpose of spawning in their headwaters. This theory seems at present hardly tenable; so little, however, is known of their habits that the theory cannot be pronounced absolutely incorrect. There are, however, certain species of lampreys in Europe which are believed to live entirely in fresh water. A similar statement can most positively be made regarding our species inhabiting the Great Lakes and other inland waters of North America. On the other hand, many of the sea-lampreys remain in salt and brackish water throughout the year. There appears, however, to be excellent evidence that some of the lampreys move from brackish water into fresh for purposes of spawning.

Benecke, speaking of the habits of the river lamprey of Northern Germany, remarks:

"Concerning the habits of 'nine-eyes' in the sea nothing is known. In summer they make their way from the Baltic into the Kurisches Haff and the Frisches Haff, and toward the end of September begin to ascend the rivers, and are caught in great numbers in baskets and pots. The ascent continues until January. In the upper reaches of the rivers they make their appearance in the early spring, and spawn in April and May in small schools in shallow places, where the water flows rapidly over shingly bottom. The act of spawning has been observed by us from year to year in the passage between the bridges at Braunsberg. After the eggs, which are one millimeter in diameter, grayish yellow in color, and entirely opaque, have been deposited in little masses, the lampreys die. The development of the spawn is extremely dependent upon the weather, so that during many years only a very small brood of young fishes makes its appearance. The young of this species have been found by August Müller in the Oder and the Alle, and in the latter (?) the drying up of one of its tributaries near the mill at Pinne gives an opportunity every year to collect hundreds of them in the bottom mud. They are never found partially grown, and we must believe that they go back to the sea, there to attain their full size."

Concerning the breeding habits of the brook lamprey, *P. planeri*, the same authority writes:

"The brook lampreys, like the allied species, feed upon little animals, and are found in almost all the clear brooks in Prussia, seeming never to migrate to the sea, although Yarnell claims that he has found them there. The clear gray, or grayish-yellow, eggs, which are one millemeter in thickness, are deposited in March or April. The adult fish gather themselves together in companies of from ten to fifty individuals to spawn in water of little depth, where the current flows swiftly over rough ground. In close proximity to each other they cling with their mouths to the bottom and their bodies streaming out in the current, squirming like the bodies of snakes. Every once in a while the observer can see a male, easily recognizable by its size and black color, seize upon one of the females with its suctorial mouth, and therewith firmly attaching itself to her close behind the head. The two then extend themselves with a powerful backward squirm, and, while the male with a half turn of his body, brings his abdominal aperture close to that of the female, a part of her spawn may be seen flowing forth in a clear, semi-opaque flood. This action is repeated until the female has deposited all of her eggs. The young lampreys, when hatched, burrow in the mud. They require a period of four or five years before they reach the size of twenty centimeters."

It is now believed by many of the best European authorities that the parent lampreys die after spawning.

The development of the lamprey is exceedingly remarkable. It was first worked out thoroughly by Prof. August Müller, in 1856.*

The young was formerly considered to be a member of a distinct genus, *Ammocœtes*. The young of the brook lamprey, *P. planeri*, which in a general way correspond to those of other species, are thus described by Professor Benecke:

"They are tawny yellow, without any trace of silvery hues, and have half-moon shaped toothless mouths, not intended for suctorial uses. Their small eyes are hidden deeply under their skins, and hardly visible. Their gill-openings lie in a deep furrow. The head is small and pointed, and the fins continuous."

It is a curious fact that as early as 1866 Leonhart Boldner, of Strasbourg, investigated and thoroughly understood the development and metamorphoses of the lamprey, as is indicated in the following paragraph translated from his work upon the water-birds, fishes, and other aquatic animals of Strasbourg:

"From August to December lampreys with eyes are not often seen and are rarely taken, but blind lampreys are found throughout the entire year. The lampreys with eyes and the blind lampreys are all of the same kind, for the young from the very beginning are all blind, and bury themselves at once in the mud as soon as they make their escape from the eggs. The blind lampreys develop no eggs until they develop their eyes."†

Like the eel, the lamprey was formerly believed to be hermaphrodite.‡

So far as I am aware few observations are on record which indicate the date of the spawning of the lampreys in this country. Wittmack, in his excellent work upon the Fishery Statistics of Germany, states that *P. marinus* spawns at Hameln in June, and in the Rhine at Zurich in March and April; *P. fluviatilis* in various parts of Northern Germany, chiefly in March, April, May and June, though in the Kurisches Haff also in November, December, and February. In Bavaria their spawning season is from March to June; in Austria, in April and May; and in Switzerland, in March and April. *P. planeri* is said by the same author to spawn in Pomerania in May, in the Rhine provinces in March and April, in Hanover in May and June, in Gotha in March and April,

* Müller's Archiv für Naturegeschichte, 1856, p. 325.

† See Von Siebold, *Süsswasserfische Mittel-Europas*, p. 378.

‡ Sir Everard Home in Philosophical Transactions, 1815, p. 266.

and in Lower Bavaria in May, June, and July; in the Tyrol in March, April, May, and June, and in Switzerland in March and April. In the rivers of Connecticut, where a lamprey fishery is still carried on, lampreys are reported to be abundant in May and June; and it is probable that these months are included within the period of spawning.

The artificial propagation of the lamprey was first successfully accomplished on the 24th day of May, 1879, when Herr M. Frauen, employed by the German Fishery Union in gathering sturgeon eggs in Schleswig Holstein, fertilized the eggs of the river lamprey and placed them in a breeding box. Between June 3 and June 16 many young were hatched out, and on July 17 the entire contents of the breeding box escaped.*

As has already been stated, it requires four or five years for the larval lamprey to undergo its metamorphoses and become capable of reproducing its kind. The sea lamprey, *P. marinus*, often attain the length of three feet, but those species which are found only in fresh water are usually much smaller.

The name *Petromyzon* signifies a "stone sucker," it being a common habit of these animals to cling to stones and pebbles. In swift currents this habit is of great importance to them, since it enables them to hold their own when their swimming powers would often be severely taxed. It is stated by careful observers that they have some way of transporting stones, and that they build nests, or rather circular fortifications of stone work around the crevices in which they lurk. As may be inferred from what has already been said of the manner in which they prey upon other fishes, lampreys are among the most troublesome enemies of many large species. Günther states that salmon have often been captured in the middle courses of the Rhine with marine lampreys attached to them. Milner, in his report on the Fisheries of the Great Lakes,† remarks:

"A parasite that troubles the sturgeon is the lamprey eel, *Petromyzon argenteus* Kirt., which is found very frequently attached to the skin. The circular scars and raw sores sometimes found upon the sturgeon, and attributed to this cause by the fishermen, are correctly accounted for in this way. It is probable that their natural food is the slime or mucus exuded in abundance from the pores, but they frequently retain their hold upon a spot until they have eaten through to the flesh, and deep ulcerous cavities occasionally result from the sore."

The lamprey was formerly highly esteemed as an article of food, and in early days is said to have constituted an important dish in certain civic feasts of Europe. It was once the custom to drown lampreys in wine and then to stew them. This process was supposed to impart a higher flavor to the flesh. It is stated by Lacépède that King Henry I, of England, came to an untimely end by too full a repast of lampreys. At the present time in Germany and France they are cooked in earthen-

*Circular der Deutscher Fischerei Verein, 1879, pp. 135–136, 159.

†Report of U. S. Fish Commission, Part II, 1874, p. 74.

ware jars with vinegar and spices, and are frequently seen among the relishes and *hors d'œuvres* brought upon the tables as a preliminary course. They are also highly esteemed in many other parts of the continent. At present in this country lampreys are but little prized except in certain portions of New England, particularly along the Connecticut River. Col. Theodore Lyman, in his report as fish commissioner of Massachusetts for 1876, states that the lamprey eel is a fish greatly esteemed by the country people of Massachusetts, and one which was formerly taken in amost incredible numbers in the Merrimac. It was found as far north as Plymouth, N. H., and by the Connecticut River, also, it passes into the same State.

In 1840 Mr. Joseph Ely took 3,800 in one night at Hadley Falls. It was then the custom of the country for each family to salt down several barrels of lampreys for winter use. "Now, in 1866," he continues, "this valuable fish has become nearly extinct in both rivers." This remark should be interpreted as applying simply to the headwaters of the Connecticut, since in the tributaries of its lower stretches there is still a considerable lamprey fishery and a large local consumption.

Mr. George Lyon, of Bridgewater, Conn., writes August 25, 1879:

"Previous to the building of the dam over the Hoosatonic, at Birmingham, lampreys were taken in large quantities as far up the river as the falls in the town of New Milford; now none are seen above the dam. Men, standing over the falls on shelving rocks, could hook them, as they clung to the rocks with their suckers, by means of a large sharp hook fastened to a long pole, this hook being imbedded in the holes in the sides of their necks. Many people formerly salted barrels of them for their own consumption. Their use at present has much decreased, owing to the disturbance in the fisheries caused by the building of the dams. Those now used in the vicinity of Bridgewater are taken in the Hoosatonic at Birmingham, and during the months of May and June are peddled though the country by the people who catch them."

Mr. N. M. Muckett, of Lakeville, Conn., states that in that vicinity the annual average catch is about 2,000, the implement of capture used being a pole about six feet in length with a hook at its end. The fisheries are located in Salmon River about two miles from the Connecticut, just above tide-water, and the lampreys sell in the markets of the adjoining villages at an average price of five dollars a hundred.

Mr. M. A. Hart, of Riverton, Conn., says that thirty years ago, and before, lampreys were found in the Farmington River in the vicinity of Riverton, but have long ago become exhausted. Quantities are sold in the city markets of Southern Connecticut, chiefly obtained in the Connecticut River in spring and early summer. They are easily caught with the hands, and fishermen in capturing them use mittens.

ACCOUNT OF OPERATIONS AT THE NORTHVILLE FISH-HATCHING STATION OF THE UNITED STATES FISH COMMISSION, FROM 1874 TO 1882, INCLUSIVE.

By FRANK N. CLARK.

[Written by request of Prof. S. F. Baird, for the London Exhibition, 1883.]

It will be admitted without argument that nature, unaided by art, is wholly unable to furnish food for the sustenance of the human race. The necessities of existence have therefore always driven man to the culture and development of those kinds of animals and plants that are able to supply him with the means of subsistence. Science has pointed out the laws which govern the myriad orders of life, and by the aid of this knowledge we are able to multiply in vast ratios all the varieties of animal and vegetable nature necessary to meet our requirements. Until within comparatively few years the attention of mankind in this direction had been expended almost wholly upon the culture and propagation of land products. That portion of human food found in the paths of the sea and rivers of the earth had been left wholly to the care of nature, man not deeming it within his power to materially aid nature in this department of her supply. Somewhat recent investigations, however, have revealed the fact that some of the largest and most important fisheries of the world must soon cease to operate, for a time at least, unless some artificial means be devised for counterbalancing the vast drainage which is rapidly depopulating lakes, rivers, and seas of their inhabitants.

That such means have been discovered and successfully applied is abundantly demonstrated by the history and work of pisciculture. A single incident will well illustrate this statement, for it is only a sample of the success which, as a rule, has everywhere attended this science. I was myself personally cognizant of the facts in the case, and therefore can speak with definite knowledge. It is a well-known fact that forty or fifty years ago shad were so abundant upon our Atlantic coast that they were "caught by the million in many bays and mouths of rivers." As early as 1860 it became alarmingly evident that this great source of revenue to the country would soon be cut off, for the fish were not only no longer abundant, but it was becoming hard to obtain them even as a luxury. I was on the Connecticut River in 1873, and I could not obtain shad for less than one dollar apiece. In 1871, and again in 1872, several millions of young shad were liberated at the mouth of the Connecticut River. In 1874, three years' time, the most marvelous results were manifest. Those first set free began to return. It was reported by fishermen "that for twenty years such shoals of shad had not been seen approaching the land, and vessels which had come through the neighboring sound reported also great shoals which stood towards the mouth of the river." Being on the ground at the time, I was offered all the fish I could buy for 10 cents apiece.

Approximately the same results are now being realized from the distribution of young whitefish in our great inland lakes. It is only within three or four years that the young fry have been liberated in sufficiently large numbers to increase the supply of the fisheries; and now from every point where such distributions have been made acknowledgments are numerous of the inestimable benefits already derived from this source. Similar results have been obtained elsewhere and with other kinds of fish; but these experiments have already entered into the history of the science, and have proven, beyond any question whatever, that pisciculture is the perfect solution of the problem of supplying the fisheries of the world with an inexhaustible revenue.

With this object in view, therefore, fish-breeding establishments have been erected at suitable localities in different parts of both the Old and New World. To begin with, these institutions were in many instances the result of private enterprise; but their work is now deemed of such great importance that states and governments have purchased the right of control over the best of these establishments.

The hatchery at Northville passed into the hands of the Government in the year 1880, and now to give a history of the inception and work of this institution is the remaining purpose of this article.

ORIGIN OF THE NORTHVILLE HATCHERY.

In the year 1868, Mr. N. W. Clark, of Clarkston, Mich., became interested in the subject of fish culture. His attention was first roused to the subject by the enormous waste of embryonic life observed among the fish, from which he concluded that not one egg out of thousands, left simply to a course of nature, could reach mature development. It is easily demonstrable that rivers, lakes, and oceans would literally overflow with their inhabitants if but a tenth or even a hundredth part of all fish-spawn should grow to adult size. Such an increase would not of course be possible, nor for many reasons desirable; but the question naturally occurred to Mr. Clark, as it had to others, Cannot some means be devised by which the prolific nature of the fish may be taken advantage of and the waste sufficiently prevented to annually restock all the important fisheries of the world with an abundant supply? This, as at once appears, was a most interesting and important question. He therefore determined to devote to experiments as much time as could be spared from his ordinary business pursuits, not so much as a means of personal profit as to appease his own love of research and experiment.

Having thoroughly informed himself of the nature and success of experiments made in this direction by other men, he at once began the erection of a building near Clarkston, and without and within he placed all the necessary appurtenances then known to the science. Here he continued experimenting, with considerable success, until the summer of 1874, when, desiring to enlarge the scale of operations, he determined to seek for some locality possessing greater natural facilities. After carefully examining different places more or less favorable for the purpose, the present site of the Northville hatchery was selected, as affording not only the best advantages he was able to find, but as leaving little or nothing to be desired in the possession of all those natural surroundings necessary to the perfect development of piscicultural science. To this point he at once removed, and began the construction of a building and of ponds and raceways suitable for his purpose.

The building is an ordinary one-story frame structure, 80 feet long by nearly 30 wide, and contains an office, sleeping apartment, and tank room, besides the main hatching room, which is furnished with such appliances as are best calculated to do the work. At first, and for several succeeding seasons, the style of incubator used was of Mr. Clark's own invention,* which had been thoroughly tested by him in the Clark-

*This invention consists in the construction of a suitable building, at one end of which, nearest the water supply, are tanks, containing many barrels of water conveyed through faucets from spring or lake, as the nature of the eggs to be hatched may require, which passes through flannel screens, and is thus filtered from all sediment before entering the troughs containing the hatching boxes. These troughs are about one foot (or more, as the case may be) in width and ten inches deep, each of them containing a series of water-tight compartments, which contain the same number of boxes of less dimensions, also water-tight, except the bottoms, which are covered with finely-perforated copper or brass wire cloth to prevent the eggs or fish from escaping when hatched out.

These last boxes are filled with several screens, each containing many thousand eggs, and may be of sufficient capacity to hatch an almost unlimited number of eggs.

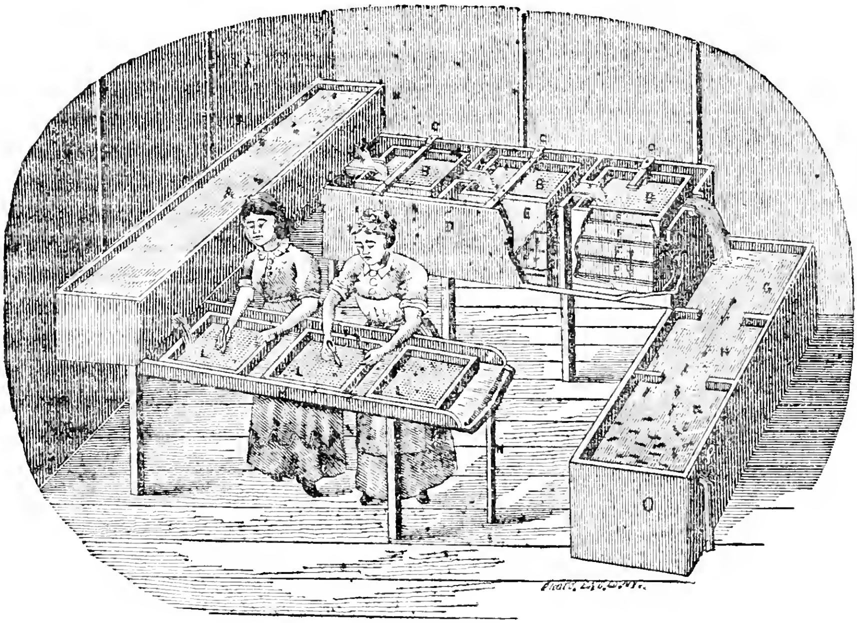
Over these screens, and after the eggs are equally distributed over them, there is placed a finely-perforated metallic plate, B, and the whole is kept in place by a cross-bar, C, fastened to the sides of the main trough. These boxes are elevated upon feet to raise them from the floor of the trough, to allow a free passage of water under them and to raise them above any sediment that may pass through and settle on the said floor.

The first screen that lies over the copper cloth is also raised to gain free circulation to the water. The main trough must have a descent of three-sixteenths of an inch to the foot, to form sufficient fall of water into each separate box to produce a moderate current of water down through the eggs.

This arrangement completed, the water is let in at the upper end of the long troughs upon the perforated cover, which spreads it equally over the whole part of the eggs below, which, owing to the declivity of the main trough and the water-tight partitions in them, causes it to flow over said partition on to the next below, which produces an up and down movement to the current running throughout the whole series of hatching boxes, making changes around and through the whole number of eggs in each compartment constant while in process of hatching.

Many more fish are hatched by this process than can be stored and cleansed from their shells and other impurities consequent upon the last stages of hatching; hence, it becomes necessary to add store-room and an additional process for cleansing the fish when hatched out from the impurities above named.

To remedy this trouble a series of large tanks, G H K, are erected for the reception of the water as it leaves the hatching troughs. From ten to twenty days are required from the commencement of the hatching season to its close, consequently a proportionate number of fish are hatched daily. These are washed from the unhatched eggs into the first receiving-tank before mentioned, and allowed to stand quietly without much current to the water in which they are. The eggs thus cleansed are returned to the hatching boxes from which they came. As soon as the shells from the eggs are well settled to the bottom, a moderate current of water is allowed to flow through an opening to the next tank below, carrying the cleansed fish with it, depositing any impurities that may yet be left with the fish in said settler; and the fish are allowed to follow on with the current, passing still through another opening to the large recepston experiments. The hatching room was at first equipped with 224 of these incubators, known as the Clark hatching box, together with their appropriate accessories. The hatching box itself was a great im-



provement over the system of gravel troughs formerly employed in fish hatching, and the method and character of its work are even now unsurpassed for incubating some of the larger eggs of the salmonoid species. The invention, however, involved the same principle of construction and operation that was embodied in two or three other similar inventions which appeared about the same time. In each the method of procedure consists in spreading the eggs in layers on wire trays, and causing the water to flow through them. In some incubators of this type the mechanical construction forces the water upward instead of downward, but whatever the direction of the water the results in all are substantially the same, since the eggs remain motionless.

From the site of the hatchery and its immediate vicinity innumerable springs send forth an inexhaustible supply of pure water. In the aggregate they furnish about 700 gallons per minute. From the head of this spring area to where the hatchery is situated occurs a natural slope

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tion room, where they remain in perfect condition in pure running water until placed in the waters designed for them.

M is a shallow trough supplied with water drawn from the main tank, being the same temperature of that in which the eggs are hatched.

During the first few weeks of their incubation many imperfect and dead eggs are found, and for the purpose of removing them from the good ones the screens upon which they lie are removed from the hatching boxes to the shallow trough of running water and picked out in the usual way with forceps, as shown by the figures in the illustration.

that gives to the former an elevation of eight feet above the latter, thus giving to the hatchery an ample volume and fall of water for hatching purposes.

THE TROUT PONDS.

These were originally six in number, and, though since found quite insufficient to meet the requirements of the increased scale of operations, they performed their service well at the time of their construction and for several succeeding years. Since the supervision of the hatchery was assumed by the United States Fish Commission, in 1880, the ponds have undergone a thorough reconstruction. They have been greatly enlarged, their sides planked and secured beyond all possibility of muskrat depredations, their banks nicely ornamented with a coat of nature's green, and their capacity increased many fold. Entire new ponds have also been built, and all are suitably provided with discharging flues and gates for the control of the water. The bottom of each pond is made to gradually slope so that the depth of the water is eighteen inches at the head and four to five feet at the foot, this conformation being necessary to tempt the breeders up into the shallow, rapid current of the raceways to spawn. As is well known, however, the fish will sometimes deposit their eggs in the gravel beds of the ponds themselves, and, to avoid any loss which might be entailed by such an occurrence, the ponds set apart for the use of the breeders are divided into two sections, the bottom of the upper and more shallow section being tightly covered with boards. Into this section the breeders are placed during the spawning season, and are prevented from entering the lower part of the pond by a temporary partition, which is removed when the spawning season is over, the lower section being used simply as a receptacle for the fish as fast as they are manipulated and the eggs secured.

The uniformly cool temperature of spring water at all seasons of the year causes these ponds to be as healthful to the various kinds of trout as their ordinary haunts furnished by nature. Indeed, this fact, combined with the abundant supply of artificial food, produces an average maximum size that is not only unsurpassed, but absolutely unobtainable in many of the streams where the fish naturally flourish.

I find that among communities having no direct commercial intercourse with the large fisheries there prevails considerable skepticism concerning the real benefit to be derived from the artificial propagation of fish. The people who live near the great fisheries have been convinced of its value by the returns which they have actually realized from the work of the states and the general government in restocking the larger bodies of water with the best varieties of commercial fishes. Those in the interior have also been indirectly benefited, but this they are slow to realize. I therefore look with great hopefulness upon the present attempts now making everywhere to introduce the trout and other valuable species into such inland waters of the country as are suitable to their nature.

Although the natural habitat of the trout is confined almost wholly to the colder streams and waters of our country, the acclimatization of these species, and of their proper food, is no longer a matter of experiment; and if success in this direction can only be achieved sufficiently to bring this delicate luxury within reach of the people at large, they will need no other argument to convince them that trout-culture is not experimental, but is a work from which all may derive direct and substantial benefits.

But so far as our brook trout (*Salvelinus fontinalis*) are concerned, until they are more abundant in their native haunts than at present, it will be practically impossible to accomplish results at all appreciable or worthy of notice, except by the method employed here and in other hatcheries. This method proceeds upon the known adaptation of spring water to the artificial development and maintenance of the species. It insures a temperature corresponding with that of the waters of their nattural habitat, and, by proper distributive arrangements, this temperature may be kept below 70° F. in the hottest summer weather. The method employed also takes into view the best means and facilities for obtaining a sufficient egg supply to meet the purpose in hand; and, with reference to this, experience has abundantly proven that there is but one reliable course to pursue, and that is to rear the breeders in sufficient numbers to obtain the desired number of eggs. To depend upon securing spawn by angling or seining these fish out of their natural streams would, at present, be almost wholly futile as well as expensive. Those ripe for spawning could not be caught in sufficient numbers by this means to pay the cost of labor expended. But where the fish are kept in ponds or preserves so constructed as to give us absolute control of every period of development from the embryo to the spawner, it is possible to secure very large returns from a comparatively small amount of stock. By this means not a single egg need be lost; every fish can be manipulated without receiving any harm, and the eggs removed and mixed with the proper amount of male secretion to fertilize at least 80 to 90 per cent. This is something, however, that art only can do. Nature alone would give fertilization to only a very small proportion of eggs spawned; but art, having the power thus to utilize all the resources which nature so lavishly furnishes, points out the way to obtain the largest results at comparatively little cost and trouble.

The ponds are fed directly from the lower spring area, which is underneath the hatchery, and indirectly by the water of the upper springs, which first makes the circuit of an artificial reservoir, from which it flows through the building, where its passage is utilized in hatching. Thence it enters the raceways at the rear of the hatchery. The amount of stock originally put into these ponds by Mr. Clark consisted of one hundred adult brook trout. This number has multiplied very many times since then. Other varieties of fish have also been introduced at various times, such as the California trout (*Salmo iridea*), California salmon (*Oncorhynchus quinnat*), lake trout (*Cristivomer namaycush*), grayling (*Thymallus tricolor*), and land-locked salmon (*Salmo salar*, var. *sebago*).

IMPROVED METHODS OF INCUBATING EGGS OF THE WHITEFISH (COREGONUS CLUPEIFORMIS).

Since the Northville hatchery was built, the method of incubating whitefish eggs has undergone a radical change. The hatching boxes are still used for the salmon and trout, but for whitefish they have been entirely supplanted by inventions which greatly reduce the expense and labor involved in hatching this species by artificial processes.

The principles upon which the construction and operation of these later inventions are based are substantially alike in all. Whitefish eggs are small and light, and hence are easily buoyed or influenced by currents of water; and the dead and confervaceous eggs are a trifle still more buoyant. These conditions are taken advantage of by having a proper head of water and releasing a graduated volume under a uniform pressure on a mass of eggs in a vessel of suitable size and conformation to secure the purposes in view. A fixed movement is thus given to all eggs of the same specific gravity, while the lighter eggs of confervaceous growth, contact with which imperils the safety of the living embryos, are driven from the presence of the latter by the outflowing current, which carries them out of the vessel or holds them at the surface, whence they can be removed *en masse* at leisure. In the use of the hatching boxes, where the eggs are not kept in motion but remain quiescent, it is necessary to be always on hand with a pair of tweezers to pick away the dead eggs one by one as fast as they become visible on the trays. Hence the hatching of large numbers by the box system involved a great deal of labor and expense, which is now largely dispensed with. Constant surveillance and manipulation to keep the dead and living ova separated is no longer necessary, and the actual work demanded to incubate any number of millions of whitefish embryos is now no greater than was formerly demanded for as many thousands.

The style of improved incubator first brought into use at the Northville hatchery is known as the Chase jar, and is the invention of Mr. O. M. Chase, of Detroit, Mich. The jar is a cylindrical glass vessel 19 inches high by 6 inches in diameter. The water is introduced through a glass tube resting in the center of the egg-chamber, and is released upon the eggs at the foot of the tube, which is slightly raised by three small feet. A tin rim provided with a gate and lip for discharging the water is fitted to the top of the jar, and the whole is placed directly underneath a spigot connecting with the top of the glass tube by a short piece of rubber hose.

These jars were used at Northville during the seasons of 1880–'81 and 1881–'82, sufficient tank room being provided to operate about 150.

Each jar will incubate 200,000 eggs of the whitefish. Tanks of uniform size are placed one above the other in three tiers, and the water enters the upper tank and feeds a row of jars on either side, whence it is discharged into the middle tank to supply another double row of jars, thence passing into the lower or waste tank. The jars rest in pairs on narrow shelves placed crosswise of the tanks.

During the season of 1881–'82 an improved whitefish incubator was devised by employés of the hatchery. The egg-chamber is substantially the same as that of the automatic jar; but the separation of the dead and living ova is more perfectly accomplished by improved distributive arrangements, which give to the currents of water absolute evenness and uniformity. A cone-shaped device is fitted to the bottom of the egg-chamber, and resting on this is the tube through which the water is introduced. The bottom of the tube assumes a conical form to correspond with the cone over which it is placed, being slightly raised or separated therefrom by narrow strips of tin soldered to the cone midway between its base and apex, to permit the water to escape. The column of water in its descent through the tube is pierced by the apex of the cone and radiated to the base of the tube, where it escapes into the egg-chamber. Side currents are thus formed which impart to the eggs the best possible motion; carrying them upward through the egg-chamber to descend again upon the base of the tube, which diverts them to its edge to be carried up again, as before, by the inflowing current. Fifty of these incubators are now employed at the Northville hatchery, and over two hundred at the Lake Huron hatchery, recently established at Alpena, Mich., by the United States Fish Commission.

As an experiment, Mr. S. Bower, of the Northville hatchery, constructed an incubator admitting of a larger scale of operations, at a greatly reduced cost for apparatus. It is made of wood and galvanized iron, in the form of a rectangular box, and is divided into upper and lower chambers; it is 11 inches wide by 13 inches deep and 30 inches long, although its length is not material, and may be extended indefinitely, increasing its capacity to correspond, without impairing or changing its operation. The movement of the eggs is obtained by introducing water into the lower chamber, whence it is admitted to the upper chamber through a sixteenth-inch crevice running lengthwise of the box. From each side the partition which divides the box into two chambers slants downward to the point where the water enters the egg-chamber. By this means the eggs carried to the surface by the inflowing current are constantly returned to the starting point, and thus a perpetual circuit is produced. The principle of operation thus reverses the motion employed in the jars, as the eggs ascend from the center and descend at the sides, instead of rising at the sides and returning through the center. Overflows are provided at intervals around the top of the box. The separation of the dead and living ova is very well accomplished with this inexpensive apparatus; it requires, however, a greater head of water than the jar incubators, and for this reason the success of the experiment as tried was somewhat impaired.

PACKING FISH EGGS FOR SHIPMENT.

There are a number of methods employed in preparing the eggs for shipping. The conditions most favorable to successful transportation are those which will best maintain a moderate degree of moisture of the eggs, and the lowest possible temperature that will not impair their vitality. Experiments have shown that 32° F. is the temperature best calculated to preserve the *statu quo* of the various species treated at this hatchery. Under the conditions named, development of the embryo proceeds very slowly, almost imperceptibly; the development of confervæ is likewise retarded. An ample period of time is therefore given them to make long journeys without losses, if the proper conditions are maintained. Various experiments have been made from time to time, by diversifying the details of preparation, but the method which has met with the greatest measure of success is substantially as follows: A sufficient number of canton-flannel trays are made to hold the eggs, and a case is constructed of such a size as to contain the trays when superimposed upon each other, and to allow 4 to 6 inches of space around the sides for packing material. The trays are placed in a tank of ice-water not less than an hour before eggs are transferred thereto. A quantity of eggs are transferred from the hatching vessels to wire-trays in the picking-trough, and feathered over to throw up dead or unimpregnated eggs, which are removed with nippers. The sound eggs are then collected by overturning and submerging the trays into a large tin vessel partly filled with water; thence they are skimmed up and measured in a graduate * and poured into the shipping trays, which are immediately taken to the packing room, where the temperature is between 30° and 40° F. The trays are then thoroughly drained of superfluous water, and the eggs are spread uniformly two layers in depth, with a half-inch margin of flannel between the eggs and wood frame of the tray. A single fold of dampened millinet is then thrown over the eggs, and over this a sufficient quantity of live moss, washed and wrung out to prevent drainage, to fill the tray when rather snugly pressed down. When admissible, the trays are allowed to stand in temperature a little below the freezing point until needles of ice have begun to form in the moss; they are then placed one above another and held to position by cleats nailed to top and bottom boards. The pack-

* The following is the standard of measurement used at the Northville hatchery: Whitefish, 1,250; brook trout, 450; lake trout, 200 to the fluid ounce. Eggs of whitefish and lake trout vary but little in size. Brook-trout eggs, however, depend in size a good deal on the age of the parent fish. Thus the product of the first egg-bearing period (fish twenty months old) will run about 500 to the ounce; from trout three and four years old, about 400 to 425 to the ounce, making 450 a fair average.

age is now transferred to the shipping case and surrounded with fine, dry, hardwood shavings, firmly champed in. The material which separates the eggs from the outside atmosphere is a poor conductor of heat, and the eggs are therefore carried through to destination in excellent condition, with very rare exceptions.

The following tables give a condensed summary of the work for the past seven years. They are somewhat incomplete, owing to the fact that the details of work were not formerly preserved with as much care as we are now accustomed to observe.

Season of 1874–'75.

Eggs placed in hatching boxes:

Whitefish	2,500,000
Lake trout	150,000
Brook trout	100,000
California salmon (in poor condition)	50,000
Wall-eyed pike (*Stizostedium americanum*)	25,000

Fish planted.

Whitefish, 2,000,000 for Michigan Commission; 100,000 for United States Fish Commission.

Lake trout, 125,000 for Michigan Commission.

Brook trout, 50,000 sold to private parties; 25,000 planted in adjoining States; 10,000 retained in ponds.

California salmon, 15,000 distributed in Ohio for United States Fish Commission; 10,000 retained in ponds.

Wall-eyed pike, 20,000 distributed in inland waters of Michigan.

During this season eggs of whitefish and lake trout were contracted for at the rate of $1 per thousand.

The requirements of the work necessitated the employment of extra help, as follows: Twenty-five girls for forty days, at 75 cents per day; three men for five months, at $50 per month.

The girls were employed to separate the dead and living ova. Seated before a long, shallow trough of running water, facing a row of windows and supplied with feathers and tweezers, the work proceeded by picking out the dead eggs one by one from the wire trays, which were transferred from the hatching boxes to the "picking trough."

Season of 1875–'76.

Eggs placed in hatching boxes:

Whitefish	3,300,000
Brook trout	50,000
California salmon	988,000

Distribution of the minnows.

Whitefish, 2,700,000, placed mostly in the Great Lakes, for United States Fish Commission.

Brook trout, 40,000 sold to private parties; 5,000 retained in ponds.

California salmon, 900,000 planted in the tributaries of the Mississippi and Ohio Rivers on account of United States Fish Commission.

During the season fifteen girls were employed for sixty days at 75 cents per day, and three men for six months at $50 per month. The whitefish eggs were supplied on contract at $1 per thousand. The California salmon were sent here from the McCloud River, California, in an advanced stage of development, to be hatched and retained in tanks until time for distribution, and for this work the charge was 50 cents per thousand.

In the spring of 1876 Mr. Fred. Mather turned over to the establishment about 2,000 eggs of grayling, taken from fish caught in the Au Sable River, Northern Michigan. Only a small percentage were hatched, and the minnows were retained in the ponds of the hatchery, together with about 150 yearlings brought from the same river.

Season of 1876–'77.

Eggs placed in hatching boxes:

Whitefish	1,250,000
Brook trout	50,000
California salmon	500,000

Disposal of eggs.

Whitefish, 500,000 shipped to California on account of United States Fish Commission; 50,000 shipped to Germany on account of United States Fish Commission; 500,000 sold to private parties.

California salmon, 450,000 hatched and planted in rivers in Ohio, Indiana, and Illinois, on account of United States Fish Commission.

The whitefish eggs were sold at 50 cents per thousand; California salmon were received from the McCloud River, California, as in the previous year, and a charge of 50 cents per thousand made for their subsequent treatment. The whitefish eggs shipped to California per express, a distance of 2,200 miles, arrived in good condition; those to Germany in rather poor condition.

Season of 1877–'78.

Eggs placed in hatching boxes:

Whitefish	1,500,000
Brook trout	50,000
Land-locked salmon from Maine	10,000

Disposal of eggs.

Whitefish, 500,000 shipped to New Zealand; 500,000 shipped to California; 250,000 shipped to Nevada; 50,000 shipped to New Jersey.

Brook trout all sold to private parties.

The land-locked salmon eggs arrived in such poor condition that but few were hatched.

The whitefish eggs sent to New Zealand were about fifty days *en route*, and arrived in very fair condition. The California and New Jersey shipments were also successful.

Season of 1878–'79.

Eggs placed in hatching-boxes:

Whitefish	2,500,000
Brook trout	75,000
California salmon	250,000
Land-locked salmon	15,000

Shipments of eggs.

Whitefish, 500,000 to California, on account of United States Fish Commission; 250,000 to Nevada, on account of United States Fish Commission; 100,000 to Iowa; 500,000 to New Jersey; 1,000,000 to New Zealand.

Disposal of fry.

Whitefish, 40,000 sold to private parties.

Brook trout, 60,000 sold to private parties; 5,000 retained in ponds; 5,000 planted in adjacent streams.

California salmon, 225,000 shipped to and planted in rivers of Texas, Louisiana, Mississippi, Arkansas, Missouri, and Illinois.

Land-locked salmon, 10,000 distributed in Ohio; 1,000 retained at hatchery, but did not do well.

Season of 1879–'80.

Eggs placed in hatching-boxes:

Whitefish	3,250,000
Brook trout	50,000
Land-locked salmon	50,000

Shipments of eggs.

Whitefish, 2,000,000 to New Zealand; 500,000 to California; 250,000 to Maine.

Brook trout, 30,000 to private parties.

Disposal of fry.

Brook trout, 10,000 sold to private parties; 5,000 retained in ponds.

The land-locked salmon eggs were forwarded from Maine to this hatchery for reshipment to California, but on opening the crates the eggs were found too far advanced for further shipment; they were, therefore, hatched and distributed to Iowa and Minnesota waters.

Season of 1880–'81.

Eggs of whitefish placed in hatching-jars, 13,780,000.

Shipments of eggs were made as follows: To Germany, 250,000; Maine, 1,000,000; Iowa, 500,000; Minnesota, 250,000; Kentucky, 500,000; California, 500,000; Nevada, 100,000; and Pennsylvania, 100,000: total, 3,200,000. With one exception, these shipments were made with perfect success. Something over nine million minnows were also hatched, and released in the waters of the Great Lakes.

Number of eggs of brook trout placed in hatching-boxes, 75,000, disposed of as follows: 50,000 sold to private parties; loss on eggs, 12,000; fish hatched, 13,000, of which 3,000 were retained in artificial ponds and the remainder planted in adjacent streams.

A few hundred eggs of California trout were also obtained from a few adult fish of this species held in the ponds of the station. These were hatched, and the fry retained at the hatchery.

Season of 1881–'82.

The work was quite largely increased this season. The number of whitefish embryos placed in the hatching-jars from fisheries of Lake Erie and Lake Huron was something over 22,000,000. From these nearly 2,000,000 were shipped, and over 17,000,000 fish hatched and planted. The minnows were distributed by the United States Fish Commission car to various points on the Great Lakes, and eggs were shipped as follows: To Germany, 300,000; France, 250,000; Iowa, 500,000; Connecticut, 10,000; California, 750,000, and New Jersey, 100,000.

About 60,000 eggs of lake trout were obtained from Lake Huron fisheries and brought to this hatchery for incubation and shipping. Of these, 20,000 were shipped to F. Mather, Newark, N. J., for transmission to Germany, and 30,000 were sent to the State of Iowa.

From the California trout mentioned above, some 4,000 or 5,000 eggs were obtained; they were hatched and the fry retained at the hatchery.

Upwards of 150,000 eggs of brook trout were laid in from the breeding-fish reared in the artificial ponds adjoining the hatchery; 30,000 of these were shipped to the Druid Hill hatchery, Baltimore, Md., and 20,000 to F. Mather, Newark, N. J., for reshipment to France. About 75 per cent. of the remainder were hatched; 30,000 of these were taken to West Virginia by United States Fish Commission car No. 1; 10,000 were retained at this hatchery; and the remaining 35,000 were planted in brooks in Oakland and Wayne Counties, Michigan.

Seventy-five thousand eggs of California trout were received from Baird Station, California, and hatched and transferred to Michigan, Illinois, and Missouri waters, except a few thousand retained at the hatchery to rear for breeders.

About 50,000 eggs of Schoodic salmon were also forwarded to this station from Grand Lake Stream, Maine. These were hatched and liberated in Michigan, Ohio, and Indiana waters, except a few hundred retained at hatchery for experiments in growing them in confinement, on artificial food.

One thousand five hundred German carp were sent to this station from Washington, D. C., and from this point dispatched in lots of 20 to various parties throughout the Northwestern States.

Season of 1882–'83.

The present season has witnessed the building of an auxiliary hatchery at Alpena, Mich., on the coast of Lake Huron. The work was begun about the first of October, and pushed rapidly forward to completion. The building was up and the equipments in by the 12th of November, when eggs began to arrive from the adjacent fisheries.

This hatchery is equipped exclusively for whitefish propagation, and will admit the easy manipulation of 100,000,000 eggs of that species. Owing to the tardy commencement of this work, however, provision was made for hatching only a little more than 40,000,000 this season. This number of eggs was safely secured from the 10th to the 30th of November. Next season and thereafter we hope to operate the hatchery to its full capacity. The location of this hatchery is all that could be desired to suit the purpose in hand, as spawning fish are caught in great numbers in the immediate vicinity, and the situation furnishes a good distributing point for a large section of the northern part of the "Great Lake Chain."

A large supply of eggs has also been placed in the Northville hatchery this season. This includes 300,000 eggs of lake trout from Lake Huron, over 400,000 eggs of brook trout from the ponds of the Northville hatchery, and nearly 30,000,000 eggs of whitefish from Lake Erie. Our brook-trout supply this year was augmented by 20,000 to 25,000 eggs obtained wholly from wild trout inhabiting the neighboring stream, out of which they had run into the waste-channel of the ponds.

The eggs in stock are in excellent condition, and the aggregate results in embryos and minnows from these alone will far surpass anything heretofore accomplished in the work of the hatchery, to say nothing of operations at the auxiliary station at Alpena. It is expected also, before the close of the current season, to lay in several million eggs of wall-eyed pike, from Lake Huron fisheries; and at least 200,000 eggs of California or rainbow trout from the parent fish now held in our trout ponds. Both of these species spawn in this latitude during the spring months.

An important departure in the method of obtaining whitefish eggs, and one which from the very outset has been signally successful in a number of instances, is a system of operations by which the fish nearly ready to spawn are confined within certain prescribed limits until their eggs have been secured. The whitefish is not adapted to continuous confinement in artificial ponds, like the trout; and as they are usually caught in very large numbers from their natural habitat during the spawning season, it has been the custom heretofore to depend for our supply of eggs of this species upon the "ripe" fish found in the nets when lifted by the fishermen; no opportunity was given to handle the "lifts" a second time; and as a great majority are either "spent" or "unripe," but a comparatively few individuals are found in which the spawn is in proper condition for fertilization, and hence but a small proportion of the spawning fish actually captured were manipulated. However, almost fabulous numbers of eggs can be secured even from this source, with fair weather prevailing during the brief period that whitefish naturally spawn; but this period is usually cotemporaneous with a series of violent storms for which our Great Lakes are noted, and which compel a discontinuance of fishing operations; so that more or less uncertainty must attend all efforts in this direction, and much labor and expense may produce only the most meager results.

The improved method referred to holds a large number of the adult fish in confinement only during the spawning season. Pens of the requisite size are constructed in those parts of the lake where the fish are caught in great numbers and where there is protection from heavy wind and sea. Being thus imprisoned they can be handled and rehandled at pleasure, regardless of wind and weather, until every egg is secured.

Thus far this season eggs have been shipped from Northville as follows: Whitefish: To Washington, D. C., 1,000,000; Maryland, 150,000; Germany, 500,000; France, 200,000; Minnesota, 5,000,000; California, 500,000; New Hampshire, 200,000; North Carolina, 250,000; Pennsylvania, 2,000,000, and Cold Spring hatchery, New York, 1,000,000; total, 10,800,000. Brook trout: To Washington, D. C., 150,000; Germany, 45,000; Bogota, South America, 10,000; France, 20,000; England, 10,000; Ohio, 15,000, and Cold Spring Hatchery, New York, 150,000; total, 400,000. Lake trout: To Washington, D. C., 50,000; Germany, 100,000, and France, 50,000; total, 200,000.

So far as reports have been received the above shipments have reached their destinations in excellent condition.

FUTURE PROSPECTS OF THE NORTHVILLE HATCHERY.

From very moderate beginnings the work here has assumed very fair proportions, and has, in some respects, surpassed the hopes at first entertained. Six seasons of work under private auspices placed the institution on a thoroughly practical basis, and since its control has passed into the hands of the United States Fish Commission new and more extended undertakings have been successfully inaugurated. There are natural facilities here, however, that have not yet been fully utilized. The trout work, to which this station is peculiarly adapted, may readily be enlarged to such an extent that our present operations may be multiplied eightfold, while the cost will not be more than three times what it now is.

The water supply now controlled by the hatchery is wholly of spring origin, the character and volume of which have been heretofore alluded to; and, while it is sufficiently ample to sustain a considerable pond area and do a creditable work, as the figures given indicate, the additional water-power adjacent and available for the purpose in question will make it possible to increase the volume of work with increased outlay in the ratios given above. The power referred to is embodied in a stream flowing near the hatchery, and which has its origin in numberless little springs one mile away, its quality being sustained and volume increased by numerous contributions of like character all along its devious channel, which finally passes within a few feet of the trout ponds in connection with the hatchery. As the degree of success already established will doubtless justify the acquisition, either by lease or purchase, of sufficient land through which the stream flows on which to create ponds and to control three-quarters of a mile of the stream itself, a prospective glance at the magnitude the work may attain is worthy of notice and will be a fitting conclusion to the history of a work just fairly begun.

The plan of utilizing this stream contemplates the creation of large ponds or reservoirs of irregular coast lines along the border of the stream, into which a sufficient quantity of water will be diverted to sustain a large stock of breeding fish. The outlet of the ponds will be so constructed as to carry the water back again into the main channel. As the capacity of this stream is fully 3,000 gallons per minute, an immense pond area can be sustained, while the stream itself will make a home for thousands of growing fish. The water is well adapted to the purpose in hand, as is attested by the fact that the stream is now inhabited by hundreds of brook trout of various sizes which are the result of plants at the beginning of the work at Northville. Schools of 10 to 25 trout can frequently be seen around favorite gravelly pools where they are wont to congregate. By actual count 350 of these wild trout were taken during the past fall from the little rivulet created by our springs and flowing into the main channel, whence they had run for spawning purposes. About 25,000 eggs were taken in this way, as before mentioned, which was clear profit, besides increasing our stock of breeders by the 350 fish that were transferred to the ponds.

The use of this stream will also make a very material proportionate reduction in cost of food, as it is stocked with shrimp (*Gammarus*), the natural food of the trout, in sufficient numbers to sustain a great many fish without the aid of artificial food.

A comparative statement in figures will better illustrate the future possible trout work of this station. The extension of facilities to the limit of the *present* water-power of the station will show an aggregate pond area of 16,463 square feet, which will contain a sufficient stock of parent fish (together with the requisite number of growing fish to keep the stock good) to yield an annual income of 1,500,000 eggs of either the *Salvelinus fontinalis* or *Salmo iridea*. The acquisition of sufficient basin of the adjacent stream for pond-room and for control of three-quarters of a mile of the channel bed will swell the aggregate pond area to about 140,000 square feet. This, with the stream itself, will carry a maximum of stock, at the minimum of cost, sufficient to yield annually 12,000,000 eggs. These figures may be regarded as an under rather than an over estimate, since they are made up from the standpoint of our present methods of rearing and handling fish, which experience and experiment are constantly improving.

We now have on hand in the ponds of the hatchery—

Brook trout:	
Fry	8,000
One year old	1,200
Two years old	850
Three and four years old	400
California trout:	
Fry	10,000
One year old	200
Two years old	700
Three and four years old	20
Land-locked salmon of last spring's hatching	500
Lake trout of last spring's hatching	300

Below is a statement of the whole number of fertilized eggs placed in the Northville and Alpena hatcheries to date, including the prospective supply of eggs of California trout for the current season:

Whitefish (*Coregonus clupeiformis*)	120,580,000
Lake trout (*Cristivomer namaycush*)	510,000
Brook trout (*Salvelinus fontinalis*)	1,050,000
California salmon (*Oncorhynchus quinnat*)	1,788,000
California trout (*Salmo iridea*)	283,000
Land-locked salmon (*Salmo salar; var. sebago*)	125,000
Wall-eyed pike (*Stizostedium americanum*)	25,000
Grayling (*Thymallus tricolor*)	2,000

Season.	Grayling.			Wall-eyed pike.			California trout.		
	Eggs received.	Eggs shipped.	Fish hatched.	Eggs received.	Eggs shipped.	Fish hatched.	Eggs received.	Eggs shipped.	Fish hatched.
1874–'75				25,000		20,000			
1875–'76	2,000		500						
1876–'77									
1877–'78									
1878–'79									
1879–'80									
1880–'81							3,000		2,500
1881–'82							80,000		70,000
1882–'83							200,000		175,000
Total	2,000		500	25,000		20,000	283,000		247,500

Season.	Lake trout.			Brook trout.			Land-locked salmon.		
	Eggs received.	Eggs shipped.	Fish hatched.	Eggs received.	Eggs shipped.	Fish hatched.	Eggs received.	Eggs shipped.	Fish hatched.
1874–'75	150,000		125,000	100,000		85,000			
1875–'76				50,000		45,000			
1876–'77				50,000		42,000			
1877–'78				50,000	43,000		10,000		2,000
1878–'79				75,000	60,000	10,000	15,000		11,000
1879–'80				50,000	30,000	15,000	50,000		46,000
1880–'81				75,000	50,000	13,000			
1881–'82	60,000	50,000	2,000	150,000	50,000	75,000	50,000		45,000
1882–'83	300,000	200,000		450,000	400,000	25,000			
Total	510,000	250,000	127,000	1,050,000	633,000	310,000	125,000		104,000

Season.	California salmon.			Whitefish.		
	Eggs received.	Eggs shipped.	Fish hatched.	Eggs received.	Eggs shipped.	Fish hatched.
1874–'75	50,000		25,000	2,500,000		2,100,000
1875–'76	988,000		900,000	3,300,000		2,700,000
1876–'77	500,000		450,000	1,250,000	1,050,000	
1877–'78				1,500,000	1,300,000	
1878–'79	250,000		225,000	2,500,000	1,900,000	400,000
1879–'80				3,250,000	2,750,000	
1880–'81				13,780,000	3,200,000	9,000,000
1881–'82				22,500,000	1,910,000	17,500,000
1882–'83				70,000,000	10,800,000	50,000,000
Total	1,788,000		1,600,000	120,580,000	22,910,000	81,700,000

SKETCH OF THE PENOBSCOT SALMON-BREEDING ESTABLISHMENT.

By CHARLES G. ATKINS.

[Written by request of Prof. S. F. Baird, for the London Exhibition, 1883.]

The rivers of the United States tributary to the Atlantic, north of the Hudson, were, in their natural state, the resorts of the migratory salmon, *Salmo salar*, and most of them continued to support important fisheries for this species down to recent times. The occupation of the country by Europeans introduced a new set of antagonistic forces which began even in the seventeenth and eighteenth centuries to operate against the natural increase and maintenance of the salmon and other migratory fishes. In many localities the closing of smaller streams by dams, and the pursuit of the fish with nets and other implements, had already begun to tell on their number; but it was not until the present century that the industrial activities of the country began to seize upon the water power of the larger rivers and to interrupt in them by lofty dams the ascent of salmon to their principal spwning grounds. These forces were rapid in their operations, aided as they were by a greatly augmented demand for food from a rapidly increasing population. In 1865 the salmon fisheries were extinct in all but five or six of the thirty rivers known to have been originally inhabited by them. In many of these rivers the last salmon had been taken, and in others the occurrence of individual specimens was extremely rare. Among the exhausted rivers may be mentioned the Connecticut, 380 miles long; the Merrimack, 180 miles long; the Saco, 120 miles long; the Androscoggin, 220 miles long; and some twenty smaller rivers. There still survived salmon fisheries in the following rivers, namely, the Penobscot, the Kennebec, the Denny's, the East Machias, the Saint Croix, and the Aroostook, a tributary of the Saint John. The most productive of these was the Penobscot, yielding 5,000 to 10,000 salmon yearly. The Kennebec occasionally yielded 1,200 in a year, but generally much less. The other rivers were still less productive.

The movement for the re-establishment of these fisheries originated in action of the legislature of New Hampshire, seconded by that of the neighboring state of Massachusetts, having in view primarily the fisheries of the Merrimack and Connecticut Rivers. The course of the Merrimack lies wholly within the states of New Hampshire and Massachusetts; that of the Connecticut lies partly in the state of Connecticut, and many of its tributaries are in the state of Vermont. These two states were therefore early interested in the project, and their action soon led to similar exertions on the part of Rhode Island and Maine. Within the borders of the six states mentioned, collectively known as "New

England," are all of the rivers of the United States known to have been frequented by the sea-going *Salmo salar*, with the possible exception of certain rivers, tributary to the Saint Lawrence, in the northern part of New York.

The governments of these states having appointed boards of commissioners to whom was confided the task of restocking the exhausted rivers, other states, one after another, adopted like measures, and in 1872 the United States Government established a commission to inquire into the condition and needs of the fisheries in general, with authority to take steps for the propagation of food fishes.

The new England commissioners turned their attention at once to the two most important of their migratory fishes, the salmon and the shad. The utter extermination of salmon from most of their rivers compelled them to consider the best mode of introducing them from abroad.

Agents were sent to the rivers of Canada, where for several years they were permitted to take salmon from their spawning beds, and some hundreds of thousands of salmon eggs were thus obtained and hatched with a measure of success. After a few seasons permits for such operations were discontinued, and the only foreign source of supply thereafter remaining open to the states was found in the breeding establishments under control of the Canadian Government, and even these were practically closed by the high price at which the eggs were valued.

In 1870 it had become clear that to a continuation of efforts it was essential that a new supply of salmon ova should be discovered. Attention was now directed to the Penobscot River in the state of Maine, which, though very unproductive compared with Canadian rivers, might yet, perhaps, be made to yield the requisite quantity of spawn. A preliminary examination of the river brought out the following facts: The Penobscot is about 225 miles in length. The upper half of its course and nearly all of its principal tributaries lie in an uninhabited wilderness, and in this district are the breeding grounds of the salmon. The fisheries, however, are all on the lower part of the river and in the estuary into which it empties, Penobscot Bay. There was no means of knowing how great a proportion of the salmon entering this river succeeded in passing safely the traps and nets set to intercept them, but supposing half of them to escape capture there would still be but about 6,000 fish of both sexes scattered through the hundreds of miles of rivers and streams forming the headwaters of the Penobscot. It was very doubtful whether they would be congregated about any one spot in sufficient numbers to supply a breeding station, and it would be impracticable to occupy any widely extended part of the river, on account of the difficulties of communication. At the mouth of the river, on the other hand, the supply of adult salmon could be found with certainty, but they must be obtained from the ordinary salmon fisheries in June and held in durance until October or November, and the possibility of confining them without interfering seriously with the normal action of their reproductive functions was not yet established. The latter plan was finally adopted, and in 1871 the first attempt at this method of breeding salmon was instituted by the commissioners of Maine, Massachusetts, and Connecticut. The site fixed upon for an inclosure was at Craig's Pond Brook in the town of Orland, and arrangements for a supply of fish were made with two fishermen of Verona at the very mouth of the river.

The salmon first brought were confined in a newly constructed artificial pond in the brook, which was of such remarkable purity that a small coin could be distinctly seen at the depth of 7 feet. All of these died except a few which after a short stay were removed to other quarters. The most prominent symptom was the appearance of a white fungoid growth in patches upon the exterior of the fish. In a lake (locally designated as Craig's Pond) of equal purity, but greater depth, several of these diseased fish recovered. Of the salmon later obtained some were placed in an inclosure of nets in the edge of a natural pond with but 7 feet of water, of average purity, some in a shallow inclosure in a brook, and some turned loose in a natural lake of some 60 acres area, with muddy bottom and peat-colored water. In each case the salmon passed the summer with few losses, arrived at the breeding season in perfect health, and yielded at the proper time their normal amount of healthy spawn and milt, though the great sacrifice of breeding fish by the early experiments of the season reduced the crop of eggs to the small number of 72,000.

The conditions of success were thus sufficiently indicated, and in 1872 the same parties, joined with the United States Commission of Fisheries, renewed operations on a larger scale, locating their headquarters at the village of Bucksport, confining the breeding salmon in Spofford's Pond (Salmon Pond on the general map of Penobscot station), and establishing their hatchery on the brook formed by its overflow. This is the lake of 60 acres in which, as mentioned above, a few salmon had been successfully confined the year before. Though not at all such water as would be chosen by a salmon at large, it nevertheless proved well adapted to the purpose of an inclosure for the breeding fish. It was shallow, its greatest depth, at the season of highest water, being but 16 feet; at its upper end it abuts against an extensive swamp, and almost its entire bottom, except close to the shore, is composed of a deposit of soft, brown, peaty mud of unknown depth. The water is strongly colored with peaty solutions, has a muddy flavor, and under the rays of a summer sun becomes warmed to 70° (Fahrenheit) at the very bottom.* Yet in such a forbidding place as this, salmon passed the summer in perfect health. There were some losses, but every reason to believe them all to have been caused by injuries received prior to their inclosure. Du-

*During the month of August, 1872, the bottom temperature at 1 p. m. was never below 70°, and on six days was found to be 71°.

ring and after the hottest term of each summer (the month of August) very few died.

The supply of salmon was obtained mainly, as in 1871, from the weirs in the southern part of Verona. They were placed in cars, specially fitted for the purpose, and towed to Bucksport on the flood tide. From the river to the inclosure they were hauled on drays in wooden tanks 3 feet long, 2 feet wide and 2 feet deep, half a dozen at once. From the weirs to the boats and from the boats to the tanks they were dipped in great canvas bags. From all this handling but few losses ensued.

In the establishment at Bucksport village the work was carried on for four years, from 1872 to 1876, with a fair degree of success. Then ensued a suspension till 1879, when the reappearance of salmon in the Merrimack, Connecticut, and some other rivers renewed the hopes of final success, and encouraged the commissioners to reopen the station. It had, however, been found that the old location had serious defects. The inclosure was costly to maintain, and the recapture of the fish involved a great deal of labor and trouble. The water supplied to the hatchery was liable in seasons of little rain to be totally unfit, causing a premature weakening of the shell and very serious losses in transportation. After a careful search through the neighboring country it was found that the most promising site for an inclosure was in Dead Brook, near the village of Orland (though within the limits of the town of Bucksport), and for a hatchery no location was equal to Craig's Pond Brook, the spot where the original experiments were tried in 1871. The only serious drawback was the separation of the two by a distance of some 2 miles, which could not offset the positive advantage of the hatchery site. Accordingly the necessary leases were negotiated, an inclosure made in Dead Brook, and a stock of breeding salmon placed therein in June, 1879. Since then the work has been continued without interruption.

It is still found most convenient to obtain the stock of breeding salmon, as in the early years of the enterprise, from about a dozen weirs in the Penobscot River along the shores of the island of Verona. The fishermen are provided with dip-nets or bags with which to capture the fish in their weirs, with tanks or cars in which to transport them to the collecting headquarters, whither they are brought immediately after capturing, about low water. The collection is in the hands of a fisherman of experience, who receives the salmon as they are brought in, counts and examines them, adjudges their weight, and dispatches them in cars to the inclosure at Dead Brook. The cars are made out of the common fishing boats of the district, called dories, by providing them with grated openings, to allow of a free circulation of water in transit, and covering them with netting above to prevent the fish from escaping over the sides. The car is ballasted so that it will be mostly submerged. Ten to fifteen salmon are placed in a single car, and from one to four cars are taken in tow by a boat with two to four oarsmen. From the collecting headquarters to Orland village, a distance of about 5 miles, the route is in brackish water, and the tow is favored by the flood tide. At Orland is a dam which is surmounted by means of a lock, and thence, two miles further to Dead Brook, the route is through the tideless fresh water of Narramissic River. The sudden change from salt to fresh water does not appear to trouble the fish except when the weather is very hot and the fresh water is much the warmest. The cars are towed directly into the inclosure, where the fish are at once liberated.

The inclosure is formed by placing two substantial barriers of woodwork across the stream 2,200 feet apart. The lower barrier is provided with gates which swing open to admit boats. Within the inclosure the water is from 3 to 8 feet deep, the current very gentle, the bottom partly muddy, partly gravelly, supporting a dense growth of aquatic vegetation. The brook has two clean lakes at its source, and its water is purer than that of ordinary brooks.

The collection of salmon usually continues from the first ten days of June until the beginning of July. During the early weeks of their imprisonment the salmon are extremely active, swimming about and leaping often into the air. After that they become very quiet, lying in the deepest holes and rarely showing themselves. Early in October they begin to renew their activity, evidently excited by the reproductive functions. Preparations are now made for catching them by constructing traps at the upper barrier. If the brook is in ordinary volume, these means suffice to take nearly all, but a few linger in the deeper pools and must be swept out with seines. About October 25 the taking of spawn begins. After that date the fish are almost always ripe when they first come to hand, and in three weeks the work of spawning is substantially finished.

Although the salmon are taken from the fisherman without any attempt to distinguish between males and females, it is always found at the spawning season that the females are in excess, the average of four seasons being about 34 males to 66 females. This is a favorable circumstance, since the milt of a single male is fully equal to the impregnation of the ova of many females.

The experiment has several times been tried of marking the salmon after spawning and watching for their return in after years. After some experiments, the mode finally fixed upon as best was to attach a light platinum tag to the rear margin of the dorsal fin by means of a fine platinum wire. The tags were rolled very thin, cut about half an inch long and stamped with a steel die. The fish marked were dismissed in the month of November. Every time it was tried a considerable number of them was caught the ensuing spring, but with no essential change in their condition, indicating that they had not meanwhile visited their spawning grounds. In no case was a specimen caught in improved condition during the first season succeeding the marking. But the following year, in May and June, a few of them were taken in prime condition—none otherwise—and it several times occurred that female salmon were a second time committed to the inclosure and yielded a second litter of eggs. The growth of the salmon during their absence had been very considerable, there being always an increase in length and a gain of twenty-five to forty per cent. in weight. The conclusion seems unavoidable that the adult salmon do not enter the Penobscot for spawning oftener than once in two years.

The method of impregnation employed has alwaysbeen an imitation of the Russian method introduced into America in 1871. The eggs are first expressed into tin pans, milt is pressed upon them, and after they are thoroughly mixed together, water is added. The result has been excellent, the percentage of impregnated eggs rarely falling so low as 95.

After impregnation the eggs are transferred to the hatchery at Craig's Pond Brook, where they are developed, resting upon wire-cloth trays in wooden troughs, placed in tiers ten trays deep, to economize space, and at the same time secure a free horizontal circulation of water.

The hatchery is fitted up in the basement of an old mill, of which entire control has been obtained. The brook is one of exceptional purity, and a steep descent within a few feet of the hatchery enables us to secure at pleasure a fall of 50 feet or less. The brook formerly received the overflow of some copious springs within a few hundred feet of the hatchery, which so affected the temperature of the water that the eggs were brought to the shipping point early in December, an inconvenient date. This has been remedied by building a cement aqueduct 1,600 feet long, to a point on the brook above all the springs, which brings in a supply of very cold water.

The shipment of eggs is made in January, February, and March, when they are sent by express, packed in bog-moss, all over the northern States, with entire safety, even in the coldest weather.

In the following statement is embraced a general summary of the results of each season's work:

Year.	Salmon bought.	Females spawned.	Eggs obtained.	Eggs distributed.
1871–'72	111	11	72, 071	70, 500
1872–'73	692	225	1, 560, 000	1, 241, 800
1873–'74	650	279	2, 452, 638	2, 291, 175
1874–'75	601	343	3, 106, 479	2, 842, 977
1875–'76	460	237	2, 020, 000	1, 825, 000
1879–'80	264	19	211, 692	200, 500
1880–'81	522	227	1, 930, 561	1, 841, 500
1881–'82	513	232	2, 690, 500	2, 611, 500
1882–'83	560	256	2, 075, 000	2, 000, 000
Total	4, 373	1, 829	16, 148, 941	14, 924, 952

SKETCH OF THE SCHOODIC SALMON-BREEDING ESTABLISHMENT.

By CHARLES G. ATKINS.

[Written by request of Prof. S. F. Baird, for the London Exhibition, 1883.]

The salmon of the Schoodic lakes belongs to the group termed "land-locked" salmon, whose distinguishing trait is the absence of the habit of migrating to the sea. It has been regarded by naturalists until recently as a distinct species from the sea-going salmon (*Salmo salar*), but the most recent researches of American ichthyologists have led to the conclusion that there are no specific differences between the two. But whatever the verdict of systematic ichthyology, the marked difference between them in habits and growth must, from the fish-culturist's point of view, separate them as widely as any two species of the salmon family.

Doubtless the absence of the migratory instinct is at the bottom of most of the variations from the normal type of *Salmo salar* which the land-locked salmon exhibits. The lakes afford a far poorer feeding ground than the sea; hence, perhaps the diminutive size and leaner flesh of the land-locked salmon. Its lower tone of color, less permanent sexual marks, and greater liability to ovarian disease, as well as different habits of feeding, may perhaps be referable to the same general cause. There are some other peculiarities which are not so easily explained. For instance, the eggs of the land-locked salmon are very considerably larger than those of the sea salmon, and the same is true of the very young fry.

My observations on the young of the Sebago land-locked salmon lead me to think that their growth is more rapid than that of the anadromous salmon, for, among other things, I have seen specimens more than a foot long still bearing plainly on their sides dark, transverse bands characteristic of young salmon. But this may be explained in another way. It may be that the land-locked fish simply retain the marks of the immature stages to a later period of life. This view is supported by another fact that I have observed, namely, that the dark bands are never completely obliterated from the sides of the land-locked salmon, being always very distinct, even in adult specimens, on the under side of the skin, a phenomenon which I have sought for in vain among the migratory salmon.

The land-locked salmon, though smaller and leaner than his anadromous brother, is yet not a poor fish. His flesh is fat and rich and of a more delicate flavor. In game qualities he is, for his size, quite the peer of the larger salmon and affords keen sport to the fly fisherman.

He is, therefore, much sought after, taking, perhaps, in public favor the lead of all fresh-water species.

The natural range of the land-locked salmon in the United States is very much restricted. Leaving out of the question the salmon formerly frequenting the rivers tributary to the great lakes, Ontario and Champlain, the extent of whose migration is a matter of doubt, we find them only in four limited districts, all in the state of Maine, namely, the Presumpscot River in Cumberland and Oxford Counties, the Sebec (a tributary of the Penobscot) in Piscataquis County, the Union River, in Hancock County, and the Saint Croix, in Washington County. There are some minor differences between the fish of these several districts, of which, perhaps, that of size is the most notable. The Sebago and Union River fish are much larger on the average than those of the Sebec and Saint Croix. The Sebago salmon average at the spawning season 4 or 5 pounds weight for the males and a pound less for the female, while specimens of 12 and 14 pounds weight are not rare, and there is even on record one of 17½ pounds. The Union River fish are about the same size. The Saint Croix fish vary in the matter of weight in different parts of their range, but the average weight of either sex at Grand Lake Stream is a little less than three pounds. Specimens of over 6 pounds are rare, and none are on record of over 10 pounds.

Attempts have been made to collect eggs of land-locked Salmon in each of the four districts mentioned above, but it is found that in the Saint Croix district alone, and there only in the single locality of Grand Lake Stream, are they sufficiently abundant to yield a large stock of eggs. In 1873 the Commissioners of Fisheries of the United States, and of Massachusetts and Connecticut, founded an establishment at Sebec Lake, but after two years of effort it was found that the supply of fish was too small, and they determined to transfer the work to Grand Lake Stream.

The land-locked salmon of the Saint Croix, though originally well distributed through the lakes tributary to that river and still inhabiting a great many of them, finds in some a much more congenial home than in others, and Grand Lake, on the west branch, or Schoodic River, is of all these waters their favorite abode. This body of water is of irregular shape, about 12 miles in length and 4 in extreme breadth, fed almost wholly by short streams that form the outlets of other lakes, and from this cause as well as from the fact that it drains a gravelly country and is girt with clean, rocky shores, it is one of the purest of the lakes of Maine. Its greatest depth is believed to be a little over 100 feet. Its outlet is Grand Lake Stream, a shallow, rapid, gravelly stream, about 3 miles long, to which the salmon resort in October and November to deposit their eggs. Comparatively few of the salmon of this lake resort to the stream tributary to it.

Of necessity the operations with land-locked salmon are conducted in a very different manner from those with migratory salmon. Being at home in fresh water and having there their feeding grounds they continue to feed until the close approach of the spawning time, and hence they could not be penned up in the summer without some provision for an artificial supply of food, which would probably involve a great deal of expense and trouble. Moreover, the necessity of collecting breeding fish early in the summer does not exist, because they are at no time more congregated and easy to catch than at the spawning season.

The capture of the fish is easily effected by stretching a net across the outlet of the lake and leading them through a tunnel-formed passage into an inclosure of netting. There happens to be at this point a wide surface of smooth bottom, with water from 1 to 3 feet deep, affording an excellent site for spacious inclosures not only for entrapping but for assorting and storing the salmon during the spawning season. Nets are generally stretched across the stream (to keep the fish back in the lake) immediately after the beginning of the close season, September 15. The very earliest of them begin to spawn before the end of October, but the actual inclosing of the breeding stock is deferred until the early days of November. The taking of spawn generally begins about November 6, and continues for two or three weeks. Commonly by November 20 or 22 this work is completed, and the breeders are carried a mile or two up the lake and liberated.

The method of manipulation is the same employed at the Penobscot station, and is not supposed to differ materially from that adopted by all American breeders of Salmonidæ. The results in the impregnation of the spawn are not so uniformly satisfactory as at the Penobscot station. There appears to be a greater prevalence of ovarian disease than among the migratory salmon. The occurrence of white eggs among the normally colored and healthy ones, as they are yielded by the fish, is very common, and occasionally the entire litter is found to be defective. It is not improbable that there are some eggs that are incapable of impregnation, though exhibiting no visible symptoms of disease. However, the general result is satisfactory, the ratio of impregnated eggs being from 93 to 95 per centum.

The facilities for developing and hatching the eggs are rather poor. No good site could be found by the side of the stream, no suitable brook could be found near enough to the fishing grounds, and the neighboring springs lacked either volume or facilities for utilization. At present there are three hatcheries in use, two of them using spring water exclusively and one of them lake or stream water exclusively. The lake water would be preferred, but unfortunately it can only be used for the slow development of part of the eggs, circumstances connected with the floating of timber down the stream compelling the evacuation of that hatchery in March. The main hatchery is very favorably located and served, except that the water is all spring water, and this unfavorable circumstance is well counterbalanced by the facilities for aëration, which are very good and very fully employed. The eggs are placed upon wire-cloth trays in stacks or tiers, ten deep, and arranged for a free horizontal movement of the water.

Of the eggs here obtained three-quarters are shipped away to the order of the parties supporting the establishment; the remaining quarter is hatched out and the young salmon liberated in the lake, to keep up the stock of fish. The shipments are made in January, February, March, and sometimes April. The eggs hatched are selected from those that have been retarded in development, and they reach the age for liberation in June, when their natural food is believed to be abundant.

The following statement shows the work accomplished each year since the organization of the establishment at Grand Lake Stream:

Year.	Salmon caught.			Eggs obtained.	Eggs distributed.
	Males.	Females.	Total.*		
1875–'76	1,055	1,571	2,628	1,077,500	933,000
1876–'77	272	749	1,021	543,000	460,000
1877–'78	1,776	2,372	4,151	2,159,000	1,970,000
1878–'79	1,122	1,785	2,908	1,723,000	1,470,000
1879–'80	938	1,084	2,022	1,113,456	992,000
1880–'81	698	1,473	2,171	2,326,740	2,068,500
1881–'82	370†	652	1,022	947,000	860,000
1882–'83	600	1,004	1,604	1,600,000	1,496,000
	6,831	10,690	17,527	11,489,696	10,249,500

*Including some whose sex was unknown. †Estimate.

TRANSPORTING CARP FROM THE UNITED STATES FISH COMMISSION TO BRAZIL.

By J. W. COUCHMAN.

[Letter to Prof. S. F. Baird.]

It is with pleasure I report the safe arrival of thirteen beautiful specimens of the survival of the fittest out of the one hundred carp which were shipped to me from New York by steamer Borghese. They were thirty-nine days at sea. The greater portion of them died before the steamer reached St. Thomas. None died during the last ten days of voyage. Your instructions for keeping them were not carefully observed. The person who had them in charge fed them on hard-boiled eggs. If it would afford you any pleasure I will be glad to give you a report of them from time to time.

RIO DE JANEIRO, BRAZIL, RUA DO OUVIDOR No. 130,

January 6, 1883.

ON THE MODE OF FIXATION OF THE FRY OF THE OYSTER.

By JOHN A. RYDER.

During the past season five American investigators have been engaged in the investigation of the question of the feasibility of rearing *Ostrea virginica* from its eggs. Of these, Dr. Brooks, Lieut. Francis Winslow, and Henry J. Rice, have not yet, as far as I am aware, published anything upon what they have done. Col. Marshall McDonald and the writer were engaged, during a part of the months of July and August last, with the investigation, in the United States Fish Commission station at Saint Jerome's Creek, Maryland. The most remarkable result which Colonel McDonald and myself obtained, with an apparatus devised by the former, was the apparent fixation of the fry to the sides of the glass hatching-vessels twenty-four hours after impregnation. We found in a temperature of 73° to 80° Fahr., that they would develop a larval shell in this short space of time, but were surprised to find the young apparently fixed in such numbers to the sides of the glass hatching-vessels. How they were attached we failed to learn; whether by means of a byssus or not could not certainly be determined. They were found fixed so firmly, however, that they could be removed only by force, such as scraping the clean, dead oyster shells upon which they had lodged in the apparatus. Holding the shells upon which the fry had caught under a strong stream of water from a faucet failed to dislodge them. Our conclusion was, in view of the foregoing facts, that these young embryos had voluntarily attached themselves. It was noticed that this young fry had a disposition to lie upon the side, with the border of the rudimentary mantle projecting over the border of the shell. Many were noticed in other positions, but I am inclined to believe that these were not normal, as will appear further on. The projecting border of the mantle, as it appeared to the writer, is probably the organ by which the adhesion of the embryo is effected—in fact, we will learn further on that this flatwise position of the fry is assumed at the time of fixation. Unfortunately for us, our endeavors to repeat our first successful experiment, which had given us such a remarkable result, invariably ended in failure, although we had taken the precaution to vary again and again the character of the apparatus to meet what were supposed to be unfavorable and fatal conditions. Several other forms of apparatus were used, which worked so unsuccessfully that their use was discontinued, including the air-blast playing upon the surface of the water in the hatching-vessels, upon which I had largely built my hopes last year.

The fixed embryos or fry alluded to above did not grow any during the three days which we were permitted to observe them, both in a continuous current and in a closed or interrupted circulation of water. Putrescence or the development of deleterious organisms did not, I believe, interfere with our experiments. At all events, they remained of about the same size as the eggs with which we started, although food was already perceptible in the stomach rotating under the impulse of the cilia which lined the gastric cavity. They had the power to retract the velum and mantle, but not wholly. The pallial and velar muscles were therefore developed as well as the adductor, which could be seen to actuate the valves. That these embryos were developed from the eggs put into our apparatus there could not be the slightest doubt, since the sea-water used was first carefully filtered through a large dense mass of cotton wool to remove impurities and small, hurtful organisms, and no additional water from the open bay was afterwards introduced.

The deflected border of the mantle in this fry seems to me an important fact in its bearing upon the manner in which the fixation of the young animal is accomplished. Though it is true there was as yet no umbo developed upon the shells of these larvæ, such as may be seen when the larval shell measures from an eightieth to a ninetieth of an inch in diameter, yet the hinge-line was straight as if the shell at this point was truncated. In the last stage of development of the larval shell, which I shall call the *umbo stage*, this apparent truncation disappears, the umbos projecting somewhat past the level of the hinge, which is still approximately straight and without teeth, contrary to the statement of Lacaze-Duthiers. Immediately following the umbo stage, the larval shell is converted into the spat, the valves of the latter growing outwards from the borders of the valves of the fry shell, or, rather, speaking more correctly, the calcareous deposits which are laid down by the young developing bivalve project past the free edges of the valves more and more, and immediately thereupon exhibit a prismatic arrangement of the shelly substance wholly different from that seen in the fry, which is laminar, homogeneous, and not prismatic. The fry shell is perfectly symmetrical and very convex up to the time when it is converted into that of the spat, which is at once developed in an unsymmetrical manner, but at first tends to simulate the rounded outline of the fry, except at the hinge, where no lateral growth of shelly matter takes place. As growth of the spat goes on, and in fact from the very first, the hinge of the fry shell is inclined slightly upward, the fixation evidently having taken place at its edge.

This I regard as the most important step which I have made in developing the history of the shell, and it is probable that in it we have a clew to the manner in which the young oyster becomes fixed to stationary objects. It is important to note in this connection that the whole of the lower surface of the under valve of the young oyster is at first firmly attached by an organic cement. So firm is this substance that the young shell can rarely be removed from its attachment without breaking the lower valve. The substance which effects this attachment is without doubt the organic matrix of the shell, viz, the so-called conchioline of the external horny covering, epidermis, or periostracum. The lower valve of the spat when growing on a flat surface may continue to adhere throughout the whole extent of its under surface, until it is nearly 2 inches in diameter, before its edge, together with that of the upper valve begins to bend upwards and become free. This attachment is effected very early, as I have met with it in spat a little over an eightieth of an inch in diameter. When it is twice this size it is scarcely possible to remove the young oyster entire from its attachment without first breaking loose with it a little flake of the object upon which it rests. When the lower valve of the fry shell is examined under a microscope it is found that a faint groove runs around its border, beyond which it is abruptly continued into the shell of the spat. This groove is perhaps more pronounced on the lower valve than on the upper, and marks the point of transition from the very convex ventricose valves of the fry to the depressed or flattened valves of the spat or fixed stage of development. These facts indicate most conclusively the means by which the final fixation is effected, viz, by cementing itself to some stationary object by means of a deposit of conchioline from the mantle border upon which the animal continued to deposit layers of calcic carbonate. This does not, it may be remarked, dispose of the possible existence of a temporary or larval byssus and byssal gland, which, by the way, no embryologist appears to have observed up to the present time at least; but, as already remarked, our failure to find such a structure with special adaptations of the microscope, in the apparently attached fry in our aquaria now renders its existence somewhat doubtful. We have already alluded to the fact that the mantle border of the fry is deflected outwards over the edge of the lower valve before the formation of any trace of the spat shell. This is shown in Fig. 1 in the plate appended to this article. It may be that a byssal organ is developed to effect the first stage of adhesion prior to the deposition of the horny cementing material which ministers to the permanent fixation of the spat.

The further development of the spat shell is interesting in that the deposit of lime is continued mainly from the free borders of the valves and not from the hinge margin, as may be gathered from Figs. 4, 5, 6, 7, 8 and 9 of the accompanying plate. It will also be noticed that the beak or umbo of the fry shell has a constant direction in all of the figures, showing that the dorsal and ventral margins of the animal, even at this stage, are constant in position; that the lower fry shell very uniformly represents the rudiment of the left valve of the adult. At the hinge margin the development of shelly matter is interrupted, as shown by the figures. In fact, the valves of the spat are at first truncated on a line with the hinge of the fry shell, and as the shelly deposit is continued outwards alæ are developed, as shown in the figures, which remind one of the lateral hinge processes in *Pecten* or the scallop. The hinge border of the spat is at first somewhat bent upwards, as may be seen in Fig. 9, which is a side view of Fig. 8. This is also shown in Figs. 5, 6 and 7, and is in conformity with the slightly upward inclination of the hinge end of the fry shell. It results from this that the hinge border of the newly fixed fry is at first free. To sum up, we find that the fry of the oyster is at first permanently fixed by a pallial secretion, probably conchioline, at the border of its valves, with the hinge end inclined upwards, and the free border of the lower valve in fixed contact with some foreign object, as shown in the annexed figures, and that the hinge end of the spat is free for some time, the whole of the rest of the under surface of the lower valve being cemented fast with conchioline. This marginal adhesion of the lower valves is well shown in Figs. 5, 6, and 7. The material from which I have obtained my figures was mainly obtained in August last, adherent to old oysters in the vicinity of Saint Jerome's Creek, Maryland. Most of the specimens, even the oldest, which I have figured, had probably not been attached quite a week; in fact, some of them had evidently only just begun to develop the spat shell. Fig. 2 is taken from a preparation of the brood *Ostrea edulis*, which was presented to me by Mr. W. H. Walmsley.

U. S. FISH COMMISSION, *December* 8, 1882.

EXPLANATION OF PLATE.

FIG. 1. Young American oyster, two days old, adherent to side of the McDonald apparatus, June 24, 1882. Viewed from the side, showing the projecting velum *v* and mantle border *m* magnified 183 times.

FIG. 2. Four shells of the fry of *Ostrea edulis*, showing their form and variable size when taken from the beard of the parent. Magnified 96 times.

FIG. 3. Young American oyster on the eve of becoming converted into the spat, having just become firmly attached during the last larval or umbo stage. Magnified 96 times.

FIG. 4. Young spat of the American oyster shortly after its transformation into the spat, viewed as a transparent object, showing the fry shells in the umbo stage and the prismatic structure of the spat shell growing from the edges of the former. The upper and lower valves are shown slightly displaced. Magnified 96 times.

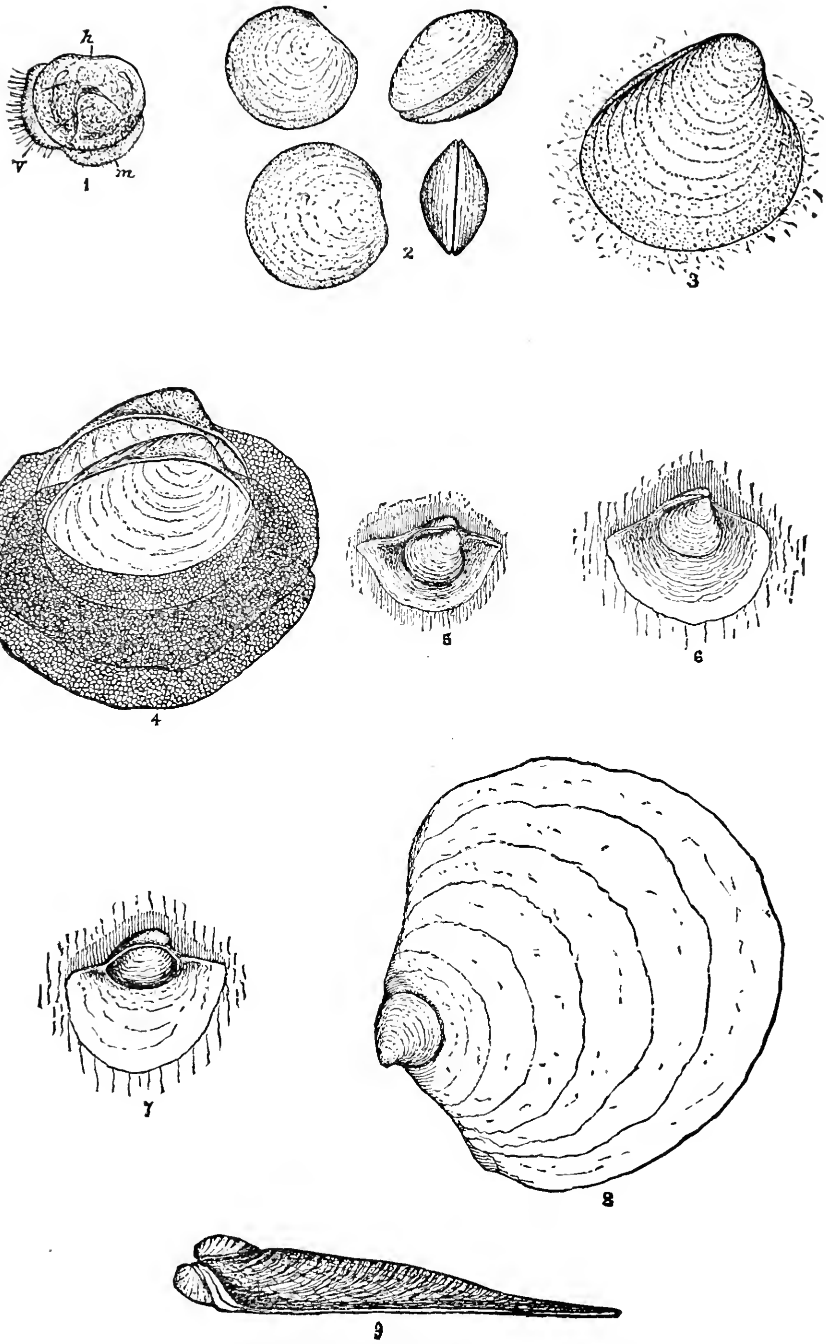
FIG. 5. Young spat of the American oyster showing the manner of the attachment of its lower valve with the downwardly bent lateral alæ of the hinge and margin of the lower valve. Magnified 35 times.

FIG. 6. Young spat of the American oyster a little older than the preceding, magnified to the same extent.

FIG. 7. Lower valve of another specimen of the young spat of the American oyster, to show the great convexity of the lower valve of the fry shell and its abrupt transition into that of the spat shell. Like Figs. 5 and 6 this specimen was drawn *in situ* from the old shell to which it was attached. Magnified 35 times.

FIG. 8. Much older spat of American oyster detached and viewed from the lower side to show the groove of the margin of the fry shell where that of the spat begins to be formed. Magnified 35 times.

FIG. 9. The preceding viewed from the edge to show the depressed form of the spat shell, its flat under valve, the inclined hinge border, the inclined and convex fry shells and slightly convex upper valve of the spat. Magnified 35 times.



Rad nat. del.

DESCRIPTION OF THE UNITED STATES FISH HATCHERY AT ALPENA, MICHIGAN.

By FRANK N. CLARK.

[Written by request of Prof. S. F. Baird, for the London Exhibition, 1883.]

This hatchery was built in the fall of 1882. It is a one-story frame building, 30 feet wide by 60 feet long, having front and rear entrances, and amply lighted by fourteen windows. The main floor includes the hatching room, and an office and sleeping apartment 10 feet wide by 18 long. The space between this office and the opposite side is conveniently utilized for storage of tools, cans, egg-cases, &c. The hatchery is arranged and equipped with especial reference to the manipulation of the embryos and minnows of white-fish (*Coregonus clupeiformis*), the most valuable commercial species of the Great Lakes. Its nominal capacity is 100,000,000 eggs.

The water is furnished by the Holly Water Works Company, of Alpena, being forced through wooden mains from Thunder Bay, an arm of Lake Huron. A 2-inch stream, under an average pressure of 20 pounds to the square inch, connects with the hatchery, the discharge being regulated by globe valves and ball cocks. The inlet pipe is laid underneath the building, near the front, and is tapped by four perpendicular arms, each dicharging into the top tank of one of the four systems of tanks for supplying water to the hatching apparatus. Each system comprises a series of four rows of tanks, one row above the other. There are two tanks to each row, making eight tanks in the series, or thirty-two in all, each of which is 15 feet long by 12 inches wide, and 10 inches deep. One series is the exact counterpart of another. A row of faucets on either side of the top tank, into which the water first enters, supplies two rows of hatching jars, or incubators, which stand on shelves placed across the second tank below and discharge into the tank between, which, in turn, feeds a second series of jars, and so on. In this way the four rows of a series operate three double rows of jars, the water being used three times over. Overflows are provided at the ends of the tanks, which discharge into the next below.

Each of these series of reservoirs is connected with larger tanks, into which the minnows are carried by the current as soon as hatched.

The outflow openings of the tanks for the reception of the minnows are protected by finely perforated tin boxes of sufficient dimensions to keep the little fish away from the vortex formed by the escaping fluid, where they would be liable to injury from the strong current. There are ten of these receiving tanks, with an aggregate capacity of 7,000 gallons.

INDUCEMENTS OFFERED FISHERMEN TO FURNISH SHAD EGGS FOR THE UNITED STATES COMMISSION OF FISH AND FISHERIES.

By SPENCER F. BAIRD, COMMISSIONER.

The co-operation of all fishermen is cordially invited in this effort to increase the supply of shad.

A liberal price will be paid to all gillers, pound net, and seine fishermen for eggs of the shad taken according to these instructions, and delivered on board the steamers of the Commission in their daily trips; by waving the hat or other signal the steamers will run down to the boats or land at the shores:

The necessary pans, trays, dippers, etc., will be furnished to responsible parties by application to the Armory Building, Washington, D. C., or on board the steamers. They must be returned or accounted for at the end of the season.

The accounts of each man will be kept separately, and the eggs measured at Washington by competent persons employed by the U. S. Fish Commission for that purpose.

HOW TO STRIP SHAD.

As soon as the shad are taken in the nets or seines, those which are ripe or soft should be selected, taking up the shad one by one. If ripe, the eggs will flow freely from the shad when a gentle pressure is applied to the belly of the fish; if unripe, the eggs will not flow at all; if the eggs are only nearly ready they will come forth with difficulty, in masses; such fish should not be taken.

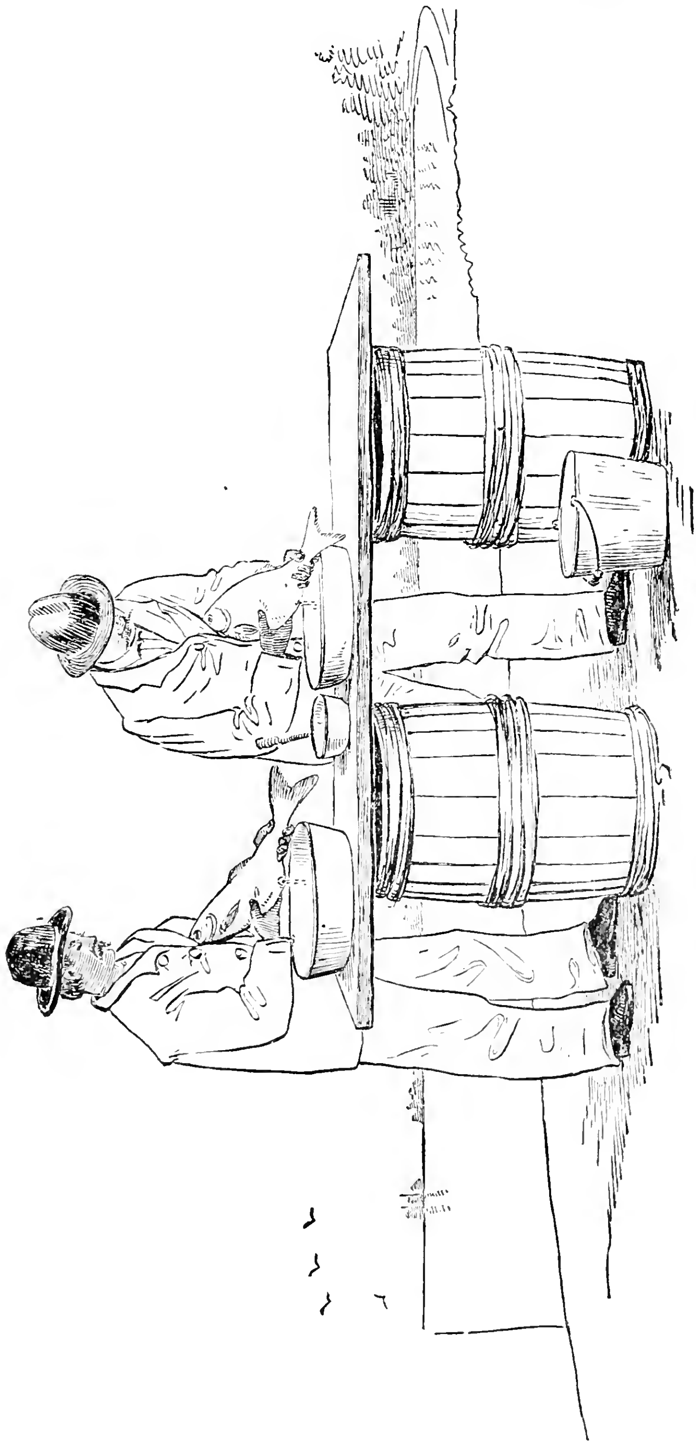
A short time before the shad spawns, clear eggs of large size will be found in the roe, while the rest is still hard; these become more and more numerous; after a time they separate and fall apart, a liquid stream of eggs flowing from the fish with the slightest pressure; unripe eggs will not flow at all.

Each person who takes the eggs should be provided with a tin pail, a pan, and a dipper.

The milter, or male shad, is rather smaller than the female; the sex will be known by the flow of milt from the fish. A very small quantity of milt will impregnate a large number of eggs; about one male in good condition to two or three females.

The *spawner*, or *female shad*, is easily known by its size and full appearance.

When a female is found from which the eggs flow freely when a gentle pressure is applied, *take the fish carefully in the hands, grasping it with the left hand close around the tail, the head of the fish being crowded closely against the body of the person, while with the thumb and forefinger of the right hand apply a slight pressure to the belly of the fish.* (See sketch.) *A*



stripping movement is executed which causes the eggs to flow rapidly into the pan, which should be clean and without water. When all the spawn is taken it will be shown by the blood appearing among the eggs. Take two or three females in this manner, then pick out a male, handle him in the same way, forcing out two or three jets of milt upon the eggs, swaying the pan gently to and fro; a little water should be added from time to time until the eggs rise, which will be in the course of half an hour; the scales and blood must be rinsed off. After they are impregnated, the eggs will be seen to have increased in size; WHEN *they have risen they can either be put on the trays or else kept in the pan.* Eggs taken at different times must be kept in separate vessels.

To put the eggs on the trays.—Wet the cotton cloth, spread it out smoothly over the tray, and pour the eggs carefully upon it, not more than two layers deep; by keeping the cloth moistened from time to time, eggs can be kept in good condition for twenty-four hours.

When eggs are kept in the pans they should be filled with water, which ought to be changed at least once every hour; *the water should be poured in on the side of the pan in order not to injure the eggs.*

In stripping fish many scales will come off and fall into the pan unless great care is taken. The scales should be gathered and thrown away by a quick movement of the hand, otherwise the eggs will become attached to them.

All eggs should be as clean as possible, and free from dirt, blood, or scales; they should be kept free from exposure or violent shocks.

Bad eggs will float on top; they are white, being called water-blown; they should be gathered and thrown away.

Good eggs will be clear and like crystal in appearance; when they have risen they will feel like shot to the hand if they are gently stirred.

Sometimes eggs assume this appearance when they are not properly impregnated. In such cases they are worthless and will not hatch. It is, therefore, impracticable to determine with certainty that eggs are properly impregnated until development has advanced somewhat, and the formation of the fish is discernible in the egg.

The utmost pains must be taken to keep the fish from slipping out of the hands, or they will fall into the pan, throw a large number of the eggs out, and damage the rest.

GROWTH, SPAWNING, AND DISTRIBUTION OF GERMAN CARP REARED FROM 20 FISH FURNISHED BY THE UNITED STATES FISH COMMISSION, NOVEMBER 29, 1880.

By KEMP GAINES.

[From letter to Prof. S. F. Baird.]

My fish did not increase any until the past summer [1882]. During the summer and fall I have furnished young Carp for stocking twenty-three ponds with from two to five dozen fish to each pond. I have kept over three hundred for stocking two ponds of my own which I constructed the past summer. When I drained my pond this fall I found that I had lost but one of the fish received from you, having nineteen old fish living and weighing from 4 to 6 pounds each. About one-third of the young fish hatched last spring and summer were from 6 to 7 inches long. By feeding them regularly they will grow much larger in the same length of time. I let one of my neighbors have forty-eight young fish from 2 to 4 inches inches in length, on the 20th of July, 1882. He fed them scraps from the table most every day. The 1st of November he drained his pond to stop a leak in the embankment and took the fish out. I was present and measured several myself. None were less than 8 inches, and many of them 12 inches long.

Sixteen applicants who did not get their ponds ready this fall expect to stock them next summer. If I still have good luck I think I will be able to fill all applications I may get another year. I have separated my scale and leather Carp, thinking they will do better.

SPRINGFIELD, CLARK COUNTY, OHIO,
December 11, 1882.

RAISING BROOK TROUT IN MINERAL WATER.

By CHARLES A. WILSON, M. D.

[From letter to Prof. S. F. Baird.]

Mr. P. S. O'Rourk, superintendent of the Grand Rapids and Indiana Railroad, has succeeded in raising a nice lot of brook trout here in a pond of his make from the mineral water that we use in our bathing department, and it is wonderful how they have grown. They were put in the pond last June not one-eighth of an inch long; now some of them are eight inches long, and will spawn this winter.

SPRING BEACH HOTEL AND SANITARIUM,
ROME CITY, NOBLE COUNTY, IND.,
December 1, 1882.

A GEOGRAPHICAL CATALOGUE OF PERSONS WHO HAVE STATED THAT THEY ARE INTERESTED IN FISH CULTURE.

By CHAS. W. SMILEY.

In the report of the United States Commissioner of Fish and Fisheries for 1872-'73 there was published an "Alphabetical List of American Fish-culturists and of persons known as being interested in Fish culture" (p. 558). That list, consisting of about 325 names, contained a fair representation of the fish-culturists of that day as known to the Commission. It was then stated that the list would be subsequently revised, but opportunity did not present itself for such revision until 1881. During that year and the succeeding year a circular was sent to each person whose name appeared in the old list and to each of the members of the American Fish-cultural Association. All were asked to furnish the names of other fish-culturists known to them. The latter were in turn addressed with the same circular, and the list which is now published has been elaborated in that way. Some 1,200 or 1,500 persons have been reported as interested in fish-culture who have not replied to these circulars; the following list, however, contains only the names of such as have been heard from direct.

Although it contains about 3,200 names, the list is by no means a complete one of the persons in the United States who are practically interested in fish-culture. All whose names are presented either have ponds or hatcheries, or have contributed to the literature of the subject, or have taken an actual interest in the stocking of public waters. The date affixed to each name denotes the year since which each correspondent, according to his own statement, has been interested in the subject. The letter P attached to the year indicates those who reported that they owned or leased ponds or lakes, and the letter H those who have in the past operated, or are now operating, hatcheries.

It is intended to supplement this list in the Bulletin for next year by printing the list of persons who, having carp ponds, have actually made application to the United States Fish Commission for carp. Only a few such persons are mentioned in the present list.

From the magnitude of this list and from the fact that it can easily be trebled may be seen something of the deep and widespread interest which has been awakened in fish-culture during the past decade.

Acknowledgment is hereby made of the kindness of all these persons in responding to the inquiries of the Commission. Many of them have given interesting information concerning the progress of fish-culture in their vicinities, which will in due time be collated and published. Acknowledgment is also made of the clerical assistance of Mr. E. H. Wilson, Mr. C. W. Scudder, and Mr. C. E. Latimer, each of whom has shown a commendable interest in securing for it the high degree of accuracy desired by the compiler.

Geographical catalogue of fish-culturists.

ALABAMA.

Name.	Post-office.	County.	Year.
Charles S. G. Doster	Prattville	Autauga	1870
A. K. McWilliams	do	do	P. 1875
John R. Barr	Batesville	Barbour	P. 1876
William N. Reeves	Eufaula	do	P. 1877
J. J. Cade	Harris	do	P. 1878
William B. Cope	Indian Creek	Bullock	P. 1880
W. T. G. Cobb	Midway	do	P. 1879
James M. Feagin	do	do	P. 1878
Robert G. Hall	do	do	P. 1876
Charles McMillan	do	do	P. 1875
Alvin H. Pruett	do	do	P. 1876
Andrew Johnson Smith	do	do	P. 1875
William C. Smith	do	do	P. 1873
John J. Taylor	do	do	P. 1880
John J. Thornton	do	do	P. 1878
Daniel Moore	Mount Hilliard	do	P. 1867
P. H. Coleman	Union Springs	do	P. 1871
George C. Morgan	Germania	Calhoun	P. (1881)
J. W. Burke	Jacksonville	do	P.
James M. Mangham	Sandy Creek	Chambers	P. 1869
Henry W. Williamson	do	do	P. 1875
E. H. Floyd	Tuckersburgh	do	P. 1874
James Arrington	Tecumseh	Cherokee	P.
M. L. Moyer	do	do	P. 1876
Willard Warner	do	do	1881
J. P. Van Derveer	Clear Creek	Chilton	P. 1877
A. J. Brooks	Verbena	do	P. 1878
John W. Hughes	do	do	P. 1872
James Hamrick	Isney	Choctaw	P. 1874
William G. Preston, jr	Rocky Mount	Clay	(1881)
T. J. Smith	do	do	(1881)
J. H. Neighbors	Hanover	Coosa	P. 1880
T. L. Quillian, M. D	Honoraville	Crenshaw	P. 1879
R. H. Stallings	do	do	P. 1877
Alexander Cauthon	Panola	do	P. 1870
John N. Cowan	Pleasant Hill	Dallas	P. 1876
S. W. Arnold	Clear Spring	Etowah	P. 1877
John C. Moore	Fayette	Fayette	(1828)
Robert B. Dunlap	Boligee	Greene	P. 1876
Greene B. Mobley	Eutaw	do	P. 1876
Walton N. Glover	Forkland	do	P. 1863
Harrison Lassiter	do	do	P.
W. J. Doswell	Abbeville	Henry	P. 1875
H. G. Peterman	Shorterville	do	P. 1878
William Gesner	Birmingham	Jefferson	P. 1850
J. W. Bass	Cedar Grove	do	P. 1850
J. M. Franklin	Trussville	do	P. (1881)
Dr. James W. Stewart	Florence	Lauderdale	P. 1878
Calvin Presley	Gold Hill	Lee	P. 1870
W. P. Spratling	do	do	P. 1871
W. B. Tucker	Opelika	do	P. 1874
Mrs. Mary E. Scott	do	do	P. 1871
Arthur Yonge	Yongesborough	do	P. 1877
John W. Bridgforth	Athens	Limestone	P. 1877
Thomas J. Cox	do	do	1858
W. W. Phillips	Elkmont	do	P. 1873
W. B. Arbery & Bro	Notasulga	Macon	P.
Thomas S. Carson	Clay Hill	Marengo	P. 1876
G. E. Jones	Dixon's Mills	do	1876
Mulford Dorlon	Bayou Labatre	Mobile	(1874)
Isaac Donavan	Mobile	do	P. 1866
W. W. McMillan	Glendale	Monroe	P. 1870
John W. Leslie	Monroeville	do	(1880)
Thomas Doron	Montgomery	Montgomery	1875
Albert Elmore	do	do	P. 1860
W. S. Reese	do	do	1875
John A. Lile	Trinity Station	Morgan	P. 1879
Mrs. S. E. Peck	do	do	P. 1873
James J. Gardner	Franconia	Pickens	P. 1876
B. T. Jones, M. D	Stone	do	P. 1877
J. C. H. Jones, M. D	do	do	P. 1875
E. Y. Lawrence	Olustee Creek	Pike	P. 1876
James P. Nall	Troy	do	H. P. 1875
W. A. Moses	Omaha	Randolph	P. 1878
James T. Nuckolls	Fort Mitchell	Russell	P.
Rowell W. Shaw	Cuba Station	Sumter	P. 1879
C. B. Cook	Sherman	do	P.
Marcus Parker	York Station	do	P. 1879
Dr. A. F. M. Garrett	Camp Hill	Tallapoosa	P. 1868
R. R. Spinks	do	do	P. 1871

Geographical catalogue of fish-culturists—Continued.

ARIZONA.

Name.	Post-office.	County.	Year.
Richard Rule	Tombstone	Cochise	1876
Joriah Wood	Phœnix	Maricopa	P. 1881
Fritz L. Brill	Wickenburgh	do	P. 1881
John H. Pierson, M. D	Antelope Valley	Yavapai	P. 1878
John J. Gosper	Prescott	do	1880

ARKANSAS.

Name.	Post-office.	County.	Year.
Gen. N. B. Pearce	Osage Mills	Benton	P. 1874
Jesse Turner	Van Buren	Crawford	1876
S. J. Matthews	Monticello	Drew	P. 1878
W. T. Wells	do	do	P. 1870
Col. James P. King	Mulberry	Franklin	1875
James T. Stuart	do	do	1876
William I. Darby, jr	Galloway	Pulaski	P. 1879
R. M. Scruggs	do	do	P. 1878
William N. Young	do	do	P.
Gilbert Knapp	Little Rock	do	P. 1870
Col. H. H. Rottaken	do	do	P. 1860
C. L. McRae	Mount Holly	Union	P. 1870

CALIFORNIA.

Name.	Post-office.	County.	Year.
J. D. Farwell	Alameda	Alameda	P. 1872
B. B. Porter	do	do	H.P.1872
Capt. James Barron	Alvarado	do	H.P.1877
A. Chabot	Oakland	do	P. 1878
John G. Woodbury	San Leandro	do	1871
B. D. Rodman	Bangor	Butte	P. 1879
N. W. Slater	Enterprise	do	P. 1881
James K. Vail	Forbestown	do	1880
J. C. Scripture	Big Trees	Calaveras	P. 1871
W. V. Clark	Railroad Flat	do	P. 1875
A. M. Sanderson	do	do	P. 1874
Fred. Greve	West Point	do	P. 1879
W. J. Clarke	College City	Colusa	P. 1874
Simon Davis	do	do	P. 1879
Judge F. L. Hatch	Colusa	do	1870
Julius Weyand	Little Stony	do	P. 1880
Mrs. Dora T. Purkitt	Willow	do	P. 1875
L. L. Robinson	Antioch	Contra Costa	P. 1878
Andrew Jackson	King's River	Fresno	P. 1877
James E. Still	Eureka	Humboldt	P. 1879
Jasper C. Palmer	Lower Lake	Lake	P. 1881
Rufus K. Robison	do	do	P. 1880
Schwartz & Weber	Middletown	do	P. 1878
H. C. Stockton	Susanville	Lassen	P. 1878
William Dow	do	do	1879
T. B. Sanders	do	do	1878
A. W. Worm	do	do	P. 1879
John W. Myers	Elizabeth Lake	Los Angeles	1879
George W. Grinter	Bolinas	Marin	P. 1875
J. D. Carr	Salinas	Monterey	1874
George Pomeroy	do	do	P. 1879
J. W. Seigh	do	do	1874
C. H. Holmes	Calistoga (Kellogg's)	Napa	H.P.1880
Thomas H. Reynolds	Calistoga	do	P. 1875
Steele Brothers	do	do	P. 1877
Charles Barker	Grass Valley	Nevada	P. 1878
Rev. J. W. Brier & Son	do	do	P. 1877
P. G. Bonivert	do	do	P. 1880
Samuel H. Dille	do	do	P. 1880
Gale A. Compton	do	do	P. 1878
Henry B. Nichols	do	do	P. 1880
Joseph Perrin	do	do	P. 1879
John T. Rodda	do	do	P. 1879
John L. Smith	do	do	P. 1877
Cornelius Taylor	do	do	P. 1878
W. H. Totten	do	do	P. 1880
S. R. Wilder	do	do	P. 1881
William Wagner	Buck's Ranch	Plumas	1862
Henry Landt	Prattville	do	H.P.1875
Owen Thomas Davies	Brighton	Sacramento	P. 1876

Geographical catalogue of fish-culturists—Continued.

CALIFORNIA—Continued.

Name.	Post-office.	County.	Year.
Samuel G. Foster	Brighton	Sacramento	P. 1875
Scipio Cragg	Colton	San Bernardino	(1880)
B. B. Harris	San Bernardino	do	P. 1876
Benjamin F. Mathews	do	do	P. 1880
J. H. Pettit	do	do	P. 1879
R. W. Waterman	do	do	P. 1878
James P. Jones	Bernardo	San Diego	P. 1878
John Judson	do	do	P. 1880
A. E. Maxey	do	do	P. 1880
Lee H. Utt	Pala	do	P. 1874
George N. Hitchcock	San Diego	do	1880
Samuel Striplin	Valley Centre	do	P. 1881
Hugh Craig	San Fanciseo	San Francisco	1875
Robert J. Creighton	do	do	1881
Charles M. Hitchcock, M. D	do	do	P. 1872
William A. Newell, M. D	do	do	1870
Henry M. Newhall	do	do	P. 1878
B. B. Redding	do	do	1869
D. J. Staples	do	do	
S. R. Throckmorton	do	do	1866
John White	do	do	1878
R. B. Woodward	do	do	H. P. 1876
Lyman Belding	Stockton	San Joaquin	1870
David Frank Newsom	Arroyo Grande	San Luis Obispo	H. P. 1860
John Greening	Morro	do	P. 1877
William Langlois	do	do	P. 1878
H. Waymire	do	do	P. 1876
E. W. Steele	San Luis Obispo	do	H. P. 1877
David J. Mills	Pescadero	San Mateo	H. P. 1874
Rev. James W. Webb	Lompoc	Santa Barbara	1877
Henry M. Briggs	Gilroy	Santa Clara	1878
James D. Culp	do	do	H. P. 1876
E. H. Farmer	do	do	1869
D. Huber, M. D	do	do	1877
George Seaman	do	do	1880
Frank Smith	do	do	(1880)
Stanley Willey	do	do	1877
Jacob S. Davis	Saratoga	do	P. 1879
Lewis A. Sage	do	do	P. 1876
J. N. Bell, M. D	Anderson	Shasta	1877
J. B. Campbell	Baird	do	H. P 1872
Myron Green	do	do	1878
Henry Hirz	do	do	1877
John E. Stockton, M. D	Cottonwood	do	P. 1874
Washington Bailey	Hazel Creek	do	H. P. 1876
B. A. B. Jenkins	Oak Run	do	P. 1878
David Gould Webber, M. D	Loyalton	Sierra	P. 1855
Merrit Harden	Sierra Valley	do	P. 1867
George Campbell	Berryvale	Siskiyou	P. 1879
J. H. Sisson	do	do	P. 1877
F. J. King	Yreka	do	P. 1876
O. P. Egbert	Rio Vista	Solano	P. 1876
A. J. McPike	Vallejo	do	1876
Sylvester Scott	Cloverdale	Sonoma	P. 1878
C. C. Davis	Forestville	do	P. 1876
J. W. Davis	do	do	H. P. 1878
Levi Davis	do	do	H. P. 1876
John R. H. Oliver	do	do	P. 1875
David T. Gilliam	Guerneville	do	P. 1878
E. F. Seward	do	do	1875
S. W. Ridenhour	Korbel's Mills (?)	do	P. 1876
Aaron Barnes	Sebastopol	do	P. 1875
Henry Ludolff	do	do	P. 1878
George J. Ragle	do	do	P. 1878
Maj. Isaac W. Sullivan	do	do	P. 1878
Samuel Talmadge	do	do	H. P. 1878
Alfred V. La Motte	Sonoma	do	H. P. 1878
Mrs. J. A. Poppe	do	do	P. 1872
R. C. Bailey	Modesto	Stanislaus	P. 1881
S. William Coffee	do	do	P. 1881
V. B. Dale	do	do	P. 1880
L. Dickey	do	do	P. 1880
I. E. Kerr	Salida	do	P. 1880
Benjamin F. Parkes	do	do	P. 1880
Oliver Osborn	Porterville	Tulare	P. 1879
Ira Benton Dillon	Three Rivers	do	P. 1879
J. L. George	Columbia	Tuolumne	1876
George W. Hale	do	do	1881
N. G. Kibbie	do	do	1876
William H. Ryan	do	do	1876

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CALIFORNIA—Continued.

Name.	Post-office.	County.	Year.
Herman Wolfe	Columbia	Tuolumne	P. 1876
Henry Kruse	Jamestown	do	P. 1880
Henry Thompson	do	do	P. 1880
B. W. Taylor	Santa Paula	Ventura	P. 1873
Hugh U. Ogburn	Woodland	Yolo	1876
Jason Watkins	do	do	1876
George Batts	Brownsville	Yuba	P. 1878
James H. Hanson	Hansonville	do	P. 1880

COLORADO.

Name.	Post-office.	County.	Year.
N. A. Baker	Denver	Arapahoe	H.P. 1874
Alonzo Allen	Altona	Boulder	1874
Henry Neikerk	Boulder	do	P. 1881
C. M. Tyler	do	do	P. 1874
Jacob Hetzel	Longmont	do	P. 1860
John Renner	do	do	P. 1878
Hon. L. C. Mead	do	do	P. 1878
William A. Davidson	Valmont	do	P. 1881
C. S. Pancost	do	do	P. 1866
Charles N. Eames	Cottonwood Springs	Chaffee	P. 1879
Philip Cook	do	do	1881
F. E. Hayden	Granite	do	P. 1880
Wilson E. Sisty	Brookvale	Clear Creek	P. 1861
Daniel Ernst	Georgetown	do	P. 1881
A. R. Forbes	do	do	(1881)
Fred. Jaenegen	do	do	P. 1880
Gordon Land	Alamosa	Conejos	H.P. 1866
Albert W. McIntire	do	do	H.P. 1880
William A. Bell	Colorado Springs	El Paso	H.P. 1874
George De La Vergne	do	do	H.P. 1877
John F. Read	Walsenburgh	Huerfano	P. 1874
John A. Higgins	Golden	Jefferson	P. 1875
George K. Kimball	do	do	P. 1877
Hon. T. C. Bergen	Morrison	do	P. 1873
Peter Fischer	do	do	P. 1872
Mrs. S. B. Millsap	do	do	P. 1873
A. Rooney	do	do	P. 1879
W. R. Scott	do	do	H.P. 1874
Hermann Hibschle	Leadville	Lake	P. 1880
Hugh C. Young	Malta	do	P. 1873
Theodore Whyte	Estes Park	Larimer	P. 1880
Col. Emil Boedicker	Loveland	do	P. 1879
Boyd & Alford	do	do	P. 1876
Matthew T. Burnett	do	do	P. 1880
George W. Richart	do	do	P. 1881
William C. Macomber	Stonewall	Las Animas	P. 1879
R. D. Russell	do	do	P. 1879
G. A. Storz	do	do	P. 1872
George H. Green	Buffalo Springs	Park	P. 1877
Webster Ballinger	Hamilton (?)	do	P. 1877
N. A. Rich	Platte Station	do	P. 1880
Hon. Benjamin H. Eaton	Greeley	Weld	P. 1873
Charles Emerson	do	do	(1881)
B. S. La Grange	do	do	P. 1876
Cyreneus D. Neff	do	do	P. 1873
S. K. Thompson	do	do	1879
George H. West	do	do	P. 1880
Charles H. Wheeler	do	do	1880

CONNECTICUT.

Name.	Post-office.	County.	Year.
Alfred J. Hobbs	Bridgeport	Fairfield	1870
Benjamin E. Cowperthwait	Danbury	do	P. 1875
Charles E. Griffing	do	do	1878
Amos Stone	do	do	P. 1870
George W. Wilson	do	do	1878
Hendrick Barnum	do	do	1879
Edwin Gilbert	Georgetown	do	P. 1879
Edmund O. Hurlbutt	do	do	P. 1881
E. R. Farrar	Huntington	do	P. 1880
C. H. Andariese	Sherman	do	H.P. 1877
Daniel B. Mallory	do	do	1877
George N. Woodruff	do	do	P. 1877

Geographical catalogue of fish-culturists—Continued.

CONNECTICUT—Continued.

Name.	Post-office.	County.	Year.
Preston H. Hodges	Stratford	Fairfield	P. 1873
George Jelliffe	Westport	do	H.P.1872
Edward M. Lees	do	do	1872
H. R. Treadwell	do	do	1872
E. Ingraham	Bristol	Hartford	H.P.1874
Alvin Taplin	Forestville	do	P. 1878
S. Belden	Hartford	do	
C. R. Belden	do	do	H.P.1877
William M. Hudson, M. D	do	do	1869
E. C. Kellogg	do	do	1855
Henry C. Robinson	do	do	1866
Eugene S. Clark	Poquonock	do	P. 1871
Henry J. Fenton	do	do	H.P.1874
Watson Holcomb	Simsbury	do	P. 1880
Eugene Farrar	Thompsonville	do	P. 1867
Joseph B. Eldridge	Norfolk	Litchfield	P. 1877
H. B. Knapp	do	do	1860
William A. Spaulding	do	do	P. 1876
Levi Hodges	Torrington	do	H.P.1871
George H. Comstock	Ivoryton	Middlesex	1857
Robert G. Pike	Middletown	do	1866
Henry Woodward	do	do	1868
E. F. Markham	Portland	do	1873
John H. Sage	do	do	1873
E. W. Sperry	Birmingham	New Haven	1869
William Wilkinson	do	do	1874
Horace C. Wilcox	Meriden	do	P. 1867
Watson E. Wilcox	do	do	1876
Edward S. Gaylord	New Haven	do	1872
W. B. Hopson	do	do	1878
Samuel H. Kirby	do	do	1871
Gardner Morse, jr	do	do	1874
Hon. N. D. Sperry	do	do	1870
George H. Townsend	do	do	1857
James M. Townsend	do	do	P. 1857
Waltonian Club	do	do	H.P.1871
John Pierce	South Britain	do	P. 1877
John Heineman	Wallingford	do	1874
John W. Webster	Waterbury	do	1845
N. A. Roberts	West Meriden (?)	do	P. 1877
John J. Beebe	East Lyme	New London	P. 1879
James A. Bill	Lyme	do	1865
Rev. William Clift	Mystic Bridge	do	1869
J. T. Shepard	New London	do	(1879)
Nelson Eno	Moose Meadow	Tolland	P. 1874
Hon. Julius Converse	Stafford Springs	do	P. 1874
Stuart Gwynn, M. D	Vernon	do	H.P.1877
Gilbert C. Brown	North Sterling	Windham	P. 1876
George F. Willis	Putnam	do	1859
Edwin G. Potter	Sterling	do	P. 1877
Albert R. Morrison	Willimantic	do	(1881)

DAKOTA TERRITORY.

Name.	Post-office.	County.	Year.
Enoch F. Molyneux	Lake Badger (?)	Kingsbury	1881
Lynn W. Barber	Nordland	do	1879
H. R. Palmer	do	do	1875
Peter Christensen	Pleasant Valley	do	P. 1866
William Haydon	Deadwood	Lawrence	1874
C. V. Gardner	Spearfish	do	1878
James C. Sherman	Pactola	Pennington	P. 1881
I. E. West	Yankton	Yankton	1870

DELAWARE.

Name.	Post-office.	County.	Year.
E. H. Bancroft	Camden	Kent	1876
L. P. Cowgill	do	do	1874
D. P. Barnard, jr	Lebanon	do	1880
Charles Denney	Little Creek Landing	do	P. 1879
John A. Gum	Frankford	Sussex	1878
Capt. Lewis Frederick	Rehoboth Beach	do	1879

Geographical catalogue of fish-culturists—Continued.

DISTRICT OF COLUMBIA.

Name.	Post-office.	County.	Year.	
Prof. Spencer F. Baird	1445 Massachusetts avenue northwest.	Washington	P.	1870
T. B. Ferguson	1435 ......do	......do	P.	1872
Theodore Gill, M. D	Smithsonian Institution	......do		1870
G. Brown Goode	do	......do		1876
Herman Haupt	1537 I street northwest	......do	P.	1876
Rudolph Hessel	Carp ponds	......do	P.	1876
Rev. Alexander Kent	930 O street northwest	......do		1872
W. T. Okie, M. D	1210 G street northwest	......do		1879
Charles W. Smiley	1443 Massachusetts avenue northwest.	......do		1880

FLORIDA.

Name.	Post-office.	County.	Year.	
William H. Bliss	Jacksonville	Duval		1845
James A. Smith	Pensacola	Escambia		1881
A. T. Yniestra	......do	......do	P.	1879
William D. Sanders	Monticello	Jefferson	P.	1878
E. G. Scott	......do	......do	P.	1879
H. H. Berry	Osceola	Orange	P.	1881
George C. Rixford	Rixford	Suwannee	P.	1874
William W. Hulst	Beresford	Volusia	P.	1879

GEORGIA.

Name.	Post-office.	County.	Year.	
Jesse Alridge	Baxley	Appling	P.	1880
W. E. Tippins	......do	......do		1861
James Hinson	Hazlehurst	......do	P.	1879
Jesse Lott	......do	......do	P.	1875
E. Pickren	......do	......do	P.	1878
W. O. Simmons	......do	......do		1881
J. T. Smith	......do	......do	P.	1880
George Eason	Surrency	......do	P.	1875
W. A. J. Faircloth	......do	......do	P.	1879
W. H. Overstreet	......do	......do	P.	1879
B. F. Suddath	Gillsville	Banks	P.	1880
Enoch C. Garrison	Nail's Creek	......do	P.	1871
Wiley Acre	......do	......do	P.	1870
D. H. P. Garrison	......do	......do	P.	1875
Freeman A. Garrison	......do	......do	P.	1873
F. Merriam Ragsdale	......do	......do	P.	1851
Richard Tucker	Tifton	Berrien	P.	1871
J. W. Aderhold	Macon	Bibb	P.	1864
Allen Bedingfield	......do	......do	P.	1875
William S. Brantly	......do	......do	P.	1874
Henry J. Lamar	......do	......do	P.	1876
Henry J. Peter	......do	......do	P.	1873
I. C. Plant	......do	......do	P.	1878
Willam C. Singleton	......do	......do	P.	1873
Johnson Wise	......do	......do	P.	1877
Elias Witkowski	......do	......do	P.	1880
J. C. Johnson, M. D	Walden	......do		1877
Thomas J. Livingston	Key	Brooks	P.	1880
T. J. James	Holcombe	Burke	P.	1875
James O. Roberts	Palmetto	Campbell	P.	1877
Jesse Gray	Villa Rica	Carroll		(1877)
Richard Boggs	Athens	Clarke	P.	1868
Albert P. Dearing	......do	......do	P.	1877
Thomas F. Hudson	......do	......do	P.	1871
Allen R. Johnson	......do	......do	P.	1870
John S. Linton	......do	......do	P.	1870
Henry B. Mitchell	......do	......do	P.	1880
B. James Parr	......do	......do	P.	1869
S. Thomas	......do	......do	P.	1878
L. C. Mattox, M. D	Homerville	Clinch	P.	1870
Jonathan L. Morgan	Wiregrass	......do	P.	1880
Robert Douglass	Douglas	Coffee	P.	1881
James M. Denton	Pickren	......do	P.	1874
Daniel Peterson	......do	......do	P.	1874
C. W. Dedge	Nicholls	......do	P.	1878
George W. Lott	......do	......do	P.	1877
Daniel Lott	......do	......do	P.	1876
C. W. Meek	......do	......do	P.	1878

Geographical catalogue of fish-culturists—Continued.

GEORGIA—Continued.

Name.	Post-office.	County.	Year.
John M. Spence	Nicholls	Coffee	P. 1878
Wiley Byrd	Pickren	do	P. 1878
J. J. Pickren	do	do	P. 1878
Henry D. Leitner	Berzelia	Columbia	1855
Henry A. Merry	do	do	P. 1877
Bradford Merry	do	do	P. 1872
Henry R. Casey, M. D	Harlem	do	P. 1858
William H. Collins	do	do	P. 1876
Hon. Charles H. Shockley	do	do	P. 1881
William U. Anderson	Newnan	Coweta	P.
E. Y. Brown	do	do	P. 1879
R. N. Carmichael	do	do	P. 1880
Dr. W. T. Cole	do	do	P. 1876
J. B. S. Davis	do	do	P. 1878
W. A. Dent	do	do	P. 1880
John William Powell	do	do	P. 1872
Stephen D. Smith	do	do	P. 1874
Augustus W. Stokes	do	do	P. 1871
Pierce Tomlin	do	do	P. 1880
L. Parks Redwine	Powellville	do	P. (1881)
Robert A. North	Sharpsburgh	do	P. 1874
William Carmical	Turin	do	P. 1875
Alexander B. Hanna	Smith	Dade	P.
John Scott	Barrettsville	Dawson	P. 1879
John W. Griffin	Eastman	Dodge	P. 1879
J. W. Anderson	Dark Corner	Douglas	P. 1879
William M. Swilby	Melrose	Echols	P. 1870
Daniel M. Carlton	Elberton	Elbert	P. 1874
Clark Edwards	do	do	P. 1876
Robert Hester	do	do	1865
John H. Jones	do	do	(1881)
Burrel Kea	Durden	Emanuel	P. 1855
Alexander R. Beasley	Fortner	do	P. (1881)
G. S. Rountree	Swainsborough	do	P. 1878
Riley J. Edwards	Brooks' Station	Fayette	P. 1878
C. E. Bennett	Fayetteville	do	P. 1878
Rowland Stubbs	do	do	P. 1877
George M. Davis	do	do	P. 1879
James C. Blackstock	Cumming	Forsyth	P. 1876
W. S. Davenport	do	do	P. 1879
E. C. McAfee	do	do	P. 1877
James T. Major	do	do	P. 1878
James S. Hawkins	High Tower	do	P. 1879
M. L. Pool, M. D	do	do	P. 1879
Hon. J. T. Henderson	Atlanta	Fulton	P. 1875
John A. Smith	Bolton	do	P. 1878
Seaborn Kitchens, jr	Gibson	Glascock	P. 1872
Seaborn Kitchens, sr	do	do	P. 1875
William R. Logue, sr	do	do	P. 1878
J. B. Williams	do	do	P. 1878
J. G. B. Erwin	Fair Mount	Gordon	(1881)
Jason W. Bright	do	do	P. 1875
Thomas P. Janes, M. D	Penfield	Greene	1876
R. S. D. Lanier	Auburn	Gwinnett	P. 1878
Joseph Sims	do	do	P. 1880
David F. Verner	Buford	do	P. 1880
Harrison Summerour	Duluth	do	P. 1879
George H. Jones	Norcross	do	P. 1868
John Turner	Culverton	Hancock	P. 1879
J. T. Midddlebrooks	do	do	P. 1880
John W. Waller	do	do	P. 1878
James Bass	Devereaux Station	do	P. 1874
R. B. Baxter	Sparta	do	P. 1876
David Dickson	do	do	P. 1870
R. Henry Thomas	do	do	P. 1877
W. Moseley Garrett	Houston	Heard	P. 1876
Thomas J. & J. L. Edwards	Hampton	Henry	1862
Daniel F. Gunn	Byron	Houston	P. 1844
William W. Wagnon, sr	do	do	P. 1876
William E. Warren	Powersville	do	P. 1879
William Means	Spoonville	do	P. 1878
Jacob Sasser	Weilborn's Mills	do	P. 1875
Rev. Zara Paulk	Sycamore	Irwin	P. 1868
E. C. David	Harmony Grove	Jackson	P. 1875
James P. Hudson	do	do	P. 1872
Jesse White	do	do	P. 1879
C. S. Hill	Hoschton	do	P. 1877
J. B. Silman	Jefferson	do	P. 1874
William H. Thompson	Eudora	Jasper	P. 1873

Geographical catalogue of fish-culturists—Continued.

GEORGIA—Continued.

Name.	Post-office.	County.	Year.
Henry B. Jordan	Monticello	Jasper	P. 1876
W. P. Johnson	Bartow	Jefferson	P. (1881)
George T. Palmer	do	do	P. 1875
W. S. Alexander	Louisville	do	P. 1870
J. G. Cain	do	do	P. 1877
Rev. Thomas J. Cumming	do	do	P. 1875
E. H. W. Hunter, M. D	do	do	P. 1877
J. C. Little	do	do	P. 1875
J. H. Polhill	do	do	P. 1877
Hon. James Stapleton	Spread	do	
J. N. Oliphant, M. D	Stellaville	do	P. 1866
Rev. James H. Oliphant	do	do	P. 1880
Noah Smith	do	do	P. 1872
John Bradley	Clinton	Jones	P. 1875
A. J. Middlebrook	Cornucopia	do	P. 1874
Hon. N. S. Glover	Five Points	do	P. 1875
Benjamin F. Finney	Haddock Station	do	P. 1875
Benjamin F. Ross	do	do	P. 1876
Jerry H. Yopp	Picciola	Laurens	P. (1881)
D. F. Sullivan	Beards Creek	Liberty	P. 1876
Dr. Alfred I. Hendry	McIntosh	do	P. (1881)
Theodore N. Winn	do	do	P. 1874
Jeremiah Elder	Taylor's Creek	do	P. 1865
W. A. Kennedy	do	do	P. 1880
John G. Martin	do	do	P. 1879
James S. Warnell	do	do	P. 1880
Dr. R. E. Aileamder	Lombardy	McDuffie	P.
John A. Faucett	do	do	P. 1881
E. J. Frederick	Marshallsville	Macon	P. 1880
James D. Frederick	do	do	P. 1877
C. J. Goodwin	do	do	
M. J. Hatcher	do	do	P. 1881
I. F. Murph	do	do	P. 1876
John J. Murph	do	do	P. 1881
L. A. Rumph	do	do	P. 1875
L. D. Rumph	do	do	P. 1881
Samuel H. Rumph	do	do	P. 1878
George H. Slappey	do	do	P. 1852
S. Warren Carithers	Danielsville	Madison	P. 1880
J. R. Donnan	Buena Vista	Marion	P. 1870
R. A. Swearingen	Tazewell	do	P. 1875
William H. Scott	Alpharetta	Milton	P. 1878
A. T. Holt	Bolingbroke	Monroe	P. 1873
E. Taylor	do	do	P. 1872
Thomas M. Tyler	do	do	P. 1872
T. E. Walton	do	do	P. 1876
C. W. Battle	Culloden	do	P. 1875
Andrew J. Brown	do	do	1877
William H. Castlen	do	do	P. 1878
John E. Cooke, M. D	do	do	P. 1878
W. W. Jackson	do	do	P.
B. F. Jordan	do	do	P. 1881
Hon. Thomas B. Cabaniss	Forsyth	do	P. 1875
D. S. Redding	do	do	P.
Ned. Ursury	Iceberg	do	1872
R. M. Williams	do	do	P. 1870
Charles B. Atkinson	Madison	Morgan	P. 1877
Emanuel Heyser	do	do	P. 1872
J. H. Holland	do	do	P. 1876
A. R. Zachry	do	do	P. 1880
John T. Harris	Covington	Newton	P. 1879
J. T. Harris	do	do	P. 1877
F. M. Holder	do	do	P. 1876
Josiah Perry	do	do	P. 1880
John W. Rogers	do	do	P. 1879
A. B. Simms	do	do	P. 1881
C. P. Lee	Oxford	do	P. 1880
Thomas G. Lester	Lexington	Oglethorpe	P. 1881
Isham H. Pittard	Winterville	do	P. 1877
J. M. Able	Dallas	Paulding	(1881)
Thomas J. Foster, M. D	do	do	P. 1878
F. M. Gann	do	do	P. 1876
J. M. George	do	do	P. 1877
B. M. C. Mathews	do	do	P. 1878
G. W. Ragsdale	do	do	P. 1880
Dr. H. H. Cogburn	Eatonton	Putnam	P. 1875
Harrison J. Bland	Georgetown	Quitman	P. 1880
J. J. Crumbley	do	do	P. 1880
T. J. Ellis	do	do	P. 1880

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GEORGIA—Continued.

Name.	Post-office.	County.	Year.
John M. Green	Georgetown	Quitman	P. 1869
William Harrison	do	do	P. 1868
T. J. Methrin	do	do	P. 1875
W. F. Davis	Coleman's Depot	Randolph	P. 1876
W. D. Hammack	do	do	P. 1876
M. J. Atkins	Cuthbert	do	P. 1875
O. A. Barry	do	do	P. 1880
J. McK. Gunn	do	do	P. 1881
James A. Hay	do	do	P. (1881)
William C. Hay, jr	do	do	P. 1875
W. C. Jenkins	do	do	P. 1872
Judge C. R. Knowles	do	do	P. 1878
James J. Mathews	do	do	P. 1874
Nathan H. Miller	do	do	P. 1845
C. N. Simpson, jr	do	do	P. 1873
J. P. Toombs	do	do	P. 1878
Dr. W. M. C. Westmoreland	do	do	P. 1879
George Symms	Augusta	Richmond	P. (1881)
F. A. Timberlake	do	do	P. 1880
Thomas Wynne	Belair	do	P. (1881)
R. H. Cannon	Conyers	Rockdale	P. 1879
S. D. Night	do	do	P. 1878
William L. Peek	do	do	P. 1880
T. C. Posey	do	do	P. 1876
Charles H. Moore	Halcyon Dale	Screven	P. 1880
John R. Evans	Ogeechee	do	P. 1878
George M. Zeigler	Rocky Ford	do	P. 1871
Israel Zeigler, sr	do	do	P. 1876
John Zeigler	do	do	P. 1875
J. H. M. Barrett, M. D	Creswell	Spalding	P. 1871
E. W. Beck	Griffin	do	P. 1878
Thomas J. Brooks	do	do	P. 1879
F. A. Freeman	do	do	P. 1874
Charles H. Johnson	do	do	P. 1875
H. C. Roberts	do	do	P. 1880
S. H. Wilson	do	do	P. (1881)
Abel A. Wright	do	do	P. 1873
Samuel F. Gray	Sunny Side	do	P. 1875
Thomas F. Shi	Pataula (?)	Stewart	P. 1872
Evan J. Prothro	Richland	do	P. 1875
Charles Bergstrom	Crawfordville	Taliaferro	P. 1877
Benj. F. Moore	do	do	P. 1877
A. J. Cameron	Cobbville	Telfair	P. 1868
W. E. Graham	McRae	do	P. 1879
P. J. Howard	Dawson	Terrell	1871
B. F. Linton	Aucilla	Thomas	P. 1872
Rutherford Shuman	do	do	P. 1877
James G. Brown	Boston	do	P. 1872
James Cone	do	do	P. 1860
Z. W. Howell	do	do	P. 1880
T. W. Jones	do	do	P. 1878
R. B. Mardre	do	do	P. 1876
A. Q. Moody	do	do	1877
David L. Pitts	do	do	P. 1878
N. R. Spengler	do	do	P. 1877
William G. Thens	do	do	P. 1873
S. Samuel Adams	Thomasville	do	P. 1874
H. B. Ainsworth	do	do	P. 1879
J. Robert Alexander	do	do	P. 1879
Rev. J. R. Battle	do	do	P. 1877
John C. Beverly	do	do	P. 1879
J. M. Chastain	do	do	(1881)
J. T. Chastain	do	do	P. 1877
W. C. & J. B. Eason	do	do	P. 1874
David J. Hall	do	do	P. 1868
W. B. Hambleton	do	do	P. 1878
Benj. F. Hawkins	do	do	P. 1881
James A. Linton	do	do	P.
J. L. Linton	do	do	P. 1868
Moses W. Linton	do	do	(1881)
James P. Millen	do	do	P. 1878
Mrs. Jane A. Mitchell	do	do	P. 1859
Thomas C. Mitchell	do	do	P. 1873
William D. Mitchell	do	do	P. 1876
John C. Neel	do	do	P. 1880
Robert Raines	do	do	P. 1877
William Stegall	do	do	P. 1877
Henry H. Sanford	do	do	P. 1870
William Vaughn	do	do	P. 1875

Geographical catalogue of fish-culturists—Continued.

GEORGIA—Continued.

Name.	Post-office.	County.	Year.
Addison Way	Thomasville	Thomas	P.
Benjamin H. Bigham	La Grange	Troup	1881
H. H. Cary, M. D	do	do	P. 1875
Blount C. Ferrell	do	do	P. 1874
Robert H. Jackson	do	do	P. 1881
Mrs. Martha G. McLendon	do	do	P. 1868
W. O. Tuggle	do	do	P. 1872
William C. Yancey	do	do	P. 1875
John D. Cavender	Gaddistown	Union	P. 1877
George W. H. Sisum	do	do	P. 1870
Thomas Y. Park, M. D	Eagle Cliff	Walker	P. 1880
J. H. Bedingfield	Jug Tavern	Walton	P. (1880)
Wiley H. Bush	do	do	P. 1876
Moses Dillard	do	do	P. 1880
Simeon W. Hill	do	do	P. 1875
J. M. Jackson	do	do	P. 1875
Henry C. Morris	do	do	P. 1880
Herman Naumann	do	do	1865
James M. Saunders, M. D	do	do	1881
J. H. Stewart	do	do	P. 1878
George A. Gibson	Social Circle	do	P. (1881)
George A. Johns	do	do	P. 1881
George W. Knox	do	do	P. 1869
John W. D. Reagan	do	do	P. 1878
Moses R. Spence	do	do	P. 1872
Hedges L. Spencer	do	do	P. 1870
Robert H. Booth	Walnut Grove (?)	do	....
Samuel H. Brodnax	do	do	P. 1877
John W. Thompson	do	do	P. 1878
P. S. Thompson	do	do	P. 1880
J. H. Brinkley	Camak	Warren	P. 1879
S. A. Gheesling	do	do	P. 1879
Andrew J. Hill	do	do	P. 1881
S. D. Mayes, M. D	do	do	P. 1877
Micajah Rogers	do	do	P. 1877
B. C. Kitchens	Warrenton	do	P. 1879
V. A. Abott	do	do	P. 1881
Henry Hicks, M. D	Oconee	Washington	P. 1868
James M. Palmer, M. D	do	do	P. 1881
Virgil S. Joyner	do	do	P. 1880
G. W. Wood	do	do	P. 1876
Mizel G. Wood, jr	do	do	P. 1876
James M. Minar	Sun Hill	do	P. 1876
James W. Bell	Preston	Webster	P. 1880
David B. Harrell	do	do	P. 1873
Wm. P. Jowers	do	do	P. 1875
William H. Mercer	do	do	P. 1881
D. J. Norman	do	do	P. 1880
Daniel R. Shepherd	do	do	P. 1879
W. F. Spann	do	do	P. 1876
A. H. Mitchell	Red Clay	Whitfield	P. 1879
J. G. W. Mills	do	do	P. 1881
W. G. Cade	Washington	Wilkes	P. 1879
F. H. Colley	do	do	P. 1879
W. A. Pope	do	do	1878
Edmund T. Shubrick	do	do	P. 1880
William W. Simpson	do	do	P. 1880
Thomas R. Willis	do	do	P. 1861

IDAHO.

James Hanity	Falk's Store	Ada	1871

ILLINOIS.

Capt. Reynard Cook	Burton	Adams	P. 1879
David Sheer	do	do	P. 1865
H. M. Mitchell	Fowler	do	P. 1879
S. P. Bartlett	Quincy	do	P. 1875
Enoch R. Chatten	do	do	P. 1874
John W. Duncan	do	do	P. 1878
Kiler K. Jones	do	do	1867
Thomas A. Kircher	do	do	P. 1870
Fred C. Turner	Ursa	do	P. 1876

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ILLINOIS—Continued.

Name.	Post-office.	County.	Year.
Richard Beech	Beechville	Calhoun	P. 1840
Simon P. Renner	Lanark	Carroll	P. 1877
Samuel Preston	Mount Carroll	do	H.P. 1876
Wash Graff	Ashland	Cass	P. 1870
Hon. Edgar M. Morrison	Morrisonville	Christian	P. 1880
Eugene M. Morrison	do	do	P. 1880
J. Sidney B. Wells	Melrose	Clark	P. 1875
Charles Clary	Charleston	Coles	1878
Robert S. Hodgen	do	do	P. 1878
G. M. Mitchell	do	do	P. 1874
Isaac Winter	do	do	P. 1870
F. F. Axtell	Chicago	Cook	1870
N. K. Fairbank	do	do	H.P. 1875
Prof. Albert D. Hager	do	do	1865
John R. Hoxie	do	do	P. 1880
George O. Shields	do	do	1875
Jacob Sarasy	do	do	H.P. 1877
E. Bruce Smith	Grand View	Edgar	P. 1877
Thomas Mays	Mays' Station	do	P. 1880
J. H. C. Smothers	Smothersville	Franklin	P. 1878
William G. Bowman	Shawneetown	Gallatin	1870
Charles Carroll	do	do	P. 1880
Charles E. Slocum	Loda	Iroquois	P. 1878
Alonzo Carman	Scemly (?)	do	P. 1877
David Holliday	Ora	Jackson	P. 1878
Jacob Raef, M. D.	West Liberty	Jasper	P. 1881
William F. Beaupre	Aurora	Kane	1880
Hon. L. B. Crooker	do	do	1870
S. P. McDole	do	do	P. 1879
William Oliver Webber	do	do	1868
Dr. W. A. Pratt	Elgin	do	H.P. 1870
J. Smith Briggs	Kankakee	Kankakee	1879
Joel B. Hawkins	do	do	H.P. 1869
J. W. Temple	Victoria	Knox	P. 1877
John R. Skelton	Skelton	Logan	P. 1877
Charles S. Dole	Crystal Lake	McHenry	P. 1877
C. M. Brigham	Hebron	do	P. 1878
Prof. S. A. Forbes	Normal	McLean	1876
Samuel W. Eldred	Virden	Macoupin	P. 1881
Charles Ryan	do	do	P. 1875
Samuel B. Thomas	do	do	P. 1877
Lewis H. Thomas	do	do	P. 1865
Hon. John M. Pearson	Godfrey	Madison	P. 1875
R. Wilson	Alma	Marion	P. 1876
S. Skallberg	New Windsor	Mercer	P. 1880
John T. Madelux	Hillsborough	Montgomery	P. 1878
Charles W. Seymour	do	do	P. 1879
George Hayden	Jacksonville	Morgan	1877
James F. Brand	Brookville	Ogle	P. 1878
William T. Porter	do	do	P. 1878
Elias Deihl	Forreston	do	P. 1878
S. Beard	Polo	do	1880
J. G. White	Smithville	Peoria	P. 1879
W. E. Lodge	Monticello	Piatt	P. 1878
C. W. Piatt	do	do	P. 1881
Jacob Hawken	Percy	Randolph	P. 1879
R. J. Short	do	do	P. 1878
J. Keller, M. D.	Steeleville	do	P. 1879
Joseph W. Brackett	Rock Island	Rock Island	1881
Samuel S. Guyer	do	do	1860
J. Ross Mills	do	do	1880
Casimir Andel	Belleville	Saint Clair	1874
Ferndale Trout Club	do	do	H.P. 1874
Joseph Fuess	do	do	1875
Hubert Hartman	do	do	1874
Ernest Hilgard	do	do	1876
C. P. Kinspel	do	do	1874
Hon. G. A. Koerner	do	do	1875
Louis C. Starkel	do	do	1875
E. L. Thomas	do	do	1874
August Tieman	do	do	1874
Herman G. Weber	do	do	1874
William Galle	Marissa	do	P. 1879
Isaac N. Nixon	do	do	(1881)
George Grossman	Smithton	do	P. 1877
Thomas E. Myers	Beck's Creek (?)	Shelby	P. 1878
Thomas Gilpin	Windsor	do	P. 1878
Charles P. Buswell	Osceola	Stark	P. 1878
Samuel Ditsworth	Loran	Stephenson	P. 1878

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Name.	Post-office.	County.	Year.
D. Clint Trail	Hilton	Tazewell	1875
A. Cover	Western Saratoga	Union	P. 1880
E. H. Gardner	Mount Carmel	Wabash	1877
Ashley Knapp	Rockford	Winnebago	H.P.1876
D. A. K. Andrus	do	do	1874
Malone Case	do	do	1874

INDIANA.

Name.	Post-office.	County.	Year.
Prof. William Fix	Hartsville	Bartholomew	P. 1875
R. O. Powell	do	do	P. 1873
J. L. Morrow, M. D	Delphi	Carroll	P. 1881
S. G. Greenup & Bro	Pittsburgh	do	P. 1872
George Speece	do	do	P. 1880
Lewis Swatts	do	do	P. 1879
Joshua W. Moore	Cloverland	Clay	P. 1879
L. C. Morgan	Montgomery	Daviess	P. 1877
Hiram Hogshead	Washington	do	P. 1877
James S. Morgan	do	do	P. 1860
R. Wes McBride	Waterloo	De Kalb	1875
Lemuel L. Kelso	Ireland	Dubois	P. 1881
Henry Crowel	Laurel	Franklin	P. 1870
Eli Hetrick	Whitcomb	do	P. 1871
George B. Creamer	Francisco	Gibson	P. 1875
Thomas H. Gillaspie	Princeton	do	P. 1879
L. D. Baldwin	Marion	Grant	1878
William Baldwin	do	do	P. 1874
Davidson Cubertson	do	do	1874
L. J. Starrett	do	do	P. 1874
Jehu Hadley	Amo	Hendricks	P. 1876
R. G. Little	Cartersburgh	do	P. 1879
George W. Scearce	Danville	do	P. 1875
Elias Hadley	Plainfield	do	P. 1877
James Riley	Middletown	Henry	P. 1875
N. D. Gaddy, M. D	Lovett	Jennings	P. 1878
Fielden Lett	Slate	do	P. 1878
James H. McKee	Vincennes	Knox	P. 1876
William H. H. Dennis	Milford	Kosciusko	1876
Calvin Franklin	Anderson	Madison	P. 1877
Leroy F. Moss	do	do	P. 1880
John Gilmore	Ovid	do	P. 1880
Samuel Starbuck	Bridgeport	Marion	P. 1874
Elijah Clare	Alamo	Montgomery	P. 1870
W. W. Tate	do	do	P. 1871
Calvin Fletcher	Spencer	Owen	P. 1869
R. C. McWilliams	Rockville	Parke	P. 1877
Monroe Hunt	Oatsville	Pike	P. 1875
T. D. Crumbaugh	Union	do	P.
Jasper Davidson	do	do	P. 1878
Jeremiah Hillman	do	do	P. 1874
William L. McRoberts	do	do	P. 1876
Daniel Shawhan	do	do	P. 1876
Lemuel Jenkins	West Saratoga Springs	do	P. 1872
S. S. Shannon	do	do	P. 1877
O. D. Ruple	South Bend	Saint Joseph	P. 1877
George Warner	Walkerton	do	P. 1873
Isaac D. Harrod	Austin	Scott	P. 1875
Joseph Gray	Graysville	Sullivan	P. 1876
G. W. Eppert	Coal Bluff	Vigo	P. 1878

IOWA.

Name.	Post-office.	County.	Year.
John Ready	Rossville	Allamakee	1877
John E. Corlett	Bismarck	Clayton	1871
John Lubbers	Lyons	Clinton	H.P.1875
J. W. Corbin	Delhi	Delaware	P. 1879
A. A. Mosher	Spirit Lake	Dickinson	H.P.1880
Rev. A. Hattenberger	Dubuque	Dubuque	P. 1874
William Parks	Hampton	Franklin	P. 1877
William L. Bass	Randolph	Fremont	P. 1872
J. Washington Moorhead	Leadville (?)	Guthrie	1881
Charles Aldrich	Webster City	Hamilton	(1880)
Leonard Farr	Mount Pleasant	Henry	P. 1881

Geographical catalogue of fish-culturists—Continued.

IOWA—Continued.

Name.	Post-office.	County.	Year.
James M. Holland	Mount Pleasant	Henry	P. 1876
J. W. Tracy	do	do	P. 1840
J. W. Frazier	Salem	do	P. 1868
A. R. Pierce	Lockridge	Jefferson	P. 1871
B. F. Shaw	Anamosa	Jones	H. P. 1870
E. R. Shaw	Cedar Rapids	Linn	H. P. 1875
Alexander Hemphill	Centre Point	do	P. 1876
John Johnston	Lisbon	do	P. 1878
Irvin Peet	do	do	1876
Judge William G. Allen	Columbus City	Louisa	P. 1874
Judge Francis Springer	do	do	(1881)
N. M. Letts	Letts	do	P. 1875
Hon. R. E. Benton	Morning Sun	do	1880
Hon. James S. Hurley	Wapello	do	(1881)
W. W. Baker	Chariton	Lucas	P. 1875
S. D. Davis	Malvern	Mills	P. 1880
John W. Millar	Muscatine	Muscatine	P. 1876
J. H. Morf	Merrill	Plymouth	P. 1881
J. W. Towner	Towner Lake	Polk	P. 1875
William A. Mynster	Council Bluffs	Pottawattamie	H. P. 1877
William Gray	Davenport	Scott	1823
M. S. McPherson	Iowa Centre	Story	P. 1881
J. W. Combs	Bedford	Taylor	P. 1875
Charles Steele	do	do	......
J. R. Standley	Platteville	do	P. 1878
John Hall	Creston	Union	P. 1874
George B. Flood	Farmington	Van Buren	P. 1880
Merchant Stoddard	do	do	P. 1878
E. C. Kitterman	Dahlonega (Ottumwa)	Wapello	P. 1865
W. H. Kitterman	do	do	P. 1877
Ed. Collin	Northwood	Worth	1865

KANSAS.

Name.	Post-office.	County.	Year.
W. L. Challiss, M. D	Atchison	Atchison	P. 1870
C. Holzgang	Clay Centre	Clay	1880
Dr. George Wigg	do	do	1862
Mark S. Titcomb	Wakefield	do	1880
A. D. Blanchett	Aroma	Dickinson	P. 1866
Rev. John Connor	Black Wolf	Ellsworth	P. 1875
D. B. Long	Ellsworth	do	P. 1877
D. Bartells	Kalamazoo (?)	Kingman	P. 1878
R. S. Craft, M. D	Blue Rapids	Marshall	1879
Bela Latham	Paola	Miami	P. 1877
Charles A. Norton	Beloit	Mitchell	1879
John W. Hobson	Missouri Flat (?)	Sumner	1870
Charles Williamson, M. D	Washington	Washington	P. 1860
Col. N. S. Goss	Neosho Falls	Woodson	(1879)

KENTUCKY.

Name.	Post-office.	County.	Year.
James T. Bullard	Bardwell	Ballard	1861
H. L. Shanklin	do	do	(1881)
Ed. A. Edmunds	Glasgow	Barren	P. 1850
John M. Hudson	Rocky Hill	do	1881
Hon. William C. Allen	Owingsville	Bath	1876
D. L. Badger	do	do	......
Capt. Louis D. Craig	do	do	1870
L. Alexander Goodpaster	do	do	P. 1876
C. W. Goodpaster	do	do	1881
C. W. Honaker	do	do	1875
James F. Maury	do	do	1875
W. R. Patterson	do	do	1877
Hon. N. P. Reid	do	do	1874
William J. Shrout	do	do	1875
John D. Young	do	do	1875
Van B. Young	do	do	1862
E. E. Peck	Sharpsburgh	do	P. 1880
R. Henry Ingram	Florence	Boone	P. 1855
S. S. Scott, M. D	do	do	P. 1875
Rev. Edward Stephens	do	do	P. 1865
Joseph Glinn	Walton	do	P. 1877
James H. Cunningham	Clintonville	Bourbon	P. 1862
W. H. Renick	do	do	P. 1850

Geographical catalogue of fish-culturists—Continued.

KENTUCKY—Continued.

Name.	Post-office.	County.	Year.
Patrick H. Darby	Princeton	Caldwell	P. 1876
Charles L. Munford	Beverly	Christian	1868
Hunter Wood	Hopkinsville	do	P. 1880
Chiles T. Barker	West Fork	do	P. 1868
Thomas M. Barker	do	do	P. 1876
Gen. T. T. Garrard	Manchester	Clay	1876
John Thorns	Lexington	Fayette	P. 1880
Stephen Black	Frankfort	Franklin	P. 1881
Gen. P. W. Hardin	do	do	1878
A. W. Overton	do	do	P. 1876
W. B. Rodman, M. D	do	do	1881
William T. Samuels	do	do	1876
Gen. Green Clay Smith	do	do	1858
Thomas J. South	do	do	P. 1879
J. Q. A. Stewart, M. D	do	do	P. 1879
E. S. Theobald	do	do	1877
H. Leigh Watkins	do	do	1840
Cadwallader Lewis	Woodlake	do	1876
Maj. H. C. McDowell	do	do	P. 1881
Hon. J. H. Bruce	Lancaster	Garrard	P.
J. A. Wade	Cuba	Graves	P. 1881
C. J. Stokes, M. D	Farmington	do	P. 1872
Jefferson Turnbow	do	do	P. 1851
A. D. McNeely	Mayfield	do	P. 1880
H. K. Wells	Millwood	Grayson	1878
John Richards	Nolin	Hardin	P. 1860
Will. K. Jameson	Bonnieville	Hart	P. 1879
J. M. Brents	Munfordville	do	1876
James H. Campton	do	do	(1881)
W. B. Craddock	do	do	P. 1879
A. Miller	do	do	1874
John P. Rowlett	do	do	1874
J. W. Smith	do	do	1870
C. J. Walton, M. D	do	do	1876
G. W. McClure	Corydon	Henderson	P. 1880
George W. White	Zion	do	P.
William S. Gibson	Pleasureville	Henry	P. 1878
I. H. Lunsford	Madisonville	Hopkins	P. 1876
Dr. J. W. Pritchett	do	do	P. 1879
John B. Walker	do	do	1876
J. L. Woolfolk	do	do	P. 1879
William Griffith	Louisville	Jefferson	1876
Dr. J. B. Lilly	do	do	1870
George K. Speed	do	do	P. 1879
Pack Thomas	do	do	1876
Col. T. W. Thompson	do	do	1879
William H. Way, M. D	do	do	1875
Hon. James B. Casey	Covington	Kenton	
Robert L. Crigler	do	do	P. 1876
James P. Orr, jr	do	do	1874
W. S. Porter	do	do	P. 1875
John Seiler	do	do	P. 1870
Joseph Slosser	do	do	P. 1875
George W. Carlisle	Independence	do	P. 1876
W. H. Wilson	do	do	P. 1876
C. M. Carlisle	Key West	do	P. 1856
H. W. Egleston	Scott	do	P. (1881)
Hon. G. W. Ewing	Adairville	Logan	P. 1876
J. B. Briggs	Russellville	do	P. 1876
Walter J. Byrne, M. D	do	do	1876
R. H. Keene, M. D	do	do	1879
N. Long	do	do	P. 1881
S. C. Long	do	do	1878
Hal. W. Walters	do	do	1879
Daniel J. Rogers	Bardstown	Nelson	P. 1872
William S. Carter	Monterey	Owen	P. 1875
E. B. Treadway	Booneville	Owsley	1876
M. Jos. Treadway	do	do	1876
William C. Herrington	Franklin	Simpson	P. 1876
Clinton Smith	Hickory Flat	do	P. 1879
Rev. M. P. Bailey	Elkton	Todd	P. 1860
Lewis Harris	Boxville	Union	P. 1864
Rev. J. L. Caldwell	Bowling Green	Warren	1878
E. F. W. Chelf	do	do	(1881)
J. B. Cooke	do	do	1875
S. W. Coombs, M. D	do	do	P. 1874
E. W. Hill	do	do	P. 1876
E. L. Hines	do	do	P. 1876
Col. William E. Hobson	do	do	(P.) 1876

Geographical catalogue of fish-culturists—Continued.

KENTUCKY—Continued.

Name.	Post-office.	County.	Year.
John W. Jackson	Bowling Green	Warren	P. 1878
Alexander Loving	do	do	P. 1880
John H. Mallory	do	do	1875
E. A. Porter	do	do	P. 1877
John A. Robinson	do	do	1868
William H. Rochester	do	do	1876
N. P. Allen	Smith's Grove	do	P. 1860
J. W. Cooke	do	do	P. 1881
W. H. Cooke	do	do	P. 1860
N. P. Dillingham	do	do	P.
Arch. Howard	do	do	P. 1864
J. R. Kirby	do	do	P. 1881
T. E. McDaniel	do	do	P. 1881
Hon. George Wright	do	do	P. 1877
J. L. Wright	do	do	P. 1878
W. W. Wright	do	do	P. 1850
Robert J. Thompson, M. D	Duckers	Woodford	P. 1879
Alfred Hurst, M. D.	Midway	do	P. 1881
M. E. Poynter, M. D	do	do	1875
George T. Graddy	Spring	do	P. 1868
Charles Alexander	Versailles	do	P. 1877
Capt. Harrison Brown	do	do	1879
J. M. Graves	do	do	H.P. 1877
Hon. R. C. Graves	do	do	P. 1868
Abner C. Hunter	do	do	P. 1875
M. S. Oneal	do	do	P. 1870
Samuel H. Shouse	do	do	P. 1881
Hon. John A. Steele	do	do	P. 1876
John Stout	do	do	P. 1856
John M. Wasson	do	do	P. 1868
D. J. Williams, jr	do	do	P. 1868

LOUISIANA.

Name.	Post-office.	County.	Year.
P. E. Durand	Crane's Forge (?)	Assumption	P. 1879
David Burns	Shreveport	Caddo	1873
J. M. White	Haynesville	Claiborne	P. 1879
J. N. Evans	Bayou Tunica	West Feliciana	P.

MAINE.

Name.	Post-office.	County.	Year.
Dr. F. F. Innis	Houlton	Aroostook	H. 1868
Nathan Decker	Casco	Cumberland	P. 1875
William L. Prince	Cumberland Centre	do	P. 1877
Brown & Wells	North Bridgeton	do	P. 1878
Byron Kimball	do	do	1873
Richard T. Kitson	do	do	1875
John Mead	do	do	1871
George H. Moses	North Gorham	do	1878
George E. B. Jackson	Portland	do	1876
J. M. Kimball	do	do	P. 1873
Everett Smith	do	do	1879
John P. Perley	South Bridgeton	do	P. 1874
Levi H. Morrill	West Cumberland	do	P. 1869
T. L. Page	Phillips	Franklin	1876
Samuel Farmer	do	do	1873
Frank C. Hewey	Rangeley	do	1877
C. T. Richardson	do	do	H.P. 1870
Charles G. Atkins	Bucksport	Hancock	1866
S. S. Brewster	Dedham	do	P. 1877
W. L. Parker	do	do	1866
Judson G. Archer	North Lamoine	do	1875
Harry H. Buck	Orland	do	1877
Nathan Shaw	West Gouldsborough	do	P. 1840
George W. Martin, M. D	Augusta	Kennebec	1870
J. H. Norris	East Monmouth	do	1876
George N. Prescott	do	do	1876
Harry H. Cochrane	Monmouth	do	(1881)
Charles A. Cochrane, M. D	Winthrop	do	1850
Erastus O. Kelly	do	do	1870
J. L. Burns	Washington	Knox	1881
Mrs. David C. Pottle	Whitefield	Lincoln	H.P. 1868
Henry O. Stanley	Dixfield	Oxford	1874

Geographical catalogue of fish-culturists—Continued.

MAINE—Continued.

Name.	Post-office.	County.	Year.
E. W. Bisbee	Norway	Oxford	1870
George A. Cole	do	do	1870
Fred. H. Holmes	do	do	P. 1873
Clarence M. Smith	do	do	H. 1868
L. L. Twitchell	do	do	1875
Elias H. Woodsum	do	do	1874
George H. Jones	Oxford	do	1875
Gustavus O. Hayford	Peru	do	H.P.1860
Samuel M. King	South Paris	do	P. 1876
E. M. Stillwell	Bangor	Penobscot	1870
George A. Abbott	Dexter	do	1874
A. R. Phillips	Holden	do	P. 1870
Asbury C. Adams	La Grange	do	1867
S. O. Brown	Dover	Piscataquis	1873
C. N. Cochrane	do	do	1870
F. W. Gifford	do	do	(1881)
Fred. E. Bailey	Foxcroft	do	1874
Addison P. Buck	do	do	1870
Josiah B. Mayo	do	do	1875
H. C. Prentiss	do	do	1870
O. A. Dennen	Greenville	do	P. 1879
Frank M. Ford	Sebec	do	(1881)
M. B. Spinney	Parker's Head	Sagadahoc	1876
William H. H. Tibbetts	Athens	Somerset	1878
William D. Hayden	Madison Centre	do	1874
Arthur Boyd	Prospect	Waldo	1877
Albert E. Neill	Calais	Washington	1875
Frank Todd	do	do	1860
C. R. Whidden, jr	do	do	(1881)
Benjamin D. Wyatt	do	do	1870
Loring Small	North Lubec (?)	do	1830
L. S. Bailey	Pembroke	do	1874
J. Coolidge Coffin	do	do	H.P.1877
T. Blood	Berwick	York	P. 1878
Benjamin T. Bragdon	Berwick	York	P. 1878
Ira Andrews	Biddeford	do	P. 1876
William E. Andrews	do	do	P. 1877
George W. Bond	do	do	H. 1879
Ferguson Haines	do	do	P. 1879
Dr. Thomas Haley	do	do	P. 1878
Charles H. Robbins	do	do	1877
Rev. Benjamin Dodge	Centre Lebanon	do	(P.) 1865
Samuel D. Wadsworth	Cornish	do	P. 1870
Hon. Nathaniel Hobbs	North Berwick	do	P. 1877
George F. Calef	Saco	do	P. 1878
E. M. Goodall	Sanford	do	P. 1878
John C. Stewart, M. D	York	do	1877

MARYLAND.

Name.	Post-office.	County.	Year.
William Cadle	Chesterfield	Anne Arundel	1877
B. Baldwin	Waterbury	do	P. 1880
Charles H. Mercer	Baltimore	Baltimore	....
Henry Cragg	Saint Denis	do	P. 1870
Simeon Van Trump	Stablersville	do	P. 1878
William Burkight	Bethlehem	Caroline	P. 1879
James E. Hignutt	Denton	do	P. 1868
Henry C. Comegys, M. D	Greensborough	do	P. 1879
William Arbaugh	Carrollton	Carroll	P. 1862
Greenbury W. Weaver	do	do	P. 1878
Michael Walsh	Houcksville	do	P. 1878
William A. McKellip	Westminster	do	1872
William A. Cunningham	do	do	P. 1876
H. H. Duyckinck	Calvert	Cecil	P. 1880
Adam R. Magraw	Colora	do	1876
Stephen C. Magraw	do	do	P. 1877
Aaron J. Michener	do	do	P. 1879
Phillip T. Bell	Conowingo	do	P. 1870
C. C. Caldwell	do	do	1876
Abel T. Lincoln	Farmington	do	P. 1878
A. L. Duyckinck	Rising Sun	do	1879
Job Haines	do	do	P. 1880
William James Evans	do	do	1878
Edwin H. Reynolds	do	do	P. 1880
George M. Christie	Rowlandsville	do	(1881)
Oliver N. Bryan	Marshall Hall	Charles	1860

Geographical catalogue of fish-culturists– Continued.

MARYLAND—Continued.

Name.	Post-office.	County.	Year.
William E. Dunnington	Pisgah	Charles	1878
A. W. Devilbiss	Linganore	Frederick	P. 1875
Thornton Poole	do	do	P. 1879
John D. Shearer	Monrovia	do	P. 1876
William W. Walker	New London	do	P. 1880
William Downey	New Market	do	P. 1880
J. W. Downey, M. D	do	do	P. 1878
Howard H. Hopkins, M. D	do	do	1876
Elisha Swomley	do	do	P. 1879
William G. Wilson	Unionville	do	P. 1880
Pearson Chapman, M. D	Perryman	Harford	(1875)
Harper Carroll	Doughoregan	Howard	1880
J. D. McGuire	Ellicott City	do	P. 1866
William M. Merrick	Ilchester	do	P. 1875
Francis Morris	Oakland Mills	do	1881
Admiral Daniel Ammen	Beltsville	Prince George's	P. 1878
JacobEggerstedt	Fort Foote	do	1881
John McFadden	Sudlersville	Queen Anne	P. 1878
Samuel A. Harrison	Easton	Talbot	1880
Edward L. F. Hordcastle	do	do	1880
J. H. T. Hubbard	do	do	1873
Thomas Hughlett	do	do	P. 1878
D. H. Newcomer	Benevola	Washington	P. 1880
John A. Nicodemus	Smithsburgh	do	P. 1878

MASSACHUSETTS.

Name.	Post-office.	County.	Year.
George W. Davis	Chatham	Barnstable	P. 1876
N. P. Baker	Falmouth	do	P. 1871
Thomas H. Lawrence	do	do	P. 1878
Charles P. Horton	Monument	do	P. 1868
George L. Fessenden	Sandwich	do	P. 1860
Charles W. Lapham	do	do	1855
Valentine B. Newcomb	West Brewster	do	1880
William C. Parker	do	do	1871
J. Howard Winslow	do	do	H.P. 1871
Daniel Bowerman	West Falmouth	do	1871
Lysander A. Chase	West Yarmouth	do	1879
Charles E. West	Dalton	Berkshire	1860
Samuel Camp, M. D	Great Barrington	do	H.P. 1878
Andrew L. Hubbell	do	do	1878
D. J. Barber	North Adams	do	H.P. 1877
George Billings	do	do	H.P. 1877
William H. Spear	do	do	1880
Edwin L. Parker	Pittsfield	do	P. 1871
Henry Russell	South Williamstown	do	1870
Spencer Borden	Fall River	Bristol	P. 1872
George F. Parlow	New Bedford	do	H.P. 1870
Eben S. Perry	do	do	P. 1872
John H. Thomson	do	do	1849
Oliver Ames	North Easton	do	P. 1872
A. J. Barker	Taunton	do	1872
Charles Baylies	do	do	1872
George A. Field	do	do	1872
Baylies, Barker & Field	do	do	H.P.
F. H. Wilber	do	do	(1879)
Allen Look	West Tisbury	Dukes	P. 1850
Charles L. Carter	Andover	Essex	P. 1875
John H. Flint	do	do	P. 1876
Moses Foster	do	do	1875
George H. Poor	do	do	1875
Joseph W. Smith	do	do	1879
William Whitman	do	do	1876
Alfred E. Towne	Bradford	do	1881
Gilman P. Wiggin	Lawrence	do	P. 1874
E. Gerry	Lynnfield	do	P. 1878
George L. Davis	North Andover	do	1880
John D. W. French	do	do	P. 1875
Moses T. Stevens	do	do	1880
Gen. Eben Sutton	do	do	P. 1878
T. Osgood Wardwell	do	do	1875
Charles T. Jenkins	Salem	do	P. 1877
George W. Chadwick	West Boxford	do	P. 1840
Henry C. Booth	Charlemont	Franklin	P. 1869
Lemuel Harris	do	do	P. 1875

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MASSACHUSETTS—Continued.

Name.	Post-office.	County.	Year.
J. Bradford Davenport	Heath	Franklin	P. 1880
Franklin Field	Montague	do	P.
J. P. Morgan	Turner's Falls	do	P. 1878
Gordon C. Rowley	Blandford	Hampden	P. 1876
Arthur B. Chase	Holyoke	do	1878
William A. Chase	do	do	1878
Hon. H. C. Ewing	do	do	P. 1877
George A. Hinks	do	do	1879
T. W. Mann	do	do	P. 1878
William B. C. Pearsons	do	do	1880
E. R. Crafts	Ireland	do	1877
Samuel A. Bartholomew	North Blanford	do	P. 1780
Rev. James H. Bradford	Palmer	do	1868
John A. Squier	do	do	P. 1875
Charles C. Smith	Springfield	do	1867
Col. James M. Thompson	do	do	P.H. 1870
D. B. Wesson	do	do	(1879)
William H. Foote	Westfield	do	P. 1875
Charles K. Foster	do	do	1872
D. C. Hull	do	do	1872
Reuben Noble	do	do	1871
Carlos Pember	do	do	1872
H n. Milton B. Whitney	do	do	1876
Russell H. Pepper	West Springfield	do	P. 1865
R. E. Sabin	do	do	1870
Daniel Holden	Ware	Hampshire	1869
D. W. Miner, M. D	do	do	1870
George Bessant	Ayer	Middlesex	1874
John B. Moore	Concord	do	1875
Henry F. Smith	do	do	1874
George E. Stearns	Billerica	do	P. 1877
Milo B. Stearns	East Pepperell	do	1870
Daniel Weatherbee	Ellsworth	do	1874
E. F. Bowditch	Framingham	do	P. 1881
Luther Prescott	Forge Village	do	1868
Joseph K. Low	Greenwood	do	1877
Hiram Newcomb	do	do	P. 1876
Lyman H. Tasker	do	do	1876
J. F. Wardwell	do	do	1876
Samuel H. Pierce	Lincoln	do	P. 1872
J. W. Chadwick	Malden	do	1860
William H. Cromack	do	do	1865
John Nichols	Marlborough	do	H. 1875
Henry A. Bush	Melrose	do	1878
Edwin M. Fowle	Newton Centre	do	P. 1873
Asa M. Swain	North Chelmsford	do	1867
Rev. A. J. Rossé	Saxonville	do	P. 1875
Frank E. Simpson	do	do	P. 1876
E. Lewis Sturtevant, M. D	South Framingham	do	1870
Oscar F. Glidden	Stoneham	do	1876
William Perham	Tyngsborough	do	P. 1875
John T. Judkins	Wakefield	do	P. 1878
Samuel T. Parker	do	do	1877
Samuel Parker, jr	do	do	1877
Oscar J. Stowell	do	do	1876
R. B. Foster	Waltham	do	P. 1874
H. E. Priest	do	do	P. 1874
Edward A. Brackett	Winchester	do	H.P. 1852
Theodore Lyman	Brookline	Norfolk	1865
John Shields	do	do	1855
W. O. Chapman	Canton	do	1877
M. B. Stetson	Cohasset	do	1860
George S. Estey	Milton	do	1870
Henry L. Pierce	Ponkapog	do	P. 1871
Hollis Hunnewell	Wellesley	do	P. 1874
James F. Simons	do	do	H.P. 1872
Rev. W. R. Tompkins	Wrentham	do	H.P. 1868
Spencer Leonard	Bridgewater	Plymouth	1872
Nahum Stetson	do	do	P. 1860
Henry Hobart	East Bridgewater	do	P. 1862
William H. Osborne	do	do	P. 1869
Col. Ephraim B. Thompson	Halifax	do	P. 1874
John T. Z. Thompson	do	do	1872
Walter L. Gilbert	Plymouth	do	H.P. 1869
John J. Russel	do	do	P. 1876
A. C. Brigham	South Abington Station	do	P. 1873
E. B. Cook	South Abingdon	do	1873
H. F. Copeland, M. D	do	do	1870
Joseph B. Howland	South Hanson	do	1874

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MASSACHUSETTS—Continued.

Name.	Post-office.	County.	Year.
Arthur W. Austin	Boston, 48 State street	Suffolk	P. 1846
Edward T. Barker	Boston, city post-office	do	1880
Francis Bartlett	Boston, 13 Exchange street	do	P. (1881)
John Bartlett	do	do	(1879)
Edward B. Bowen	Boston, 114 Pearl street	do	1877
James B. David	Boston, 8 Dock square	do	1867
Edward Dexter	Boston, 11 Tremont Place	do	H.P. 1868
Sewall H. Fessenden	Boston, 21 Federal street	do	P. 1860
Augustus Flagg	Boston, 110 Washington street.	do	(1881)
Charles Houghton	Boston, 28 State street	do	P. 1876
Arthur Hunnewell	Boston, 15 Exchange street	do	P. 1874
Samuel M. Johnson	do	do	(1879)
Lorenzo Prouty	do	do	1870
W. A. Ramsay	Boston, 99 State street	do	1840
John Revere	Boston, 93 Beacon street	do	1860
C. W. Seabury	do	do	1879
Edmund M. Wood	Boston, 34 Oliver street	do	P. 1874
Charles Granville Way	Boston, 11 Mount Vernon street.	do	1870
J. R. Downing	Brighton	do	P. 1880
Mrs. Anna M. Wright	do	do	P. 1875
Col. Henry Smith	Dorchester	do	1858
Eben N. Hewins	Jamaica Plains	do	(1881)
Elbridge Howe	East Brookfield	Worcester	1875
George D. Colony, M. D	Fitchburgh	do	1871
George Jewett, M. D	do	do	H.P. 1871
Rodney Wallace	do	do	1871
A. D. Waymoth	do	do	P. 1873
Andrew Whitney	do	do	(1881)
Amory Jewett, M. D	Hubbardston	do	P. 1875
Rufus Eager	Lancaster	do	1872
William H. McNeil	do	do	1872
Henry S. Nourse	do	do	1874
J. L. S. Thompson, M. D	do	do	1870
G. W. Willard	do	do	P. 1870
Julius A. George	Mendon	do	P. 1870
Seth P. Carpenter	Milford	do	H.P. 1860
Rolon E. Foster	do	do	1870
Dwight Russell, M. D	do	do	P. 1870
Moses Hildreth	Northborough	do	H. 1873
Francis Hapgood	North Rutland	do	H.P. 1874
George W. Whitin	North Uxbridge	do	P. Prior to 1875
Edgar A. Abbott	Paxton	do	P. 1879
A. E. Maynard	do	do	P. 1877
J. A. Cairuth	Phillipston	do	1876
Charles E. Lamb	do	do	1876
George W. Cowden	Rutland	do	P. 1875
Joseph Burnett	Southborough	do	1872
Hon. George A. Parker	South Lancaster	do	H.P. 1853
M. B. Heywood	Sterling	do	P. 1874
Elisha D. Stone	Still River	do	P. 1878
C. O. Longley	Westborough	do	1875
Henry Pierce	West Boylston	do	P. 1872
Lemuel Fullam	West Brookfield	do	1873
Edward Whitin	Whitinsville	do	P. 1876
Andrew P. Bateman	Winchendon	do	1876
Sidney Fairbanks	do	do	1875
Daniel F. Hall	do	do	H.P. 1870
George S. Loud	do	do	H.P. 1868
Edwin S. Merrill	do	do	P. 1870
Capt. Ephraim Murdock	do	do	P. 1878
Horace H. Wyman	do	do	1876
Sumner Wyman	do	do	P. 1875

MICHIGAN.

Name.	Post-office.	County.	Year.
J. D. Dumont	Allegan	Allegan	1875
Norman R. Ayers	Atwood	Antrim	P. 1871
Daniel H. Fitzhugh, jr	Bay City	Bay	1868
Judge Sidney T. Holmes	do	do	1860
T. C. Phillips	do	do	1879
C. C. Sutton	Benton Harbor	Berrien	H P. 1873
George H. Jerome	Niles	do	P H 1867
Junius H. Hatch	Saint Joseph	do	H.P. 1876
William B. Ransom	do	do	1874

Geographical catalogue of fish-culturists—Continued.

MICHIGAN—Continued.

Name.	Post-office.	County.	Year.
Isaac F. Camp	Alganscе	Branch	P. 1876
John B. Shipman	Coldwater	do	P. 1877
Alexander L. Clark	Battle Creek	Calhoun	1869
Franklin Ewer	do	do	P. 1876
Thomas Hart	do	do	1873
Alexander C. Hamblin	do	do	....
Jabez L. Hayward	do	do	1870
B. F. Hinman	do	do	1876
Henry T. Hinman	do	do	1876
Henry H. Hubbard	do	do	1870
Martin Metcalf	do	do	H.P.1856
N. A. Osgood	do	do	1870
Henry Willis	do	do	P. 1865
A. Garwood, M. D	Cassopolis	Cass	P. 1878
James G. Portman	Pokagon	do	H.P.1871
J. Frederick Merritt	Williamsville	do	1876
Otis Moor, M. D	do	do	1876
George B. Thompson	Boyne	Charlevoix	1870
Andrew Jackson	Sault de Saint Marie	Chippewa	1873
A. F. Young	Escanaba	Delta	H.P.1876
Leonard S. Hoxsie	Acme	Grand Traverse	P. 1875
Amos Bond	Traverse City	do	1865
Nelson Hammond	do	do	P. 1874
John A. Jackson	do	do	1878
C. E. Lockwood	do	do	(1880)
Morris Mahan	do	do	H.P.1870
W. H. C. Mitchell	do	do	H.P.1866
L. Sabine	do	do	P. 1860
Samuel Weidenhamer	do	do	P. 1876
Francis M. Forman, M. D	Walton	do	P. 1860
Arnold Burges	Hillsdale	Hillsdale	1869
B. B. Heacock	do	do	P. 1877
Henry Obenhoff	Houghton	Houghton	P. 1872
Erastus Hedden	Devoreaux	Jackson	P. 1877
William G. Brown	Parma	do	P. 1875
Joseph Brockie	Kalamazoo	Kalamazoo	1864
Hon. Thomas S. Cobb	do	do	1874
Dr. A. T. Metcalf	do	do	P. 1873
George C. Palmer	do	do	1880
Eli R. Miller	Richland	do	1874
Charles F. Holt	Cascade	Kent	P. 1874
Alpha Child	Grand Rapids	do	(1880)
John T. Elliott	do	do	1862
Samuel L. Fuller	do	do	P. 1880
R. N. Goodsell	do	do	(1880)
George A. Gould	do	do	1880
George A. Hall	do	do	1865
William T. Hess	do	do	1875
L. S. Hill	do	do	1870
Dr. E. S. Holmes	do	do	1870
W. O. Hughart	do	do	1880
James M. Nelson	do	do	1880
Dr. J. C. Parker	do	do	1861
G. W. Perkins	do	do	1874
E. A. Strong	do	do	1858
Henry Widdicomb	do	do	(1881)
Henry Green	Grattan	do	P. 1872
John D. Brown	Columbiaville	Lapeer	1869
Leander LeValley	do	do	1878
Asa Richard	do	do	1875
William Keyes	Omena	Leelenaw	P. 1876
Antoine Manseau	Sutton's Bay	do	P. 1860
H. B. Blackman	Howell	Livingston	1876
Edgar Weeks	Mount Clemens	Macomb	1875
Fitch Phelps	Big Rapids	Mecosta	1874
William Rogers	Crystal	Montcalm	1876
H. H. Steffy	do	do	1876
Capt. Erskine B. Fuller	Bluffton	Muskegon	1870
D. B. Allen	Four Towns	Oakland	1877
Henry S. Holdridge	Highland	do	1875
John D. McIntire	Ortonville	do	P. 1874
Peter L. McIntire	do	do	P. 1871
E. D. Richmond	Hart	Oceana	1876
Frederick J. Russell	do	do	1878
A. S. White	do	do	1878
John McNitt	Six Corners	Ottawa	P. 1876
Prof. H. B. Roney	East Saginaw	Saginaw	1875
Hon. William L. Webber	do	do	(1880)
Israel N. Smith, M. D	Saginaw	do	1872
G. Archie Stockwell, M. D	Port Huron	Saint Clair	1869

Geographical catalogue of fish-culturists—Continued.

MICHIGAN—Continued.

Name.	Post-office.	County.	Year.
C. Engle	Paw Paw	Van Buren	P. 1878
George Haunahs	South Haven	do	P. 1876
Alexander M. Campau	Detroit	Wayne	1865
Oren M. Chase	do	do	1873
John P. Clark	do	do	1872
William C. Colburn	do	do	(1880)
James Craig	do	do	1865
C. W. Gauthier	do	do	P. 1870
Andrew J. Kellogg	do	do	1872
E. B. Paxton	do	do	1872
R. H. Tenny	do	do	1875
Frank N. Clark	Northville	do	H.P. 1868

MINNESOTA.

Grover C. Burt	Mankato	Blue Earth	1876
E. L Brackett	Farmington	Dakota	1877
L. P. Dodge, M. D	do	do	1870
Judge F. M. Crosby	Hastings	do	1874
John H. Heath	do	do	1870
C. H. L. Lange	do	do	1876
John C. Meloy	do	do	1877
John P. Gray	Wells	Faribault	1877
George P. Haslerud	Peterson	Fillmore	H.P. 1874
B. Bendickson	Scotland	do	P. 1877
T. B. Sheldon	Red Wing	Goodhue	1877
William W. Sweney, M. D	do	do	1870
S. S. Watkins	do	do	H.P. 1870
John H Webster	do	do	1874
Hon. E. T. Wilder	do	do	1864
Hon. Daniel Cameron	La Crescent	Houston	1878
B. F. Hartshorn	Motley	Morrison	1880
J. Craft, M. D	Worthington	Nobles	1875
Joshua B. Bassett	Douglass	Olmsted	P. 1855
A. C. Miller	Genoa	do	1859
George Welker	do	do	P. 1880
James Button	Rochester	do	1881
——— Popple (see Scott & Popple)	do	do	1879
W. Gilbert Scott	do	do	1879
Scott & Popple	do	do	H.P. ....
Hon. Edmund Rice	Saint Paul	Ramsey	H.P. 1873
Hon. H. M. Rice	do	do	1870
Robert O. Sweeny	do	do	1875
Hon. Horace E. Barron	Faribault	Rice	1847
William W. Champlin	do	do	1870
George M. Gilmore	do	do	P. 1876
Thomas C. Jackson	do	do	1875
Stephen Jewett	do	do	1875
John Mullin	do	do	1874
James G. Scott	do	do	1875
W. W. Waugh, M. D	do	do	1875
Prof. Harry E. Whitney	do	do	1878
George Weston Wood, M. D	do	do	1873
Seth H. Kenney	Morristown	do	1877
Stepehn W. Kenney	do	do	P. 1877
M. T. Porter	Murdock	Swift	1860
Mrs. S. L. Carruth	Lake City	Wabasha	P. 1881
William P. Brown	Mazeppa	do	P. 1876
George Davis	Stillwater	Washington	H.P. 1865
William Schermnly	do	do	H.P. 1873

MISSISSIPPI.

A. M. Belsher	Rienzi	Alcorn	P. 1879
C. W. Williams, sr	do	do	P. 1870
M. G. Anderson	Centreville	Amite	P. 1850
T. N. L. Anderson, sr	do	do	P.
Daniel McNeil	do	do	P. 1876
J. H. Hines, M. D	Merwin	do	P. 1877
G. W. Crowder	Kosciusko	Attala	P. 1880
S. P. Rimmer & Son	do	do	H.P. 1889
P. T. Stephens	do	do	P 1880
Sallis & Ware	Sallis	do	P. 1879

Geographical catalogue of fish-culturists—Continued.

MISSISSIPPI—Continued.

Name.	Post-office.	County.	Year.	
J. M. Dalton	Dido	Choctaw	P.	1880
M. S. Humphreys	Port Gibson	Claiborne	P.	
S. E. Scarbrough	De Soto	Clarke	P.	1880
Mrs. Mollie W. Smith	do	do	P.	1879
C. A. Stovall	Shubuta	do		1879
J. B. W. Pitchford	Tibbee Station	Clay	P.	1875
G. V. Young	Waverly	do	P.	1880
William L. Young	do	do	P.	1850
William H. Stovall	Prairieville	Coahoma	P.	1880
E. R. Brown	Hazlehurst	Copiah	P.	1880
William King	do	do	P.	1880
Judge E. G. Peyton	do	do	P.	1879
W. W. Bott	Olive Branch	De Soto	P.	1880
H. F. Buchanan	do	do	P.	1880
A. A. Ulman	Bay Saint Louis	Hancock	P.	1874
Joseph R. Davis	Beauvoir	Harrison		1878
E. E. Baldwin	Bolton's Depot	Hinds	P.	1877
Ira E. Davis	do	do	P.	1880
C. C. Harris	do	do	P.	
A. Lacey	do	do	P.	1874
T. A. Mellon	do	do	P.	1881
James Parkman	do	do	P.	
Mrs. Ann R. Robertson	do	do	P.	1865
John Shelton	Raymond	do		1880
I. W. Burch	Fayette	Jefferson	P.	1877
Put. Darden	do	do	P.	1877
W. L. Harper	do	do	P.	1879
P. M. Pearcefield	do	do	P.	1881
J. B. McCormack	do	do	P.	1865
George W. Shackleford	do	do	P.	1869
W. V. Sneed	Oxford	La Fayette	P.	1880
R. G. Hewlett	do	do	P.	1872
M. A. Goodwin	Spring Dale	do	P.	1879
E. M. Chandler	Taylor	do	P.	1879
R. W. Banks	Cobb Switch	Lowndes	P.	1875
J. J. Colmant	Columbus	do	P.	1860
G. W. Cox	do	do	P.	1877
C. A. Johnston	do	do		1875
William C. Richards	do	do		1875
James S. Rily, M. D	Quincy	Monroe	P.	1878
H. C. Terrell & Co	do	do	P.	1878
James B. Gaines	Decatur	Newton	P.	1875
G. M. Gallaspy	do	do	P.	1879
W. H. Gallaspy	do	do	P.	1877
M. J. L. Hoye	do	do	P.	1879
H. W. Laird	do	do	P.	1877
Thomas B. McCune	do	do	P.	
A. Russell	do	do	P.	1881
Martin W. Stamper	do	do	P.	1880
J. W. Guthrie	Newton	do	P.	1880
J. C. McElroy	do	do	P.	1880
R. H. Weir	do	do	P.	1880
William H. Harvey	Sessumsville	Oktibbeha	P.	1879
D. W. Outlaw	do	do	P.	1879
A. F. Young	do	do	P.	1881
William B. Aikin	Starkville	do	P.	1881
A. B. Dille	do	do	P.	1878
H. M. Nason	do	do	P.	1870
H. L. Muldrow	do	do	P.	1881
John Oswalt	Whitefield	do	P.	1876
William J. Barron, M. D	do	do		1870
Maj. James J. Conway	Chatawa	Pike	P.	1880
W. Alexander Gordon	do	do	P.	1870
Sisters of Notre Dame	do	do	P.	1880
M. M. Whitney	Summit	do	P.	1880
Richard Bolton	Pontotoc	Pontotoc	P.	1860
Michael Cox	Orizaba	Tippah	P.	1870
George E. Hess	Iuka	Tishomingo	P.	1870
S. W. Boswell	Vicksburg	Warren		1878
W. P. Mauldin	Tokio	Wayne		1880
Joseph G. Meador	Winchester	do	P.	1872
Gen. W. L. Brandon	Fort Adams	Wilkinson	P.	1855
L. L. Babers	do	do	P.	1858
Joseph Redhead, M. D	Woodville	do	P.	1849

Geographical catalogue of fish-culturists—Continued.

MISSOURI.

Name.	Post-office.	County.		Year.
Hon. David Rea	Savannah	Andrew		
Dr. Benson Bond	Elk Dale	Atchison	P.	1880
Nelson O. Hopkins	Rockport	do	P.	1880
J. M. Proctor	Sturgeon	Boone	P.	1873
Daniel W. Clouser	Halleck	Buchanan	P.	1880
R. H. Faucett	do	do	P.	1873
James Terrell	do	do	P.	1877
John W. Mattucks	do	do	P.	1876
J. H. C. Robinson, M. D	do	do	P.	
James N. Burnes	Saint Joseph	do	P.	1873
Thomas J. Burgess	do	do	P.	1876
H. C. Carter	do	do		1870
George C. Catlett, M. D	do	do	P.	1875
Frank G. Hopkins	do	do		1879
Hon. Silas Woodson	do	do		1870
R. J. Hughes	Breckenridge	Caldwell		1882
John S. Kirby	Guthrie	Callaway	P.	1879
Harvey Batts	Battsville	Carroll	P.	1876
Bryant Bartlett	Clarke City	Clarke	P.	1867
John Weaver	Centre Town	Cole	P.	1874
James A. Green	Cuba	Crawford	P.	1877
John Green, M. D	do	do		1875
Newton Jones	do	do		1875
C. Brickey	Osage	do	P.	1878
Mrs. Susan Carlock	Dadeville	Dade	P.	1880
John C. Alther	Clover Bottom	Franklin	P.	1864
John S. Vowak	do	do	P.	1881
Levi Dodge	Mound City	Holt	P.	1878
Granville Shults	do	do	P.	1879
John H. Delano	Arcadia	Iron	P.	1876
Hon. J. W. Emerson	Ironton	do	P.	1877
Spencer & William	Avilla	Jasper	P.	1871
James P. Betts	Carthage	do		1879
John O. Lockhart	Dover	La Fayette	P.	1880
Col. John Reid	Lexington	do		1876
Oliver P. Johnson, sr	Paris Springs	Lawrence	P.	1876
Robert J. Alexander	Pierce City	do	P.	1872
A. McKinney	do	do	P.	1878
A. C. Persing	do	do		1878
N. H. Smith	do	do		1871
Rufus Baird	Fredericktown	Madison	P.	1880
W. H. Gosney, M. D	do	do	P.	1878
James C. Linton	do	do	P.	1878
William Nifong, M. D	do	do	P.	1880
Samuel Newton	High Point	Moniteau	P.	1875
David C. Sterling	do	do	P.	1875
Horace W. Pocoke, M. D	Montgomery City	Montgomery		1877
George W. Varnum, M. D	do	do	P.	1875
Jackson Brothers	Hughesville	Pettis	P.	1880
William Lowry	do	do	P.	1880
R. E. Baker	Sedalia	do	P.	1873
Lucius L. Bridges	do	do	P.	1850
Logan Clark, M. D	do	do		1880
James D. Cobine	do	do		(1881)
Hezekiah E. Depp, D. D. S	do	do		(1881)
Henry C. Sinnett	do	do		1862
John W. Trader, M. D	do	do		1880
Hon. R. P. C. Wilson	Platte City	Platte		1879
Theodore F. Warner	Weston	do		1879
M. McKenzie, M. D	Centreville	Reynolds		1879
A. H. Shy	do	do		1879
John R. Hereford, M. D	Ferguson	Saint Louis	P.	1876
Oscar Reid	do	do	P.	1873
John Y. Page	do	do		1873
Hon. Erastus Wells	Rinkelville	do	P.	1878
W. W. Dedrick	Saint Louis	do		(1880)
Edward G. Eggeling	do	do	P.	1879
W. R. Faribault	do	do		1881
John D. Johnson	do	do		1870
Henry S. Lipscomb	do	do	P.	1876
L. G. W. Steedman, M. D	do	do		1872
Eugene F. Weigel	do	do	P.	1878
Neziah W. Bliss	Kingston Furnace	Washington		1879
John D. Hearst	do	do		1865
George W. Taylor	do	do		1870
Hon. L. J. Farwell	Grant City	Worth	P.	1853

Geographical catalogue of fish-culturists—Continued.

MONTANA TERRITORY.

Name.	Post-office.	County.	Year.
John P. McKenzie	Dewey's	Beaver Head	1880
John R. Cox	Fort Shaw	Lewis & Clarke	P. 1879

NEBRASKA.

Name.	Post-office.	County.	Year.
A. L. Nickerson	Albion	Boone	1880
J. W. Currie	do	do	P. 1878
Robert R. Livingston, M. D	Plattsmouth	Cass	1879
Romine & Decker	South Bend	do	H.P. 1878
Hon. J. T. Clarkson	Schuyler	Colfax	1881
Rev. John G. Gasmann	do	do	P. 1879
John Burns	Stockton (?)	Franklin	P. 1880
Nathan Blakely	Beatrice	Gage	1870
L. B. Wamsley, M. D	Scotia	Greeley	1879
G. D. Proctor	Meridian	Jefferson	P. 1875
S. C. Elliott	Lincoln	Lancaster	1879
J. H. Harley	do	do	1876
Hon. O. P. Mason	do	do	P. 1878
Burr H. Polk	do	do	1876
Hon. Guy C. Barton	North Platte	Lincoln	1876
Rev. Frank E. Bullard	do	do	1876
Walter W. Conklin	do	do	1878
Hon. Beach I. Hinman	do	do	P. 1880
John F. Hinman	do	do	P. 1879
I. W. La Munyon	do	do	P. 1877
J. H. McConnell	do	do	1874
H. N. Nichols	do	do	1867
Charles L. Wood	do	do	1879
Robert W. Furnas	Brownville	Nemaha	1860
Dr. D. P. Neihart	Nebraska City	Otoe	1850
M. W. Neihart	do	do	H.P. 1878
Albert J. Arnold	Columbus	Platte	P. 1873
George W. Hulst	do	do	P. 1876
Dr. J. S. McAlister	do	do	1870
Rev. Andrew Henrich	Metz	do	P. 1876
Hugh M. Ross	Alexandria	Thayer	1878
George D. Rathmann	Blair	Washington	P. 1877
H. S. Kaley	Red Cloud	Webster	H.P. 1877

NEVADA.

Name.	Post-office.	County.	Year.
Henry Clay Fenstermaker	Eureka	Eureka	H.P. 1877
Joseph Mendes	do	do	P. 1879
T. D. Page	do	do	P. 1879
Pablo Laveaga	Unionville	Humboldt	P. 1879
Edward W. Harris	Silver City	Lyon	1870
Mrs. L. W. Compton	Belmont	Nye	P. 1868
E. H. Kincaid	do	do	P. 1880
George Nicholl	do	do	1871
Isaac D. Pasco	do	do	P. 1879
Peter Peterson	do	do	P. 1880
J. T. Williams	do	do	P. 1878
Mrs. Elizabeth Wilson	do	do	P. 1879
C. A. Brown	Duckwater	do	(1880)
A. H. Greenhalgh	Junction	do	P. 1874
Frank H. P. Miller	Morey	do	P. 1879
Archer Moore	do	do	P. 1878
George H. Davis, jr	Carson City	Ormsby	1878
Edward Harper	do	do	1833
Ernest Harris	do	do	1870
H. G. Parker	do	do	H.P. 1876
George C. Bryson	Virginia City	Storey	1877
Frank Green	do	do	H.P. 1875
W. A. Perkins	do	do	(1880)
George W. Taft	Diamond	White Pine	P. 1879

NEW HAMPSHIRE.

Name.	Post-office.	County.	Year.
J. S. Robinson	Meredith Village	Belknap	P. 1867
Charles E. Dickerman	New Hampton	do	H.P. 1874
Wesley Knowles	Tilton	do	P. 1879
Jonathan W. Sanborn	Sanborn's Mills (?)	Carroll	H.P. 1877

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NEW HAMPSHIRE—Continued.

Name.	Post-office.	County.	Year.
Augustus Eastman	North Conway	Carroll	P. 1870
D. S. Burley	Union	do	1872
Frederick J. Chandler	Alstead	Cheshire	P. 1870
W. La Roy Felch	Ashuelot	do	P. 1880
Cyrus H. Bemis	East Sullivan	do	P. 1870
H. B. Streeter	Hinsdale	do	P. 1881
J. J. Streeter	do	do	P. 1865
George A. Starkey	Troy	do	H.P.1873
L. T. Hazen	Hazen's Mill	Coos	P. 1877
E. B. Hodge	Plymouth	Grafton	1867
Albina H. Powers	do	do	1876
Daniel Abbott	Rumney	do	P. 1874
Albert C. Emerson	do	do	P. 1869
I. M. Williams	Brookline	Hillsborough	P. 1875
George K. Wood	Francestown	do	P. 1876
John Hoyt	Manchester	do	(P.) 1870
Samuel Webber	do	do	1870
George F. Andrews	Nashua	do	1881
Hon. Virgil C. Gilman	do	do	1877
Charles H. Nutt	do	do	1877
Oliver H. Phillips	do	do	1867
Gilman C. Shattuck	do	do	P. 1860
Edward Spalding, M. D	do	do	H.P. 1867
Gen. George Stark	do	do	1870
A. H. Crosby, M. D	Concord	Merrimack	1865
Eilson C. Eastman	do	do	1869
Arthur Fletcher	do	do	1865
Dr. William W. Fletcher	do	do	1865
J. H. Gallinger, M. D	do	do	1880
Hon. John M. Hill	do	do	1860
Jonas B. Aiken	Franklin	do	(P.) 1862
G. L. Flint	Henniker	do	1875
O. H. Noyes	do	do	P. 1862
M. Eldredge	Portsmouth	Rockingham	P. (1881)
Newell J. Bickford	Great Falls	Strafford	P. 1877
Thomas G. Jameson	do	do	P. 1877
George Worster	do	do	P. 1871
Luther Hayes	Milton	do	1876
James Farrington, M. D	Rochester	do	P. 1876
Cyrus K. Sanborn	do	do	1877
H. H. Hooper	Charleston	Sullivan	1864
Arthur G. and Charles H. Smith	do	do	P. 1874
Livingston Stone	do	do	H.P. 1864

NEW JERSEY.

Name.	Post-office.	County.	Year.
Wakeman Holberton	Hackensack	Bergen	1860
George Ricardo	do	do	1874
George M. Fairchild, jr	Paskack	do	1872
Wheeler W. Phillips	Ridgewood	do	1878
Prof. John H. Brakeley	Bordentown	Burlington	P. 1871
William Griswold	Jobstown	do	1878
P. Lorillard	Lewistown	do	P. 1878
James A. Fenwick	New Lisbon	do	P.
Franklin Antrim	Red Lion	do	P. 1878
B. W. Braker	Camden	Camden	1878
Richard T. Miller	do	do	1878
Joseph W. Oro	do	do	1878
Smith E. Hughes	Cape May Point	Cape May	P. 1880
John Hartman	Millville	Cumberland	P. 1879
George Wood	do	do	1870
Fred. Mather	Newark	Essex	P.H. 1867
H. N. Munn	Orange	do	1875
Milton P. Peirce	Wenonah	Gloucester	H.P. 1855
George G. Green	Woodbury	do	P. 1877
Lewis M. Green	do	do	P. 1876
Benjamin P. Howell, M. D	do	do	1870
Samuel H. Kirby	do	do	P. 1877
A. A. Anderson	Bloomsbury	Hunterdon	P.H. 1867
R. B. Reading	Raven Rock	do	1878
George O. Poulson	Sergeantsville	do	P. 1878
Col. E. J. Anderson	Trenton	Mercer	H.P. 1860
Thomas Crozer	do	do	H.P. 1873
Hal. Allaire	Allaire	Monmouth	H.P. 1874
John Bruere	Allentown	do	P. 1876
Elwyn S. Green	East Long Branch	do	1878
Robert Bruere	Imlaystown	do	1875

Geographical catalogue of fish-culturists—Continued.

NEW JERSEY—Continued.

Name.	Post office.	County.	Year.
Robert Kirby	Imlaystown	Monmouth	P. 1870
William S. Conover	Marlborough	do	1875
J. D. Houce	Wickatunk	do	1879
George Shepard Page	Stanley	Morris	1867
J. W. Kinsey	Barnegat	Ocean	1877
John C. Roe	Paterson	Passaic	H.P. 1862
Abram S. Hewitt	Ringwood	do	H.P. 1870
Jehiel T. Smith	Andover	Sussex	1875
Theodore Morford	Newton	do	1877
J. R. Shotwell	Rahway	Union	1873
Lewis C. Weller	Columbia	Warren	1872
George Young	do	do	H.P. 1872

NEW MEXICO.

Name.	Post office.	County.	Year.
Carl W. Wildenstein	Watrous	Mora	(1881)
William Kroenig	do	do	P. 1876

NEW YORK.

Name.	Post office.	County.	Year.
George Dawson	Albany	Albany	1844
Chauncey P. Williams	do	do	1874
Ira Cutler	Almond	Allegany	P. 1878
A. L. Maxson	Little Genesee	do	P. 1874
O. D. Browning	Wellsville	do	1878
Clarence A. Farnum	do	do	1873
G. Eugene Farnum	do	do	1878
George Howe	do	do	1878
H. K. Opp	do	do	1878
C. L. Parker	do	do	1873
J. Cotton Smith	do	do	1850
Henry C. Wilcox	do	do	1877
A. P. Vining	Conkling Forks	Broome	P. 1869
George McDonald	Sanford	do	P. 1876
William Dorchester	Whitney's Point	do	1876
William Pool	Windsor	do	P. 1861
L. G. Brainard	Randolph	Cattaraugus	1878
E. K. Carpenter	do	do	1881
Carpenter & Willoughby	do	do	H.P.
J. B. Eddy	do	do	1873
J. B. & F. W. Eddy	do	do	H.P.
Frank W. Eddy	do	do	1873
Benedict Freeburg	do	do	1872
Rev. B. C. Willoughby	do	do	1878
John Carr	Union Springs	Cayuga	P. 1865
Charles Davis	do	do	P. 1870
A. G. Howell	do	do	1876
B. Robinson	do	do	P. 1876
Jefferson P. Myers	Frewsburgh	Chautauqua	P. 1875
D. Hall	Smyrna	Chenango	1875
Ira G. French	Canaan Four Corners	Columbia	P. 1873
H. C. Bradley	East Chatham	do	P. 1872
Gifford W. Chrysler	Kinderhook	do	H.P. 1868
William J. De Silva	Grant's Mills	Delaware	P. 1875
Peter H. Christie	Clove	Dutchess	P. 1866
John S. Van Wyck	Clove Valley	do	(1872)
J. G. Burrow	Fishkill	do	1858
Robert N. Verplank	Fishkill Plains	do	P. 1870
Albert Emans	La Grangeville	do	1873
S. H. Mase	Matteawan	do	1875
P. A. M. Van Wyck	New Hamburg	do	1870
Henry E. Hawkey	Poughkeepsie	do	1865
J. S. Van Cleef	do	do	P. 1865
T. G. Palmer	Schultzville	do	P.
Theodore Wheeler	Wing's Station	do	P. 1877
Amos Freeman	East Hamburg	Erie	P. 1879
Harvey White	Keene Valley	Essex	P. 1861
Myron Buttler	Newcomb	do	H.P. 1877
B. T. Sprague	Wadhams Mills	do	P. 1878
A. A. Pierce	Westport	do	P. 1870
Alonzo R. Fuller	Malone	Franklin	H.P. 1865
Miss Josephine Hopkins	Catskill	Greene	1877
P. V. Van Orden	do	do	1875
J. S. Whitbeck	Gayhead	do	P. 1879

Geographical catalogue of fish-culturists—Continued.

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Name.	Post-office.	County.	Year.
John M. Goodwin	Palenville	Greene	H.P. 1877
A. W. Marks	do	do	1870
Hon. F. James Fitch	Prattsville	do	1854
S. S. Mulford	Tannersville	do	H. 1877
Aaron Roggen	do	do	1876
W. Duane Histed	Cedar Lake	Herkimer	1876
Seth George Fenner	Cold Brook	do	P. 1874
John M. Alvord	Frankfort Hill	do	P. 1870
John Hemstreet	Gray	do	P. 1868
John Russell	Russia	do	P. 1868
Alfred A. Moor, M. D	West Winfield	do	H.P. 1876
J. W. Stanton	Wilmurt	do	P. 1881
C. E. Mosher	Le Raysville	Jefferson	P. 1877
Alexander Brown	Rutland	do	1879
S. J. Mooney	do	do	P. 1878
A. K. Tuttle	Saint Lawrence	do	H.P. 1872
Dr. John D. Huntington	Watertown	do	P. 1867
Arthur W. Benson	Brooklyn	Kings	P. 1877
James B. Blossom	do	do	1871
Anthony F. Campbell	do	do	1870
John Y. Culyer	do	do	1870
Charles Hallock	do	do	1850
H. D. McGovern	do	do	P. 1858
John B. Morgan	do	do	H. 1878
Nicholas Pike	do	do	1845
R. E. Van Gieson, M. D	do	do	(1880)
N. W. Hunt	Williamsburgh	do	(1880)
Joseph Simonett	Belfort	Lewis	P. 1876
James D. Smith	Greig	do	P. 1865
Leonard C. Davenport	Lowville	do	P. 1877
Fred. S. Easton	do	do	P. 1881
Judge Eliada S. Merrell	do	do	P. 1860
Pulaski G. Swan	Petrie's Corners	do	P.
Charles Fenton	Watson	do	P. 1876
Edmund Harvey	do	do	P.
Peter Kirby	do	do	P. 1881
James Annin, jr	Caledonia	Livingston	H.P. 1872
Samuel P. Allen	Geneseo	do	1876
L. W. Ledyard	Cazenovia	Madison	1872
S. Newhouse	Community	do	P. 1874
George Cross	Morrisville	do	1871
O. E. Messinger	Oneida Lake	do	1868
George E. Harmon	Churchville	Monroe	P. (1881)
J. F. Ward	Mumford	do	P.
Seth Green	Rochester	do	1864
Alexander B. Lamberton	do	do	1870
Rev. H. H. Thomas	do	do	H.P. 1872
Hon. John H. Starin	Fultonville	Montgomery	P. 1879
S. L. Frey	Palatine Bridge	do	1876
Hon. Martin Schenck	Spraker's Basin	do	H.P. 1875
E. G. Arthur	New York, 29 Drexel	New York	(1881)
Eugene G. Blackford	do Fulton Market	do	1872
W. L. Breese	do Union Club	do	1878
J. E. Briggs	do Box 1116	do	H.P. 1875
I. S. Coffin	do Box 3634	do	1873
Oscar Comstock	do Fulton Market	do	1850
William A. Conklin	do Central Park	do	1874
W. C. Comp	do	do	1876
Townsend Cox	do 258 Fourth av	do	P. 1876
Henry F. Crosby	do 18 Cliff st	do	1878
William E. Damon	do 270 W. 23d st	do	1870
Gen. Thomas A. Davies	do 610 Fifth av	do	1849
H. P. De Graaf	do Bowery Bank	do	H.P. 1870
George W. Dow	do	do	P. 1865
Gaston L. Fenardent	do 30 La Fayette av	do	1860
William M Fliess	do 47 Broadway	do	1875
George Gifford	do	do	(1881)
Livingston Gifford	do	do	(1881)
H. W. Gray	do South Side Club	do	1881
Albert Haley	do	do	1877
William P. Holly	do	do	(H.P) 1868
P. Kelly	do 346 Sixth av	do	(1881)
William O. McDowell	do 20 Spruce st	do	P. 1871
F. H. Macy	do	do	1874
A Bell Malcomson, jr	do 37 Park Row	do	1873
Robert T. Morris	do	do	(1881)
Benjamin E. Mull	do Fulton Market	do	P. 1874
John Mullaly	do 114 White st	do	1873
Philip Neidlinger	do 27 Beekman st	do	1878
Franklin T. Pember	do 164 Fifth av	do	1874

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Name.	Post-office.	County.	Year.
Barnet Phillips	New York, Times Office	New York	1865
Thomas E. Porter	do Box 512	do	1868
Roland Redmond	do 113 Franklin st	do	1881
J. Reynal	do 84 White	do	1877
C. B. Reynolds	do 39 Park Row	do	(1881)
Garrett Roach	do 814 E. Ninth st	do	P. 1872
A. L. Rogers	do 15 Fulton st	do	1848
R. Barnwell Roosevelt	do 76 Chambers st	do	H.P. 1850
James W. Simonton	do 195 Broadway	do	1880
Thomas B. Stewart	do 23d street	do	P. 1870
Sumner R. Stone	do 46 Exchange pl	do	1860
Col. James Monroe Tower	do 254 Broadway	do	1868
Thomas E. Vallentine	do Box 452	do	P. 1876
Cornlius Van Brunt	do 121 Chambers st	do	H.P. 1871
George W. Van Siclen	do 99 Nassau st	do	1870
George Van Wagenen	do 212 West st	do	(1881)
Lawrence Van Wyck	do 216 W. 21st st	do	1863
George E. Ward	do 43 South st	do	P. 1872
Edward R. Wilbur	do 111 Fulton st	do	P. 1870
H. W. Leonard, M. D	Camden	Oneida	1874
David Morris	Cassville	do	P. 1877
B. G. Chapman	Clayville	do	P. 1880
A. H. King	do	do	P. 1878
George F. Waldron	do	do	P. 1877
Chester M. Osborn	Florence	do	P. 1874
Merchant M. Mayhew	Marcy	do	P. 1864
A. L. Edie	Maynard	do	P. 1860
J. O. Gaymonds	do	do	P. 1879
Thomas W. Jones	do	do	P. 1878
William Jones	do	do	P. 1875
John French	New Hartford	do	P. 1868
Richard U. Sherman	do	do	1875
Hon. John Stryker	Rome	do	P. 1868
Charles W. Hutchinson	Utica	do	P. 1870
Horatio Seymour	do	do	1867
John F. Seymour	do	do	1881
George Michael Weaver	do	do	P. 1873
William Watson	Whitestown	do	P. 1880
James M. Halsted	Elbridge	Onondaga	P. 1979
James Geddes	Fair Mount	do	1879
Israel K. Perry	Half Way	do	H.P. 1873
Henry H Porter	do	do	H.P. 1872
James H. Anderson	Onondaga Valley	do	P. 1874
C. F. Merrill, M. D	Skaneateles	do	(1880)
Joseph C. Willetts	do	do	1876
L. A. Eddy	Syracuse	do	1871
Reuben Wood	do	do	1864
L. M. Drury	Canandaigua	Ontario	P. 1854
N. Sutton	Naples	do	P. 1879
Hon. Stephen H. Ainsworth	West Bloomfield	do	H.P. 1860
Samuel B. Beyen	Howell's Depot	Orange	P. 1873
John Logue Ketcham	Otisville	do	P. 1881
William Mapes	do	do	P. 1872
William H. Wood	Slate Hill	do	P. 1881
Carlon Church	Fulton	Oswego	P. 1865
Myron Pardee	Oswego	do	H.P. 1868
A. R. Ware	Oswego Falls	do	P. 1870
W. R. Field	Richland	do	H.P. 1873
Edward Clark	Cooperstown	Otsego	1869
Capt. P. P. Cooper	do	do	1871
Elihu Phinney	do	do	1870
A. W. Thayer	do	do	1870
Niram Vaughn	Worcester	do	1880
Albert Rackow	Foster's Meadow	Queens	H.P. 1877
Samuel L. M. Barlow	Glen Cove	do	1880
Joshua W. Barnum	Hempstead	do	P. 1870
William H. Furman	Maspeth	do	H.P. 1867
Edward H. Seaman	Ridgewood	do	H.P. 1873
Thomas Clapham	Roslyn	do	H.P. 1870
John M. Crowell	Sea Cliff	do	H.P. 1835
George S. Floyd-Jones	Seaford	do	P. 1881
John D. Jones	do	do	P. 1865
William Floyd-Jones	do	do	P. (1881)
W. R. T. Jones	do	do	P. (1881)
Thomas Jeffrey	Smithville South	do	P. 1859
Andrew Conselyea	Springfield Store	do	P. 1878
Albert Roeckel	do	do	1875
Thomas M. Newbould	Valley Stream	do	P. 1880
Nathaniel T. Green	Berlin	Rensselaer	P. 1873
D. J. Hull	Centre Berlin	do	P. 1879

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Name.	Post-office.	County.	Year.
Alfred Judd	Parishville	Saint Lawrence	1840
Josiah L. Brown	Potsdam	do	1879
Robert Gridley	Saratoga Springs	Saratoga	H.P. 1864
Milo N. Bradley	Richmondville	Schoharie	P. 1878
T. V. Smith	Sharon Springs	do	P. 1880
Charles Kellogg	Odessa	Schuyler	1877
Byron Pierce, M. D	Cooper's Plains	Steuben	1860
Samuel M. Alley	Hornellsville	do	(1881)
J. W. Bachman	do	do	1860
J. Otis Fellows	do	do	1879
Daniel F. Gardner	do	do	1873
H. D. Leach	do	do	1880
J. W. Robinson, M. D	do	do	1878
Chansey Jordon	Wayland Depot	do	H.P. 1867
Timothy C. Carman	Amityville	Suffolk	P. 1842
John E. Ireland	do	do	P. 1860
Erastus Tooker	Babylon	do	P. 1855
Nathaniel Miller	Brook Haven	do	H.P. 1871
Charles Valentine	do	do	P. 1876
Townsend Jones	Cold Spring Harbor	do	P. 1876
Samuel H. Tuthill	East Marion	do	(P.) 1880
John. W. Masury	Eastport	do	H.P. 1868
William Nicoll	Islip	do	P. 1876
Roscoe Bishop	Northport	do	1875
Hon. Henry J. Scudder	do	do	H.P. 1868
James Benkard	Oakdale Station	do	H.P. 1866
William H. Hines	do	do	1875
W. K. Vanderbilt	do	do	(1881)
George W. Thompson	Sag Harbor	do	H.P. 1874
Edward Thompson	Saint Johnland	do	H.P. 1878
Aaron S. Vail	Smithtown	do	P. 1859
John M. Tyler	Smithtown Branch	do	H.P. 1868
J. Grafton	South Haven	do	P.
Lewis S. Davis	Stony Brook	do	P. 1871
W. J. Weeks	Yaphank	do	P. 1878
Ira Hoyt	Halsey Valley	Tioga	H.P. 1872
C. H. Farnham	Milton	Ulster	1868
Jesse M. Bush	Adirondack	Warren	P. 1876
Eben D. Whitcomb	Centre White Creek	Washington	H.P. 1865
Clarence F. Stoddard	Granville	do	1873
C. B. Blossom	West Granville Corners	do	1880
N. E. Paine	Hallock's Mills (?)	Westchester	P. 1875
George W. Dibblo	Irvington	do	P. 1879
Samuel Shethar	New Castle	do	P. 1881
G. P. Lowrey	Tarrytown	do	P.
George Caulfield	White Plains	do	P. 1870
O. S. Reddout	Middlesex	Yates	1865
Cyrenius C. Townsend	Penn Yan	do	P. 1875

NORTH CAROLINA.

R. B. Pickard	Mebanesville	Alamance	P.
George W. Thompson	Cherry Lane	Alleghany	P. 1868
George T. Little	Wadesborough	Anson	P. 1881
W. R. Capehart, M. D	Avoca	Bertie	H.P. 1877
Henry Addix	New Supply	Brunswick	1870
Capt. J. C. Mills	Brindletown	Burke	P. 1877
James W. Wilson	Morganton	do	P. 1878
Stephen G. Worth	do	do	H.P. 1877
Alexander Blackwelder	Concord	Cabarrus	P. 1878
Charles McDonald	do	do	P. 1875
Thomas L. Martin	Harrisburgh	do	P. 1876
Lawson Heilig	Mount Pleasant	do	P. 1877
C. A. Barringer	Springsville	do	P. 1881
J. B. Harris	do	do	P. 1881
Rector Dyson	Collettsville	Caldwell	P. 1878
R. L. Beall, M. D	Lenoir	do	P. 1867
Col. George N. Folk	do	do	P. 1878
J. H. Powell	Catawba	Catawba	1880
William H. Ellis	Hickory	do	P. 1878
G. M. Yoder	Jacob's Fork	do	1880
H. F. Carpenter	Newton	do	P. 1878
Matthew L. McCorkle	do	do	P. 1879
John B. DeGraffenriedt	Hadley's Mills	Chatham	P. 1878
John W. Perry	Leewood	do	1881
J. L. Sheppard	Osgood	do	P. 1878

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Name.	Post-office.	County.		Year.
J. B. Harris	Pittsborough	Chatham	P.	1874
John W. Taylor	do	do	P.	1878
Isaac H. Clegg	Saint Lawrence	do	P.	1874
M. R. Kimsey	Hayesville	Clay	P.	1878
H. F. Schenck	Cleveland Mills	Cleveland	P.	1875
C. C. Durham	Shelby	do	P.	1868
Albert Green	do	do	P.	1877
Rev. A. L. Stough	do	do	P.	1876
Col. H. B. Short	Flemington	Columbus	P.	1870
Jonathan Gore	Pireway Ferry	do	P.	1876
John R. Hanes	Fulton	Davie	P.	1881
H. B. Ireland	do	do	P.	1877
Virgil A. Wilson	Bethania	Forsyth	P.	1878
James T. Tate	Mountain Island	Gaston		1881
D. W. C. Benbow	Greensborough	Guilford	P.	1868
James Joyce	do	do	P.	1879
W. T. Jenkins	Edgewood (?)	Halifax	P.	1880
I. Faulcon Browne	Littleton	do	P.	1852
Charles W. Garrett	do	do	P.	1880
John P. Leach	do	do	P.	1880
W. E. Spruill	do	do	P.	1877
John J. Williams	Oakland (?)	do	P.	1875
John A. Spears	Lillington	Harnett		1860
Isaac M. Lyda	Edneyville	Henderson	P.	1877
James W. Lyda	do	do	P.	1879
Mrs. Hayne Davis	Statesville	Iredell	P.	1880
W. A. Eliason	do	do	P.	1880
W. W. White	do	do	P.	1881
M. Zachary	Junaluska	Jackson	P.	1879
Benjamin S. Guion	Lincolnton	Lincoln	P.	1870
Vardny A. McBee	do	do	P.	1871
Hon. David Schenck	do	do	P.	1867
S. T. Kelsey	Highlands	Macon		1874
Col. C. W. Alexander	Charlotte	Mecklenburgh	P.	1880
Sydenham B. Alexander	do	do	P.	
Col. Frank Coxe	do	do	P.	1858
Maj. James M. Davis	do	do	P.	1878
W. W. Grier	do	do	P.	1858
Lester W. Hunter, M. D	do	do	P.	1879
T. A. Kirkpatrick	do	do	P.	1878
Baxter H. Moore	do	do	P.	1876
W. W. Pegram	do	do	P.	1876
W. W. Phifer	do	do	P.	1870
I. J. Sloan, M. D	do	do	P.	1878
Joseph K. Rankin	do	do	P.	1879
W. S. Stewart	do	do	P.	1879
W. R. Trotter	do	do	P.	1878
Hon. Zebulon B. Vance	do	do		1876
W. T. Wilkinson	do	do	P.	1879
Robert Grier	Matthews	do	P.	1858
Henry T. Petty	Cameron	Moore	P.	1879
J. M. Campbell, M. D	Jonesborough	do	P.	1879
Evander McGilvary	Pocket	do	P.	1880
J. M. Chasten	Wilmington	New Hanover	P.	1875
A. C. Compton	Cedar Grove	Orange	P.	1873
Thomas P. Davis	Bethel Hill	Person	P.	1881
Robert T. Thruston, M. D	White Oak Hall	Polk	P.	1878
Preston J. McCall	Laurinburgh	Richmond	P.	1880
William H. McLaurin	do	do		(1880)
Frank P. Tatum	do	do	P.	1876
Pressley N. Stanback	Little's Mills	do	P.	1876
Eli Gibson	Old Hundred	do		1879
Robert L. Steele	Rockingham	do	P.	1880
Thomas B. Russell	Shoe Heel	Robeson	P.	1880
G. P. Bailey, M. D	Lawsonville	Rockingham	P.	1880
Thomas J. Motley	do	do	P.	1881
Joseph B. King	Leaksville	do	P.	1881
H. C. Comer	Pleasantville	do	P.	1867
James M. Price	Price's Store	do	P.	1878
S. H. Hand	Reidsville	do	P.	1879
N. Ware	do	do	P.	1877
Jesse Carter, M. D	Waddell's	do	P.	1881
James H. Hall	Wentworth	do	P.	1880
Thomas A. Ratliffe	do	do	P.	1879
H. C. Agner	Salisbury	Rowan	P.	1878
David Barringer	do	do	P.	1876
O. P. White	Clinton	Sampson	P.	1861
James White	Owenville	do	P.	1875
Thomas Biles	Bilesville	Stanly		1870

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Name.	Post-office.	County.	Year.
A. H. Joyce	Danbury	Stokes	P. 1878
H. M. Joyce	do	do	P. 1878
N. M. Pepper	do	do	P. 1875
Richard S. Martin, M. D	Peters (?)	do	P. 1881
W. H. Gentry	Sauratown	do	P. 1879
Dr. M. R. Banner	Walnut Cove	do	P. 1879
Abram G. Jones, M. D	do	do	P. 1878
W. A. Lash, M. D	do	do	P. 1877
James Gwyn	Elkin	Surry	P. 1881
Ephraim Galyen	Good Spring	do	P. 1881
John W. Rawley	Mount Airy	do	P. 1876
William H. Robinson	Balsam Grove	Transylvania	P. 1881
W. P. Southern	Brevard	do	P. 1877
L. C. Laney	Wolf Pond	Union	P. 1881
Thomas H. Avera, M. D	Eagle Rock	Wake	P. 1869
William E. Anderson	Raleigh	do	1879
Col. Paul F. Faison	do	do	P. 1873
John Pugh Haywood	do	do	P. 1876
Thomas D. Hogg, M. D	do	do	1879
W. C. Kerr	do	do	1874
Richard H. Lewis, M. D	do	do	P. 1879
W. S. Primrose	do	do	1880
Dr. V. E. Turner	do	do	1881
J. D. Whitaker	do	do	P. 1879
Col. Wharton J. Green	Warrenton	Warren	P. 1866
L. W. Estes	Blowing Rock	Watauga	P. 1877
W. B. Councill, M. D.	Boone	do	1877
M. H Bizzell	Goldsborough	Wayne	P. 1876
Major B. F. Hooks	do	do	P. 1878
Caleb F. R. Kornegay	Mount Olive	do	P. 1880
Daniel Kornegay	do	do	P. 1879
W. M. Cooper	Oshornville	Wilkes	P. 1875
R. J. Banguss	Trap Hill	do	P. 1880
J. M. McCann	do	do	P. 1881
Marion McCann	do	do	P. 1881
C. C. Benham	Jonesville	Yadkin	P. 1878
O. A. Lineberry	do	do	P. 1879
G. B. Reves	do	do	P. 1879
M. G. Shores	do	do	P. 1878
W. C. Shores	do	do	P. 1878
James M. Gudger	Burnsville	Yancey	1881

OHIO.

Name.	Post-office.	County.	Year.
Samuel P. Clark	Wheat Ridge	Adams	P. 1879
George Russell	Ashtabula	Ashtabula	P. 1878
R. L. Forman	South New Lyme	do	P. 1875
Lewis D. Campbell	Hamilton	Butler	P. 1878
William V. B. Snyder	Millville	do	1881
John F. Ward	Reiley	do	P. 1866
James W. Ferree	Blanchester	Clinton	P. 1875
Thomas Templin	do	do	P. 1877
Henry Trickey	do	do	1875
J. C. Fisher	Coshocton	Coshocton	1874
E. W. Hawthorn	do	do	1876
William Bucklew	Helmick	do	P. 1875
C. H. Meredith	Mohawk Village	do	P. 1874
Samuel Mills	New Castle	do	P. 1845
George W. Cullison	New Guilford	do	P.
Andrew Jackson Mills	do	do	P. 1878
William H. McNeal	Spring Mountain	do	P. 1880
Abram Funk	Warsaw	do	P. 1875
Nicholas Kissner	do	do	P. 1878
Alexander McCaskey	do	do	P. 1878
Pren. Metham	do	do	P. 1874
Henry Still	do	do	P.
W. P. Wheeler	do	do	P. 1870
James Cox	Bedford	Cuyahoga	P. 1877
Dr. T Garlick	do	do	P. 1874
James Matthews	do	do	P. 1874
Leveret Tarbell	do	do	P. 1880
Charles Force	Chagrin Falls	do	1875
George Gladden	do	do	1881
J. J. Stranahan	do	do	P. 1860
A. C. Williams	do	do	P. 1870
Fayette Brown	Cleveland	do	1878

Geographical catalogue of fish-culturists—Continued.

OHIO—Continued.

Name.	Post-office.	County.	Year.
D. W. Cross	Cleveland	Cuyahoga	1836
Henry C. Gaylord	do	do	1854
Lee McBride	do	do	1878
F. H. Mason	do	do	1876
John R. Ranney	do	do	1873
E. A. Scovill	do	do	1878
Dr. E. T. Sterling	do	do	1852
H. B. Stranahan	do	do	(1881)
F. P. Vergon	Delaware	Delaware	P. 1874
Benjamin Budd	Galena	do	(1881)
Elijah Mulen	Harlem	do	P. 1877
J. H. Field, M. D	Ostrander	do	P. 1875
T. C. Adams	Castalia	Erie	P. 1873
A. George Miller	do	do	1871
Wickham & Co	Huron	do	(1881)
Charles Carpenter	Kelley's Island	do	P. 1856
F. W. Alvord	Sandusky	do	1872
Hon. H. E. O'Hagan	do	do	P. 1860
H. C. Post	do	do	1855
Charles W. Sadler	do	do	1878
David S. Worthington	do	do	H.P. 1879
James Kenny	Columbus	Franklin	P. 1881
L. W. Budd	Dublin	do	P. 1878
John M. Thomas	do	do	(1880)
David Taylor, jr	Taylor	do	P. 1860
W. D. Graham	Eureka	Gallia	P. 1876
H. B. Johnson	Burton Station	Geauga	P. 1880
James Cullen	Cincinnati	Hamilton	P. 1875
Prof. Charles Dury	do	do	18 5
L. A. Harris	do	do	1878
Adolph Strauch	do	do	1858
Abraham York	New Haven	Huron	P. 1875
Simon Ashcraft	Bladensburgh	Knox	P. 1875
E. A. Harris	do	do	P. 1878
Jesse Harris	do	do	P. 1875
John Harris	do	do	P. 1878
Henry C. Beardslee, M. D	Painesville	Lake	1865
Orin H. Sharpe	Willoughby	do	P. 1860
Hon. H. G. Tryon	do	do	P. 1870
George McQueen	Fallsburgh	Licking	P. 1875
E. W. Metcalf	Elyria	Lorain	P. 1875
Jonah Crowell	Toledo	Lucas	1879
Robert Cummings	do	do	1863
J. E. Curtis	do	do	1879
J. C. Davis	do	do	1872
J. H. Davis	do	do	1872
J. C. & J. H. Davis	do	do	H.P. 1872
Maj. E. S. Dodd	do	do	1875
Col. S. R. Holmes	do	do	1869
John F. Kumler	do	do	1870
William R. Leflet	do	do	1875
Hon. Emery D. Potter	do	do	H.P. 1875
Henry Sprague	Canfield	Mahoning	P. 1865
Newton N. Reese	Le Roy	Medina	P. 1878
Franklin Edmundson	Alberta	Meigs	P. 1876
Henry Brown	Piketon	Pike	P. 1879
Robert H. Bentley	Mansfield	Richland	P. 1859
A. Freeman	Newville	do	P. 1877
S. L. N. Foote, M. D	Yellow Bud	Ross	P. 1861
Jacob Sloger	do	do	1880
Franklin Groff	Massillon	Stark	H.P. 1877
J. E. Mentzer	Navarre	do	P.
Moses Harlan	Ridgeville	Warren	P. 1870
William H. Stokes	Waynesville	do	P. 1874
Frank Knowles	Little Hocking	Washington	P. 1881
Solomon B. Firestone	Apple Creek	Wayne	P. 1880
Thomas H. McCaughey	do	do	1874
David F. Carr	Orrville	do	P. 1872
John Long	do	do	P. 1875
Peter Juilard	Stryker	Williams	P. 1878
James Winstead	Nevada	Wyandot	P. 1861

OREGON.

Joseph B. Lewis	Oneatta	Benton	1850
A. W. Wright	do	do	1880

Geographical catalogue of fish-culturists—Continued.

OREGON—Continued.

Name.	Post-office.	County.	Year.
Ernst Rambow	Sandy	Clackamas	1860
Waldo F. Hubbard	Clackamas	do	1874
A. J. Adams	Mishawaka	Clatsop	(1881)
R. J. Morrison	Skipanon	do	(1881)
Charles Ward	do	do	P. 1880
A. G. Langdon	Civil Bend	Douglas	1881
J. W. Cook	Portland	Multnomah	H.P. 1876
Capt. John Harlow	do	do	H.P. 1878

PENNSYLVANIA.

Name.	Post-office.	County.	Year.
Theodore Gray	Allegheny	Allegheny	1870
Rev. J. Franklin Core	Pittsburgh	do	H.P. 1877
Core, Reily & Pugh	do	do	H.P. 1877
Robert Dalzell	do	do	1879
George Finley	do	do	P. 1870
James G. Henry	Kittanning	Armstrong	1876
W. H. H. Piper	Manorville	do	P. 1875
John Briney	Pine Creek Furnace (?)	do	P. 1881
John W. Titley	Sherrett	do	P. 1880
George W. Dunn	Baden	Beaver	P. 1878
M. Darragh	West Bridgewater	do	1877
Adam Ketring	Maria	Bedford	P. 1877
Daniel S. Replogle	do	do	P. 1877
David L. Replogle	New Enterprise	do	P. 1875
John K. Teeter	do	do	P. 1880
Abraham Moses	Osterburgh	do	P. 1875
John S. Guyer	Pattonville	do	P. 1876
Peter Hull	Spring Hope	do	P. 1873
Samuel G. Statler, M. D	Spring Meadow	do	P. 1878
Thomas Johnston	Woodbury	do	P. 1860
John Becker	Centreport	Berks	P. 1879
David W. Mogle	do	do	P. 1879
John H. Riegel	do	do	(1879)
Reese Davies	East Berkley	do	P. 1872
John W. Degler	Strausstown	do	P. 1881
Benjamin L. Hewit	Hollidaysburgh	Blair	1865
John A. Biddle	Williamsburgh	do	P. 1877
J. E. Cleveland, M. D	Canton	Bradford	P. 1872
T. M. Fassett	do	do	1874
T. O. Hollis	do	do	P. 1875
Theo. Pierce	do	do	1874
J. H. Tripp	do	do	1870
Ansel D. Williams	do	do	1876
S. B. Eilenberger	Laddsburgh	do	P. 1872
James B. Thompson	New Hope	Bucks	1878
J. S. W. Thompson	do	do	1878
W. H. Thompson	do	do	1878
Thompson Bros	do	do	H.P. 1878
Thomas P. Chambers	Newtown	do	1878
J. L. Janney	do	do	1876
T. J. & J. L. Janney	do	do	H.P. 1876
William H. Swartz	Point Pleasant	do	1873
Alexander W. Leisenring	East Mauch Chunk	Carbon	P. 1875
Samuel W. Hudson	Hudsondale	do	P. 1859
John R. Leisenring	Mauch Chunk	do	1875
Thomas Burnside	Bellefonte	Centre	1872
George Valentine	do	do	H.P. 1869
Emanuel Brown	Madisonburgh	do	1877
Joseph K. Moyer	Centre Mills	do	1879
William Dripps	Coatesville	Chester	H.P. 1871
C. Marshall Ingram	Embreeville	do	1871
Francis D. Wetherill	Pawling	do	(1881)
C. J. Morton, M. D	Toughkenamon	do	P. 1879
Henry Coburn	West Grove	do	P. 1872
Milton Conard	do	do	P. 1880
Warren R. Shelmire	do	do	P. 1878
Joseph Pyle	do	do	P. 1878
Maximillian Flecher	Lickingville	Clarion	P. 1875
Isaac Shaffer	Shannondale	do	P. 1878
Hon. George R. Barrett	Clearfield	Clearfield	1876
James A. Moore	do	do	P. 1878
Richard Shaw, jr	do	do	P. 1878
William E. Wallace	do	do	P. 1880
Charles Reed	Berwick	Columbia	P. 1878
Hugh W. Appelman	Buckhorn	do	P. 1879

Geographical catalogue of fish-culturists—Continued.

PENNSYLVANIA—Continued.

Name.	Post-office.	County.	Year.
B. Frank Webb	Spartansburgh	Crawford	P. 1876
George R. Dykeman	Shippensburgh	Cumberland	P. 1870
Hon. Simon Cameron	Harrisburg	Dauphin	P. 1840
D. W. Seiler	do	do	1869
James Worrall	do	do	1870
Samuel A. Miller	Linglestown	do	P. 1874
John F. Bickel	Morton	Delaware	P. 1880
Kingston Goddard, M. D	do	do	P. 1879
John H. Irwin	do	do	P. 1881
Joseph Willcox	Sharon Hill	do	1880
R. Brennen	Wilcox	Elk	P. 1873
H. Perkins	Corry	Erie	1873
Seth Weeks	do	do	H.P. 1872
George Doll	Erie	do	P. 1876
Clark Olds	do	do	P. 1875
Casper Doll	Fairview	do	P. 1879
John Doll	do	do	P. 1878
D. R. Cushman	North East	do	P. 1876
Elmer Green	do	do	P. 1874
B. P. Griffith	do	do	1878
Alfred Short	do	do	1879
Samson Short	do	do	P. 1879
J. K. Spofford	do	do	P. 1871
John Bennett	Wattsburg	do	P. 1879
William T. Russell	Perryopolis	Fayette	P. 1875
George W. Etter	Lemasters	Franklin	H.P. 1872
J. Mitchell Stover	Greencastle	do	P. 1872
Samuel B. Grove	Airy Dale	Huntingdon	P. 1881
J. E. Robb	Alexandria	do	P. 1881
David Dunn	Huntingdon	do	P. 1880
Hon. Horatio G. Fisher	do	do	1869
W. S. Huyett	do	do	P. 1868
William A. Orbison	do	do	P. 1870
E. C. Summers	do	do	P. 1876
E. B. Isett	Spruce Creek	do	P. 1874
Jacob Creps	Indiana	Indiana	P. 1876
George Gumbert	Heathville	Jefferson	P. 1879
John S. Shaffer	Stanton	do	P. 1878
A. P. Gardner, M. D	Dunnings	Lackawanna	P. 1863
William Baylor	Fleetville	do	P. 1849
Isaac J. Post	Scranton	do	P. 1875
William H. Richmond	do	do	P. 1876
A. B. Groff	Bareville	Lancaster	P. 1868
William Baker Fahnestock, M. D	Lancaster	do	1870
William D. Gill	do	do	1873
J. P. Creveling	Marietta	do	1867
James Duffy	do	do	P. 1864
Benjamin L. Garber	do	do	P.
H. C. Bacon, M. D	Harveyville	Luzerne	P. 1875
A. N. Harvey	do	do	P.
Charles T. Barnum	Ruggles	do	P. 1871
Thomas Davenport	Town Line	do	P. 1877
C. E. Butler	Wilkes Barre	do	1878
J. M. Courtright	do	do	P. 1876
Milton Courtright	do	do	P. 1870
John B. Crawford, M. D	do	do	1875
Edmund L. Dana	do	do	P. 1876
E. P. Darling	do	do	P. 1868
H. H. Derr	do	do	P. 1876
Urbane Dilley	do	do	P. 1880
B. F. Dorrance	do	do	P. 1872
H. C. Gates	do	do	1874
Harry Hakes	do	do	1872
E. V. Jackson	do	do	P. 1872
Gen. W. H. McCartney	do	do	1874
G. M. Miller	do	do	P. 1870
Paul A. Oliver	do	do	P. 1870
Henry W. Palmer	do	do	P. 1868
Col. R. Bruce Ricketts	do	do	P. 1872
H. S. Rutter	do	do	P. 1876
Byron Shoemaker	do	do	1871
A. W. Stedman	do	do	1878
William Stoddart	do	do	P. 1875
S. B. Sturdevant, M. D	do	do	1877
Harrison Wright	do	do	P. 1879
Hon. Hendrick B. Wright	do	do	P. 1872
James D. Brewer	Muncy	Lycoming	1864
George L. Sanderson	Williamsport	do	P. 1870
Oliver Watson	do	do	P. 1876

Geographical catalogue of fish-culturists—Continued.

PENNSYLVANIA—Continued.

Name.	Post-office.	County.	Year.
L. B. Hoffman	Ludlow	McKean	H.P. 1874
M. Hargen Brooks	Greenville	Mercer	1875
James T. Blair	do	do	1875
James Strannahan	Mercer	do	P. 1879
John R. Eberman	Sandy Lake	do	P. 1873
W. A. Moore	do	do	P. 1875
J. Fearon Mann	Lewistown	Mifflin	P. 1870
Arthur Maginnis	Forks Station	Monroe	P. 1869
Caleb Cresson	Oaks	Montgomery	1874
Charles W. Gumbes, M. D	do	do	1874
Rev. Joel Ruddnow	do	do	1874
Jeremiah Comfort	William Penn	do	P. 1865
Prof. W. H. Chandler	South Bethlehem (?)	Northampton	1876
H. S. Boyer	Sunbury	Northumberland	1872
Austin Flint Clapp	do	do	1872
Edward B. Ferris	Philadelphia	Philadelphia	1869
Jonathan Gillingham	do	do	1873
William C. Harris	do	do	1873
George Janney	do	do	1860
C. A. Kingsbury, M. D	do	do	P. 1860
Newell & Ridgway	do	do	P. 1880
Alexander Purves	do	do	1873
Lewis Thompson	do	do	P. 1878
Richard Wood	do	do	1870
Nelson Clark	Condersport	Potter	P. 1868
W. B. Gordnier	do	do	P. 1867
Lewis W. Lyman	do	do	P. 1878
Hon. A. G. Olmsted	do	do	1875
C. Stearns	do	do	P. 1875
B. A. Greene	Roulette	do	P. 1866
Laroy Lyman	do	do	P. 1850
Simeon M. Beckwith	Williston	do	P. 1877
William A. Stutzman	Fountain	Schuylkill	P. 1862
Henry H. Lesher	Pitman	do	P. 1872
Charles Miller	Salem	Snyder	1877
Samuel Alleman	Selin's Grove	do	1876
John Hummel	do	do	1879
Franklin Weirick	do	do	1860
Samuel Sanders	Shamokin Dam	do	P. 1881
C. C. Musselman	Somerset	Somerset	1875
J. B. Brown	Colley	Sullivan	P. 1879
Adam Messersmith	do	do	P. 1878
William Reeser	do	do	P. 1875
Edward Miller	Lake Run	do	P. 1878
Peter Gavitt	Sonestown	do	P. 1877
J. F. Blessing	Hickory Grove	Susquehanna	P. 1879
W. D. Stoddard	Susquehanna	do	P. 1880
S. B. Elliott	Arnot	Tioga	H.P. 1869
D. A. Stowell	Delmar	do	P. 1873
Abram Eartley	Liberty	do	P. 1875
C. H. Hassenplug	Lewisburgh	Union	P. 1874
Thomas C. Thornton, M. D	do	do	1877
Conrad Mitchell	New Berlin	do	P. 1870
I. St. Clair, M. D	Franklin	Venango	1876
C. L. Goold	Reno	do	1876
W. S. Adams	Utica	do	P. 1880
William M. Irvin	McGraw	Warren	P. 1873
Samuel Guy Wallis	Sheffield	do	P. 1870
George M. Ramsey, M. D	Clokey	Washington	P. 1880
A. A. Bush, M. D	Merwin	Westmoreland	1877
A. B. Sprout	New Florence	do	H.P. 1871
Jacob Shearer	Seward	do	P. 1876
Jonathan Jenkins	Osterhout	Wyoming	P. 1870
Hon. R. R. Little	Tunkhannock	do	1870
W. E. Little	do	do	P. 1870
J. D. Keller, M. D	Glenville	York	(1881)
J. Benson Gable	Stewartstown	do	H.P. 1879

RHODE ISLAND.

Name.	Post-office.	County.	Year.
James Nisbet	Pawtucket	Providence	1872
George W. Pitcher	do	do	1872
Newton Dexter	Providence	do	1868
Alfred A. Reed	do	do	1871
John W. Sawyer, M. D	do	do	P. 1872
Amos D. Smith	do	do	P. 1862

Geographical catalogue of fish-culturists—Continued.

RHODE ISLAND—Continued.

Name.	Post-office.	County.	Year.
John H. Barden	Rockland	Providence	1870
Charles A. Hoxie	Carolina	Washington	H. P. 1877
John W. Hoxie & Co	do	do	H. P. 1878
Rowland Hazard	Peace Dale	do	1878
Halsey W. Burdick	Westerly	do	P. 1870

SOUTH CAROLINA.

Name.	Post-office.	County.	Year.
James Crawford Keys	Anderson C. H	Anderson	P. 1872
E. B. Murray	do	do	P. 1881
Maj. Thomas B. Lee	do	do	P. 1877
W. C. Brown, M. D	Belton	do	P. 1872
A. M. Holland	Holland's Store	do	P. 1877
Thomas G. Clemson	Pendleton	do	1850
M. B. Williams	Piercetown	do	1859
W. P. Cave	Barnwell C. H	Barnwell	P. 1878
J. B. Bates	Millettville	do	P. 1876
E. M. Gaillard, sr	Eutawville	Berkeley	P. 1842
P. G. Stoney	Mount Holly	do	P. 1881
F. W. Heyward	Oakley Depot	do	P. 1879
R. C. Clowney	Black Stocks	Chester	(1881)
O. Barber	Richburgh	do	P. 1876
J. T. Marion	do	do	P. 1878
T. H. Moffatt	do	do	P. 1880
W. S. Culp	Wylie's Mill	do	P. 1881
John H. Mahony	Packsville	Clarendon	1881
N. S. Connelly	Bells	Colleton	1879
C. C. Stephens	do	do	1870
Alex. B. Stephens, jr	do	do	1865
J. J. Lucas	Society Hill	Darlington	P. 1868
Hartwell H. Riser	Etheridge	Edgefield	
S. W. Bookhart, M. D	Blythewood	Fairfield	P. 1859
T. E. Cloud	Ridgeway	do	P. 1879
R. H. Edmonds, M. D	do	do	P. 1879
S. Robert Simonton	White Oak	do	P. 1881
Thomas W. Woodward	Winnsborough	do	P. 1856
T. P. Mitchell	Woodward	do	P. 1880
W. St. J. Mazyck	Waverly Mills	Georgetown	1877
D. R. Pool	Bellevue	Greenville	P. 1876
Stephen H. Poole	do	do	1878
H. B. Bates	Freeman	do	P. 1881
William C. Cleveland	Greenville C. H	do	P. 1878
M. L. Donaldson	do	do	P. 1878
Alexander McBee	do	do	P. 1878
William A. McDaniel	do	do	P. 1875
H. C. Markley	do	do	P. 1881
P. D. Roper	do	do	P. 1878
P. F. Suddath	do	do	P. 1877
R. Thurston	do	do	P. 1876
John W. Wood	do	do	P. 1881
F. H. Fuller	Lima	do	P. 1881
John L. Westmoreland, sr	Sandy Flat	do	P. 1878
J. D. Cooper	Traveller's Rest	do	P. 1877
Andrew W. Hardee	Board Landing	Horry	P.
Dr. R. Vampill	Mullin's Depot	Marion	P. 1870
Alexander L. McLaurin	Clio	Marlborough	P. 1876
J. F. McLaurin	McLaurin's Mills	do	P. 1878
J. J. McLaurin	do	do	P.
Eli Willis	do	do	P. 1877
D. V. Scurry	Chappell	Newberry	P. 1859
A. G. W. Glymph	Glymphville	do	P. 1880
Thomas W. Keitt	do	do	1878
J. M. H. Ruff, M. D	do	do	1880
William H. Ruff	do	do	P. 1855
Lambert I. Jones	Newberry C. H	do	P. 1860
Frederick Werber	do	do	P. 1881
Rev. J. A. Sligh	Prosperity	do	P. 1874
P. H. Koon	Vaughnsville	do	P. 1871
Christopher Jones	Cheohee (?)	Oconee	P. 1876
William P. Calhoun	Fair Play	do	1880
D. H. Glenn	do	do	P. 1880
Isham L. McCurry, M. D	do	do	P. 1881
James Seaborn	do	do	(1881)
Silas K. Cannon	High Falls	do	1880
J. B. Maret	Oakway	do	P. 1880
Dr. Thomas G. C. Fahnestock	Walhalla	do	P. 1879

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SOUTH CAROLINA—Continued.

Name.	Post-office.	County.	Year.
John M. Hendrix	Walhalla	Oconee	P. 1881
Joseph W. Holleman	do	do	P. 1880
D. A. Mulkey	do	do	P. 1881
Joseph W. Shelor	do	do	P. 1880
D. A. Smith	do	do	1881
J. W. Stribling	do	do	P. 1880
Robert A. Thompson	do	do	P. 1878
John S. Verner	do	do	P. 1880
Gottlob Wanner	do	do	P. 1878
Col. A. P. Butler	Columbia	Richland	P. 1879
C. J. Huske	do	do	1878
Nathaniel Ramsay	do	do	P. 1849
Simpson & Simpson	Glenn Springs	Spartanburgh	1879
William Choice	Spartanburgh C. H	do	1876
Henry S. Farley	do	do	P. 1880
John W. Buckner	Stateburgh	Sumter	P. 1870
Hon. Thomas B. Jeter	Union	Union	P. 1859
E. A. Crawford	Guthriesville	York	P. 1878
R. E. Guthrie	do	do	P. 1877
John F. Hinson	do	do	P. 1878
W. A. Wyatt	do	do	P. 1880

TENNESSEE.

Name.	Post-office.	County.	Year.
J. L. Jones	Cleo	Bradley	P. 1880
S. Y. Pierce	Cleveland	do	P. 1868
J. R. Hodge	Hollow Rock	Carroll	P. 1878
Eugene Hawkins	Huntingdon	do	P. 1876
Col. George F. Akers	Nashville	Davidson	1876
Rev. A. J. Baird	do	do	P. 1880
John H. Callender, M. D	do	do	(P.) 1872
Hon. John C. Ferris	do	do	P. 1875
Temple O. Harris, jr	do	do	P. 1877
Col. Ira P. Jones	do	do	1850
C. L. Lewis, M. D	do	do	P. 1878
James E. Warner	do	do	H. P. 1880
A. F. Whitman	do	do	P. 1880
A. J. Wheeler	do	do	P. 1880
Samuel J. Alexander	Macon	Fayette	(1880)
John H. Garnett	Somerville	do	P. 1878
James T. Smith	Brazil	Gibson	P. 1869
Rogers & Sons	Trenton	do	P. 1878
Thomas D. Clinton	Bolivar	Hardeman	P. 1880
William R. Kearney	do	do	P. 1879
E. P. McNeal	do	do	P. 1866
Charles A. Miller	do	do	1874
Austin Miller	do	do	P. 1878
Horace M. Polk	do	do	P. 1870
Isaac W. Coppedge	Dancyville	Haywood	P. 1863
Mrs. W. B. Douglass	do	do	P. 1880
Joseph B. Moore	do	do	P. 1872
F. T. Seymour, M. D	do	do	P. 1875
J. B. Brantly	Wellwood	do	P. 1876
H. M. Clarke	do	do	P.
D. S. Chandler	do	do	P.
J. D. Marbury	do	do	P.
A. F. Austin	Scott's Hill	Henderson	P. 1877
M. B. Young	Gainesborough	Jackson	1881
George Bend	Ebenezer	Knox	P. 1878
John M. Boyd, M. D	Knoxville	do	1875
Prof. Hunter Nicholson	do	do	P. 1873
John B. Turley	do	do	P. 1877
J. W. Walker, M. D	Durhamville	Lauderdale	P. 1869
John M. Arnent	Tony	Lewis	P. 1865
T. L. Arnwine	Athens	McMinn	1878
T. J. Dement	do	do	1876
W. G. Horton	do	do	P. 1876
H. H. Matlock	Riceville	do	1878
Parmenio P. Transou	Denmark	Madison	P. 1870
Hon. J. J. Boon	Jackson	do	(1880)
Hon. Milton Brown	do	do	P. 1881
John Y. Keith	do	do	P. 1875
Daniel S. Lacy	do	do	P 1880
E. A. Lindsey	do	do	P. 1878
Robert S. Lindsey	do	do	P. 1880
T. C. Long	do	do	P. 1877

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TENNESSEE—Continued.

Name.	Post-office.	County.	Year.
Henry T. Johnson	Medon	Madison	P. 1880
David H. Parker, M. D	do	do	P. 1880
H. F. Parker	do	do	P. 1880
E. Douglas Thompson	Chapel Hill	Marshall	P. 1865
Charles Royster	do	do	1865
John B. Wilhoite	do	do	P. 1850
Col. P. C Bethell	Columbia	Maury	P. 1880
J. H. Andrews	do	do	1865
S. D. Herndon, M. D	do	do	1875
A. S. Horsley	do	do	1878
James Marsh Moyes	do	do	(1881)
Edward M. Sheegog	do	do	P. 1878
Edward Williams	do	do	1875
Thomas H. Williams	do	do	P. 1879
W. E. B. Green	Dark's Mill	do	(1881)
James H. Parrish	do	do	(1881)
J. E. Roan	River Station	do	P.
William Hughes Brown	Spring Hill	do	P. 1878
Nathaniel B. Cheairs	do	do	P. 1870
Rev. F. A. Thompson	do	do	P. 1857
J. T. S. Thompson, M. D	do	do	P. 1876
E. Y. Salmon, M. D	Lynchburgh	Moore	P. 1876
James L. Sloan	Linden	Perry	1875
W. E. McElwer	Rockwood	Roane	P. 1878
Francis Pride	Cedar Hill	Robertson	P. 1880
S. K. Cromwell	Green Brier	do	P. 1879
Archie Thomas	Springfield	do	1875
W. W. McDowell	Memphis	Shelby	H.P. 1875
Larkin B. Craig	Carthage	Smith	P. 1873
B. F. Atwood	Grant	do	P. 1880
Buck McClanahan	do	do	P. 1879
Turner McClanahan	do	do	P. 1879
John G. King	Bristol	Sullivan	P. 1850
Henry Fry	Gallatin	Sumner	P. 1879
J. B. Howison	do	do	P. 1879
J. K. Miller	do	do	P. 1877
James Soper	do	do	P. 1881
Dr. O. G. Wilson	do	do	1875
Dero F. Mills	Hendersonville	do	P. 1879
John M. Shute	do	do	P. 1880
Jonathan Walker	Nave Hill	Union	P. 1878
William Davidson Smarth	McMinnville	Warren	1880
William O. Whitson	do	do	1879
Thomas E. McColloch	Viola	do	P.
J. T. Galloway	Dukedom	Weakley	P. 1880
R. S. Murrell	do	do	P. 1880
Isaac Joy	Basin Spring	Williamson	P. 1880
William Beasley	Boston	do	P. 1879
S. F. Glass	Franklin	do	1870
Hon. John B. McEwen	do	do	P. 1865
Thomas F. Perkins, sr	do	do	P. 1875
E. W. Buford	Thompson's Station	do	P. 1881
Thomas L. Critz	do	do	P. 1876
William B. Patton	do	do	P. 1869
W. J. Zellner	do	do	P. 1860
John S. Claybrooke	Triune	do	P. 1865
Samuel Perkins	do	do	P. 1865
Col. James Hamilton	Lebanon	Wilson	P. 1875
J. Peter Bashaw	Mount Juliet	do	P. 1878
J. W. Barton	do	do	P. 1878
P. Peyton Carver	do	do	P. 1875
J. P. Cawthon	do	do	P. 1878
Charles E. Harrison	do	do	P. 1874

TEXAS.

Name.	Post-office.	County.	Year.
John W. Goode	Bellville	Austin	P. 1880
William Thompson	Nelsonville	do	1881
W. P. McKinney	Blanket	Brown	P. 1879
John B. Pendleton	do	do	P. 1880
W. W. Henderson	Cussera	Cass	P. 1877
William G. Hampton	Hermitage	do	P. 1878
John B. Henderson	Red Hill	do	P. 1876
John A. Bryan, sr	White Sulphur Springs	do	P. 1876
J. Lee Faires	McKinney	Collin	P. 1849
Isaac F. Graves	do	do	P. 1865
George White	do	do	P. 1879

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TEXAS—Continued.

Name.	Post-office.	County.	Year.
H. C. Smith	Mount Blanco	Crosby	P. 1878
Col. J. W. Kidd	Dallas	Dallas	P. 1880
Arthur O'Keeffe	Honey Grove	Fannin	P. 1875
R. E. Hancock, M. D	Ragsdale	do	P. 1880
Alfred Medlen	Richlandville (?)	do	P. 1876
John L. Bonner	Steward's Mill	Freestone	P. 1860
Washington Steward	do	do	P. 1877
John H. Ashley	Denison City	Grayson	H.P. 1880
Samuel A. Cook	do	do	P. 1876
Jessee Looney	do	do	P. 1879
William Pennington	White Wright	do	P. 1880
Hampden Wilson	Iron Bridge	Gregg	1876
J. A. Martin	Kilgore	do	P. 1877
J. C. C. Winch	Houston	Harris	1880
T. W. Winston	Jonesville	Harrison	P.
Prof. Jasper Starr	Yale Seminary (?)	Henderson	1876
Thomas F. West	Jacksborough	Jack	1873
Robert P. Mayo	Brookston	Lamar	P. 1874
B. M. Godfrey	Groesbeck	Limestone	P. 1871
O. A. Godfrey	do	do	P. 1880
J. D. Rankin, M. D	do	do	P. 1881
S. S. Walker	do	do	P. 1879
O. Wiley	do	do	P. 1877
R. Wiley	do	do	1865
Samuel Bell	Kosse	do	P. 1879
T. W. Wade	Mexia	do	P. 1876
Dr. A. P. Brown	Jefferson	Marion	1870
M. D. K. Taylor, M. D	do	do	P. 1879
Hon. J. P. Beamer	Kelleysville	do	P. 1874
L. W. Carothers	Thorndale	Milam	P. 1880
W. T. Barnes	Daingerfield	Morris	P. 1876
G. C. Chambers	do	do	P. 1880
J. Monroe Connor	do	do	P. 1876
W. T. Connor	do	do	P. 1880
B. C. Hinnant	do	do	P. 1872
Henry M. Ryan	Corsicana	Navarro	(1879)
C. A. Denison, M. D	Clarksville	Red River	P. 1877
Rev. E. H. Hearn	Center	Shelby	P. 1877
J. H. Dinkins	Austin	Travis	1874
Hon. John Hancock	do	do	1874
Hon. W. A. Pitts	do	do	1874
Hon. William C. Walsh	do	do	P. 1875
B. H. Bassett	Brenham	Washington	P. 1877
C. B. Breedlove	do	do	P. 1868
Hon. D. C. Giddings	do	do	P. 1879
A. Lauraine	do	do	P. 1880
T. W. Morriss	do	do	P. 1877
J. B. Campbell	Gay Hill	do	P. 1878
Thomas C. Clay	Independence	do	P. 1880
George Stratton, M. D	do	do	1875
Jules A. Randle	Washington	do	P. 1868
William Elliott	Taylor	Williamson	1880
C. L. Fouzer	do	do	P. 1880
J. Allen Gano, jr	do	do	(1880)
W. W. Mumford	do	do	P. 1881
C. B. Wilson	do	do	P. 1876

UTAH.

Charles W. Rockwood	Centerville	Davis	1871
William Foxley	Kaysville	do	P. 1878
Andrew J. Allred	Fremont	Piute	P. 1878
James H. Whitlock	do	do	P. 1878
Prof. Joseph L. Barfoot	Salt Lake City	Salt Lake	1878
H. J. Richards, M. D	do	do	1880
Canute Peterson	Ephraim	San Pete	P. 1881
Daniel B. Funk, sr	Manti	do	H.P. 1872
William W. Cluff	Coalville	Summit	1878
Stephen S. Worthington	Grantsville	Tooele	1879
William Atkin	Saint George	Washington	P. 1878

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VERMONT.

Name.	Post-office.	County.	Year.
A. E. Manum	Bristol	Addison	(1880)
W. R. Peake	do	do	1856
Gideon B. Ridley	do	do	P. 1874
A. Nichols	East Middlebury	do	P. 1872
Mrs. Alma Chittenden Dow	Middlebury	do	P. 1877
John J. Kelsey	Salisbury	do	P. 1874
Oscar D. Baldwin	Starksborough	do	P. 1878
R. Burgess & Sons	Bennington	Bennington	H.P. 1876
M. S. Colburn	Factory Point	do	(1881)
Charles F. Orvis	Manchester	do	1876
Perry H. Thompson	Pownal Centre	do	P. 1871
Daniel G. Smith	South Shaftsbury	do	P. 1876
Mrs. C. J. Barnard	Saint Johnsbury Centre	Caledonia	1877
Charles Coob	do	do	P. 1878
L. A. Drew	Burlington	Chittenden	P. 1867
Solomon Johns	Huntington	do	1870
Wesley M. Johnson	do	do	P. 1876
H. G. Boardman	Milton	do	P. 1875
F. J. Robinson	North Underhill	do	P. 1879
Uriah Colburn	Vershire	Orange	P. 1875
Chauncey C. Colton	do	do	P. 1876
G. E. Griswold	West Randolph	do	P. 1877
Noble H. Kinney	Craftsbury	Orleans	P. 1867
Horace D. Stratton	do	do	P. 1878
G. M. Cuthbertson	Greensborough	do	1878
George M. Martin	do	do	P. 1876
Delano F. Goodrich	Brandon	Rutland	1876
Henry L. Leonard	do	do	P. 1878
E. A. Smith, M. D	do	do	P. 1872
W. H. Williams	do	do	P. 1880
Hon. Redfield Proctor	Centre Rutland	do	P. 1870
H. N. Mandigo	Cuttingsville	do	H.P. 1870
Alfred N. Baker	Danby	do	P. 1877
William H. Bond	do	do	P. 1874
E. G. Wight	do	do	P. 1879
Noah E. Gifford	Danby Four Corners	do	P. 1876
Percy W. Johnson	do	do	P. 1878
William P. Johnson	do	do	P. 1878
W. H. Lyon	do	do	P. 1878
Daniel C. Wetherby	do	do	P. 1879
Spencer & Steward	East Clarendon	do	H.P. 1879
Wallace Steward, M. D	do	do	1879
Joel Todd	East Wallingford	do	P. 1874
Charles S. Colburn	Pittsford	do	P. 1872
Samuel E. Burnham	Rutland	do	1879
Charles Clement	do	do	P. ——
Dr. Middleton Goldsmith	do	do	P. 1865
F. S. Hale	do	do	P. 1872
G. H. Reynolds	do	do	P. 1879
William Y. W. Ripley	do	do	1870
John P. Williams	Shrewsbury	do	1878
Henry D. Noble	Tinmouth	do	P. ——
J. W. Noble	do	do	P. ——
Isaac D. Tubbs	do	do	P. 1870
Charles H. Barber, M. D	Wallingford	do	H.P. 1878
Orrin Hager	do	do	P. 1857
B. Marc Mattison	do	do	P. 1871
Burton A. Lewis	Wells	do	P. ——
James McBreen	do	do	1869
Nelson Paul	do	do	(P.) ——
L. B. Drew	East Calais	Washington	P. 1875
Alfred P. Wheelock	do	do	P. 1877
C. C. Warren	Waterbury	do	P. 1875
J. D. Bridgman	Bellows' Falls	Windham	H.P. 1866
Richard Bradley	Brattleborough	do	(1881)
Frederick W. Childs	do	do	1872
R. C. Cressy	do	do	1865
E. G. Frost	do	do	P. 1878
George F. Gale, M. D	do	do	P. 1868
H. R. Lawrence	do	do	(1881)
N. M. Perry	do	do	1875
E. B. Richardson	do	do	P. 1875
Rufus Scott	do	do	1870–'78
J. R. Nourse	Dummerston	do	P. ——
Charles Barrett	Grafton	do	1865
J. Henry Kidder	Wilmington	do	P. 1876
William C. Raymond	Bridgewater	Windsor	1876
George W. Hall	Chester	do	P. 1870
Homer W. Vail	North Pomfret	do	H P. 1874

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VERMONT—Continued.

Name.	Post-office.	County.	Year.
A. J. Russ	Norwich	Windsor	P. 1881
J. K. Polk Chamberlin	Pomfret	do	P. 1876
Owen Monroe Chedel	do	do	P. 1865
Gardner Winslow	South Pomfret	do	P. 1870
Thomas J. Whitcomb	Springfield	do	H.P. 1868
Daniel W. Hazelton, M. D	do	do	P. 1867
George E. Persons	West Bridgewater	do	H.P. 1876
Merritt C. Edmunds, M. D	Weston	do	1864
Charles B. Evarts	Windsor	do	P. 1871
George B. French	Woodstock	do	P. 1873
F. A. Persons	do	do	P. 1877

VIRGINIA.

William W. Womack	Clifton Forge	Alleghany	1873
R. M. Brown, jr	Amherst C. H	Amherst	1866
Capt. Thomas S. Doyle	Staunton	Augusta	P. 1871
W. L Bumgardner	do	do	P. 1874
Michael Graybill	Amsterdam	Botetourt	P. 1877
A. K. Layman	Daleville	do	P. 1875
William G. Nininger	do	do	P. 1876
Nash J. Baker	Fincastle	do	P. 1878
Alfred Beckley	do	do	P. 1878
Henry Booze	do	do	P. 1875
B. C. Hedrick	do	do	1860
Lewi Housman, jr	do	do	P. 1879
William J. Price	do	do	P. 1858
Lewis Shuey	do	do	P. 1877
John B Sessler	Haymakertown	do	P. 1878
W. H. Cummings	Old Hickory	do	P. 1878
Madison Flanagan	Flanagan's Mills	Cumberland	P. 1860
William E. Gray	do	do	P. 1878
A. John Singleton	Delaplane	Fauquier	P. 1881
Asa Wall, M. D	Markham Station	do	P. 1871
Henry M. Price, M. D	Antioch	Fluvanna	P. 1879
Lewis L. Thomas	Ridgeway	Henry	P. 1880
William A. Carter	Tan Yard	do	P. 1879
Thomas Williamson	Leesburgh	Loudoun	H. 1873
J. Thompson Brown	Arrington	Nelson	1874
H Clay Baker	Gordonsville	Orange	P. 1879
William M. Baker	do	do	P. 1880
Gen. James G. Field	do	do	P. 1875
R. Barton Haxall	do	do	P. 1870
M. A. Miller	do	do	P. 1879
J. W. Ramey	Constoel	Pittsylvania	P. 1873
James H. Jennings	Danville	do	P. 1878
William J. Brown	Kentuck	do	P. 1880
John A. Slaughter, M. D	do	do	P. 1877
P. B. Farmer	Laurel Grove	do	P 1877
Lovel Walters	do	do	P. 1878
Germon H. Williams	Malmaison	do	P. 1875
E. G. McClanahan	Big Lick (?)	Roanoke	P. 1881
D. S. Read	do	do	P. 1881
James S. Persinger	do	do	P. 1876
W. W. Brand	Catawba	do	P. 1876
George G. McConkey	do	do	P. 1876
Mark B. Moomaw	do	do	P. 1872
John Martin Kittinger	Poage's Mill	do	P. 1876
F. J. Chapman	Salem	do	P. 1876
Thomas Lewis	do	do	(P.) 1870
J. J. Moomaw, M. D	do	do	1876
John W. Ribble	do	do	1878
David E. Trout	do	do	P. 1877
Alexander White	do	do	P. 1880
William M. Dunlap	Kerr's Creek	Rockbridge	P. 1877
John A Lusk	Lexington	do	1878
Col. Marshall McDonald	do	do	1874
Col. Edmund Pendleton	do	do	1869
Col. H W. Williamson	do	do	P. 1878
Alfred Miller	McKemy s Mills (?)	do	P. 1870
George M. Miller	Edenburgh	Shenandoah	1877
John S. Apperson, M. D	Town House	Smyth	1879
John H. Downing	Linden	Warren	P. 1870

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WASHINGTON.

Name.	Post-office.	County.	Year.
G. W. Wilson	Bay Centre	Pacific	(1853)
R. H. Espy	Oysterville	do	(1853)
E. Hammond	Cypress	Whatcom	1853
J. J. Imbrie	Cottage Glen	Yakima	P. 1880
J. O. Clark, M. D	Yakima	do	P. 1880
Charles Schanno	do	do	P. 1880

WEST VIRGINIA.

Name.	Post-office.	County.	Year.
John G. Johnson	Meadowville	Barbour	P. 1878
William W. Johnson	do	do	P. 1877
John A. Trimble	Overfield	do	P. 1881
Isaac W. Post	do	do	P. 1881
T. P. R. Brown	Philippi	do	1873
Luther C. Elliott	do	do	1881
Job H. Glascock	do	do	1875
James E. Hall	do	do	1874
J. L. Hall	do	do	1871
H. J. Thompson	do	do	1873
O. Brown La Fever	Bunker Hill	Berkeley	P. 1880
Adam Michael	Black Rock	Grant	P. 1881
Joseph V. Williams	Williamsport	do	P. 1879
J. M. Skaggs	Clintonville	Greenbrier	P. 1881
Hon. R. F. Dennis	Lewisburgh	do	1875
John W. Harris	do	do	1876
Hon. Cecil Clay	Ronceverte	do	(1879)
Wallace S. Rader	Williamsburgh	do	P. 1877
William V. Herriott	Romney	Hampshire	P. 1879
Christian S. White	do	do	P. 1877
John R. Donehoo	Fairview	Hancock	P. 1879
Samuel Edie	New Cumberland	do	P. 1879
James S. Freeman	do	do	P. 1878
Ed. S. Alexander	Moorefield	Hardy	1876
Jarrett Cunningham	do	do	P. 1878
G. W. Dasher	Peru	do	1878
Col. Francis Yates	Charlestown	Jefferson	P. 1877
Hugh Ballard	Indian Creek	Monroe	1880
D. A. Mann	do	do	P. 1880
J. D. Beard	Johnson's Cross Roads	do	1879
James M. Johnson	do	do	P. 1881
William F. Ryan	Red Sulphur Springs	do	P. 1881
Henry B. Miller	Wheeling	Ohio	1876
Milum Keaton	Forest Hill	Summers	P. 1881
Andrew Mann	do	do	P. 1880
N. M. Lowry	Hinton	do	P. 1879
Robert C. Lilly	Jumping Branch	do	P. 1880
J. J. Bailey	Astor	Taylor	1880
Patrick F. Bartlett	do	do	P. 1879
Silas P. Bailey	Flemington	do	P. 1879
Eppa T. Bartlett	Parkersburgh	Wood	P. 1870

WISCONSIN.

Name.	Post-office.	County.	Year.
Alphonzo H. Doty	Grantsburgh	Burnett	P. 1879
B. I. Durward	Alloa	Columbia	P. 1878
Alexander Prentise	do	do	1878
Peter L. Furland	Lodi	do	P. 1877
L. K. Goodall, jr	do	do	P. 1874
N. Goodall, sr	do	do	P. 1874
James McCloud	do	do	H.P. 1875
L. S. Rolleston	Portage	do	1875
Elijah Hinkson	Poynette	do	1878
F. C. Curtis	Rocky Run	do	(1880)
J. C. Dundas, M. D	Cambridge	Dane	1880
James Mathison	do	do	1877
Thomas C. Slagg	do	do	1868
Philo Dunning	Madison	do	1879
Gov. William E. Smith	do	do	1877
William Welch	do	do	1873
H. W. Welsher	do	do	1868
E. Lawrence	Token Creek	do	H.P. 1876
Christopher Hutchinson	Beetown	Grant	P. 1877
James Ballantine	Bloomington	do	P. 1872

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WISCONSIN—Continued.

Name.	Post-office.	County.	Year.
Frank L. Greer	Bloomington	Grant	P. 1879
Alfred Palmer	Boscobel	do	H.P. 1864
William W. Pratt	do	do	P. 1875
James N. Borah	Lancaster	do	P. 1880
Robert Chandler	Montfort	do	H.P. 1877
Lucian Dewey	Patch Grove	do	P. 1878
Theodore Hail	Potosi	do	P. 1876
John Murray	Woodman	do	H.P. 1872
W. E. Rowe	Arena	Iowa	P. 1860
Samuel W. Reese	Dodgeville	do	1875
Goodwin Lowrey	Helena Station	do	H.P. 1873
William T. Henry	Mineral Point	do	1877
William Lanyon, jr	do	do	1876
Calvert Spensley	do	do	1877
John H. Vivian, M. D	do	do	1874
Mark Douglas	Melrose	Jackson	1872
Abner D. Polleys	do	do	H.P. 1877
Dempster Danon	Sentinel	Juneau	1880
Charles Hanneman	Ahnapee	Kewaunee	H. 1874
Ernst Ludwig Pfaff	Burr Oak	La Crosse	P. 1878
Michael Pfaff, sr	do	do	P. 1880
James Barclay	Stevenstown	do	P. 1876
William A. Garden	Belmont	La Fayette	1874
Henry Harris	do	do	1878
Edwin Johnson	do	do	P. 1872
John E. Jones	do	do	H.P. 1878
O. E. Minor	do	do	1872
Joseph H. Clary	Darlington	do	1876
Hon. John W. Blackstone	Shullsburgh	do	1879
Joseph Jackesch	Rosecrans	Manitowoc	P. 1876
C. F. Dunbar	Wausau	Marathon	1880
W. C. Silverthorn	do	do	1879
George C. Young	do	do	1870
John F. Antisdell	Milwaukee	Milwaukee	1870
John Griffin	Cashton	Monroe	P. 1871
Richard T. W. Cole	Melvina	do	P. 1878
Alexander H. Moll	Tunnel City	do	P. 1875
W. Young	Medina	Outagamie	H.P. 1876
Asa Worden	do	do	
Philip Pfaff	Pepin	Pepin	P. 1876
Baker Signe	do	do	(P. 1879)
A. G. Littlefield	Trenton (?)	Pierce	H.P. 1870
Samuel Thomson	Osceola Mills	Polk	P. 1865
Thomas J. Leatherbery	Henrietta	Richland	P. 1876
G. W. Collins	Richland Centre	do	P. 1876
B. C. Hailin	do	do	P. 1875
Jeremiah Clark	Viola	do	P. 1862
C. L. Valentine	Janesville	Rock	1878
C. F. Reed	Reedsburgh	Sauk	H.P. 1872
Michael Rentz	Esofea	Vernon	P. 1880
H. W. Worth	Delavan	Walworth	P. 1874
Albert E. Lytle	Geneva	do	H. 1875
Bart B. Scott	do	do	1875
C. L. Douglass	Walworth	do	P. 1871
James Brierton	Mapleton	Waukesha	P. 1879
John A. Rice, M. D	Merton	do	P. (1881)
Col. Henry Shears	North Lake	do	P. 1868
F. M. Spear	Oconomowoc	do	1878
Hon H. F. Dousman	Waterville	do	H.P. 1870
J. W. Bishop	Northport	Waupaca	P. 1878
James V. Jones	Oshkosh	Winnebago	1876

WYOMING.

Name.	Post-office.	County.	Year.
William E. Carlin	Como (?)	Carbon	P. 1879
H. J. Maynard, M. D	Cheyenne City	Laramie	1860

NOTE.—Some of the above-named post-offices appear to have been discontinued or their names changed since this list was prepared. These are indicated by (?) following the name of the office.

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NOTE.—The following typographical corrections should be made in the catalogue to correspond with this index:

Page 394, for Thomas Doron, read Thomas L. Doron.
Page 402, for William Vaughn, read William Vaughan.
Page 403, for Herman Naumann, read Hermann Naumann.
Page 411, for Daniel Weatherbee, read Daniel Wetherbee.
Page 412, for J. D. Dumont, read J. B. Dumont.
Page 419, for Robert N. Verplank, read Robert N. Verplanck.
Page 421, for Thomas E. Vallentine, read Thomas E. Valentine.
Page 423, for Pressley N. Stanback, read Presley N. Stanback.
Page 423, for M. R. Kimsey, read M. R. Kinsey.
Page 433, for Chauncey C. Colburn, read Chauncy C. Colton.

 July 3, 1883.

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