NINTH BIENNIAL REPORT

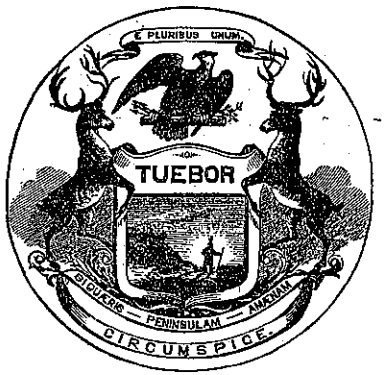
OF THE

STATE BOARD

OF

FISH COMMISSIONERS

FROM DEC. 1, 1888, TO OCT. 1, 1890.



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1890.

STATE BOARD OF FISH COMMISSIONERS.

1890.

COMMISSIONERS.

HERSCHEL WHITAKER, PRESIDENT, - - Moffat Block, Detroit.
DR. JOEL C. PARKER, - - - - - - Grand Rapids.
FOYT POST, - - - - - - - - McGraw Block, Detroit.

OFFICERS.

WALTER D. MARKS, SUPERINTENDENT, - - Paris, Mecosta County.
GEORGE D. MUSSEY, SECRETARY, - - - No. 33 Moffat Block, Detroit.
WM. A. BUTLER, JR., TREASURER, - - - Mechanics' Bank, Detroit.

OFFICE OF THE BOARD.

NO. 33 MOFFAT BLOCK, DETROIT, MICH.

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REPORT OF THE BOARD OF FISH COMMISSIONERS.

To his Excellency, EDWIN B. WINANS,
Governor of the State of Michigan.

According to the provisions of law, the Michigan Board of Fish Commissioners submits herewith its ninth biennial report of operations. This report covers a period since the submission of the eighth report, which closed with the fall of 1888, and includes all operations to October 1, 1890.

The work of two years covered by this report has beeu in some respects the most important in the history of the board. With the large and improved whitefish station at Detroit, Michigan now ranks first in the magnitude and importance of its work in restocking the waters with important commercial fish. With a capacity for hatching one hundred and sixty millions of whitefish (Corregonus culpeiformis) annually and more than four times this quantity of the pike perch (stizostedium) or wall-eyed pike, with such other spring spawners as may be deemed desirable, it is one of the largest establishments of its kind in the world. While Michigan ranks first in the output of artificially propagated fry of the commercial fishes, she could do no less without being open to the charge of gross negligence of her best interests. With a coast line of fresh water lakes of more than two thousand miles, her waters produce annually about three-fourths of the fish product of the great lakes, while her multitude of inland lakes and spring fed streams abound with the trout, grayling and bass, which are the pride of the angler.

As an important food of the people, fish enter largely into the economy of their daily life, and the maintenance of the supply or its increase cheapens the price to all.

The increasing demand for the food fish of our great lakes within the last twenty years, has entirely revolutionized methods of fishing, and has resulted in greatly improved appliances for the capture of fish, to meet the demands of daily consumption.

For many years the fishing on the great lakes was prosecuted by fishermen with Mackinaw boats, with which they fished small gangs of gill nets, and their work for a long period was confined almost exclusively to gill net fishing. The fishing industry as it is now conducted, however, with its improved methods, has been concentrated into fewer hands, and is controlled by those possessing large capital. The nets have increased in number from a few gangs of gill nets fished in a primitive manner, until our statistics now show that one proprieter alone is fishing seventy-five miles of gill nets and prosecutes his work, as is now quite commonly the case, with steam craft. The pound net which is a device of later growth, than the gill net is a much

more effective and destructive method of capture than the gill net, and large quantities of fish are now taken by this method of fishing. Fishing is now conducted largely with steam vessels with which the nets are set and lifted, and instead of the fisherman fishing only for home consumption during certain seasons, they prosecute their fishing during the greater part of the year, sending their product all over the country to every city of importance, from the great lakes to the extreme south, east and west. The supply thus taken, over and above the needs of present consumption for home market, instead of being salted and smoked as was formerly the custom, which largely reduced its market value, is now either packed in ice in fish cars having a capacity of about two tons, and sent to southern, eastern and western cities for distribution, commanding a high price as fresh fish; or the fish are frozen by the large dealers on the lakes and held in refrigerators to await future orders. These fish are sold as fresh fish at a later period in the season at good prices. From the fishing business alone there results yearly a large contribution to the material wealth of the State. Statistics now annually collected show that the value of the product of the commercial fisheries of Michigan amounts to about $1,500,000, besides furnishing a means of livelihood to a large number of our people.

To keep good this annual depletion by fishing, and to restore the catch and waste of years, before the methods of artificial hatching and restocking could begin to repair the loss, is the task to which we have set ourselves, and one which it must require years to complete.

The enlargement of the capacity of the trout station at Paris, Mecosta county, since the last report, with present facilities to still further increase the output, with some further minor additions from time to time, will enable us to sustain good fishing in the streams already stocked by the State, and enlarge our operations by stocking streams along the new lines of railway which are constantly being built through the newer portions of the State.

The importance of this work in contributing to the material progress of the State is scarcely appreciated by the public generally. Year by year the numbers of people from other States who are attracted here by reason of the sport with rod afforded to them by our waters, are increasing. The railroads have long recognized that a large number of this sport seeking element of our population are seeking desirable points for summer outings, and watchful of their own interests, by liberal advertising they are seeking to divert as large a portion of this travel as possible over their own lines of road. The summer pleasure seeker belongs to that portion of the community which has money and spends it freely, and as a consequence a large amount of money is left each summer by this class in our State. Beyond question it has been one of the most potent factors in developing that region of the State known as the Grand Traverse region; and has also been instrumental in developing other portions of the State.

By a liberal stocking of suitable streams with game fish, the State is pursuing a wise and judicious policy which cannot but result to the material advantage of her people.

In this connection, and showing the character of the inland work in stocking the streams with brook trout, it may be stated that prior to the organization of this board, trout were practically unknown in the streams of the lower peninsula below the latitude of the Boardman river. Mr. Bela Hubbard in his valuable and interesting book "Memorials of Half a Century" says, p. 265, "The moment the Straits of Mackinaw are crossed

the brook trout is found in abundance in all the rills of the upper peninsula. Some other reason exists for the absence of this fish from the lower streams than the character of their waters, for all these, as well as the interior lakes that exist so numerously in Michigan, abound in the same kind of fish as are found in the eastern states." This is an extract from a letter written in 1841, and is authentic as to the condition of things existing at that period.

These observations are fully substantiated by the recollection of many of our older inhabitauts and sportsmen. It may be cited as an instance of this fact, and also as showing the changes in the fauna of our streams, that twenty-five or thirty years since the Jordan, now one of our finest trout streams, contained no other fish but the grayling, while uow a grayling is seldom seen in these waters.

It is a matter of common observation that at the present time fine trout fishing is to be had in very many of the counties of the lower peninsula, and these streams never knew the speckled trout until they were artifically introduced. Even in the extreme southern portions of the State, noticeably in the immediate vicinity of Kalamazoo and Battle Creek, the streams now abound in trout, furnishing the finest sport, and giving a wide-spread reputation to these localities for the size and quality of fish taken there each year.

Newaygo county has become a famous locality of resort for sportsmen. Its streams now abound with fine brook trout, which were never found there before they were artificially stocked. This is also true of Oceana, Lake, Mecosta, and many other counties of the State. It may be mentioned in passing, as an instance bearing upon the practical feature of the question, that two years ago a fine hotel was erected at Hart in Oceana county for the accommodation of sportsmen who sought the waters of this locality in pursuit of its game fish.

As illustrative of the character of these streams, it may be said that nearly all the streams of the lower peninsula north of the Detroit, Grand Haven & Milwaukee Railway, teem with the natural food of the trout, the caddis, shrimp, etc., and the growth of fish planted in these streams, by reason of the abundance of this natural food, is marvelous and almost beyond belief. Trout have often been taken at the age of three years weighing upwards of one and one-half pounds, and even as high as two pounds.

It may be said that all streams in the lower peninsula lying south of 44°60′, now having brook trout, are streams to which the trout were not indigenous, and the trout now found in them are the results solely of artificial propagation and stocking.

Some comprehension of the efforts made by this commission to stock the inland waters, may be gathered from our statistics, which show that trout were planted in the year 1888 in forty-six counties, in 1889 in forty-eight counties, embracing three hundred and thirty-nine streams, and in the year 1890 distributions were made in fifty-two counties, embracing three hundred and ninety-eight streams.

Favorable comment upon this work is being received constantly from all portions of the State, and largely increased demands are being made upon our capacity each year for more fry.

Each year new lines of railway are opening up new territory with streams which lie in the latitude most favorable to the growth of the trout. The policy of the board is, and has been, that all new waters favorable for

stocking shall be planted as rapidly as possible. Although some of this country is now a wilderness, these streams when stocked will become favorably known as trout streams, and they will become important factors in the development of the country and its settlement.

There is no good reason why every stream capable of sustaining these fish should not be cared for, and the near future should enable us to largely contribute to an end much to be desired; the extinction of the feeling so commonly held by the people of all communities under our form of government, where the waters are held to be common property, that no streams shall be preserved, but that all waters shall be open to the general public for fishing. This can be accomplished by enlarging our work and increasing the output of fry, so that ultimately all waters shall be stocked with fish and they shall be so plentiful that there will be no object in the individual preserving any water.

It is our aim to fill all applications for fish as soon as possible after they are received. Distributions of trout, whitefish and pike perch (wall-eyed pike) are made in the spring, while the carp distributions are made during the summer months. Measures have been taken by the board to determine in passing upon applications whether they are for public or private waters. In all cases where the waters are ascertained to be private, applications are refused, and the applicant is informed that the work in which we are engaged is sustained by the public, for the public benefit, and that it is against public policy to stock private streams with public funds. We have now and then found instances of imposition by applicants in claiming private waters to be public, but as a rule it is safe to say that these instances are infrequent. When an applicant has once been detected in making a fraudulent application subseqnent applications by him are refused in each instance.

The usage of the board is to go over each application before the distributions are finally made, and to then determine whether the waters covered by the applications on file are suitable for the fish asked for. After this is determined the parties are notified of all applications passed upon favorably and are notified when they may expect the fish. They are also directed to meet them promptly on time, and if for any reason parties fail to meet the fish at the appointed time and place, the fish are not left at the station to which they are consigned, but are taken on by the car and put into some other suitable stream.

VALUE OF FISHING INDUSTRIES.

In the year 1883 the legislature passed an act making it the duty of all fishermen on the great lakes or Detroit river, to report annually on or before the twenty-fifth day of November in each year to this board, the number of pounds of fish taken during the year, together with the average price per pound received for the same.

The entire lack of data of any authentic value, as to the quantities or amount of commercial fish taken in this State, had long been apparent to this board; and the necessity that such information should be had as a basis for determining the value of our fisheries, and whether in the future we were losing, gaining, or holding our ground in the work of artificial restocking was quite apparent. No provision was made under the act for the determination of the correctness of the reports received under the provisions of the law. The reports were received whether they were correct or not.

The whole matter of the accuracy of the report was left to the judgment of the fishermen, and the question of whether they would report or not was left to their inclination. No appropriation was made and placed at the disposal of this board, wherewith an agent could be sent into the field to ascertain whether all fishermen had reported as required by the act. The data which was sent in voluntarily was found to be very meagre. Indications were sufficient to show that the reports would be of little value, unless means were taken to personally canvass the territory in which fishing was done to ascertain as nearly as might be the facts and verify the reports. It was therefore thought best by the commission to seud into the field some person with sufficient tact and address to secure the desired imformation. The reports for the first year showed that some such course was necessary consequently Mr. Lyman Brant was sent into the field soon after the passage of the act, and as a result of his labors, reports were obtained from 432 fishermen.

This work has since been followed up from year to year with varying success, and while the returns are believed to be imperfect, in some degree the data received gives sufficient information on which to base a reasonable calculation of the amount and value of fish taken annually.

Considerable trouble arises, at times from the reluctance of individuals to furnish the information required by this act. Many fishermen are suspicous that it is a covert attempt to obtain information for the purposes of taxation. others think it is an attempt to secure information upon which complaint may be based for illegal methods of fishing, and there are still others who refuse on the ground that it is an unwarrantable interference with their private affairs, and that any report they may make, providing it shall show a successful catch, will result in bringing other fishermen to their grounds to interfere with their business.

No attempt has been made by us to enforce the provisions of the law by fining the delinquents, for the reason that it has been hoped they might, after a time, comply with the provisions of the act. It has been a matter of doubt with us whether an example might not be beneficial. The State is unquestionably entitled to the reports provided for in this act, and the information thus derived might be made of much value in future comparisons as above suggested. The State is making every effort in its power to restore exhausted waters, and to sustain fishing in localities where fishing is now being prosecuted, and it has the right to insist upon a full compliance with such reasonable objects as are expressed in this act.

The commission after the passage of the law, prepared a blank report which is annually sent to the fishermen of the lakes, which has embodied in it the information asked for by the act, together with such additional information as the board consider of statistical value. The form of the report is as follows:

This blank must be filled out and sent to MICHIGAN FISH COMMISSION, Detroit, Mich.

STATE BOARD OF FISH COMMISSIONERS.

REPORT TO SUPERINTENDENT. OF FISHERIES,

In accordance with act 141, laws of 1883.

ACT 141, LAWS OF 1883, OF MICHIGAN.—Section 4. All persons having a residence in this State, engaged in fishing as a business, for a whole or any portion of a year, in any of the great lakes or Detroit river, shall, on or before the twenty-fifth day of November of each year, report to the Superintendent of Fisheries, at Detroit, the amount in pounds of all the food fish caught by them during the year, together with

the average price per pound. Any person neglecting or refusing to make the report provided for in this section, shall, upon conviction thereof, pay a fine of ten dollars and costs of suit, to be recovered by the Superintendent of Fisheries, or any one of the Fish Commission, in an action before any justice of the peace in the State of Michigan. [This act to take immediate effect. Approved June 2, 1883.]

Name of fishery owner or operator..... Location of fishing station.....

P. O. address.....

This report covers fishing season from.....18.....to.....18.....

Species of fish caught.	Average weight of fish.	Total number of lbs.	Average price per pound.		Length in fathoms of each net.	Size of mesh.	Remarks.
Whitefish				No. of gill nets used			
Lake Trout				No. of pound nets used			
Herring				No. of seins used			
Sturgeon				No. of fyke nets used			
Pickerel				No. of other nets used			
Bass							
All other kind							
Caviare							

Number of men employed..... Kind and number of boats used.....

Remarks as to season—favorable or unfavorable; as to weather and catch:

Signature.....

The value of the commercial fish taken in this State, in the year 1888 and reported to this board, by 102 firms, engaged in the business, was as follows:

	Pounds.
Whitefish	2,686,720
Trout	1,679,994
Herring	1,457,766
Sturgeon	207,341
Pickerel	348,713
Other kinds	814,752
Total pounds	7,258,226
Caviare	21,890
Total value at wholesale cost	$214,976 01
Total value at market price	580,658 08

The following nets were in use:

Pound nets	289
Gill nets	6,364
Seines	2
Fykes	50

The following boats were used:

Steamers	18
Sail boats	61
Pound boats	62
Skiffs	88

Total number of men employed, four hundred and seventy.

The value of the commercial fish taken and reported according to law, in the season of 1889, to the Fish Commission by 146 firms, was as follows:

	Pounds.
Whitefish	3,219,176
Trout	2,672,335
Herring	2,327,993
Sturgeon	304,098
Other kinds	936,263
Total pounds	9,459,865
Caviare	13,419
Total vulue at wholesale cost	$271,654 01
Total value at market price	756,789 20

The following nets were in use:

Pound nets	1,152
Gill nets	9,762
Seines	14
Fykes	78

The following boats were used:

Steamers	29
Sail boats	103
Pound boats	94
Skiffs	52

Total number of men employed, six hundred and seven.

LEGISLATION.

During the session of the legislature of 1889, the commmissioners visited Lansing frequently, for the purpose of explaining their estimates to the legislature, and twice, at the invitation of the Fisheries Committees of the Senate and House of representatives, who desired their advice on bills pending, affecting the regulations regarding the nets.

Several changes were made in the laws. Some of these, if not the greater part, related to the regulation of fishing in the inland waters, and it was desirable in most cases that bills should pass. Other bills relating to the great lake fisheries should not have passed, their enactment was against the advice of this board, and their final passage resulted in the repeal of certain laws which were very wholesome if properly enforced.

The law regulating the close season for grayling was changed, to make the season uniform with the close season for brook trout. We would recommend that the law as it now stands be repealed and that an act be passed at this session making the close season for grayling commence October 1 and expire June 1 of each year, leaving the law as it formerly stood.

All laws providing for close seasons, are passed with the object of protecting fish during the spawning season, and for a short time prior and subsequent thereto. Trout begin to spawn variably with latitude from Sept. 1 to 25 and are through by the last of December, or the first of January. The grayling spawns during February, March and April.

There is therefore, no reason why the close season should begin with the grayling earlier than October 1, and we would recommend that the law as it now stands be changed as here suggested.

Complaints are numerous from fishermen, as will be seen by the report of the statistical agents herewith submitted, of the fouling of waters by mill owners with sawdust and refuse. Great injury arises to the fishing industries of the State from this cause; perhaps greater than from any other one cause reported. A much better enforcment of the laws in this regard should be had than has heretofore obtained. This law is quite frequently ignored, and the violations arise from various causes. The principal reason is a desire on the part of mill owners to save themselves the expense of the erection of sawdust burners. One locality in this State may be mentioned, where the mill proprieters have contributed as much, if not more to the destruction of the whitefish spawning beds than any other one locality that can be instanced. For years it has been the custom of these parties to allow the sawdust and refuse of their mills, in the shape of edgings and slabs, to run into the lake from their mills. This refuse has floated for miles upon the water, and has settled on the spawning beds, thus driving the fish from the spawning grounds forever. In many instances

nets have been seriously injured by the slabs and edgings, resulting in serious loss to fishermen. It may be further instanced, as an evidence of the short sightedness of this firm's policy that the refuse sawdust thus flowing into the lake has created bars in front of its own docks, necessitating the continned employment of a dredge to remove the bars thus formed, to furnish opportunity for vessels to reach their own docks for loading. Not only is this true of their own property, but the docks of another company, some distance removed from these mills, but fronting on the lake, are also subject to the same nuisance. The company creating this nuisance has voluntarily, and for the purpose of not being interfered with in their dumping operations, kept the slips of their neighbor dredged to allow vessels access to their dock.

Attention should be given to these complaints by the legislature at its coming session, and steps should be taken by legislative enactment, to give the Game and Fish Warden an opportunity for a better and more efficient enforcement of the law than is at his command under existing acts.

In our jndgment the present act providing for the appointment of deputy wardens should be radically changed. By the present system of appointment, boards of supervisors may or may not appoint a warden, as they choose. It is also within their province to fix the compensation of the warden and he is paid for his services out of the county treasury. The compensation is often fixed at too low a rate, and the term of service is too short to command the services of a good man. It is quite often the case that no allowance is made by the board for a warden at all, and thus no enforcement of a just law is had for the connty. The principal difficulty which renders the law as it now stands practically of no value, is the difficulty of securing from the neighborhood where the offense is committed, a warden who dares or cares, for his own good, to make complaint against his neighbors, or to assume the distasteful role of an informer. As an illustration: the company just referred to owns the town where its mill is located, and no one could be secured at this point who would care to make tronble for himself in attempting to secure an enforcement of the law against this corporation.

By a law which would authorize the warden to appoint say three or five deputy wardens, whose jurisdiction should extend over the state without reference to particular locality, and who, at the direction of their superior, might be sent to any locality, this difficulty would be overcome and the laws would be euforced uniformly in all localities. The salaries and expenses of these wardens should be borne by the State.

REPORTS OF STATISTICAL AGENTS.

On August 28, 1889. Mr. Mussey, the Secretary of the board, was directed to go to Alpena to investigate dispatches received from that point which appeared in the Detroit daily papers, and verify the truth of the published reports that a large catch of whitefish had been made at that point.

His report is as follows:

As directed by the President of the board, I left Detroit on the 28th of August for Alpena to verify the truth regarding certain newspaper reports, showing that large quantities of whitefish were being or had been caught in the vicinity of Alpena.

Arriving at Alpena on the morning of the 29th I at once secured an interview with Mr. E. Harrington, a fish dealer of this place, who had succeeded to the retail business of the Alpena Fish Co. He informed me there was no truth in the report of a large catch of whitefish at this point. He also said that very few fish were being caught, barely enough for the Alpena market, in fact so few that none whatever could be shipped,

I endeavored to see Mr. Caspar Alpern, the president of the Alpena Fish Co., whom the newspapers had reported had taken the large catch of whitefish. I could not secure an interview with him, as he was confined to his bed with an injury received a few days before. I did, however, see his foreman, Mr. William Paxton. He informed me they were getting no fish at Alpena or Thunder Bay of any amount. He said that about the first of August there had been one lift made of 1,200 pounds and a day or two subsequently another of 1,300 pounds, but that since that time the catch had been so light that none could be shipped. He thinks the fish caught were of small size, being about one pound in weight, and that they were planted fish. He said further that no results could be expected from the planting of whitefish in Thunder Bay near Alpena while the water contained so much sawdust. He reported the catch no better, if it was as good as last year. He said that the Alpena Fish Co. receive all the fish caught in the vicinity of Alpena.

I visited Captain Dervin, who is manager of a fishing tug at this place, who corroborated Paxton's statement in every particular.

An interview with Morris Alpern, a son of the president of the Alpena Fish Co., confirmed the report that I had received from the others interviewed. All these parties believe the fish caught were planted fish.

I afterwards visited Mr. Henry Bolton, a general wholesale and retail dealer in merchandise, and the most prominent sportsman in Alpena county. He is a gentleman who is particularly interested in game fish, and has interested himself in the stocking of streams in this locality. He informed me that he had recently caught in the Qssineke river two brook trout, one of which weighed one and one quarter pounds, and the other one pound and three ounces, and one from a creek on section 16, inside the city limits of Alpena, which weighed one pound. He further stated that all these fish were the results of the plant of 1886. In company with him I visited Norwegian creek and a small pond on the same creek, distant about four miles from Alpena, which was planted with brook trout three years ago. One was taken by ns at this visit measuring ten inches in length. This was a genuine brook trout, and furnishes satisfactory evidence that the streams of this vicinity are adapted to the growth of the brook trout.

Respectfully,
GEORGE D. MUSSEY.

In January, 1890, Mr. S. C. Palmer, was employed to visit the American shore of Lake Erie, for the purpose of securing detailed information regarding the catch of the preceding season, and to ascertain from the fishermen their opinion of the results of the stocking of these waters. The occasion for this trip was the phenomenally large catch of whitefish taken in Lake Erie in the fall of 1888. The catch of whitefish at that time was a matter of comment among the fishermen all over the lakes, and one of the most extensive fishermen in Detroit renewed fishing operations in Lake Erie, which he had abandoned some years before. His seasons business on Lake

Erie in the fall of 1888 proved very profitable. The agents' canvass included every point where fishing of any importance is done on this lake, and is a fair index of the opinions of fishermen in these waters. His report is as follows:

To HERSCHEL WHITAKER, ESQ., *Pres't Michigan Fish Commission:*

SIR—Agreeably to your instructions, and as your special agent to collect statistics for the information of the Board of Fish Commissioners as to the condition of the fisheries along the south shore of Lake Erie, I left Detroit on the 6th day of January, arriving at Buffalo, N. Y. at 9 o'clock p. m. of the same day. The following were the dealers in fish at Buffalo whom I interviewed:

Mr. E. J. Trible was sick in bed and could not be seen. His foreman says the fishing has been very light this year, although trout fishing off the reefs at Dunkirk is better than ever before. They are still fishing there, a thing unknown before at this time of the year. Mr. Trible is a gill net fisherman and wholesale dealer.

Walter J. Robins, vice-president and manager of the Buffalo Fish Co., says: The whitefishing this year has been lighter than last year, but it is not because whitefish are getting scarce, but because at the time of the whitefish run the lake was disturbed at the bottom. That is, it was owing more to other circumstances than to a falling off in the supply of fish. However, there were plenty caught. He says: "I came here about six years ago. At that time the Buffallo dealers were selling whitefish at ten cents a pound and there were not enough for the demand. The next year the fisheries on Lake Manitoba and Lake Winnipeg were being fished and the fish were sent here. For the first two years the fish were caught late in the fall and sent down by the car load. Since that time two or three parties have put up extensive freezers. Last fall there were stored not less than 150,000 tons of whitefish in the freezers at Manitoba ready for shipment to the United States markets. This has reduced the price so we are selling whitefish at eight cents a pound that would otherwise be sold for ten. It has made a glut in the market.

"I am most decidedly in favor of artificial propagation of fish. It has proved a success beyond a doubt. I know that fish fry have been put in the lake here and caught out again. The fish commissioners are doing a good work, and the people of the different States should give them all support."

Mr. Sweet, of Sweet, Smith & Co., thinks there have been as many whitefish caught in the aggregate at Dunkirk as in previous years, but there have been more fishermen, so each boat has had less in count. He says: The catch would have been much larger, but at the season of whitefishing the lake was foul. Cannot tell in pounds the exact number of whitefish caught, but estimates the falling off as about one-fourth from last year's catch. Had a little better price for fish than before. The State should turn its attention to propagating pike rather than whitefish. The herring will take care of themselves. No pound nets are used about Dunkirk.

Sweet, Smith & Co. are fishermen and dealers in fish. They fish with tugs and gill nets off Dunkirk, above and below. They have three tugs.

Erie, January 8.

Saw E. D. Carter. He is the most extensive gill net fisherman here. He has six tugs and uses more than 3,000 pounds of twine. He is in sympathy with artificial propagation; says it has shown itself a success; says the catch of all species of fish fell off this year about one-fourth, as compared with last year.

Lewis Strader, an extensive fisherman, is one of the Pennsylvania Board of Fish Commissioners. He says: "The first of the season we had the greatest catch of whitefish ever known, but it fell off after that, probably from the disturbed condition of the lake. A short time after the commencement of whitefishing the lake was very roily. Two years ago we had a great catch of sturgeon in pound nets. Last year we had none; no sturgeon were caught. I have twenty-eight pound nets. I believe the commissions have kept up the supply of whitefish which would otherwise have been depleted. They are now fishing for trout off the reefs, a thing unknow before in the month of January."

Cleveland, Ohio, January 8.

I saw Mr. Munson, of Munson & Co., fishermen and dealers. He says the fishing has been very light here this fall. The spring fishing was very good. The fall off was one-half from last year. It was in my opinion owing to the unfavorable winds at the time of the catch.

Messrs. Munson & Co. use both gill and pound nets, but use no gill nets for whitefishing.

He says: "We are decidely and heartily in favor of artificial propagation. Gill net fishing is something new here. Six years ago there was only one tug here, now there are six or eight. This firm fishes with pound nets principally at the Rocky river." He attributes the decrease in the catch of fish to unfavorable winds and currents, because in the spring when the winds were favorable the catch was fully up to the average.

Sandusky, Ohio, June 9.

Saw Mr. J. A. Hosmer, of the firm of J. A. Hosmer & Co., dealers in fresh, frozen and salt fish, Railroad St. between Columbia and Jackson. He is enthusiastic in the matter of artificial propagation, and says it has proved itself a grand success. Says the falling off in the catch of whitefish was due to the unfavorable winds and currents at the time.

Interviewed Mr. H. C. Post, of the firm of H. C. Post & Co. They are the most extensive fishermen and dealers at Sandusky; doing as much or perhaps more business than all the other dealers combined. They have operated here nearly twenty-five years. They have the fish from 150 pounds, handling fish for thirty miles along the Canadian shore and forty miles along the American, besides at the Islands. They have two steamboats running to the Canadian shore. Last year, they had 600 tons of frozen fish, sixty tons of which were whitefish. Owing to their increased facilities they have handled more fish this year than ever before; all kinds, including whitefish. They now have eighteen tons of frozen whitefish. Says the catch of whitefish was not so large this year as heretofore, but that is due partially to the fact that the gill nets keep ahead of the schools, and get them before they get here, and partially to adverse winds and currents.

Mr. Post holds up both hands in favor of artificial propagation, he says the supply of whitefish in the lake was practically exhausted until five years after the commission put their first fish fry in the lake, when the catch became good again, and it is nonsense to suppose the increase was due to natural causes or to a miracle performed at just that period—at just exactly the time when the work of the commission would show itself. No, he says let us give credit to whom credit is due; to the fish commissioners of the States and to no others. Why should not artificial propagation be a success? You hatch the fish in houses, and care for them until they can take care of themselves. Why should not a greater proportion of fry live than if hatched in the beds naturally and left to run the gauntlet of their enemies the suckers, sturgeon and other species of fish that feed on fish spawn? By all means let the work of artificial propagation go on. Our legislators make no mistake when they appropriate the people's money to keep up the supply of fish in our great lakes.

Toledo, Ohio, Jan. 10.

Called on Wm. St. John, of Wm. St. John & Son. He says: The catch of whitefish has fallen off one-half from last year but it is owing entirely to local causes. Uses pound nets only. They operated fifty nets last year but this year have only six. Whitefish have averaged about 2½ pounds. There are now three firms doing business where there used to be only one.

I interviewed Mr. Alexander St. John of the "Lake Erie Fisheries." He says: "The catch of whitefish this season has fallen off one-half from last year's catch. Last season's catch was enormous. This year we had about twenty tons of whitefish. The herring catch was in the neighborhood of one hundred tons; perhaps eighty tons would be a fair estimate. We use no gill nets. We run pound nets; fifty nets this year. Last fall we made some money, this fall nobody made any; what money was made was made in the spring. We handle more fish here than are handled in any part of the globe. There were twelve hundred tons of frozen fish here last year, and eight hundred tons of fish were salted. The year before there was from ten to twelve hundred tons." Believes that artificial propagation should be continued.

J. N. Dewey & Co. fishermen and dealers in fish, say the catch of fish, especially whitefish, was lighter than last year. Last year we had more than ever before. The fall off in the catch was due entirely to the temperature; at least it had much to do with it. If we have the wind northwest, we do not catch as many as we do with the wind south-west. The currents were also more unfavorable. We catch in Ohio waters and Michigan waters. We have this year 75 tons of whitefish; 500 tons herring, 80 tons No. 1 pickerel, 100 tons No. 2 pickerel; 1,500 sturgeon by count and 100 soft perch. We get fish from 100 pound nets. Thinks that but for artificial propagation the whitefishing would be virtually run out before now. Believes the commission are doing a great work.

Following the return of the statistical agent from Lake Erie and the submission of his report, he was sent to visit the Lake Huron coast, from Port Huron to Caseville on Saginaw Bay. His instructions were somewhat enlarged as to the scope of inquiry to be made.

In planting whitefish fry it is desirable that they should be placed, when possible, on the natural spawning beds of these fish. The agent was accordingly instructed to ascertain as nearly as possible at each place the locality of spawning grounds, for future guidance in making distributions of fry.

He was also directed to make particular inquiry as to the former presence of whitefish on this shore, the magnitude of the industry there as it once existed, and on what scale present fishing is being done. He was further directed to elicit such other information relating to the subject, as might seem to him to be of value. His report may be prefaced with the general statement, that this portion of the coast has been but little fished for the past few years, although some years since profitable fishing was conducted all along this shore. Attempts have been made for several years to reach this coast with whitefish plants, but the Pt. Huron & Northwestern R. R. steadily refused to transport fry and men and no plants were made there. Since the acquirement of this line by the F. & P. M. Ry., however, its liberal and progressive managers have extended every facility to this board to reach this shore, and we shall now make annual plants here as referred to in another part of this report.

The report of the statistical agent on this coast here follows:—

To HERSCHEL WHITAKER, *Pres. Mich, Fish Commission*:

SIR—In accordance with your instructions, and as your special agent to collect statistics as to the condition of the fisheries along the south-west shore of Lake Huron and the eastern shore of Saginaw bay, I beg leave to submit the following report:

I left Detroit Monday, February 3, arriving at Port Huron on the same evening. At Port Huron I saw Mr. Lang of the firm of Lang & Craig, who are the only fishermen here fishing on the American shore. He said: "We have fished here only two years but have dealt largely in fish for many years. People do not know where the whitefish spawning beds here are, it is only conjecture. In fact there is no whitefishing here. We never catch a hundred pounds a year. The only places where whitefish are caught at all now, are at Port Crescent and off Forester, and not very many there. If the commission wants pickerel eggs we will furnish them what we have. They can start about the 14th of May. Stony Point is a good place to plant whitefish in my opinion.

"The Fibre Works on Black river are killing more fish than all the commissions can make by artificial propagation. They let their acids into the river and poison the water and kill the fish by the thousand, and the stench from the water is simply intolerable; so much so that the authorities of the city have talked of having the works indicted as a nuisance. I think the commission ought to do something about it if it is possible." Captain Moffat also told me the acids in the water were so strong that they destroyed the paint on his boats, so he had to paint them below the water line several times last summer because of it.

Fort Gratiot, Feb. 4.

Rantz R. Holland and Joseph Miller are the fishermen at Fort Gratiot. Joseph Miller was not at home. I saw his son John. He said: "We have fished here, off and on, for the last ten years. We use pound nets; have three this year. The fishing has decreased steadily for the last few years. This year the catch has fallen off about one-third from last season's. I think 200 pounds of whitefish would exceed in amount the season's catch at this fishery." Mr. Miller promised that his father would make his report at once. I left a blank for the purpose.

Rantz R. Holland was not at home when I was there. I saw Mr. Hall who has fished for him for the last five years. He said: "We use pound

nets altogether. Have five nets and one seine. Fishing generally has been full as good as usual, except the sturgeon fishing has fallen off. As to whitefish we do not actually get enough for our table; do not think we have caught one hundred pounds all told this season. Of sturgeon we have averaged a ton a day. Pickerel have been an average catch. The mills and their refuse are a thing of the past along this shore.

I do not think the whitefish spawn here at all, nor nearer here than Saginaw Bay. I would not deliver a whitefish to plant within ten miles of this river. One reason is that the current is so strong it would carry the fish back in the river. A log will drift at the rate of two and a half miles an hour and we are four miles from the river. I think the current here is too strong for those little fish. There is a solid sheet of moss here and I would go far enough away to get clear of that."

In the evening I saw Mr. Holland. He said his father and he had fished in this vicinity for the last forty years. Said essentially the same thing as to the best place for planting of whitefish as Mr. Hall; that is that whitefish ought not to be put in the lake within ten miles of Port Huron light. He said that 12 or 14 miles out there was clear water and clear bottom, and plenty of moss which he thinks the young whitefish feed upon. Last year, the State Commission planted some here—about ten miles out—which will be heard from some time probably, and it is the first time a plant of fish has ever been made that will benefit us at all. The fishing is nothing compared with what it was when my father and I fished here years ago. It has fallen off somewhat from the last year even. I use five inch mesh: cribs are two and one-half.

Mr. Holland procured the tug to do the planting last year, and will this year if the commission desire him to do so. Does not think he could get one for less price than Capt. Moffat gave me. His fishery and Mr. Miller's are situated three miles from Ft. Gratiot up the lake.

In negotiating for a tug to deliver the plant, I saw all the tug owners and agents. Edward Linn will not do the work for less than $50.00 a day. Captain Moffat will work for $5.00 an hour. Capt. Oscar Henkett, boards at the Elliot House, at Port Huron; he will work for the commission for $25.00 a day if he is at Port Huron at the time. Must write him at the Elliot House a day or two before you need him; possibly he will be at Sand Beach at that time.

Messrs. Selkirk & Co., large dealers in fish are not fishing except in Canadian waters this year. Next year they expect to give a report of themselves they will put in ten or twelve nets another season. If the commission's whitefish fry are delivered when their tug is at Port Huron, they will carry them out free of cost. But about three or four weeks from now they will not be here.

Lexington, February 5, 1890.

I saw Mr. Andrew Monroe, the only fisherman at this place. He has two pound nets and two strings of gill nets. Has fished here for thirteen years. Runs seventy-five gill nets. He says the fishing is not to be compared with what it was when he first commenced fishing. Thinks the reason principally is that they have been caught out, but another is that the fish migrate. They are here this year and some other place next season. Doesn't think the mills throwing their refuse into the water makes much difference with the catch. To the question, should there be a close season, he said: Yes, if the fall fishing could be stopped for four or five years it would make a difference with the catch, but there is no use expecting anything of that kind. We talked it all over in Detroit four years ago and it did not amount to any thing. A few of us would be willing to stop fishing a few years, but the most of the fishermen would not be willing and I don't think such a law could be enforced. I don't think the whitefish spawn this side of Saginaw bay. There is no shelter for them from the current.

Mr. Munroe introduced me to James S. Hunter, of the firm of Hunter Bros. fisherman at Port Sanilac. He said: I don't believe there are any whitefish spawning beds between here and Saginaw bay. There are no reefs nor anything to shelter them, I think is the reason, but east by north from Port Sanilac, about eighteen miles, there is a large reef called "Honey Comb Rock" that I think would be a good place to plant whitefish fry. A close season would amount to somethiug if it could be carried out. It ought to commence the last of September and continue through November.

Port Sanilac, February 5.

Talked with Mr. Wright, of Wright Bros., fishermen at this place. He said: We have fished here twelve or fourteen years. We have sixty-two gill nets and two pound nets. There is no comparison between the fishing for any kinds of fish here now, with what it was when we first came here. We catch one now where we caught hundreds at that time. Ten years ago, in one season, we caught 2,500 pounds of whitefish, since then we have caught none to speak of; and of other kinds of fish, where we caught barrels at a haul then, we hardly catch barrels in a season. One season ten years ago we caught nine barrels at a haul; now we don't get nine barrels in a whole season. Of whitefish we perhaps caught fifty in count, and no more than that. I think fish come and go; they are here this season and some other place next year.

About sixteen or eighteen miles east by north from here is "Honey Comb Rock" that is the nearest place I would think of planting whitefish. There are no herring there to interfere with them and they would have clear water. I think a close season to commence the first of September and end the first of January, would be what we ought to have. I think the State ought to take the money that is expended in hatchiug fish, and pay the fishermeu to stop fishing during the close season; that is, pay the fishermen for their time while they are lying still in the fall, during the fall fishing season.

Port Sanilac, February 6.

Mr. Richard Hunter of Hunter Bros. says: We have fished here 12 years; we use gill nets only. The fishing now is much lighter than it was when we first commenced fishing. "Honey Comb Reef" is east, half north from here, and about six miles due east from Forester. There is a deep hole there with clay bottom where whitefish may possibly spawn, at least it would be the place to plant them, for they are caught there in larger quanties than at any other place between Port Huron and the "Bay;" although really I don't think there is now a spawning bed this side of Sagiuaw bay, nor between here and Port Huron. We never catch any whitefish until after the spawning season, so I think they go off somewhere to spawn.

This year we caught whitefish—sometimes one, two, three or four at nearly every lift; something unusual for us, and I believe they run in from Lake Erie. I believe that every whitefish that is caught in Lake Huron comes from Lake Erie. I believe in artificial propagatiou of fish, because

I know there is whitefishing now in Lake Erie where ten years ago they had none any more than we have now in Lake Huron, and I know that the Lake Erie whitefishing is the result of artificial propagation.

There is no one fishing at Richmondville this season. Allen Brothers are the only fishermen at Forester; they use pound nets. Off Forester due east, is the only whitefishing of any account between Port Huron and Saginaw bay.

Sand Beach, February 6.

The only fishermen operating here are David E. Dues and Levi Brown. Saw Mr. Dues this evening. He says: I have fished here twelve years, off and on. Have five miles and a half of gill nets. There used to be good fishing here, but not now. The winds were favorable but the fishing was poorer this year than last. Trout fishing is fair in the winter. I am now fishing 900 hooks about four miles out; in the summer we go out about twelve miles. I do not know of any whitefish spawning beds this side of Alpena; they spawn there.

I think a close season should commence the last of September or first of October, and end at any time after the first of December. That would give the fishermen a chance after they spawn. As it is now, they go with their traps on the spawning beds at Alpena and catch tons and tons of them. They catch the little whitefish and salt them and sell them for salted herring, and that is not all, I have seen tons of whitefish rotting on the beach that they could not take care of.

Just east of here there is a reef called "Honey Comb Reef." There the bottom is clear and clean; it would be a good place to plant whitefish fry in my opinion. It is about twelve miles out. Do not plant the fry near the shore, for the herring will eat them. Herring live on minnows larger than the whitefish your commission put in, and of course they will eat whitefish just the same as any other.

There is no one fishing at Port Austin except Henry Martin. No one fishing at White Rock; August Lacy will start in there soon. At Forestville, Easton Brothers. No one fishing at Port Hope this season.

Sand Beach, Februarg 7.

Saw Mr. Levi Brown. He is the most extensive fisherman here; has 60 gill nets and uses one tug. He says: I have fished here at Sand Beach ten years; came just as the whitefishing failed. Compared with the fishing when we came here, the fishing of any kind now is nothing. We have to use finer twine now than we did then. Could not tell you the reason why, but the same rig we used then would not catch fish now.

The "Honey Comb Reef" is about eighteen miles from here; it runs nearly parallel with the shore down to within ten miles of Port Huron light, and it is no doubt the only place to distribute whitefish fry. Ask your commission to give the man in charge of the car positive instructions where to plant the fish.

Three years ago the U. S. Commission planted fish here about two miles from the shore. They had 40 cans, or three millions of whitefish they said. We tried to have them go out towards the reef and so get away from the schools of herring which are always to be found close to the shore. Herring hug the shore always. But the man with the fish knew so much about fish we could not tell him anything. I actually believe he might as well have thrown them on the dock as where he did. Mr. Brown said

again: Ask the commission to give the men with the cans positive instructions, not advice, to plant them no nearer here than "Honeycomb Reef." Of the U. S. plant, I think what the current did not carry into Lake Erie were eaten up by the herring, certain.

About a close season, Mr. Brown says: If the gill nets and pound nets could be deterred from fishing, from the first of September to the first of January, it would be just what would help us out; but the fact is that no two men think alike, and probably it would be impossible to enforce a close season law. So we must do the next best thing, which seems to be, to let the fish commissions hatch and plant fish and plant them out of the reach of their enemies, so far as possible.

Mr. Brown will furnish his tug to plant the fry for $25 a day, or at that rate if it should require but part of a day. He says three or four weeks from now the lake may be full of ice and a tug the size of his could not be navigated. He wishes to be notified a few days before he is needed, and he will answer promptly and tell the board if the lake is navigable, etc.

At parting Mr. B. said: Tell the commission to instruct their man in charge of the car, and let their voice have no uncertain sound when they tell him to plant the whitefish on the "Honey Comb Reef" this spring.

Bay Port, on Wild Fowl Bay, Feb., 1887.

J. & J. Gillingham and Wm. Gillingham are the only firms of fishermen operating at this point. Saw John Gillingham, of J. & J. Gillingham, and William Gillingham together in their store.

They have fished here about fourteen years. Compared with the fishing a dozen years ago, the fishing now cannot be called fishing, but compared with last year, our catch of everything, except herring, was fully as good as last season. Of course, we are not speaking of whitefishing, that is a thing of the past. Whitefishing is of no account whatever. There is a flat here, running from the Charity Islands to the river, which is regular pickerel ground. If you should make a plant of whitefish here, do not put them this side of the channel, but beyond this flat. In the channel would be the place. We know of no whitefish spawning beds this side of Alpena; they spawn there. Some of our neighbors catch them in trap nets and sell them for herring.

We have thrown back thousands, yes, tons of fish into the water. If there could be a law compelling everybody to do that, there would be no need of a close season. We do not believe it would be practicable to have a close season, because it would interfere with the herring fishing in the fall. Of course, if there was a close season, it would have to commence the first of September on account of the trout. They go for the spawning beds about the first of September, and fool around ten or twenty days. They spawn about the fifteenth or twentieth of September. But a close season would not be practicable anyhow.

The Gillinghams gave me the names of several parties at Bay City who fish on the Charity Islands.

Caseville, February 8.

Alexander Truedell, who operates the "Lewis Truedell Fishery" at Caseville, is the only fisherman at this place. He said: We have fished here for fifteen years on the Charity Islands and Sand Point. The fishing compares very unfavorably with the fishing years ago, when we first com-

menced operations here. I attribute it principally to the fact that they are caught out. The catch is not more than half it was even five years ago. Get some whitefish, but not nearly as many as we did. We used to get 25 and 30 barrels at a lift, but not now; four to five hundred pounds is a big lift of whitefish now. We used to get many sturgeon, now they are caught out. I have seen schools of sturgeon in the Pigeon river so thick that their fins were above the water, but that is ancient history. Nothing of that kind has occurred late years. They ought to prevent the slaughter of small pickerel, the small ones should be thrown back in the water.

Mr. Truedell uses 22 pound nets. His mesh are as follows: Leaders, six inch; heart, four inch; pound and sides, three inch; backs, two and a half inch. Uses one flat boat.

Respectfully submitted,

S. C. PALMER.

In June, 1889, the statistical agent, Mr. Palmer, under direction of the board, visited the Lake Michigan shore from the south line of the State to the Straits of Mackinaw, including a trip to the Beaver islands, which lie off the coast of Michigan in the upper end of Lake Michigan.

The followiug is a copy of the instructions given to him, and his report follows:

INSTRUCTIONS TO STATISTICAL AGENT.

Detroit, Mich., June 9, 1890.

SYLVANUS PALMER, ESQ., *Dear Sir*—You are hereby appointed statistical agent of the Michigan Board of Fish Commissioners, and under the direction of the board you are directed to visit the following places, and gather statistics in accordance with instructions contained in this letter.

You will proceed to New Buffalo on Lake Michigan, and commencing there, visit the following places:

St. Joseph, South Haven, Saugatuck, Holland, Grand Haven, Muskegon, Whitehall, (Sammon's Landing), Pentwater, Ludington, (Pt. Sauble), Manistee, Frankfort, (Glen Haven), (Leland, Northport, Sutton Bay), Traverse City, Charlevoix, Petoskey, Cross Village, Beaver Island, Straits of Mackinaw (which will be covered by St. Ignace and Mackinac Island), Cheboygan, Tawas and Alpena.

You will then, unless otherwise directed, return to Detroit. The places marked in parentheses are places about which the board has no information as to whether fishing is being prosecuted or not, and before visiting them you may make inquiries at adjacent points as to whether they are being fished or not. If you are satisfied that fishing is being done at these places, you will visit them, otherwise not.

The Beaver islands you will reach by boat, probably from Petoskey, but you can learn definitely by inquiry in that neighborhood by which route you can reach there best.

You will understand that you are not to be confined in your inquiries to the questions contained in this letter solely, but you are instructed to go beyond this and acquire such valuable information as may present itself to you in the direct line of your duty. You will see that the following questions are answered as near as may be.

1. Inquire of each fisherman whether he has made his last annual report to this board, as required by statute. If he has not so reported, have him fill out a blank under your direction, which you will return to this office by mail.

2. Ascertain by inquiry of the most reliable and experienced fishermen, with all the exactness possible, the precise location of the spawning beds of the whitefish in his locality, making a record of such information in such a plain manner that the beds may hereafter be located when plants are made in that vicinity.

3. Ascertain whether the fishing in each particular locality during the past year has been better or poorer than in former years.

4. If reported better, ascertain from the fishermen what, in their opinion, it is attributable to, and if poorer, what has caused the decline.

5. Ascertain whether the waters have been fouled by mill or other refuse, and if so, to what extent the fishing has been injured.

6. Learn what recommendation the fishermen would make with reference to methods of fishing to overcome the evils of loss of catch.

7. Do they think a close season for whitefish would help matters? If so, what period of time in their opiniou ought the close season to cover.

8. In cases where fishermen express themselves of opinion that artificial stocking has helped the waters, ascertain by questions the basis upon which they form their opinions.

9. Ascertain whether in the opinion of the fishermen there should be any restriction placed upon the size of meshes of nets to permit the escape of small and unmarketable fish.

10. Ask fishermen conducting large fishing operations whether they would be willing to meet the fish commissioners of the different States bordering the Great Lakes, and the persons engaged in fishing on the lakes at some central point in the near future to discuss methods by which fishing may be improved.

11. Has artificial propagation helped the fishing?

Respectfully submitted,

HERSCHEL WHITAKER,

Prest. Mich. Board Fish Commissioners.

HERSCHEL WHITAKER, ESQ.,

Pres. State Board Fish Commissioners, Detroit, Mich.

SIR—Having received from you the appointment of statistical agent, with orders to inquire into the state of fisheries along the Michigan lake shore, for the information of the board of State fish commissioners, and to obtain reports of the last season's catch of fish where fishermen have failed to report, I left Detroit June 10th and proceeded to New Buffalo.

There is no fishing being done at New Buffalo at present. Joseph Hass *formerly fished here with six pound nets, but is not fishing this season.*

Saw Mr. Theodore Lutz, of Campbell & Lutz. They are now fishing at Michigan City. They have removed to Michigan City permanently, as they are nearer their fishing ground than when at St. Joseph. He said: We *have about 1,200 gill nets all told; our nets are about 250 feet long. Fishing generally is fully as good as usual, but the whitefish are scarce, and they will not be any more plenty until the fishing during the spawning season is stopped, and the pound nets are shut out. I believe that the fish caught* by the small mesh pound nets, more than balances the number put in by the commissions. We have twelve or fifteen pound nets, but we will throw them away if others will. But we cannot afford to let others have the advantage of us, so we shall use ours as long as others do. I don't know

where the whitefish spawning beds are. There used to be spawning beds about eight miles south-west of St. Joseph. I think there should be a close season for whitefish, to commence the first of November and end about the fifteenth of December.

Mr. Lutz's recommendation, to insure due increase in the catch, is to throw out pound nets entirely.

At St. Joseph saw but one or two fishermen, the others were at their nets.

Those I saw here said there had not been much if any improvement in the fishing, and thought there was some question about artificial stocking having helped in this locality.

[It is but just to say that fishing has been prosecuted at this point for a long time very vigorously, and small mesh twine has been used to take small fish that have never had an opportunity to spawn. The work of the commission has thus been very heavily handicapped in this locality.—*Commissioner.*]

South Haven, June 13.

Messrs. Boyne & Paxton are the only fishermen here. They fish with a tug; use eight pound nets and ship most of their fish to Chicago fresh. I talked with Mr. Paxton. He said there are no whitefish spawning beds that we know of this side of the Manitou islands. We don't believe that there are any, though some say there are spawning grounds off Saugatuck. We have had a great deal of trouble from mills fouling the waters, and we had to resort to the courts and restrain them by injunction from throwing their refuse, such as sawdust, shingle shavings, etc., into the water. That is just what has driven the whitefish away. No clean fish would stay where there is so much foul water. Whenever there was wind to distnrb the surface the sawdust would rise from the bottom, and something had to be done. The mills were driving the fish and fishermen from the shore.

Do not think a close season would benefit us. We don't catch spawners, because there are no spawning beds near us. There are good regulations now as regards size of mesh. Of course we lost money at first by following the law.

I am a most thorough believer in artificial propagation; that is all that saves us now. All the whitefish that we catch now were artificialy propagated, there cannot be any doubt of it.

I can tell an artificially propagated fish from a native fish as readily as you recognize any member of your board of fish commissioners, but I cannot tell you so you would know one from the other perhaps.

I judge them by their general shape and size. They are of an almost uniform size, and they are shorter; have a more stubbed appearance, with short necks, while the naturals are longer and slimmer, and do not look as fat as the artificials. Another thing. There is more slime on the planted fish; more on the fish and on the board where they are dressed.

Mr. Paxton has no recommendation to make as to methods of fishing. Would be willing to meet with the board to discuss matters. Have mailed you Boyd & Paxton's report of last season's catch.

Saugatuck, June 14.

The Shriver Bros. are not fishing here this season; they are at Charlevoix. Alexander Shriver is the only fisherman whom I saw. He is a gill net fisherman: has 35 nets of 45 fathoms each. Catches mostly sturgeon and herring, with some trout and a sprinkling of every other kind, except he does not take anything that he calls whitefish.

He says the whitefish have not spawned here for three or four years. The spawning beds are about a mile due south, extending probably a mile into the lake. Does not think restricting the size of mesh would make any difference. The pound net men use legal size mesh, but they slip an apron into the pot, with mesh small enough to catch everything that comes along.

Have had plenty of annoyance from the mills, but they are mostly gone now. The government scow dumps shingle shavings and sawdust back in the lake and that does not help the water any.

We catch a great many "long jaws." They are the same as a whitefish, only they have a long jaw. I think the commissions have propagated them for whitefish through mistake, as they are of uniform size and have come into the water here within a few years. I think the hatcheries are a good thing, because, if they can hatch long jaws they can hatch whitefish.

[Mr. Shriver is laboring under a misapprehension in this respect, as the "long jaws" are peculiar to the waters of Lake Michigan alone, and no ova has ever been taken by this commission on this lake.—*Commissioner.*]

The pound nets have cleaned Lake Michigan out of fish. I have seen 3000 pounds of whitefish sent to Chicago and you could put thirteen of them in a cigar box holding 50 cigars. They got one cent a pound for them.

Have seen 300 sturgeon taken out of a pound net just for the bladders and caviare; the fish were buried on the bank.

I threw away my pound nets because they were 3½ inch mesh.

Would be willing to meet the commission and fishermen to talk over methods of fishing, but it is no use; these conventions are always in the interest of pound net men.

I hand you Shriver's report of last year's catch.

Holland, June 13.

William Baker is fishing six pound nets off Mackatawa Park in Black lake. The only one fishing here; did not see him.

Grand Haven, June 14.

Saw the elder Mr. Fisher of A. & A. Fisher. He says the spawning beds in this vicinity are about eight miles west by southwest from Grand Haven, where they used to catch the best spawning whitefish.

"The whitefish are about all gone, the pound nets having taken them. I don't think that planting can amount to anything as long as the pound nets are allowed in the water. That is, it cannot amount to as much as it might, because as fast as they are hatched they are caught out. Fifteen or sixteen years ago we could get fifteen hundred pounds or more at a lift, but they were about all gone until four or five years ago when they seemed to commence to come on again; that is, they must have been hatched and planted faster than they were caught out. Mr. Obeke caught 1,300 pounds in one night last year, and I caught over 600 pounds at one lift. I believe they were planted fish because they were all alike; they seemed to be all the same age. The fry of a planted fish is all the same size, but the fry of a naturally grown fish is different; it is sometimes little and sometimes large. The spawn of a young fish is a yellow color and of an old fish is red.

"There is no necessity for mistaking a black fin herring for a whitefish, the herring's lower lip sticks out, and a whitefish's upper lip projects.

"The refuse from the mills have interfered to some extent with whitefishing along the shore, but perhaps they have driven away no more fish than the fish offal that we used to dump into the water. Now we utilize every part of the fish; we cook the entrails and extract the oil and sell it. We have one tug and sixteen miles of gill nets. Will meet in council with commissioners and fishermen if they will let us know when and where they are to meet."

Saw the Vandervere Bros. They only fished last season from Oct. 20 to Dec. 31. Their rig is only for outside fishing. They have a tug and sail boat. Use 120 gill nets, 3⅞ mesh. They have fished for the last thirty years.

Do not believe in regulating the size of mesh. If the fish were divided or separated in different places you could do it. If the perch would not run where the whitefish are, you could, but as it is you cannot. We caught about forty-five pounds of planted whitefish yesterday, one weighed nine pounds.

To my question how he knew the fish he spoke of were planted fish, he said: We know by the shape of head. You plant the short neck, humpback Lake Superior whitefish. There are at least two varieties of whitefish: the short neck Lake Superior whitefish, and a longer variety with a projecting under jaw. Some call them "long jaws" as if they were a different species of fish, but they are a whitefish pure and simple, and not a distinct species at all.

We have had in the past trouble with the saw mills running their refuse into the river, and when the government filled the piers with shavings, sawdust and cedar bark the sawdust washed out into the lake, and to cap the whole some fool fishermen threw all their offal into the water and where that was done no whitefish were caught in the vicinity the following year. No one does that now if he intends to fish in the same locality, or near there again.

We would be glad to meet the commissioners as you suggest, but the meeting might occur in one of our hurrying times, otherwise we would do so of course.

Mr. Ruster, of John Ruster & Co., has fished here three years. Uses 140 gill nets 42 fathoms 3½ mesh. The whitefish spawning beds must be off six or eight miles west by southwest in deep, clear water. You don't have to go more than one mile from the shore to find twenty-five fathoms at Muskegon. Since I have been here the mills have not fouled the water to any extent.

While I do not wish to interfere with any man's means of earning his bread and butter, I do think that if the pound nets were run out of existence and the commission kept planting fish, that those two conditions would solve the problem of fish or no fish.

I have reports from Ruster & Co. and C. Van der Vere & Brother.

Muskegon, June 15.

Went to Port Sherman. Saw H. J. Johnson. He only fishes for sturgeon and perch; most of the time works in mill. He has been successful in getting sturgeon. Has had experience in the old country. Has 12 gill nets with 14 inch mesh for sturgeon, 2½ for perch. Caught 3,000 lbs. sturgeon last season and had 1,050 lbs. cavaire.

He looks forward to seven years hence, when he says the mills will be every one gone and he can fish all the time and make a living at it. Caught a few whitefish this year; thinks they were planted because they were all the same size.

H. Trempe & Co. are the most extensive fishermen here. They run 85 gill nets 3½ mesh for trout and three for herring. I saw Garrett Trempe. He said: I don't know where the whitefish spawn. The shore whitefish, that is, the planted fish spawn in the fall and spawn near the shore in shallow water. The outside whitefish I think do not spawn in less than twelve fathoms; all the way from twelve to twenty-five. As to that variety of whitefish we have only caught four this year. I think they have gone north. We depend upon the white herring. You cannot catch them with less than a 3-inch mesh. They average about two pounds. We ship our fish to Chicago fresh, only where we neglect to lift and they gill and die. Those we smoke. Would be willing to meet with commissioners to talk over the fishing business.

Whitehall, June 17.

I saw only one man, Frank S. Nickett. He says they are having a fine catch of whitefish, much better than last season. I have his report of last season's catch. He is the only fisherman here who had not reported.

Pentwater, June 18.

The first big catch of what they admit to be whitefish was reported to me here. Mr. Robert Venn on the 16th caught 1,000 lbs. of whitefish, all "firsts" and "seconds", On Tuesday he brought in 750 lbs. and on Wednesday the 18th I saw his catch of 400 lbs. He has been the most successful though not the most extensive fisherman at this point. He has two pounds nets and the help of a boy only. Last year with the same outfit he caught 10,500 lbs. whitefish and about 6,000 lbs. of sturgeon. Had 2,400 lbs. caviare. All are pound net men, but all use 3½ mesh. I talked with Mr. Venn. He said: I am certainly very much elated over the prospect for future whitefishing. I have caught more whitefish the last three days than in any other three days' fishing in the last five years. They have been increasing in numbers in the lake for the past three years, but we have nothing like this. I believe it to be the result of planting. I do not claim to know by his looks a whitefish that has been artificially propagated or was hatched naturally; but when I say I don't know one from the other I don't wish to be understood as saying that no one else can, for some say they know one from the other and I presume it is true. I believe these fish were planted because it stands to reason. They are certainly here. That we all admit. If they were fish driven away by the foul water now returned again, they would be older and consequently larger. They were not hatched here, because there have been no old fish to hatch them. They are in the lake because they were put in—that's what!

The saw mills have damaged our business very much; they have driven the fish away and just about ruined us. We complained to the Fish Warden and he made them burn their refuse instead of throwing it into the water, and now that that nuisance is abated we hope that by the aid of artificial propagation—and through that only—that we shall yet stem the tide; but I tell you it has looked pretty black for us fishermen for the last few years.

We are all using 3½ mesh for our pots and that is plenty large; fish

weighing less than a pound will go through the meshes. The shore whitefish, that is, the planted fish, spawn in the fall and spawn near the shore in shallow water. Our whitefish weigh from two to six pounds, probably 2½ on an average. We fish nets under the water to avoid the drift wood.

I think the whitefish spawning beds must be about eight miles due north on the clay banks. The sturgeon spawn there and I am sure the whitefish do.

If others would, I would be willing to stop fishing from the 10th of October to first of April. Will meet with the commissioners at some central point if I am notified and can leave my work.

Messrs. Warner & Co. fish six pound nets. I saw Mr. Warner who concurred in all that Mr. Venn said as regards artificially propagated fish and said: There is one thing Congress ought to do, that is, fix a tariff of one cent a pound on fish brought here from Canadian waters. They get their work done for less money than we do and can afford to sell their fish for less than we can. That cheapens the fish in the Chicago market. I was in Chicago last week and one firm, Wittal & Co., received that afternoon 23 cars of whitefish containing 2,500 pounds each from Georgian bay. Our State is doing a great thing for us in sustaining the Fish Commission, and the general government ought to do that much to keep the price up. The last few years the Canadians have had the advantage of us, because their waters have not been fouled. While we have not been doing anything they have been making some money.

Ludington, June 18.

Messrs. Degergus & Son are the principal fishermen here. They have 100 gill nets; use four inch mesh for trout and whitefish and 3¾ for blackfins. They have two pound nets, 3½ mesh. They have one tug and one skiff.

Mr. Degergus said: We run our gill nets for blackfins and herring. The blackfins you can't catch in less than sixty fathoms. You can't catch the genuine whitefish in gill nets, for they will not "gill;" they swim along by the side of the net and go by it.

A good many call the blackfin whitefish, but they are not; the whitefish has a round jaw, like the sucker's lip. Some come here and want some of "those whitefish." Well, we don't take pains to tell them they are not whitefish; we sell them the fish they are looking at and if they like to call them whitefish they are welcome and at liberty to call them by that name; but they are blackfins just the same.

I hand you their report.

Could not see the pound net men without waiting a day and that seemed to be a waste of time. I moved on to Manistee.

Manistee, June 19.

Chas. Blanchard is the most extensive fisherman at Manistee, fishes 150 nets of 40 fathoms. Does not catch any whitefish to speak of, but his catch of trout last year was very satisfactory. He says:

I would recommend that fishermen use gill nets altogether; the pound nets are destroying all the fish. It was the pound net men championed the 4¾ law for gill net mesh. We use 5½ inch during the spawning season and catch no small fish at any time.

The spawning beds are further north; off Leland and Frankfort there are spawning beds.

We had more mill refuse fifteen years ago than today.

I have reports from Olson & Peterson, who use 80 gill nets, and Hendrickson Bros., who use 100 nets. Hendrickson Bros. caught sixty pounds of whitefish yesterday. They caught none last season.

Alger Bros., pound net men, and Andrew Peterson are fishing this season for the first. If blanks are sent them they will report this fall.

I saw Andrew Peterson's catch of 400 pounds of whitefish today. He has pound nets.

Frankfort, June 20.

I interviewed Mr. Thos. Rudick. He has a tug and more than 900 gill nets of 45 fathoms, 4¼ mesh. Does outside fishing altogether, from four to twenty-five miles off shore. He says: I am in entire sympathy with artificial propagation. I believe the State of Michigan is doing a great work in restocking the waters of the Great Lakes, and if we had a close season from the 20th of November to the 15th of December, and the pound nets could be thrown out, and the whitefish were planted where they should be, we would be on the road to fish happiness again. There were two plants made here last spring by the State. The first shipment of fish they carried out from the shore, but the last lot they dumped off the dock. But the man in charge was not to blame, for it was so rough he could not get a tug to go out.

Now, the fish should be planted on the spawning beds of course, and I claim to know where they are, and I don't believe all the fishermen do, if any of them. They are at Empire and at the Manitou island. Off the northwest corner of South Manitou island, about thirty miles north northwest from here there is a rocky reef; and off Empire is another place on the rocks. That is seventeen miles northerly. At either of these places you will find whitefish at spawning time.

If the commission will notify me beforehand a few days, I will take the fish to the reef off Empire for $10.00, just enough to pay the expense of running my tug there.

Saw the Rubier Bros. They run 100 nets (gill nets) and one pound net. They say the catch of whitefish has been much better so far this season than for the corresponding period last year. They lifted 400 pounds of whitefish yesterday.

Have their report and left blank at the house of Lyberg Bros.

Traverse City, June 23.

Talked with Mr. John Johnson. He has 21 pound nets. He does no fishing himself, but farms his nets out to others. Said he really could not tell how many pounds of fish had been caught in his nets, nor how many had been sold, because he shipped some to Chicago and sold some to neighbors and had salted some. Says he does not keep a regular system of books. Supposed his men reported their catch to the commission, but if they do not if the Secretary will send blanks to him he will see that they are filled out. We are fishing mostly in the the east bay, off Old Mission Point. We do not fish out in the lake until July.

Last year, off Antrim, one of my men, Staggers, got about 26,000 pounds of whitefish averageing probably 2⅓ lbs. each. Got five cents a pound. The most of my lake fishing last year was done off Antrim. My nets are five rod hearts and 45 rod leads.

I don't think that planting fish the way they do can increase the supply.

They planted here six years ago. They dumped them off the R. R. bridge there, which you see must be fifteen feet from the water. [The planting of fish from the railroad bridge referred to was not made by this board.] But I can tell you one queer thing: This bay is full of brook trout and they were not here eight years ago; especially at the mouths of the streams you can catch enormous trout as fast as you can throw in your line, if the conditions are favorable. Did not believe they came from streams planted with trout; they multiply so wonderfully because no other fish disturbs them, they are too swift for them.

Returning to the whitefish subject he said: If the State would pay fishermen a price per quart for spawn and they strip the males and females and deposit the eggs right on the spawning beds, it would be more economical than supporting the hatcheries, but, (he said parenthetically, if not pathetically) we would have no way of shoving them under the stones.

Went to Sutton's Bay and Omena. Omena was the nearest I could get to Leland without waiting two days. Did not go from Omena to Northport because there was not time to do it and get boat back to Traverse without losing a day, and as the commission have reports from all fishing at Northport, I thought it not best to do so.

The only firm fishing at Omena is Blanchard & Barnes. They are using 12 gill nets and 2 pound nets. The whitefish do not run so early as further south—not until July. They had a light catch last season. They think the pound net fishing should be prohibited for a few years. Would put theirs away if others would.

Charlevoix, June 24.

Saw G. C. Gerkin, who has fished here twelve years. Has about five miles of gill nets. He says: The whitefish spawning beds are off the Fox Island reef, about thirty-five miles due west. Probably there are beds nearer, but no one knows where. I believe there should be a close season, to commence about the 18th of October and end the 18th of December. I think there should be a restriction as to size of mesh. The pound nets ought to be the same size mesh as gill nets, that is, the pots. I don't care what size lead they use, whether it be 8 inches or only 2. I use six inch mesh for trout, coarser than for whitefish.

When the pound net men comply with the law technically by using 3½ mesh they will buy the soft lay twine which will shrink an inch to the mesh after it is put in the water. They should use only hard lay twine.

About the small mesh nets: my proposition is that fishermen have two years to dispose of them or wear them out and at the end of that time do away with them altogether. I have been before the Legislature several times. We had a bill framed at one time and likely to pass, but the sawdust bill was added to it and it failed.

I would be willing to meet with the board and the fishermen to talk matters over if I could get away at the time.

Lewis Gard is fishing at Charlevoix, was not fishing here. Also a Capt. Carter had a tug and 50 gill nets.

Petoskey, June 25.

Saw Albert Miller. He has fished here for the last ten years; uses 50 gill nets of 70 fathoms each and three pound nets, 3½ mesh. Says the whitefish probably spawn off the Foxes on the reef, and of course off the Manitous where the same reef is. Thinks 4¼ for whitefish and 6 inch for trout a good mesh for gill nets. He caught 160 pounds of whitefish yesterday (25th) the first this year.

Saw Messrs. Kirby & Ringle together. They think that there should not be less than 4¼ inch mesh for gill nets, and 3½ for pound nets. They could not agree as to whether the long jaws are a variety of whitefish or a distinct species.

Mr. Kirby said: Long jaws are doubtless a planted fish, planted perhaps for whitefish, and in fact, they may be a variety of whitefish. There are unusually large schools of them and seem about the same size. Mr. Ringle said: The whitefish spawning beds are west southwest on the reefs off the Manitous and Foxes. Don't think a close season necessary, as their nets are pulled before the spawning time of the whitefish.

Mr. Kirby says the inland lakes up along the Elk and Cheboygan rivers are full of whitefish. They went up there to spawn, and some of the lakes' outlets are dammed and the fish cannot escape.

Called on R. Connable & Son. I saw the son; the elder Connable is in Chicago. He was dumb so far as telling me his price or amount of catch. They are running 150 nets of their own and use 150 owned by a Mr. Brown in Chicago. They buy most of the fish caught at Petoskey, Charlevoix and Harbor Springs. He declined to fill the report "for the edification of other fishermen and to the detriment of own business."

He said: We are most assuredly in hearty sympathy with the idea of artificial propagation. The fact that we wrote to President Whitaker last spring offering the use of our tug to deposit the fry free of cost, if they would make a plant here, proves that. And I made the offer from a perfectly selfish motive you may be sure. Any fisherman who doubts the entire feasibility and practicability and already demonstrated success of artificial propagation must be a fool!

I found reports from all fishing here, except the Connables.

Wilson Bros. are fishing six pound nets at Harbor Springs, but I did not see them.

Beaver Islands, June 27.

Visited the Beaver Islands from Petoskey today. The Beavers proper consist of the following islands as named by one of the citizens: Big Beaver, Garden, Hog, High, North and South Foxes, Hat, Whiskey, Gull, Trout, Rabbit, Squaw and Pissmire.

This is the fishing ground of all others on the Michigan shore of Lake Michigan. They ship on an average through the season five tons a day. Today (27th) over 13 tons. The fishing season opened a month earlier than last year. I mean the run of whitefish which they do not usually begin to catch until after the "Fourth." This season the first lift was made June 6.

Endress & Son, dealers in fresh and salt fish, buy the most of their fish, and Neil Gallagher their salted fish.

Talked mostly with Wm. J. Gallagher of Gallagher & Sandenberg. Mr. G. is the Deputy Co. Clerk and is an intelligent and seemingly candid man. He says: As to restriction on size of mesh: 3½ inch for pound net pots is plenty small enough; we use 3¾ to 4 inch for our pound nets and 6 inch for our gill nets. We use 4 inch mesh in the pound nets that we are using now. We don't want the little fish; after we dress them and salt them and send them they bring us the enormous sum of one cent a pound. A man can't do the work alone and he certainly can't afford to pay another man

to help him. No, sir, if it was a legitimate business and no waste of future dollars and cents to slaughter little fish in that way, it would not pay to do it. Most emphatically we don't want anything less than "firsts" and "seconds" in our nets and while I am talking about little fish, we don't like to have men who were, perhaps, driven out of Charlevoix come here with their little 2 inch meshes. One man is Hugh Donnelly from Charlevoix now fishing at High island, and if the fish warden will come and see me I will point out several others. They tell the deputy, Joseph Smith, that there is no *law* only *custom* has established 3½ inch and he dare not act. None of our local fishermen use less than 3½ inch pots and I think you will find that most of us fish with a larger than legal sized net. There may be a few of our old small meshes in the hands of the Indians, but not many.

Our pound net fishing ends in August. We don't care to have our nets blown out by the gales and we pull them the last of August, so we don't fish pound nets during the spawning season at all. The fish we get as early as this are artificially propagated. There are three distinct varieties of the whitefish; the black fins are just the same as the long jaws. (He showed me some black fins in the car, they were that morning's catch; the fin was not black entirely, just the tip of the fin.)

We are all well aware that artificial hatching is a success. I don't suppose any one questions that now. If any fisherman who has fished here for the last ten years has in his mind the least doubt that every whitefish he has caught during the last two years were hatched at Detroit he is too simple to argue with.

The catch of whitefish has been increasing here for the last three years and this year the prospect is still more flattering, for the whitefish season is a month earlier and the catch is better than at this date last year. There are 12 nets in now where there were three last year; that does not look as if the fishermen were quite discouraged. One can't buy a net or even set it in for nothing, and we fishermen have not made enough money for the last few years so we could take many chances.

I feel inclined to give the State Board of Fish Commissioners what is their due. If artificial hatching had proved a failure, where would we be? When a drowning man is helped out of the water he ought to remember the hand that pulls him ashore.

The whitefish spawn on Gull island and Fox island, all along there.

There ought to be a tariff on fish brought to the United States from Canada. I am as firm a believer in that as I am in the policy of hatching fish artificially.

Saw the Martin Bros. They appreciate the work that is being done for them in replenishing the waters with fish. One of them said: You probably find most of the fishermen with the blues, but the truth is that this year we have reason to be encouraged and hopeful. The whitefish catch has been increasing for the last three years and we have no idea that they came from the clouds. The old fish had been all caught out or driven out so there were none left that we could catch, and if there were none to catch there were none to spawn, none anyway. But they are there now and we believe artificial propagation has been our salvation. To demonstrate to you that we have faith I will tell you that last year we had 50 gill nets and a sail boat, but this year we have invested $2,200 in a tug and bought 20 more nets. We are fishing on our old ground.

I remained at the Beavers until Saturday p. m., but could not see all the fishermen. Have reports from ten and below is a list of those fishing here whom I could not see: Nicholas Plant, Pat McDonald, Nathan Sanders, Johnson & Larrison, Pat. McConley, Francis McConley, Owen McConley, John Gallagher, Dominick Gallagher, Joseph Left, James Gordan, James Walker, John Oliver.

June 30.

Left Petoskey for Mackinaw City where I found a letter from the commission with orders to return. Called on Mr. D. A. Trumpour, but he was very busy. He had fish to ship on the train I had to take for Detroit.

He said: There are whitefish spawning beds off St. Helena island, northwest from here along the shore there. Said he had made report of his fishermens' catch as well as he could. His fishermen are all Indians, whom I could not communicate with without an interpreter.

Very respectfully submitted,

SYLVANUS PALMER.

NEW WORK.

Effort is being constantly made by this board to enlarge the scope and efficiency of the work of the board. As fast as opportunity and means at command will allow, experiments in the propagation of food and game fish of those species which have not yet received attention, are being made.

During the time which has elapsed since the submission of the last report, considerable effort has been expended, in attempts to artificially hatch the sturgeon and white bass. These experiments were each successful, and the numbers hatched warrant us in the belief that with the benefit of experience already gained, and with the added experience of the future, each of these fish will annually be cared for and the waters will be stocked with them.

The commercial importance of the sturgeon has become so great within the past few years that every effort will be made to increase its numbers. From a despised fish fit only for the offal pile, the sturgeon has now become of great commercial value, and in certain localities is fished for exclusively.

Reports received by the board show that in many instances the market price paid for the sturgeon equals that of the white fish, and it is now one of our most valuable commercial fish.

The white bass is a prolific fish and abounds in certain localities in this state. Its flesh is very good, and its introduction into new waters must result in increasing the food supply, to the advantage of the people.

The importance of the experiments to artificially propogate both these fiish, is of considerable significance in fish culture. But one previous attempt has been made to artificially hatch sturgeon, and that experiment was made several years ago, before the fish had attained any commercial importance. The successful hatching of the white bass in July 1890 by W. D. Marks was the first attempt, as we believe, to artificially breed this fish ever made in America. Its successful introduction in our waters we hope will be accomplished the coming season, and will mark an important step in the stocking of our inland lakes with a valuable fish.

The pike-perch, wall-eyed pike, or dore is a fish of much commercial importance in Michigan and the other states bordering the great lakes.

It has received the attention of nearly all the northwestern and middle State fish breeders by reason of its marketable value, and because of its accomodation to change of locality, together with its value and desirability

in stocking inland lakes. In the judgment of many its flesh is superior to that of the bass, and it affords good sport to the angler.

With other spring spawners it has presented difficulties in its manipulation which have usually resulted in a very low percentage of impregnation when compared with the results of impregnation with trout and whitefish. Eighty to ninety-five, and sometimes a higher percentage, is attained in the handling of the last mentioned fish, while it is fair to say that forty-five or fifty per cent has been a high impregnation with the pike-perch, and oftener the percentage has been below this figure. The cause of so low an impregnation was not known, and surmise could alone account for it. By reasons of these poor results, where better ought to have been obtained, we felt the necessity for an intelligent inquiry into the causes of failure, and at the January, 1890, meeting of the board, it was decided in the interests of the State, as well as of fish culture in the main, some attempt should be made to solve the difficulty.

Arrangements were accordingly made with Prof. Jacob Reighard of the University of Michigan, assistant Prof. of Biology, and an intelligent and untiring scientist, to go with the crew charged with the spawning of this fish, and there conduct his inquiries into the causes of failure. His investigations covered the entire period from the time of the stripping of the fish and the fertilization of the ova, over the various changes in the development of the egg and absorption of the food sac, to a time when the fish was ready to search for its natural food. His experiments were entirely successful and the results of his inquiry, if carefully followed out, must tend to largely increase the efficiency of this branch of our operations.

For detailed reports of the above experiments, see Appendix A.

PETOSKEY.

The buildings at Petoskoy were disposed of according to the recommendation of the Senate and House fisheries' committees, of the last legislature, at the best figures that could be obtained for them. Messrs. Rose and Hayes of Petoskey, purchased the buildings at $425.00. The interior equipment consisting of jars, tanks etc., was removed to Detroit, and was used in equipping that station when it was enlarged. In this way nearly everything in the buildings at Petoskey was utilized at the Detroit hatching station and a considerable outlay of money was thus saved, which we should otherwise have had to expend in fittings in the Detroit hatchery.

The removal of this house in no way affected the output, and permits us to do the same work with more economy, and to better advantage.

MEETINGS OF THE BOARD.

Meetings of the board are held monthly at the office of the board in Detroit. At each meeting the necessities of the different stations with report of progress for the past month are submitted and considered.

Two members of the board act as a committee of audit on all accounts and bills. This committee for the past two years has consisted of Mr. Whitaker and Mr. Post. All bills are in duplicate and must be O. K.'d by the employé in charge of the work.

Meetings were held as follows in 1889-90:

In Detroit on January 22, February 23, March 28, April 23, May 28, July 1, July 27, August 27, September 24, October 26, November 26 and December 26—1889. January 28, February 28, March 25, May 29, June 27, July 25, August 29, September 26– 1890.

In Paris on June 25, 1889; and May 1, 1890.

COST OF FRY, ETC.

The enlargement of the whitefish station at Detroit has permitted us to largely increase the output of fish over former years, with a comparatively small increase in the number of employés, and with a small increase in the cost of the maintenance of the station.

The cost per thousand of fry has been considerably lowered in the past year, and it may be well to institute a comparison of the cost per thousand of fry to this board, with the cost per thousand to other States.

The Canadian Department of Marine and Fisheries in its report for the year 1888, in speaking of the cost of fry to that government, instituted a comparison of the cost of fry per thousand to Canada with the cost to the State of New York, and Mr. Wilmot very properly says:

"It becomes unavoidable at times to make comparisons on subjects in which the public is concerned and it is a necessity also in some cases, in order that the actual merits of a public industry in a country may be fairly upheld, that any erroneous views entertained by any portion of the public on that industry may be openly dispelled." This reasoning is sound, and will serve as an explanation why comparisons are instituted in this connection.

The Canadian report goes on to show that the average cost to its government per thousand of fry, was $39\frac{3}{4}$ cents, while the cost to New York for the same year (1887) was $\$1.33\frac{1}{3}$ cents per thousand.

The cost per thousand to Michigan during the year 1888 was $10\frac{51}{100}$ and for the year 1889 the cost per thousand was $10\frac{50}{100}$ cents per thousand. This showing is one which shows conclusively that the work as conducted in this State, is beyond question conducted with a reasonable degree of economy, and at an expense that will compare favorably with the work of other States.

FISH WAYS.

In the year 1877 the legislature passed an act relative to fish ways in the streams of this State, and in the provisions of said act was the following:

"It shall be the duty of the fish commissioners of this State to procure made a draft of a general plan on a scale of sufficient size for a working plan for a suitable chute or fish ladder, of such construction as will in their opinion best subserve the free passage of fish, both up and down the streams at the dams, on which plan shall be designated the greatest allowable slope per foot run of said chutes etc., * * * * *; and it shall be the further duty of said fish commissioners to procure to be lithographed two thousand fair copies of said plan and specifications, and to cause to be mailed to the address of the township clerk of each organized township in the State one copy of said plan and specifications, with instructions to said township clerks to place the same on file in their offices and not to allow said plans and specifications to be taken thence, but to keep them open to inspection of owners and occupants of dams and persons using the water thereof in the township for the purpose of taking copies of the same; said plans and specifications shall be open to the inspection of the general public when not

in use as above * * * * *. The expenses incurred in procuring and mailing of said lithographed copies of said plans and specifications shall be audited by the Board of State Auditors and paid by the State Treasurer out of any money's in the State Treasury not otherwise appropriated.

In accordance with the above act, the fish commissioners, in 1878, after making an experimental fish way on a small scale and satisfying themselves that fish would use the ladders, adopted the Shaw fishway as the best fishway then in use, and procured lithographed copies of the same and forwarded them to all township clerks in the State. We believe that nearly all of these lithographs have long since disappeared from their places of custody. For several years past applications has been frequently made for these cuts, and we are informed that none are on file with the clerks of the townships from which the applications are made for plans and specifications. During the last two or three years no lithographed copies or plans of this fishway have been in our possession, the supply having been exhausted, with which applicants could be furnished plans, etc. Considerable improvement has been made in fishways in the period which has elapsed since the act was passed. Other fishways have been invented and some have proved successful in their practical operation. The most successful fishway, perhaps, as well as the most economical in construction, is the Rogers. It is now in successful operation in dams at Lackawaxen, Pa., and on the Hudson in two or more dams, besides in many other places. Negotiations are now pending between the commission and Mr. W. H. Rogers of Amherst, Nova Scotia, the patentee of the Rogers fishway, looking to some arrangement which shall be mutually satisfactory to both parties, whereby we may secure the right to the State to use his patent in the erection of fishways. Should we be able to come to terms, an estimate will be presented to the Legislature to secure his invention.

The commissioners of New York and Pennsylvania, who have had considerable practical experience with this fishway, speak of its efficiency in the highest terms. We have taken every means to ascertain the practical value of this fishway, and all who are familiar with it recommend it.

EXHIBITS.

In the summer of 1889 the managers of the International Exposition at Detroit, and the president of the State Fair Association each invited the board to make an exhibit of the fish natural to the waters of this State.

The invitations were laid before the board for consideration at the May meeting. The matter was fully considered by the board at this meeting, and it was deemed advisable for the purpose of bringing the subject of fish culture before the people for their better information, that these invitations should be accepted. These exhibitions afforded opportunities to lay before the public the extent and character of our work, and to disseminate a knowledge that fish might be had for suitable waters without expense to the applicant, and they have by judicious effort been made to serve the purpose of promoting and increasing the efficiency of our work. They resulted in immediately increasing the number of applications, and the inquiries and correspondence thereby entailed upon the secretary's office a large amount of work. It soon developed the fact that many of our people were unaware that fish could be had free of charge upon application. The result has justified the judgment of the board, and many of

the streams and inland lakes have by this means been stocked, which might not have received any benefit from our work for years, had it not been for these exhibits.

A brief paper showing the objects of this board, and containing other information for the general public was prepared and widely distributed, a copy of which follows.

AQUACULTURE.

Aquaculture, or fish culture, is one of the many new occupations which have sprung out of modern inquiry in response to our necessities. While to insure success it demands of those who pursue it a reasonable expenditure of time and attention, it affords in return a reasonable profit, and a large measure of pleasure and diversion. The soil promises ample return to the diligent husbandman, and so do our countless streams and lakes to those who give fish culture deserving care. Why may not the two vocations be united to the resulting advantage of both, without sacrificing either to the other, when they are so nearly allied?

The rich prairies and rolling woodlands of Michigan, are traversed everywhere with an interlacing network of rivers and streams, and are dotted with countless beautiful lakes, capable of affording to the farmer, if properly stocked with fish, a pleasing variety for his table, and opportunities for pleasant outings for himself and family, which will relieve the monotony of daily life. The slight attention required in attending to the proper stocking of the waters of his neighborhood, and to the enforcement of existing laws regulating the close seasons, will yield an ample return in pleasure and profit, for all the time and care he may bestow upon it.

In considering the question from its practical side, we should not lose sight of the source of profit, resulting from the stocking of our inland waters with choice varieties of game fish. For years there has been a large and increasing stream of non-resident sportsmen pouring into the State, seeking our streams for the sport which they afford the angler, and this class of pleasure seekers leave annually thousands of dollars within our borders, thus adding to the material wealth of the State, sustaining our summer resorts with their patronage, and incidentally affording a market for the products of the farm.

Fish, as a part of the food of the people, enters largely into the economy of our daily life. It is no longer a luxury, but has become one of the common articles of diet of the household.

The increasing demand for the food fishes of our great lakes within the last twenty years, has entirely revolutionized methods of fishing, and has resulted in greatly improved appliances for the capture of fish, to meet the demands of daily consumption.

For years the fishing of the great lakes was prosecuted by fishermen in Mackinaw boats, handling small gangs of gill nets, and was confined almost exclusively to gill net fishing. The fishing industry as now conducted, however, has been concentrated into fewer hands, the nets have increased in number from a few gangs of gill nets fished by hand, until statistics now show that one proprietor is fishing *seventy-five miles of gill nets*. The pound net which is a device of later growth is a much more effective method of capture than the gill net, and large quantities are now taken by this method of fishing. The gill net fishing is now conducted largely with steam vessels with which the nets are set and drawn, and instead of the fishermen fishing for home consumption alone, during the fishing season, they engage in fishing during the greater part of the year, and send their product all over the country to every city of importance, from the great lakes to the extreme south, east and west. The supply thus taken, over and above the needs of present consumption for the home market, instead of being salted and smoked as was formerly the custom, thereby reducing its market value, is now either packed in ice in fish cars having a capacity of about two tons, and sent to southern, eastern and western cities for distribution, commanding a high price as fresh fish; or the fish are frozen and held in refrigerators to fill future orders, and sold as fresh fish at a later period in the season at good prices. From the fishing business alone there results a large contribution to the material wealth of the State, as statistics already collected show that the value of the product of the commercial fisheries of Michigan amounts, annually, to about $1,500,000, besides furnishing a means of livelihood to a large number of our people.

The inland waters of the State originally abounded in the better varieties of edible food fishes, notably with the king of game fishes of our fresh waters, the small-mouthed black bass, which has a wide natural distribution over the temperate zone.

be passed upon by the board. It is frequently the case that two or three letters pass upon the application and the work of the office is thereby considerably increased. As showing the growth of applications, we will take the years 1888 and 1889 and eight months of the year 1890. During 1888 there were received 375 applications. In 1889, 520 applications, and for the eight months of 1890, 420 applications. Much the larger number of applications are usually received during the latter months of the year, and the probabilities are that the number in 1890 will exceed considerably the number for 1889.

The exhibits made by the commission at the State Fair and Detroit Exposition in 1889, were means whereby the public were informed that upon application fish could be had for suitable waters, and the increase of applications and correspondence relating to our work in the nature of inquiries was very noticeable. This correspondence has rather increased than fallen off in the time which has since intervened.

DISTRIBUTION OF WORK.

For the better conduct of the work of the commission, and in order that each member shall do his fair share of the work, at the June meeting of each year the work of supervision is alloted among the commissioners.

For the past two years the trout station at Paris has been in charge of Dr. Parker, the whitefish station at Detroit in charge of Mr. Whitaker and the carp station at Glenwood and examination of waters and propagation of new species in charge of Mr. Post.

SPAWN GATHERING.

The ova of the whitefish for all our whitefish work has for five years past been taken on the Detroit river. The sheltered nature of these waters makes it the most favorable and certain locality in which to conduct these operations. Its nearness to the whitefish station, also affords an opportunity to do the work more economically than it could be done at any other point.

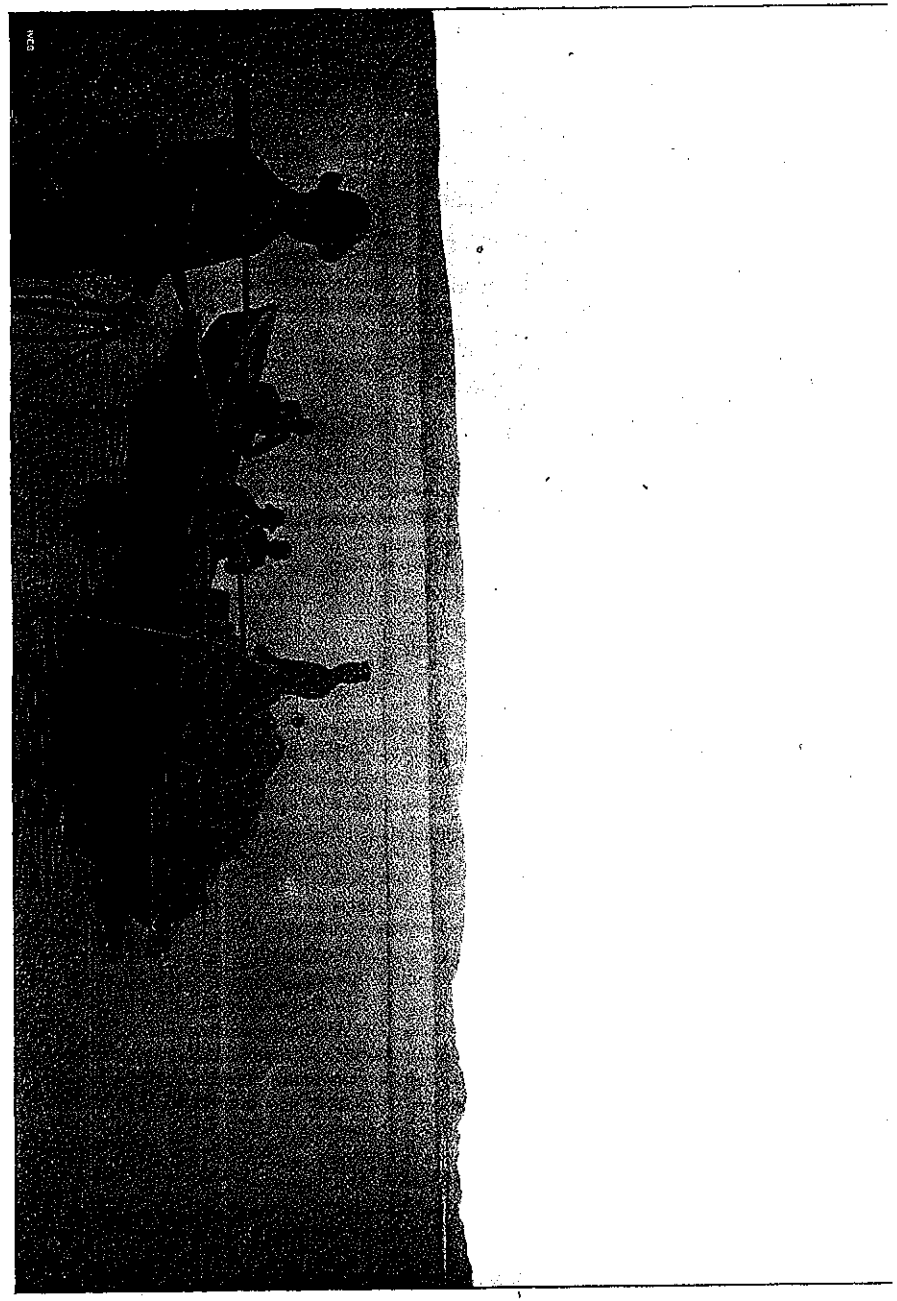
Our operations in this branch of the work have been so much enlarged, that it has become necessary to secure nearly every fishery upon the American side of the river. The fish as soon as taken are placed in crates made of slats, which are anchored in the water near the shore, and the fish are retained therein until they are ready to be manipulated.

Except at a late period in the fishing season, the fish are not ready to be handled when taken, and even then but few are in what is termed a "ripe" condition. When first taken, the belly of the fish is hard to the touch, but when it has arrived at the condition when it is ready to be handled the eggs have become separated, and to the touch the fish feels as though it was filled with shot. The fish is then relieved of her eggs, and after being fertilized they sent to the hatchery.

The ova of the pike perch, or wall-eyed pike, has all been taken on Saginaw bay below Bay City for two years. This point has been found to be quite favorable for these operations.

When the eggs have been fertilized they are sent to the Detroit station where they are hatched.

Some conception of the magnitude of the operations may be had, when



GOING OUT WITH SEINE.

it is shown that the quantity, by measure, of whitefish eggs taken in the fall of 1889 was *ninety-six bushels.*

There are now eight fisheries controlled by the board on the river, as follows; Belle Isle, Craig's, Fort Wayne, Stock Farm, Mammy Judy, Grassy Island, Red Shanty and Stony Island. From these fisheries we secure the entire stock of eggs with which we fill our jars at the Detroit station.

The number of whitefish handled each season varies with the catch, from seven to fifteen thousand.

RAILROAD AND OTHER COURTEFIES.

Too full acknowledgment of the liberality of the railroads of the State, in granting free transportation for employees and for the car in the distribution of fry, cannot be made. They have manifested the keenest interest in our work and have afforded us every facility for quick and easy transportation. The car is hauled on passenger trains on our request, and the men are furnished with trip passes for all the work.

The broad and liberal views entertained of the importance of our work, and the hearty co-operation of the railroads, is one of the greatest aids to the State, and results in a practical donation to the State of many thousand dollars annually. With these grants of free transportation withdrawn, the State would be compelled to appropriate a large sum to carry on the work of distribution, or the work we are now conducting would be harmfully curtailed. While nearly all roads to which application for transportation has been made have granted our request, especial mention should be made of the following lines:—Grand Rapids & Indiana, Detroit, Lansing & Northern, Flint & Pere Marquette, Michigan Central, Chicago & West Michigan, Detroit, Grand Haven & Milwaukee, Grand Trunk, Lake Shore & Michigan Southern, Chicago & Grand Trunk, Toledo & Ann Arbor, and Duluth, South Shore & Atlantic Railroads.

With the increased output of both whitefish and trout fry in the spring of 1890, it was found the car would be unequal to the work of making the distributions alone. It therefore became necessary to make other provisions whereby the distributions might be made.

Application was made to the U. S. Fish Commission for the use of one of its cars to assist in the work. The U. S. Commissioner at once detailed a crew and car, which were placed at our disposal, and were of valuable assistance in the spring distributions of fry.

The car was engaged in this work for a period of forty-two days, commencing March 1 and terminating April 11. A crew of four men were constantly with the car, and the Commissioner refused to accept compensation for the services of his men for this period, thus making a valuable donation to the State. The only expense entailed upon this commission was the charge for subsistence and for the running expenses of car.

We wish to say in this connection that the interchange of courtesies between the U. S. Commission and this board have been uniformly extended by each board to the other in the past, and have resulted in mutual advantage.

The U. S. Commissioner has donated to this State in the last two years 30,000 Loch Leven trout eggs, 18,000 Swiss trout eggs, 150,000 Land Locked Salmon eggs, 1,349,637 Lake trout two years old, 35,000 brook trout and 3,500 California trout about one year old.

This is in pursuance of the policy of the U. S. Commission, whose efforts have been largely instrumental in introducing new species of fish from foreign countries into American waters, some of which promise to be valuable additions to our native species. The practice of the U. S. Commission has been to allot among the States having waters suitable to new species, reasonable quantities for experimental purposes, a work which is peculiarly within its province.

BLACK BASS.

Perhaps no other species of our fresh water fish has such a wide natural distribution in the streams and lakes of the United States as this highly esteemed and valuable fish. It is fouud in our waters from the British Possessions to the Gulf, and from the Rocky mountains to the Atlantic, and is known under different names in different sections. In the south it is quite generally called trout, but in all localities where it is known it is highly esteemed for its game and edible character.

The multitude of inland lakes of Michigan almost invariably abound with the bass, but the constant fishing of the streams and lakes has resulted in many localities in serious inroads on the original stock.

The applications for bass to this board have been so numerous in the last two or three years, that it has been seriously considered by the board what means can be taken to furnish them to those who apply.

Bass have, until a comparatively recent date, been so plentiful that but little attention has been given them by this board, but the time must soon come when an effort greater than has yet been made, must be put forth to meet the wants of the people in respect to this fish.

Like many other spring spawners, it presents some difficulties in artificial propagation which are hard to overcome. The ova is viscid and much care must be taken in handling to obtain good results.

We know hardly enough of them to state with any certainty what percentage of successful impregnation can be obtained. It is quite likely that ponds might be prepared for holding the adult fish which would give satisfactory results, much the same as in trout breeding. It is also possible they may be bred successfully in the same manner in which carp are now reared, by allowing the spawning to take place naturally in ponds, the adult fish being taken from the ponds after the spawning period is over. These are experiments, however, which have not been tried, and experience alone will show whether they are practical.

Our operations thus far have been confined to the taking of young bass from lakes which are now well stocked and putting them in lakes which have been over-fished, and this work has been carried on as far as possible by the crews engaged in the examination of waters.

Many orders are now on file for bass which we are unable to fill, but with the imperfect methods at hand, we are doing the best that is possible. Steps will be taken with the appropriation asked for, to give the bass orders the attention they deserve, and we trust that another year will see this work well under way.

CAR.

The experience of the past two years with the fish car "Attikumaig" has fully justified the wisdom of the expenditure made in its purchase. With

HAULING THE SEINE.

it, distributions of fry have been made expeditiously, and a wider territory has been covered than could have been covered but for its use. Equipped as it is with all the appliances used upon passenger coaches, the different railway companies haul it regularly in passenger trains, thus giving prompt dispatch in the distributions of fish.

It has also incidentally resulted in economy of the use of funds for the subsistence of the force engaged in the work of planting. The regular crew while engaged in this work, are in charge of the captain of the car, who has absolute control of the work and is held responsible for the conduct of the distributions. A cook is provided for the car by the board, the subsistence of each man is fixed at $3.50 per week and all their meals are served on the car. This amount is allowed in the monthly accounts of the men, and permits them to live comfortably. The men also sleep on the car and are not worn out from loss of rest or sleep, as thay otherwise would be. Under the system in vogue before the car was purchased, the men were compelled to use a baggage car in making plants, which afforded no opportunity for rest or sleep. Meals were hastily bolted at wayside stations at irregular hours, and at prices which were much higher than those now established. As a measure of economy in this respect, the car will go far to save money to the State and make the work much more economical, as well as increase the efficiency of the work.

Formerly when the fry were carried in baggage cars, there was considerable difficulty experienced at stations from the liability of applicants to miss the car in which the fish were carried, there being nothing to distinguish the car carrying fish from other baggage and express cars on the same train. As the stopping time of passenger trains is necessarily short at stations, it frequently happened that persons missed their fish because they did not find the car readily, and trains would not wait. These embarrassments have been overcome by the use of our own car. It is conspicuous by the difference in its appearance from other cars in the train, and bearing, as it does, the name "Michigan Fish Commission, Attikumaig," the persons intending to meet it are directed at once to the proper car, and annoying delays formerly caused to the railways are thus avoided.

It is quite possible that it may become necessary te procure another car to assist in this work in the near future, as the capacity of the present car, even when in constant use, was found last spring to be entirely inadequate to do all the work of the board. The largely increased capacity for hatching whitefish trout and pike perch, the distributions coming as they do so nearly at the same period of time, necessitated the application of a loan of one of the cars of the U. S. Commission in the spring of 1890, and in addition to this the employment of an express car for a period of twenty-eight days. The purchase of another car would be a wise expenditure, and will at an early date be an absolute necessity.

After the season of trout, whitefish and pike-perch distributions has passed, these cars, under the scheme proposed elsewhere in this report might be operated during a number of months in each year in the distribution of black bass, and other indigenous fishes, thus enlarging the period of use, and adding much to the valne of our work.

To show the efficiency of the car in its present work, it may be stated that in the year 1889, between Feb. 15, and June 10, and while engaged in the distribution of fry from the different hatcheries, the mileage of the

car amounted to 18,731 miles, to which should be added about 2,000 miles made during the remainder of the year on special trips.

During 1890 the car made a mileage of 14,825 miles on regular distributions, with an extra mileage on special work of about 1,500 miles. To this should be added the mileage of the two other cars employed in the same work, 5,432 miles, making a total mileage for 1890 of 21,757 miles.

When we consider that this large mileage was made within the boundaries of our State alone, some idea may be formed of the magnitude of the work, and of the effort that is being made to reach all portions of the State in our distributions of different species of fish.

It becomes necessary in transporting fish from one point to another in the warmer weather of spring and summer to reduce the temperature of the water in the cans in order that the fish may be carried successfully. If the water were permitted to remain at the normal temperature of the streams and lakes at these seasons of the year, frequent changes of water would become necessary and the fish would then be carried long distances only with extreme difficulty. Refrigeration of the water by carrying ice in the lockers lowers the temperature and largely overcomes this problem in transportation, and when a low temperature is successfully maintained safe transportation is guaranteed and economy of labor results.

Repeated demonstrations of the superior facilities afforded by the construction of the car to secure and maintain a low temperature in the lockers have been made. Frequently the temperature of the water in the cans has been reduced from 58 degrees to 35 degrees, and has been maintained at this point for hours. The fish were thus carried without change of water and without any loss of fish worthy of notice.

The New York Fish Commission, in asking its legislature for an appropriation for a fish car, instanced the efficient work of the car owned by this commission, and have asked that the plans and specifications of our car be forwarded to them for inspection. Their legislature will undoubtedly give them the appropriation asked for at its coming session.

Repairs have been made to the car during the past season whereby we have secured a different arrangement of the side doors and sleeping berths, which have resulted in greater convenience in its use.

SCIENTIFIC WORK.

The investigations made by Prof. Reighard of the embryo of the pike perch, or wall-eyed pike, during the spring of 1890, have resulted in a most valuable addition to the practical side of fish culture. To fish culturists the suggestions made in his report read at the American Fisheries Society in May, 1890, which appears in the appendix, if followed out intelligently, will be of much value and should result in a decided increase in per centage of the artificial fertilization of the ova of this fish. Scientific investigations of this nature can and do lend efficiency to the work of the fish culturist.

The work of artificial propagation of fish is today largely in the hands of men whose whole experience has been gained by practical experience in this work. While many of them are careful, painstaking and observant of the details of these operations, and thus become successful fish culturists, and hold high rank in their calling, they occasionally meet with difficulties which cannot be overcome by methods known to them, and which are controlled by causes that can only be explained by the aid of the

microscope in the hands of some person, who, by reason of his education in biology and zoölogy, can determine the causes of failure in particular cases. Science can be made to contribute to more successful practical results in fish culture, if its aid be invoked when needed, and a wise and judicious expenditure of money in this direction must redound to the credit of the State, and largely add to the value of its undertakings. The State which thus wisely uses all means at command to enlarge the usefulness of its boards charged with public work, pursues a policy which tends to practical success, and gives the State itself a character for a broad policy in its public work.

While the work and investigations of Prof. Reighard connected with the pike perch are not by any means on a new line of inquiry, yet so far as they pertain to this particular embryo, they are original and of value, if his suggestions be followed out to their practical conclusions.

This is a fish that possesses a commercial value to the State, and any practical solution of the difficulties which have always given a low percentage of fertilization of the ova, results in an immediate practical benefit to the industry.

There are many points upon which science may enlighten the fish culturist, even with the species which have long been successfully hatched. It is an important thing for the fish breeder to know how long the spermatozoon retains its vitality or life power after it has been taken from the fish. It is important to know with some definiteness how long a period elapses after the ova has been taken from the female fish, before it reaches the condition where fertilization is impossible. It is important to the fish breeder that he should know whether there is a certain time when the male and female may be handled and the very best results be obtained, and the highest point of success reached in artificial impregnation. It is important for him to know within reasonable limits how long a period is covered by the maturation of the egg after it is taken. These and many other things are of the first importance to be known in our work, and can only be solved by the use of the microscope in the hands of some person skilled and educated in the study of embryology. Science should be made to cast its light in these dark places, and thus reasonably insure the practical results of our work to the point of greatest success.

To accomplish these objects and to secure the services of a person competent to conduct intellegent inquiry along these lines of investigation, a conference has been had with Prof. Reighard, looking to his employment in this work for specified times for the coming year. An arrangement can be made with him, which will give us the benefit of his services for a specified time each day, outside the time allotted to his regular duties, which will secure to the board a valuable service at a very reasonable compensation. We therefore ask that the sum shown in our estimates for this item be allowed, and we are satisfied that it will be a wise and judicious outlay of money.

The importance of these investigations in aid of practical fish culture cannot be overrated. A reasonable appropriation of means to further such investigations must reflect credit upon the intelligence of the legislature which makes it possible to pursue inquiries of this nature and in these channels.

MUSKALLONGE.

The muskallonge is one of the most highly prized of the native fishes of the waters of this State. Its flesh is delicate and rich. It attains a large size and was formerly abundant. Its gamey qualities make it a prime favorite with sportsmen. Like the other valuable fish, its numbers are becoming rapidly depleted and it is already comparatively scarce. The desirability of doing something to replenish the number of this excellent fish has been long recognized by this board. In the spring of 1889 an effort was made to inaugurate this work, which, however, was unfortunately not very encouraging, but the board do not intend to let the matter rest with this experiment.

On May 1, 1889, Mr. Orr D. Marks, having been entrusted by the board with the undertaking, went along the west shore of Lake St. Clair where this fish had formerly abounded, to investigate the facilities for obtaining spawn and the opportunites for hatching the same. The famous spawning ground of Baltimore bay was visited and at New Baltimore two fishermen were found who were fishing with some small nets in the bay, and it was learned that they caught a few muskallonge after the middle of May, which they were willing we should handle. Five miles south of there a fisherman fished off the shore with a seine, who said he caught a few the latter part of May, which we could have the privilege of handling if we wished.

At Milk river, still further south, a man who fished with a gang of small pound or trap nets, said he caught now and then a small muskallonge and was willing to grant the right to handle such as he caught.

The above being the only places along that shore where he could learn that this fish was caught in any quantities, he returned to Detroit.

On May 13 word was received that the fishermen at New Baltimore had some muskallonge, and on the next day Mr. Marks went there. He found three large fish in the nets, a male weighing about twenty-five pounds and two females, the latter both ripe, one weighing between forty and forty-five pounds and the other about thirty pounds. These were crated on the 14th and on examination the next day the male was found to be spent. On the 20th the larger female died and on opening her the lower side of each row of eggs was found to be dead and fungused.

On the same day the seine fisherman above referred to caught a female which had cast her eggs. He caught no males that spring up to May 30 when the work was abandoned by Mr. Marks.

On the 22d the fishermen at New Baltimore caught another female which, however, had cast nearly all her eggs. On the 23d the other female which had been crated on the 14th was found to be spawning her last eggs.

Several small males were caught, but upon examination were found to contain no milt sack, and the conclusion was reached that they had not arrived at the age of maturity.

The only male that was caught in that vicinity, so far as came to the knowledge of Mr. Marks, that was of sufficient age to fertilize the eggs, was the one above alluded to, which was spent about the time it was caught.

The indications being clear that further attempts to accomplish anything that season in that locality at least would be futile, on May 30 Mr. Marks returned to Detroit.

In the following year the other work of the board was so urgent and pressing at the proper season for further continuing the experiment, that this work was reluctantly postponed for another season.

The increasing scarcity of this fish and the high estimate put upon it by both sportsmen and epicures will prompt an early and earnest renewal of the efforts to increase its numbers by artificial propagation.

WHITE BASS.

In the spring of 1890 it was learned that a favorable opportunity existed to make some experiments in hatching white bass. Through the courtesy of the Superintendent of Fisheries of the State of Wisconsin, who contemplated experimenting there in the same line, we were offered the privilege of taking eggs for this experiment at Winueconne on the Wolf river in that State.

Mr. Walter D. Marks on May 21, 1890 left Detroit for Winneconne, where it was reported the white bass were very plentiful. He went prepared to take and fertilize the eggs and if necessary transport them to Michigan for hatching. He arrived at Winneconne on the 23d and found the fish there in large numbers. He learned from the fishermen and residents that the fish had for many years been abundant there at the spawning season. They are taken principally in hoop or fyke nets. They come up the river from Lake Winnebago and quite likely through the rivers and lakes from Lake Michigan, and afford sport and food for a great many people. They are shipped from here to St. Paul and St. Louis and other markets. They are excellent food fish with a flavor much like the striped bass, and when taken with rod and line afford excellent sport, to the enjoyment of which a new zest is added by the glistening, silvery, irridescence of their color and the beauty of their graceful form.

The nets when lifted in these waters were filled with the white bass and nothing else, they were so abundant. The fish taken in the hoop nets were not ripe and no eggs were obtained from them. No eggs were taken until June 1st, and they were taken from fish caught in gill nets set on a gravel rift which was their spawning ground. On June 1 sixteen were caught with a short piece of gill net rented from one of the fishermen. Three of these were spawning and the eggs were taken and fertilized.

The eggs are very small, running 32 to the linear inch and 32,768 to the cubic inch. They very much resemble coarse corn meal in bulk. A full grown fish, weighing say 2½ pounds will yield upwards of 65,000 eggs.

The eggs fertilized June 1st at about 11 A. M., were put into Seth Green shad-hatching boxes and placed in the river with a current of three miles an hour flowing through them having a temperature of about 68. After six hours the form of the fish showed in the egg, and motion was apparent after 18 hours, and hatching was complete at the end of 36 hours.

A gang of three nets was obtained and on June 2 two quarts of eggs were taken and on the 3d a like amount. Of these about 35% were hatched. The fish which were hatched escaped into the river. Cheese cloth was used as a screen on the boxes, which would hold the eggs and the fish when first hatched, but when the sack was absorbed the fish were so small that even the fine cheese cloth would not hold them. This was a difficulty that had not been foreseen and prevented saving any of the hatch to transport to Michigan, as had been planned. The period of hatching, too, was so short as to render it impracticable to transport the eggs dry for

hatched was from eight to ten thousand. They were released in the river at the place of hatching on July 2, the 12th day after they were fertilized. This closed the work at Algonac.

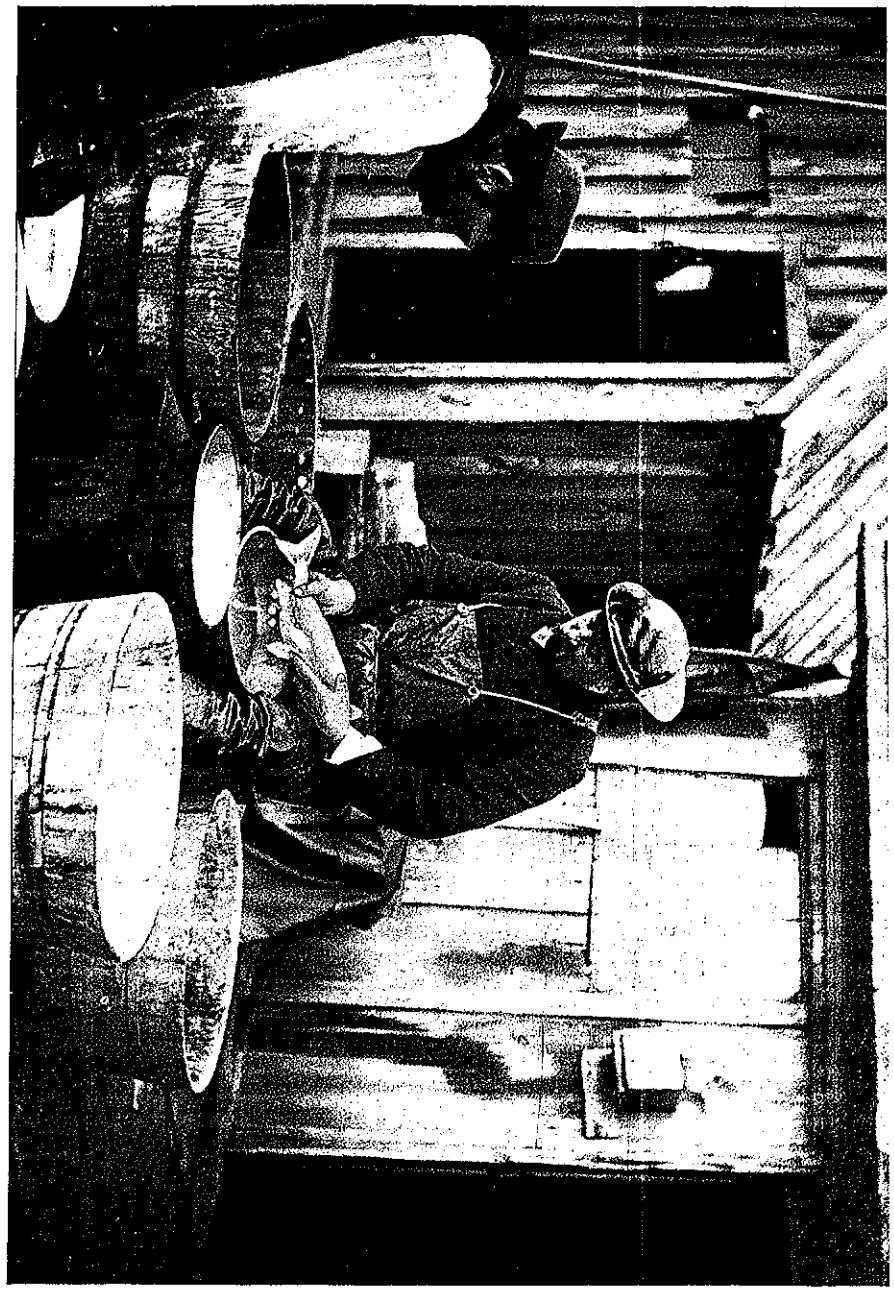
The eggs are a rich dark bronze color and are very easily broken. They require careful handling and will not stand rough usage. They must be stirred very gently and for a long time to separate them. The milt forms a heavy coating on the eggs which sticks them to everything they touch. When only good eggs stick together they hatch well enough, but when a bad egg adheres to good ones it is difficult to separate them without destroying the good eggs, and if not separated the bad egg destroys the good ones. On this account the percentage of loss of fertilized eggs was large.

On July 5 eighteen sturgeon, twelve females and six males, that had been caught in pound nets, were procured from the Canadian side of Lake St. Clair and crated and towed by row boats about ten miles to the fish pond at the fishery controlled by the Commision near Fort Wayne below Detroit. One small male was killed and opened to ascertain the growth of the milt in young fish, and it was found to be well developed. This fish was estimated to be about four years old. The pond where these fish were placed is about six feet deep, in the edge of the current of the river, with soft bottom and detached from the shore. The fish were handled by seine from a platform at one end of the pond. They were carefully handled twice a week for over two months without any success, no eggs being taken. Upon opening a female the eggs seemed to be blasted and the milt of the males appeared to have dried up. One male and one female were kept in the pond till October, when the female, on being taken out, was found to have spent her eggs, and new eggs were forming.

Mr. Aaron W. Marks, who had charge of these experiments, was formerly in the employ of Mr. Seth Green and took part in 1876 at New Hamburg on the Hudson river, in what was perhaps the first successful hatch of sturgeon eggs in this country. The number of eggs taken for that hatch was about 20,000 and they were taken from a single fish. The number hatched was about 140,000. The treatment of the eggs and mode of hatching was substantially the same as that adopted at Algonac as above described.

The board planned to continue the experiments below Detroit in the season of 1890, where it was learned the fish were taken in spawning condition. When about ready to commence the work it was ascertained that Mr. Frank Clark of Northville, Michigan, had been to the fisheries below Detroit and had succeeded in hatching some, but that the season was over, the spawning there apparently having taken place earlier than the experiment the year before had led us to expect.

These experiments demonstrated the feasibility of artificially propagating the sturgeon, but it is apparent it is necessary to take the fish just about the time they are ripe and in the act of spawning, and that probably the fish will not ripen in confinement and especially when they are wounded when captured.



STRIPPING WHITEFISH.

DETROIT STATION.

In the months of September and October, 1888, the capacity of this station was increased by the addition of the jars formerly carried at the Petoskey station, which station it had been decided to discontinue.

This change in the Detroit hatchery was effected by the addition of one row of jars to the top of each gallery, and by a rearrangement of the jars, which placed the jars closer together, and gave six additional jars to each row.

The station when thus altered had in operation five hundred and twenty-five jars, with a capacity for hatching annually eighty-five millions of whitefish fry. These changes entailed but a small expense, and still retained the capacity for output of fry which was formerly possessed by both the Detroit and Petoskey stations. These changes necessitated an enlargement of the storage tank capacity of the station, in order to successfully and safely carry the added fry, and there was added one new storage tank thirty feet long, five feet wide and eighteen inches deep, and two other and smaller tanks with a united capacity equal to that of the larger one. A new tap connection was made with the water-main on Joseph Campau avenue, two inches in diameter. This gave the needed additional supply of fresh water required to meet the increased capacity of the house.

A telephone was placed in the Detroit hatchery on February 28th and another in the office of the board. The work has been greatly facilitated thereby. Frequent and imperative demands upon the hatchery are made for quick communication with different points, particularly in the egg taking season, when the season is busiest, and in the spring when distributions of fry are being made, and the telephone has served such a very useful purpose that it could scarcely be dispensed with.

No serious trouble was experienced in the practical operations of this station during the hatching season, but as all the whitefish ova was carried by the commission in one house and no precautions could be taken to save the eggs in case of a failure of the pumping supply, considerable anxiety was felt until the season closed for fear of some failure of the pumping works. In the event of such a failure, if it were of long duration, the loss of the entire stock of whitefish eggs for the season would natually follow. On the 31st day of March, 1889, there was a failure of the city pumping works for a short time, caused by a breakage of one of the mains. The eggs, however, were at this time well toward the end of the hatching season and close upon the time when they would naturally hatch, so the danger was not so great as would have threatened earlier in the season. A comparatively insignificant number of fish were prematurely hatched at this time, but the pumps were soon again in operation and the danger was past for the time.

Our experience in the winter of 1888 when an entire failure of the water supply occurred lasting nearly two hours, threatened such serious results that we decided to include in our last estimates submitted to the legislature, an item sufficient to cover the expense of a relief pump of our own in the building, which could be used in emergencies of this kind and which would preclude any possibility of such disaster in the future.

The other repairs put upon the property this season were of minor consequence, and covered what may be termed ordinary current repairs such

as were sufficient to maintain the property in good condition and prevent deterioration.

The work of taking whitefish ova on the Detroit river in the fall of 1888 was begun some days earlier than in the fall of former years, the fish running on at a much earlier date than usual. Arrangements were made whereby we secured for our egg taking operations, the fisheries at Fort Wayne, Mammy Judy, Grassy Island, Red Shanty, Belle Isle and Craig's all of which are on the Detroit river.

The first eggs taken on the river this year were taken on Oct. 31, and the work of egg taking was closed on Dec. 5. A much larger number of eggs were taken this season than had been taken in a number of years before, but owing to some causes not yet fully determined, a much larger number than usual were lost. This loss of eggs not only occurred in the eggs taken from the fish handled by this board, but the same trouble was experienced at all other fisheries where operations were conducted during this season to secure eggs for other hatcheries.

At the close of the egg taking season all the jars in the Detroit house were filled, and a sufficient number of eggs were also obtained to make good the usual percentage of loss from unimpregnated eggs, after the percentage of poor eggs had run off. Soon after the eggs were placed in the house, it became manifest to us that for some cause there would be a great loss, and the result was that within a comparatively few days there was a total loss in the Detroit house of about sixty jars of the first eggs taken.

Wisconsin was at the same time conducting egg taking operations upon the Canadian side of the Detroit river and the U. S. Commission were conducting operations at Put-in-bay Islands on Lake Erie. At each of these points a similar experience was had, and in the case of the U. S. Fish Commission they experienced a much more serious loss of eggs than we suffered, in fact their house was filled early in the season to its capacity, but owing to the causes spoken of hereafter, or some other unexplainable cause, this entire take of eggs was lost. They succeeded later in the season, however, in making good a portion of this loss.

The only known causes which contributed to this loss seem to be the following. The weather during the season continued warm until late in the fall and the water of the river remained for a long time at 53 degrees Fah. The fish taken in the nets and afterwards held in pounds and crates, suffered almost an epidemic from a fungus growth. In many instances the fish died in the pounds, their bodies being so badly fungused that they were entirely worthless as food. This condition of things was exceptional to a degree, and has never before or since occurred to anything like this extent in any of our egg taking operations. The fungus not only attacked the fish, but followed the egg itself through its early stages, and there was a consequent large loss from this cause. We were unquestionably better situated by reason of the nearness of the hatchery to the fishing grounds to secure a large percentage of good eggs and avoid great losses, than we would have been if the hatchery had been more remote from the fishing grounds. Care was taken to avoid overcrowding the fish in the crates, not more than three hundred being placed in each crate, the size of each crate being sixteen feet in length, five feet wide and five feet deep.

The fungus growth referred to gave trouble for quite a period of time even after the eggs had been placed in the jars and the percentage had worked off. It was a matter of common occurrence in the hatchery to free the eggs of this fungus growth by washing them, and even then but three quarts of eggs could be run in each jar, while under ordinary conditions they carry easily four quarts.

During the season's fishing there were crated and handled at the various fisheries the following number of whitefish:

	Females.	Males.
At Grassy Island	1,251	683
At Red Shanty	489	238
At Mammy Judy	794	174
At Fort Wayne	1,118	1,952
	3,652	3,047
Total of male and female fish handled		6,699

The first eggs were taken on the river on November 1. This date was ten days earlier than the first take of the preceding season, and about that number of days earlier than usnal. Egg-taking operations closed on Dec. 5. The total number of eggs taken at all the fisheries in the fall of 1888 was 81,575,000. Out of this number there were hatched and distributed 63,000,000, leaving a percentage of loss of 22%. This loss exceeded the average loss by about 12%, and can be accounted for by the causes above mentioned. The eggs began hatching on March 18, 1889, and the last eggs were hatched on the 22d day of March. This was one of the most rapid hatches ever had, the whole time covered being only seven days from the time the hatch was commenced until it was finished.

On December 20, 1888, there were donated to the N. Y. Fish Commission, and shipped to Monroe Green, Esq., superintendent of the Caledonia hatchery, 1,024,800 whitefish eggs. On January 30, 1889, 300,000 eyed whitefish eggs were shipped to J. H. Marks, Bloomingdale, N. Y., for the N. Y. Fish Commission. In return for these eggs this commission received brook trout eggs, as shown in another part of this report. Distributions of whitefish fry were made in the spring from the Detroit hatchery, as shown in the schedule of whitefish plants in the appendix to this report.

Soon after the 1st of July, 1889, when the funds appropriated by the legislature for permanent improvements at the Detroit whitefish station became available, bids were solicited for the work and a contract was entered into with Candler Bros., of Detroit, they being the lowest bidders, to make the contemplated improvements.

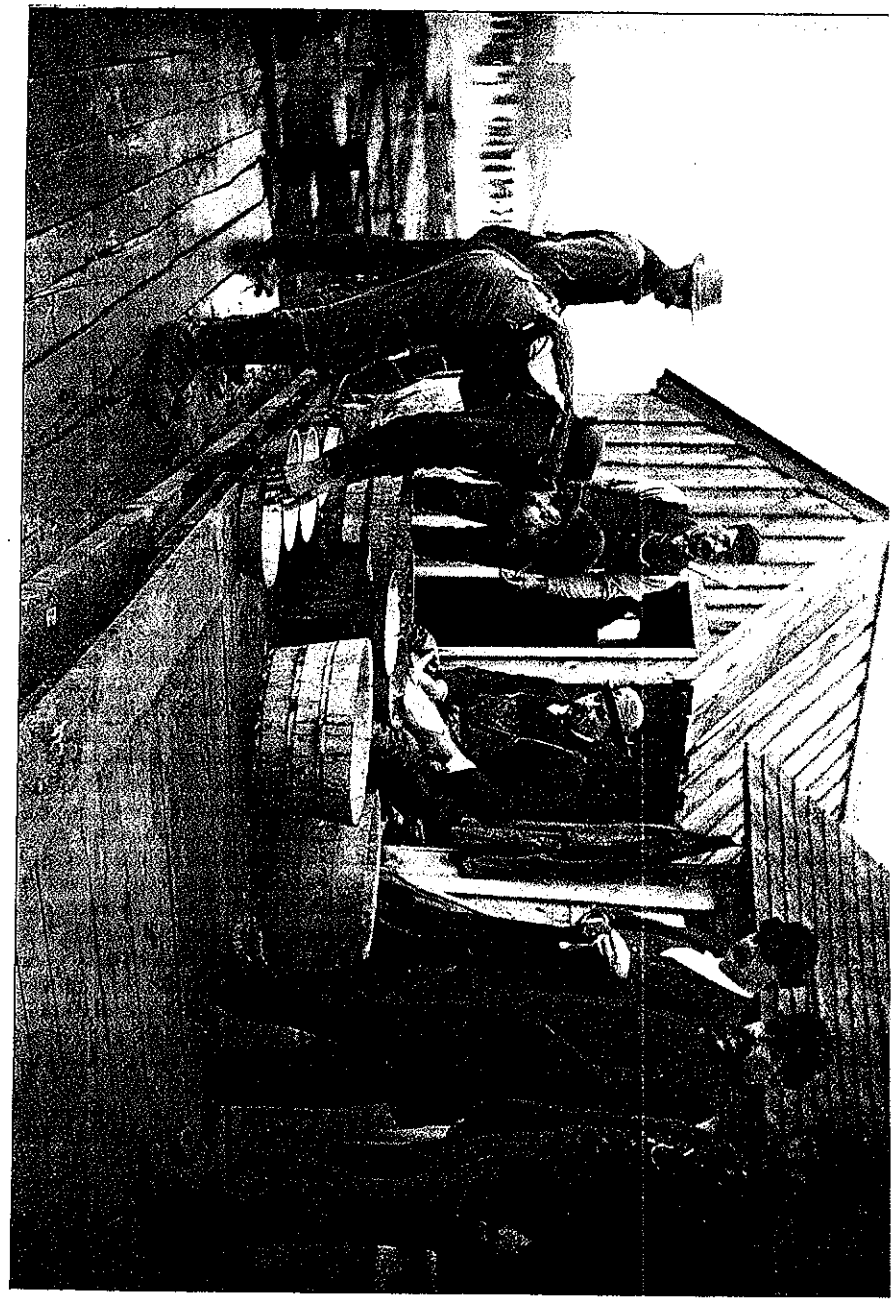
These improvements were designed to enlarge the capacity of this station from a house having a capacity of about 80,000,000 to 160,000,000. In order to effect this change, it had not been thought to be nesessary to in any wise change the structure of the building itself. It was found, however, before the work had proceeded far that unless some change was made whereby the wing part of the hatchery should be extended, we should be lacking room for storage tank capacity for the increased quantity of fry which the house would accommodate. We accordingly, as the most

inexpensive method of securing the desired accommodation, proceeded to raise the roof of the wing and move the west wall of this building fifteen feet further to the west. It was alsofound that at a very small expense the roof could be raised another story, thus giving a storage room on the second floor and a room for a shop, both of which are necessary and both of which had formerly been on the ground floor of the wing, occupying the room which was now to be occupied as a tank room.

On Aug. 15, 1889, the carpenter work commenced on the wing, and improvements in the main building. The roof was raised, giving two large rooms upstairs, which are used for a work shop and storage room. The large room which is called the tank room is 47x34 feet with 10 foot walls ceiled up with pine and painted. The large tanks that were formerly used at Petoskey were placed in this room and the additional large tanks were taken from the main building of the Detroit house and placed by their side. These tanks are 35 feet long 4 feet wide and 20 inches deep. All the interior fittings of the Petoskey house were used in refitting this wing. The two small storage tanks were spliced to the same length as the other large storage tanks and four new ones were added to them, making eight storage tanks in all. All the posts of the jar galleries were spliced out and carried one tier of jars higher on each gallery. The large foot tanks at the east end of the house were cut in two, and the house made a double house, containing four galleries of jars, with a capacity of 1,053 Chase jars. The addition of the extra row of jars at the top of the jar galleries put the jars on these extra rows too high to be worked from the floor conveniently and we constructed a platform between the galleries about half way up the height of the galleries, upon which the two upper tiers of jars are worked with ease. An open space was made through the wall between the main building and wing to allow ready access to the tank room from the main building. A ten foot opening was thus given which was arranged so as to be closed by two sliding doors with half sash openings. A large window, 3½ feet wide by 9 feet in length was placed in the east gable of the main building to give needed light in place of two other windows closed by the enlargement of the wing.

It was found necessary to move the water closet from the tank room or wing to the northeast corner of the main building to make room for trucks when handling cans. A coal house was built and painted to correspond with the hatchery 12x4x7 at the east side of the tank room in the alley adjoining the building. The contract for making a concrete floor in the tank room was let to Chandler Bros., and the improvements were finished on the 20th of September. The concrete floor was not as good as we should have had according to the contract, but was afterwards relaid by the contractor and is now in good condition.

The contract for all sewer connections, water taps and general plumbing was let to Lane Bros. of Detroit. A six inch water-pipe forms the connection between the foot tanks and storage tanks running under the floor in the shape of a siphon. This arrangement puts the connection between the foot tanks and storage tanks eutirely out of the way of all work done on the floor of the house and works with entire satisfaction. The flow of water through these pipes is easily regulated by a funnel shaped opening and is entirely successful in its operation. As it reaches the storage tank room it forms a "Y" and branches to each double storage tank. The flow of water through these pipes is controlled by a tube that is connected to the iron pipe. This tube is a bell-shaped or funnel-shaped adjustable pipe



STRIPPING WHITEFISH AND HANDLING EGGS DURING IMPREGNATION.

cut with a thread and can be lowered or raised by turning it either way, thus regulating the quantity of water passing through the siphon pipe. This pipe and the new arrangement work very nicely. A larger supply of water was needed to run the added jars and the right to put in a two-inch tap was granted us by the Board of Water Commissioners. It was made in the main on Champlain St. A water-meter is attached to the pipe supplying the large tanks in the tank room carrying the young fry. A connection was also made from this pipe to the four-inch pipe to add to the feed of the jars. The wells through the floor leading to each water connection were boarded up, and as they were commencing to decay they were laid up anew with brick and mortar, making them more substantial than before. The water connections from Joseph Campau Ave. which formerly fed the tanks in the west end of the main building were changed, and a connection was made from this to the four-inch main feeding the jar tanks.

The large tanks at the west end of the house were taken out to make room for an emergency boiler. The commission found it necessary to put in a boiler for protection; and it was necessary to have an iron smoke-stack, or a chimney in connection therewith.

The floor of the hatchery building had up to this time and throughout each winter season remained constantly damp from the great amount of water constantly passing through the house, and the employés suffered considerable discomfort from this condition of things. It was decided in making the changes in the building to construct a chimney and fire place in the main hatchery, to overcome this trouble and make the building dry and comfortable. Accordingly, with this object in view, and to secure better ventilation and to prevent the sweating of the walls in winter, a chimney twenty-eight feet in height having a fire place with a flue nine by twenty inches in dimensions was erected. To this flue is also connected the smoke flue of the boiler. This improvement has effected all that was sought for and the hatchery is now dry and comfortable at all times.

For reasons already given, a pump and boiler were put in the Detroit hatchery to be used in cases of emergency in case of failure of the city water mains. A boiler of the "Economic" pattern of thirty horse power and a pump were purchased and placed in the main building. The pump has a throwing capacity of one hundred and sixty-seven gallons per minute.

The boiler was placed on a suitable foundation in the northwest corner of the main building and proper steam connections were made with the pump which is set about forty feet to the east, and is so placed in the partition between the hatchery proper and tank room, as to be attended to from either room. The suction pipe, four inches in diameter, is all connected under the floor. The pump is well set on a foundation of brick and stone. The boiler serves also to furnish heat, as well as power for pumping. Ten to fifteen pounds of steam is kept on the boiler night and day. The feed pipe from the pump goes with a stand pipe up through the ceiling of the tank room, then passes through the the main building over the jar brackets with all the shut-off cocks that are necessary. When the pump is worked, which is done as a test every Thursday, the water from the main is shut off and the pump throws a sufficient supply for our jars with the greatest of ease, and so far has given entire satisfaction, and furnishes ample protection in cases of emergency. The smoke pipe from the boiler is connected with the chimney in the main building and a damper is placed below the connection of the boiler with the chimney. When the

damper is shut off a good draft is had in the boiler. Soft and hard coal mixed are used generally for keeping up a low head of steam. The fire is usually half banked. The exhaust from the pump escapes near the wing of the main building. With the small exhaust drum this boiler is allowed 150 pounds of steam, but a pressure of five to ten pounds is usually carried. Water to supply the pump in case of accident, is held in the large tanks in the tank room with which our suction is connected. This water may be thrown through the pump to the upper tanks feeding the jars. It flows back through the jars into the main tanks again, and so on through, and the same water can be used as often as necessary until our supply of water is again secured from the city mains. As a proof of this it may be noted that on the 12th of December the supply of water from the mains stopped and in fifteen minutes we had 150 gallons of water going through our pump, which gave us an ample supply. This has since been improved upon and within five minutes the pump can be run to its capacity.

It was thought advisable by the commission to introduce gas into the house to secure better light for night work, and it has proved a great help, especially in case of accident the house can be illuminated quickly, showing every faucet in the house and all connections. There being twenty-eight gas jets in all, the jars can be worked at night as easily as during the day. The contract for putting in the gas pipes was let to Daniel Lane of Detroit. No leak in any pipe has been yet discovered.

The painting of the new woodwork was done mostly by the regular employès of the commission connected with the station. All the jar brackets, shelves, and the jar galleries were painted three coats and were finished with a black varnish, which looks very tidy. All jar tops were painted with the same varnish. The tank room was given two heavy coats of light drab.

On the 15th day of September five hundred and seventy-one glass jars arrived from C. E. Dorflinger & Son, Pennsylvania. They arrived in first-class condition, only two jars being broken. On the 18th of September a contract was let to the Detroit Tin Manufacturing Co. for *making* five hundred tin jar tops at four dollars and fifty cents per hundred. Also a contract for five hundred jar tubes to the same party at two and one-half cents apiece, the commission to furnish the material. The work was done in a satisfactory manner. Lead was used for the purpose of making the tubes for the jars, instead of block tin, it being one-half cheaper and equally good. The new jars are topped by the employès with white lead putty. The glass tubes we have used in the jars have been discarded, metallic tubes have taken their place, being a great improvement and entirely doing away with breakage. Five hundred wooden faucets were bought for the new jars, and two hundred feet of siphon hose for jar connections.

It was found that the fire pot in our large coal stove was burned out; it was taken apart and a new one put in its place. This stove was placed in at the east end of the main room to preserve an even temperature.

The fisheries at which whitefish were taken in the fall of 1889 were Belle Isle, Craig's, Ft. Wayne, Grassy Island, Mammy Judy, Red Shanty and the Stock Farm, all on the Detroit river. These fisheries were all placed in condition to be fished in the latter part of October.

The egg taking began on the river on November 3, eighteen quarts being taken on this day, and the egg taking closed on December 5, the

WHITEFISH HATCHERY.

same day as last year. The largest number of eggs taken any one day was taken on November 15. On this day 422 quart of eggs were taken.

Fish were crated and handled to the following number:

Fort Wayne	3,048
Grassy Island	1,656
Mammy Judy	255
Belle Isle	1,844
Stock Farm	399
Craig's	1,228
Red Shanty	712
Total	9,142

The total number of females stripped was 3,455.

The total numbr of eggs placed in the house was 122,683,200. The total hatch was 109,700,000.

The catch of whitefish on the river this year was very light, and had it not been for the exceptionally large yield of eggs per fish, we should have fallen far short of the number taken.

The condition of the fish taken on the river this year was excellent, in fact equal to the best ever taken, and much superior to those taken for the past three years.

Five men were regularly employed at the Detroit station during the season, one man acting as night watch.

Owing to the falling off of the catch of whitefish on the river, efforts were made to secure the right to go upon the Canadian side of the river to strip certain fish then crated on Fighting Island ready to cast their spawn. Application was made to the overseer in charge of the Sandwich, Ont, hatchery for permission to handle these fish, as more than a sufficient quantity to fill their own house had already been secured by that government. Permission was granted us to handle 105 whitefish at the fishery at Stony Island which was being fished on the American side of the river by the Canadian government, and a sufficient number of male fish to fertilize these eggs were placed in a floating crate and taken in tow of a small boat to the island. On arriving there, owing to the rapidity of the current and the high wind prevailing, the men lost control of the boat and the crate was stranded on one of the piers of the bridge and the fish were lost. The result of this accident was a loss of the opportunity to take this spawn.

A formal application was made previous to this to the Minister of Marine and Fisheries to grant us the privilege of handling the whitefish before referred to on Fighting Island, as in the event of their not being handled by us the ova would be entirely lost. This point was stated in the letter, and a promise was made that if the right were granted, we would agree to plant the fry from the eggs so taken in the Detroit River, on the frontier of the two countries, so that a mutual benefit might result. A reply was received after some days had elapsed denying our request. Some time further on we were notified that the matter had been reconsidered and permission was granted. The permission, however, came too late, as by the time the permit arrived the fish had been spent and freezing weather had set in, making it practically impossible to conduct further operations.

Matters were not, however, permitted to go by default. On the 20th of November Mr. A. W. Marks was ordered to go to Manistique to gather, if possible, at that point, sufficient eggs to fill the house. Upon his arrival he found the New York and Wisconsin commission men had arranged for all the eggs which might be taken at this point, and there was no prospect of securing a supply there.

From Manistique he went to Sault Ste. Marie, but by the time of his arrival there the season for fishing was practically closed, and he returned to Detroit.

By reason of the light catch of fish in the river, we were not able to fill the Detroit station to its capacity, yet when we compare the output of 1889–90 with former years, we find that we have made a substantial and decided gain upon the output of all former years, and we are now provided with a station which must greatly increase facilities in the future.

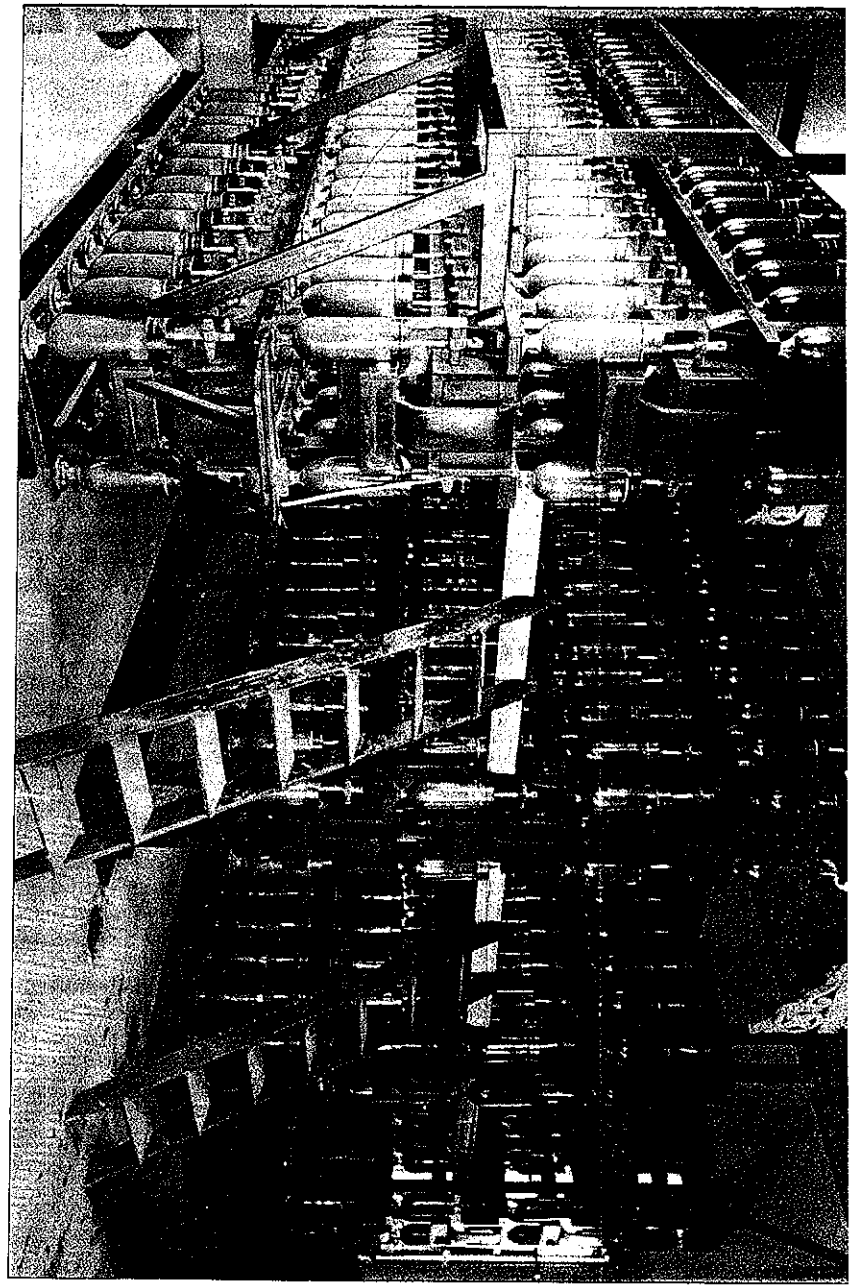
In the fall of 1889 the Detroit Water Board from which we received our water to run the Detroit hatchery, notified the public and its consumers, that after a certain date water meters would be put into all establishments consuming a large quantity of water, and users would be charged according to consumption. In pursuance of this policy and soon after this notice was given, a meter was placed in the hatchery.

A petition and statement showing that our operations were for the public benefit, was prepared and sent the water board, and at a regular meeting of that Board the two resident fish commissioners appeared and laid the matter fully before them. After a statement that the legislature had allowed a certain specific sum for the water consumed here for the ensuing two years, and that we had no other fund to devote to this purpose, and that if metre rates were adhered to in our case, it would result in a discontinuance of our whitefish work, and the further statement that the work was not to be considered as a private enterprise, but was conducted wholly for the benefit of the public, they unanimously and willingly granted our request that the water necessary to conduct the work here should be granted for the next two years at the sum named in our appropriation. There is no question that the water board is desirous of giving the state fair treatment in this matter, and will willingly grant all reasonable concessions to this enterprising public work.

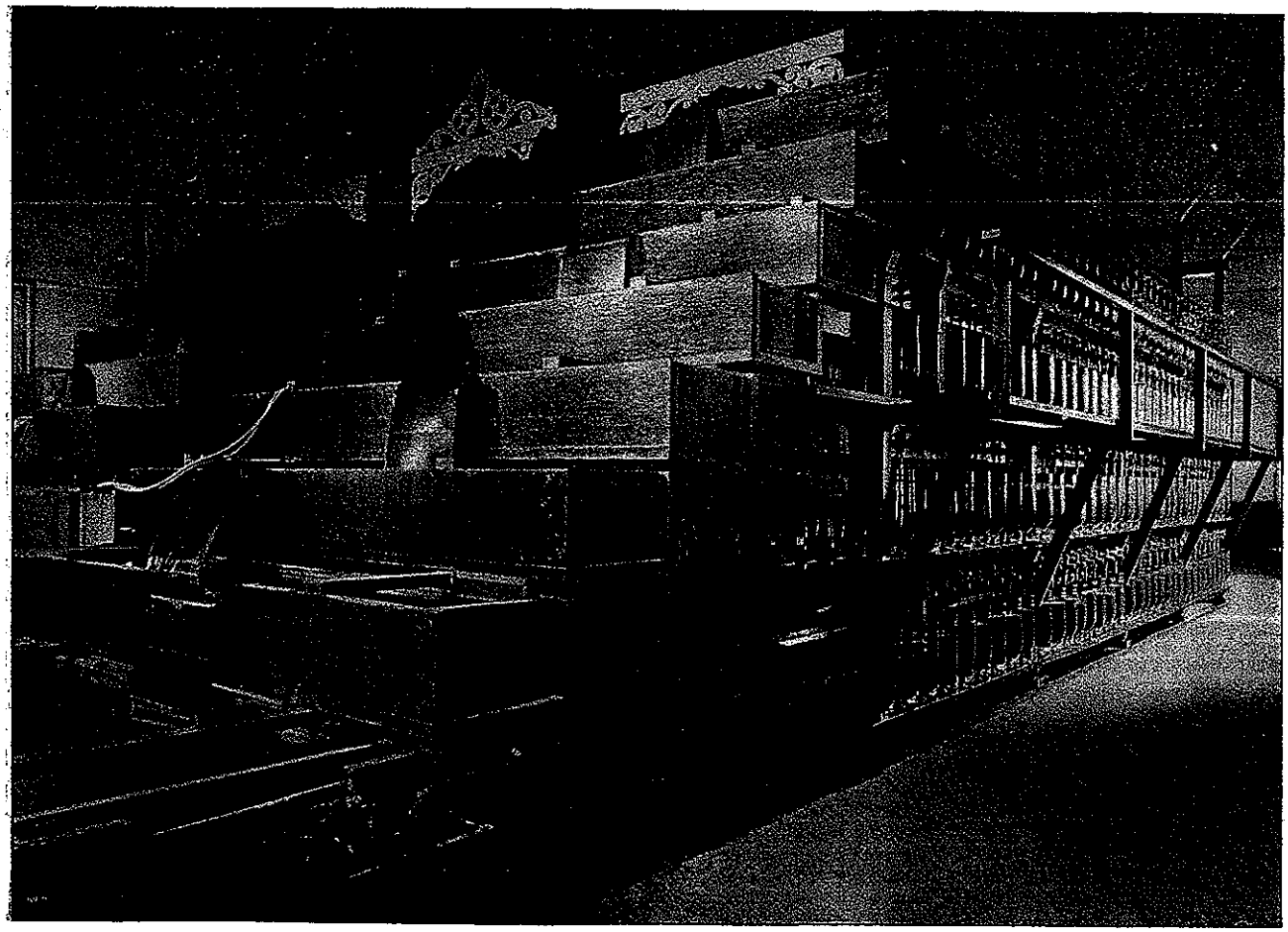
At the close of the fishing season of 1889 the board of park commissioners of Detroit decided to change the policy of their board regarding the leasing of special privileges to individuals on Belle Isle Park. Up to this time the fishing privileges on the Island had been leased at an annual rental to different individuals by the board since the acquirement of the property for public park purposes. The board came to the conclusion, after fully canvassing the matter, that this was against good policy, and determined that no more leases should be granted of fishing rights. They were further moved to this conclusion by reason of the unsightly fish pounds and fishery buildings that disfigured the island for park purposes and decided upon their entire removal.

With our largely increased demand for eggs with which to fill the whitefish hatchery, and with the necessity of retaining the product of this fishery which we had enjoyed for two or three years, it seemed to us a matter of great moment that our facilities for spawn gathering should be in no way curtailed by the loss of this fishery, if it possibly could be avoided.

We, therefore, early in the summer of 1890 made a formal application



MICHIGAN WHITEFISH HATCHERY, DETROIT,
INTERIOR OF HATCHING ROOM—FRONT VIEW.



MICHIGAN WHITEFISH HATCHERY, DETROIT.
INTERIOR OF HATCHING ROOM—REAR VIEW.

to the park board for permission to go upon the island on the part of the State, under such restrictions as they might see fit to impose, and take whitefish during the fall of each year, during the season.

Several conferences were held and an entire willingness was expressed by the park board to extend every opportunity to the State to further the interests with which this board was charged. The result finally arrived at was that they would grant to this board the right to fish the Inselruhe fishery free of cost to the Fish Commission, provided we would agree to put up a tasteful and satisfactory building to be used by our fishermen, which should be in keeping with the appearance of other buildings on the island, and that only such temporary structures as were absolutely necessary to a proper conduct of the fishery should be erected. It was further agreed that all temporary structures should be removed at the close of each fishing season. A just comprehension of the liberality of the park board in this matter may be formed when it is stated that the fishery was rented by the board for the season of 1889 for a rental of two thousand dollars.

This generous action deserves the special mention here given it and reflects credit upon the liberal views of the board in respect of an important State work. A contract was entered into for the construction of a building which has been erected at a cost of $385.00, which is a very reasonable figure.

In this connection mention deserves to be made of the liberality of the Michigan Central Railroad Company. This company has upon its premises on Stony island in the Detroit river a fishery known as the Stony Island fishery. These premises have been under lease for several years to parties who have fished it for the Canadian government. Their lease expired in the summer of 1890.

With our increased necessities in the matter of spawn gathering it became necessary to secure every available fishery upon the American side of the river. Steps were therefore taken in the summer of 1890 to secure this fishery. Application was made to the officers of the Michigan Central railroad and a lease for three years was secured of this fishery for the nominal rental of one dollar per annum.

PIKE PERCH OR WALL-EYED PIKE.

On April 9, 1889 the crew charged with the spawn taking operations with the wall-eyed pike arrived on the grounds of Saginaw bay, and at once perfected arrangements for taking and holding in crates at the mouths of the Saginaw and Kawkawlin rivers the necessary fish. The captain in charge of this crew of men was informed by the fishermen here that the fish had been running some little time and the fish taken showed the eggs were in a ripened condition and the fish had been spawning about six days.

On April 11, spawning operations were commenced by the men and the first eggs were taken on this date. On the 20th, operations were closed and the men returned to their stations.

There were taken during the eight days work on the bay 71,323,928 eggs. Had the men arrived on the ground at an earlier date, and had it not been for the storm at the height of the run, a larger number of eggs would have been taken. Arrangements were made with the fishermen at this point to notify us next season when the fish begin to run on, so measures may be taken to have the crew on the ground at an earlier period. The season for the handling of this fish coming as closely as it does on the heels of the

trout and whitefish plants somewhat embarrassed us in this work this season.

The eggs were sent to the Detroit hatchery. The time occupied in the hatching of the eggs from the time the eggs were placed in the house to the time the hatch was completed, covered a period of about thirty days. This was a somewhat longer time than is usually taken with these eggs, and it resulted in the whole number of eggs in the house being hatched within twenty-four hours. The fish were strong and in fine condition, being practically of the same age. There was an entire absence of cannabalism, which is usually a serious trouble in hatches as ordinarily made of these fish.

The total number of eggs put in the house was, as before stated, 71,323,928. The number hatched and distributed was 39,941,399, giving a percentage of successful impregnation of 56%. This was a most satisfactory result and was fully as good as we have ever been able to obtain.

These fish were mostly distributed in the inland waters, on application from people desiring them for the lakes and streams. Distributions were made in over fifty localities. This work of restocking the inland lakes with wall-eyed pike is giving great satisfaction to the people. One large plant was made on the fishing grounds from which the eggs were taken in Saginaw Bay. Owing to the sudden hatch and the necessity of getting the fish into the water as soon as practicable, some applications were not filled, but these were carried for the next season.

Details of the plants of this fish will be found in the appendix.

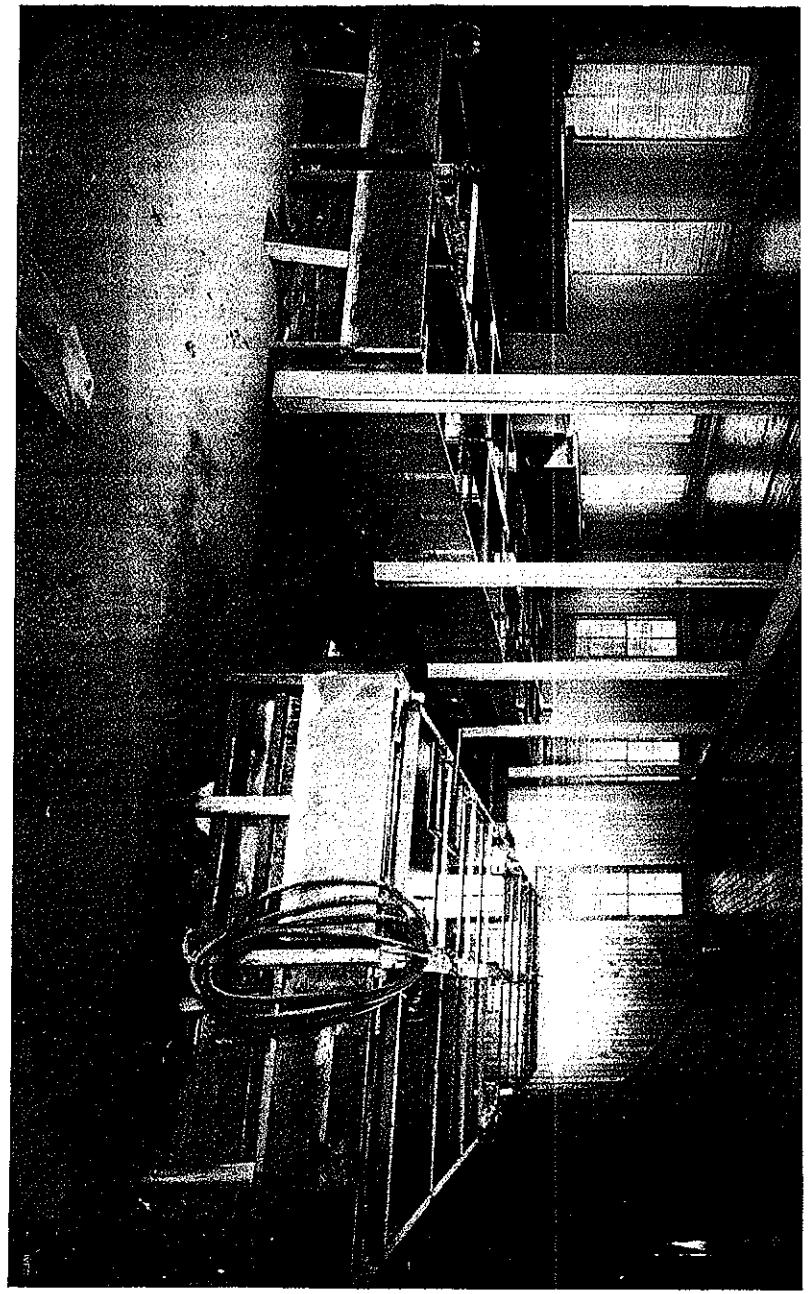
In the spring of 1890 the force went to Saginaw bay and entered upon the work of taking and fertilizing wall-eyed pike eggs in the same localities as in the previous years, namely, at the mouth of the Saginaw and Kawkawlin rivers.

Egg taking was commenced on the 12th day of April and the last eggs were taken on the 26th of April. On the 14th of April a severe storm set in on Saginaw bay, which prevented the fishermen lifting their nets for some days. This storm occurred in the height of the run and was a serious interference with our operations. It was found after the storm that the large female fish had lost their spawn. The total number of eggs taken during our operations was 76,602,876. The eggs were sent to the Detroit hatchery and commenced hatching on May 6. The hatching was completed on May 22, covering a period of about twenty-seven days from the time the eggs were taken until they were hatched. There were hatched of this number of eggs taken 25,000,000, or 30%. Of this number 22,300,000 young fish were planted, the rest dying before the plants were completed, or being eaten by the remainder of the fry. These eggs were not in as good condition as those taken the previous spring, being attacked by fungus, which caused a large loss in percentage.

See appendix for details of plants.

PARIS STATION.

There has been a constantly increasing demand for the products of the Paris hatchery since our last report. In some respects our work on brook trout has been phenomenal. When the commission first began their distributions of this fish all the streams in the lower peninsula, with the exception of three or four in the northwestern portion, were entirely destitute of this fish. It was hardly expected therefore, by even the most san-



MICHIGAN WHITEFISH HATCHERY, DETROIT.
TANK ROOM.

guine of the commissioners, that trout could be grown successfully at any point much south of the D. G. H. & M. Railway. But in a faint-hearted way some experiments were tried in the vicinity of Kalamazoo with the most surprising success, the trout attaining wonderful growth and increasing rapidly in numbers. This led to increased activity by the commission in later years in the direction of stocking the streams and the results of this work have been most satisfactory. As a consequence, nearly the whole State has been considered in the planting of trout and but few failures have been met wherever the requisite care and judgment have been used in making the plants. The economic nature of this fish alone can hardly be estimated. One of the members of the legislature of 1887–8 said: "The cash value of brook trout in my county alone is worth at least $10,000 a year."

The improvements at Paris in 1889 and 1890 have been of a very gratifying and substantial character. The meander of the stream for some distance was the first land acquired at this station when it was originally located here. This gave the board a strip of land following the meander of the stream for seven rods upon each side of Cheney creek, on which the ponds and hatcheries are located for a distance of about fifteen or twenty rods. Up to the spring of 1890 the fences marking the meander boundary between the State property and that of individual owners adjoining, did not follow with anything like exactness the true boundaries. Following the appropriation allowed by the last legislature for the acquirement of necessary additional land at this station, one of the adjoining proprietors owning a considerable quantity of land adjoining the State property, sought to sell the entire quantity of land which he owned to the State. There was but a small parcel of his land which would be of any value to the board for its purposes. The remainder of his property was neither necessary nor desirable in connection with the work at this station. Some negotiations were had to acquire, if possible, at a reasonable figure the small parcel referred to, but the owner would not dispose of this parcel unless he could sell the entire amount of the land he owned. His price per acre was exhorbitant beyond reason, being about double its value and the board declined to enter into any negotiation for this property. Upon finding he could not dispose of his land to the State, he notified the board of his intention to build a road house immediately adjoining the north line of the State property and facing their grounds, intending to make the hatchery and its attractions an inducement to the public to patronize his place. He was at once notified that he could in no wise use the State property to his personal advantage, and he would receive no courtesies in connection therewith, further than those furnished the general public, to wit, access to the grounds individually.

Immediately following this the superintendent was instructed to have a re-survey of the meander of the stream made. A surveyor was employed and a new and proper meander line was established according to his re-survey. This survey carried the north line of the meander considerably further to the north than it had formerly been, and correspondingly farther from the ponds. This tends to lessen the liability of annoyance from any threatened unwelcome neighbor upon this side of the State property. Subsequently the meander lines upon both sides of the stream, so far as we have the meander right, were substantially fenced with a post and board fence and our lines have thus been definitely established.

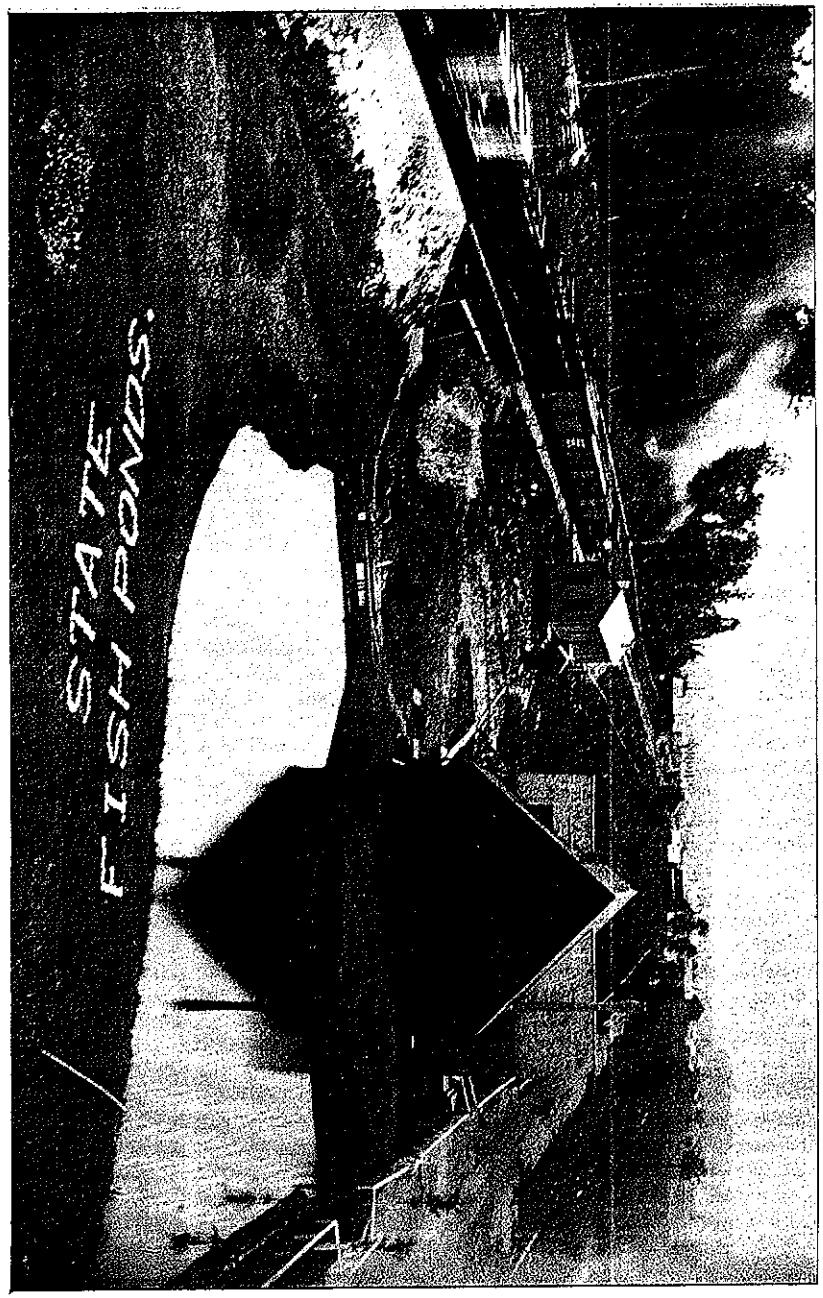
When the Paris station was first located in its present situation some years since, the surrounding country was a new and comparatively unsettled portion of the State. The face of the country was covered with its natural forests, and with the exception of a few rods of the lower portion of the stream, Cheney Creek was covered with a fine growth of timber. The stream has its sources in springs which rise at no great distance from the hatcheries, and the entire length of the creek from its furthest sources to its mouth, where it discharges into Muskegon river, does not exceed a mile and a quarter to a mile and a half.

As the country developed and became cleared of its forests, the sources of the stream were threatened with denudation and a resulting loss of volume and a consequent raising of the temperature during the summer months, which would render the supply of water necessary to conduct operations there uncertain and its temperature unsuitable for uses as a trout hatching station. The commission some years since foresaw these results unless proper steps were taken to prevent them, and has urged upon the legislature the necessity of acquiring all the land at the sources of the stream, in order to protect our rights. From time to time the State has acquired parcels needed, with one or two exceptions. At the last session of the legislature money was allowed the board to purchase other lands and we have since purchased a 40 acres lying upon the sources of the stream from Mr. George F. Stearns, and the commission now practically controls all of the more important sources of Cheney Creek, and a lasting supply of water is reasonably insured. The consideration paid for this forty acres was $1,000, which was a reasonable figure. The amount of land now owned by the State at Paris is 158 acres. If the State should ever decide to discontinue this station, the land which it now owns there could be disposed of at an advance on the prices paid, and has therefore been a good investment, even aside from its uses as a trout station.

A large amount of fencing has been done around the other State property and it has all now been reclaimed from its former condition as a common.

A windmill and pump were purchased at the sale of some railroad property in the immediate vicinity of Paris for the use of this station at the very low figure of $75. This property was all in good condition and was subsequently taken down and put upon the State property, just across the highway from the superintendent's dwelling, upon the highest ground belonging to the State. It now furnishes water for fire protection for all our buildings, having a large tank, which is kept constantly filled with water, and which is several feet higher than the roof of any of the buildings. Its supply of water is taken from wells which have been sunk underneath the tank. The reservoir also furnishes a supply of water for the lawns during the summer season. The total cost of the pump, windmill, tank, connections, water mains and all complete has been in the neighborhood of $700.

There have been constructed at this station since the last report five new breeding ponds for brook trout. These ponds are constructed with gravel bottoms and with sides rip-rapped with stones, and the lawn upon each side has been brought down at a gentle slope properly graded and sodded. The bed of the stream under the railroad bridge has been changed from its natural condition, has been laid up with neat, sloping stone walls on each side and the adjoining earth has been sodded and graded and put into excellent condition. Considerable grading has also been done along the



NEW TROUT HATCHERY AND CAR HOUSE, PARIS, MECOSTA COUNTY.

embankment of the railroad, which passes through the property. The banks of the creek along the old bed of the stream below the railroad, have been graded and sodded and present a very much improved appearance. These banks formerly were nothing but bare sand, but are now all nicely turfed. Above the highway the ponds which formerly were separated in two or three instances by board dams, have been remodeled, the old dams being taken out and replaced with dams constructed of stone and earth, all of which has been nicely graded and turfed over. A terrace has been constructed on the south side of the new hatchery and all has been nicely sodded and graded and is now in a very presentable condition.

It is impossible to go into detail as to all the improvements to the grounds but a large amount of work has been done since the submission of the last report, which has largely tended to beautify the property.

A suitable car house has been erected upon the grounds adjacent to the hatching house for the car during that portion of the season when it is not in use, and the Grand Rapids & Indiana Railroad Co. have constructed a side track from the main line into the house.

The taking of brook trout eggs at this station commenced on the 22d day of Sept., 1888, and closed on the 29th day of Dec. of the same year. The total number of brook trout eggs taken was 2,866,500, and the total number of German trout eggs taken was 20,000. Of this quantity of eggs there were hatched and planted in the streams of this State 2,468,000 trout fry, there being a loss of a little over 14%.

The first brook trout eggs taken in 1889 were taken on Sept. 23, and the egg taking operations closed on the 24th day of December. There were taken this season 2,909,000 brook trout eggs, 70,565 German trout eggs, and 35,500 California or mountain trout eggs. Of this quantity there were hatched and planted of the brook trout eggs 2,578,000, being a loss of a trifle less than 11%. The details of distribution of these fish will be found in the appendix.

The following donations and exchanges of eggs were made during the biennial period. In Dec., 1888, there were received from the U. S. Commission 100,000 land locked salmon eggs. In Feb., 1889, there were received from the New York Commission 8,000 eggs of the Adirondack wild brook trout. In March, 1889, from the U. S. Commission 13,467 salmon trout, 3,500 brook trout and 3,500 California trout. All of these fish were yearlings.

In January, 1890, 15,000 brook trout eggs were donated to the New York Commission and sent to the Adirondack hatchery. In return we received from that station 15,000 eggs of the Adirondack trout, which were taken from the wild trout in the streams in that vicinity.

These crosses are very desirable and the quality of the stock is much improved thereby. Each year we have added largely to our stock of fish and to its quality by taking fish from the wild streams upon the State property at Paris in the immediate neighborhood of the hatchery.

The promise of output for the years 1890 and 1891 is very gratifying. The stock fish are in excellent condition and the appointments of the hatchery are all that could be desired. There are now at this station 13,000 adult brook trout and 1,800 German trout, the fish varying in age from two years to six. We also have a considerable quantity of yearlings.

During the year there was purchased for the use of the board at this station a leveling instrument at the nominal cost of seven dollars. This

has been a very useful instrument in the hands of the overseer at this station, and has been of much value in the construction of dams, ponds, etc., and in establishing levels for the different water courses. It has resulted in the saving of a considerable amount which would otherwise have been paid to some surveyor, and has answered every purpose.

The experiments of Prof. Reighard have demonstrated the value of clear and accurate observations in the earlier progress of the work of fertilization, and we think it would be of great value to the commission if some first-class microscopic instruments could be put into the hands of our employés for use under proper instruction. The infinitely little is as important as the infinitely great. There is such a wide field still uncultivated that only needs clear seeing eyes and brains to yield results of untold benefit. These things can only be determined when investigated by the use of good instruments and we desire to put into the hands of our employés at an early date the necessary instruments and accessories, which we believe will be of great benefit to the work. We have put into the budget of estimates for the coming two years the amouut it will be necessary to expend for this purpose, feeling that the money thus expended will yield good results.

CARP.

The demand for carp is increasing and we have been able to supply all applications. The carp, while not the equal of many of our abundant native fish, yet as a food fish it has its merits. It grows rapidly and attains large size in a few years. It multiplies speedily and is easy to raise and to keep, and it lives and flourishes in waters that will not support more delicate fish. Its flesh, while coarse, is much prized by those who are accustomed to it and know how properly to prepare and cook it.

The carp does well in many shallow and muddy ponds and cat holes where the water is too warm and too impure to sustain other fish.

In many places where applications are made for other kinds of fish and where the commission are of opinion that the waters are not suitable, but believe carp will do well, they are recommended and accepted and prove satisfactory.

The number of carp distributed in 1889 was 2490 and the plants were made in 33 different counties; in 1890 the number was 5798 covering 30 counties. The tables showing the distribution appear in the appendix.

No expenditures for permanent improvements and no additions have been made in the Glenwood station during the past two years beyond the small repairs necessitated by damage from floods, and some ditching. The station is in good order and the fish are in good condition and both are sufficient for all present requirements.

CALIFORNIA OR RAINBOW TROUT.

Nothing particularly new is to be said regarding this fish. Considerable trouble has always been experienced in holding them in the ponds as they do not stand confinement well with us. Good results have not been shown with this fish, except in a few instances. It seems to have a propensity to leave the smaller streams where it is planted and is seldom heard from again. We have concluded, from experience gained within the past two

OLD HATCHERY OFFICE AND ICE HOUSE, PARIS, MECOSTA COUNTY.

years, that it is likely to show a better record if placed in some of the larger streams of the State. Some adult fish which were doing poorly in the ponds were put into the Muskegon and Hersey rivers, and these fish have shown up well during the past two summers. Several very large California trout have been taken from both these streams, which were in exceedingly fine condition. One or two individuals have been taken weighing in the neighborhood of six pounds.

In the neighborhood of Paris on the Muskegon at the mouths of the spring streams considerable numbers of these fish have been caught by residents of the localities. A sufficient number of stock fish will be carried at the Paris station to stock streams for which they seem to be calculated.

Details of plants of these fish appear in the appendix to this volume.

SALMON TROUT.

No operations have been conducted in connection with the artificial hatching of this fish since the submission of the last report. It has not seemed necessary in our judgment that such steps should be taken at present as there is no perceptible diminution in the catch.

In the spring of 1889 the U. S. Commission donated from the Northville hatchery 13,467 two year old salmon trout which were planted in suitable lakes in the interior of the State. The detail of these plants appear in the appendix.

GERMAN TROUT OR BROWN TROUT.

Salvelnius Alpinus.

Of the numerous species of foreign fish which have been introduced into the waters of this country at various times within the last ten or fifteen years, few have given the promise of success which the German trout furnishes.

It has been given considerable attention by two or three states, notably so in New York, and is receiving the attention which experience will prove it deserves at our hands.

As its scientific name would seem to denote, it is an inhabitant of clear cold mountainous streams and lakes and is hardy in character. They are not migratory in habit, and our American experience leads to the belief that they thrive well in water suitable to the brook trout.

In color they are what might be termed a deep olive, spotted with crimson and gray. In respect to their mottlings they show much irregularity in marking, in fact it is difficult to find two alike. They are strong, vigorous and of rapid growth, attaining to a larger size than the speckled trout of our streams.

As a pond fish their history with us is good. They stand domestication well and compare favorably with the brook trout in this respect. Our experience with them at the exhibition made in Detroit is strongly in their favor. Fifteen of these trout were put upon exhibition and they were carried through the entire period of about fifteen days without the loss of a single fish. This was an exceptional case and no similar experience was had with any other fish.

Many of these fish have been caught in the streams in the neighborhood of the Caledonia hatchery in New York, and they show a rapid growth, and first class game qualities. With the stock now on hand some of our streams will be planted with this fish, and its desirability as an addition to our game fish fully demonstrated. Four streams have been planted already and in the next two years we shall know the results of our initial plants.

NEW STATION ON LAKE SUPERIOR.

Lake Superior, the greatest of our large inland seas, has been noted since its earliest discovery for the size and superior quality of its whitefish, and until within a comparatively recent period, for their plentifulness. Time, however, and a vigorous prosecution of the fishing industry with all the modern and destructive methods at command, has wrought serious inroads upon the fish, and the history of fishing upon this lake has been a repetition of that of all the lakes, a rapid falling off of catch in many localities.

Time has been when the plentifulness of whitefish and trout in this lake was so great that fishing was prosecuted profitably within the present harbor of Marquette, and the people of this locality were able to buy fish for almost nothing.

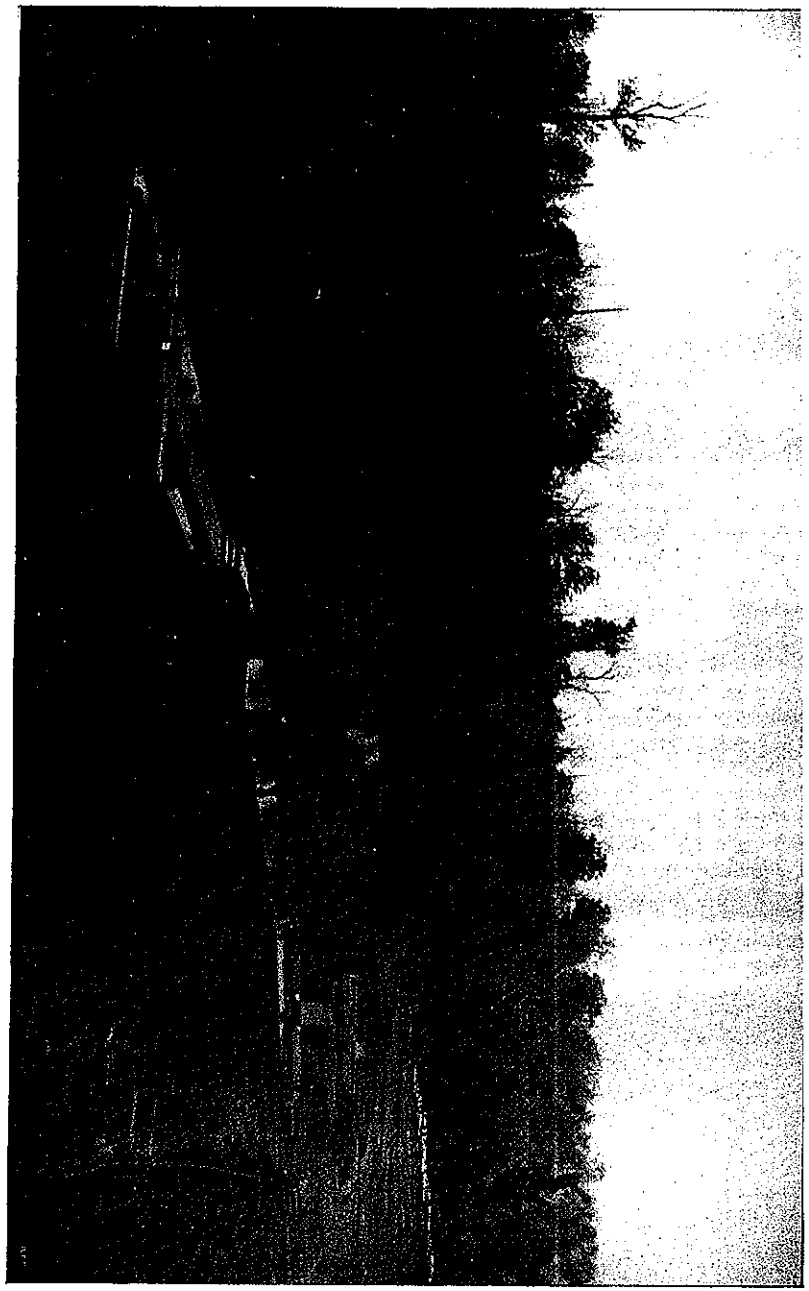
It is scarcely necessary to say that the fishing in this harbor has long since entirely ceased, and that Marquette as a fishing center is fast losing its prestige. Data gathered from the fishermen and residents there the past summer show that the comparatively small amount of fishing done there at present, compared with former years, is now entirely prosecuted by the use of steam craft, which fish at such distances from this point that the entire day is consumed in a visitation of the nets, and the fishing is not very profitable even then.

Inquiry also developed the fact that two at least of the leading firms finding the business unprofitable have left this locality and commenced anew at Ontonagon, in the spring of 1890. At Grand Island, Grand Marias and other points this is in a measure true.

There are certain localities where profitable fishing is yet done. As an illustration of the prolific nature of these waters, where they are yet productive, we may instance the returns of one fisherman for the year 1889. The catch reported by him of whitefish was 510,000 pounds, and of lake trout 490,000 pounds. The cash value to this fisherman of this catch was not far from $40,000.

To preserve the fishing grounds which can yet be profitably fished, and to restore those already exhausted, is a task which the State should assume. The fisheries of this lake as reported alone yield a value annually to the fishermen as follows:

Kind of Fish.	Pounds.	Value.
Whitefish	1,911,888	$95,594 40
Salmon trout	731,564	29,262 56
Herring	31,250	468 76
Total	2,674,702	$125,325 72



PORTION OF FISH STREAM AND BREEDING PONDS, PARIS, MECOSTA COUNTY.

When viewed from an economic standpoint, it will be seen that these fisheries contribute a large amount each year to the wealth of the State. It must be remembered also that these figures do not include the amount caught and used in local consumption, which is not taken into account. These figures represent only the fish caught and sold for shipment. Neither is it likely that these figures represent the entire amount caught and sold, as it is believed that it is impossible to secure full reports from fishermen of the catch. Many of the fishermen who fish in a small way dispose of their catch to other dealers and we are satisfied that many fish so taken are not reported.

The coast line of Lake Superior lying withiu this State has a length of between five and six hundred miles, and it is within bounds to say that fully one-half, if not more, of this extent of water affords opportunity for the prosecution of the fishing industry.

The time has arrived when Lake Superior should receive the benefits to be derived from artificial restocking. The inhabitants of the upper peninsula contribute their proportionate share in taxes to sustain the operations of this board, and should receive in return a just and fair share of its benefits.

By reason of the difference in latitude the temperature of the waters of the upper and lowet peninsulas differ in a very marked degree, and this difference presents a physical difficulty which makes it absolutely necessary that a station should be established somewhere on Lake Superior to care for these waters. Repeated attempts have been made each spring for several years to make plants of whitefish fry in Lake Superior from the hatcheries of the lower peninsula, but with two exceptions every attempt has failed.

Spring comes so much later in the upper peninsula that in attempting to hold the fish until the harbors on the upper lake have become free from ice we have uniformly been compelled to put the fish into the lower lakes in order to save them.

Some years since a station was erected at Petoskey which was designed to care for the upper portion of Lake Michigan and that portion of Green bay lying in this State, and the Straits of Mackinaw, together with Lake Superior and the Sault river. After being run for several years it was found that the hatch of fry was too early at this point, and it was abandoned. The difficulty in crossing the Straits of Mackinaw was another obstacle and no benefit was experienced from this effort. There then remains the question what shall be done for this great lake and the waters of Green bay, which is also another very important fishing point?

This board prepared detailed estimates of the cost and erection and maitenance for two years, of a whitefish station on Lake Superior in connection with its last report and submitted the same to the legislature at its last session. The matter was fully considered by the fisheries' committees of the Senate and House and its need was apparent, but owing to the board being unable to determine the exact location of such a station, it was deemed best to postpone the appropriation until another session, both committees advising the board to visit the upper peninsula before another session, fix upon a desirable site, and then present to the legislature at the session of 1890–1 their estimate for consideration.

Acting upon this suggestion the Board in August, 1890, visited the upper peninsula to find some locatity which would best furnish the facilities requisite to the establishment of a whitefish station.

We decided that the location of the station must be determined on the grounds of advisability and desirability. The question of locality must be determined:

1. By the opportunity afforded for the collection of ova in the surest and cheapest way, with a prospect of a continuing supply.
2. The fitness of the water with which to run the station, as to temperature and purity.

We visited Marquette, Munising and Sault Ste Marie with this object in view, and at Marquette and Sault Ste Marie conferences were had with the city authorities, fishermen and leading citizens. At both points a proper degree of public spirit was manifested in the proposed work, and an earnest desire was expressed to use every proper means to secure the proposed station for this section of the State. At both places a willingness was expressed to contribute a site and perpetual supply of water free of expense to the State should the hatchery be located at either of these points. The Board will at the coming session of the Legislature make a recommendation as to a proper location for the proposed station.

WORLD'S FAIR.

On October 25, 1890, this board received an invitation from the secretary of the Committee of Fisheries and Fish Culture of the World's Columbian Exposition to meet the Fish Commissioners of the various states and territories in Chicago on the 22d of November, 1890.

The object of this meeting, as stated by the secretary of the committee, is "for a general conference of the commissioners of the states and territories with reference to making a great exhibit at the World's Fair, agreeing, if possible, upon some general plan for making the exhibit in conjunction with the government exhibit."

The commissioners will probably be present at the meeting but as it will occur at a time after this report will have passed into the hands of the printer, no statement can be made of the results of the conference.

An exhibit which will show the advancement in methods of fish culture from its infancy to the present time, joined with a full exhibition of the indigenous fish of America, will make a most entertaining and instructive department at this great fair.

If satisfactory arrangements can be made, Michigan can contribute largely to the success of such an exhibit and should join with the other states in the contemplated arrangement.

During the coming session of the legislature the commissioners will take occasion to make a further report upon this subject to both houses, with such recommendations as to the means to represent the State at the exposition as they may deem advisable.

EXAMINATION OF WATERS.

No more important work is done by the commission than that which is embraced under this department. Its valne and necessity are becoming more and more recognized by those interested in fish culture. Pertinent to this subject and well put are the words of Dr. James A. Henshall in a paper read before the American Fisheries Society at its meeting at Put-in Bay in May last, viz:

"There seems to be a wide spread popular fancy that the introduction of

County, Kalamazoo
Township, Richland & Ross

MICHIGAN FISH COMMISSION.

Lake Gull Lake 7

EXAMINATION OF INTERIOR LAKES.

Season of 1886 Crew O. D. Marks, M. J. McGowan, W. D. Sargeant

DESCRIPTION:— Length Five Miles, Width One Mile, Greatest Depth 105 ft.

Shores, High shores, except around inlets and outlet which is marshy for 4 to 10 rods gravel & sand beach

Bottom Clay bottom.

Inlets, Three inlets, two large ones on west & south west side and one small one on south side

Outlets, One outlet on south side a large stream clay & sand banks with gravel bottom

Dates of Examinations,	Sept 24	Sept 25	Sept 26	Sept 27	Sept 28		
Weather,	Cloudy windy	Cloudy windy	Cloudy W'ly storm	Cloudy rainy	Cloudy W'ly wind		
Temperature—Surface,	6 a.m. 64°	6 a.m. 60° / 6 p.m. 75°	6 a.m. 66° / 6 p.m. 65°	6 a.m. 67° / 6 p.m. 66°	6 a.m. 60° / 6 p.m. 67°	6 a.m. 60° / 6 p.m. 63°	
" Bottom,	6 a.m. 48°	6 a.m. 46° / 6 p.m. 46°	6 a.m. 47° / 6 p.m. 46°	6 a.m. 46° / 6 p.m. 45°	6 a.m. 45° / 6 p.m. 46°		
Hours, and Number of Hauls,	Haze	6 A.M. one	6 A.M. one	7 A.M. one	6 A.M. one		
Condition of Water,	Clear	Clear	Clear	Clear	Clear		
Number and kinds of Fish taken,		61	Haze	Haze	27		
Pickerel		a. 1					
Perch		a. 60			a. 5		
Herring					a. 19		
Suckers					a. 3		
Bass							

REMARKS.

(Sept. 25) a. 1 Taken in net; a. 60 in net

(Sept. 28) a. 3 Taken in net & still fishing; a. 19 Taken in net; a. 3 Taken in net

The food in stomachs of fish proves so well digested that it could not be recognized except the pickerel in which was found minnows.

Nets Used, Gill net — Kind. — Length. 343 2½ fathoms — Depth. Av 3 ft — Mesh. 1½, 2, 2½, 3, 4, 4½ inches in a gang.

Remarks on Fish Taken: The fish were all hard, well fed and showed great growth, except the herring which were small.

Recommendation as to Future Planting: Would recommend for future planting, native fish, adults, pickerel, salmon trout.

Reported by O. D. Marks.

FAC-SIMILE OF
EXAMINING CREW'S REPORT.

ination so that the work once done would be of permanent utility for many years to come.

This broader scheme was fully inaugurated as early as 1886, and has been pursued every year since as persistently as the other work of this commission would permit. The plan adopted contemplated beginning the southern tier of counties of the State and doing the work thoroughly. For the sake of economy the work is done by the regular employés of the board in the summer months when they can be spared from the active work of hatching and distributing.

The examination is made by two crews of three each. Each crew is provided with a boat and camping outfit, a gang of gill nets of four different sizes of mesh, various kinds of fishing appliances, a deep-sea, self-registering thermometer, a dredge for examining the bottom and the various kinds of animal life inhabiting the bottom, and bottom-vegetation, a lead and line for sounding, together with printed blanks for making full reports. On the back of the report is a blank space for a drawing of the shape of the lake, on which the soundings are marked and the character of the bottom and shores.

These blanks are of uniform size and shape and the reports when made on these blanks are bound into volumes and indexed, making a convenient and permanent record for ready reference at any time in the future.

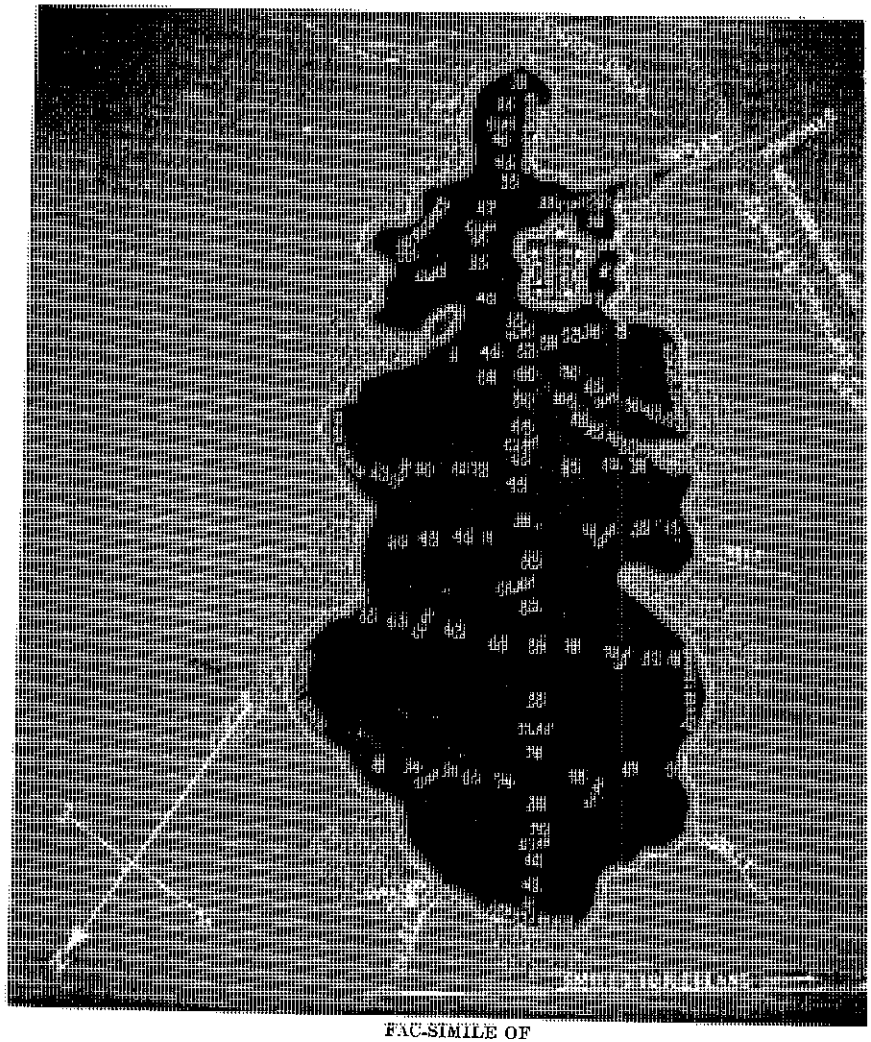
The points covered by these reports are briefly, the location of the lake, length, width, shape, depth and soundings, character of shores and bottom, inlets and outlets and surroundings, kind of water and temperature at top and bottom, date of examination and kinds of weather at the time, number and kinds of fish caught and their condition and what they are feeding upon, the kinds and quantity of fish food, the kind of fish recommended to be planted, if any, and any other special information deemed of value.

In 1886, upwards of 50 lakes were examined and reported, and in 1887 eighty lakes were examined. In 1888 only about 20 were examined, but special attention was given to some larger lakes out of the regular order, which required longer time than the routine work. In 1889 the examination was interrupted somewhat by other urgent matters, and only 25 lakes were completed. In 1890, however, the work was taken up with renewed zeal and resulted in the examination of 72 lakes. The larger and more important streams are examined and reported upon also in connection with the lakes.

The three lower tiers of counties, except Allegan county, have now been substantially completed, and the record contains a sufficiently accurate description of every considerable sheet of water in that territory, with proper data upon which to form an intelligent opinion and judgment as to what fish, if any, are required and will flourish in each.

Before any applications for fish are granted by the board now, for any waters which the examining crew have visited, these reports are consulted, and only such fish sent as are suited to the waters. And if requests are made for unsuitable fish, intelligent recommendations of the kinds that will do well can be readily furnished.

Of the inland lakes examined during the past two years, whitefish were found in but three, viz: Base lake in Livingston and Washtenaw counties (greatest depth 65 feet); Black Walnut Lake (greatest depth 97 feet); and Elizabeth Lake (greatest depth 71 feet), both in Oakland county. Herring were found in several, and in some quite plentiful. In Black



FAC-SIMILE OF
MAP BY EXAMINING CREW

Walnut lake besides whitefish were found salmon trout and wall-eyed pike.

The fish usually found are bluegills, perch, sun fish, bass of all varieties, grass pike or pickerel, gar pike, bullheads, dog fish, mullet, and suckers. Probably the blue gills are as numerous and wide spread as any. The large-mouth bass is quite plentiful, but the scarcity of the small-mouth black bass is noticeable.

A synopsis of the reports is given below.

Calhoun County.

Cedar Lake, Fredonia Township:
Length, ¾ mile; width, ½ mile; greatest depth, 6 feet.
Shores, high banks on north, west and east: flat and marshy on the south.
Bottom, very deep mud.
Inlets, none; outlets, none.
Date of examination, July 25.
Weather, fair and warm.
Water, clear.
Fish, a few minnows seen; water too shallow for future use.

Fish Lake, Fredonia Township:
Length, ¾ mile; width ½ mile; greatest depth, 18 feet.
Shores, surrounded by a marsh.
Bottom, soft marl, mud from 4 to 6 feet deep.
Inlets, none; outlets, none.
Date of examination, July 25.
Weather, cloudy.
Water, clear.
Fish, none taken.

Long Lake, Fredonia Township:
Length, ¾ mile; width, ¼ mile; greatest depth, 18 feet.
Shores, soft and marshy; from 6 to 10 rods from water's edge the banks on east and west are flat; on north and south mud.
Bottom, mud.
Inlets, none; outlets, none.
Temperature—surface, 77°; bottom, 58°.
Date of examination, July 25 and 26.
Weather, clear.
Water, clear.
Fish, Bluegills, calico bass, and dogfish. They were hard and well fed; food, plenty.
Would not recommend future planting.

Lee's Lake, Newton Township:
Length, 1 mile; width, ½ mile; greatest depth, 51 feet.
Shores, north and east, high and sandy; south and west, flat and marshy, wooded on north and part of east.
Bottom, hard marl, sand and gravel.
Inlets, none; outlets, none.
Date of examination, July 26.

Weather, cloudy.
Water, clear.
Temperature—surface, 77°; bottom, 48°.
Fish, grass pike, strawberry bass, sunfish, suckers, and dogfish; all well fed and of large growth.
Recommend black bass and wall-eyed pike for future planting.

Nottawa Lake, Tekonsha Township:
Length, not stated; width, 40 rods; greatest depth, 20 feet.
Shores; flat, marshy and muddy all around the lake.
Bottom, muddy.
Inlet, Nottawa creek; outlet, Nottawa creek.
Date of examination, July 26.
Weather cloudy.
Temperature—surface, 78°, bottom, 58°.
Water very black.
No fish taken.
Recommend for future planting, eels only.

Pine Lake. Fredonia Township:
Length, ½ mile; width, ½ mile; greatest depth, 12 feet.
Shores, flat and marshy, lined with rushes for from 4 to 6 rods, banks high.
Bottom, mud.
Inlets, none; outlets, connected with Long lake on the east by a ditch.
Date of examination, July 26.
Weather, clear.
Temperature—surface, 77°; bottom, 58°.
Water, clear.
No fish taken.
Could not recommend for future planting.

Turtle Lake, Burlington Township:
Length, 1 mile; width, ¼ mile; greatest depth, 18 feet.
Bottom, black mud from 4 to 6 feet deep.
Inlets, none; outlet, a ditch.
Date of examination, July 27.
Weather, cloudy.
Temperature—surface, 70°, bottom, 63°.
Condition of water, dark.
No fish taken. This lake has been lowered by a ditch so that very little water is left.
Cannot recommend it for anything but eels.

Pine Lake, Broomfield Township:
Length, ¾ mile; width, ½ mile; greatest depth, 21 feet.
Shores; part of northeast high, sandy and timbered; the balance marshy and wooded on south and west.
Bottom; along the highlands hard and gravely; in the center mud about two feet deep.
Dates of examination, July 28 and 29.
Weather, 28 clear; 29 cloudy.

Temperature—surface, 73°; bottom, 64°.
Water dark.
Fish; bluegills, strawberry bass, sunfish, bullheads and dogfish, all small and well fed.
Would not recommend anything but eels.

Garfield Lake, Convis Township:
Length, ¾ mile; width, ½ mile; greatest depth, 26 feet.
Shore high and sandy.
Bottom: hard around shores, off shores from one to two feet of mud.
Inlet, none: outlet not named.
Dates of examination, July 30 and 31.
Weather, 30 clear; 31 high winds.
Temperature—surface, 76°; bottom, 56°.
Water clear.
Fish, grass pike, bullheads, strawberry bass, swamp bass, large-mouth bass and bluegills. The grass pike, bullheads and swamp bass were good size and exceedingly fat.
This lake has an abundance of native fish; protection is all it needs.

Duck Lake, Clarence Township:
Length, 2½ miles; width, 1½ miles; greatest depth 61 feet.
Shores, high, sandy and bold. A ditch has caused the water to recede from 6 to 12 feet from the original shore line.
Bottom, sand and marl, very little mud in the center; rocky on a portion of the southeast.
Dates of examination, July 31, Aug. 1, 2 and 3.
Weather, July 31, fair and warm, Aug. 1, cool and cloudy, 2 cool and clear; 3 clear.
Temperature—surface, 74°, bottom, 63°.
Fish, black bass, strawberry bass, rock bass, large-mouth bass, perch, gar pike, suckers, bluegills and dogfish. The perch and grass pike were small, the strawberry bass and bluegills very large.
Would recommend wall-eyed pike and black bass for planting.

Prairie Lake, Clarence township:
Length, ¾ mile; width, ¼ mile; greatest depth, 28 feet.
Shores, low and marshy nearly all around the lake.
Bottom, soft black mud.
Inlet, north branch of Red creek.
Outlet, south branch of Red creek.
Dates of examination, Aug. 3 and 4.
Weather, clear.
Temperature—surface, 74°; bottom, 60°.
Water, dark.
Fish, grass pike, suckers, blue gills and dog fish. The suckers were very large, the blue gills and pike small.
Would recommend nothing but eels for this lake.

Eaton County.

Long Lake, Brookfield Township:
Length, 1½ miles; width, 40 to 130 rods; greatest depth, 48 feet.
Shores, bold, high and sandy; marshy on the south.
Bottom, for a short distance on the east, hard gravel and sand, the remainder muddy; the south end grown up with weeds and grass.
Inlets, not named; ontlet, Battle creek.
Date of examination, Aug. 5.
Weather, clear.
Temperature—surface, 71°; bottom, 44°.
Water, dark.
Fish, Bullheads, dogfish, strawberry bass, suckers, warmouth and blue gills; all medium size and fat.
Would recommend nothing but eels for planting.

Jackson County.

Swain's Lake, Pulaski Township:
Length, 1 mile; width, 160 rods; greatest depth, 63 feet.
Shores, bold, high and wooded on east and west; marshy on north and south.
Bottom, hard sand and gravel with a little mud in center.
Inlet, none; outlet, north branch of Kalamazoo River.
Dates of examination, Aug. 7, 8 and 9.
Weather Aug. 7, clear; 8 and 9, rainy.
Temperature, 73°; bottom, 7th, 63°; 8th, 45°; 9th, 63°.
Water, clear.
Fish, perch, suckers, bullheads, bluegills, calico bass and herring; all in good condition, fat, well-fed, but small.
Would recommend wall-eyed pike and black bass for planting.

Paddock Lake, Concord Township:
Length, 70 to 80 rods; width, about 40 rods; greatest depth, 43 feet.
Shores, soft and marshy all around the lake; from six to twelve rods back of water line, high, bold and sandy.
Bottom, soft mud.
Inlet, Spring creek; outlet not named; empties into Kalamazoo river.
Date of examination, Aug. 9.
Weather, cloudy.
Temperature—surface, 70°; bottom, 49°.
Fish, perch, bluegills, large-mouth bass, pickerel and sunfish; all small, but very fine.

Round Lake, Hanover Township:
Length, ¾ mile; width, ½ mile; greatest depth, not stated.
Shores, bold, high and sandy, except a small portion on the west, which is marshy.
Bottom, hard sand and gravel.
Inlet, none; outlet, a ditch connecting this lake with Lake Farwell.
Dates of examination, Aug. 10, 11 and 12.
Weather, clear.

Temperature—surface, 73°; bottom, 63°.
Water, clear.
Fish taken; perch, suckers, black bass, rock bass, large-mouth bass, small-mouth bass, bluegills, gar pike and dogfish. The perch and blue gills were exceedingly large, plump and fat; bass, small. Wall-eyed pike and black bass are in this lake now, and if protected there would be no necessity for further stocking.

Farwell Lake, Hanover Township:
Length, 1¼ miles; width, 100 rods; greatest depth, 43 feet.
Shores, high and sandy off shores; around shores, low and marshy.
Bottom, hard sand with gravel.
Inlet, a ditch to round lake; outlet, north branch of Kalamazoo river.
Dates of examination, Aug., 10, 11 and 12.
Weather, clear.
Temperature—surface, 73°; bottom, 50°.
Fish taken, perch, bluegills, large-mouth bass, suckers and bull-heads. Perch and suckers, large and in fine condition; the other kinds medinm size and well fed; would recommend wall-eyed pike and black bass for future planting.

Skiff Lake, Liberty Township:
Length, ¾ mile; width, ½ mile; greatest depth, 35 feet.
Shores, marshy from 6 to 12 rods all around; on the west, bold, high and stony; on northwest and southeast there is a tamarack swamp.
Bottom, along shores sandy marl; in center, hard.
Inlet, not named; outlet, south branch of Grand River.
Dates of examination, August 13, 14 and 15.
Temperature—surface, 74°; bottom, 64°.
Water, clear.
Fish taken, grass pike, warmouth, rock bass, large and small-mouth bass, perch, blue gills and bullheads which were good size and fat. Would not recommend this lake for future planting as there is not food enough for the native fish already in the lake.

Clark's Lake, Columbia Township:
Length, 2½ miles; width, ¾ mile; greatest depth, 53 feet.
Shores, high, sandy and wooded on the north for the distance of a mile; wooded on south and part of the east.
Bottom, sand and gravel for from 10 to 12 rods from shore; soft marl through center.
Inlet, none except a number of springs along shore; outlet, one during high water which flows east to the river Raisin.
Dates of examination, August 13, 14, 15, 16 and 17.
Weather, clear except on the 14th when it was cloudy and rainy.
Temperature—surface, 72°; bottom, 63°.
Water, clear.
Fish taken, black, swamp and rock bass, grass pike, blue gills, sunfish, perch, bullheads and gar pike. Would recommend wall-eyed pike. The small fry planted here last spring can be found in large schools.

Vineyard Lake, Columbia and Norveli Townships:
Length, 1¾ mile; width, ¾ mile; greatest depth, 45 feet.

Shores, on north and west low and marshy; on east and south high sand and gravel banks; 10 to 20 feet high.
Bottom, a large part of the lake is sand and marl, on east and south gravel and rocks.
Inlet, Kedson creek; outlet, Raisin river.
Dates of examinations, Aug. 15, 16, 17 and 18.
Weather, clear.
Temperature—surface, 72°; bottom, 57°.
Water, clear.
Fish taken. large-mouth, small-mouth and rock bass, bluegills, sunfish, perch, bullheads, gar pike, grass pike and dogfish, all of good size, fat and well fed.
Recommend for planting, wall-eyed pike.

Stony Lake, Napoleon Township:
Length, ¾ mile; width, ½ mile; greatest depth, 30 feet.
Shores, high, bold and sandy on north, east and west; low and marshy on south.
Bottom, hard marl and sand.
Inlet, not named; outlet, a branch of the River Raisin.
Dates of examination, August 19 and 20.
Weather, clear and windy.
Temperature—surface, 72°; bottom, 55°.
Water, dark.
Fish taken, large-mouth and rock bass, bluegills, perch, grass and gar pike, bullheads, warmouth and dogfish. The fish, as a rule, were large, fat, well fed and plump. Would not recomend future planting, as by draining the feeding grounds have been destroyed.

Browns Lake, Summit Township:
Length, ¾ mile; width, ½ mile; greatest depth, 43 feet.
Shores, bold and hilly on northeast, low and level on the east, high and timbered on northwest, southeast, high land, and southwest tamarack swamp.
Bottom, hard marl, gravel and stone.
Inlet, connected with Vandercooks lake; outlet, Grand river.
Date of examination, August, 21, 22 and 23.
Weather, clear.
Temperature—surface, 74°; bottom, 53°.
Water, clear.
Fish taken, herring, large-mouth and calico bass, perch, bullheads, grass and gar pike. All good size, fat, plump, hard and well fed.
Would recommend for planting, wall-eyed pike, black bass, and eels.

Vandercook's Lake, Summit Township.
Length, 1 mile; width, ¾ mile; greatest depth, 48 feet.
Shores, northeast and a part of the north, high, bold and sandy; west off shore high; south a low tamarack swamp; east low dry and sandy.
Bottom, hard marl and sandy.
Inlet a branch of Grand river; outlet Grand river.
Dates of examination, August 20, 21, 23 and 24.
Weather, clear.
Temperature—surface, 74°; bottom, 49°.
Water, clear.

Fish taken, bluegills, herring, large-mouth, small-mouth and calico bass, sunfish, grass and gar pike. All good size, fat, plump and well fed. Recommend for planting, black bass, wall-eyed pike and eels.

Michigan Center Ponds, Napoleon Township:
Length, 2⅓ to 3 miles; width, 1¼ miles; greatest depth, 42 feet.
Shores, mostly high and sandy, marshy in a few places.
Bottom, soft and muddy in places, in others hard sand and marl.
Inlet and outlet, Grand river.
Dates of examination, August 24, 25, 26 and 27.
Weather, clear.
Temperature—surface, 75°; bottom, 68°.
Water clear in some places, dark and muddy in others.
Fish taken, perch, bluegills, calico, large-mouth and small-mouth bass, warmouth, mullet, bullhead, gar pike. Short bill pike and dogfish. In some of the ponds the fish were fair size and fat; in others small.
Would recommend wall-eyed pike and eels.

Little Wolf Lake, Napoleon Township:
Length, ¾ mile; width, ½ mile; greatest depth, 50 feet.
Bottom, hard sand.
Inlet and outlet, Grand river.
Dates of examination, August 28 and 29.
Weather, clear.
Temperature—surface, 75°; bottom, 49°.
Water, dark.
Fish taken, bluegills, bullheads and sunfish; fat, fair size and plump.
Would not recommend planting in this lake.

Wolf Lake, Napoleon Township:
Length, 1¾ miles; width ¾ miles; greatest depth. 40 feet.
Shores, very high on the north,; on the east and west, marsh.
Bottom, hard sand marl.
Inlet and outlet, Grand river.
Dates of examination, August 27, 28, 29 and 30.
Temperature—surface, 87°; bottom, 58°.
Water, clear.
Fish taken, bluegills, bullheads, grass and gar pike, large-mouth bass, and dogfish; all fine, plump and exceedingally fat.
Would recommend wall-eyed pike and bass for planting.

Barry County.

Tupper Lake, Woodland Township:
Length, ½ mile; width, ½ mile: greatest depth, 37 feet.
Shores, marshy all around the lake, north and south wooded; east and west, cleared land.
Bottom: marl.
Inlet and outlet, a tributary of Grand River.
Date of examinatiou, Aug. 27.
Temperature—surface, 69°, bottom, 48°.

The water in this lake is very dark. The lake contains the same kind of fish as lake Odessa, and the only means of getting on this lake is through the outlet which empties into lake Odessa.
No recommendation as to future planting.

Barry and Ionia Counties.

Lake Odessa, Woodland and Odessa Townships:
Length, 3 miles; width, 1 mile; greatest depth, 53 feet.
Shores, sandy, surrounded by rushes. The banks are low and wooded nearly all around the lake.
Bottom hard, sand and clay.
Inlet and outlet a tributary of Grand river.
Dates of examination, Aug. 25, 26 and 27.
Weather, clear.
Temperature—surface, 69°, bottom, 51°.
Fish taken, bluegills, bullheads and perch.
The fish were large and well fed.
Recommend wall-eyed pike and eels for future planting.

Barry County.

Thornapple Lake, Castleton and Hastings Townships:
Length, 3 miles; width, ¾ miles; greatest depth, 33 feet.
Shores marshy; wooded on north and west.
Bottom, hard and sandy, gravel near inlet and outlet.
Inlets, Thornapple river and Mud creek.
Outlet, Thornapple river.
Dates of examination, Aug. 28, 29 and 30.
Weather, clear.
Temperature—surface, 70°, bottom, 59°.
Fish taken, bluegills, sunfish, bullheads, perch, warmouth, speckled bass, suckers and dogfish.
The bluegills, sunfish and perch were very small but fat and hard.
Recommend wall-eyed pike, black bass and eels for future planting.

Barlow Lake, Yankee Springs Township:
Length, 2 miles; width, ¼ mile; greatest depth, 62 feet.
Shores, sandy and gravelly on every side.
Bottom, hard in south part; north covered with decayed vegetable matter.
Inlet, springs; outlet, a tributary to Kalamazoo river.
Date of examination, September 5 and 6.
Weather, 5th rainy; 6th, clear.
Temperature—surface, 70°; bottom, 43°.
Fish taken, bluegills and perch. The fish were fair size and well fed.
Recommend eels and bass for future planting.

Gun Lake, Yankee Springs Township:
Length, 3½ miles; width, 2⅓ miles; greatest depth, 57 feet.
Shores, sandy and gravelly, generally, except the west lake which has marshy shores.
Bottom, hard sand or gravel and marl; rocky in several places.

Inlets, several spring brooks not named; outlet, Gun river; a tributary of the Kalamazoo river.
Dates of examination, September, 1, 2, 3, 4, 5, 6, 7 and 8.
Weather, clear except on 6, 7 and 8, rainy.
Temperature—Surface, 67°; bottom, 53°.
Fish taken, black bass, gar pike, small-mouth bass, bluegills, herring, perch, calico bass and bullheads.
The fish were large and well fed.
Recommend wall-eyed pike, white bass and eels for future planting. There are now plenty of black bass in this lake.

Cobb Lake, Yankee Springs Township:
Length, 80 rods; width, 80 rods; greatest depth, 40 feet.
Shores, sand and gravel; bottom, hard.
Inlet, a small stream with no name; outlet, a tributary to Thornapple river.
Date of examination, September 6.
Weather, clear.
This lake is quite small but the water is clear. It is said to contain sunfish, perch, bullheads and large-mouth bass. No recommendation as to planting.

Clear Lake, Johnston Township:
Length, ¾ mile; width, 20 rods; greatest depth, 15 feet.
Shores, sandy and hard except on the northern point.
Bottom, sand and gravel.
Inlet, a small stream with no name; outlet, a tributary of the Thornapple river.
Date of examination, September 12.
This lake has been drained until fifteen feet is its maximum depth. A channel about three rods wide through the lake is from three to fifteen feet deep. No recommendation as to planting.

Big Cedar Lake, Hope Township:
Length, one mile; width, 80 rods; greatest depth, 33 feet.
Shores, full of springs; back one or two rods the banks are high and hard.
Bottom, sand and gravel.
Inlets, springs along the shores, and streams from springs farther away; outlets, Cedar creek into Thornapple river.
Dates of examination, September 11 and 12.
Weather, clear.
Temperature—surface, 67°; bottom, 54°.
Fish taken, perch, bullheads, rock bass, bluegills, calico bass and sunfish. The fish were large and in fine condition. Recommend wall-eyed pike, black and white bass, for future planting.

Bristol Lake, Johnstown Township:
Length, 1 mile; width 100 rods; greatest depth, 55 feet.
Shores, low and marshy all around the lake, but a few rods away the banks are high.
Bottom, marsh.
Inlet and outlet, Highbank creek.

Dates of examination, Sept. 12 and 13.
Temperature—surface, 65°; bottom, 48°.
Water, dark.
Fish taken, bluegills, suckers and perch, all in good condition and showing good growth.
Recommend wall-eyed pike, black bass and eels.

Wall Lake, Hope Township:
Length, 1¼ miles; width, ½ mile; greatest depth not stated.
Shores, hard except on the southwest where they are marshy.
Bottom, hard except the southwest part.
No inlet or outlet.
Dates of examination, Sept. 10, 11, 12 and 13.
Weather, clear.
Temperature—surface, 69°; bottom, 64°.
Fish taken, perch and bullheads. The fish were of large size and in good condition.
Recommend eels for future planting.

Fine Lake, Johnston Township:
Length, 1 mile; width, ⅓ mile; greatest depth, 48 feet.
Shores, sandy.
Bottom, sand and gravel except on the east where it seems to consist of sediment.
Inlet and outlet, Highbank creek.
Dates of examination, Sept. 13 and 14.
Weather, clear.
Temperature—surface, 68°; bottom, 49°.
Fish taken, bluegills, bullheads, sunfish and rock bass.
The fish were small but in good condition.
Recommend eels for future planting.

Pleasant Lake, Barry Township:
Length, ¾ mile; width, ¾ mile; greatest depth, 27 feet.
Shores, sandy on south; marshy on north.
Bottom, hard.
No inlet or outlet.
Dates of examination, September 14 and 15.
Temperature—surface, 68°; bottom, 59°.
Fish taken, bullheads, perch and bluegills; all of good size and in good condition.
No recommendation as to future planting.

Long Lake, Hope Township:
Length, 3 miles; width, ¼ mile; greatest depth, 45 feet.
Shores, marshy on the northwest; sandy on the south.
Bottom, marl on the south and sand and gravel in most of the northern part.
Inlet, none; outlet, a tributary to Thornapple river.
Dates of examination, September 15 and 16.
Weather, clear.
Temperature—surface, 66°; bottom, 55°.
Water, clear.

Fish taken, bluegills, sunfish, bullheads and perch. The fish were well fed and showed large growth.
Recommend wall-eyed pike for future planting.

Eaton County.

Pray's Lake, Eaton Rapids Township:
Length, 30 rods; width, 20 rods; greatest depth, 12 feet.
Shores, marshy; bottom, soft.
Inlets, none; outlet, a tributary of Thornapple river.
Date of examination, August 23.
This is nothing but a small pond of water and amounts to nothing.

Sobby Lake, Sunfield Township:
Length, ¾ mile; width, ¾ mile; greatest depth, 20 feet.
Shores, low and marshy; bottom, black muck.
Inlet and outlet, Mud creek.
Date of examination, August 24.
This lake does not amount to anything for stocking. It is nothing but a big flat covered with water. They catch grass pike, bluegills, bullheads and very few bass.

Ingham County.

Lowe Lake, Stockbridge Township:
Length, 100 rods; width, 80 rods.
Shores, marshy and low entirely around the lake.
Bottom, mud.
Inlet, none; outlet, Turtle creek.
This lake is surrounded by swamp, and has been lowered so that it amounts to nothing for stocking.

Jackson County.

Gillett Lake, Leoni Township:
Length, 1½ miles; width, ¾ mile; greatest depth, 22 feet.
Shores, low and marshy; the surrounding country high and rolling with sandy and clay soil.
Bottom, on the east near shore hard; the balance of the lake is soft and covered with weeds and grass.
Inlet, a small spring brook headed by springs and flowing about 80 rods, emptying into the lake on the east side; outlet, quite a large stream flowing south-west into Grand river.
Dates of examination, June 13 and 14.
Weather, clear the 13th, cloudy on the 14th.
Temperature—surface, 76°; bottom, 62°.
Water, dark.
Fish taken, gar pike and sunfish; the fish were very small but well fed. Would recommend nothing but eels.

Jackson and Washtenaw Counties.

Clear Lake, Parma and Sylvan Townships:
Length, ¾ mile; width, ½ mile; greatest depth, 25 feet.
Shores, high, gravel and sandy; wooded on south, north and a part of the east.
Bottom, hard gravel near shore, clay through the center.
Inlets, none; outlet, a small stream on the southeast side, a tributary to Grand river.
Dates of examination, June 20 and 21.
Weather, rainy.
Temperature—surface, 75°; bottom, 63°.
Water, clear.
Fish taken, bluegills, sunfish, perch and large-mouth bass. The bluegills were large, the perch and bass small but fat, plump and hard. Would recommend eels and black bass for future planting.

Livingston County.

Indian Lake, Deerfield Township:
Length, 1½ miles; width, ¼ mile; greatest depth, 20 feet.
Shores, marshy nearly all around the lake; bottom, soft and muddy.
Inlet and outlet, Yellow river.
Date of examination. July 31.
This lake is simply the wide water of Yellow river made by daming at Deerfield. It is in the center of a tamarack swamp and is entirely inaccessible to any but the two or three families on its banks.
Not recommended for future planting.

Rumyen Lake, Tyrone Township:
Length, ¾ mile; width, ½ mile; greatest depth, 15 feet.
Shores, marsh except on the south; bottom, soft mud.
Inlet, a small stream not named.
Outlet, a tributary of Shiawassee river.
Date of examination, July 31.
This lake is surrounded by marsh except on the south; there are rushes and weeds on every part of the lake.
Not recommended for future planting.

Leonard Lake, Deerfield Township:
Length, ⅓ mile; width, ¼ mile; greatest depth, 34 feet.
Shores, low and marshy; bottom, soft.
Inlets, a small stream from the south, not named, and Cranberry creek.
Outlet, Cranberry creek, a tributary of Shiawassee river.
Date of examination, July 31.
Temperature—surface, 76°; bottom, 52°.
This lake is inaccessible from any point; it is entirely surrounded by swamps, and mud from 2 to 4 feet deep. It contains perch, grass pike, large-mouth bass and bluegills, but they do not grow to very large size.
No recommendation as to future planting.

Long Lake, Genoa Township:
Length, 2 miles; width, ¾ mile; greatest depth, 68 feet.
Shores, bold except on the east where they are low.
Bottom, south end covered two feet deep with mud.
Inlet, none; outlet, Cranberry creek.
Dates of examination, August 2, 3 and 4.
Weather, clear.
Temperature, surface 78°, bottom, 46.
Fish taken, sunfish, bluegills, grass pike, large-mouth bass, small-mouth bass, speckled bass, perch and bullheads.
The fish were in good condition but small.
Recommend wall-eyed pike for future planting.

Long Lake, Hartland Township:
Length, one mile; width one half mile; greatest depth, 79 feet.
Shores, bold on each side; bottom hard.
Inlet, Maxfield creek; outlet, Ore creek.
Dates of examination, August 4 and 5.
Weather, rainy and windy.
Temperature— surface, 77°; bottom 42°.
Water, clear.
Fish taken, bullheads, sunfish, small-mouth bass and rock bass.
The fish were in fairly good condition.
Recommend, wall-eyed pike, eels and black bass for future planting.

Maxfield Lake, Hartland Township:
Length, ¼ mile; width, ¼ mile; greatest depth, 60 feet.
Shores, high on the north and south; low on the east; on the west a black ash swamp; wooded on the north.
Bottom, hard all round near the shore; center of lake soft marl.
Inlet, none; outlet a small stream running into Long lake.
Dates of examination, August 4 and 5.
Weather, 4th rainy; 5th clear.
Temperature—surface, 78°; bottom, 42°.
Fish taken—herring, bluegills and grass pike.
The fish were in good condition and showed good growth.
Would not recommend for planting as there are plenty of native fish in this lake.

Island Lake, Green Oak Township:
Length, one mile: width, ½ mile; greatest depth, 27 feet.
Shores, gravelly; banks, high.
Bottom, hard.
No inlet or outlet.
Dates of examination, August 6 and 7.
Weather, clear.
Temperature—surface, 79°; bottom, 69°.
Fish taken, perch and bluegills. The fish were in poor condition. Recommend eels for future planting.

Fonda Lake, Brighton and Green Oak Townships:
Length, ½ mile; width, ¼ mile; greatest depth, 35 feet.
Shores, gravelly; banks, high; bottom, soft.
No inlet or outlet.

Dates of examination, August 6 and 7.
Weather, clear.
Temperature—surface, 78°; bottom, 64°.
Fish taken, bluegills. The fish were good size but in poor condition. Recommend eels for future planting. This lake has been stocked by people from Brighton with whitefish, wall-eyed pike and lake trout, but the water is too shallow and too warm for anything but native fish, unless eels would do well.

trawberry Lake, Hamburg Township.
Length, 1 mile; width, ¾ mile; greatest depth 45 feet.
Shores, marshy.
Bottom, mostly soft.
Inlet and outlet, Huron river.
Weather, clear.
Temperature—surface, 74°; bottom, 48°.
Water, reddish.
Fish taken, bluegills, bullheads and mullet. The fish showed good growth, and were well fed.
Recommend, carp, eels and wall-eyed pike for future planting.

arner Lake, Brighton Township:
Length, 60 rods; width, 60 rods; greatest depth, 18 feet.
Shores, low.
Bottom, soft.
Inlet, none; outlet, a small stream running through Woodruff lake.
Date of examination, August 8.
Weather, clear.
Temperature—surface, 75°; bottom, 60°.
Water, dark.
This lake has been drained by ditches so it does not cover more than 20 acres, and is entirely surrounded by marsh.
No recommendation as to future planting.

each Lake, Brighton Township:
Length, ¼ mile; width, ¼ mile; greatest depth, 20 feet.
Shores, marshy; bottom, soft.
No inlet or outlet.
Date of examination, Aug. 8.
Weather, clear.
Temperature—surface, 75°; bottom, 60°.
Water, dark.
This lake is not accessible from any road, and is marshy on east, west, and south. The water is dark. The bottom is entirely covered with vegetation. It contains bluegills, perch, rock bass, and bullheads.
No recommendation as to future planting.

leasant Lake, Hamburg Township:
Length, ½ mile; width, ¼ mile; greatest depth, 54 feet.
Shores, on the north and south, high; banks, high; wooded on the south and west, also about 20 rods on the east. Gravelly and sandy, rocky in places. Rushes extend along the edge of the water nearly around the lake.
Bottom, hard; covered with moss.
No inlet or outlet.

Dates of examination, August 8 and 9.
Weather, clear.
Temperature—surface, 79°; bottom, 48°.
Fish taken, bullheads, rock bass, sunfish and bluegills. The fish showed very large growth. No recommendations as to planting.

Orr Lake, Hamburg and Green Oak Townships:
Length, one mile; width, one mile; greatest depth, 55 feet.
Shores, low banks; on the west, marshy; on the east, marshy; and on the north and south high banks and gravelly.
Bottom, soft.
Inlet, Ore creek; outlet, Huron river.
Dates of examination, August 7, 8 and 9.
Weather, clear.
Fish taken, strawberry bass, herring, grass pike, gar pike, bullheads, sunfish and black bass. The herring were of large size but poor; grass pike in fair condition, good growth; sunfish and bass, small. No recommendation as to planting.

Big Lake, Green Oak Township:
Length, ¼ mile; width, ¼ mile; greatest depth, 22 feet.
Shores, gravelly.
Bottom, marl.
Inlet and outlet, Davis creek,
Date of examination, August 10.
Weather, clear.
Temperature—surface, 78°; bottom, 60°.
This is one of a chain of lakes along Davis creek and does not amount to anything.

Nitchwage Lake, Green Oak Township.
Length, 1 mile; width, ¼ mile; greatest depth, 25 feet.
Shores, low and marshy.
Bottom, mud.
Date of examination, August 10.
Weather, clear.
Temperature—surface, 77°; bottom, 60°.
This lake is one of the chain on Davis creek and is inaccessible.
No recommendation as to planting.

Crooked Lake, Green Oak Township.
Length, ½ mile; width, ¼ mile; greatest depth, 16 feet.
Shores, marshy.
Bottom, soft.
Inlet and outlet, Davis creek.
Date of examination, August 10.
Weather, clear.
Temperature—surface, 77°; bottom, 61°.
Water, clear.
This lake is located in a big swamp. It is marshy all around. Davis creek runs through it and connects a chain of lakes, none of which amount to anything.
No recommendation as to planting.

Silver Lake, Hamburg Township:
Length, ¾ mile; width, ½ mile; greatest depth, 40 feet.
Shores, bold; high land all around the lake.
Bottom, from 1 to 1½ feet of mud.
No inlet or outlet.
Dates of examination, Aug. 12 and 13.
Weather, clear.
Temperature—surface, 76°; bottom, 56°.
Water, clear.
Fish taken, bullheads, bluegills, sunfish, perch, rock bass, and large-mouth bass.
The fish showed large growth and are well fed.
Recommend eels and carp for future planting.

Livingston and Washtenaw Counties.

Whitmore Lake, Green Oak and Northfield Townships:
Length, 2 miles; width, 1 mile; greatest depth, 55 feet.
Shores, bold; banks high except at extreme northern point.
Bottom, hard, covered with vegetation.
No inlet or outlet.
Dates of examination, Aug. 9, 10 and 11.
Weather, clear.
Temperature—surface, 77°; bottom, 70°.
Fish taken: bullheads, sunfish, perch, large-mouth bass and rock bass.
The fish taken were small, except large-mouth bass, which showed good growth.
Recommend eels for future planting.

Big Portage Lake, Putnam and Dexter Townships:
Length, 1½ miles; width, ¾ mile; greatest depth, 75 feet.
Shores, gravelly; on the east, high banks.
Bottom, hard.
Inlet, a stream from the north with no name.
Outlet, a tributary of Huron river.
Dates of examination, Aug. 13 and 14.
Weather, clear.
Temperature—surface, 77°; bottom, 48°.
Water, clear.
Fish taken: herring and gar pike, which show good growth.
Not recommended for planting. The lake contains all we could supply except trout.

Base Lake, Hamburg and Webster Townships:
Length, 1 mile; width, ¾ mile.
Shores, high banks on northeast and southwest; southeast and northwest low and swampy.
Bottom, around shore is hard and sandy; through deep water is soft, with moss and vegetation.
Inlet and outlet, Huron river.
Dates of examination, Aug. 12, 13 and 14.
Weather, clear.
Temperature—surface, 73°; bottom, 51°.

Water, dark.
Fish taken, whitefish, bluegills, sunfish, grass pike and bullheads.
The fish were large and in good condition.
No recommendation as to future planting. This lake contains every variety we can furnish, except trout.

Oakland County.

Lakeville Lake, Addison Township:
Length, one mile; width, ½ mile; greatest depth, 26 feet.
Shores, marshy on every side.
Bottom, muddy.
Inlet and outlet, Stony creek.
Date of examination, July 23.
This lake is virtually a millpond made by damming Stony creek. It is all grown up with weeds, there being but very little open water. It is covered with stumps, logs, roots and grass. No recommendations as to future planting.

Black Walnut Lake, West Bloomfield Township:
Length, 1½ miles; width, one mile; greatest depth, 97 feet.
Shores, high and bold: rock, sand and clay except about 40 rods of marsh on the northeast near the inlet.
Bottom, hard sand and clay; rocky through a great portion of the lake.
Inlets, two small brooks with no names, emptying in on the north; outlet, one small outlet on the west side empties into a tributary to Rouge river.
Dates of examination, June 24, 26 and 27.
Weather, clear on 24 and 25, cloudy on 26.
Temperature—surface, 78°; bottom, 44°.
Water, clear.
Fish taken, whitefish, lake trout, bluegills, rock bass, perch, grass pike and wall-eyed pike. The fish were in good condition but small, except the perch which were very large. Almost any kind of fish will do well in this lake.

Walled Lake, Commerce and Novi townships:
Length 1½ miles; width, 1 mile; greatest depth, 51 feet.
Shores, high, sand, gravel and clay, with very little timber near the shore.
Bottom, sandy except in deep water where there is more clay than sand, but it is very hard.
Inlets, none visible; outlet, one small stream flowing into the river Rouge.
Dates of examination, June 23, 24, and 25.
Weather, 23, clear; 24, rainy, 25, clear.
Temperature—Surface, 82°; bottom, 48°.
Water, clear.
Fish taken, grass pike, bluegills, black bass, perch, striped bass, rock bass, bullheads and suckers.
The fish were very hard and fat and showed large growth.
Would recommend bass, eels and wall-eyed pike, for future planting.

Orchard Lake, West Bloomfield Township:
Length, 1½ miles; width, 1½ miles; greatest depth, 96 feet.
Shores, gravel and sand except about 80 rods on the northwest.
Bottom, gravel and sand in shallow water and on shoals; clay or marl in deep water.
Inlet, one which is the outlet of Pine lake; outlet, one which empties into Cass lake.
Dates of examination, June 28, 29, 30, and July 1.
Weather, rainy on June 28 and July 1, clear on July 29 and 30.
Temperature—surface, 80°; bottom, 46°.
Water, clear.
Fish taken: black bass, grass pike, sunfish, bluegills, bullheads, perch, rock, large-mouth and striped bass. Fish were very large, well fed, and show great growth. Recommend wall-eyed pike and lake trout for future planting.

Pine Lake, West Bloomfield Township:
Length, 1 mile; width, ½ mile; greatest depth, 80 feet.
Shores, high, sand and gravel; timber in small patches around the lake.
Bottom, soft black mud, except near shore there is sand or gravel with weeds and rushes.
Inlet, none; outlet, one, which flows into Orchard lake.
Dates of examination, June 29 and 30, and July 1 and 2.
Weather, June 29, 30 and July 2, clear; July 1, rainy.
Temperature—surface, 80°; bottom, 53°.
Water, clear.
Fish taken: grass pike, bluegills, sunfish, perch, rock bass and black bass.
The fish were small, but in fair condition.
Bass, eels and wall-eyed pike may live here, but I think the bottom is too muddy.

Cass Lake, West Bloomfield Township:
Length, 3 miles; width, 1 mile; greatest depth, 115 feet.
Shores, high banks, gravel very little marsh on south, east and northeast; timber on the east and south.
Bottom, sand, marl, clay, gravel and rocky in several places.
Inlets, Clinton river and the outlet of Orchard lake; outlet, Clinton river.
Dates of examination, July 1, 2, 3 and 4.
Weather, 1, rain; 2, 3 and 4, clear.
Temperature—surface, 79°; bottom, 46°.
Water, clear.
Fish taken, black bass, rock bass, grass pike, gar pike, sunfish, bluegills, herring and bullheads.
The fish were large and well fed and showed large growth.
Would recommend lake trout and wall-eyed pike for future planting.

Elizabeth Lake, Waterford Township:
Length, one mile; width, ½ mile; greatest depth, 71 feet.
Shores, high, sand and clay banks. The shore is gravel nearly all around the lake, with timber on the east end.
Bottom, mostly hard sand and clay; gravel and sand near shore.
Dates of examination, July 5 and 6.

Weather, 5, clear; 6, cloudy.
Temperature—surface, 78°; bottom, 48°.
Water, clear.
Fish taken, herring, whitefish, long jaws, black bass, rock bass, sunfish, bluegills, grass pike and perch. The fish taken were hard, well fed and showed large growth. Would recommend wall-eyed pike and lake trout for future planting.

Upper Straits Lake, West Bloomfield Township:
Length, 1¾ miles; width, ¼ mile; greatest depth, 48 feet.
Shores, high, gravel and sand with clay banks; shore, hard gravel and sand.
Bottom, hard sand; marl and clay with gravel near shore.
Inlet, none; outlet, one into Middle Straits lake. These lakes are the headwaters of Huron river.
Dates of examination, July 6 and 7.
Weather, 6, cloudy; 7, clear.
Temperature—surface, 75°; bottom, 45°.
Water, clear.
Fish taken, black bass, rock bass, sunfish, bluegills, grass pike, perch and gar pike. The black bass are the nicest I have ever taken. All the fish taken were hard, well fed and large. Would recommend lake trout and wall-eyed pike for future planting, and some herring for food for the trout.

Green Lake, West Bloomfield township:
Length, 1 mile; width, ½ mile; greatest depth, 65 feet.
Shores, high, sandy and gravelly; timbered except on west and a little on the northwest side.
Bottom, hard clay and sandy.
Inlet, none; outlet, a small stream into Union lake.
Dates of examination, July 7 and 8.
Weather, clear.
Temperature—surface, 76°; bottom, 46°.
Water, clear.
Fish taken, perch, grass pike, bluegills, sunfish, rock bass, and black bass.
The fish were large and well fed.
Would recommend lake trout, wall-eyed pike and black bass, for future planting.

Union Lake, West Bloomfield and Commerce Townships:
Length, 1¼ miles; width, ¼ mile; greatest depth, 102 feet.
Shores, high; bottom, hard. Rushes extend into the water eight or ten rods; woods on the southwest, northeast and southeast.
Inlet, none; outlet, one; a small stream flowing southwest into the Huron river.
Dates of examination, July 7 and 8. Weather clear.
Temperature—Surface, 77°; bottom, 46°.
Water, clear.
Fish taken, perch, black bass, gar pike, grass pike, bluegills and sunfish. The fish were large and well fed.
Would recommend lake trout, wall-eyed pike and black bass for future planting.

Commerce Lake, Commerce Township:
Length, 1 mile; width, ½ mile; greatest depth, 65 feet.
Shores marshy and flat; sand and gravel near water's edge.
Bottom, soft generally; a few places near the islands are hard.
Inlet, the Huron river.
Outlet, the Huron river.
Dates of examination, July 8, 9, and 10.
Weather, clear and windy.
Temperature—surface, 76°; bottom, 50°.
Water, dark.
Fish taken, herring, bluegills, bullheads and gar pike.
The herring showed good growth, hard and well fed; bluegills small but well fed.
Would not recommend anything for this lake. The fish have free access to all the lakes along the Huron river.

White Lake, Highland and White Lake Townships.
Length, 1½ miles; width, ¾ of a mile; greatest depth, 25 feet.
Shores, high, sandy and gravelly; wooded in places.
Bottom, generally soft, except near the islands where it is rocky.
Inlet, none; outlet, none except an artificial outlet into Duck lake.
Dates of examination, July 10,.11 and 12.
Weather, clear.
Temperature—surface, 82°; bottom, 73°.
Fish taken, bullheads, large-mouth bass, rock bass, perch and sunfish.
The large-mouth showed good growth; the others were small.
This lake is now well stocked with native fish; would not recommend future planting.

Watkins Lake, Waterford Township:
Length, 1¾ miles; width, ⅓ miles; greatest depth, 28 feet.
Shores, high and gravelly; no marsh.
Bottom, generally hard.
No inlet or outlet.
Dates of examination, July 12, 13 and 14.
Weather, clear.
Temperature—surface, 80°; bottom, 71°.
Water, clear.
Fish taken, bullheads, bluegills, perch, rock bass, large-mouth bass, dog-fish, sunfish and small-mouth bass.
Each variety taken showed good growth and were very plentiful.
Not recommended for planting as native fish are very plentiful here.

Scott Lake, Waterford Township:
Length, ½ mile; width, ¼ mile; greatest depth, 35 feet.
Shores, high, sandy and gravelly.
Bottom, generally hard.
No inlet or outlet.
Dates of examination, July 13 and 14.
Weather, clear.
Temperature—surface, 77°; bottom 59°.
Water, clear.
Fish taken, perch, sunfish, bluegills, rock bass and large-mouth bass.
The fish showed good growth and well fed.
Not recommended for future planting.

Mace Day Lake, Waterford Township:
Length, 1½ miles; width, ½ mile; greatest depth 115 feet.
Shores, north and south marshy; rushes extending into lake; east and west high bluffs.
Bottom, generally hard.
Inlet, none; outlet, a tributary of the Huron river.
Dates of examination, July 14 and 15.
Temperature—surface, 81°; bottom, 42°.
Water, clear.
Fish taken, herring, bluegills, perch, rock bass, sunfish and gar pike.
The fish showed good growth and were well fed. Owing to a great amount of spearing fish are scarce.
Would recommend black bass, lake trout and wall-eyed pike for future planting.

Loon Lake, Waterford Township:
Length, 1 mile; width, ½ mile; greatest depth, 65 feet.
Shores, on the south and west marshy, on the northeast hard, on the northwest marshy; mostly high ground except on the east and west.
Inlet and outlet, Clinton river.
Date of examination, July 15.
Water, clear.
Temperature—surface, 84°; bottom, 52°.
This is practically a mill-pond. It has been raised about six feet, and is connected with Silver lake by an artificial canal. No nets were set. They catch grasspike, perch, bluegills, large-mouth bass, sunfish, bullheads and rock bass.
Not recommended for future planting.

Silver Lake, Waterford and Pontiac Townships:
Length, ¾ mile; width, ½ mile; greatest depth, 70 feet.
Shores, generally sandy; timbered on the south and a small portion of the north.
Bottom, sand and marl.
Inlet, none; outlet, an artificial opening into Loon lake.
Dates of examination, July 15 and 16.
Temperature—surface, 80°; bottom, 42°.
Water, clear.
Fish taken, herring, bluegills, sunfish, perch and black bass.
The fish showed good growth.
Not recommended for future planting.

Cedar Island Lake, Whitelake Township:
Length, 1 mile; width, ¾ mile; greatest depth, 70 feet.
Shores, marshy; entirely surrounded by tamarack swamps.
Bottom, marl.
Inlet and outlet, Huron river.
Date of examination, July 16.
Water, clear.
Temperature—surface, 87°; bottom, 38°.
This lake has good water, but it is entirely surrounded by tamarack swamps, and is not accessible from any road without crossing private fields. It is said to contain all the different varieties of native fish.
Not recommended for future planting.

Long Lake, Whitelake Township:
Length, ¾ mile; width, ⅛ mile; greatest depth 40 feet.
Shores, marshy; surrounded by tamarack swamp.
Bottom, mud.
Inlet and outlet, Huron river.
Date of examination, July 16.
Weather, clear.
Temperature—surface, 80°; bottom, 49°.
Water, clear.
No nets were set in this lake. It is said to contain large and small-mouth bass, grass pike, bluegills and sunfish. Not recommended for future planting.

Oxbow Lake, Whitelake Township:
Length, 1¼ miles; width, ¾ mile.
Shores, high bluffs on the west, north and east; south, low and marshy.
Bottom, mud.
Inlet and outlet, Huron river.
Date of examination, July 16.
Weather, clear.
Temperature—surface, 76°; bottom, 43°.
Water, clear.
No nets were set. This lake contains billfish, grass pike, eels and bass. Not recommended for future planting.

Three Mile Lake, Waterford and Pontiac Townships:
Length, 2½ miles; width, 1 mile; greatest depth, 90 feet.
Shores, high, except on the southeast at its outlet.
Bottom, hard, stony and gravelly.
Inlet, a spring brook; outlet, one, through Schoolhouse, Joe Smith, and Upper Three Mile lakes into Clinton river.
Dates of examination, July 18 and 19.
Weather, clear.
Temperature—surface, 78°; bottom, 44°.
Water, clear.
Fish taken, black bass, herring, perch, large-mouth bass, bullheads, rock bass, gar pike, sunfish, and pickerel.
The fish taken were hard and in good condition.
Recommend wall-eyed pike, lake trout and eels for future planting.

Vorhees Lake, Orion Township:
Length, 1 mile; width, ½ mile; greatest depth, 70 feet.
Shores, high bluffs on north and south; low on east and west; rushes extend into the water from every side.
Bottom, hard.
Inlet, a small stream from Lake Sixteen; outlet, Clinton river.
Dates of examination, July 19 and 20.
Weather, clear.
Temperature—surface, 71°; bottom, 49°.
Water, clear.
Fish taken, rock bass, bluegills, black bass, bullheads, gar pike and perch.
Fish are very plentiful and show large growth. Black bass appear to be plentiful.
Recommend wall-eyed pike and eels for future planting.

Orion Lake, Orion Township:
Length, 2 miles; width, 1½ miles; greatest depth, 75 feet.
Shores, bold and timbered except on the east and south.
Bottom, generally hard.
Inlet, a stream connecting a chain of lakes, called Paint creek.
Outlet, Paint creek.
Dates of examination, July 21, 22 and 23.
Weather, clear.
Temperature—surface, 77°; bottom, 46°.
Water, dark.
Fish taken, bluegills, rock bass and bullheads.
The fish were of small growth. Food is scarce in the lake.
Recommend black bass and eels for future planting.

Long Lake, Orion Township;
Length, 1 mile; width, ½ mile; greatest depth, 54 feet.
Shores, rocky; high banks except on the north, which is a tamarack swamp. Rushes extend into the lake from every shore.
Bottom, marl.
Inlet, none; outlet, a tributary of Stony creek.
Dates of examination, July 22, 23 and 24.
Weather, clear.
Temperature—surface, 75°; bottom, 46°.
Fish taken, rock bass, bluegills and bullheads.
The fish all show small growth and are scarce in the lake.
Recommend black bass and eels for future planting.

Stony Lake, Oxford Township:
Length, ¾ mile: width, ½ mile; greatest depth, 65 feet.
Shores, bold and rocky, except on the west where it is marshy.
Bottom, hard.
No inlet or outlet.
Dates of examination, July 24 and 25.
Weather, clear.
Temperature—surface, 75°; bottom, 46°.
Water, clear.
Fish taken, perch and shiners. The fish were very large and well fed.
Recommend black bass, eels and wall-eyed pike for future planting.

Deer Lake, Independence Township:
Length, 1½ miles; width, ½ mile; greatest depth, 60.
Shores, bold on the north and south; east and west low, gravel and sandy.
Bottom, hard clay and sand.
Inlet, one; an outlet of a chain of small lakes from the west. No name.
Outlet, a tributary of Clinton river.
Dates of examination, July 26 and 27.
Weather, clear.
Temperature—Surface, 75°; bottom, 45°.
Fish taken, herring, sunfish, rock bass, gar pike and bullheads.
The fish were hard and well fed and show good growth.
Would not recommend for planting unless protected from spearing.

Long Lake, Rose Township:
Length, 1½ miles; width, ½ mile; greatest depth, 20 feet.

Shores, high land on the east and west; low on the north and south.
Bottom, soft and covered with sediment.
No inlet or outlet.
Dates of examination, July 27, 28 and 29.
Temperature—surface, 78°; bottom, 70°.
Water, dark.
Fish taken, large-mouth bass, grass pike, bullheads, bluegills and sunfish. The bass and sunfish show large growth; the bluegills and bullheads small. Recommend eels for future planting.

Fish Lake, Rose Township:
Length, one mile; width, ½ mile; greatest depth, 17 feet.
Shores, hard sand and gravel; banks high on west, north and south; wooded on north and south.
Bottom, soft and covered with weeds.
No inlet or outlet.
Date of examination, July 30.
Temperature—surface, 77°; bottom, 69°.
This lake is said to contain bluegills, perch and large-mouth bass. Recommend eels for future planting.

Oakland and Livingston Counties.

Dunham Lake, Highland and Hartland Townships:
Length, 1 mile; width, ½ mile; greatest depth, 110 feet.
Shores, high and timbered; rocky in places.
Bottom, clay.
Inlet none; outlet, a tributary of Cornell creek. It has been stocked with brook trout.
Dates of examination, July 28, 29 and 30.
Weather, clear.
Temperature—surface, 77°; bottom, 42°.
Water, clear.
Fish taken, herring, bluegills, bullheads, suckers and perch. The fish taken were very fat but small.
Recommend wall-eyed pike, lake trout and black bass for future planting.

Washtenaw County.

Josslyn Lake, Lyndon Township:
Length, ¾ mile; width, ½ mile; greatest depth, 25 feet.
Shores, sandy, low banks.
Bottom, soft and covered with weeds.
Inlet and outlet a tributary of Huron river.
Date of examination, August 18.
Temperature—surface, 78°; bottom, 60°.
This lake is said to contain large-mouth bass, grass pike, sunfish, perch, bullheads and bluegills.
Recommend eels and carp for future planting.

Bruen Lake, Lyndon Township:
Length, ¼ mile; width, ¼ mile; greatest depth, 15 feet.
Shores, low and swampy on every side.

Bottom, soft.
Inlet and outlet a tributary of the Huron river.
Date of examination, August 18.
There is very little water left in this lake. There are no fish but bullheads, bluegills and perch.
Not recommended for future planting.

South Lake, Lyndon Township:
Length, ¾ mile; width, ⅓ mile; greatest depth, 20 feet.
Shores, marshy; high banks on the north, west and south.
Bottom, soft.
Inlet and outlet, a tributary of Huron river.
Date of examination, August 18.
Weather, rainy.
Temperature—surface, 78°; bottom, 60°.
This lake is full of rushes. There are only a few rods in the center of clear water. No fish were taken, and no recommendation made as to future planting.

North Lake, Dexter Township:
Length, 1½ mile; width, ¾ mile; greatest depth, 55 feet.
Shores, sand and gravel.
Bottom, hard.
Inlet, none; outlet, a tributary of Huron river.
Dates of examination, August 16, 17, 18, 19, 20, 21 and 22.
Weather, clear.
Temperature—surface, 74°; bottom, 61°.
Water, clear.
Fish taken, speckled bass, bullheads, bluegills and gar pike. The fish were large and in good condition. Recommend wall-eyed pike and eels for future planting.

Cavenaugh Lake, Sylvan Township:
Length, 1 mile; width, ⅓ mile; greatest depth, 25 feet.
Shores, high, sand, gravel and clay; wooded on southeast and north.
Bottom, hard, clay and gravel; rocky in spots, with boiling springs.
Inlet, none except springs; outlet, none.
Dates of examination, June 18, 19 and 20.
Weather, clear on the 18th and 19th, rainy on the 20th.
Temperature—surface, 74°; bottom, 60°.
Water, clear.
Fish taken, black bass, large-mouth bass, rock bass, strawberry bass, sunfish, perch and bluegills. The fish were in good condition, hard and showed large growth.
Would recommend black bass and eels for future planting.

The foregoing report embraces a relation of the operations of this board, covering a period of two years, and shows the effort of the commission to intelligently maintain the success heretofore realized in the work and to increase its efficiency in the future.

The data contained in this report justifies the conclusion that our work has been successful. Our inland streams have long since put at rest the question whether artificial propagation is a success. They attest in the

most undeniable manner that where conditions are favorable the ingenuity of man can cause waters to swarm with fish, which nature herself never originally stocked.

The evidence obtained from the reports of fishermen which have been returned to this office, from time to time, shows conclusively that in many localities the catch of whitefish has increased and that artificial propagation has been felt in these waters. Our great lakes, which comprise the largest bodies of fresh water on the globe, are so vast in extent, the waste in fishing was so long continued before artificial means came to the aid of nature and her methods, the contrivances for the capture of fish have been so multiplied and improved that the road to pronounced success has been long and the obstacles have been great. The gradual development of hatcheries, furnishing adequate facilities to produce large quantities of fry, has been a matter of such gradual and progressive growth, that it has only been within the past five or six years that they have furnished anything like a sufficient amount of fry wherewith we might hope to obtain substantial results. Yet the success in this direction has been fully demonstrated from many sources. In conclusion it may be said that our past experience has fully justified our hopes, and the future is full of promise.

All of which is respectfully submitted,

HERSCHEL WHITAKER.
J. C. PARKER.
HOYT POST.
Commissioners.

APPENDIX.

APPENDIX.

THE DEVELOPMENT OF THE WALL-EYED PIKE,

Stizostedion vitreum, Raf.

A POPULAR INTRODUCTION TO THE DEVELOPMENT OF BONY FISHES,

BY JACOB REIGHARD,

ASSISTANT PROFESSOR OF ZOÖLOGY IN THE UNIVERSITY OF MICHIGAN.

INTRODUCTION.

A.—*Aims and Methods.*

The following account has been made as simple and as free from technicalities as the subject seems to admit. The development of the wall-eyed pike has never before been studied, so that all the facts with regard to it that are here presented, are now printed for the first time. But many other bony fishes have been studied and in its main features development is the same in them all. It is these main features of development that are here presented and no attempt is made to discuss or to settle those points upon which original workers are still in controversy. Indeed matters of controversy are, to a large extent, excluded from the plan of the paper and only those points are presented that are agreed upon by the best modern investigators. Authorities on the subject are not cited in the text, as it is believed that an exposition of the results and opinions of various writers would only lead to the confusion of the reader. There is appended a short list of those recent writings on the subjects that are most important, and of those that are likely to be accessible to the reader. Most of the literature is in the French and German languages and in inaccessible scientific periodicals.

The drawings, most of which have been made from the living specimen,

After a stage a little later than E. is reached the use of Perenyi's fluid causes distortions of the embryo through the contraction which it causes in the muscular system. It is best then to remove the embryos from the egg shell and to kill them in a cold saturated solution of corrosive sublimate in water. After half an hour in this, they should be transferred to pure water, which should be several times changed in the course of two hours, the embryo should then be placed in 50% alcohol for one hour; in 70% alcohol two to twelve hours, and finally preserved in 96% alcohol.

The Cell Structure of Animals.

In order to understand fully the development of any animal it is necessary, first, to acquire some knowledge of the structure of animals and particularly of the animal under discussion.

It was the intention of the writer to have prepared a short account of the gross anatomy of the wall-eyed pike and to have illustrated it by drawings, in such a way that it might serve as an introduction to the study of the development of this fish. But unfortunately the time necessary for the preparation of such an account could not be afforded and it is therefore assumed for the reader that he has an elementary knowledge of how a fish or some other back-boned animal is constructed.

In its minute structure the fish, like every other animal, may be compared to a building. If we tear to pieces a building, we soon come to the individual stones or bricks or boards of which the building is made up. If we break to pieces these stones or bricks or boards, we destroy the units of which the building is composed, and we cannot again construct the building from the pieces. So too, if we take any part of the body of a fish and, putting it under the microscope, tear it into pieces with fine needles, we shall soon have separated it into certain parts which, like the bricks in a building, are the units or elements of which the fish is composed. If we tear to pieces these elements of structure we cannot conceive of their being again put together so as to make a fish, any more than we can think of a pile of broken bricks being put together to make a building.

These elements or units of which the fish is thus built up are so small that they are only to be seen by the use of the microscope; *they are called cells.* Each cell is made of a substance called *protoplasm*, a semi-fluid material looking not unlike the white of egg, though it is by no means identical with the white of egg. The minute mass of protoplasm which makes up each cell is usually enclosed in a firm covering which surrounds it like a bag. This outer covering is known as the cell wall and serves to protect the cell and to give to it firmness and its special form. In the center of the cell the protoplasm is more dense than on the surface and, if the cell be stained or dyed by using some such coloring substance as a solution of carmine or logwood, it is found that this central portion of the cell becomes more deeply colored than the other parts. In looking at a cell that has been thus stained the central part is by far the most conspicious part of it. This central, easily-staining part of the cell is called the nucleus. In Figure 21, Plate III is shown a thin section through a fish egg at a very early stage and in this the cells may be seen. On the right of the figure the parts of a cell have been indicated by explanatory letters and the same parts may be recognized in the adjacent cells. The same parts are shown in the diagram, Figure 13, B.

We are to think of the fish as made up of cells, as the building is made up of bricks, only that each cell is very small and much more complex than a brick, being made up usually of the three parts, cell protoplasm, cell wall and nucleus. These cells are fitted together to make the fish much as the bricks are fitted together to make the building. Yet there is this important difference between the two. The bricks are made up of non-living material and require to be put together, while the cells are made of living protoplasm and fit themselves together and adapt themselves to the particular work that is required of them in the body of the fish. Just as the wood that is to be used in making a building is sawn into shingles, laths, siding and flooring, according to the part of the building that is to be made of it and the work that it must do there, so the cells are of different forms and of different sizes, according to the part of the fish that is to be made from them, and according to the work that they must do. Thus certain of the cells on the surface are flat and joined together by their edges, and are horny and hard. These cells form a protective covering for the surface of the animal and are known as epidermal cells. Other cells have long branching processes, like roots running out from them, and the spaces between these processes and between the cells are filled with hard lime-salts so as to form a very firm mass in which the cells lie embedded like the plums in a pudding. Such a mass is a bone and the cells are bone cells. Other cells are spindle shaped or cylindrical and very long and are able to shorten themselves, as a piece of stretched india rubber does when it is let go. These are known as muscle cells and by shortening and lengthening they cause the movements of the animal. Taken together they form the muscular system of the fish. Other cells, composing the central nervous system, are connected by means of long, slender processes known as nerve fibres, either to the surface of the animal's body, or to some of its muscles, or to one of its special sense organs, as eye or ear. If anything irritates the surface, an impulse is sent along one of these nerve fibres to the cells with which the fibre is connected; from this cell, or some other, a second impulse is sent to a muscle; the muscle contracts and moves the fish away from the irritation. This whole system of nerve cells and nerve fibres makes up the nervous system of the animal. And so there are other sorts of cells making up other systems, as the digestive system, the excretory system and the reproductive system.

How does a young fish begin? We shall be helped in answering this question if we turn again to our simile of the building. We may imagine a single brick to be able to detach itself from the rest of the building and to be able to grow. When such a detached brick has grown to twice its original size, suppose it to divide into two bricks, and let each of these again grow and divide until there is a large number of bricks, all formed from the single original brick. We may suppose, further, that as the bricks increase in number, they adapt themselves to special purposes. Some may be thought to form mortar about themselves and, by arranging themselves, to give rise to the walls of the building. Others may be thought of as flattening themselves out to form tiles for the roof and floors. And so it is possible to think of an entire building as originating by the continued division of a single brick, together with the adaptation to special purposes of the products of this division.

However fanciful this picture may appear to be when applied to a building, it is, nevertheless, when applied to a fish, literally true. The fish

ns as a single cell; by the division of this cell there is formed a multi- of cells, each of which adapts itself to the special work that it has to nd becomes muscle cell, nerve cell, or bone cell, as may be required. single cell is known as the *fertilized ovum*.

'e have imagined the brick in the illustration to be derived from a le building. The fertilized ovum is not, however, derived from a e fish, but is formed by the union of two cells, derived from two dis- t fish. One of these cells is known as the ovum and is derived from nale fish, while the other is known as the spermatozoön and is derived 1 the male fish. It is as if the brick, by the division of which we imagined a building to be formed, were itself to be first formed by union of two bricks, derived from two distinct buildings.

PART I.

he Ovum and Spermatozoön, and their History until Segmentation Begins.

he ova of animals are to be considered as single cells. They are cells ch have not become adapted to any special use, but have been set aside, e used at the proper time in the production of new animals. The ans in which the eggs or va are produced are known as ovaries. By ning a female fish they may be seen in the breeding season, completely ng the body cavity and causing the body to bulge at the sides and w. In the ovaries are to be found eggs of different sizes. The largest those that are to be laid during the season. The smaller eggs will grow be laid during the next season, and the smallest, which can not be seen 1 the naked eye, will grow and be laid at some still more remote season. these ova of different sizes, with the tissue that holds them together and blood vessels that run to them, make up the ovary. There are two ries in each fish.

'he eggs are laid in April. There are no observations on this subject there is no record known to the writer, of the eggs having been found he water. In the spring the fish travel from the Great Lakes up the rs, so that the eggs are doubtless laid some distance from the lakes. y sink to the bottom when placed in water, and when first laid, are y adhesive, so that they are probably to be found attached to water nts or other submerged objects at the bottoms of the rivers. The ployés of the State Board of Fish Commissioners obtain the eggs by pping the fish, that is by pressing them out as the fish, still alive, are en from the nets by the fishermen. The eggs pass out of the fish along h a considerable quantity of a slightly yellow, watery fluid.

Although the egg is a single cell of enormous size, it is at first difficult recognize it as such. Under the microscope the eggs appear irregularly yhedral, (Pl. I, Fig. 1). They would be spherical were it not that y are so closely packed together that they are distorted by the pressure. ey are soft to the touch like so many little balls of putty and each is out one-twentieth of an inch in diameter.

The most conspicuous part of the egg, as one looks down on is a spherical body at or near its center (Pl. I, Fig. 1, o. d.). is sphere, which has a diameter more than a third that of the itself, is an oil-drop. It looks very bright at its center and y dark at its borders. That it is an oil-drop may be shown either treating it with ether, which disolves it, or by treating it with

osmic acid, which turns it black. The oil-drop is enclosed by a second, larger, spherical body (Fig. 1, yk.) which is perfectly transparent and also appears dark bordered. This second sphere is the yolk of the egg. The oil-drop does not lie in the exact center of the yolk, but near the surface; and, since the oil-drop is lighter than the yolk, it always comes uppermost when the egg is in the water. If one looks down on the egg from above the oil-drop appears to be in the center of the yolk (Fig. 1); but if one turns the microscope so as to look through the tube while horizontal, and so sees the egg from the side (Fig. 2), the oil-drop is seen to be at the surface of the yolk and always uppermost. In this view it is also evident that the oil-drop causes a projection on the surface of the yolk, so that the yolk is not spherical but has the form of a bird's egg with nearly equal axes.

Surrounding the yolk so as to enclose it as in a sac, is a layer of protoplasm. This layer is extremely thin over most of the yolk, so thin that it is not readily seen in the living egg and has not been represented in Fig. 1. Over about one-third of the surface of the yolk this layer of protoplasm is much thicker and the thicker portion is fitted like a cap against the surface of the yolk. This is seen in Fig. 2, g. d. and also in Figs. 1, 1ª and 3 g. d. In Fig. 2, which represents a side view of a somewhat older egg, it is seen that one edge of this cap touches the oil-globule.

The cap of protoplasm is known as the germinal disc. The edge of the germinal disc that touches the oil drop will be called the posterior edge, since it is here that the tail of the embryo usually appears in later stages. The edge opposite the posterior will be called the anterior edge, since here the head of the embryo usually appears. The germinal disc contains the nucleus of the egg, but owing to the thickness and consequent capacity of the disc, the nucleus can not be seen in the living egg and it has not been demonstrated in sections of preserved eggs of the wall-eyed pike.

Finally, surrounding and enclosing all the parts of the egg previously mentioned, are the egg membranes. These are represented by a colorless band outside the yolk (Fig. 1, z. r.), and by the space included between the two parallel lines which are somewhat further from the yolk in the other figures (Fig. 2 and Fig. 3, z. r.). Before describing the egg membranes, it is well to notice that at first they lie close against the protoplasmic investment of the yolk, but that, as the egg lies in the water, the membranes become gradually raised up from the protoplasmic investment by the formation of a space between them and it. This space grows larger until at the end of two hours, it has grown so large that the diameter of the egg has increased from one-twentieth to one-thirteenth of an inch. The water in the sub-zonal space contains substances in solution, since it becomes cloudy when the egg is placed in certain preserving fluids such as Perenyi's fluid.

By this accumulation of fluid between the egg and its membranes, the membranes become tightly stretched, so that not only has the egg increased in size, but it has become firmer to the touch, feeling like a shot under the finger. The accumulation of water also causes the membranes to become thinner, as may be seen from a comparison of Figs. 1 and 3, these two figures having been drawn to the same scale. The water in the sub-zonal space forms a cushion between the egg and the membranes above the egg, and serves to protect the egg from mechanical injuries.

If the egg membranes be examined with care under a high power, it may

› seen that there are two of them, but so close together that they behave a single membrane. The inner one, next the yolk, is four or five times thick as the outer one and measures about one nine-hundredth of an ch. It is pierced by numerous very fine canals which run through it perndicularly from its outer to its inner surface. These canals are so merous that when one looks down on the surface of the shell it appears arked by closely-set fine dots which are the ends of the canals. ach dot looks as if it had been made by pricking the shell with e point of a fine needle (Fig. 4, b.). If one examines the shell in me place where it has been folded or wrinkled in handling, one may ceed in getting an edgewise view of a small part of it. In such view the canals are seen from the side instead of from the end, and appear fine lines or bands apparently parallel to one another and running from e surface of this layer to the other (Fig, 4 a, Fig. 5 z. r.). These fine nals through the inner egg membrane are to be seen in the eggs of many imals, and, when examined in an egg that is so small that the whole of it ay be seen under the microscope at one time, the canals appear to radiate om the egg like the spokes of a wheel from the hub. For this reason the embrane which contains them has been named the zona radiata, or simply e zona. The fluid-filled space beneath the zona is known as the subnal space.

Outside the zona radiata is the second membrane. It has about onefurth or one-fifth the thickness of the zona, being therefore about onehree-thousandth of an inch thick (Fig. 4 a, em., Fig. 5, ew). It will be lled simply the external egg membrane. This membrane, as seen from e surface, appears wrinkled; as seen on the edge it appears to be made › of numerous thin layers, one over another, like successive layers of per on a wall. In some places the outer membrane may be seen torn ay from the inner one.

The extreme adhesiveness of the egg is undoubtedly due to this ter membrane. The freshly laid eggs adhere to almost any object firmly that it is difficult or impossible to remove them without uring them. That the adhesiveness does not reside in the fluid ich bathes the eggs when they are laid is sufficiently shown by the fact at the eggs continue to be adhesive after this fluid has been removed by shing. It is further shown by the fact that it is impossible to stick gether with this fluid bits of glass or other material, although the eggs here very firmly to glass.

If one places a freshly laid egg in water on a glass slide, it at once heres firmly to the glass. If the egg be then left in the water until the b-zonal space is partly filled, the egg membranes will have become raised from the protoplasmic investment of the yolk, while at the same time, eir relation to the yolk investment will be the same that it was before the ing of the sub-zonal space. That part of the membranes that covered e germinal disc before the filling of the space, will lie opposite the disc er the filling of the space. But if the sub-zonal space be allowed to fill d the egg be then handled in order to place it on the slide, it will usually found that the egg has rolled or turned about in the egg membranes, so at the part of the membrane that covered the germinal disc before the ing of the sub-zonal space may be at the opposite pole of the egg er the filling. If now one places a freshly laid egg on the slide and thout afterward disturbing it, allows the sub-zonal space to become partly ed and if one then examines with a high power that part of the membrane that lies opposite the germinal disc, one may, with care, find a funnel shaped passage leading through the egg membranes. It is known as the microplye and it lies, usually, opposite the germinal disc with the broad open end of the funnel directed outward and the smaller end of the funnel directed toward the germinal disc (Figs. 7–8 mi.) In its smallest part this passageway is extremely minute but it is not by any means so small as the canals in the zona radiata. It measures in its smallest part about one eighteen-thousandth of an inch or many times as much as the canals in the zona radiata. It is, morever, a passageway that leads entirely through both the zona radiata and the external egg membrane. Any sufficiently small object might thus pass through the microplye from the external water to the fluid in the sub-zonal space. If an object should thus pass through before the sub-zonal space had been formed, it would come at once into contact with the germinal disc. On the other hand objects attempting to pass into the sub-zonal space through the canals in the zona radiata would be stopped by the external egg membrane. The micropyle therefore affords the only natural passageway by which a solid body may get access to the sub-zonal space. Liquids, such as water, pass readily through the membranes, apparently at any point.

To sum up, the egg consists of the following parts:

1. The two egg membranes, the external egg membrane and the zona radiata, the micropyle being the only opening through both.

2. Within the egg membranes and separated from them by the sub-zonal space are the remaining parts of the ovum or egg. These are:

A. An external layer of protoplasm forming a spherical sac. This layer of protoplasm is thickened in one place to form the germinal disc which containes the nucleus of the egg.

B. Within the sac formed by the protoplasmic portion of the egg and completely filling it is the yolk of the egg. The yolk is spherical, except where it is caused to protrude on one side by the presence of the oil-drop.

C. The oil-drop is spherical and imbedded in the yolk near its surface. It always comes uppermost when the egg is turned and so causes the germinal disc to lie always on one side of the egg (Fig. 3.).

The egg has been spoken of as a single cell, which may be compared to any other cell in the body of the fish. Yet it is a cell that has so many peculiarities that its cell nature is not at first apparent. By referring to the diagram of a typical cell (Plate III, Fig. 13 B) it will be seen that it consists of the parts already given, an external cell wall and inside this a mass of protoplasm containing near its center the nucleus. In the egg of the wall-eyed pike the egg membranes correspond probably to the cell wall of the ordinary cell and these membranes are separated from the cell or egg within by the fluid-filled sub-zonal space which serves to protect the parts within. The egg differs from the ordinary cell in being many thousand times larger. An ordinary cell in the body of an animal gets its nourishment from the food which the animal eats, the nourishment being carried to the cell in the blood of the animal. The food is supplied to the cell continously, so that it is not necessary that the cell should store up within itself food for use in case its regular supply fails it. Such cells consequently remain so small that they are quite invisible to the naked eye. But the egg cell is differently situated. When it has been fully formed it passes out of the body of the fish and is completely cut off from the supply of food which the other cells find in the blood of the fish. While thus cut off from all food supply the the egg-cell has

thrown upon it the work of producing a young fish, and must not only produce the fish but must provide it with food until it is sufficiently well developed to feed for itself.

The egg must therefore have stored up in it, when it leaves the body of the fish, food material enough for the purposes mentioned. The yolk of the egg and its contained oil globule are this food material. When the egg is first formed in the ovary it resembles any other cell of the body, but as it grows older, more and more food-yolk is accumulated in it, until finally, just before it is laid, it becomes greatly distended by food material. The eggs that are to be laid the following year have less food material; those that are to be laid two years hence have still less, and so on back to those that are still entirely without it. This food material is accumulated at the center of the egg-cell (Pl. III Fig. 13 A.) and the protoplasm of the egg-cell is pushed out by it to the surface of the egg, so that it forms a layer covering the yolk. The nucleus also is crowded to the surface but it draws to itself the larger part of the protoplasm (Fig. 13 A. g d.) and so forms the thickening already known as the germinal disc. From this germinal disc with its contained nucleus the fish is developed. The yolk and oil drop are used as food for it; the egg membranes serve to protect it.

THE SPERMATOZOÖN.

The egg alone can never grow into a fish. Eggs that are taken from the female and allowed to remain in the water without further treatment, undergo no developmental change and finally decay. The egg, the product of the female fish, must first fuse with the spermatozoön, the product of the male fish. The spermatozoa are produced in those organs of the male that are known as the testes. They are large milk-white bodies, occupying the same position in the male that the ovaries occupy in the female. In the breeding season there is produced in the testes a milk-white fluid as thick as cream. It is called the milt. If the male fish are taken at the right time, the milt may be stripped from them in the same way that the ova are stripped from the female. The milt mixes readily with water.

If one places on a glass slip a little milt well diluted with water and, after covering it, examines it with a power of at least five hundred diameters, one may see the individual spermatozoa in the milt. Each spermatozoön, like each ovum, is a single cell, equivalent to any other cell in the body of the fish. Each is extremely minute. To those who are unaccustomed to the use of the microscope, measurements do not convey a very precise notion of the size of very small objects, so that one may perhaps best realize the dimensions of these spermatozoa by a comparison. Some spermatozoa of the wall-eyed pike are represented in Plate 1, Fig. 10, and are there shown magnified six hundred and fifty times. If one were to magnify one of the eggs as much as this, it would appear a trifle more than four feet in diameter. If one then imagines a globe, four feet in diameter, placed beside the drawing of spermatozoa shown in Fig. 10, one has a conception of the relative size of ovum and spermatozoön. Each spermatozoön is shaped like a tad-pole. It has a bean shaped head which is about twice as long as broad and is a little more pointed at one end than at the other. Attached to the more pointed end is a slender tail which is about eight times as long as the head. By the use of this tail the spermatozoön drives itself through the water much as a tad-pole does. It is difficult to rid ones self of the notion that

these are animals, and indeed the name spermatozoön means sperm animal. Each spermatozoön is nevertheless a single cell. The head is the nucleus of the cell and is the part of most importance, while there is only enough cell protoplasm left in connection with this nucleus to serve for moving it through the water. In order to serve well as an organ of locomotion this protoplasm is gathered into the form of a vibratile tail.

Why is there this great difference in size between the ovum and the spermatozoön, the ovum having a bulk more than 3,000 million times that of the spermatazoön; the ovum the largest, the spermatozoön the smallest cell in the body of the fish? The reason for the great size of the ovum has been already alluded to. It must be large enough to accommodate food material for the nourishment of the young fish. Since it is thus rendered too unwieldy to move through the water, it is the spermatozoön that has taken on itself the work of moving to the ovum. For this reason it is small. It is the opinion of most morphologists that the only part of the spermatozoön or sperm-cell that is necessary to the development of the ovum is the head or nucleus. In the head of the spermatozoön the substance of the nucleus is condensed into the smallest possible space, packed as one packs one's valise for a journey, and in the tail there is retained only enough of the protoplasm of the original sperm-cell to move the head. And thus the problem is solved, the ovum, large, unwieldy and loaded with food material, the spermatozoön small, compact and able to move itself to the ovum.

When the female lays the eggs in the water, the male no doubt follows immediately after and ejects the milt on to or near the eggs. Thrown into the water in this way, ova and spermatozoa come together largely by chance. Certainly most of the spermatozoa perish without having reached the ova, but they are present in such multitudes that the loss is of little consequence. By this wasteful method of bringing ova and spermatozoa together no more young fish are produced than would be obtained by bringing together carefully a much smaller number of them.

Maturation and Fertilization, or Impregnation.

When the ovum is first laid it is not ready to receive the spermatozoön. It must first go through a process called maturation, the ripening or maturing of the egg. This process is difficult to observe in bony fishes and, owing to the comparatively large size of the egg, the writer has not been able to observe it in the wall-eyed pike. It is also a process as to the meaning of which there is much controversy, and it will therefore be passed over without further notice.

Once matured, the egg is ready to receive the spermatozoön. The process of the union of the egg and the spermatozoön is called the fertilization, fecundation or impregnation of the egg and, after it is accomplished, the eggs are said to be fertilized, fecundated or impregnated. The egg of the wall-eyed pike is not a favorable object in which to observe fertilization, so that what follows on this head has only a general bearing. The spermatozoön enters the egg, head foremost, through the micropyle. This probably takes place before the sub-zonal space has filled, so that the spermatozoön finds itself at once in contact with the germinal disc. The head of the spermatozoön, i. e., the nucleus of the sperm cell, then penetrates the germinal disc and unites with the nucleus of the egg-cell. The two nuclei form a new nucleus which then lies in the germinal disc in the position

formerly occupied by the original egg nucleus. When the nuclei have thus united the process of fertilization is completed and the fertilized ovum is ready to develop. The question as to what becomes of the tail of the spermatozoon is still unsettled.

It requires but a single spermatozoön to fertilize each ovum. The effect of the penetration of more than one spermatozoön into an ovum is, in the case of certain animals in which it has been studied, to produce monsters, and from this it is very likely that the monstrous fish embryos that are always to be found in the jars at fish hatcheries are produced by the union with a single ovum of more than a single spermatozoön. These monsters are fish with two heads, or fish with two tails, or double fish joined to one another by their bellies and many other deformities.

So important does it seem to be that not more than a single spermatozoön should gain access to the egg, that there exist contrivances for preventing the entrance of others. In some fish eggs the micropyle is observed to be filled by a plug immediately after the first spermatozoön has entered. In the wall-eyed pike no special contrivance was noted for preventing the entrance of a second spermatozoön. Yet it seems very probable that in the wall-eyed pike, the filling of the sub-zonal space closes the micropylar canal. The writer tried several times to fertilize eggs after the sub-zonal space had filled and always without success. The only explanation of this seems to be that the micropylar canal is then closed so that the spermatozoön cannot gain access to the egg. By what means it is closed can only be conjectured. By referring to Fig. 8, which represents an optical cross section of the egg in the region of the micropyle, it will be seen that the membranes are thickened and bent inward around the point where the micropylar canal pierces them. The micropylar canal thus passes inward from the bottom of a saucer shaped depression on the surface of the egg membranes. As the sub-zonal space fills the egg membranes become tense; they are pressed upon from the inside by the water accumulated in the sub-zonal space, so that the saucer shaped depression alluded to above is probably obliterated and the external surface becomes smooth. Such a change probably leads to the closure of the inner end of the micropylar canal, since that part of the membrane within the saucer shaped depression would, by being flattened out, be crowded into a smaller space.

It is always a matter of surprise to learn of the enormous number of eggs and of spermatozoa that are produced by fish. Were all the eggs to become fish, our waters would in a very few years be packed full of them. That the numbers of our fish do not greatly increase from year to year is sufficient proof that only a small per cent of all the eggs laid, ever become mature fish. Their production in such quantities is to insure that at least a few shall mature out of all the many. The failure to become fertilized is one great source of loss. Consider the chances. The spermatozoa may be deposited so far from the eggs that they are swept away by the current, or have died before reaching the egg. When they reach the egg there is only one spot on its surface where they may gain entrance. Having reached this spot they may find it obstructed by some stray object in the water or by the position of the egg, or they may find it closed by the filling of the egg, or they may find that the egg has so far filled that the germinal disc is no longer in contact with the micropyle. The chances in fertilization, once understood, are, in themselves alone, an ample justification of the wisdom of artificial impregnation.

PART II.

The Development of the Ovum Until the Appearance of the Embryo (70th hour) as Seen in the Living Egg and in Sections.

SEGMENTATION.

Fertilization of the egg probably takes place within a few minutes after it has fallen into the water. Indeed it is stated on good authority (Henneguy) that fish spermatozoa die in a few minutes when the milt has been mixed with water, although they live for many days if no water is added to the milt.

The next process of importance is the segmentation of the egg. By this is meant the division of the single celled ovum into many cells. This is a process that may be readily observed in its earlier stages, even with an ordinary hand lens, it being only necessary to throw light through the egg by means of a piece of mirror glass and then examine the egg holding it between the eye and the reflected light of the mirror, so that the egg is seen by transmitted light. The first change that is noticed, aside from the filling of the egg, is that the germinal disc draws itself together so as to diminish its diameter and become thicker. When the egg is first laid the disc covers about one-third the surface of the yolk (Fig. 1.) but, as the sub-zonal space forms, the disc gradually contracts (Fig. 1, A.) until it finally forms a lens-like projecting mass on one side of the egg (Figs. 2 and 3). This concentration of the protoplasm of the disc takes place, whether or not the egg has been fertilized; in eggs that do not afterwards develop as well as in those that do develop. It is then no indication that the egg is fertilized. The concentration is accompanied by irregular protrusions of the protoplasm of the disc, some of which are represented in Fig. 1b, in an egg which contained an unusually large number of small oil globules. The protuberances are in the direction of the greatest accumulation of protoplasm and seem to be waves flowing toward it. The result is the rounded lens-shaped germinal disc represented in Figs. 2 and 3.

At the temperature of probably 45°, F., the egg requires about four hours to fill and form the germinal disc. It then begins to segment. A line drawn from the anterior to the posterior edge of the disc will be spoken of as longitudinal and a line at right angles to this, as transverse. The first runs usually lengthwise of the future embryo, while the second runs usually across it. After about four hours it is noted that the germinal disc becomes elongated transversely, so that it is no longer circular in outline but oval. It is difficult to see this oval form in the living egg since the oil-drop interferes with the light, but it is readily made out in eggs that have been preserved and are examined as opaque objects. Referring to the living egg seen from the side, as in Fig., 2, it is next noticed that a shallow longitudinal groove or furrow has appeared on the surface of the now oval germinal disc. This groove appears as a notch when the egg is looked at sidewise (Fig. 11, fr), and from the bottom of the notch a clear line is seen running downward toward the oil-drop and separating the disc into equal or nearly equal parts. Half an hour later

each of these parts is seen to have rounded up and taken on somewhat the form of the original germinal disc (Fig. 12) and the two appear to be sharply separated by a distinct double-bordered wall.

After twenty minutes more a second furrow (Fig. 14 fr^2) is seen forming and running rapidly across the surface of the disc. The second furrow is usually at right angles to the first and is therefore transverse. As a result of it the disc is divided into four parts (Fig., 14). The egg then rests for about an hour. At the end of that time two new furrows (Fig., 15, fr^3, fr^3) are formed at the same time, both running parallel to the first or longitudinal furrow and one on either side of it. By these the disc is divided into eight parts. The eight segments are usually arranged in two rows of four each and the rows usually run transversely. But there are many variations from this and the eight segments are often quite irregular in size and arrangement. After this the division of the germinal disc continues slowly at a low temperature, more rapidly if the temperature is raised. Each of the eight segments divides and each of the resulting segments again divides, but the process now becomes irregular and is no readily followed in its details. Indeed, the process varies so much that it is difficult to find two eggs in which it is the same. The result is the production of a larger and larger number of segments, the segments themselves becoming consequently smaller and smaller as shown in Figs., 16 and 17, Pl., II. and Fig. 18, Pl., III, which represent eggs of 27 hrs, 30 hrs., and 37 hrs., respectively. At the end of the process of segmentation the egg looks at first sight very much as it did before the process began (Figs. 3 and 18), but now, instead of a germinal disc made up of a uniform mass of protoplasm, we have a germinal disc which is broken up into a large number of separate segments or cells. During segmentation, and for some time afterward, the mass of cells resulting from the segmentation of the germinal disc is known as the blastoderm.

In order to understand fully the process of segmentation we must study it not only as seen in the living egg, but as seen in thin sections made through preserved eggs. The germinal disc is too thick and opaque to allow one to see in it all the changes that are taking place there, but by cutting it into thin sections the details may be followed with great certainty and ease.

Fig. 19, Pl. II represents a part of a section through an egg in which the first furrow has been formed. The egg was therefore in the stage shown in Fig. 12 and the section was made through its center and in a plane at right angles to the furrow. Only the outline of the upper part of the yolks (yk.) is represented in the drawing and on this is seen the blastoderm. At its edges it is continuous with the thin protoplasmic investment of the yolk (yk. i). Near the middle of its upper surface is the section of the first furrow (fr^1) which is now seen to be very shallow. Beneath this furrow the two segments into which it appears to divide the blastoderm are seen to be separated from one another only by a faint light colored band with a darker line through its middle. Along this band the protoplasm is a little less dense than elsewhere, so that it has taken up less of the staining solution used in coloring the blastoderm. There is no cell wall formed along this band. On the contrary the protolasm is continuous from one segment or cell to the other, the only break in continuity being just beneath the groove where there are a few spaces or vacuoles (vac.). The line which separates the yolk from the blastoderm is well marked

except under the middle of the blastoderm. Here the blastoderm has been causing changes to take place in the yolk. The sharp line separating yolk and blastoderm does not appear and the two seem to be intermingled for a little distance. Here the yolk is seen filled with spaces which make it look spongy (yk. sp.) in section. From this spongy part of the yolk little globular masses of yolk (yk) break off and pass upward into the blastoderm. They are shown in the drawing as black spots of considerable size and it is worthy of note that, while a few appear scattered throughout the blastoderm, most of them are collected at its base near the yolk or are seen in the act of traveling up between the two segments along the light band already referred to. The meaning of this is that the blastoderm, which is the living part of the egg, is beginning to make use of the yolk as food material. It causes the yolk to break up into little spheres which are then transported upward between the segments and outward beneath them, and are gradually drawn into the segments and used by them as food material. Finally, at the center of each segment is its nucleus (nu). Each nucleus appears to be made up by the aggregation of a number of smaller spherical bodies, an appearance which, as we shall see later, is not the usual one. Each nucleus is the center of a system of radiating lines in the cell protoplasm.

Fig, 20 represents a section through an egg eight and one-quarter hours old. The living egg of this stage is not represented in the drawings, but it comes between Figs. 15 and 16. In the section only a part of the yolk is shown and in the center is seen the irregular outline of the space which, in the living egg, was occupied by the oil-drop. The space is marked Sp. o. d. The number of segments is greatly increased but they are still separated from one another only by light areas as in the two-cell stage. The light areas are, however, more pronounced and across them may be seen stretching fine strands of protoplasm connecting cell to cell. There is, therefore, protoplasmic continuity throughout the blastoderm. The blastoderm is seen to have burrowed still deeper into the yolk and a stream of little yolk masses is passing up into it. These yolk masses are most numerous in the clear areas between the cells. In each cell is the nucleus, in the center of a radiating system of rays in the cell protoplasm. The changes up to this time have been in the direction of increase in the number of cells and of better separation of the cells from one another.

Fig. 21, Pl. III, represents a similar section through an egg 27 to 30 hours old. A living egg of the same age is represented entire in Fig. 17. In the section it is seen that the cells of the blastoderm have increased greatly in number, and are well separated from one another by distinct cell-walls. The cells which are upon the surface have become somewhat flattened and are smaller than the deeper-lying cells. They are fitted together like the blocks in a pavement and make what we may call the "covering layer" of cells (l. c.). The cells beneath the covering layer are many sided and closely packed, so that only here and there a space appears among them. Each contains a nucleus of the usual form surrounded by he rays in the cell protoplasm.

The mass of cells now described rests upon a layer of somewhat coarsly granular protoplasm which lies underneath the entire blastoderm. This layer of protoplasm is thickened underneath the edge of the blastoderm and then thins out rapidly to become continuous with the very thin protoplasmic investment of the yolks (yk. i.). In

it are scattered nuclei, usually of considerable size. This layer of protoplasm is of great importance in the development of the embryo and has been given a great variety of names by the different writers on the subject. One of the most suitable of these names and the one by which it will be spoken of hereafter is *parablast*. It is shown projecting from beneath the edge of the blastoderm in Figs. 17 and 18. There is no part of the subject of fish-development about which there is more controversy than about the origin of this layer of parablast. This is a matter of very great theoretical importance. But as it is not the purpose of the present paper to enter into matters of controversy, the various views with regard to its origin will not be here discussed. The nuclei which the parablast contains are equivalent to the nuclei of the blastoderm, and have been derived from them, so that the parablast has the morphological value of a large number of cells between which cell walls have not been formed.

Fig. 22 represents a section through the blastoderm of an egg somewhat older than that represented in figure 18. Only a small part of the surface of the yolk (yk.) is represented. The cells have now become very small and very numerous. They are so small that although the drawing represents them magnified about twice as much as in Figs. 20 and 21, yet they appear so small that it has not been possible to represent the details of structure in the individual cells. On the surface of the blastoderm is seen the covering layer of cells (l. c.) and beneath this the remaining polyhedral cells of the blastoderm. In the parablast (prb.) the nuclei (prb. nu.) have increased greatly in number and have also become larger. Many of the nuclei of the parablast layer are now as large as entire cells of the overlying blastoderm.

With the stage represented in Fig. 22 the segmentation may be said to be ended. It has resulted in the breaking up of the blastoderm into a large number of small cells which are of two kinds, the "covering cells" and the lower layer cells, and it has resulted also in the formation of the parablast layer. At the end of segmentation, if the eggs have been kept at a low temperature (40° to 45° F.) they are about forty-eight hours old.

GASTRULATION.

Returning now to the living egg, it is very soon noticed that the blastoderm is beginning to spread itself over the yolk. At the end of segmentation the blastoderm, together with the parablast, has the form of a skull-cap which fits against one side of the yolk, much as a skull-cap fits against the top of the head. Now the blastodermic cap gradually becomes both broader and deeper and covers more and more of the surface of the yolk. The process is very much like that to which one might subject a skull-cap if one should take it by its edges and stretch and pull it down over the head until its edge clasped the neck below the ears and chin, the skull-cap representing the blastoderm while the head represents the yolk.

An early stage in this process is represented in Fig. 24, Plate III. The egg is seen in the same position as in Fig. 2, Plate I, i. e., from the side and the blastoderm (bl.) has covered considerably more than one-third of the surface of the yolk. The edge of the blastoderm is slightly turned in and there is thus formed a triangular groove (gr.) running around the egg between the edge of the blastoderm and the parablast. The edge or rim of the blastoderm is considerably thicker than its middle and the parablast

(prb.) is seen extending out on the surface of the yolk for a little way beyond the rim of the blastoderm.

As the blastoderm thus extends itself over the yolk, it slowly shifts its position. In an early stage of the process it lies as shown in Fig. 24, bl., upon one side of the yolk while the oil-globule occupies the top of the yolk-mass. The diameter of the mouth or opening of the blastodermic cup is however less than the diameter of the yolk, the result of this being that the yolk is constricted by the passage over it of the rim of the blastoderm. This is shown in Fig. 25, Plate IV, where the blastoderm has covered about one-half of the yolk. The yolk completely fills the blastodermic cup, which, although represented as below in the figure, really lies on one side of the egg, which, in the figure, is represented as seen from above.

It will be seen that the yolk is narrowed where it is clasped by the rim of the cup, and that it therefore takes the form taken by a rubber ball when a string is tied tightly around its middle. In the half of the constricted yolk which is not covered by the blastoderm lies the oil-globule. This is illustrated by the diagram Figure 28, b., where it is seen that the encroachment of the blastodermic rim has displaced the oil globule so much that it no longer lies at the middle of the top of the yolk but rather toward one side. A comparison of Figures, 24 and 25 illustrates the same points. The constriction now travels slowly over the yolk so as to make the part of the yolk covered by the blastoderm continually larger and the part not covered by the blastoderm contiually smaller. The constriction, moreover, drives the oil globule ahead of it into the smaller part of the yolk and consequently into the opposite side of the egg (Fig. 28, b.). But the oil globule is so much lighter than the yolk and blastoderm that it tends continually to occupy the highest position in the egg. Its tendency is to travel in the direction indicated by the arrow in the diagram (Fig. 28). This tendency results, not in the traveling of the oil-drop through the yolk, since that is prevented by the rim of the blastoderm and the constriction of the yolk, but it results rather in the turning of the whole egg in the direction indicated by the arrow in Figs. 28, b. and c. Finally, when the constriction caused by the rim of the blastoderm has driven the oil globule to the opposite pole of the egg, the globule by its lightness will be found to have turned the egg through an arc of 90°, so that the blastoderm covers its lower pole (Figure 28, d.) and the oil-drop occupies its upper pole.

An examination of the diagram Figure 28, a, shows that at the beginning of the revolution a line, xy, passed radially through the middle of the exposed surface of the oil-drop, crosses at right angles a line drawn through the center of the blastoderm perpendicular to the surface. During the revolntion this angle gradually increases until at the end of the revolution the two lines meet at the center of the egg so as to form parts of one straight line. Figures 26 and 27 represent eggs seventy-two hours old in which the rim of the blastoderm has traveled so far that it clasps the oil-drop about its middle. The blastoderm then assumes the form of a flask without a neck.

Let us leave the egg in this condition and turn for a moment to another change which has been taking place in the blastoderm while it has been moving over the yolk. At the beginning of the process the blastoderm was compared to a skull cap. The thickened rim just alluded to may be compared to the thickening of the rim of a skull-cap which we

nay suppose to be caused by the presence in it of a sweat-band. Such a sweat-band is a flat ring of considerable width fastened above its edges o the rim of the cap. In the living egg of the wall-eyed pike this thickning of the rim of the blastoderm makes the rim seem opaque as one ooks through the egg. This opacity is shown by the darker color of the im as seen in Figures 24 and 25 at r. bl.

This thickening of the rim is not, however, of uniform width throughut as is the sweat-band in the cap. At one place the rim is very nuch widened and extends toward the center of the blastoderm as rounded triangular extension. This one may easily represent to nes self by cutting out a piece of paper of the form shown in Figure 3 a. If the ends of this paper be brought together as shown in 'igure 23 b. it has the form of the sweat-band. If the piece of paper be tted into a tea-cup with the pointed projection directed toward the ottom of the cup and if the edges of it be then glued to the edge of the ip the whole makes a very good model of the blastoderm of the wall-eyed ike at this stage. A ball dropped into the cup would then represent the olk. This broadened part of the thickening of the blastoderm rim is epresented in Figure 25 e. a.

As the blastoderm surrounds the yolk, the broadening extends connually toward the middle of the blastoderm until it finally forms long, tongue-shaped extension of the thickened rim. This is shown, s seen from the edge, in Figure 26 e. a. and as seen from the surce in Figure 27 e. a. both figures being made from the living egg. long this tongue-like area the first trace of the embryo is to be und. It is formed with its head end at the apex of the triangle and its il end touching the rim of the blastoderm. This part of the blastoderm therefore known as the embryonic area. It is marked h. t. in the outline the strip of paper given at 23 a., the head end of the future embryo ing at h. while the tail is at t.

Turning now from the appearance thus described in the living egg, an amination of sections will show us the cause of the thickening of the astodermic rim and of the embryonic area. Fig. 24 a, represents a ction made through an egg of about the stage shown in Fig. 24. The ction passes through the middle of the oil-globule and through the ddle of the yolk, i. e., in the plane of the paper if referred to the egg own in Fig. 24. The yolk is represented only in outline. At the left o. d., is seen the space occupied in the living egg by the oil-drop. The noval of the oil-drop (it has been dissolved during the process of preving the egg) has caused the yolk to protrude into its cavity. Underath the blastoderm and projecting a little way beyond its edge is seen parablast, thickened at its margin. Its nuclei are not shown. Above parablast is seen the blastoderm, its cells appearing very small because little magnified. It has become cup shaped and, having spread out, is ich thinner than in Fig. 22. At its edge it *looks as if it had been ubled under*. It is certainly double at its edge being made up of an per and a lower layer of cells. The origin of the lower of the two layers the rim is still a matter of controversy. This lower layer may be called primary hypoblast, and it is the presence of the primary hypoblast, t causes the rim of the blastoderm to appear thick and opaque, and it the extension of the primary hypoblast that causes the thickening own as the embryonic area.

Fig. 29 represents a section through an egg of the stage shown in Fig. 26

and, as before, in the plane of the paper. The cavity which contained the oil-drop is shown as before at o. d. The parablast is seen to have extended itself as the blastoderm has. It is now a very thin layer closely applied to the yolk as shown at prb. It is thickened at its edge. The dark spots in it represent its nuclei, and they are seen to lie in depressions on the surface of the yolk. On the right side the primary hypoblast is seen to extend only a little way inward from the margin of the blastoderm, so that the marginal thickening is here narrow. On the left side, however, the primary hypoblast extends to the bottom of the cup, and the section therefore passes lengthwise through the middle of the embryonic area, or in the direction of the dotted line in figure 27. Between the limits of the invaginated layer on the right and left the blastoderm is seen to be extremely thin and separated from the parablast by a space.

Fig. 29 b shows a little of this part of the section much more highly magnified. The parablast (prb.) is seen containing a nucleus (prb. nu.). Under the nucleus is seen the depression in which it lay, but from which it has been removed in the process of sectioning. The blastoderm is seen to be composed of two layers of cells. The upper one of these (l. c.) is extremely thin and is the covering layer of Fig. 22, the cells of which have become very much flattened out to accommodate them to the much larger area which they have now to cover. Beneath the covering layer is seen the lower layer (l. l.), here reduced to a single tier of cells which are also slightly flattened. The nuclei of most of these cells are shown and at nu. a nucleus is shown which is in the process of division. Fig. 29a shows a little of the embryonic area highly magnified. At the right is the parablast with its nuclei (prb. nu.); next this is seen the primary hypoblast (h. p.), the cells of which are seen to be irregularly rounded and somewhat loosely fitted together. To the left of this are seen the lower layer (l.l.) and the covering layer (l. c.). The covering layer is made up here also of very much flattened cells in one of which a nucleus is seen. The lower layer is made up of two tiers of cells closely fitted together.

The whole egg now, leaving out of account the membranes, which have not changed, consists of the following parts: *a*, the yolk in the upper part of which is the oil globule. *b*, Closely covering the yolk is the parablast layer extending up to about the middle of the oil-drop where it ends in a thickened edge. *c*, Surrounding the parablast (and separated from it by a cavity) is the blastoderm which also extends up to the middle of the oil-drop where it ends in a thickened rim. This thickening of the rim extends downward as a triangular projection, the embryonic area, to the lower pole of the yolk. The thickening of the rim and of the embryonic area is due to the fact that the blastoderm is double, or two layered, over these parts. Of these two layers the inner one, next the parablast, we have called the primary hypoblast. The outer layer which is contiuous over the whole surface of the cup-shaped blastoderm we may call the epiblast. The epiblast is in turn, made up of the layer of covering cells and the layer of lower-layer cells. The epiblast and the primary hypoblast pass into one another at the edge of the cup. At a temperature of about 48° F. the egg will have reached this condition at about the end of the third day (70 hrs.).

The process by which the blastoderm grows about the yolk is known as *gastrulation*, and the blastoderm is said during this process to be in the *gastrula stage*. The word gastrula means a little stomach and

the stage is one through which it is believed that all animals pass in the course of their development. A gastrula is typically a cup with double walls, the outer wall being called the epiblast and the inner wall being called the primary hypoblast. This inner wall of the cup is incomplete in the eggs of the wall-eyed pike, appearing only at the rim and over the embryonic area. But if we consider the parablast as only a specially modified part of the primitive hypoblast, then we may think of the inner wall of the gastrula cup as complete. The cavity of the cup is the primitive digestive cavity or archenteron, and the opening of the cup, its mouth, is known as the blastopore. It is believed that at one time the gastrula was an independent animal which was able to swim about and take food through the blastopore into the archenteron and there digest it. Even now some animals pass through a gastrula stage of this sort, while others remain permanently in this stage. In the wall-eyed pike the gastrula is much modified by the presence of food-yolk. When the gastrula is formed it slips over the yolk and encloses it, and apparently assimilates it.

The blastopore then grows smaller and smaller as the gastrula continues to envelop the yolk until finally the gastrula lips meet and the blastopore is obliterated. The embryo makes its appearance a little before the closure of the blastopore.

The formation of the primary hypoblast and the consequent appearance of the embryonic area, that is the *gastrulation*, having occupied the time between the 56th and the 70th hours, this stage of development will be spoken of hereafter as Stage A and the later stages will also be spoken of by the letters of the alphabet as B, C, D etc. This is done in order to be able to refer briefly and precisely to particular stages in development. As with all animals that develop subject to a varying temperature, so with the wall-eyed pike, the precise stage which the egg has reached after a certain length of time is dependent on the temperature at which it has been kept. If the temperature has been low, the egg has developed slowly; if high, the egg has developed rapidly. It is best therefore to divide the development into arbitrary stages and to let each of the letters A, B, C, etc., represent a certain stage of development no matter what the age of the egg in which it occurs.

Seven stages may be distinguished in the development of the wall-eyed pike from the appearance of the embryonic area until after the hatching of the fish. There will be first given a description of the embryo in each of these stages as it may be seen in the living egg—a description which anyone may easily verify by the use of the microscope. Next there will be given an account of the main facts that may be made out concerning the early stages by the study of thin sections. Finally, there will follow a brief description of the development of each system of organs, as the nervous system and digestive system as seen both in sections and in the living egg.

In all cases sections will be referred to only where it is not possible to make out the structures by other means.

PART III.

The Development of the Embryo up to the Forty-fifth day as seen in the Living Specimen at Certain Stages.

STAGE A.

At a temperature of 48° F. this stage covers about the time between the 56th and the 70th hours. It is represented in its beginning in Figs. 24 and 24a, Pl. III and at its close in Figs. 26, 27 and 29, Pl. IV. It is the stage during which the embryonic area is formed, that triangular projection of the thickened blastodermic rim whose growth has been followed. The stage has been fully described. It closes with the first appearance of the embryo. It is represented diagramatically in Figs. 35a. and b.

STAGE B.

At a temperature of 48° F. this stage lasts from about the 70th hour to about the 80th. It is represented in the living egg in Figs. 30 and 31. It differs from the preceding stages in that the blastoderm has now extended itself as to very nearly cover the yolk, leaving only a small circular patch uncovered. This is not shown in Figs. 30 and 31. It differs further in that a broad opaque band (Figs. 30 and 31 n. r.) has made its appearance on the embryonic area. The band is narrower at one end, gradually widens toward the other end and, just before ending, flares abruptly; it thus has very much the form of the outline of a trumpet. The band runs lengthwise of the embryonic area, the narrow end being against the attached or blastodermic rim and the broad end lying at the apex of the triangular area. It is therefore formed in the position of the straight line h t. in Fig. 27, with the broad end at h.

There is a groove on the surface of the embryonic area, running lengthwise over the embryonic rudiment. The groove, like the embryonic rudiment, is narrow behind and broad in front. It is not shown in the figures. The opaque band is the first trace of the embryo and is largely caused by the formation of the central nervous system. In Fig. 30 the band is shown in a position at right angles to that which it usually occupies. In its usual position it lies with the smaller end over the oil-drop where it is seen with difficulty, on account of the distortion of the light by the oil globule. For this reason the egg shown in Fig. 30 was selected for drawing. In Fig. 31 the embryo is shown in nearly the normal position. The relation of the embryo to the ring formed by the thickened rim of the blastoderm is shown in Fig. 36 and a comparison of this with Fig. 35 shows that the embryonic area (Emb.) has become longer and narrower and that the blastodermic rim now forms a smaller ring (r. bl.) attached to the tail end of the embryonic area. The space enclosed by the ring is much narrowed while the ring itself is much broadened.

STAGE C.

At a temperature of 49° F, this stage is reached at about the 100th hour. It is represented in Fig. 34 and the head of an embryo of about the same stage is represented in 34a.

By reference to Fig. 34 and to the diagram, Fig. 37, it will be seen that

the embryo has lengthened so much that it now reaches about half way around the yolk. It is also raised up, so as to form a ridge on the surface of the yolk, and the groove which ran along its middle in the preceding stage has been obliterated. At the anterior or head end, which in the preceding stage was marked by a simple broadening of the embryo, there are now seen two hemispherical masses, one on either side and separated from the middle portion by grooves. These masses are the optic vesicles (op. v.) which later develop into important parts of the eyes. The part of the embryo between the optic vesicles and in the middle line behind them becomes the brain. Passing further back there is noticed in the middle line a narrow dark band (ch.). This is the notochord, a structure to be described in detail later on. About the notochord the back bone or vertebral column makes its appearance, and until the vertebral column has appeared the notochord serves as the chief support and only axial skeleton of the embryo.

On either side of the embryo are seen short lines running outward and backward parallel to one another. These lines form two sides of diamond shaped areas for which the notochord forms the third side while the fourth side, opposite the notochord, is not yet formed. These areas are the surfaces of the mesoblastic somites, or protovertebrae. They increase greatly in number in later stages and the cells which form them develop into the masses of muscle which are to be seen along the side of the adult fish after removal of the skin. In the adult fish these masses are still separated by lines as the mesoblastic somites are in the embryo.

At the posterior end the embryo broadens into a flat irregularly rounded plate called the caudal plate. This is shown in Fig. 34 at c. pl. as seen somewhat from the edge. A comparison of Fig. 34 with the diagrams Figs. 36 and 37 will show that this caudal plate, from which the tail and perhaps a part of the body is afterwards formed, is itself formed by the further narrowing of the ring shown at r. bl. in Fig. 35. The area surrounded by the ring, the blastopore, is now obliterated, the dot in the center of the caudal plate in Fig. 37 showing the position formerly occupied by its center. The thickened blastodermic ring is thus converted into the *caudal plate* of the embryo.

STAGE D.

The embryo is in this stage at a temperature of 49° at the end of the sixth day. There are therefore, at this temperature, two days between stage C and stage D. Fig. 40 represents the egg in this stage, while Figs. 41 and 42 represent the anterior and posterior ends of the same embryo more highly magnified. Figs. 38 and 39 represent the anterior and posterior ends of an embryo between stages C and D both more magnified than Figs. 41 and 42.

Referring to Fig. 40 as typical of the stage, it is seen that the embryo now surrounds more than two-thirds of the circumference of the yolk. The head in the usual position now touches the oil-drop, as shown in the figure, while the tail does not quite reach the oil-drop. The embryo is much more raised up from the yolk so that it forms on the surface a projecting ridge of considerable height. It not only thus forms an external ridge-like projection but it projects also as a ridge in the direction of the yolk, so that the surface of the yolk is marked by a gutter-like depression into

which the lower surface of the embryo fits. This is best seen in section but may be made out in the living egg if the egg is so placed that one looks endwise at the middle of the embryo (Pl. V, Fig. 43). The caudal plate is rounded up and has formed a blunt projection, like the tip of a finger (Fig. 40, c. d.). This projection is the beginning of the tail. The last trace of the blastopore, or opening in the ring from which the caudal plate was formed, is shown at bl. in Fig. 39.

The notochord (ch. in all the figures) is seen in the same position as before. It ends in a point in front, some distance back of the eyes and, becoming enlarged posteriorly, gradually merges into the tissues of the tail. On the sides of the notochord the mesoblastic somites (ms. so.) are seen to have increased in number being now about twenty-five, instead of five as in the preceding stage. They are elongated in the direction from above downwards (dorso-ventral) and each is bent at its middle, the apex of the angle formed by the bend pointing forward.

In the central nervous system a cavity has made its appearance. This begins on the fifth day as a diamond shaped space (Fig. 38, vn^3). This space then gradually extends backward as a narrow slit which is shown in Fig. 41 extending from vn^3 to c. c. It appears in the figure as a narrow line which gradually broadens posteriorly where it is seen overlying the notochord (ch.). The central nervous system is also seen to have become larger at its anterior end than at its posterior. The anterior large part forms the brain and is already marked by two constrictions (Figs. 38 and 41, $con.^1$ and $con.^2$) which separate from one another three enlargements of the brain. In the foremost of these enlargements the diamond shaped space lies as shown in Fig. 38, vn^3., and with this enlargement the optic vesicles (op. v.) are seen to be connected. The enlargement is called the forebrain (f. b., Figs. 38 and 41).

The second enlargement (m. b.) is known as the midbrain and the two constrictions just mentioned lie one at its anterior and one at its posterior end. The constriction in front of it, which separates it from the forebrain is not very well marked in this stage. Behind the midbrain separated from it by the constriction con^2, is the third enlargement, the primary hindbrain (h. b.). Behind the hindbrain the central nervous system becomes gradually smaller and the part of it lying behind the hindbrain becomes in later stages the spinal cord. The whole central nervous system may thus be divided into two parts, the brain and the spinal cord, and the brain may be further divided into forebrain, midbrain and hindbrain. With the forebrain the optic vesicles are connected as seen in Fig. 38.

In each of the optic vesicles a slit-like cavity has appeared, Fig. 38, c. op., before stage D is reached. The vesicle, which in the preceding stage is solid, is thus converted into a sac. One wall of the sac (Fig. 38, rtn.) lies next the external epiblast while the other wall (rtn. p.) lies against the sides of the fore-brain and mid-brain. By the time stage D is reached the first of the walls of the optic vesicle, as shown in Fig. 41, rtn., has become much thickened while the second has become thinner. The thicker wall has moreover the appearance of having been pushed in against the thinner as one may push one side of a rubber ball against the other and so collapse the ball. The thicker wall of the optic vesicle instead of appearing convex on its outer surface, as in the earlier stages, has become concave. The vesicle thus takes on the form of a shallow cup or saucer and is called now the optic cup.

Into the cavity of the optic cup the external epiblast has fitted

itself so that it no longer passes smoothly over the optic vesicle as at epb. Fig. 38, but dips down and lines the optic cup (formerly vesicle) as at lns. Fig. 41. The whole eye thus consists of a shallow cup, with double walls separated by a slit-like space. The cup is connected by a hollow stalk with the forebrain. The cavity of the cup contains a part of the external epiblast which dips down into it.

From the thicker wall of the cup in later stages is formed the sensory portion of the retina of the eye; from the thinner wall is formed the dark colored pigment layer of the retina and from the stalk of the cup is formed the optic nerve. From the portion of the epiblast which fits against the concavity of the cup is produced the crystalline lens of the eye.

Back of the optic vesicles there are seen (at au. v. in Figs. 40 and 41) two smaller thin walled vesicles, one on either side of the nervous system. They appeared as solid masses in an earlier stage, just as the optic vesicles did, and their cavities were afterwards formed. They are the rudiments of the internal ear of the fish (the fish never possesses an external or middle ear) and undergo important changes in later stages.

In front of the eyes in Figs. 40 and 41 at olf. are seen two much smaller cup-like depressions of the epiblast. They lie as shown in Figure 41, in the angle between the anterior end of the snout and the anterior border of the eye. Their walls are much thicker than the external epiblast. They are the rudiments of the organs of smell, or the olfactory organs and are known as the olfactory pits.

At the sides of the head in Fig. 38, are seen a great many irregular cells, (amb.) that are represented in outline only. These cells are able to move from place to place and appear to be coming off from the sides of the head. In Fig. 41, which represents an embryo slightly older than the one shown in Fig. 38, it is seen that these cells are accumulating about the front end of the notochord at the point marked ht. in Fig. 41. In this place the heart appears in the next stage and it seems to be formed at least in part from these cells.

STAGE E.

At a temperature of about 49°, F., the embryo is in this stage at the end of the tenth day. There are therefore four days between stage D. and stage E.

Such an embryo removed from the egg membranes is represented in Fig. 47. The embryo is now larger in every way. Its tail has become free from the yolk and, when the membranes are removed so that the tail can straighten, it points directly backward. On this account the embryo appears much more nearly straight than in the preceding stages. About half of it is attached to the yolk while the remaining or tail half is free. The tail is no longer round, like a finger tip, but is flattened from side to side, so that it resembles the tail of an adult fish. The body is still further raised up from the yolk above, while below it is still further sunken into the yolk. In the figure the heavy dark line which represents the outline of the yolk is seen to extend up to the level of the notochord.

Over the yolk, or rather over the yolk sack, which is the name given to that part of the blastoderm which surrounds the yolk and holds it to the embryo, there are seen numerous black spots which send out irregular branching root-like processes. Others of these are seen along the lower half of the side of

the tail. They are cells which possess the power of movement, being able to crawl slowly about, as a snail crawls. In the center of some of these may be seen the lighter-colored nucleus. These cells have become filled with little black granules and are hence called pigment cells. They give the color to the fish and by sending out and drawing in their processes they are able to make the fish appear darker or lighter in color as occasion may require.

The *notochord* is seen (Figs. 46 and 47 ch.) ending as before in a point just back of the eye and broadening out posteriorly to become lost in the tissues of the tail. It has changed in appearance on account of changes in the cells which compose it, but these changes may be best followed by means of sections.

The *mesoblastic somites* have increased to forty-five or more. They reacb the whole length of the body and the angle noticed in the previous stage at the middle of each is sharper than it was. Some of the cells of the somites have now been converted into muscle fibres which are able to contract. Before stage E is reached (on the eighth day at the temperature given) the embryo is able to move itself. The movements consist in bendings of the body sidewise so as to bring the head and tail more nearly together. The embryo usually makes this movement several times in succession and is then quiet again for awhile before repeating the movements.

Important changes have taken place in the central nervous system, so that all the divisions that are to be found in the adult fish may now be made out. The central cavity noted in the anterior part in the preceding stage has extended as a narrow slit to the tail of the embryo, so that the whole central nervous system forms a tube. Aside from the extension of the cavity the spinal cord is unchanged.

The midbrain (compare Figs. 44, 44ª, 46 and 47 mb.) has gradually broadened, as the embryo has passed from stage D to stage E. In Fig. 46 it is seen to be so broad that it overlaps the optic cups at the sides. The midbrain retains the same name in the adult fish and its roof then forms the optic lobes, the part of the brain in which the optic nerve has its origin. In front of the midbrain in stage D, was the forebrain, separated from the midhrain by a slight constriction.

Three outgrowths have now been formed from the forebrain, one directed upward and backward from the roof of the forebrain toward the top of the head (pn. Fig. 47) and known as the pineal gland, another directed downward and backward from the floor of the forebrain toward the end of the notochord (inf. Fig. 47) and known as the infundibulum, and a third directed forward, best shown at cbr. Fig. 44ª and known as the cerebrum. Each of these outgrowths is hollow and each therefore contains a cavity which communicates freely with the cavity of the forebrain. The optic cups are also connected by the hollow optic stalk with the sides of the fore-brain.

The most important of the parts thus formed as outgrowths from the forebrain is the cerebrum. It forms a slight, very blunt, rounded projection of the forebrain. Owing to its position it is not shown in Figs. 44 and 46. In subsequent stages it increases greatly in size and importance and in the higher animals it becomes the largest part of the brain, and of great importance, being the seat of intelligence. As the cerebrum thus grows in size the forebrain itself remains small and forms the connection between the much larger cerebrum and the midbrain. It then takes the

name of 'tweenbrain. Indeed it is customary to say that the forebrain becomes divided into cerebrum and 'tweenbrain.

The pineal gland or outgrowth from the roof of the 'tweenbrain is shown at pn. Fig. 46 where itis seen to be a bladder-like body with a large cavity and a thin wall. It is attached to the 'tweenbrain by a somewhat narrow stalk directly over, the diamond-shaped space which is the first cavity to appear in the central nervous system. In Fig. 47 is given a side view of the pineal gland where it is seen that its free end points backward and that it causes a slight elevation on the surface of the head. It is now generally agreed that the pineal gland is a rudimentary sense organ. It was probably an eye which in the ancestors of our present fish occupied a position in the middle of the top of the head. It was probably of use to those ancestral fish as a light or heat perceiving organ but, owing probably to the development of the paired eyes, it has, in their descendents, fallen into disuse. Consequently in our present fish, although it is formed in the embryo, in the adult fish it becomes changed in structure and probably useless. It is found in all the back boned animals including man.

The infundibulum or outgrowth from the 'tweenbrain is best seen in Fig. 44 inf. where it reaches almost to the tip of the notochord. In the other figures it is seen from above and consequently through the 'tweenbrain which it underlies (Figs. 41 44 and 46 inf.). The infundibulum degenerates in the adult fish. It is an organ as to the meaning of which we are still in the dark. It was probably at one time of use to the fish, but if it now has any use we do not know what it is.

The third of the original divisions of the brain, the hindbrain, is seen to be divided before stage E is reached into six cubical masses on each side. The masses are separated from one another by transverse grooves as shown from above in Fig. 44 nmr. and from the side in Fig. 44^a cbl,. nmr.

These cubical masses are known as neuromeres and they are formed by the separation into cubical blocks of the cells composing the sides of this part of the central nervous system. Even before stage E is reached the posterior five pairs of neuromeres are no longer to be seen in views of the living embryo. The anterior pair persists, as shown in Fig. 46, cbl, and forms the cerebellum, the little brain, of the adult fish. In the place where the five posterior pairs of neuromeres were the nervous tube is entirely free from any external indication of segmentation. The tube has here become much broader and its roof, as shown in Fig. 47 vn^4. r. is now very thin compared with its floor and sides. This part of the brain is known as the medulla oblongata. It becomes rapidly narrower behind and merges gradually into the spinal cord.

As the result of these changes we have the brain in stage E divided into five parts which lie in a line one behind the other. In front is the cerebrum, still hardly more than indicated; behind this the 'tweenbrain with the optic vesicles, pineal gland, and infundibulum arising from it; behind this is the broad midbrain; behind the midbrain and separated from it by a deep constriction is the cerebellum; behind the cerebellum is the medulla oblongata.

As the brain thus becomes divided into its five parts, the central cavity which, as shown in Fig. 41, consisted at first of the diamond-shaped space in the 'tweenbrain with its slit-like backward extension, also undergoes changes. The diamond-shaped space in the 'tweenbrain enlarges and is known as the third ventricle (vn^3.); the space in the cerebellum and midbrain becomes broad and shallow and is known as the

fourth ventricle (vn^4.); it continues back as a very narrow cavity, the central canal of the spinal cord. The third and fourth ventricles are connected by the space in the midbrain, which in most animals is very narrow and is known as the aqueduct of Sylvius. Then, as the cerebrum enlarges, it comes to have it in two cavities, one in either half, and these cavities are known as the lateral ventricles. They are the first and second of the four venticles. They both communicate with the third ventricle. All the ventricles are filled with a water-like fluid which serves to protect and to nourish the brain.

By the time stage F is reached the *optic cup* has become deeper as shown in Fig. 44 and the inner wall of the cup is still more thickened while the outer one is thinner. The depression of the external epiblast, which in stage D occupied the cavity of the cup, pushes further in as the cup deepens (Fig. 44 lns.). It soon forms a hollow, almost spherical sac which is connected by a narrow neck with the external epiblast, and the cavity of which communicates with the exterior by means of this neck. Finally this spherical sac separates itself from the external epiblast and lies independent in the cavity of the optic vesicle, as shown in Figs. 46 and 46^a, lns. This is the lens of the eye. Fig. 44a, is a side view of the head in which the observor looks down upon the open mouth of the optic cup, op. c., in which lies the lens (lns.). In such a view it is seen that the cup is not complete but that there is a slit running along its lower side from its edge to its bottom (ch. slt. Fig. 44^a). In viewing the head from above this slit (Figs. 46 and 46a ch. slt.) is seen to be triangular with the apex at the triangle at the bottom of the cup.

The slit is called the choroid slit. In Fig. 46^a there is to be seen a space between the bottom of the cup and the lens and in this space are seen some migratory (amoeboid) cells of the sort that were formed at the sides of the head in Figs. 34^c, 38 and 41. These cells have passed into the optic cup through the choroid slit and form, or have to do with forming the vitreous humor, the jelly-like mass which, in the adult fish, fills the space between the back of the lens and the retina.

The cavity of the *auditory vesicle* (aud. v.) has grown larger and in it are to be seen two opaque masses, one at each end of the vesicle (otl. Fig. 46). Each of these masses looks black by transmitted light and each appears to be made up of several smaller masses, like little grains of sand. These bodies are the otoliths, or ear stones. When the sound vibrations through the water cause vibrations of the fluid in the auditory vesicle the otoliths are set in motion. This vibration of the otoliths brings them into contact with fine hair-like processes on the cells of the auditory vesicle. These cells are connected with nerve fibres and thus the stimulus produced by the sound vibration is transmitted to the brain. It is not known how early in its history the fish is able to hear.

The *olfactory pit* is larger in stage E. and in front view has a triangular outline (olf. in the figures).

The *alimentary canal* is present in this stage, but in Fig. 47 only the posterior portion is shown at alm. In Fig 51, which represents a somewhat more advanced stage, the alimentary canal (alm., alm.) is seen througout its length, and is here but little more advanced than in stage E. It seems to be an almost straight tube, beginning with a slight enlargement just beneath the anterior end of the notochord, and continuing back for a little distance into the tail. This tube, as shown in the figure, ends blindly in front and behind, so that food cannot pass in at the anterior

end, nor excrement pass out at the posterior end. The tube shows scarcely a trace of the division into æsophagus, stomach and intestine, which is soon to take place in it. At the posterior end is seen at prc. in Figs. 47 and 51, an opaque band leading from the border of the tail upward toward the closed posterior end of the digestive tube. This band is a short tube which has been formed by the growing in of the external epiblast. Its cavity opens freely to the outside but there is not yet any communication between it and the cavity of the digestive tube. This tube is known as the proctodæum and later forms the posterior part of the alimentary canal.

The *heart* is present in stage E and the first channels for circulating the blood are established. The heart is first seen on the eighth day, at the temperature given, and therefore before stage E is reached. It is shown in Fig. 46 at ht. It lies at the front end of the notochord in the position where the amœboid cells were seen accumulating in the previous stage and it has been formed, at least in part, from these cells. It has the form of a powder horn. The smaller end lies at the point of the notochord to which it appears to be attached. The heart then turns abruptly toward the left and the broad end reaches to the edge of the body, under-lying for a little way the optic vesicle. We thus have the curious spectacle of the heart lying in contact with the eye. The heart beats as soon as it is formed and long before there are any muscle fibres in its walls. It beats about sixty times per minute and with great regularity. The beat is a wave of contraction which begins at the large and apparently open end of the heart and runs rapidly around it to the smaller end. The wave drives the fluid in the heart ahead of it so that the direction of the current is in at the large end of the heart and out at the small end. The blood is at this stage entirely colorless and its movements are only to be followed by watching the few cells that are seen floating in it. The cells are also colorless and transparent and are probably amœboid, though the writer did not observe in them any movements except such as were produced by the liquid in which they floated.

The heart is a double-walled tube. It consists of an outer wall which, as shown in Fig. 50, is made up of cubical cells, and of a lining of very much flattened cells. The two sorts of cells are separated by a considerable interval. From the outer cubical cells, which in this stage are those to which the contraction is due, the muscles of the adult heart are formed. The inner layer forms the lining of the adult heart, the endothelium. It is probable that at this stage the stream of blood upon leaving the smaller end of the heart divides into two, one of which passes on either side of the alimentary canal, and that these two then unite above the alimentary canal and between it and the notochord. Yet this arrangement was not made out until a later stage. The current of blood which issues from the small end of the heart passes along underneath the notochord as shown in Fig. 48. When it has reached about the middle of the length of the tail the stream turns abruptly and runs toward the head parallel to its first course and a little below it. When it reaches the yolk it passes downward and forward along the opposite side of the yolk to that occupied by the embryo until it comes to the oil-globule. During all this course the stream is seen to be confined by well marked walls, i. e., it is contained within a blood vessel. When it reaches the oil-globule the blood stream spreads out and moves here and there irregularly, as though there were no well-marked channel in which it flowed. In this way it passes about the oil globule, on its left side, along the line where it joins the yolk. Finally it reaches the starting point at the broad end of the heart. The whole circulatory system is thus extremely simple. It may be thought of as a tube, so bent as to bring its ends together; one-half of the tube lies in the body of the embryo while the other half lies on the surface of the yolk. Under the head of the embryo where the two parts join the tube is enlarged to form the heart. By its beating the heart drives the blood backward along the body of the embryo. The blood then returns forward along the yolk to its starting place. By such a circulation it is probable that the nourishment which is afforded by the yolk is carried into the body of the embryo.

About the oil-globule the blood flows in a broad, very shallow and irregular channel and, since the oil-globule lies uppermost in the egg, the blood is there brought into close contact with the external water and, being spread out in a thin layer, exposes a large surface to the water. It is likely then that the exchange of gases between the water and the blood, which constitutes breathing or respiration, is carried on at this point.

STAGE F.

At a temperature of about 49° F. this stage is reached on the twenty-fifth day after fertilization. It is represented in Fig. 56. At this time the fish is ready to hatch and does so if the temperature is slightly raised. If the temperature be kept as low as 49° F. the fish remains in the egg-membranes for a number of days after the twenty-fifth.

The embryo has now increased greatly in size, as may be seen from comparison of Figs. 47 and 56 which are drawn to the same scale. The yolk is reduced to perhaps half its former bulk and the yolk sac, which in the preceding stage protruded greatly on the ventral side of the embryo, has become so much reduced that it seems to form a part of the ventral body wall of the embryo. The head of the embryo has extended forward beyond the yolk sac, so that now the anterior limit of the yolk sac is beneath the posterior limit of the auditory vesicle, instead of beneath the olfactory pit as in the preceding stage. The yolk lies in contact with the posterior surface of the oil globule, but does not now enclose it. The oil globule, has become but little if any smaller. The embryo is much more fish-like in form, both on account of the reduction in size of the yolk and on account of the further flattening of the body. The median fin-fold has become broader and the broadest part of it, about the tip of the tail, is now marked off as the tail fin or caudal fin (Fig. 56, f. cd.).

A little way back of the auditory vesicle and above the oil globule there is a flat nearly circular projection (f. pct) from the body of the embryo. One of its surfaces looks outward while the other looks inward toward the body of the embryo. The beginning of this projection is seen in an earlier stage in Fig. 53, f. pct. where it has the form of an equilateral triangle with rounded angles, and attached to the body of the embryo by one of its sides, while its opposite angle points directly upwards. This is the rudiment of the pectoral fin, Fig. 56, f. pct.

The *notochord* still forms the most prominent part of the skeleton. Its anterior end, as before, bends downward and tapers to a point just behind the eye. Its posterior end has become sharply marked off from the tissues

of the tail (Figs. 51, 52–56 ch.). The notochord has the appearance of being made up of closely packed spherical sacs filled with fluid (Fig 51). When stage F is reached these structures have become angular in outline apparently on account of mutual pressure (Figs. 52 and 56). The explanation of this appearance is best made out from sections. The bar of cartilage which serves as the foundation for the lower jaw is now present (Figs 52. and 56, c. mck) as is also the one about which are formed the bones of the tongue (Figs. 52 and 56, c. hy.). In Fig. 52, at c. br. and c. br^2 it may be seen that the first two of the bars of cartilage which serve as supports for the gills have been formed. In the median fin fold and particularly in the caudal fin may be seen fine threads running from the edge of the mesoblastic somites outward to the edge of the fin fold and serving to support the fin. These are the first traces of the fin rays, Figs. 51, 52 and 56 f. r. The notochord, the cartilaginous basis of the lower jaw, tongue, and gill arches, and the fin rays, are the only parts of the skeleton yet present.

The *mesoblastic somites* have not increased noticeably in number. The angle at the middle of each is now sharper and there is a connective tissue partition running lengthwise of the embryo through the apices of all the angles of the mesoblastic somites, in such a way as to divide each somite into an upper and lower portion (Fig. 56, prt.). The somites are now entirely converted into muscle fibers and the cross striations of the muscle fibers have been for some time visible. Each mesoblastic somite has thus become a myotome, or muscle segment, and these myotomes have much the appearance that they have in the adult fish. All the myotomes taken together make up the lateral body-muscles and the whole mass of lateral body muscles is divided, by the partition above referred to, into two parts, one lying above the partition or dorsal to it and known as the dorsal, lateral body muscles, and the other lying below it or ventral to it and known as the ventral, lateral body-muscles. The dorsal, lateral body-muscles are derived from the upper or dorsal portions of the mesoblastic somites while the ventral lateral body muscles are derived from the lower or ventral portions.

The fish is now able to move vigorously inside the egg membranes bending the body and head from side to side and lashing the tail. These movements all grow more vigorous when the temperature is raised and becomes less pronounced when the temperature is lowered.

The only notable change in the *central nervous system* has been the growth of the cerebrum which now forms a considerable, rounded projection beyond the olfactory pit (Fig. 56, crb.). The eye has become intensely black from the deposit of pigment in the pigment layer of the retina. Fig. 51 shows the beginning of this process, the fine pigment granules having made their appearance in the dorsal half of the optic cup and in the outer wall of the cup. Figs. 52 and 53 show the process carried still further, while in Figs. 54 and 56 it is completed. The choroid slit, which in the preceding stage was a wide triangular opening into the optic cup from below, has closed. The closure takes place from its inner (median) towards its outer (lateral) end. In Fig. 54 the lateral half of it is still visible as a narrow light colored notch, extending inward from the edge of the cup, while in Fig. 56 the notch is no longer to be seen. The whole eye is now more nearly spherical, as may be seen when it is looked at from above or below. This rounding-up is doubtless due to the formation of the vitreous humour between the back of the lens and the retina.

The epidermis covering the lens is pushed outward by the growth

of the eye-ball and forms a hemispherical covering for its outer half. The middle part of this covering is transparent and together with the connective tissue which comes to underlie it forms the cornea (Figs 52 and 54). The sclerotic coat is a later formation.

The *auditory vesicles* are larger and their walls are relatively thinner. The otoliths are more compact, so that it is no longer easy to distinguish the separate granules of which they are made up. As early as the eighteenth day the walls of the vesicles begin to show the characteristic markings shown in Fig. 53. These markings are due to elevations and depressions of the surface of the vesicle and they lead to the formation of the semicircular canals of the ear. The process by which the auditory vesicle becomes changed into the membranous labyrinth of the adult fish is a complicated one and difficult to follow without the use of sections and of models made from series of sections. It is sufficient to say here that by the time stage F is reached the outlines of the three semicircular canals have been established (Fig. 56 ss, ss^2, ss^3).

The cavity of the *olfactory pit* has now become larger so that the surface which its cells are able to expose to the water is increased. Before this stage is reached the cells of the olfactory pit are seen to be provided with projecting hair-like processes, called cilia. The cilia are very slender, but may be made out under a moderate power of the microscope. They are in rapid motion back and forth, the whole moving mass of them resembling a field of wheat over which the wind blows. By the motion of the cilia a current of water is kept up over the walls of the olfactory pit. It often happens that small dark colored particles that are in the water are drawn into the pit and may be seen buffeted about there by the cilia. The water is thus carried by the cilia into the organ of smell, so that the fish may perceive the odors that are in it. In higher animals the same thing is accomplished by forcibly drawing the air in through the nose.

The *alimentary canal* has now undergone numerous changes. In stage F the thickness of the embryo and the position of the yolk and oil globule are unfavorable to the study of the canal, but in somewhat earlier stages it may be studied to advantage. It is difficult in any stage to make out much with regard to the anterior part of the canal, but the passages leading into the anterior part, which have now been formed, are readily made out. Fig. 53 shows the largest of these, the mouth (mth). As soon as the head has grown out enough so that the anterior limit of the yolk sac is about on a level with the posterior limit of the eye, the mouth cavity is seen as a depression of considerable area. In side view it is seen that the depression is triangular, with the apex of the triangle projecting backwards, and it is also seen that the mouth opens on the lower side of the head, being as yet unprovided with a lower jaw and being consequently without a floor. Back of this oral depression may be seen indistinctly the anterior part of the pharyngeal portion of the alimentary canal, but it is not yet possible for food to pass along the alimentary canal. In Fig. 54, is shown a view of the mouth from below, as seen in a somewhat later stage.

The lower jaw with its supporting cartilage (mck.) has appeared and has extended forward far enough to form a floor for the posterior half of the mouth cavity. In front of this may be seen the triangular anterior part of the mouth still opening below. In Fig. 56 very much the same thing is seen in side view. The lower jaw, (mnd) is by no means long enough to close the mouth cavity below so that the roof of the mouth, bounded at the sides

and in front by the upper jaw, remains exposed in front of it. While the mouth is being formed other openings into the alimentary canal are making their appearance, back of the eyes and beneath the auditory sac at the sides of the head. They are the gill slits. They are indicated in Figs. 51 and 53, br. slt., where they appear as opaque patches at the side of the alimentary canal. A little later (Fig. 54, br. slt.) in the place of these patches are seen slit-like openings from the outside into the alimentary canal. The first of these is just back of the lower jaw and the others are parallel to it and behind it. Four of these may be counted and they become successively shorter, the last being shortest. The slits are separated from one another by means of connective tissue arches known as gill arches or branchial arches. Along the middle of each branchial arch there runs a supporting rod of cartilage, the branchial cartilage, noticed when speaking of the skeleton. There are in this stage three branchial arches and three branchial cartilages formed, no arch or cartilage being yet formed behind the last slit. In Fig. 54 the slits, arches and cartilages are represented on one side of the fish only. On the opposite side of the fish, where the heart lies, a part of the first slit is shown, the others having been omitted in order not to interfere with the view of the heart. In side views these structures are shown on one side only and since they are crowded together from behind forward, and thus overlap one another, it is difficult to make out details with regard to them. Yet in Fig. 56 three of the arches may be seen (br. a.).

At first these slits are not hidden by the gill cover or operculum as they are in the adult fish but they open directly to the outside, as they do throughout life in the sharks. In stage F the gill covers are beginning to be formed. The cover of the left side is shown in Fig. 56 at opc. It is a thin semi-circular plate of tissue which grows backward from the first or hyoidean gill arch. It thus comes to cover all the gill arches and gill slits except the first slit which finally disappears. The result is, that in looking at the side of the head of a bony fish, one sees only a single opening on each side along the edge of the gill cover, whereas in sharks one sees five openings on each side, openings which exist in the bony fish but which are hidden by the gill covers. In later stages of the embryo the water passing in through the mouth makes its way through the gill slits into the space beneath the gill cover and so to the outside, as it does in the adult fish.

Just back of the pectoral fin and below it there is shown, in Fig. 53, an ovoid, somewhat opaque mass which seems to be attached by one of its ends to the alimentary canal. This is the liver. It is not shown in Fig. 56, but appears in figures of later stages. It appears to begin as a solid outgrowth from the ventral wall of the alimentary canal back of the pharynx as shown in Fig. 51, hpr. Its precise mode of origin and growth are best followed in sections.

Back of the liver, where it appears in the figures, the alimentary canal is seen to be a nearly straight tube of almost uniform diameter. It passes beyond the yolk sac into the tail and bending downwards ends at the border of the ventral fin fold. The fin fold is notched where the anus opens. The part of the alimentary canal which lies between the bend and the external opening is the same that in the preceding stage was seen in the form of an outgrowth from the external epithelium.

The outgrowth has fused with the posterior end of the alimentary canal, so that there is a passageway by which excrement may escape. We thus

have the alimentary canal made up of the mouth, the pharynx with the gill slits, and a portion behind the pharynx from which the liver has grown out and which later is divided into œsophagus, stomach and intestines.

The *heart* in the figures is longer and more bent than before, the broader, open end having been carried further back and further up, so that the whole heart is now somewhat V shaped. The large, apparently open end into which the blood enters is now marked off by a constriction from the rest of the heart. This, the receiving portion of the heart, is called the auricle (Figs. 58 and 62 au.). Beyond the constriction the heart tube is again enlarged and then again grows smaller, until it divides into the aortic arches. The enlarged portion is called the ventricle (v) and the smaller portion between the ventricle and the aortic arches is the truncus arteriosus. The auricle receives the blood, appearing to draw it in from the veins as a suction-pump would. It is then forced along into the blood vessels by the contraction of the ventricle. Owing to the fact that the ventricle forces the blood through all the vessels of the body it has much more work to do than the auricle and its walls are consequently much thicker. There are not yet any valves in the heart for preventing the return of the blood as it passes from one part of the heart into the next. The circulation changes considerably between stages E and F, so that it is best first to describe as it is a little while after stage E.

The diagram Fig. 61 shows an embryo of the thirteenth day. From the truncus the blood passes into two arteries, the first pair of aortic arches. The aortic arches bend up at the sides of the pharynx so as to embrace it and then run backward on the upper or dorsal side of pharynx and between it and the notochord, until they finally meet and unite. The artery formed by their union is known as the dorsal aorta. It passes back beneath the notochord into the tail, being known in the tail as the caudal artery. Near the tip of the tail, the caudal artery turns about and runs forward to the yolk sac, as in the preceding stage. The part of it in the tail is called the caudal vein (v. cd.). The caudal vein then follows along the lower, middle line of the yolk sac until it reaches the oil-globule. Over this part of its course it is called the vitelline vein. The blood from the vitelline vein enters the large space (sp.), previously noted about the oil globule, and so passes into the auricular end of the heart. Some of the blood in the caudal vein, instead of passing to the heart by way of the vitelline vein, passes forward from the caudal vein into two veins one of which lies on each side of the body above the alimentary canal. These are the posterior cardinal veins (v. crd. p. l. and v. crd. p. r.).

Two arteries, (crt.) arise, one from each of the aortic arches at the point where they turn to run backward. These two vessels, the carotid arteries, run forward to the front of the head and eye. The blood which they carry out is gathered up by two veins which form arches over the eyes and finally pass backward and downward to join the posterior cardinals. These are the anterior cardinal veins, (v. crd. a. l.) and (v. crd. a. r.). Thus there is formed a vein on the right side by the union of the right anterior and posterior cardinals and a vein on the left side by the union of the left anterior and posterior cardinals. These two are called the ducts of Cuvier, (d. Cu.). The right duct of Cuvier passes beneath the body of the embryo from right to left and joins the left duct of Cuvier. The blood from the two then enters the auricular end of the heart. In this stage it is difficult to detect any walls to the space through which the blood flows in passing from the