ELEVENTH BIENNIAL REPORT

OF THE

STATE BOARD

OF

FISH COMMISSIONERS

FROM DEC. 1, 1892, TO DEC. 1, 1894.

BY AUTHORITY.

LANSING
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APPENDICES.

ERRATA.

Page 45. "Lake Huron" in ninth line should read Lake Michigan.

Omitted between 13th and 14th lines, p. 45, Fourth District; west shore of Lake Huron, south to Port Huron, St. Clair river and Detroit river to Detroit.

"Lake Huron" in first line under head of Fifth District, should read Lake Superior.

On p. 53, 35th line, "200,000" should read 1,762,852. "500,000 pounds" in line 36 should read 2,764,587.

REPORT.

To the HON. JOHN T. RICH, *Governor of Michigan:*

SIR—A detailed report of the operations of the State Board of Fish Commissioners, covering the period from December 1, 1892, to December 1, 1894, is herewith submitted in accordance with law.

The established work of the board has been carried forward during this period with a gratifying measure of success, and with increasing usefulness. This work consists of the artificial propagation of the commercial fish of the great lakes, consisting of the whitefish (corregonous culpeiformis), the pike perch (stizostedion vitreum), the salmon trout (salmo namaycush), and of brook trout (salvelinus fontanalis), the rainbow trout (salvelinus irideus), the brown trout of Europe (salvelinus alpinus), the carp (cyprinus carpio), and the sturgeon (acipenser sturio).

The stocking of the streams of the State with brook trout, brown trout and rainbow trout has been somewhat increased as to output over the report of two years since, and is now being conducted in a manner somewhat commensurate with the needs of the State. The results of the stocking of the streams with these varieties is very gratifying and has met with universal favor.

In the lower peninsula, where, until within recent years the stocking has been principally done, the trout plants have been phenomenally successful. Streams in more than fifty counties of the State have been successfully planted, and in every instance where the waters have been suitable and the fish have been properly planted; the success has been unqualfied.

The measure of success of this branch of the work will be better understood when it is known that before the introduction of the artificial propagation of this fish, none of the streams of the lower peninsula, with the possible exception of one or two small river basins, contained brook trout.

By a liberal and careful stocking of these waters with fry, this has all been changed, and now it can be said that nearly all of the streams in these localities rank with any other streams of the country in the superior trout fishing they afford.

It has been a commonly accepted notion that brook trout will not thrive in many of the streams of the lower peninsula because of the latitude in which they lie, and the height to which the temperature rises in many of these waters. But the abundance and size of the artificially bred brook trout in the streams of Calhoun, Barry, Kalamazoo and other counties in the southern portion of the State, have changed this prevalent notion, and in many of the spring fed streams and brooks of this section of the State fine trout of good size have been taken for a number of years.

The natural condition of these streams is such that the fish kindly take to the new habitat. Nearly all the streams in this State which are fed from spring water sources are filled with the natural food of the trout, such as the caddis, fresh water shrimp and other crustacea. Our experience with all these streams shows that if they are not overstocked the fish will attain a remarkable growth in a short time.

The Au Sable, the Maple, the Pigeon, the Sturgeon, the Pere Marquette with its numerous tributaries, and other rivers in the middle portion of the State, were once well stocked with the grayling, which are natural to those waters. Since lumbering operations were began, however, these fish have been gradually growing less in numbers. Log running operations have made thoroughfares of these rivers, and have been the principal cause of the disappearance of this fish. These rivers, in the language of the early explorers, are "sweet water" streams, being pure, cold and clear, and are fit rivers for either the grayling or trout.

When it became apparent, some years since, that the grayling were diminishing in the streams which lie in what may be termed the "grayling belt" of the State, the commission was solicited by several of the prominent sportsmen of the State to stock them with brook trout. The board refused to do this, and determined it was best to try and restock them with grayling.

We then began a series of experiments, extending over a period of about three years, to artificially propagate the grayling. Repeated attempts resulted in failure. Under domestication they showed no disposition to spawn. Different plans of procedure were adopted, but they did not respond to any attempts to artificially propagate them. We finally became satisfied that like certain other fish and quadrupeds they could not be reproduced while held in restraint, or under domestication, and we were reluctantly compelled to abandon all hope of making any success in this direction.

We are convinced from our knowledge of the life history of the grayling in some of the streams in the State, which at one time were log running streams, but have long since been abandoned as such, that in time natural conditions will assert themselves, and that the small tributaries of these streams contain grayling enough that have escaped the log destroying gauntlet, to stock the streams fairly well again.

Experience, and investigation of the facts, further show that the commonly accepted notion, that if grayling and brook trout are placed in the same stream it will ultimately end in the destruction of the grayling, is unfounded. It is well known that in several streams in England and Wales the grayling and trout are found in common in the same streams. According to Walton, Francis, and the testimony of present day anglers, this condition exists and has existed there for many generations.

After all efforts to artificially hatch the grayling had proved unsuccessful, we decided it was better policy to stock these grayling rivers with trout. Since then these streams have been liberally planted with brook trout and rainbow trout, and in some instances with the brown trout. The result following these plants has fully justified the course taken. Several of these rivers today are becoming known as famous trout streams, and in a number of them grayling, brook trout, rainbow trout and brown trout are interchangeably taken in a day's fishing.

In passing, it may perhaps be well to say a word regarding the decline and probable future history of the grayling in Michigan waters. The great factor in the diminution of their numbers we believe may be attributed almost wholly to the logging operations which have been carried on for many years on the grayling rivers. The grayling's spawning season may be stated as extending from February to April. The ova is then cast and remains upon the gravelly beds of the streams until about the last days of March, when it hatches. The sun in its northward course, with the spring rains finally loosen the icy fetters which have held the streams in their grasp for months, and the vast quantity of logs which have been cut during the winter and thrown upon the ice are released. These masses of logs come plunging down the river channels, furrowing and plowing up the beds of the streams, tearing up the ova from the places where it is deposited, and thus destroying the means which nature has provided for a restocking of the streams. This occurring from year to year has worked largely to lessen the numbers of these fish. Such stocking as the stream gets, comes therefore from the small tributary brooks and creeks of the rivers which are too small to be run with logs, and we believe that in the end these natural nurseries will serve to at least preserve in some degree the grayling in this State. When lumbering shall cease on the grayling streams, restocking will again be begun by nature and we believe these fine game fish will be known and found in Michigan for many years to come.

The success of the brook and other trout in these streams can be accounted for by reason of the difference in the spawning season of the grayling and brook trout. The eggs of the brook trout are cast from September to December, approximately, and are hatched before the breaking up of the rivers by the spring freshets, thus giving the young an opportunity to take care of themselves.

The rainbow trout is a spring spawner and its ova would stand but little better chance of coming to maturity than those of the grayling in these streams. There are but few streams in the State where the liberating of the young of this fish have been successful, and those are the larger streams lying in the grayling belt in which the log running has practically come to an end. As a game fish, the rainbow trout has no superior among the salmonidae found in our waters, and in edible qualities is equal to any of its congeners. A small stock of the parent fish of this variety is now carried in one of the ponds in Paris, sufficient with which to stock the waters which experience has demonstrated are suitable for its habitat.

The operations embracing the hatching of the commercial fishes have been somewhat increased in the last two years, although not to any great extent, and we are now conducting a very large and important work in this direction. This work includes the hatching of whitefish, salmon trout and the pike-perch or wall-eyed pike of commerce. The output of whitefish fry has amounted for the past four years to upwards of one hundred and fifty millions per year, and of the pike-perch more than twenty-five millions. The large plants of whitefish made from the hatcheries of the State have served to sustain the productiveness of the fisheries to a considerable extent. This is better demonstrated by a comparison of the condition of the commercial fisheries of Lakes Ontario and Erie with the fisheries of the upper lakes, Huron, Michigan and Superior. As pointed out in another portion of this report, if proper legislation can be had to protect these fisheries in our waters, we have no hesitation in asserting that they may be brought back in the course of a few years to something like their former productiveness by the aid of artificially hatched fish.

With a view of securing a more economical, wider and better distribution of the whitefish fry during the hatching period in each year, and to avoid the losses resulting from an overcrowding of our facilities for distribution at that time, we established last year a relief station for whitefish ova at Charlevoix. With the large hatch of whitefish at the Detroit hatchery when the eggs are all carried at that station, we have been unable, even with the constant use of two cars, to make the distributions rapidly enough to prevent a considerable loss of fish. This relief station has been established at a small expense to the State and will be of great service. The resulting benefit has been apparent even during the one season it has been in operation.

With the wide distribution of small-mouthed black bass in all the waters of this country lying east of the Mississippi river basin, and the profusion with which the inland lakes and streams of this State were naturally stocked with these fish, it has not been found necessary until within the past few years that we should give this fish any attention. But the steadily increasing number of our people who resort to these lakes to catch the black bass and the persistent fishing to which they have been subjected has at last made it manifest that steps must be taken to renew the fish in these lakes by artificial means. The demand for young bass for this purpose has been constantly growing and in the season of 1893 we took the initial steps looking to the establishmnt of an experimental station for this purpose. No branch of our work is likely to prove more popular than the hatching and distribution of these fish and the popular demand has been so imperative that we believe the establishment of this station meets with the entire approval of the public.

Several years ago the commission began a series of investigations of the fauna of the inland lakes of the State. The object of that inquiry was to determine what was the character of the life of our inland lakes the different varieties of fish food they contain, and upon the results of these investigations we might more intelligently base a judgment in alloting fish to applicants for different waters. The object aimed at was to get if possible an intelligent understanding of the natural conditions relating to the food supply, etc., by which we might be guided in making future allotments of fish to applicants. These investigations were carried forward for a number of years, and there is now on file in the office of the board a tolerably complete survey of the inland lakes and different river basins of the State.

SCIENTIFIC INQUIRY.

It has long been apparent to the commission that our knowledge of the kind of food upon which the young whitefish subsisted was at best but very meager. Very complete mineralogical, topographical and other kinds of surveys have already been made of the State, touching many of her material interests, but singularly enough no comprehensive biological or zoological survey has yet been made which furnishes us a knowledge of the fauna of our great lakes and inland waters. The possession of this knowledge is of as much importance to the public welfare as the information derived from any of the surveys that have been made along the other lines referred to, and affects our material interests as deeply. The monetary and food value of our commercial fisheries to the State cannot be overestimated, and a complete knowledge of the food of the commercial fish is one of the things which closely affects successful fish culture.

Fish commissions were first establised about twenty-five years ago and at once sprang into deserved popularity. They appealed to the public as a means by which the fisheries, which for such a long period had been subjected to wasteful fishing, might be in a large measure restored to their former fruitfulness. The wonderful success of Dr. Garlick, Seth Green, Samuel Wilmot and other fish culturists of twenty years ago in the successful artificial propagation of the salomnidæ lead to great encouragement in fish cultural work, and the states eagerly entered upon the work of the artificial breeding of fish. It was demonstrated that whitefish ova could be successfully handled, with a wonderful degree of success, and Michigan, with her usual encouragement of promising enterprises began the work of the artificial hatching of whitefish.

The food of the young trout was known long before their artificial propagation was begun, but when it came to the question of the food of the commercial fish of the great lakes, fish culturists were confronted with conditions about which they knew little, and but little has been since added to our knowledge of the subject. The food of the adult whitefish was pretty definitely determined at an early stage of fish culture, but the food of the fish from its infantile stage to an age when partially grown was entirely unknown.

It has been enforced more and more upon us during our entire experience that this subject was one which should be thoroughly investigated, so that we might act intelligently in liberating the fry of this fish in localities where their food could be found in greatest abundance. It is important that the fish culturist should know what the food of the infant whitefish is, where it is most abundant, whether it is found in shoal water or in the deeper parts of the lakes. It is of importance to know where the young fish resort at different seasons of the year; whether their food changes at certain stages of growth, and if so of what it consists during these different periods. It is important that we should know how long they remain upon their natural spawning beds after they are hatched, where they go, and in search of what food. These, and numberless other questions which are closely related to the practical results of fish culture should be determined. With these questions solved, a more certain result can be reached in fish cultural operations than is now possible. We believe it is strictly within the scope and duties of the Fish Commission to settle these unknown conditions as absolutely as may be, by the institution of a systematic series of investigations which shall be carried on from year to year by skilled scientific observers, acting under the general direction of this board along lines which shall lead to practical results.

These questions have been frequently discussed and considered by the commission, and their importance in connection with our work fully realized, and in the spring of 1893 it was decided to commence the inquiry. Arrangements were made with Prof. Jacob Reighard, the professor of animal morphology of the University of Michigan, to take charge of the investigation and to organize the necessary force to carry on the work.

The services of scientific men connected with the Universities of Michigan, Wisconsin and other states, were enlisted in the service. It was arranged to take up the work at the commencement of the college vacations, and to prosecute the inquiries as far as the time would permit each season. The University of Michigan co-operated with us by the loan of the necessary literature and instruments. With the small means at our disposal the work has been carried forward, with good results, for the past two summers. By conducting our investigations upon this plan we have been able to secure the co-operation of skilled scientific men in this work at but little outlay, and the State has been subjected to no expense for their services. Too much cannot be said in commendation of the disinterested way in which these gentlemen have served the State in this most important work. The experience of the past two seasons has shown that the work has taken a broader and more important scope than was originally contemplated. Subjects of scientific investigations kindred in their character and necessarily closely related to the work entered on have been carried along, and the result has been a thorough identification of the fauna and flora so far as the territory has been covered.

Owing to the absence of Prof. Reighard in Europe during the season of 1894, Dr H. B. Ward, of the University of Nebraska, undertook the direction of the work during the past summer, and is entitled to credit for the results of the season's explorations.

We believe the State should carry forward this work which has been so well begun and which promises to be so important in its results. We would therefore recommend that an allowance of $2,475 per year be made for the coming biennial period for the prosecution of this inquiry. The necessities of the work require the allowance of this amount to carry forward these investigations successfully, and with advantage. The work should be continued from year to year in the future until the waters of the State are thoroughly explored, and their fauna is thoroughly identified.

So far as the results of this work have been published, it has received much commendation from scientific students and observers, and has reflected credit on the State for its enterprise in entering upon this work.

REGULATION OF THE COMMERCIAL FISHERIES.

For more than ten years, the commission has periodically called the attention of the legislature to the necessity for the enactment of better laws for the protection of the commercial fish of the State, and for the better enforcement of the laws already enacted for this purpose.

At the last session of the legislature we presented to both houses for their consideration, a statement of the conditions surrounding the fisheries, which threatened their destruction unless the strong arm of the law should intervene for their preservation. The facts presented showed that present methods of fishing were of such a character, if continued, as to lead to their ultimate extinction. A number of hearings were had before the committees of fisheries of the Senate and House, sitting jointly, where these matters were fully discussed, and the commercial fishermen were given a full opportunity to be heard upon the question of the legislation we proposed for the protection of fish. Those committees agreed to report favorably the bill we presented, and did so report. Immediately following this action, the fishermen began an active opposition to the proposed measures, and with such success that when the bill was reported in the Senate, although supported with an able argument by the chairman of the committee of fisheries of the Senate, enough influence was brought to bear to defeat it. This ended the matter, no report being made by the House committee.

The results of the fishing of the last two years have only confirmed and made stronger our belief, that unless prompt and effective measures are soon taken the fisheries of the great lakes in this State will soon follow the history of the fisheries of Lake Ontario and Lake Erie. The Lake Ontario fisheries have been absolutely wiped out, although once of the first importance. The majority of the fishermen who once followed a profitable occupation upon that lake have long since been driven to other callings for a livelihood, and the industry has practically come to an end.

Dr. Hugh Smith, Superintendent in charge of the Division of Statistics of the United States Fish Commission, in reporting upon the condition of the fisheries of this lake to the commissioner in the year 1891, says:

"The scarcity of fish that formerly abounded in Lake Ontario, and the possibility of a further decrease in those and other species, have been the basis for an agitation which has become one of the most noteworthy movements of the kind in recent years. Fish and game clubs, anglers' associations and economic trade organizations have given the matter consideration; sporting and industrial publications have contained numerous and detailed accounts of the progress of the movement; the daily press has noticed the subject editorially and opened its columns to correspondence and news; conferences have been held between representatives of the countries immediately interested in the preservation of the lake fisheries; the New York legislature has provided for a new code of fishery laws with a view to securing better protection to fish, and the national congress has made provision for the establishment of a fish hatching station on or near Lake Ontario.

"The species of which the greatest quantity was caught (speaking of the year 1891) were the cisco and the other minor varieties of whitefish, classed in the tables under the general name of herring."

Dr. Smith gives some tabulated statements showing the quantities of whitefish taken in Lake Ontario upon the American side of the lake in 1890 and 1880, and a comparison of the same shows the following:

In 1880 there were taken 1,064,000 pounds. In 1890 there were taken of whitefish 148,771 pounds, thus showing in the ten years a decrease of 915,229 pounds, or 86.02 per cent.

The catch of salmon trout in the American waters of Lake Ontario for 1880 was 569,700 pounds, and for 1890, 41,010 pounds, showing a decrease in pounds of 528,690, and a percentage of loss of 92.80 per cent.

Speaking further on this same subject, he says:

"Trout are now very scarce on the American shore of Lake Ontario, and the decrease of catch since 1880 has been one of the most remarkable changes in the fisheries of that body of water. In 1880 over half a million pounds were taken, and in 1890, although the yield was double that of 1885, only one-fourteenth of the catch of 1880 was obtained.

"The present scarcity of the highly esteemed whitefish (corregonous culpeiformis) in American waters of Lake Ontario is one of the most noteworthy features of the life of the lake. The yield of this species is now only one-tenth of what it was ten years ago, and in many localities in which the fish was formerly caught in considerable numbers, it is now rarely if ever taken."

The history of the commercial fisheries of Lake Erie has been that of uninterrupted decline for years. Many of the whitefish gronnds, which once yielded a profitable return to the fisherman, have been abandoned, and the inevitable result must be that the remainder will cease to be productive in a very few years.

The condition to which those fisheries have now been brought can be better understood, and the decay which has fallen upon them is made apparent in an article published in the Detroit Free Press of April 14, 1894, which follows:

LAKE ERIE OVERFISHED.—SANDUSKY FISHERMEN ARE GOING NORTH FOR THE SUPPLIES.

"Toledo, April 13 (Special).—The scarcity of fish in Lake Erie and the somewhat inferior quality is causing something of an exodus of dealers form Lake Erie to the Northern United States. The Sandusky Fish Company, which consists of all the firms at and in the vicinity of Sandusdy, has decided to remove its entire business to the Lake of the Woods on the boundary between the United States and Manitoba. Nine carloads of nets, a tug, etc., were shipped to Duluth today, en route to the point stated. On this lake it is said that whitefish and sturgeon exist in great quantities. The company expects to catch sufficient to meet the demands of trade, and when the rigorous northern winter sets in will come back to Lake Erie and go to work. It is stated that numerous companies along the northern coast of Lake Erie will soon follow. Lake Erie supplies nearly all the northern states with fresh water fish, but excessive netting for several years back has almost ruined the business."

The Fishing Gazette, a paper devoted to the interests of commercial fishermen of the United States, in its issue of April 5, 1894, says:

"Speaking of the fish industry of Lake Erie and the large and alarming decrease of food fishes, and the causes that have led to it, State Fish and Game Warden L. K. Buntain, said to the Cleveland Leader reporter a few days ago, among other things:

'The cause of the great decrease lies in the systematic efforts of the fishermen to get the greatest amount of fish possible. The pound netters, with their inside nets, catch great numbers of small fry not large enough for food, and in Sandusky alone a year ago, thousands of tons of these small fish were ground up for fertilizers, and then, what the pound netters leave, the gill netters take. No wonder that like the buffalo of the great western plains, the food fishes of Lake Erie are about to become extinct. We are told of one Sandusky firm which last year took 400 tons, and had a catch of only 30 tons this year.' "

The following upon the same subject is from the Fishing Gazette of February 8, 1894:

PORT CLINTON, O., Jan. 25, 1894.

EDITOR FISHING GAZETTE—Being a subscriber to your valuable paper, I enclose a clipping from one of our papers, which gives the situation pretty well. At the present time people are alarmed at the disastrous consequences which would follow if Lake Erie is allowed to be fished out as the other great lakes have been. The end is about in sight, and it will take years of the most stringent enforcement of laws confining fishing, to bring the fishery to anything like it has been. Lake Erie is supposed to have been the greatest fresh fish fishing water in the world, but it is about fished out. Already one-half of the fishermen have made assignments and more will follow. Of course the gill netter will not agree to any regulation. We are both gill net and pound net catchers, having forty-eight miles of gill net web in length and about eight miles of pound net. The responsible houses are proposing to limit all fishing to six miles from main shore, and within two miles from shores of any island; also to leave not less than one half of all passages open. Then to make it obligatory to return all undersized fish to the water; also to lift nets in a manner so as to not injure the fish. This limit is opposed by gill netters; also the returning of the fish, as they say they can't do it in cases of whitefish, which, while unmatured, are caught by thousands in herring nets, and are so soft that they are used only to be made into fertilizer. The people have the right to know the exact state of affairs, and no doubt it would be interesting if your paper would give attention to it.

Respectfully,

W. E. B.

At the bottom of this article the editor of this paper says:

"(Attention is invited to the letter of our correspondent, W. E. B., who, being the senior member of a large house engaged in fishing, knows what he is talking about. Extracts from the clipping he refers to appear elsewhere. Evidently something should be done, and done quickly in the lakes, and the fishermen know it and are asking for it.—Ed.)"

LAKE ERIE FOOD FISH.—THEY ARE DECREASING SO FAST AS TO OCCASION GREAT APPREHENSION.

The following is from a Cleveland paper of December 20, 1894:

Cleveland, Dec. 20.—The activity of the pound and gill net fishermen in Lake Erie has resulted in largely decreasing the number of food fish in the lake, and grave fears are felt for the future in consequence. During the last few days State Fish and Game Warden L. K. Buntain, of Dayton, has been in the city obtaining facts and figures for his annual report. He said:

"The report is due the Governor on January 15, and I am now at work on the final details of it. There has been a remarkable decrease in the number of fish caught in Lake Erie waters during the season, and it is causing the greatest apprehension among fishermen. Formerly they have fought against any efforts to confine their occupation within the requirements of the law, and gave me a great deal of trouble, but they are asking for help now. The cause of the great decrease lies in the systematic efforts of the fishermen to get the greatest amount of fish possible. The pound netters with their inside net catch great numbers of the small fry, not large enough for food, and in Sandusky alone, a year ago, thousands of tons of these small fish were ground up for fertilizers.

"Then the gill netters cover the entire lake, going across from one side to the other. These, with their powerful tugs and immense nets, intercept the fish and break them up into groups, which are practically valueless so far as spawning is concerned. One man in Sandusky that a year ago had a total catch of 400 tons, this year had only 30 tons. That shows the extent to which the business has suffered.

The State fish hatchery at Sandusky has done nothing this year, as it was impossible to obtain spawn for hatching purposes, and the hatchery consequently went out of business. In 1889 the catch of fish was so heavy that it could not all be put up. The United States hatchery at Put-in-Bay also did nothing in this year. It is useless to expect that artificial hatching and planting alone will make good the wanton destruction of past and present fishing.

"The value of food fish in inland waters would be fully realized this year if the streams and rivers and small lakes throughout the state were well stocked. If a poor man were able today to go out and catch fish enough to last him a week, it would be a beneficial thing. There is no reason why the lesser bodies of water in the state could not be well supplied with fish."

The Fishing Gazette, of November 24, 1894, contains the following upon the same subject:

"The Erie Connty Reporter, at Huron, Ohio, commenting on the catch of fish in that section, says that it has been the most disappointing known. Thus far there have been absolutely no herring caught in the pound nets, and the gill nets have shown a large falling off as compared with other years. Earlier in the season the catch of pickerel was fully up to the standard, and with anything like an ordinary catch of herring, the season would have proven fairly profitable. But the season is rapidly drawing to a close, and it would require an old time 'run' from now on to bring the total of herring to anything approaching a paying basis. With ordinary conditions this would be possible, but gill net tugs even now are unable to find herring within about twenty-five miles of here steering about north by east, which takes them nearly to Point Pelee. This leads the experts to infer that there are no herring on the American shore, and while fishermen are proverbial optimists, they begin to fear the worst, and all unite in the opinion that the great lake fisheries will soon be but a memory. The shrinkage in the catch of herring, the staple of Lake Erie, is almost incredible. In 1885, Wickham & Co., with thirty-five nets, caught over one million pounds of herring, and each year since then the catch has steadily decreased, until last fall, when their total catch of herring, with seventy nets, was only seventy tons, only about one-fourteenth as much per net as in the first year named. The decrease in the catch of pound nets on the west end of Lake Erie dates from the introduction of gill nets into these waters, each year being considerable less than the preceding one in catch.

"There has been much agitation for several years of the question of preservation of fish in Lake Erie, and several laws have been framed by the pound and gill net factions, but the laws framed by one party have always been bitterly fought by the other, with the result that today the fishing laws of Ohio are practically inoperative, and the food fishes of the most productive body of fresh water in the world are rapidly becoming extinct.

"Stringent legislation to cover the abuses of both gill nets and pound nets should be passed without delay, limiting the gill nets to a certain depth of water, and the pound nets to a certain sized mesh at a certain distance from shore. By this means only can the absolute depletion of the lakes be avoided, and one of the cheapest and most nutritious varieties of food be preserved."

Now that the fisheries of Lake Ontario have been exhausted, New York has begun to fully realize the situation. She now appreciates that, although she has at her door a great reservoir, capable of furnishing an important food product, it yields her nothing. The people of the state have finally awakened to the situation, and her fish commission is making every effort to bring the lake back to something like its former productiveness. Even in these efforts they find themselves hampered, because the lake has been so depleted of its fish that they are unable to get from it a sufficient number of parent fish with which to do the needed restocking, and they have been compelled to come to the upper lakes for the ova. The public have become so much interested in the idea of a restocking of this lake that a society known as the Cheap Food Fish Association, was formed sometime since in that portion of the state lying along Lake Ontario. The association embraces among its members leading business and professional men, whose efforts have been directed to the calling of the attention of the public to the necessities of a restocking of the lake, and they are also seeking to influence legislation in the same direction.

Governor Flower, who lived for many years near the border of the lake, and was familiar with the wealth of fish food it at one time produced, and of the low condition to which it has subsequently come, called the attention of the legislature a year ago to the necessity of a liberal appropriation for the purpose of restocking the lake and urged the fish commission to make greater efforts in the direction of the propagation of the commercial fish. Among other things he said:

"The commissioners of fisheries are continuing the stocking of lakes and streams and with apparently good results. Their efforts should be directed, mainly, however, to increasing the supply of food fish. Merely as conservators of sportsmen's interests their official existence and powers would scarcely be justified by the tax paying public. The scope of their responsibility and the measure of their opportunity are much wider than is prescribed by any such narrow field. There are fifeen hundred square miles of water within the area of our state, capable of producing an unlimited supply of food fish, thus cheapening in large degree the cost of living to the people, creating additional employment and adding to the state's wealth. * * * *

"Liberal stocking of Lake Ontario with whitefish, pike and lake trout, assisted by proper regulations for catches, would build up an important industry in that vicinity, profitable alike to the fishermen and the public. I bespeak for this subject the earnest consideration of the legislature, believing that with comparatively small expenditure great good can be accomplished."

What is true of Lake Erie and Lake Ontario in the matters referred to above by disinterested authorities, is in a large measure true of the great lakes which encircle this State. The decay which has set in and progressed so far on the two lower lakes of the great chain, is in the nature of a creeping paralysis, and unless adequate means are taken to prevent further wanton waste and destruction, the paralysis will soon have equally affected our own lakes, and those great bodies of water must in the future serve no other purpose than that of a highway upon which to float the commerce of the great lakes.

In a monetary sense, Michigan is more deeply interested than any other state lying upon the borders of the lakes in the maintenance of the commercial fisheries. She is surrounded on almost every side by these great fresh water seas, which furnish a substantial food supply to her citizens, and which, if properly conserved, will always be a source from which may be drawn annually a large and important acquisition to our wealth.

When we consider the enormous numbers of nets fished in our waters, and the fact that they are fished at all seasons of the year, except when interfered with by storms, we are surprised to find that any fish are left. If the nets fished in the waters of this State were put end to end, they would encircle the whole State two and a half times.

The State has taken pains to surround the game fish, the game birds and the game quadrupeds of this State with the most rigid laws during their period of reproduction, and for a sufficient time thereafter to protect the young until they can care for themselves; yet the State does not invest one single dollar in their propagation, neither does it derive any substantial return from their capture. Stringent laws have been passed and are rigidly enforced to protect the peach orchards of the State from the scourge known as the "yellows." These laws are wholesome and have been adopted and are rigorously enforced in the interest of the public good; but the great commercial fisheries of the State, which yield more than a million of dollars yearly at the wholesale price are constantly subjected to the most destructive methods of fishing, with the almost certain result that in a short time they will become absolutely extinct. If there is any one

material industry in the State that deserves protection, the commercial fisheries is that industry; and it is not only a matter of the greatest interest to our present population, but it is of vital interest to those who are to come after us.

The State has, with its usual liberality, by the erection of hatcheries, sought to perpetuate the fisheries, and considering these facts and the necessity of maintaining the future supply of food fish, the State should take prompt action to protect the fisheries, and the legislature should enact such reasonable and just laws to protect the public's rights therein, as may be necessary.

It is expected that the Fish Comimssion will restock the gerat lakes and maintain profitable fishing, and yet the fisherman prosecutes his work of destruction without let or hindrance, in season and out of season, with all manner of devices of the most destructive character, and the wholesale slaughter of the young fish which are too young to have yet spawned, still goes on. The task thus set for us is too great to be accomplished without the assistance of natural conditions to aid us. Not only are the young whitefish taken which have been hatched naturally, but those put into the water by the commission are also captured before they have come to spawning age, and thus are the efforts of nature and the ingenuity of man both overcome. Thousands upon thousands of small fish are taken each season, and the advent of each year under present conditions marks a step nearer the end.

The standard of inspection which governs the inspection of whitefish on the lakes, sufficiently characterizes the present methods of commercial fishing, and it may not be without interest to introduce them here.

They are as follows:

Standard No. 1, whitefish, shall consist of sound whitefish well cleaned, trimmed with head off, split on the back, smooth on the face, free from rust or ragged, weighing not less than one and one-quarter pounds each, nor measuring less than twelve inches, measured from extreme scale on tail to extreme scale on neck.

Standard No. 2, whitefish. The same, but it is prescribed they shall not weigh less than three-quarters of a pound each, nor measure less than ten inches.

Standard No. 3. The same, but includes all fish under ten inches in length and weighing less than three-fourths of a pound.

The size of a spawning female whitefish is not less than a pound and a half in weight. The statistics on file in this office show that about three-fourths of the entire catch of whitefish taken in the waters of this State will grade as No. 2 and under. No argument seems to us necessary to show that the criminal results of the methods of fishing now being pursued must soon end in the destruction of our commercial fisheries.

All attempts thus far made to secure the passage of laws regulating fishing have been met with the most stubborn opposition on the part of the fishermen. They have insisted to the legislature that the commission is actuated by some ulterior object and improper motive in attempting to pass protective laws. They have insisted that such laws would ruin their business, and their arguments have heretofore had sufficient strength to defeat all legislation proposed in the public interest.

The duties laid upon the State Board of Fish Commissioners require them to submit a report to the Governor of the conduct of their work, and further requires them to submit suggestions from time to time as to the needs of the fisheries. In pursuance of this duty we have frequently suggested such reforms as seemed to us necessary and proper, and have asked for action thereon. We have no interest beyond that which concerns the public; and although such proposed measures may be defeated our plain duty and our inclination when possessed of all the facts, urge us to again bring this matter to your attention.

The claims of the fishermen that the commission is governed by improper motives has had some weight with the legislature, and we have been improperly looked upon as parties to a controversy who are acting from selfish motives, rather than as State officers performing their proper duties. It seems to us that this subject is of such great importance to the State, that an inquiry as to the condition past and present of the fisheries, the causes of decay, etc., should be made by some authority outside of the commission and reported upon to the Governor, together with such recommendations as may seem necessary for the regulation of fishing methods as will preserve the fisheries in the future. In accordance with this idea we would suggest that the Governor recommend to the legislature that an act be passed at the coming session authorizing the Governor to appoint a commission of three disinterested persons, who shall make a thorough canvass and tour of the great lakes bordering the State, whose duty it shall be to inquire into the past and present condition of the fisheries, the extent of their decay and the causes which have contributed thereto; that such commission be directed to present a finding and report thereon to the Governor at a date, not later than October 1, 1897, together with such recommendations as to needed legislation as the facts may warrant.

We further recommend that at the coming session of the legislature a bill be passed authorizing the imposition of a license fee upon all nets which may thereafter be fished in the great lakes and their connecting waters, and that the fund so obtained from such licenses shall be turned into the State treasury to the credit of the sustentation fund of the State Board of Fish Commissioners, to be used in the propagation of food fish for stocking the great lakes of this State.

The state of New York has a law now in force similar to this, licensing the use of the oyster beds within the state jurisdiction. The dominion of Canada has long had in force a license law governing the use of nets. The wholesale commercial fish business carried on in this State is largely in the hands of individuals and corporations living outside of the State who come into our waters and enjoy the rights to fish therein in common with our citizens and it seems to us but just that they should contribute in this way to the support of the work of artificial propagation.

DETROIT STATION.

JESSE P. MARKS, OVERSEER.

At this hatchery the bulk of the hatching of the commercial fish is conducted, and it is under the immediate charge of the superintendent. It has an equipment of 1,025 Chase Automatic Hatching jars, each jar carrying four quarts of eggs. This station is made to do double duty each year in the hatching of commercial fish. During the month of November in each year the house is filled with whitefish ova, and the winter months are occupied in the hatching of the eggs and the distribution of the fry when hatched. The distributions are made during the months of March and April in all the great lakes and connecting waters bordering the State.

At the close of the distribution of the whitefish, and during the month of April, the house is again stocked with the ova of the pike-perch, or the wall-eyed pike of commerce, one of our most valuable commercial fish. Like all spring spawning fish, the hatching period of this species is much shorter than that required for the fall spawners, like the whitefish and trout and other salmonidæ. The time occupied in hatching the pike-perch is not more than three or four weeks. Immediately upon the completion of the distribution of the pike-perch fry, the house is closed until the operations of the following fall are begun, and the force at the station is put upon other work.

The young of the pike-perch or wall-eyed pike are mostly distributed in the inland lakes and rivers of the State, although a considerable quantity is each year liberated upon the grounds from which the parent fish are taken, to maintain the stock.

The sturgeon hatching operations closely follow the hatching of the pike-perch and are carried on during the month of June, by the regular force connected with the Detroit station. This work is all conducted upon the Detroit river.

The fisheries for the taking of the whitefish are located upon the American side of the Detroit river, and are controlled and managed by the State Board of Fish Commissioners. From these fisheries the ova is gathered with which the Detroit and Sault hatcheries are stocked. The seining season for whitefish begins in the latter part of October and is continued until the last days of November, the time varying somewhat with the character of the season.

These fisheries possess superior advantages for the capture of whitefish over those of any other locality in this State, and for the taking of whitefish ova. Egg gathering upon the open lakes is, at best, a most uncertain undertaking. Its success is largely dependent upon favorable conditions of the season, and the uncertain character of the weather prevailing during November, when spawn gathering should be at its best, renders the result of spawn taking operations a very uncertain matter. Upon the open waters of the lakes the only opportunity afforded for egg taking, is the chance of the spawn gatherer being upon the grounds at just the period when the fish are ready to cast their ova naturally. He is fortunate if he is able to find a very few days out of the entire season when an abundance of ripe fish can be found, from which the ova may be stripped. Under specially favorable conditions only, and with a large force, is there a possibility of securing a reasonably good supply of eggs upon these waters. The history of spawn taking on the open waters of the lakes has been that of partial, rather than of complete success.

This commission having a familiarity with the history of this work and a knowledge of its uncertainties, determined some years since to acquire control of the fisheries upon the American side of the Detroit river, from which to secure their parent fish. We now control six fisheries on the river that are fished by us every fall. The right to fish at these various places has been granted to the commission by the parties who own and control them, free of all rental. They are fished by our own employes, and the fish when taken are placed in crates which permit a free circulation of water, and they are thus held in good condition until their eggs have been taken from them. Experienced egg-takers are in charge of each of these fisheries during the entire spawning season and exercise a constant supervision and oversight of the fish from the time they are taken in the nets until the egg taking season has closed. Operations conducted in this way result in the taking of nearly all the eggs the female fish contain.

The eggs are taken and fertilized and are then removed, each day, to the Detroit hatchery, where they are placed in automatic jars and are kept in constant movement by the circulation of water taken directly from the Detroit river, and are hatched in about four months, the time varying according to the temperature of the water and character of the season.

The success of the work of planting young whitefish has been shown in many localities upon the lakes. If we compare the condition of fishing on our lakes with that of the lower lakes, there can be no question that the present condition of our fisheries has been largely maintained because of these plants. The Detroit river is a fair example of the success of the work of the artificial propagation and planting of this fish. Formerly there was a large run of herring up the Detroit river from Lake Erie in September, and the herring fisheries were a source of considerable profit. Following the herring run each year came the whitefish, which also appeared in the river in very large numbers, until serious inroads had been made upon them by long continued fishing. Within the past ten years the herring catch on the Detroit river has entirely failed, while the catch of whitefish has held its own, or perhaps been a little better, notwithstanding the fact that these fish, running up from Lake Erie to spawn in the Detroit river and Lake St. Clair, are compelled to run the gauntlet of a large number of pond nets at the mouth of the river. The State has done nothing in the way of propagating the herring, while it has made liberal plants of whitefish fry in the river and in Lake Erie; and this accounts for the difference in the catch of these two varieties. The same state of affairs exists with reference to the herring and whitefish catch in Lake Erie itself.

DETROIT RIVER FISHERIES.

1893.

The field work in connection with the Detroit hatchery during the fall of 1893 was carried on at six fisheries on the Detroit river, viz.: East Point, Willis Fishery, Fort Wayne, Grassy Island, Mamajuda and Stony Island.

The first seine hauls on the river were made at Belle Isle and Grassy Island, October 16, and the last at Belle Isle, November 25. A total of 2,123 hauls was made at all the fisheries. The total number of whitefish taken, crated, 14,526. Of this number 7,863 were males and 6,663 females, being a small increase over the total catch of the preceding year.

The average number of whitefish taken, per haul, at all the fisheries, 6¾.

The average weight of fish, 2 7-16 pounds. The total number of eggs taken, 156,227,100. Average number of eggs per female, 28,411. First eggs taken, November 7. Last eggs taken, December 12, being from fish transferred from Belle Isle to tanks in the Detroit hatchery.

Although the crop of eggs taken was large, filling the Detroit hatchery to its utmost capacity with a small surplus for transfer to the Sault station, the supply was somewhat less than that of the preceding year, which was the largest at that time in the history of the work.

The percentage of females spawned was considerably lower than in the preceding year, which accounts for the shortage. This falling off was due to the low stage of water at the Fort and Grassy Island fisheries, thereby causing injury to the fish. The water at these fisheries where the crates are placed is shoal at best, and must be deepened by dredging in the near future.

The percentage of females spawned at the Fort fishery was 72½, and at Grassy 72 1-5, or about 18 per cent less than at Belle Isle, where the crates are set in deeper water with a better current.

BELLE ISLE FISHERIES.

The regular fishing crew was put on at the Willis Fishery, October 16, and at East Point, October 29. A second or night crew was put on at the Willis ground November 5 and laid off November 22. The crew upon the other ground was not doubled and no night fishing was done there, except as done by the day crew fishing over time. The fishing was discontinued at these points November 24, and at the Willis ground on the 25th. One hundred and fifteen fish were taken at the latter ground on the last day of the operations. The run was not over, evidently, but the ice then running in the river precluded a further prosecution of the fishing.

The total number of hauls at East Point was 216. Male whitefish taken, 1,404; females, 553; total, 1,957, or an average per haul of nine. These fish were all crated at the Willis fishery.

The total number of hauls at the Willis fishery was 647. Number of whitefish caught, males, 1,654; females, 1,705; total, 3,359; average per haul, 5 1-5.

Number of females spawned (including those from East Point), 2,043.

Number of eggs taken, 54,735,300, an average per female of 26,791. First eggs taken November 9, last December 8.

The station was closed December 10.

FORT WAYNE FISHERY.

The catch at this fishery for this season was larger than for a number of years. Fishing was begun October 23 and closed November 24. A night crew of fishermen was run at this fishery from November 13 to 22, inclusive. Total number of fish taken, 3,670, of which 2,068 were males and 1,602 females. The average number of fish per haul was 8. The number of females spawned, 1,161; number of eggs taken, 36,636,600, averaging 31,556 per female. First eggs taken November 9, last December 8. Fishery closed December 9.

STONY ISLAND FISHERY.

The catch at this fishery was very light because of the low stage of water during the fishing season. The water is much shoaler here than at any other ground on the river. The ground is an inviting one upon which whitefish may spawn, but in low water the fish do not run near enough in shore to be reached with a seine, which owing to the rapid current is necessarily short. The fish taken at this fishery are much larger in average size than at any of the fisheries above, and the females usually outnumber the males two to one. The fishing at this fishery is all night fishing. Fishing was begun here November 1 and ended the 13th. Total number of hauls, 107. Whitefish caught, males, 119; females, 195. The station was closed within a day or two after the fishing ceased. At that time 72 females had been stripped, yielding 3,165,900 eggs, and average of 43,970 per female. The remainder of the fish were taken to Grassy Island and spawned there. The first eggs were taken at Stony Island November 8.

MAMAJUDA FISHERY.

But a small amount of fishing was done at this fishery, and the operations were carried on by a single crew and continued from October 19 to November 11, inclusive. Total number of whitefish taken, 574, of which 371 were males, 203 females. The station was closed November 13, and the fish were taken to Grassy Island. Twelve females were stripped at the fishery before it was closed, from which were taken about 500,000 eggs, or an average of 42,000 per female.

GRASSY ISLAND FISHERY.

One year with another this is probably the best and most reliable ground on the American side of the river. The catch here in 1893 was about 1,500 greater than in the preceding season. The time from October 21 to 26, inclusive, was occupied in removing obstructions from the ground which interfered with seining and fishing operations during this time were necessarily suspended. Regular fishing operations were begun October 16 and ended November 23. The night crew was worked from November 7 to 22. Fishing terminated on November 23. Total catch of fish, 4,652, of which 2,247 were males and 2,405 females. Females handled that were taken at Grassy, 2,405; females handled which were taken from Mamajuda fishery, 191; females handled taken at Stony Island, 123; total of females handled, 2,719. The females stripped here averaged 27,500 eggs each, making a total of 64,277,000 eggs. The first eggs were taken November 7, the last December 9. Station closed December 10.

In February, 1894, 22,000,000 whitefish eggs were sent from the Detroit station to the relief station at Charlevoix, and were there hatched and distributed at various places on Lake Michigan and the Straits of Mackinac.

DETROIT RIVER FISHERIES.

1894.

The results attending the collection of whitefish ova on the Detroit river in the fall of 1894 were considerably greater than those of any preceding season. The season was not especially favorable for fishing because of more interruptions by storms and severe weather than usual, but this was more than compensated for by the cold weather and low temperature of the water, which caused the spawn to mature rapidly and run freely. Ninety-three per cent of the crated females were spawned, as against 79 per cent of the preceding season. The average weight of the fish was 3½ ounces greater than that of the year before. The total number of eggs obtained was 188,133,000, an increase in round numbers of 32,000,000 over the preceding season. The average number of eggs per female was 32,350, an increase over last year of nearly 4,000. This was due in a measure to the increased size of the fish, but more largely to the exceedingly favorable spawning conditions that prevailed.

The aggregate catch of whitefish was almost identical with that of last year, although one less fishery was operated. The catch at Grassy Island fishery was 34 per cent larger than last year. The figures for the Belle Isle fishery and for Stony Island fishery also show a substantial increase, but there was a marked falling off at the Fort fishery. The cause of this was its more exposed condition to the southwest gales which prevailed than that of any other fishery on the river. Two such gales occurred at the height of the run and resulted in a considerable loss. The East Point fishery catch was less this year than last. This fishery suffered considerably by interruptions from passing vessels, which interfered with the throwing of the seine.

The cleaning of the grounds at Grassy Island resulted in an increased catch of fish at that point.

FORT FISHERY.

The fishing crew was set at work on this fishery October 30 and fishing closed November 25. A second crew for night fishing was put on November 5 and was continued to the 24th, inclusive of both dates. Total number of fish taken, 1,775, of which 1,052 were males, 723 females. Number of females stripped, 630; number of eggs taken, 19,992,750; average number of eggs per female, 29,400. First eggs taken November 12; last, November 28.

GRASSY ISLAND FISHERY.

Fishing was commenced at this point October 20 and closed November 23. A night crew was put on and worked from November 5 to 23, inclusive. Total number of fish taken, 6,255; males, 3,576; females, 2,769. There were also bought to this station from the Red Shanty fishery 87 males and 39 females. Number of females stripped, 2,578. Number of eggs taken, 90,992,750. Average number of eggs per female, 35,683. First eggs taken November 12; last, December 9.

BELLE ISLE FISHERIES.

EAST POINT.

Fishing was commenced at this point October 26 and discontinued November 24. A second crew for night fishing was run at this fishery from November 5 to 19, inclusive. The total catch of fish was 2,306, 1,662 being males, 644 females.

WILLIS FISHERY.

Fishing was begun at this station on October 25 and ceased November 26. An extra crew fished at this fishery from the 4th to the 24th of November, inclusive. Total number of fish caught at this fishery, 3,977, of which 2,103 were males, 1,874 females. The fish from the East Point fishery were brought to the Willis ground to be handled, and there were stripped at this fishery of the fish taken at East Point, 1,655 males and 644 females. The number of eggs taken was 66,044,700. Average per female stripped 29,094. The first eggs were taken November 12, the last December 7.

STONY ISLAND.

This fishery was operated by Joseph Grondy, under a special arrangement with the board by which we were to have the ova from the fish taken. Fishing was begun here November 1 and continued to November 18. There were 437 fish caught, of which 151 were males, 286 females. Total number of eggs taken, 11,419,200. Average number of eggs to female, 40,000. First eggs were taken November 12, the last November 26.

PIKE PERCH 1893.

The wall-eyed pike eggs used at the Detroit hatchery in the spring of 1893 were taken at Saginaw Bay, and the spawn taking operations began there on the 13th April.

The work was interfered with by serious storms from time to time, but in the main the work was fairly successful. Twenty-two million eggs were taken at this point. The work of egg taking closed upon Saignaw Bay at the end of April. From this place the crew was sent to St. Clair river and egg taking operations were begun at Robert's Landing at the fishery carried on there by commercial fishermen. The first eggs were taken at this fishery on the 4th May, and immediately after being taken they were put in Holton hatching boxes, wherein they were carried until the larger percentage of poor eggs had worked off.

A portion of these eggs were run in the boxes with starch added to the eggs which prevented adhesion, and as high as seventy-three per cent of successful inpregnation was obtained. After the eggs had been run in the boxes for some time they were sent to the Detroit hatchery and were there hatched and distributed. Two hundred and thirty thousand of the fry were planted in the waters from which the parent fish were taken. The total number of eggs taken and hatched from this station was 34,280,000.

PIKE PERCH 1894.

In the spring of 1894, the egg taking of the pike perch was conducted on Saginaw Bay and at the west end of Lake Erie. The eggs taken at these places were held in hatching boxes as usual for a few days before being shipped to the Detroit station.

The first eggs were taken on Saginaw Bay March 31, and on Lake Erie April 15. The egg taking season on Saginaw Bay closed April 20, and on Lake Erie April 24. These eggs were all hatched at the Detroit station. They began hatching April 28, ended May 10. The distribution began 7th May and closed on the 16th. The total output of pike perch at this station this season was 28,000,000, and 9,000,000 were hatched and distributed in hatching boxes on Saginaw Bay. Distributions of this fish were made in fifty-three inland lakes and two rivers of the State.

Owing to the difficulty in transporting these fish for considerable distances after they are hatched, we believe it will be better in the future to liberate them after they are hatched in the waters where they are taken, and to confine our operations with the pike perch largely to hatching for commercial purposes. We may be able, however, to make some few distributions in the inland lakes. We believe salmon trout fry can be furnished to take the place of plants heretofore made of these fish in the inland waters of this State, and that they will be much more satisfactory in the end. The salmon trout have succeeded well in the interior lakes of New York, and we see no reason why they should not do well in Michigan. With this end in view, in the spring of 1894 we distributed a considerable number of salmon trout in the inland lakes, and during the spring of 1895 we contemplated a largely increased distribution in the inland lakes.

Extensive repairs were necessary on the Detroit river fisheries in the summer and fall of 1893 in order to make good the wear and tear of fishing operations. A new building was built at the fishery at Fort Wayne for the accommodation of the crews engaged on the fishery. The general river repairs amounted to about $1,200. Six new nets were also purchased for the use of the fisheries. The usual and necessary repairs in and about the hatchery have been made during the past two seasons.

The second floor of the wing of the Detroit station is used for the storage of nets and other material. The weight of this material in the summer of 1893 caused the walls of the building to spread, and the building was strengthened, the walls were drawn together, and it will hereafter carry any weight it is called upon to bear. A lighter was built during the winter of 1893 to be used in the transportation of material and apparatus to and from the fisheries, at a cost of $105.

The houses belonging to the commission on Belle Isle and the one at the Fort Wayne fishery were each painted during the fall of 1892. There has been no considerable expense incurred upon the river fisheries during the fall of 1894, beyond the dredging away of the mud on the channel bank at the Grassy Island fishery. This work was thoroughly done and the increased catch at this fishery has justified the outlay.

It will become necessary in the near future to select a new site for the whitefish hatchery at Detroit, but until that shall be done there must be some necessary repairs made in the next two years to the present station.

Many of the wooden tanks and troughs, which have become decayed from long use, must be renewed. While this will involve no great amount of expenditure, it should be allowed for in the current expense required at this station for the next two years.

There will also be some repairs necessary to put the dock into usable condition at the Willis station on Belle Isle. Some of the piling must be renewed and new stringers, cross pieces and planking will be necessary.

This dock is now used but little by the park board for any purpose, and that board in the fall of 1894 considered the propriety of its removal, because of its present insecure condition. The dock is quite important for our own operations in connection with the island fisheries, and if it should be removed we would be compelled to go to considerable expense each year in each fishing season to erect a temporary dock for the shelter of crates, which structures would have to be removed at the close of each fishing season, under the rules and regulations of the park board. Upon consultation with that board, they have signified their willingness to share the expense of the repair of the dock with us. This is a generous offer when we consider the little use they make of the dock at this point and the fact that they have granted to us the use of the fisheries on the island and many other favors in connection with our operations there, free of charge.

We therefore recommend that a sum sufficient to allow the fish commission to join in the repair of the dock be granted.

The interior of the hatchery should be painted. This work should have been done long ago, but the urgent demands in other directions and a lack of funds has caused its postponement. It will also be necessary to provide new spigots to make good the necessary equipment of the house, which has resulted from ordinary wear and tear, and a small amount will be necessary for other equipment. Fifty cans for use in planting are also needed.

The river fisheries will require new equipment in the way of nets and other implements and pharaphernalia connected with the fishing operations to maintain their efficiency.

STURGEON.

The operations for the hatching of sturgeon in the spring of 1893 were conducted on the Detroit river by the force of the Detroit hatchery. Under favorable conditions we believe 75 per cent of successful impregnations can be reached by artificial methods with the eggs of this fish. These eggs hatch in about four days after being fertilized. During the season of 1893, 450,000 young sturgeon were hatched and liberated in the Detroit river, from which the parent fish were taken.

In 1894 the sturgeon work was carried on, on the Detroit river at two field stations, one being at Clarke's Point, and the other at the Michigan Central railway bridge at Grosse Isle. No fish were hatched at the Grosse Isle station on account of the failure to secure females in a fit condition to be spawned.

At these places on the river a considerable number of set lines are fished each spring. By this method of fishing the fish are hooked in the body and are thus captured. The chances of securing good eggs from fish caught in this way, we believe to be too meagre for successful work on a scale of any magnitude, and the results of the past two seasons do not warrant us in making further efforts in this direction. It is difficult with this mode of fishing to secure a ripe fish at the right time. Occasionaly, if the lines happen to be raised shortly after the fish is hooked and before its fight for freedom is abandoned, a successful impregnation may be had. The struggle that ensues when the fish is hooked results in an expulsion of most of the eggs that are sufficiently matured to run freely. The relaxation that follows exhaustion permits water to enter the vent of the fish and the remaining eggs are thus rendered infertile. It is too much to expect the natural functions will not be disturbed by the violent and barbarous method of grappling, and we believe the non-success of former operations may be largely attributed to this cause. The plan which promises most success is by capturing the parent fish in seines. By this method of fishing the fish are brought in, in good condition, and the eggs can be taken and fertilized with good results. We believe, therefore, that these fish should in the future be taken in this way, and we may then hope for better results.

These conclusions are justified by the fact that at Clarke's Point, where the fish are taken with seines, a good proportion of the fish were found in such condition that the ova could be taken and successfully fertilized. More than a million of eggs were taken at this fishery in one day from fish held in crates awaiting shipment to market. We believe with the knowledge gained from last season's operations a greater success may be had in the artificial propagation of this fish in the future.

Eleven females were stripped at this hatchery and three males, and there were planted 130,000 fry.

PARIS STATION.

J. W. POWERS, OVERSEER.

This station is located at Paris, in Mecosta county, on the line of the Grand Rapids & Indiana Railroad, and is the station where the principal work of the hatching of trout is carried on. There are raised at this station brook tront, rainbow trout, and the brown trout of Europe.

The culture of trout calls for a different class of operations than those used in connection with the hatching of whitefish and pike-perch. The ova of the whitefish is taken from wild fish and with favorable conditions and an ample stock of parent fish a sufficient quantity of fry can be obtained each season. But with the brook trout and the other varieties of trout named, a different state of affairs obtains, and the stock fish needed for trout work must be obtained from parent fish held under domestication throughout the entire year.

Two principal things are necessary to run a trout station successfully. The first is a pure spring fed stream, and the second is a suitable location upon which to construct ponds in which to carry the fish used for spawning purposes. The State owns at Paris 158 acres of land, which has been acquired from time to time, and owns and controls altogether, or in part, on this property, three spring fed streams which are suitable for trout culture. The hatchery itself is situated upon what is known as Cheney creek. This stream is about a mile in length from its source to where it discharges itself into the Muskegon river, and upon this stream there are some twenty-five ponds in which the stock fish are carried for this station. The character of the water of Cheney creek is of the best for the purpose for which it is required. The temperature is low and the creek has a fall of about thirty feet from source to outlet, thus affording a good opportunity for the construction of ponds for the adult fish. This stream for its entire length is owned by the State. The other two streams upon the property are known as the Big Buckhorn and the Little Buckhorn streams, both lying about a quarter of a mile north of Cheney creek. The larger part of the Little Buckhorn creek is owned by the State and about a mile of the Big Buckhorn. Some years since the water of the Little Buckhorn was diverted from its natural channel and taken by a conduit a distance of some 80 rods into Cheney creek. This added a considerable volume of water to the latter stream, and largely increased the opportunities for the development of a larger work upon that stream.

When the hatchery was established at Paris, Mecosta county was a new country, was the center of a large lumbering operations and was but sparsely settled. As the country grew older and settlers became more numerous and farms began to be made, in order to protect the sources of these streams it became necessary for the commission to acquire title to the lands immediately surrounding the streams and their sources, to make secure the future water supply, and to maintain the temperature of the water in the streams. This accounts for the considerable holding of land which the State has at this station. This land has increased in value materially since its purchase, and if for any reason in the future it becomes necessary to remove this station to some other locality, much more can be realized from its sale than the original investment.

During the season of 1893 and 1894, a large number of salmon trout eggs were hatched at this station, in addition to the brook trout work, and those fish were distributed in the inland lakes of the State. From ten to twelve thousand adult brook trout are carried in the ponds from which the eggs are taken for the hatchery, and the output of the brook trout for the last two years has been as follows: 1893—2,626,000; 1894—2,788,000.

Out of this number, in 1893, there were sent to the Sault station from Paris, to be distributed in the waters of the upper peninsula, 200,000; and during the year 1894, 300,000 were sent to the same station.

In 1890 the hatching of rainbow trout was discontinued owing to the unsatisfactory results of the plants that had been made in previous years, and to the fact that a much lower percentage of eggs were hatched from rainbow trout under similar conditions than from the brook trout; nor did the adult rainbow trout carry as well in ponds under domestication. At the time the breeding of this fish was discontinued, the most of the parent fish held in the ponds had become affected with some disease which had apparently become epidemic, and this also had its influence in causing us to abandon their further culture.

Since that time, however, several of the rivers into which they had been introduced have furnished excellent rainbow trout fishing, and are apparently favorable streams in which to liberate these fish. Considerable numbers of these fish are now taken in those streams every summer, many individuals are taken of large size, and this fish has become deservedly popular with sportsmen. When these facts became manifest, we decided to again enter upon their propagation. It is our present intention to carry a sufficient stock of these fish to maintain good fishing in streams for which they are suited. We now have on hand at Paris about 200 rainbow trout. Our present stock was kindly donated to us by the New York Fish Commission, to whom we here wish to make proper acknowledgment. Under ordinary conditions the stock from which our breeding fish of this variety would be obtained in starting anew could be had only by raising them from the eggs, necessitating a delay of from three to four years before the restocking of the streams could be commenced again. The New York Fish Commission also donated at the same time 10,000 rainbow fry, which were planted in the tributaries of the Pere Marquette river.

The brown trout is one of many varieties of European fish introduced into this country that have taken kindly to the new condtions of a strange environment, and that have proved an entire success. Held under domestication they are equal if not superior in hardiness to the brook trout. The losses of these fish carried in ponds at Paris are comparatively

insignificant, and in many of our streams they have proved to be a healthy and vigorous fish, and rapid growers. In Europe this fish is natural to the mountain streams and the lakes lying in high altitudes, and they are abundant in the lakes of Switzerland. It was first introduced into America by Dr. Von Behr of Germany several years since, and for this reason they are sometimes called the "Von Behr trout." Individuals of this variety have been taken in American waters from the original stock weighing as high as 11½ pounds, and they attain to a considerably larger size in Europe. They are strong and vigorous fighters and are of most excellent character as an edible fish. Two ponds of adult fish of this variety are carried at Paris.

The output of brook trout from this station has been increased considerably during the past two years. There is yet opportunity to further increase the brook trout output from this station by the construction of new ponds.

The opening of the new hatchery at Sault Ste. Marie will add largely to the number of trout fry liberated by the commission in our streams each spring. That hatchery has been constructed with the view of taking care of the trout streams of the upper peninsula, while the Pairs station will furnish the stock for the lower peninsula streams.

There are two hatcheries, an overseer's dwelling, two smaller dwellings for employes, a barn, shop, ice house and connecting buildings for the cold storage of fish food and for the cutting of food, a store house for material, tools, etc., and a car house upon these premises.

In the summer of 1893, with a view of increasing the number of stock fish at this station, two large wild ponds were constructed on the Big Buckhorn creek for wild trout. The construction of these ponds has resulted in considerably increasing the number of wild fish from which ova is taken.

In the summer of 1894, one of the large ponds above the highway on Cheney creek, known as the "Elbow pond," was remodeled and two good sized ponds were made from it, both new ponds being riprapped with boulders. This work was made necessary because of the bad condition of the Elbow pond, and resulted in increasing the number of fish that could be carried in practically the same area. Three of the ponds below the railroad upon the same stream have been remodeled. They were originally constructed with plank sides and bottoms, the upper half of each pond being used as a spawning pond, in season. The barriers were removed, the planking of the bottoms and sides was removed, the banks were riprapped with cobblestone, and a considerably larger number of fish are now carried in these ponds because of these improvements. Early in the summer of 1894 a severe storm utterly demolished the car house. The structure was replaced in the summer of 1894 with a more substantial and somewhat larger building, which will better serve the purpose than the one which was destroyed. The building was constructed largely by the regular force of the station during the season when the work was lightest.

There has also been constructed by the regular force at this station, upon the south side of the waste ditch, a structure about 15x25 feet in size, sheathed with rough lumber, shingled and painted, which is used for the storage of material used about the grounds and in making repairs. The construction of this building affords shelter from the weather of material and affords an opportunity to remove unsightly piles of lumber, etc., from the grounds.

In the summer of 1893 a severe storm which swept over that part of the State blew down a large quantity of trees on the State property, and in the winter following a contract was let for clearing away the fallen timber, which was cut into firewood for the use of the station.

Both hatcheries, the cold storage house and ice house, the car house, water tank and windmill were all repainted during the summer of 1894. The office has also been newly painted and a new floor was laid in a part of the new hatchery.

The old hatchery and shop, because of the grading of the ground several years since, were from a foot to eighteen inches below the surface of the ground, and had become somewhat decayed. In the summer of 1893 those buildings were raised about twenty inches, the decayed sills were replaced with new timbers, and these buildings are now in excellent condition and much improved in appearance.

It will be necessary to make the following improvements and repairs at this station during the coming year:

A large part of the flooring of the new hatchery is in such a condition that it must be replaced with new together with some of the floor joists. It will become necessary to take up the floors for iuspection and repairs. This work may be done during the season when work is the lightest by the regular force.

About twelve feet of the fireplace and chimney in the hatchery should be taken down, relaid and relined with fire brick.

The hatching room and front hall should have two coats of paint throughout.

As there are no hotels within six miles of the station, additional sleeping rooms should be furnished for the accommodation of visiting officials and extra employes when needed temporarily at this station. For this purpose the two rooms already partitioned off on the second floor of the hatchery should be papered and painted and provided with suitable bedding and furniture.

The overseer's residence is in need of considerable repair, which has been deferred from time to time for lack of funds, preferment in the matter of expenditures having invariably been given to the demands of the hatchery and to pond work. When the house was built, the excavation for the cellar was not carried out to the foundation walls, and the earth has caved in from time to time. A light retaining wall should be laid in the cellar and a new cement floor in the cellar is needed.

The house is uncomfortably cold in the winter, due to the loose fitting of the windows and the shrinkage of the wainscoting in the dining room and kitchen. To make the house comfortable, the wainscoting should be removed and the walls plastered down to the baseboard. Storm doors and double windows should be provided for the comfort of the occupant. The house should be painted outside.

The dwelling on the Buckhorn should be given an outside coat of paint, and the barn and roof require two coats of paint.

A woodshed should be built at some point near the hatchery.

The loss of stock fish by theft during the past summer suggests the necessity for a better protection of the ponds. We think the ponds should be encircled with a high wire fence, except on the highway front. Unless such protection is provided, losses of this nature will doubtless continue to occur, as the temptation to poach is great and the opportunity favorable under cover of the dense undergrowth skirting the west side of the grounds. The nature and extent of the grounds are such that it is impossible for the night watchman maintained there since the discovery of the robberies, to command a view of the entire ground from any one point.

A telephone line between the hatchery and depot at Paris, a distance of about a mile, would not only be a great convenience, but would pay for itself in a sinlge year. Every telegram received now costs 25 cents for delivery, and considerable time, both of men and team, would be saved that is now wasted in making trips to meet fish food and supplies that fail to arrive when due. Poles for the line can be cut from the State property and set by the regular employes, so the outlay for this purpose will be light.

Two lengths of hose for additional fire protection should be purchased. This will enable us to reach the car house from the nearest hydrant. Three hundred feet of inch hose with two portable lawn sprinklers for lawn use are needed.

The demand for cold storage room for fish food has outgrown our present needs, and additional facilities must be provided. Much labor and time would thereby be saved and better results obtained. Provision should also be made for utilizing the water power for cutting food instead of the use of manual labor. A small turbine wheel should be purchased for this purpose.

A set of platform scales for weighing fish food are needed, two new pond seines and other small implements used in spawn gathering.

A new supply tank and new hatching troughs are needed for the "old hatchery." One hundred new fish trays will also be needed and 200 new egg trays. Fifty new cans are also needed for this station.

The volume and low temperature of the water of Cheney creek, in connection with the 30 feet of fall in the stream, afford ideal conditions for trout culture. The productive capacity of the station has not reached its limit, and there is no doubt that an increase of 50 per cent in the output can be shown when the possibilities of the perfect conditions at hand shall be realized. The ability of the water supply to carry a 50 per cent increase of stock fish is unquestioned, and the question of increased production is simply a matter of providing additional pond storage and breeding fish. The pond development should be chiefly in the line of fitting up and utilizing the excavations on the lower levels known as the wild ponds. These ponds will prove more suitable for the fry and younger stock than the ponds above the highway, as the somewhat higher temperature is conducive to a more rapid growth.

Above the highway there is room for a pond for adult fish just south of the old hatchery to replace the abandoned and unsightly nursery races formerly used for rearing fry.

The capture of wild trout running up Cheney creek from the Muskegon river into the wild ponds is a matter of considerable importance, as the expense and trouble of rearing that number of fish is thus saved. Practically, all the fish running up the creek might be easily taken by heading them off at the first and second levels. For this purpose a small trap or pound should be provided and securely housed in.

SAULT STE. MARIE STATION.

H. H. MARKS, OVERSEER.

Owing to the difference in latitude between the upper and lower peninsulas of Michigan, and to the late advent of spring in the upper peninsula when compared with the lower, we have found in fish cultural operations that it is impossible to plant the streams and great lakes in the farther north from the hatcheries already established for that purpose below. Taking into consideration these facts, the commission some four years ago decided to establish an experimental station at Sault Ste. Marie for the propagation of whitefish and salmon trout.

This station was established by a co-operation between the city council of Sault Ste. Marie and this board. The common council furnished the commission, rent free, a vacant store building on Water street for use as a hatchery; and also furnished the necessary supply of water, free of charge, for two years. The State equipped the building with the necessary jars and other apparatus for use in hatching the fish, and this arrangement has been in force for the past four years. The hatchery has 200 automatic jars for hatching whitefish, and a number of troughs for hatching brook trout. Its capacity is 30,000,000 whitefish and about 500,000 brook trout. The brook trout eggs distributed from this station are transferred from the hatchery at the Paris station and are hatched and planted in the upper peninsula streams.

In July, 1894, funds being available for that purpose, and the experimental station and work having shown the desirability and necessity of establishing a permanent station at this point the board decided to build a hatchery at the Sault, provided satisfactory arrangements could be made. Application was made to the Secretary of War for the grant of a site embracing what is known as Island No. 3, and 700 feet of the river bed immediately below it, lying to the north of the government canal and lock. This territory lies within what is known as the Canal Reserve, and is owned by the United States government.

On the 31st day of August, 1894, a revocable lease was granted to this board by the Secretary of War, giving this board the use of this property for the uses of a State hatchery. Owing to the fact that there is ample room for the construction of another new lock, if so desired, between the premises now occupied by the commission under this grant and the new canal, there is no likelihood of the lease ever being revoked.

There is no water in this country to be compared with the water flowing over the Sault rapids for the propagation of fish. Coming as it does from

the great reservoir of Lake Superior, in which the brook trout and whitefish are natural, with a temperature remarkably low, even in midsummer, and being excellently aerated in its flow over the rocky rapids of the Sault, it offers conditions for the most successful operations. Nowhere else in the world can be found water permitting the carrying on of whitefish and trout culture under such perfect conditions for both varieties.

Upon the concession of this grant by the Secretary of War, the matter of construction of a new hatchery was brought to the attention of the common council of the Sault, and they were asked to donate to the State, upon condition that a hatchery should be erected, a permanent supply of water sufficient for the needs of the hatchery. The common council adopted a resolution on the 16th day of July, 1894, granting this request, and a final arrangement was entered into between the State Board of Fish Commissioners and the city on the 20th day of September, 1894, in accordance with that agreement.

Mr. A. B. Cram, the architect who had prepared the designs for the Detroit and Paris hatcheries, was engaged to make the plans for the contemplated new station. Plans were accordingly made providing for a hatchery to be erected on Island No. 3, 40x82 feet, and two stories in height. The lower story of the building is divided in the center, one half of the building to be used in brook trout operations and the other for a whitefish hatchery. After the plans had been accepted, and on the 15th day of September, 1894, the commission and the superintendent, Mr. Bower, went to the city of Sault Ste. Marie and advertised for bids for the construction of a hatchery according to the plans and specifications. Bids were submitted by six bidders and the contract was let to the lowest bidder, Mr. J. B. Sweatt, for $3,444.

The construction of the hatchery was begun at once and was completed upon the 10th day of December, 1894, with the exception of the painting, which will be completed in the spring. The building is well constructed, is of handsome design, and is well calculated for the purpose for which it is intended. It will have a capacity of 300 Chase automatic jars, giving an output in round numbers of 40,000,000 whitefish. The capacity for the hatching of brook trout will be amply sufficient to furnish all the trout needed for planting the upper peninsula streams for many years.

It will be necessary for the legislature to allow a sufficient sum of money at the coming session with which to equip the house with the necessary jars for the propagation of whitefish, and with troughs for the hatching of brook trout and salmon trout, and necessary interior fittings. A sufficient sum will also be needed to construct 30 ponds, in which the parent fish may be held in connection with the brook trout hatching operations. It will also be necessary to construct a bridge from the main land to the island and a sufficient sum should be allowed for grading and sodding the grounds.

When this station is completed it will be one of the best equipped and most efficient stations of the board and will contain all the latest and most improved devices used in the artificial propagation of fish.

The United States engineer's department, which has charge of the canal reserve, contemplates the carrying out of a general parking scheme of the property surrounding the locks and canal, and as the premises occupied by the hatchery are within these boundaries, we desire, in conformity with their plan, to grade and lay out the premises occupied by us so as to conform to the general parking plan of the United States engineer. When these improvements are completed, the hatchery and ponds will form one of the most attractive features of the park, and the facilities it will offer for the hatching and distributing of fish will give to the upper peninsula a participation in the work of fish culture which has up to this time been to a considerable extent denied it.

We submit that the concession on the part of the Secretary of War of a site for the hatchery, and of the city authorities of Sault Ste. Marie of a perpetual supply of water, are deserving of proper recognition, and we hereby desire to make the same. These concessions are valuable and have saved the outlay of a considerable sum of money, and tbey reflect credit on the liberality and public enterprise of the city.

The hatchery is located just below the dam of the electric light and power company, and that company has granted to the board the right to take such water as may be necessary from their reservoir for the running of the trout work. The supply of water for trout culture will all be taken from this reservoir, the dam furnishing a sufficient head of water for a gravity supply. The reservoir does not give sufficient head for the supply needed for the whitefish operations, and the city has taken it upon itself to purchase a pump to furnish this supply, together with an electric motor, and the electric current to run the same.

CASCADE SPRINGS STATION.

C. F. HOLT, OVERSEER.

Late in the spring of 1893 we decided to find some suitable place where operations could be carried on for the artificial propagation of the black bass. We believed with a small outlay of money, experiments might be made to determine the practicability of hatching the black bass for stocking our inland lakes, and if those operations were successful we should be justified in entering upon that work in the near future, upon a scale sufficient to meet the wants of the State for this fish.

We wished to find some suitable water in which the parent fish could be held under domestication, and a place where suitable ponds might be constructed in which to hold them. It was also necessary to settle upon a place where the parent fish could be readily secured. Several places were considered and visited, and it was finally determined that a stream at Cascade Springs, Kent county, offered advantages over any other available site. We found there a tributary of the Thornapple river could be secured with a suitable place upon which to build the ponds necessary for use in the work. This property was offered to us free of expense by the association controlling the Cascade Springs resort. The Thornapple river was close at hand, from which the stock fish needed in our experiments could be taken. We were further influenced in our selection of this site because the services of Mr. C. F. Holt, a private fish culturist of much experience who resided there, could be had to carry forward the work under our direction.

Immediately following the selection of this location, work was begun upon the construction of two large ponds. One of these ponds was to be set apart for the stock fish to be used in our artificial operations, and the other was intended for the fish to be used in pond culture. When completed in the fall of 1893, these ponds were stocked with about 250 small-mouthed black bass from the Thornapple river. These fish wintered well in the ponds with no loss.

Early in May of 1894, a close surveillance was begun of the fish in the ponds, in order to be able to take the ova as soon as the spawning period arrived. This supervision extended over a period of several weeks, and during this time several hundred eggs were taken and fertilized. The result of the season's operations demonstrated, with the information gained in the work of the summer, that we shall be able to meet with a good measure of success in the future by artificial methods. Our experience also proved that pond culture work with the black bass can also be made successful, and the two operations combined will furnish a sufficient stock for our purposes.

It will be necessary to transfer the work to another stream in the immediate neighborhood, as the stream used last season is unsuitable for these operations. The stream during every considerable fall of rain becomes turbid and renders a close observation of the fish impossible, and is injurious to the fish themselves.

We recommend that a sufficient amount be allowed in our estimates for the following two years to construct suitable ponds for the stock of fish needed, together with a proper building for hatching and other purposes connected with the station to enable us to carry on this work. The establishment of such a station will require the allowance of only a moderate sum, and if the demands in the future make it necessary to extend this work, future additions can be made.

Fifty-three thousand fry of the small-mouthed black bass were hatched and distributed at this station in 1894 in the inland lakes in Allegan, Barry, Berrien, Calhoun, Cass, Charlevoix, Eaton, Emmet, Grand Traverse, Jackson, Kent, Oakland, Otsego and Washtenaw counties. With adequate facilities, we expect to be able to distribute several hundred thousand each season. No other branch of new work the board has undertaken in recent years is calculated to meet the public demand more fully than this, or prove more popular.

GLENWOOD.

WORDEN WELLS, OVERSEER.

At this station, situated at Glenwood, in Cass county, is carried on the work of carp culture. This work is confined to pond culture, the parent fish being allowed to spawn in the natural way, being subsequently removed to other ponds and isolated from the ponds containing the ova.

The carp is highly esteemed in Germany, where it is an indigenous fish. The female is very prolific, the fish is a strong and rapid grower and is specially susceptible to pond culture. It is granivorous in its habit, living on aquatic vegetation. It feeds readily on our common grains and with proper attention is fitted for many of our inland waters not calculated for other fish life.

It is of good edible quality and is superior to the red horse, sucker and shovel-nosed pike. It was introduced into America a few years since, and has taken so well to its new habitat that it is now found in our markets. In the eastern cities it commands a good price and seems bound to become an important food for those who consume the commoner varieties of fish.

No plants have been made of this fish in the great lakes, but they have been introduced by individuals into ponds constructed for their confinement, which have proved insecure and they have been liberated by high water and floods, and by escaping into tributary streams have gradually come to Lake Erie and Detroit river, and Saginaw bay where many are now taken.

The carp station at Glenwood was originally established as a private enterprise, but the State, desiring to enter into the culture of this fish, to meet the demands made upon it, made a very favorable arrangement with the owner, Mr. Wells, and the station is conducted under his management much more cheaply than it could be done otherwise.

Distributions are made of this fish during the summer months.

Some slight repairs in the way of new raceways are necessary, and it would be desirable to construct one new pond here to permit a better handling of the fish.

CHARLEVOIX STATION.

J. P. MARKS, OVERSEER.

The whitefish hatching operations for the past four years have assumed such large proportions that it was found impossible, even with the aid of two cars in constant service to get the young fish into the great lakes soon enough to prevent considerable loss by overcrowding in the tanks at the Detroit hatchery. These fish lose their food sac in from ten to fourteen days after they are hatched, and should be liberated in the waters of the great lakes, where they may find their natural food before that period terminates. It seemed to the board desirable that some arrangement should be made whereby a better distribution of the fish might be made and the percentage of loss saved, and in the winter of 1893 it was decided to establish a relief station, where a portion of the eyed eggs might be hatched and to that extent relieve the Detroit station.

At the direction of the board the superintendent visited the Lake Michigan shore, with instructions to secure, if possible, some suitable location which would furnish an adequate water supply for a contemplated station of this character, where a considerable quantity of eggs might be carried for a month or six weeks before fish were hatched, and from which the fish might be easily distributed. Frankfort and Charlevoix were both visited with this end in view. Both of these points were considered available because of their convenience to the whitefishing grounds lying off that coast and in the neighborhood of the Beaver Islands. After a careful investigation, it was concluded that Charlevoix possessed advantages not enjoyed by other places, on account of its good railroad facilities and because of the number of fisheries conducted from this place and was accordingly located at that point. The city authorities of Charlevoix granted the board a free supply of water for the operation of the hatchery. A suitable building, formerly used as a foundry, was secured at a rental of $75 a year and was fitted up for a hatchery, and for the purpose for which it was intended it served the purpose quite well. A pump was bought and placed in the water works building, by which our supply of water was obtained and is run by the city free of cost to this board. About 33,800,000 whitefish eggs were taken from the Detroit hatchery to this place on the 28th day of February, 1894, and were hatched and distributed from that point. The relief station was entirely successful and the fish were distributed by boat from this point and by rail to adjoining ports, and the hatching was conducted without loss. The relief afforded by this station enabled

us to make the remaining distributions from the Detroit hatchery easily, and the loss that had heretofore occurred at that station was saved. The expense involved in the installation of this hatchery was small compared with the actual benefits which resulted, and experience has justified the wisdom of the establishment of this station.

Charlevoix is the seat of the largest salmon trout fisheries now conducted upon the lakes. The time has arrived in our opinion when the artificial breeding of salmon trout should be entered upon by the State, and no more convenient point than Charlevoix could be selected for this purpose. The salmon trout is only second to the whitefish in importance of the commercial fish of the lakes, and the decreasing quantity of this fish in certain localities demands that the State should enter upon the work of their artificial propagation at as early a date as possible.

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CAR "ATTIKUMAIG."

H. H. MARKS, CAPTAIN.

The car used in the distribution of the fish is one of the most useful agencies by which the work is carried on. It is simple and plainly constructed, is well arranged and contrived for its purpose, and is in almost constant use for about six months of the year. The average mileage made by it during the year is about 25,000 miles. Distributions are made with it to all parts of the State of every variety of fish hatched. During the whitefish distributions it is inadequate for the work, and it is supplemented by the employment of a baggage car. The large quantities of fish distributed each season called for relief, and resulted in the establishment of a relief station at Charlevoix. Relief was afforded in some degree, and yet the car is continuously employed in all parts of the State for the period above named.

With the enormous mileage made the wear and tear is considerable, and repairs are made frequently. It will be necessary to allow a sufficient sum to keep the car in proper repair for use.

DONATIONS AND EXCHANGES.

We received from the New York Fish Commission about two hundred adult rainbow trout in the last of April, 1893, also 10,000 rainbow trout fry.

From the United States Commission in November, 1894, 200 gold fish.

We donated in December, 1894, 10,000,000 whitefish eggs to the New York Commission and 10,000,000 of the same to the United States Fish Commission.

AQUARIAL EXHIBITS.

In September, 1893, an exhibit was made by this board at the West Michigan Fair in Grand Rapids, of fish artificially hatched and reared and of the native indigenous fish. In connection with this was also shown models of the apparatus and utensils used in different hatcheries.

The fish were shown in seventeen aquaria, in which were carried salmon trout of different sizes and ages, grayling of different ages, German carp, brook trout from the fry age to fish five years old, sunfish, bullheads, chubs, shiners, rainbow trout of different ages, the black spotted trout, the brown trout of Europe, small-mouthed bass and gold fish.

In September, 1894, two exhibits were made, one at the State fair at Detroit, which was composed of 27 aquaria, containing the following varieties: Brook trout of all ages, rainbow trout, brown trout, salmon trout, black spotted trout, German carp, goldfish, sunfish, stone rollers, wall-eyed pike, grass pike, dog fish, mullet, sheep head, small-mouthed bass, big-mouthed bass, white bass, rock bass, calico bass, sturgeon, cat fish, bullheads, perch, gar pike, grayling and a varied assortment of minnows.

At the West Michigan fair the exhibit consisted of 21 aquaria, containing most of the varieties exhibited at Detroit.

These exhibits have proven the most popular feature at every place where they have been exhibited and have served the purpose of popularizing and calling to the attention of the people of the State the work being carried on by the Board of Fish Commissioners. Urgent requests have been made each year by the managers of both of the fairs above referred to, to have these exhibits made, and so long as public interest seems to be maintained in these displays, it would seem that it is good policy to make them. The cost attaching to such exhibition is not great, and it seems expedient to maintain them for the present at least.

STATISTICS OF THE COMMERCIAL FISHERIES.

CHARLES H. MOORE, AGENT.

As early as 1885 the work of gathering statistics relating to the commercial fisheries of the State was begun. The object of these investigations has been to ascertain, primarily, the value of the commercial fisheries to the State; secondarily, to determine the results of fishing on the natural stock, and, thirdly, the results of stocking by methods of artificial propagation.

These inquiries have been prosecuted from year to year since that time, and a sufficient period has now been covered in this work, to furnish some reasonable data upon which comparisons may be instituted. The canvass made of the coast has been very thorough, and while it is possible that a few small operators have now and then been missed, they are so small in number and so insignificant in quantity as to cut no figure in the totals.

The work of gathering the statistics has been done by the same agent for the past three years, and familiarity with the work gained by experience gives to this work greater value than if it had been done by different individuals.

The value of the catch of the entire lake coast within the State, at the wholesale price, annually, is over one million of dollars. This represents the price paid by the large dealers who buy directly from the smaller fishermen, and does not represent the actual value of the fish when marketed in the cities where they are consumed, which would be much larger.

Deductions made from these reports show that present methods of fishing are most disastrous to a proper maintenance of the fisheries, and this question is fully discussed in an earlier part of this report.

The success of planting is manifest from the fact that, notwithstanding the wholesale capture of small and immature fish, and the entire lack of enforcement of existing laws intended for the protection of the fisheries, the fisheries are still profitable in many localities because of the work of this board in restocking the waters. The force of this statement is greatly emphasized when it is considered that the present condition of the fisheries of Lakes Ontario and Erie have reached a very low ebb, so low in fact that Ontario has ceased to be a profitable field for the fishermen, and Erie is fast becoming so. In addition it may be stated that neither of those lower lakes have received anything like the stocking by artificial means that the upper lakes have received. There are certain

localities, like the northern end of Lake Huron in the neighborhood of Detour, the eastern shore of Lake Michigan from Ludington north to the neighborhood of Charlevoix, and the Detroit river, which show a small degree of improvement in the catch of fish of the varieties planted.

For convenience in instituting comparisons, a geographical division of the coast into districts has been made in the last two years. The territory has been divided into five districts. The first district includes the Detroit river, from Detroit to Lake Erie, and all of Lake Erie lying within the State. The second district comprises the east shore of Lake Huron, the south shore of the Straits of Mackinac and west shore of Lake Huron to Hammond's bay. The third district embraces the north shore of Lake Michigan and Green bay, the north shore of the Straits of Mackinac, the north shore of Lake Huron to Detour and the Beaver Island group. The fifth district comprises the south shore of Lake Superior east from the State line between Michigan and Wisconsin, and the Sault river to the Detour.

A reference to the report of the statistical agent, which follows, and to the tables connected therewith, will prove interesting and instructive, as bearing upon the present condition of the fisheries and kindred matters.

DETROIT, December 31, 1894.

To the State Board of Fish Commissioners:

GENTLEMEN—In connection with my work as statistical agent of the board, I herewith submit a narrative statement of the condition of the commercial fisheries of the State for the past two years. This report in connection with the detailed reports on file in the office, made from time to time during the progress of the work, fully show the condition of the fisheries, the output, money invested in the way of plant, nets, docks, boat and other equipment for the years 1891 and 1892.

FIRST DISTRICT.

The fishing in this district covers the Detroit river, from Detroit to the mouth, and Lake Erie lying within the State. The fishing in the Detroit river on the American shore is entirely conducted by the Fish Commission, and the fish here taken are exclusively used in the spawing operations of the board, and all the ova used in the hatcheries for the propagation of whitefish are taken here. Large plants have been made in this river each year for a number of years, and the fishing has undoubtedly been maintained in its present good condition in the river and west end of Lake Erie by reason of these plants. Were it not for the large number of nets which obstruct the passage of the fish at the mouth of the river, these fisheries would be much more productive.

The fishing on the west coast of Lake Erie, from the mouth of the Detroit river to the Ohio line, is done principally with pound and fyke nets and but few gill nets are used. The principal catch is of "rough fish," such as perch and suckers. The catch of wall-eyed pike is first in quantity of the better kinds of fish taken in this district. Whitefish and sturgeon follow next in relative order, but the catches of each have been light

SECOND DISTRICT.

At Hammond's bay, 40 miles above Rogers City, on the west shore of Lake Huron, the fisheries were at one time largely productive of whitefish and are still known as whitefish grounds, yet the catches of 1892 and 1893 showed a falling off in the catch of whitefish. Seven pound nets were fished, taking a light catch of whitefish and a few trout, sturgeon, pickerel and suckers. No gill nets are fished here.

The next station is Cheboygan, situated on the Straits of Mackinac. At this point and on the shore above as far as Waugoshance, across the straits to Bois Blanc island, and below Duncan bay, the fishing is done with pound nets. Three tugs and six sail boats fish gill nets out of Cheboygan. The catch of the pound nets is whitefish, herring, suckers, trout and sturgeon, and of the gill nets trout, Menominees and whitefish, in the order named as to the quantity caught of each kind.

At Mackinaw City pound nets only are fished on the shores above and below the point. The catch is composed of whitefish, herring, suckers, trout and sturgeon. Information was gained here from a reliable source concerning the destruction of small whitefish. Heavy purchases of fish of this grade, largely No. 3, and under, were made during the seasons of 1892 and 1893 in this vicintiy. Buyers refused to buy whitefish grading below No. 2, except in limited quantities, unless they were salted, as the fish are so small and soft they could not be placed upon the market except as salted fish.

In a bay on the west shore of Lake Michigan, just beyond and south of Waugoshance point, is the old town of Cross Village. The water in this bay is shoal, with a sandy or gravelly bottom, allowing the use of pound nets only. Years ago heavy catches of whitefish and sturgeon were made here, but of late years the grounds have become unprofitable and the seven pound nets fished there during the season of 1892 and 1893 did not pay expenses.

Middle Village, located on the same shore, and is twelve miles south, and the fishing here is carried on exclusively by Indians. Ten or twelve sail boats, with poor gill net outfits, were fished from here, the catch being largely of trout. The catch of whitefish is of little importance.

Little Traverse bay was once a very productive whitefish and trout ground, but these waters have been overfished and now yield but slight returns. The unprofitable catches of late years have driven the fishermen at this point to other grounds. They yet retain their headquarters at Petoskey, which is a good distributing point. The fishermen whose headquarters are here have operated at Charlevoix and Cheboygan on Lake Michigan, and at Grand Marais and Bete Grise on Lake Superior, during the past two seasons. During 1892 and 1893 ten pound nets and a few small meshed gill nets were fished in Little Traverse bay, the catch being very light of whitefish, herring, suckers, trout and sturgeon.

Charlevoix, located at the outlet of Pine lake, and the next fishing station to the south, is the most important fishing station on the east shore of Lake Michigan. This point is noted for its large catches of trout during the fall, that is during the last half of October and the earlier part of November. Eight steam tugs and twelve sail boats, with gill net outfits, were fished at this station in 1893. The catch of trout for that year shows

a marked falling off when compared with 1892, notwithstanding there was considerable more twine fished in the latter year. Summing up the catch at this point, it is shown that there was a falling off, as compared with 1892, of five-eighths of trout, one-quarter of whitefish and one-eighth of long jaws or black fins; no pound nets are in use at this station.

The next place is Antrim City, then Eastport, Torch Lake and Elk Rapids, all being located on the east shore of the east arm of Big Traverse bay, and all being whitefish grounds. Formerly these grounds were productive of large quantities of whitefish, from the fact that large spawning beds were found at Old Mission point and at other places near the mouth of the bay, with good feeding grounds for young whitefish farther down towards the head of the bay. The fishing is carried on at these stations principally with pound nets. While the catch was reported to be about the same in each year, 1892 and 1893, it was composed of about three parts whitefish to one of trout.

At the head of the west arm of Big Traverse bay is Traverse City. The shipping facilities at this point makes it a good point of distribution for the fish caught in this neighborhood. This arm of Big Traverse bay was in former years a favorite whitefish ground, but the large deposits of mill refuse from the sawmills operated at this point have covered the ground and driven the fish away Extending out a distance of 18 miles, through the middle of Traverse bay, is a narrow neck of land, the extreme point of which is known as Old Mission point. For a considerable distance out from this point the water is shoal, being a reef of porous rock and coarse gravel, and is a famous spawn ground for the whitefish. Only pound nets are fished here, but up the west arm at Little Hog island, Baptist Resort, Sutton's Bay and Omena, both pound and gill nets are used, taking whitefish, trout, herring and long jaws.

Further down this arm of the bay and within nine miles of Cat Head Light, which stands upon the extreme point of the main land at the mouth of the bay, is the village of Northport. From this point there are fished two tugs and six sail boats, with gill and pound nets, and nearly all the fish caught at Lighthouse point, Cat Head, Lake Shore, Gill's Pier and Leland, all located on the east shore of Lake Michigan, also including the catch of North Manitou and South Fox island, are bought here for shipment. At all of these fishing stations both gill and pound nets are fished, and fish taken are composed of whitefish, trout, long jaws and black fins. Fully one-quarter of a million pounds less of fish were shipped from Northport in 1893 than in 1891 or 1892. The fishermen claim that the falling off of the catch was due to the severe storms of the fall, but however that may be, the falling off of the catch of whitefish was more marked than that of any other kind taken.

On the shore of Lake Michigan, opposite the Manitou islands, and between Leland and Sleeping Bear point, fishing stations are located at the following places: Good Harbor bay, Port Oneida, Glen Arbor and Glen Haven. The water is shoal, with a sand and gravel bottom, and the fishing is carried on with pound nets. These grounds seem to be natural to the young whitefish. The heavy catches reported to have been made at one time by the fishermen of this locality were made during the months of June and July, the season of the year when the immature whitefish come to these favorite grounds, and the catch at these stations for the past three years, which has been composed almost entirely of small whitefish, show conclusively that they still make their annual appearance there, but in much smaller schools. The catch at these fisheries is salted and inspects largely No. 3 and none above No. 2.

South from Sleeping Bear point, at Empire, Otter Creek and East Bay, pound and gill nets are fished. Fair catches of whitefish, trout, sturgeon and long jaws were made. Two tugs and five sail boats with gill nets fished out of Frankport, which is located at the outlet of the Aux bec Scies river, sometimes called the Betsey river. The tugs from here made long runs into the lake, frequently going out to the Foxes and Manitou islands, about 60 miles distant. The catch consists of trout, whitefish, long jaws and black fins and was considerably less in 1893 than in either 1891 or 1892. One pound net was fished at Arcadia last season, but the catch was of little importance.

The village of Onekema, is situated on the shore of Portage lake, about two miles inland from Lake Michigan, the lake being connected by a canal with the great lake. Four sail boats, with an equipment of gill nets and one pound net, are fished at this point, and the character of the fishing is much the same as at Frankfort.

Twelve miles south is the city of Manistee. From this point one tug and eight sail boats with gill nets are engaged in fishing, taking a considerable catch of long jaws, trout and black fins. The mesh of the twine used here is two and a half and three inches, and consequently the size of the trout is small and the quantity is likewise.

Ludington, the next station south, once held high rank with the best fishing stations on this shore for catches of whitefish. The fouling of the waters with sawdust and mill refuse has driven the fish away, and the catch of late years of this species has been light. Some of the fishermen have sought other grounds, because of the poor fishing at this place. During the seasons of 1892 and 1893 five sail boats, and five pound nets were fished out of this station, and two tugs a portion of these years. The catch is composed of long jaws, trout, black fins and a very few whitefish. There has been but little variation in the catch of the last three years.

Pentwater is the next fishing station, and at this point there are fished two pound net rigs. Less twine is fished here than in former years, when the whitefish were abundant, which is true of many other places on the east shore of this lake. The catch at this station has varied but little since 1890, except that a better catch of sturgeon was made here in 1893 than in any of the three preceding years. The varieties taken here are sturgeon, whitefish, trout and pike perch.

We come next to the fishing station of Clay Banks and Little Point Au Sable. At each of these stations only a few gill nets are fished, and the catch is insignificant.

Whitehall is the next station, and the fishing is done here at the mouth of White lake. The fishing is much the same here as at Muskegon, 18 miles south. Both pound and gill nets are fished at these stations, and each is a lumbering town. We have also to note here the almost total disappearance of whitefish since the sawmills of Muskegon and Whitehall began the manufacture of lumber and threw into the lake such immense quantities of refuse. This has also been injurious to other kinds of fish.

The catch of long jaws, black fins, trout and sturgeon is very light at these points, and these comprise the varieties taken.

The next point south of Muskegon is Lake Harbor, and from here there were fished in 1893 two pound nets, which report a fair catch of whitefish, much better than they have had for several seasons past. The fishermen here attribute this increase to the planting of whitefish fry by the commission.

The two principal fishing stations on the east shore of Lake Michigan, not yet mentioned, are Grand Haven and St. Joseph. Of these Grand Haven takes preëminence and ranks second only among the fishing stations on this shore. The three most productive stations being Charlevoix, Grand Haven and St. Joseph, in the order named, as to importance and magnitude of catch. Nine steam vessels and six sail boats fish out of Grand Haven, with a total catch of 1,500,000 pounds in 1893, showing a falling off of 250,000 pounds from 1892. One million pounds of this catch was of long jaws, or deep water herring, the remainder of the catch being made up of trout, and a few whitefish and perch. A. A. Fisher & Co., who have been engaged in fishing here for the past thirty years, report a single lift of 1,100 pounds of whitefish on November 9, 1893, with a small gang of four inch mesh gill nets, upon an old whitefish spawning ground, about four miles in a southeasterly direction from the mouth of the river.

They report that they were uniform in size, averaging from one and three-fourths to two pounds each, and having the distinctive features of the Lake Erie whitefish, which are distinguishable from the whitefish natural to Lake Michigan. During all these years they have followed the fishing business exclusively and have caught hundreds of tons of native whitefish, and the supply then seemed to be to them inexhaustible. Bnt they have lived to witness the gradual decrease of the whitefish until it has become of very little importance. Fisher Bros. assert that there is no doubt that the catch of whitefish above referred to were from the plants of Lake Erie whitefish fry made by the Michigan commission. This opinion is corroborated by many other fishermen in this neighborhood.*

The general character of the fishing at St. Joseph is much the same as Grand Haven. A few pound nets are fished here, which make a light catch of sturgeon and whitefish, the total catch being half a million pounds less than at Grand Haven. Six tugs and five sail boats, equipped with a full complement of gill nets, are fished here, the catch being chiefly long jaws, black fins and a small quantity of little trout. It is obvious from the catch of the fisheries, both at Grand Haven and St. Joseph, that small twine is largely used.

At Holland, Pier Cove and South Haven, pound nets only are fished, and the catch is of very small importance, whitefish, suckers and trout being the kinds taken in the order named.

At Saugatuck, small meshed gill nets are used and ten small rigs are fished. Perch is the chief product and they are dressed with special reference for shipment to Chicago market. Shriver Bros. report a better catch of whitefish here in 1893, and express a firm belief that the planting of whitefish fry is the true cause of the improvement. Shriver Bros. have fished here for 27 consecutive years and they have seen and noted the decay of whitefish, but express the belief that through the restocking of the waters, they will again see whitefish more plentiful in the near future.

* Inasmuch as all of the whitefish fry distributed in the great lakes are the progeny of the Lake Erie whitefish, this statement is of great importance.—Commissioner

THIRD DISTRICT.

This district includes the north shore of Lake Michigan, beginning at the State line between Michigan and Wisconsin, a portion of Green bay, the north shore of the Straits of Mackinac and the north shore of Lake Huron to the Detour, and also includes the Beaver Island group.

The character of fishing is much the same as upon the east shore of Lake Michigan, although the catch differs by reason of the large lifts of herring, which constitute fully half of the quantity taken in this division.

From Menominee north, for 40 miles, fifty pound nets were fished in 1893. These nets took 2,500,000 pounds of herring, and these are the largest herring fisheries in the State. There are important fisheries at Gros Cap, near Point St. Ignace, and large quantities of herring are taken here. The Menominee whitefish is found on this shore and the wall-eyed pike is quite abundant at the head of Big and Little Bay De Noquet and are of good size and superior quality. Fabulous catches of whitefish were also taken in this locality in years past and there were undoubtedly no whitefish grounds superior to these on the lakes. St. Martin's island, Fairport, Manistique, Seul Choix, Mille Coquin, Epoufette and the Ware House were the most notable fishing stations, and are even now resorted to by the fishermen, although the catch is comparably much smaller. The decay began with the introduction of the pound net and the construction of sawmills along this shore, which have made the lake and straits a dumping ground for mill refuse. The result has been that the spawning grounds, even as far as the Beaver islands, have been covered with sawdust and the spawning beds have been ruined. This, together with unlimited netting, has worked destruction to these once valuable fisheries.

Pound and gill nets are fished at the Beaver islands, but the old time catches of whitefish have passed. These grounds, however, have held out much better than many others.

In the neighborhood of the Detour and the Cheneaux islands, the result of the plants made by the commission have been manifest by the numbers of small whitefish taken. The fishing is only fairly good even now along this shore.

FOURTH DISTRICT.

From Detroit, up the river to Baltimore bay and the St. Clair river to Port Huron, there are fished pound nets, fykes and seines, the catch consisting largely of "rough fish." The principal kinds taken are perch, although the wall-eyed pike is an important factor. This fish is taken principally with seines and the main fisheries of this kind are at the mouth of the Clinton river, Algonac, Marine City and St. Clair. There are quite a number of pound nets fished in Lake St. Clair from the head of the Detroit river to and including Baltimore bay, and a few whitefish are caught there duirng the fishing season, in October and November principally.

At Port Huron the hook and line fishing for pike perch is quite important. The aggregate purchases of the dealers of these fish taken with lines for 1893 was something over 70,000 pounds; and the buyers at St. Clair, Marine City and Algonac purchased nearly the same amount. The season for this kind of fishing begins in the latter part of May and lasts through June and July. It is estimated by those who are best able to judge that there are at least 100 skiffs, with two men each, engaged in the hand line fisheries on the St. Clair river during the season. The catch by this method of fishing, however, for 1893, was 30,000 pounds less than in 1892, and the fish were much smaller in size, being largely No. 2 and under.

Two tugs fish gill nets out of Port Huron, going quite a distance out into Lake Huron. These nets made fair lifts of lake trout in the spring and fall. The Fort Gratiot fishery, near the outlet of Lake Huron is noted as one of the best sturgeon grounds to be found anywhere in Michigan waters. The catch of sturgeon with seines at this station during the seasons 1892 and 1893 shows this statement to be true.

Leaving Port Huron and following the west shore of Lake Huron to Lakeport, Lexington, Port Sanilac, Forrester, Richmondville and Forestville, pound nets are fished exclusively. The herring catch of these fisheries is far in excess of that of any other kind, and in 1893 was the largest ever known on this shore. Pickerel, pike and suckers are also taken, but the whitefish, which were quite abundant here 15 or 20 years ago, now make but an insignificant part of the catch. Two pound nets were fished at Sand Beach during the fall, taking but light catches of whitefish and a fair catch of herring. Four fish tugs and eight sail boats with gill nets are also operated from this station, and took fair catches of lake trout and a small per cent of whitefish. This is the most important fishing station on the west shore of this lake, with the exception of Alpena.

Port Hope, Grindstone City and Port Austin come next in order. But one small gill net rig at each of the first two of the latter named places were fished, and the catch was of little account.

At Port Austin no pound nets are fished, but there are five sail boats well equipped with gill nets, doing a good business during the fishing season, which begins toward the end of April and continues to about the first of December. Four-fifths of this catch are of trout, the remainder being whitefish. The trout are taken in Lake Huron and the whitefish off Big Charity island in Saginaw bay.

In Saginaw bay proper and in the Saginaw river and its tribuatries, something over 500 nets are fished, of the following kinds, pound nets, fykes, gobblers and drive nets, with a total catch of something over 6,000,000 pounds, comprising in quantity nearly one-sixth of the fish produced in the State from the commercial fisheries. The value of this catch, however, when compared with other fisheries, does not bear the same relative proportion, as they are of the cheaper kind, or so called "rough fish," such as perch, suckers, bullheads, sunfish, etc., the price realized being from half a cent to three cents per pound. Tons of wall-eyed pike are also taken and are shipped to all the markets, east, west, north and south. These fish command a good price and are unrivaled for shipping long distances. The herring catch is also an important feature of the fishing in this bay. The catch was very large for the year 1893, as was the case on the shore of Lake Huron below this point. With the exception of a few whitefish, trout and sturgeon, caught on the east shore of the bay, from Port Austin to Quinicassee; on the west shore, from Alabaster to Neaumquam bay, and also at the Charities, the kinds already mentioned make up the catch.

At Alabaster and East Tawas fishing is carried on with pound nets only, the catch being of the same kinds as above mentioned, except that a great many small, immature whitefish were taken at East Tawas in 1892. The herring catch at these fisheries in 1893 was in excess of any previous year.

The extensive sawmill interests at Au Sable and Oscoda foul the water with sawdust and mill refuse and have destroyed the fishing grounds at and in the neighborhood of these stations and have driven the whitefish from this locality from which they were once so plentifully taken. The tugs and sail boats, with gill net rigs, have fished here for some years past, but are obliged to make long runs into the lake and are rewarded only with unprofitable catches of trout and whitefish. The proportion of whitefish caught is very small.

At Seven Mile Point, above Oscoda, is a whitefish ground which is operated with pound nets and a fair catch is taken each season. Pound nets are fished at Harrisville, Sturgeon Point Light and Alcona, the catches being of little importance.

Alpena is the next and most important fishing station on this lake, the principal catch consists of lake trout. Thunder bay, upon which Alpena is situated, was once a very productive water of two valuable kinds of fish, viz., the whitefish and wall-eyed pike, but since the advent of saw mills and wood-working factories, and the commencement of the towing of timber rafts down Thunder Bay river, these fish have been driven away and this once famous fishing ground has been practically abandoned by the fishermen. Six tugs with large and complete gangs of gill nets, fished from four to six in a gang, are fished out of this point. They make long runs out into Lake Huron and take fair catches of trout, with an occasional lift of whitefish during the month of November.

North Point, the shore above, and Sugar Island, are adjacent to Alpena, and the fish taken at these places are marketed there. Something like twenty pound nets were fished at these places in 1892 and 1893, with six sail boats and gill nets. Trout and whitefish are the product of the sail boat fishing, while the pound net catch comprises a greater variety, composed of whitefish, herring, suckers, wall-eyed pike, trout and sturgeon. Nearly 300 packages of immature whitefish, mostly No. 3, were taken by these pound nets in 1892. From personal observation I can state that this wanton catch of little whitefish is carried on all along the shores of the great lakes, wherever pound nets are used.

Rogers City is the last fishing station in this division. Six sail boats, fitted out with gill nets, take fair catches of whitefish and trout each season, the catch consisting principally of trout. No pound nets are fished here.

FIFTH DISTRICT.

This district embraces the south shore of Lake Huron, east from the State line between Michigan and Wisconsin to the Sault river, and the Sault river to the Detour.

The fishing is carried on with pound and gill nets in this district, and the same falling off in the catch of fish at the fishing stations on Lake Superior is also noticed. Trout and whitefish are the chief kinds taken, together with some sturgeon. In this lake is found the siscowet, one of the trout family, inhabiting the deeper waters of the lake. Commercially, this fish does not command as high a price in the fresh fish market as the shoal water trout, being too fat, but when salted it ranks with the best salt trout upon the market.

The most extensive fishery upon this lake is at Whitefish point. From this point large and complete outfits of pound and gill nets are fished, and the catch is mainly whitefish and trout, about one-half of each variety.

Marquette and Portage Entry rank next in the order named, but the proportion of whitefish taken at these points is much smaller.

At Ontonagon, once an important fishing station, the fishing is now of little consequence.

From Ontonagon to Keweenaw point the catches are light, but from the latter point down the shore of Keweenaw bay to L'Anse better catches are made, especially of whitefish. At Huron bay the catch of 1893 was the lightest ever known. Not enough fish were taken to pay for driving the stakes of the seventeen pound nets fished there, and yet, according to the statement of the veteran fishermen who have lived here for the past 25 years, this bay was a very important whitefish ground at one time, and the catches that were formerly taken there were so large as to be almost incredible.

At Autrain and Old Munising, the fishing is similar to that in Huron Bay, and the present exhausted condition of the grounds is manifest. The best spawning grounds of the shoal water trout are said by the fishermen to be at Isle Royal, Manitou Island and at the head of Keweenaw Point and Stannard Rock.

The fishing at Grand island and vicinity, while once good, has also deteriorated.

At Sault Ste. Marie nearly thirty skiffs, with dip nets, are fished by the French and Indians during the early spring and fall each season. The catch consists wholly of whitefish. The catch for 1893 was fully 30 per cent less than in 1892, and the fish were of smaller size.

Detour, situated at the extreme north end of Lake Huron, is widely known as an important fishing station, chiefly so for the vauable kinds of fish taken at the numerous islands near by. The catch in 1893 was 20 per cent less than in 1892, and included the following varieties in the order named as to quantities: Whitefish, trout, pike perch, herring, suckers, sturgeon, black bass and occasionally a muskallonge. The latter fish was once very plentiful in the Sault river and among the islands at the head of Lake Huron.

A comparison of the tables of 1891, 1892 and 1893, showing the total catch of the various kinds of fish, will show the marked falling off in the quantity taken each year. The catch of whitefish for 1892 was 200,000 pounds less than in 1891, and that of 1893 was 500,000 pounds less than that of 1891. The catch of herring for 1893 was the largest ever known.

It is also manifest that there is a gradual decrease, not only in the quantity taken, but in the average weight of whitefish.

This is one of the most potent factors in the destruction of the whitefish, and unless prevented must lead to the extinction of the fisheries, and the destruction of small whitefish, while most pronounced at some places, is quite general throughout the enitre coast.

CHARLES H. MOORE,
Statistical Agent.

The following tables are submitted in connection with the foregoing report and serve to make the facts therein shown more plain.

Comparative Table of the Catch of Commercial Fish of Michigan.

DISTRICT NO. 1.

Kind of Fish.	Pounds.			
	1885.	1891.	1892.	1893.
Whitefish	60,011	144,355	123,050	61,000
Salmon Trout				
Pike Perch	719,342	84,900	173,000	107,000
Herring		335,400	208,075	57,500
Sturgeon		22,260	13,800	16,600
Bass		920	1,000	16,000
Saugers		20,000	101,200	37,000
Perch			138,000	223,000
Suckers		124,000	76,500	295,000
Cat Fish		16,000	81,000	18,700
Caviare				
All other kinds	162,873	64,000	85,700	249,000

DISTRICT NO. 2.

Kind of Fish.	Pounds.			
	1885.	1891.	1892.	1893.
Whitefish	1,463,260	1,093,402	1,112,990	1,156,500
Salmon Trout	1,023,267	2,962,060	2,580,711	2,498,400
Pike Perch	272,428	19,492	22,133	26,400
Herring		1,846,400	510,320	2,496,650
Sturgeon		170,110	122,722	63,200
Bass		6,640	14,400	7,625
Saugers			37,700	
Perch		68,950	241,100	296,000
Suckers		34,250	131,050	184,500
Cat Fish			1,450	
Caviare		27,662	26,630	9,970
All other kinds	925,680	189,510	1,867,397	94,000

DISTRICT NO. 3.

Kind of Fish.	Pounds.			
	1885.	1891.	1892.	1893.
Whitefish	2,700,577	1,669,790	1,887,045	1,296,450
Salmon Trout	1,280,838	1,020,410	1,174,019	1,086,400
Pike Perch	1,500,663	121,200	215,868	183,300
Herring		1,828,600	2,043,000	3,360,500
Sturgeon		89,586	62,337	49,000
Bass		800	550	1,950
Saugers				
Perch		500	11,800	76,100
Suckers		74,400	157,500	215,500
Cat Fish				
Caviare				130
All other kinds		330,700	235,500	900,750

DISTRICT NO. 4.

Kind of Fish.	Pounds.			
	1885.	1891.	1892.	1893.
Whitefish	2,121,591	377,940	470,850	406,250
Salmon Trout	2,019,568	1,377,800	2,616,100	2,528,700
Pike Perch	2,103,796	2,414,353	1,936,850	1,366,950
Herring		3,459,500	2,575,200	4,050,000
Sturgeon		454,650	264,400	291,850
Bass		86,458	23,200	60,150
Saugers		50,150	5,000	8,000
Perch		1,943,350	2,168,900	2,021,600
Suckers		1,125,000	1,900,700	2,275,900
Cat Fish		143,290	125,500	45,950
Caviare		31,836	32,290	33,685
All other kinds	3,458,994	567,300	245,717	294,361

DISTRICT NO. 5.

Kind of Fish.	Pounds.			
	1885.	1891.	1892.	1893.
Whitefish	1,029,020	4,819,900	2,754,200	2,423,600
Salmon Trout	644,015	3,772,500	2,509,069	2,835,000
Pike Perch	30,906	153,248	8,600	178,000
Herring		359,000	228,000	214,000
Sturgeon		95,000	37,900	47,800
Bass		500	3,000	4,000
Saugers				6,000
Perch		4,500		5,000
Suckers		34,500	96,500	143,000
Cat Fish				
Caviare				
All other kinds	98,800	137,900	39,700	394,000

Amounts Invested in the Operation of the Fisheries, Freezers, etc., by Districts.

DISTRICT NO. 1.

	1885.	1891.	1892.	1893.
Number of gill nets				104
Number of pound nets	85	190	180	187
Number of seines and fykes	4		37	266
Number of steam vessels	1	2	3	1
Number of sail vessels	10	30	19	23
Number of pound boats	7	8	17	19
Number of skiffs	8	15	13	24
Number of men employed	33	106	116	157
Value of nets	not taken	$40,550 00	$27,870 00	$32,048 00
Value of boats	not taken	11,805 00	11,028 00	4,285 00
Value of lands and buildings	not taken	5,925 00	19,575 00	16,963 00
Total capital invested	not taken	58,280 00	58,473 00	53,296 00

DISTRICT NO. 2.

	1885.	1591.	1892.	1893.
Number of gill nets	12,419	18,665	20,809	28,251
Number of pound nets	160	501	307	284
Number of seines and fykes	12	89	39	11
Number of steam vessels	26	40	29	84
Number of sail vessels	56	157	149	145
Number of pound boats	45	67	70	81
Number of skiffs	60	69	49	65
Number of men employed	472	384	756	892
Value of nets	not taken	$133,830 50	$139,863 00	$168,740 00
Value of boats	not taken	98,699 00	124,721 00	135,260 00
Value of lands and buildings	not taken	58,263 00	65,876 00	77,330 00
Total capital invested	not taken	295,792 50	330,460 00	381,830 50

DISTRICT NO. 3.

	1885.	1891.		1893.
Number of gill nets	7,465	5,887	6,285	7,096
Number of pound nets	249	415	364	370
Number of seines and fykes	23	2	2	5
Number of steam vessels	16	5	6	9
Number of sail vessels	118	143	141	165
Number of pound boats	78	68	63	78
Number of skiffs	30	20	15	59
Number of men employed	497	292	560	780
Value of nets	not taken	$96,061 00	$99,212 00	$114,959 00
Value of boats	not taken	26,289 00	35,605 00	41,150 00
Value of lands and buildings	not taken	52,816 00	62,483 00	71,720 00
Total capital invested	not taken	175,166 00	197,300 00	227,829 00

DISTRICT NO. 4.

	1885.	1891.	1892.	1893.
Number of gill nets	3,591	3,106	4,081	4,503
Number of pound nets	471	704	604	509
Number of seines and fykes	20	40	248	391
Number of steam vessels	11	6	14	17
Number of sail vessels	88	88	193	127
Number of pound boats	84	104	114	102
Number of skiffs	60	384	190	260
Number of men employed	655	1,464	1,296	1,294
Value of nets	not taken	$144,748 00	$145,813 00	$180,707 00
Value of boats	not taken	43,851 00	60,325 00	74,249 00
Value of lands and buildings	not taken	145,732 00	179,796 00	171,620 00
Total capital invested	not taken	334,331 00	385,934 00	376,576 00

DISTRICT NO. 5.

	1885.	1891.	1892.	1893.
Number of gill nets	1,360	6,828	5,472	5,626
Number of pound nets	39	218	181	253
Number of seines and fykes		9	27	5
Number of steam vessels	14	17	9	12
Number of sail vessels	28	156	148	168
Number of pound boats	23	56	48	54
Number of skiffs	10	58	44	88
Number of men employed	183	1,679	544	874
Value of nets	not taken	$102,871 00	$93,135 00	$120,294 00
Value of boats	not taken	79,590 00	51,569 00	68,519 00
Value of lands and buildings	not taken	58,930 00	52,385 00	86,770 00
Total capital employed	not taken	241,391 00	197,089 00	275,583 00

Comparative statement showing the total number of pounds of whitefish caught and total number of nets, steamers and other boats used in Michigan waters in the years 1885, 1891, 1892 and 1893, with the percentage of increase or decrease of each.

Total whitefish caught in 1885, 8,143,626 pounds.
Total whitefish caught in 1891, 8,110,387 pounds, or 4-10 of 1 per cent less than in 1885.
Total whitefish caught in 1892, 6,347,535 pounds, or 22 per cent less than in 1885.
Total whitefish caught in 1893, 5,345,800 pounds, or 35 per cent less than in 1885.
25,839 nets were used in 1885 and they averaged to catch, 315⅙ lbs. each.
36,514 nets were used in 1885 and they averaged to catch, 222⅛ lbs. each.
38,283 nets were used in 1885 and they averaged to catch, 165¾ lbs. each.
42,073 nets were used in 1885 and they averaged to catch, 127½ lbs. each.

The increase in nets used in 1891 over 1885 was 26 per cent, and the decrease in pounds of fish caught per each net was 34 per cent.

The increase in nets used in 1892 over 1885 was 48 per cent, and the decrease in pounds of fish caught per each net was 48 per cent.

The increase in nets used in 1893 over 1885 was 64 per cent, and the decrease in pounds of fish caught per each net was 59 per cent.

58 steamers were used in 1885.
70 steamers were used in 1891, or 20 per cent increase over 1885.
61 steamers were used in 1892, or ½ of 1 per cent increase over 1885.
73 steamers were used in 1893, or 2½ per cent increase over 1885.
733 boats, other than steam, were usd in 1885.
1,423 boats, other than steam, were used in 1891, or 94 per cent increase over 1885.
1,167 boats, other than steam, were used in 1892, or 54 per cent increase over 1885.
1,403 boats, other than steam, were used in 1893, or 91 per cent increase over 1885.

The following diagrams are published in connection with the above to emphasize the facts therein shown:

8

DIAGRAM No. 1—Showing relative catches of Whitefish for years 1885, 1891, 1892, 1893.

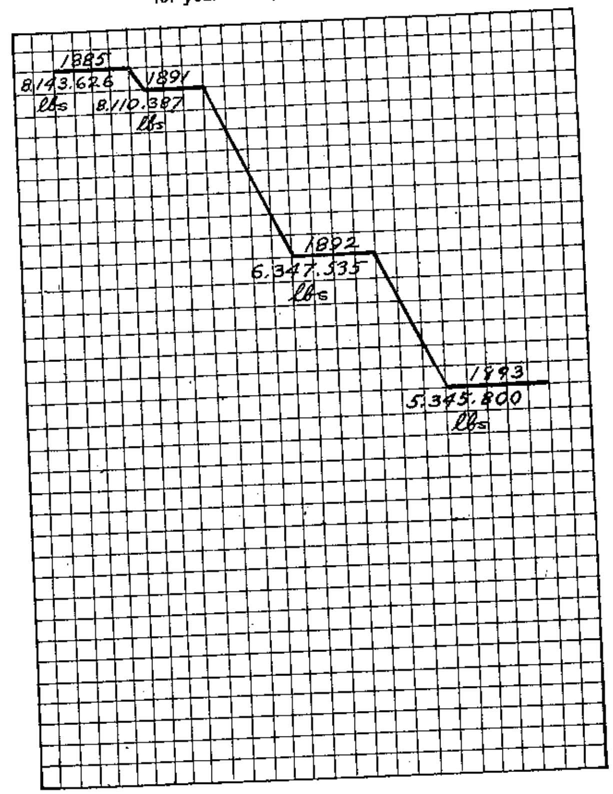


DIAGRAM No. 2—Showing relative catch of Whitefish per net for the years 1885, 1891, 1892, 1893

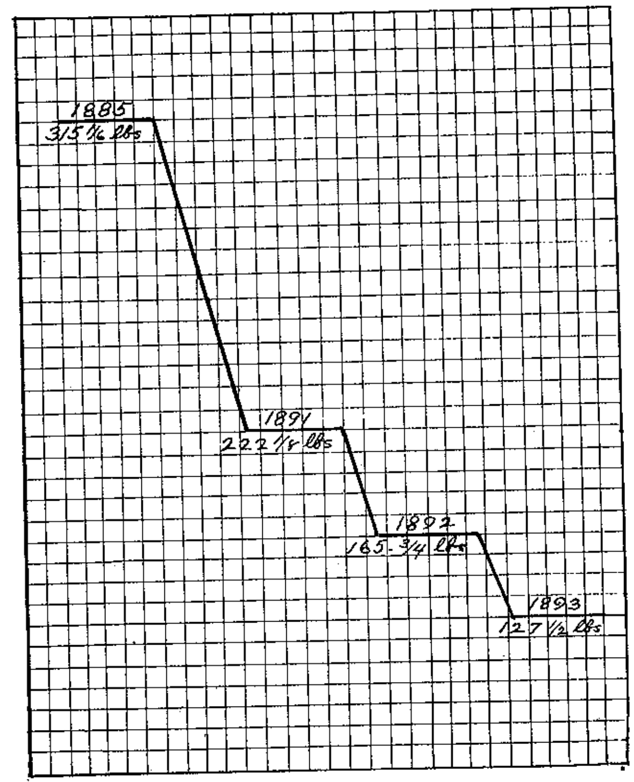
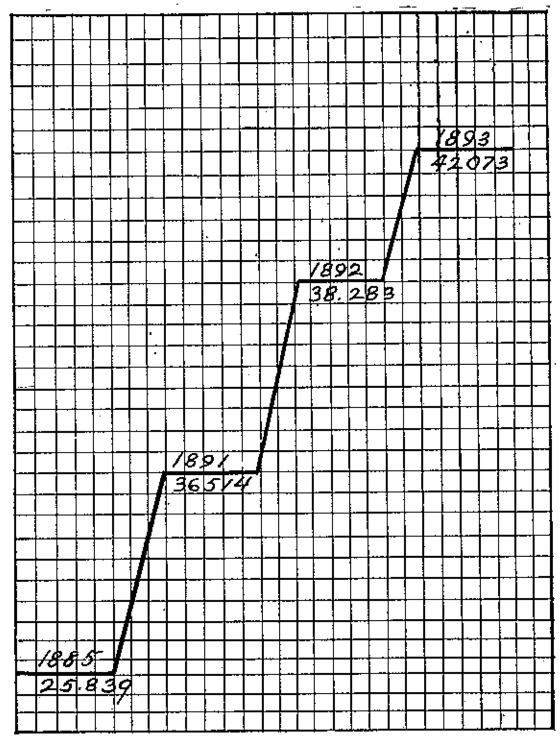
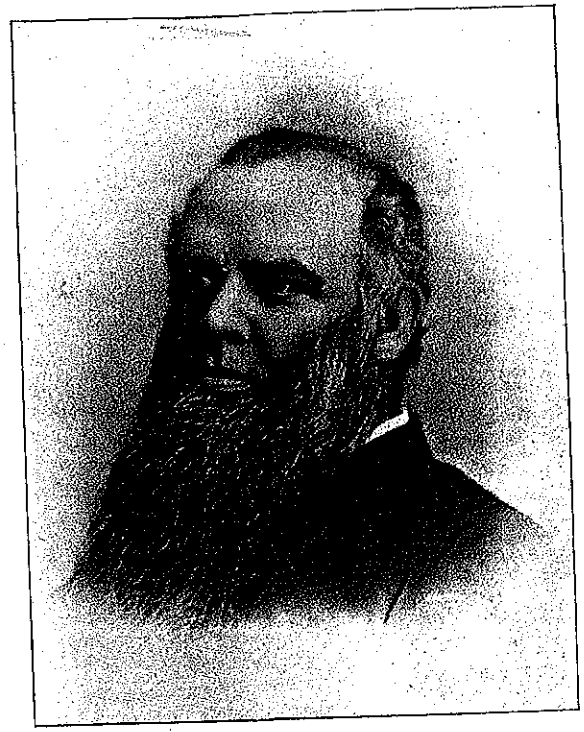


DIAGRAM No. 3—Showing increase in number of nets used for years 1885, 1891, 1892, 1893.



The foregoing report covers the operations of the biennial period, and is herewith respectfully submitted.

HERSCHEL WHITAKER,
HOYT POST,
HORACE W. DAVIS,
Commissioners.



JOHN J. BAGLEY.

FIRST BOARD OF FISH COMMISSIONERS.

The portraits of the first Board of Fish Commissioners the Hon. John J. Bagley, Hon. George Clark and the Hon. George H. Jerome, are published in connection with this report.

The creation of the State Board of Fish Commissioners was due mainly to the efforts of these men, and it seems best, in view of the passage of time, which will soon make it impossible to reproduce the connterfeit presentment of some of the original members of the board that they should now be published for future preservation. All of these gentlemen have passed from the field of activity, but the good they did lives after them.

John J. Bagley, the great commoner, needs no introduction to the people of Michgan. His keen interest in all things which pertained to the welfare of the State, his humanity, large heartedness and his democratic manners and life endeared him to the people of the State, and his memory with them is a sweet remembrance.

He took an active interest in the legislation resulting in the formation of the Board of Fish Commissioners, and his influence as the then Governor of tbe State, was all important in securing the necessary legislation. Under the act creating the board the Governor was made an ex officio member of the Commission.

George Clark, of Ecorse, Michgan, was a commercial fisherman. He was appointed as a representative man of enlarged views, and as one who saw the possibilities of fish culture, as a means by which the fisheries might be renewed. He was a strong advocate of the establishment of a commission, and his practical knowledge and his hard common sense contributed much to the success of the early work of the board.

George H. Jerome, of Niles, was one of the original members of the board, but resigned to become Superintendent of Fish Cnlture. What a figure he was in the early history of fish culture in Michigan! His reports, which cover the first six years of the operations of the board, are permeated with enthusiasm and read like novels. What the practical resnlts lacked in realization was more than compensated for by the eloquence of the superintendent, who wrote with more method even than he knew. Who can read those reports without being stirred with his enthusiasm? While his style may be open to the charge of being turgid, his enthusiasm and his perception of what the future held in store for the work are plainly manifest, and we of a later time have seen his prediction realized. He was a pioneer in fish culture, and the new enterprise was full of discouragements and disappointments, but like all pioneers he possessed that sturdy and strong individuality which makes its possessor conspicuous amongst his fellows. Verily, "The blood of the martyr is the seed of the church."

APPENDIX.

FISH PLANTS, 1893-1894.

Whitefish plants, 1893, from Detroit house.

Name of waters.	Where planted.	Date.	Number.
Detroit river	Grassy Island	April 5	5,000,000
"	Belle Isle	" 6	5,000,000
"	"	" 8	5,000,000
"	"	" 10	5,000,000
"	Foot of Dubois street	" 10	15,000,000
"	Mamajuda Island	" 11	5,000,000
"	Belle Isle	" 12	5,000,000
"	Foot of Dubois street	" 12	10,000,000
"	Mamajuda Island	" 24	5,000,000
"	Belle Isle	" 26	5,000,000
"	Grassy Island	" 26	5,000,000
Lake St. Clair	Windmill Point	" 7	5,000,000
" "	One mile west of Lightship	" 7	5,000,000
" "	Grosse Point	" 8	5,000,000
" "	One mile above Grosse Point	" 9	5,000,000
" "	Three miles above Detroit river	" 24	5,000,000
" "	Five miles above Detroit river	" 25	5,000,000
Lake Michigan	Muskegon	" 12	3,000,000
" "	Manistee	" 13	3,000,000
" "	Grand Haven	" 15	3,000,000
" "	Ludington	" 15	3,000,000
" "	Frankfort	" 17	3,000,000
Saginaw bay	Bayport	" 17	3,000,000
" "	"	" 23	3,000,000
Straits of Mackinac	Cheboygan	" 19	3,000,000
Lake Huron	Sand Beach	" 21	3,000,000
Total			127,000,000

Whitefish plants, 1893, from Sault Ste. Marie house.

Name of waters.	Where planted.	Date.	Number.
Straits of Mackinac	St. Ignace	May 9	1,000,000
Lake Michigan	Manistique	" 16	3,000,000
" "	"	" 20	3,000,000
Lake Huron	Detour	" 15	1,500,000
" "	"	" 17	1,500,000
Lake Superior	Marquette	" 16	3,000,000
Taquemanon bay	Taquemamon Bay	" 19	4,000,000
Sault Ste. Marie river	Mission	" 23	2,000,000
" "	Sault Ste. Marie	" 28	1,833,960
Total			20,833,960

Whitefish plants, 1894, from Detroit House.

Name of waters.	Where planted.	Date.	Number.
Detroit river	Belle Isle	Mar. 17	1,000,000
"	Grassy Island	" 19	4,000,000
Lake Michigan	St. Joseph	" 24	3,000,000
" "	Ludington	" 25	3,000,000
" "	South Haven	" 27	3,000,000
" "	Pentwater	" 28	2,500,000
" "	Muskegon	" 29	2,500,000
" "	Manistee	" 31	2,000,000
" "	Grand Haven	April 2	3,000,000
Lake St. Clair	Grosse Point	" 1	4,000,000
Lake Huron	Au Sable	" 4	3,000,000
Lake St. Clair	Belle Isle	" 3	9,000,000
Saginaw bay	Bay City	" 4	3,000,000
Lake St. Clair	Belle Isle	" 4	2,000,000
Lake Michigan	Saugatuck	" 5	3,000,000
Lake St. Clair	Lightship	" 5	2,500,000
Detroit river	Fort Wayne	" 5	3,000,000
Lake Erie	Monroe	" 5	3,000,000
Detroit river	Belle Isle	" 6	3,000,000
"	Grassy Island	" 6	3,000,000
Lake Michigan	Manistee	" 7	9,000,000
" "	St. Joseph	" 7	3,000,000
Lake St. Clair	Grosse Point	" 8	2,500,000
" "	Lightship	" 9	8,000,000
Lake Michigan	Ludington	" 10	2,500,000
Lake St. Clair	Above Grosse Point	" 10	2,500,000
Detroit river	Belle Isle	" 11	2,500,000
"	Grassy Island	" 12	3,000,000
Lake Huron	Alpena	" 13	2,000,000
Lake St. Clair	Lightship	" 15	2,000,000
Lake Huron	Sand Beach	" 16	2,000,000
Detroit river	Belle Isle	" 16	1,500,000
Saginaw bay	Bayport	" 16	2,000,000
Lake Erie	Newport	" 19	600,000
Lake St. Clair	Lightship	" 20	2,000,000
Total			90,600,000

Whitefish Plants, 1894, from Sault Ste. Marie House.

Name of waters.	Where planted.	Date.	Number.
Tequamenon bay	Tequamenon bay	April 26	1,500,000
Sault Ste. Marie river	Mission	" 28	2,540,000
Lake Huron	Detour	" 30	4,000,000
Lake Superior	Whitefish point	May 2	1,020,000
Lake Manistique	Lake Manistique	" 4	841,800
Lake Superior	Manistique	" 4	1,500,000
" "	Marquette	" 7	2,000,000
Lake Michigan	Little Bay de Noquet	" 9	2,000,000
Hurlburt lake	Hurlburt station	" 11	50,000
Lake Superior	Whitefish point	" 15	1,875,000
Lake Michigan	Manistique	" 19	2,000,000
Sault Ste. Marie river	Sault Ste. Marie	" 22	1,933,600
Total			21,260,400

Whitefish Plants, 1894, from Charlevoix House.

Name of waters.	Where planted.	Date.	Number.
Lake Michigan	Seven-mile reef	April 11	2,000,000
" "	Fisher's reef	" 12	2,000,000
" "	Seven-mile reef	" 13	2,000,000
" "	Between Norwood and Cathead point	" 13	2,000,000
" "	Frankfort	" 18	3,500,000
" "	Seven-mile reef	" 19	2,000,000
" "	Fisher's reef	" 20	4,200,000
Pine lake	Charlevoix	" 21	2,250,000
Lake Michigan	Frankfort	" 21	2,500,000
" "	White shoals	" 22	3,000,000
Pine lake	Charlevoix	" 23	1,550,000
Round lake	"	" 23	4,000,000
Total			31,000,000

Brook Trout Plants, 1893.

County and name of waters.	Town.	Depositor.	Date.	Number.
Alcona:				
Van Etten creek	Mikado	Phillip O. Partridge	April 10	12,000
Block House creek	Potts	J. W. Morrin	" 10	9,000
Smith creek	Curtis	John Bowser	" 10	4,500
Webber creek	"	" "	" 10	4,500
Sucker creek	Alcona	D. McGregor	" 10	6,000
West branch	Haynes	" "	" 10	8,000
Stony creek	"	Addison Silverthorn	" 10	6,000
Jim's creek	"	" "	" 10	6,000
Wolf creek	Mitchell	Lawrence R. Dorr	" 10	6,000
Silver creek	"	" "	" 10	6,000
McGenn creek	"	" "	" 10	6,000
Silver creek	"	John Freer	" 10	6,000
Wolf creek	"	" "	" 10	6,000
Fox creek	Haynes	Owen Fox	" 10	6,000
Elm stream	Harrisville	H. W. Lyman	" 10	6,000
Indian river	"	"	" 10	6,000
Indian creek	Mikado	Ambrose Thompson	" 10	9,000
Spring creek	"	" "	" 10	9,000
Wilson creek	Harrisville	John Van Buskirk	" 10	3,000
Van Buskirk mill pond	"	" " "	" 10	3,000
Allegan:				
North branch Rabbit river	Wayland	Elias Sias	March 15	6,000
Manlius creek	Maolins	C. B. Conger	" 7	6,000
Big creek	Martin	J. D. Kelley	" 13	3,000
Bellingham creek	"	"	" 13	8,000
Bayley pond tail race	Orangeville	"	" 13	3,000
Clifford creek	Trowbridge & Otsego	Conrad Bros.	" 13	6,000
Butler creek	Otsego	John N. Perkins	" 13	4,500
Yerrick creek	"	" "	" 13	4,500
Branch of Schuable brook	"	L. D. Ballou	" 13	3,000
Silver creek	Gun Plains	C. D. Stewart	" 13	4,500
Watkins creek	" "	"	" 13	4,500
Cold Stream brook	Otsego	Buchanan B. Jones	" 13	3,000
Barnes brook	Trowbridge	C. Engles	" 13	3,000
Spring Grove creek	Otsego	John D. Woodbeck	" 13	3,000
Scott creek	Lee and Casco	George Moore	" 7	9,000
Spring Brook creek	Lee	Henry Motte	" 7	6,000
Alpena:				
Crowel creek	Ossineke	W. E. Wright	April 10	7,500
Morse creek	"	"	" 10	7,500
Antrim:				
Dick creek	Banks	Jeff Bearrs	" 4	6,000
Wood creek	"	" "	" 4	6,000
Orr creek	"	C. S. Campbell	" 4	12,000
McCartney creek	Antrim	Geo. H. Van Pelt	" 4	18,000
Spencer creek	Helena	Main & Sanford	" 4	12,000
Cedar creek	Kearney	Arthur Watkins	" 4	9,000
Cold creek	"	" "	" 4	9,000
Alger:				
Rock river	AuTrain	Horatio Seymour	May 5	7,000
Laughing Fish creek	Onota	" "	" 5	7,000
Union river	Munising	W. S. Wetmore	" 5	28,000
Rock river	"	N. M. Kaufman	" 5	28,000
Arenac:				
Deep river	Deep River	A. C. Maxwell	April 6	9,000
Name not given	" "	John E. Gilbert	" 10	15,000
Barry:				
Bentley's creek	Rutland }	Sidney A. Crowell	March 10	18,000
Lane's creek	" }			
West creek	" }			
Butler's creek	Hastings }			
Fall creek	Hope and Hastings }			
White creek	Thornapple	John McQueen	" 10	3,000
Leonard creek	"	" "	" 10	3,000
Coldwater creek	Odessa	Oliver J. Wait	" 10	12,000
Yankee Springs creek	Yankee Springs	A. C. Hunt	" 15	9,000
Ellis or Marsh brook	Assyria	P. K. Jewell	" 30	12,000
Leslie stream	Carlton	F. J. Wolfe	" 27	10,000
Name not given	"	A. S. Taylor	April 27	10,000

Brook Trout Plants, 1893.—CONTINUED.

County and name of waters.	Town.	Depositor.	Date.	Number.
Benzie:				
Little Betsey river	Colfax	Wm. Cherryman	April 4	12,000
Big and Little Betsey rivers	"	A. C. Wilkinson	" 4	12,000
Berrien:				
Farmer's brook	Pipestone	Charles K. Farmer	March 30	9,000
Dayes brook	Buchanan	Levi Redden	" 7	8,000
Estes brook	"	" "	" 7	3,000
Jeffries creek	Galien	Lyangee Jeffries	" 7	4,500
Valentine creek	"	" "	" 7	4,500
Spring creek	Three Oaks	D. F. Bommerscheim	" 7	4,500
Kinne's creek	" "	" "	" 7	4,500
Tributary to Hickory creek	Lincoln and Royalton	J. H. Hatch	" 7	6,000
Pipestone creek	Benton Harbor	L. T. Burridge	" 7	3,000
Bonnson creek	" "	"	" 7	3,000
Edmonds creek	" "	"	" 7	3,000
Chadwick creek	" "	"	" 7	3,000
Eastman creek	" "	"	" 7	3,000
Rockleff creek	" "	"	" 7	3,000
Milk creek and tributaries	Watervliet and Bainbridge	A. N. Woodruff	" 7	3,000
Calhoun:				
Alder creek	Burlington	Zachariah Little	" 7	6,000
Mt. Jack spring brook	Newton and Leroy	C. B. Lowell	" 7	6,000
Wormley's creek	Marshall	J. F. Garwood	" 15	4,000
Hinkle creek	"	"	" 15	4,000
Enos brook	"	"	" 15	4,000
Dixon creek	"	C. R. Harris	" 15	4,000
Helmer creek	Bedford	"	" 15	4,000
Seven Mile creek	"	"	" 15	4,000
Cox brook	Emmet	"	" 15	4,000
Pratt brook	Bedford	"	" 15	4,000
Mineral Spring brook	Battle Creek	"	" 15	4,000
Austin brook	" "	"	" 15	4,000
Partridge Spring brook	Bedford	"	" 15	4,000
Spring brook	Assyria	"	" 15	4,000
Cass:				
Pea Vine creek	Pokagon	F. L. Colby	" 30	9,000
Penn creek	Penn	B. L. Rudd	" 7	6,000
Thorp creek	Jefferson	C. H. Kimmerle	" 7	4,000
Pokagon creek	Pokagon and Howard	"	" 7	4,000
Stephenson creek	Jefferson	"	" 7	4,000
Shaws creek	Jefferson and Howard	"	" 7	3,000
Centennial Mill creek	LaGrange & Jefferson	"	" 7	3,000
Hadsell's creek	Jefferson and Howard	John Condon	" 7	3,000
Coulter creek	Jefferson	Fred A. Hadsell	" 7	3,000
Lee creek	"	"	" 7	3,000
Smith's creek	"	S. S. Condon	" 7	3,000
Heddon creek	Wayne	Wm. H. Murphy	" 7	3,000
Indian Lake outlet	Silver Creek	"	" 7	3,000
Charlevoix:				
McGeogh creek	Marian }	L. D. Bartholomew	April 4	25,000
Inwood creek	Norwood }			
Stovers creek	Charlevoix }			
Hortons creek	Hayes and Bay	C. Hewitt	" 4	9,000
Cheboygan:				
Middle branch of Little Sturgeon river	Towns 34 and 35 }	H. J. Graves	" 6	24,000
Cedar creek	Tuscarora }			
Cold creek	Town 35 }			
Clark creek	Ellis }	W. H. Merritt	" 6	18,000
Dale's creek	Menton }			
Mill creek	Hebron	John Reycroft	May 6	6,000
Chippewa:				
Sault Ste. Marie river	Cedar Point and Little Rapids	Cace Robotham	April 20 " 25 " 28 " 29 May 3	6,000 12,000 7,000 15,000 30,000
Brown creek			April 28	5,000

Brook Trout Plants, 1893.—Continued.

County and name of waters.	Town.	Depositor.	Date.	Number.
Clare:				
Green's creek Norway creek	Redding	H. S. Anderson	March 27	18,000
Giebawash creek	Several	H. C. Potter, jr.	" 24	18,000
S. br. of Tobacco river	Grant	Wm. Ross	" 24	6,000
Chord creek	Not stated	W. B. Mershon	" 24	18,000
Mid. br. Tobacco river	" "	C. H. Davis	" 24	18,000
Chippewa river	Surrey	Harry T. Wickes	" 24	15,000
Dock and Tom creek	Frost	W. W. Green	" 24	18,090
Town Line creek	Several	W. F. Potter	" 24	18,000
N. br. of Tobacco river	Not stated	J. J. Reik	" 24	5,000
Norway creek		A. E. Cobb	" 27	6,000
Clinton:				
Curtis' creek	Duplaine	George Randolph	" 20	3,000
School Section creek	Essex	J. Betts	" 20	3,000
High Bank creek	Lebanon	James A. Valentine	" 20	4,500
Coon creek	Ovid	" " "	" 20	4,500
Alder creek	"	Elisha F. Edward	" 20	6,000
Post creek	Victor	Cassius Alexander	" 20	6,000
Spring creek Moore creek Bruice creek W. br. of Maple river	Eagle Duplaine " Ovid	A. M. Birmingham	" 20	12,000
Eaton:				
Sand Stone creek	Oneida	J. Carliele	" 20	6,000
Emmet:				
Big creek	Carp lake	J. C. Schmalzreid	" 20	6,000
Spring creek	Maple river	E. L. Lyon	" 20	6,000
Gladwin:				
Sugar river	Butman & Sherman	F. C. Stone	" 24	18,000
Prindle brook	Gladwin	F. L. Prindle	April 6	24,000
Gogebic:				
Montreal river	Ironwood	L. L. Wright	May 2	5,000
Grand Traverse:				
Whitewater brook	Whitewater	Frank H. Vinton	April 4	9,000
Barker creek	Blair and Green lake	D. E. Crandall	" 4	0,000
Cranes creek Barker creek Mill creek Whitewater brook	Whitewater	L. L. Lydell	" 4	9,000
Hillsdale:				
Greenshaws creek Ramsdell springs	Hanover	G. F. Greenshaw	March 10	9,000
Skinner's creek	Cambria	M. G. Mallery	" 10	6,000
Harrison's creek Britton's creek Bean creek Hillsdale creek	Pittsford	James B. Thorne	" 10	18,000
Houghton:				
Trap Rock creek	Schoolcraft and Calumet	Frank Hann	May 5	3,000
Sweed Town creek Pilgrim river	T. 55 N., R. 34 W. T. 54 N., R. 34 W. and 54 N., R. 33 W.	Mich. Copper Journal	" 5	27,000
Otter river	T. 51, 52, and 53 N., 34 W.	N. E. McBride	" 5	7,000
Salmon Trout creek	Adams and Hancock	J. A. Cameron	" 5	7,000
E. br. of Otter river	Portage, Adams, and Chappell	Jay A. Hubbell	" 5	10,000
Cole's creek	Adams and Hancock	A. R. Gray	" 5	10,000
Slott's creek	Hancock	F. J. Bowden	" 5	10,000
Graveract creek	"	Allen F. Ries	" 5	10,000
Mizery creek	Adams	C. C. Douglass	" 5	10,000
Boston and Albany creek	Franklin & Hancock	James H. Seager	" 5	9,000
Elm creek	Adams and Hancock	James H. Blondy	" 5	9,000
Elm creek	Adams	" " "	" 5	7,000
Salmon Trout creek	"	C. D. Sheldon	" 5	11,000
Pilgrim river	Portage and Adams	W. D. Caermley	" 5	30,000
Pike river	Chappell			

Brook Trout Plants, 1893.—Continued.

County and name of waters.	Town.	Depositor.	Date.	Number.
Ionia:				
Steel creek	Ionia	H. L. Bailey	May 5	6,000
Derby creek Stony creek	Danby	George D. Allen	" 5	3,000
Spring brook	"	W. D. Crane	" 5	3,000
Crydeman creek	Campbell	Samuel W. Burt	" 5	6,000
Duck creek				
Iosco:				
Vaoghn creek	Plainfield	Warren S. Hodges	April 6	3,000
Cold creek	Tawas and Baldwin	C. W. Luce	" 10	9,000
Isabella:				
Stony Brook	Bloomfield & Deerfi'd	Norris & Co.	March 27	6,000
N. br. Cedar river Notawa creek	Deerfield Notawa	Geo. L. Granger	" 27	12,000
N. br. of Chippeway	Gilmore	C. H. Freeman	" 27	6,000
Willow creek	Four townships	Chas. B. Hull	" 27	15,000
Herring creek	Vernon	Joseph Verrett	" 27	6,000
McDonald creek	"	Allen McDonald	" 27	6,000
Baker creek	"	J. H. Seeley	" 27	6,000
Johnson creek	Union	Warner Churchill	" 27	6,000
Jackson:				
Headwaters Kalamazoo river	Hanover, Spring Arbor, and Concord	R. S. Woodruff	" 7	9,000
Coltron's creek Trib. to Sandstone creek	Summit Spring Arbor	J. G. O'Dwyer	" 7	9,000
Mill creek	Summit	C. B. Bush	" 7	6,000
R. R. pond	Rives	Will D. Casey	" 10	9,000
Williams' creek	Hanover	A. L. Ambrose	" 10	6,000
Blaisdell's mill race	Waterloo	Wilfred O. Wellman	" 15	3,000
Kalamazoo:				
Collier brook North Stacey brook South Stacey brook	Cooper Richland "	J. Frank Cowgill	" 13	12,000
Little Portage creek	Kalamazoo	J. W. McElwain	" 13	6,000
Frake's creek	Schoolcraft	H. F. Badger	" 13	6,000
Spring brook	Cooper	Levi F. Cox	" 13	6,000
Pierson creek	Alamo	Chas. W. D. Allen	" 13	6,000
Spring run	Prairie Ronde	John E. Pabst	" 13	6,000
Mill creek Shutes creek	" "	Thomas Hewitt	" 13	6,000
Crooks creek Boles or Stanley creek	Portage	Charles S. Bollee	" 13	6,000
Black river Lane's creek	Schoolcraft	Henry J. Allen	" 13	9,000
Teake's creek Parsel creek	Prairie Ronde	A. D. Koon	" 13	3,000
Harrison creek Yetter creek	" "	Wm. House	" 13	3,000
Mud Lake stream	Texas	John Harrison	" 13	3,000
DeWolf's creek	Schoolcraft	A. M. Fellows	" 13	3,000
Taylor's creek	Portage			
Knap creek Ridler creek Earl creek Pierce creek Billows creek	Charleston & Comstock Charleston & Comstock Charleston & Climax Charleston & Climax	H. Dale Adams	" 15	15,000
Kent:				
Berkely creek Shaw creek Rives creek	Cannon & Plainfield Courtland & Algoma " " " " " "	F. E. Wright	April 27	24,000
Stegman creek	Courtland, Oakfield, and Spencer	Freeman Addis	March 10	9,000
Crimson creek	Oakfield	A. W. Stevens	" 10	3,000
Sugar Bush creek Little Cedar creek Moore's creek	Courtland & Algoma	W. H. Wheeler	" 10	15,000
Spring creek Muro's pond Newman pond	Algoma " Courtland	Homer B. Stevens	" 10	9,000
Anderson's pond	Caledonia	Hilbert Moffit	" 10	6,000
Moffit creek				

Brook Trout Plants, 1893.—CONTINUED.

County and name of waters.	Town.	Depositor.	Date.	Number.
James creek	Caledonia	G. W. Barbour	March 10	3,000
Cooley's creek		George Eastman	" 10	6,000
Buck creek	Wyoming	C. C. Darling	April 4	18,000
Silver creek	Tyrone and Sparta			
Sparta creek	Sparta			
Ball creek	Tyrone and Sparta	A. A. Place	" 4	18,000
Hanley creek	Sparta			
English creek		J. S. Ingram	" 4	6,000
Camp creek	N. pt. Tyrone tp.	W. R. Holden	March 22	6,000
No name	Algoma and Solon			
Cedar creek				
Lake:				
Mid. br. Pere Marquette	Three towns	R. H. L'Hommedieu	" 27	9,000
Lacy creek	Yates	B. B. Mitchell	" 27	9,000
Sanborn creek	Three towns	A. H. Morley	" 27	9,000
Br. of Little Manistee	Ellsworth	Jas. B. Peter	" 27	6,000
Danagher creek	T. 17 N., 13 E.			
Little Manistee	Lake	C. H. Bates	" 27	18,000
Buck creek				
Weldon creek				
Bowman creek	Pleasant Valley	I. F. Brand	" 27	6,000
W. br. Danagher creek	Cherry Valley	W. A. Avery	" 27	6,000
Avery creek	Elk	J. S. Stearns	" 27	6,000
Little Sweetwater creek	Pleasant Plains	L. H. Carpenter	April 4	3,000
Danagher creek				
Livingston:				
Cedar creek	Marion	David O. Smith	March 20	9,000
Lenawee:				
Big Meadow creek	Madison, Palmyra, and Ogden.	M. J. Pierce	" 10	15,000
Gleason brook	Fulton & Williams.			
Bear creek or Tiffin river	Hudson	James B. Thorn	" 10	18,000
Hillsdale creek	"	John H. Combs	" 10	9,000
Britton creek	Rome			
W. br. River Raisin				
Macomb:				
Wilson brook	Washington	Andrus & Stewart	" 15	6,000
Streetor's creek	Bruce			
Troop's creek	"	H. W. Bradley	" 15	24,000
Eldred's creek	"			
Frost's creek	Washington			
Smith's creek	"			
No name	"	F. P. Andrus	" 15	12,000
Gutche's creek	Bruce			
Smith's creek				
Manistee:				
Clear brook	Brownstown	Loren Pierce	" 27	6,000
Gable creek	Cleon	W. R. Smith	" 27	12,000
Br. of Bear creek	Maple Grove	J. A. Higgins	" 27	6,000
Beaver creek	Brownstown	H. A. Bahr	" 27	6,000
Sickles creek	Onekama	J. A. Shults	" 27	6,000
Printing Office creek	Maple Grove	Alfred H. Mills	" 27	12,000
Cedar creek				
Marquette:				
Dead river	Marquette	Horatio Seymour	May 5	8,000
Chocolay creek	Chocolay	" "	" 5	8,000
W. br. Escanaba river	Republic	David T. Morgan	" 5	12,000
Michigamme river	"	" " "	" 5	12,000
Carp river	Negaunee & Marquette	John C. Fowle	" 5	8,000
Harlow's creek	Marquette & Ishpim'g	" " "	" 5	7,000
Garlic river	" " "	" " "	" 5	7,000
Rainey's creek	Marquette	" " "	" 5	7,000
Green creek	Town 47	Geo. A. Newett	" 5	10,000
Huron creek	Ishpeming and Ely	" " "	" 5	10,000
Gold creek	Tilden	" " "	" 5	10,000
Mason:				
Butler creek	Lincoln	M. Butler	March 27	12,000
Daunhalin's creek				
Gebolt's creek	Amber	V. R. Penny	" 27	9,000
Dan Whalen's creek				
Two inlets to Round lake	Sheridan	C. O. Holmes	" 27	6,000
Upper Weldon creek	Branch	H. C. Ransom	" 27	9,000
Car Settlement creek	Lake	B. F. Barnett	" 27	9,000
Weldon creek	Branch	F. Lyon	" 27	6,000

Brook Trout Plants, 1893.—CONTINUED.

County and name of waters.	Town.	Depositor.	Date.	Number.
Missaukee:				
W. br. of Muskegon river	Forest	James McGinness	March 27	12,000
Mecosta:				
Hinton creek	Hinton and Morton	C. M. Helms	" 13	24,000
Simmons' creek	" " "			
Mills' creek	Deerfield			
Hiberger creek	Hinton	W. W. Northcott	" 13	6,000
Fetterhoff creek	"	James C. Boyd	" 13	6,000
Big creek	Ætna and Deerfield	" " "	" 13	6,000
Haney creek	Deerfield	E. J. Marsh	" 13	6,000
Bruce creek	"	Frank Parry	" 20	6,000
Janette creek	Grant	Lorenzo D. Decker	" 20	3,000
Marsh creek	Morton	Mich. Fish Com.	April 4 and 5	20,000
Black Lake creek	Millbrook and Belvidere	" " "	" 4 and 5	30,000
Buckhorn creek	Green	" " "	" 7	15,000
Cheney creek	"	" " "	May 6	10,000
Paris creek	"			
" "	"			
Menominee:				
Hay creek	Menominee	R. A. Kirkham	April 26	5,000
Birch creek	Mea	Chas. Springer	" 26	5,000
Big brook	Town 36, R. 26	J. H. Hanrahan	" 26	5,000
Pembina brook	Holmes	C. F. Carney	" 26	5,000
Merrill's brook	Nadeau	J. G. Little	" 26	5,000
Holmes' brook	Stephenson	W. P. Kezar	" 26	5,000
Olson creek	"	Edward Sawbride	" 26	5,000
Montcalm:				
Wabasis creek	Eureka	W. R. Holden	March 22	6,000
Cedar creek	Winfield	Sid V. Bullock	" 13	6,000
W. br. of Fish creek	Sidney and Douglass	C. Ellis Elliott	" 20	6,000
Br. of Fish creek	Sidney			
Hemingway creek	Douglass	George T. Howarth	" 20	6,000
Hooker creek	Day	S. Perry Young	" 20	3,000
Br. of Fish creek	Sidney	J. A. Dockery	" 20	9,000
Black creek	Maple Valley			
Dickson creek	Douglass, Sidney, and Fairplain	T. I. Phelps	" 20	18,000
Clear creek	Maple Valley	W. R. Jones	" 20	9,000
Sackett's creek	Home			
Kirby creek	Pine	S. J. Youngman	" 20	9,000
W. br. of Flat river	Belvidere			
Horseshoe Lake creek				
Montmorency:				
Little Black river	Wheatfield	F. W. H. Hameston	" 20	9,000
Muskegon:				
Dalton creek	Montague	George Klett	" 22	3,000
Belleview Trent creek and pond	Fruitland	W. C. Weigo	" 22	3,000
Cedar creek	Holton	Stephen S. Skeels	" 22	18,000
Cushm creek	Greenwood			
Skeel's creek	Holton	John Dagen	" 22	3,000
Little Cedar creek	Cedar Creek	J. D. Hart	" 22	6,000
Titatute creek	Ravena	C. C. Tuxbury	" 22	9,000
Crockery creek	Fruitport	C. S. Gunn	" 22	6,000
Norris creek	Eggleston			
Musquito creek				
Duck creek				
Little Bear creek	Fruitland	E. D. Magoon	" 22	18,000
Big Bear creek				
Black creek				
Green's creek	Casnovia	E. Farnham	April 4	12,000
Muma creek	Tyrone			
Fenton creek	"			
Moon Lake creek				
Newaygo:				
Temwait creek	Croton	S. D. Thompson	" 26	18,000
Thompson's creek	Evart			
Bington creek	"			
Moore's creek	Ensley	W. H. Wheeler	March 10	15,000
Spring creek				
Little Cedar creek				

Brook Trout Plants, 1893.—CONTINUED.

County and name of waters.	Town.	Depositor.	Date.	Number.
Williams' creek	Sheridan			
Helster creek	Dayton			
Black creek	Dayton and Danver	A. Gerber	March 22	18,000
Kenepor Big Gulley creek	Sheridan			
Odell creek				
Soutier creek	Dayton	Frank Cole	" 22	3,000
Cole creek				
Pickerel creek	Troy	Chester Brown	" 27	9,000
Cedar creek	"	T. A. Harvey	" 27	6,000
Hay Lake creek	Monroe	Mich. Fish Com.	May 6	5,000
N. br. of Pere Marquette	Norwich and Monroe	" " "	" 6	10,000
Peas creek	Barton and Monroe	" " "	" 6	10,000
Oakland:				
Moyer's Spring and Tribs.	Oxford	O. E. Bell	March 15	6,000
Oceana:				
Cedar creek				
Annly creek	Pentwater	D. C. Wickham	" 22	15,000
Sand creek	Otto	C. E. Covell	" 22	9,000
Stony creek	Benona	Henry J. Marsh	" 22	6,000
Ogemaw:				
Mackie's creek	West Branch	James Mackee	April 6	6,000
Brooks' creek	Rose			
Wilkins' creek	Klacking and Cumming	Hiram Hodge	"	6,000
Osceola:				
Chippewa creek	Osceola	F. S. Sovereen, M.D.	March 24	6,000
Dacey's pond and creek	Evart	James Deacey	" 24	8,000
Comstalk creek	Evart and Osceola	Peter Comstalk	" 24	6,000
Dock and Tom creek	Hartwick and Sylvan			
Hicks' creek	" " "			
Hofmeyer's creek	Osceola and Sylvan	J. J. Reik	" 24	20,000
Grindstone creek	Hartwick and Sylvan			
Ghost creek	Marion	J. D. Try and F. C. Desmond	" 27	6,000
Oscoda:				
Glennie creek	Cummins	Joseph Sullivan	April 10	6,000
Ottawa:				
Br. of Big Crockery creek	Chester	W. R. Holden	March 22	6,000
Milk creek				
Black creek	Jamestown	Francis J. Buege	" 13	12,000
Whipple creek	Georgetown	Hiram Haight	" 7	6,000
Otsego:				
W. br. of Sturgeon river				
Au Sable river	T. 31 N., R. 3 W.	D. H. Fitzhugh	April 6	9,000
Upper branches of Pigeon and Black rivers				
Sturgeon river	Corwith and Dover	A. A. Crane	"	24,000
Black river				
Pigeon river				
Outlet of Bradford lake	T. 29 N., R. 4 W.	Henry Stephens	"	6,000
Outlet of Woodin and Berryville lakes	Corwith	Thomas C. Woodin	"	9,000
Roscommon:				
Dunham creek	Nestor	S. V. Thomas	"	9,000
Sanilac:				
Mills' creek	Worth	Rudolph Papst	March 15	9,000
St. Joseph:				
Spring run	Flowerfield	Chas. Rice	" 7	6,000
Spring creek	Nottawa and Colon	L. A. Clapp	" 7	6,000
Trib. to Spring creek	Nottawa	George Keech	" 7	6,000
Spring creek	White Pigeon	L. N. La Gro	" 13	6,000
Houston's run	Fawn River	Alex. Houston	" 13	6,000
Str. on secs. 21, 22, 28	Sherman	Frank Kenyon	" 13	6,000
Tuscola:				
Montague creek	Indian Fields			
Goodin creek	Millington & Watert'n.	F. S. Wheat	" 15	6,000

Brook Trout Plants, 1893.—CONCLUDED.

County and name of waters.	Town.	Depositor.	Date.	Number.
Van Buren:				
Butternut creek	Geneva			
Cedar creek	Covert and Geneva	J. C. Merson	March 7	15,000
Mill creek	Geneva			
Maple creek	Bangor and Arlington			
Bruch's creek	" " "	Wm. Broadwell	" 7	9,000
Three Mile creek	Bangor and Geneva			
Barrett creek	Hamilton	Milton Barrett	" 7	3,000
Sink creek	Almena	T. A. Sprague	" 7	6,000
Watkins' creek				
Silver creek	"	C. D. Stewart	" 13	9,000
Crystal Spring creek	Porter	C. F. Dey	" 7	6,000
Washtenaw:				
Str. on sec. 5	Scio	Jacob Krause	" 15	3,000
Stony creek	Augusta	F. H. Barnum	" 15	6,000
Casey creek	Superior and Ypsilanti	H. I. Knapp	" 30	6,000
Wayne:				
Willow run	Van Buren	J. B. Goudry	" 15	6,000
Farmington brook	Livonia	S. Walker	" 20	6,000
Wexford:				
Pott's creek	T. 24 N., R. 9 W.	Samuel D. Mills	April 4	6,000
Fresh Water creek	Wexford			
Bock creek	Springville	Thomas Gale	March 27	18,000
Fletcher creek	"			
Total				2,741,000

Brook Trout Plants, 1894.

County and name of waters.	Town.	Depositor.	Date.	Number.
Alger:				
Rock river	T. 46 N., 22 W.	M. M. Kaufman	April 26	6,000
Anna river	Munising	W. S. Wetmore	" 26	15,000
Rock river	Au Train	Horatio Seymour	" 26	6,000
Laughing Fish river	Onota	" "	" 26	9,000
Alcona:				
West branch	T. 26 N., 8 W.	A. Backus, jr.	March 20	3,000
Backus creek	T. 26 N., 8 W.	" " "	" 20	6,000
Elm stream }	Harrisville	H. W. Lyman	" 20	5,000
Indian run }				
Stony creek	Haines	Addison Silverthorne	" 20	10,000
Wilson's creek }	Harrisville	A. Van Buskirk	" 20	1,000
Van Buskirk's mill pond }				
Ettan creek	Mikado	Philip A. Partridge	" 20	10,000
Indian creek	"	Ambrose Thomas	" 20	5,000
Spring creek	"	" "	" 20	5,000
Allegan:				
Scott creek	Casco	Joshua Smith	February 14	3,000
Spring Brook creek	Lee	Henry Mottie	" 14	3,000
Scott creek	Lee and Casco	George Moore	" 14	9,000
Manlius creek	Manlius	C. B. Conger	" 14	6,000
Spring Grove creek	Otsego	John D. Woodbeck	" 20	3,000
Silver creek	Gun Plains	C. D. Stewart	" 20	4,500
Cold Stream creek	Otsego	Buchanan R. Jones	" 20	3,000
Adsit creek	Watson	Fred Tubbs	" 20	3,000
Franklin creek	Adams and Otsego	" "	" 20	3,000
Adsit creek	Watson	H. D. Mills	" 20	500
White's creek	Gun Plains	Conrad Bros.	" 20	3,000
Indian stream	Wayland	John A. Turner	" 20	2,000
Butler creek	Otsego and Gun Plains	John N. Perkins	March 9	4,000
Alpena:				
Smith's creek	Green	D. D. Hanover	" 20	3,000
Crowel creek }	Ossineke	W. E. Wright	" 20	15,000
Morse creek }				
Antrim:				
Cedar river }	Kearney	Arthur Watkins	" 14	17,000
Cold creek }				
Dick creek }	Banks	Jeff. Bearss	" 14	5,000
Wood creek }				
Spencer creek	Helena	Main & Sanford	" 14	3,000
Arenac:				
Br. of Au Gres	Turner	George Lewis	" 20	10,000
Barry:				
Messer brook	Carlton and Campbell	John Donley	April 11	10,000
Prichard brook	Baltimore	Charles Prichard	February 22	3,000
Haney creek	Rutland	J. W. McElwain	" 22	3,000
Tamarack creek	Hastings	Peter Cockburn	" 22	3,000
Fuller brook	Carlton	Kip Silsbee	" 22	2,000
Stream on sec. 24	Rutland	F. H. Barlow	" 22	3,000
Fall creek	Hope and Hastings	Sidney A. Crowell	" 22	3,000
Bentley's creek	Rutland	" " "	" 22	3,000
Lane's creek	"	" " "	" 22	3,000
Kenny or West creek	"	" " "	" 22	3,000
Butler's creek	Hastings	" " "	" 22	3,000
Kelley or Spence brook	Baltimore	W. H. Spence	" 22	10,000
Stanley creek	Hastings	Luke Waters	" 22	3,000
Leslie creek	Carlton	F. I. Wolf	" 22	3,000
Stream on sec. 24	Rutland	Richard Doyle	" 22	1,500
Cedar creek	Baltimore	James McGlynn	" 22	5,000
Fall creek	Hastings	W. D. Hays	" 22	5,000
Ingram creek	Irving	John Kurtz	" 22	3,000
Ellis brook	Assyria	P. K. Jewell	" 22	5,000
Baraga:				
Spring brook	Baraga	N. S. Pennock	April 26	9,000
McKernan creek	L'Anse	" "	" 26	6,000
Fall river	"	" "	" 26	9,000
Meadow brook	"	" "	" 26	6,000
Berrien:				
Farmer's brook	Pipestone	Chas. K. Farmer	February 14	3,000
Farmer's creek	"	A. L. Hammond	" 14	3,000
Trib. to Hickory creek	Lincoln and Royalton	J. H. Hatch	" 14	3,000

Brook Trout Plants, 1894.—CONTINUED.

County and name of waters.	Town.	Depositor.	Date.	Number.
Kinnie's creek	Three Oaks	D. F. Bommerschine	February 14	3,000
Spring creek	" "	" "	" 14	3,000
Jeffries' creek	Galien	Langes Jeffries	" 14	3,000
Benzie:				
Crystal creek	Benzonia	C. Stein	April 17	3,000
Little Betsey river	Thompsonville	"	" 17	6,000
Betsey river }	Colfax	A. Wilkinson	March 17	15,000
Little Betsey river }				
Cold Spring creek }	Benzonia	L. T. Van Winkle	" 16	9,000
Eaden branch }				
Cedar creek }				
Little Betsey river	Colfax	W. C. Cherryman	" 16	15,000
Branch:				
Noble creek	Noble	C. D. Warner	February 21	5,000
Crooked creek	Kinderhook	" "	" 21	5,000
Stream on secs. 1 and 2	"	" "	" 21	2,000
Calhoun:				
Warsop creek	Athens	Joseph Warsop	" 23	2,000
Alder creek	Burlington	Zachariah Little	" 23	5,000
Saunders' creek	"	Edson Treadwell	" 23	3,000
Colborn creek	Athens	J. Colborn	" 23	5,000
Paie creek	Athens and Le Roy	W. H. Hubbard	" 23	5,000
Le Bow creek	Athens	Earnest C. Hampton	" 23	2,000
Not named	"	W. D. Farnam	" 23	5,000
Cox creek	Emmet }	C. R. Harris	" 15	15,000
Pratt brook	Bedford }			
Mineral Spring brook	Battle Creek }			
Austin brook	" " }			
Partridge Spring brook	Bedford }			
Spring brook	Assyria	" "	" 15	3,000
Hinkle's brook }	Marshall	J. F. Garwood	" 15	4,000
Talmadge brook }				
Wormley's creek	"	" "	" 15	2,000
Tamarac creek	"	" "	" 15	2,000
Enos brook	"	" "	" 15	2,000
Knight's brook	"	" "	" 15	3,000
Cass:				
Smith's creek	Jefferson	S. S. Condon	" 23	1,000
Shaw's creek	Jefferson and Howard	C. H. Kimmerle	" 23	3,000
Centennial Mills creek	La Grange and Jeffers'n	" "	" 23	3,000
Pokagon creek	Pokagon and Howard	" "	" 23	4,000
Stephenson creek	Jefferson	" "	" 23	3,000
Hadsell's creek	Jefferson and Howard	John Condon	" 23	3,000
Sharp's creek	Jefferson	C. H. Kimmerloe	" 23	3,000
Not named	Marcellus	W. L. Arnold	" 23	3,000
Penn creek	Penn	B. L. Rudd	" 23	5,000
Spring creek	Pokagon	W. H. Murphy	" 23	3,000
Indian Lake outlet	Silver creek	" "	" 23	3,000
Macy creek	Wayne	" "	" 23	1,000
Pea Vine creek	Pokagon	F. L. Colby	" 23	5,000
Hedden creek	Wayne	W. H. Murphy	" 23	1,000
Charlevoix:				
McGeogh creek	Marian	L. D. Bartholmew	March 14	5,000
Inwood creek	Norwood	" "	" 14	5,000
Stover's creek	Charlevoix	" "	" 14	5,000
Cheboygan:				
Mid. br. of Little Sturgeon river	T. 34 and 35 N., 2 W.	Henry J. Graves	" 27	5,000
Cold creek	T. 35 N., 2 W.	" " "	" 27	2,000
Mett creek	Hebron	John Reycroft	" 23	3,000
Stewart creek	Nunda	R. H. L'Hommedieu	" 31	15,000
Chippewa:				
Brown creek	Sault Ste. Marie	F. M. Taylor	May 3	5,000
Spring creek	Drummond	J. Wells Church	April 25	5,000
Sault river	Sault Ste. Marie	H. H. Marks	" 13	60,000
" "	" " "	" "	May 3	5,000
Clinton:				
W. branch of Maple river	Ovid	A. M. Birmingham	March 6	6,000
Little Maple river	"	F. D. Cleveland	" 6	10,000
Spring brook	Duplain	David Moon	" 6	2,000
Post creek	Victor	Elisha F. Edwards	" 6	9,000
Curtis creek	Duplain	A. E. Cobb	" 6	6,000

Brook Trout Plants, 1894.—CONTINUED.

County and name of waters.	Town.	Depositor.	Date.	Number.
Clare:				
Gishawash creek	Temple	C. Stine	April 17	6,000
Norway creek	"	" "	" 17	6,000
Chord creek	Grant	Wm. Ross	March 22	5,000
Town Line creek	Frost	W. W. Green	" 22	10,000
Headwaters of Chippewa and trib.	Surrey	J. Van Valkenberg	" 22	15,000
Chippewa river	"	C. H. Davis	" 22	10,000
Dock and Tom creek	"	Henry T. Wickes	" 22	15,000
Mid. br. of Tobacco river	"	W. B. Mershon	" 22	10,000
Silver creek	T. 17 N., 6 W.	Geo. M. Brown	" 22	5,000
Lakes and streams (several)	" "	" " "	" 22	5,000
N. br. of Tobacco river	Several	Wm. F. Potter	" 22	15,000
S. br. of Tobacco river	"	H. C. Potter, jr.	" 22	10,000
Narraway creek	Surrey	J. J. Reik	" 22	1,000
Crawford:				
N. br. of Au Sable river	Several	George Fauble	" 20	15,000
Mid. br. of Big creek	"	" "	" 20	5,000
W. br. of Big creek	"	" "	" 20	8,000
Palmer creek	Grove	" "	" 20	3,000
Fauble creek	"	" "	" 20	3,000
N. br. of Au Sable river	T. 28 N., 1 W.	R. H. L'Hommedieu	" 31	25,000
E. br. of Au Sable river	T. 27 N., 3 W.	" "	" 31	20,000
Br. of S. br. Au Sable river	Center Plains	" "	" 31	10,000
Emmet:				
Birdseye creek	Littlefield	Milton E. Gray	" 23	10,000
Maple river	Maple River	Wm. B. Stimson	" 23	15,000
Carp river	Carp Lake	" "	" 23	15,000
Bear river	Bear Creek	" "	" 30	15,000
Town Line creek	" "	" "	" 30	5,000
Syder creek	" "	" "	" 30	5,000
Conway Spring creek	" "	" "	" 30	5,000
Eaton:				
Sand brook	Vermontville	Benjamin Height	" 9	5,000
Gladwin:				
Sugar river	Butman and Sherwin	F. C. Stone	" 22	15,000
McNellie creek	Sage	F. L. Prindle	" 22	5,000
Cedar creek	Several	" "	" 22	10,000
Gogebic:				
Slate river	Gogebic	C. L. Ryder	July 14	6,000
Meriwether creek	Not given	" "	" 14	5,000
Trout brook	" "	" "	" 14	5,000
Six Mile creek	" "	" "	" 14	5,000
Grand Traverse:				
Crane's creek	Blair and Green Lake	D. E. Crandall	March 14	1,000
Barker creek	Whitewater	L. L. Lydell	" 14	3,000
Mill creek	"	" "	" 14	8,000
Whitewater creek	"	" "	" 14	3,000
Trib. to Platt river	Long Lake	Jeremiah M. Thomas	" 14	10,000
Hillsdale:				
Harrison's creek	Cambria	M. G. Mallery		2,000
Bear creek	"	E. D. Babcock	February 23	3,000
Britton's creek	Pittsford	James B. Thorne	" 23	5,000
Bean creek	"	" " "	" 21	5,000
Hillsdale creek	"	" " "	" 21	5,000
Fellows creek	"	" " "	" 21	5,000
Houghton:				
E. br. of Otter creek	Portage and Adams	J. A. Cameron	May 1	20,000
Cole's creek	Adams and Hancock	J. A. Hubbell	" 1	6,000
Stoll's creek	Hancock	A. R. Gray	" 1	6,000
Pike river	Chassell	W. D. Caernly	April 30	9,000
Graveraet creek	Hancock	J. F. Bawden	May 1	20,000
Salmon Trout creek	Adams and Hancock	N. E. McBride	" 1	10,000
Elm creek	Adams	James H. Blandy	" 1	9,000
Salmon Trout creek	"	" " "	" 1	9,000
Elm creek	Adams and Hancock	Jas. H. Seager	" 1	15,000
Mizery creek	Adams	Allen F. Ries	" 1	20,000
Sweed Town creek	Adams and Hancock	James B. Sturgis	" 1	6,000
Boston and Albany creek	Franklin and Hancock	C. C. Douglass	" 1	9,000
Pilgrim river	Portage and Adams	C. D. Sheldon	" 1	10,000
Trap Rock creek	Schoolcraft & Calumet	Frank Hann	" 1	15,000

Brook Trout Plants, 1894.—CONTINUED.

County and name of waters.	Town.	Depositor.	Date.	Number.
Sweed Town creek	Adams	Mich. Copper Journal	May 1	5,000
Pilgrim river	"	" " "	" 1	5,000
Otter river	"	" " "	" 1	5,000
Pilgrim river	Portage	Lawrence Corrigan	April 26	10,000
Slate creek	Hancock	" "	" 26	9,000
Cowles' creek	Adams and Hancock	" "	" 26	6,000
Dollar Bay creek	Franklin and Osceola	" "	" 26	9,000
Boston creek	Franklin and Hancock	" "	" 26	9,000
Coral creek	Franklin	" "	" 26	3,000
Ingham:				
Seeley's creek	Delta and Lansing	Dewey A. Seeley	March 7	5,000
Ionia:				
Crydeman creek	Darby	W. D. Crane	February 10	2,000
Huron creek	Boston	A. W. Huntley	March 6	8,000
Dock creek	Campbell	Samuel W. Bart	" 7	13,000
Iosco:				
Coal creek	Au Sable and Wilber	C. R. Henry	" 20	5,000
Spring creek	" " "	" "	" 20	5,000
Cold creek	Tawas	C. W. Luce	" 20	10,000
Isabella:				
Herring creek	Vernon	Joseph Verrett	April 4	5,000
N. branch of Chippewa	Gilmore	C. H. Freeman	" 4	5,000
Norton creek	Lincoln	Birton I. Gee	February 27	5,000
Willow creek	Several	Chas. B. Hull	March 22	15,000
Child's creek	Coe }	L. D. Estee	" 17	15,000
Cedar creek	Lincoln }			
Johnson creek	Union	Warner Churchill	" 17	5,000
Mission creek	"	Geo. L. Granger	" 17	10,000
Healey creek	Deerfield	" "	" 17	5,000
Onion creek	Chippewa	" "	" 17	10,000
Nottaway creek	Nottawa	" "	" 17	6,000
N. branch of Cedar creek	Deerfield	" "	" 17	5,000
Jackson:				
Trib. to Grand river	Liberty	Charles Van Schoick	February 23	6,000
E. branch of Snyder's creek	Spring Arbor	Edward A. Hough	" 23	3,000
Kipp's brook	Summit	George Moister	" 28	3,000
Mills' creek	"	" "	" 23	5,000
Crouch creek	"	" "	" 23	5,000
Coltron's creek	"	J. G. O'Dwyer	" 23	5,000
Not named	Summit and Liberty	" "	" 23	3,000
" "	Blackman	" "	" 23	3,000
Williams' creek	Hanover	A. L. Ambrose, M. D.	" 23	9,000
Thompson's spring brook	Moscow and Hanover	Eugene Strait	" 23	5,000
Blaisdell's mill race	Waterloo	Wilfred O. Wellman	" 15	1,500
Locher stream	Green Lake & Waterloo	D. W. Clark	" 15	5,000
Railroad pond	Ricks	Will D. Casey	March 9	1,000
Kalamazoo:				
Franke's creek	Schoolcraft	J. W. McElwain	February 21	5,000
Mill creek }	Prairie Ronde	John E. Pabst	" 20	6,000
Shute's creek }				
Crook's creek }				
Cogle's creek	" "	W. C. Kohl	" 20	2,000
Lane's creek	Portage	Charles L. Bolles	" 20	6,000
Taylor's creek	Schoolcraft	John Harrison, jr.	" 20	3,000
Black river	Prairie Ronde	Thomas Hewitt	" 20	6,000
Dixon's creek	Alamo	Fred Tubbs	" 20	5,000
Sumner creek	Comstock }	H. Dale Adams	" 15	5,000
Lawler or Whitford creek	Charleston }			
Ridler creek }	Charleston & Comstock	" "	" 15	6,000
Earle's creek }				
Pierce creek }	Charleston and Climax	" "	" 15	7,500
Bellows' creek }				
Kalkaska:				
Rapid river	Not given	W. B. Stimson	March 23	10,000
Kent:				
Austin creek	Courtland	Robert Carlyle	February 6	3,000
Baker creek	Canon	" "	" 6	3,000
Becker creek	Courtland	Henry Parkinson	" 6	3,000
Barkely creek	Canon and Plainfield	F. E. Wright	" 6	5,000
Runn creek	Courtland and Algoma	" "	" 6	3,000
Shaw creek	" " "	" "	" 6	3,000

Brook Trout Plants, 1894.—CONTINUED.

County and name of waters.	Town.	Depositor.	Date.	Number.
Stegman creek	Courtland and Algoma.	F. E. Wright	February 6	5,000
Little Cedar creek	" " "	W. H. Wheeler	" 6	5,000
Stream on sec. 24	Caledonia	D. W. Dutcher	" 22	3,000
Smith's creek	"	" "	" 22	3,000
James creek Cooley's creek	"	G. W. Barbour	" 22	3,000
Buck creek	Wyoming	George Eastman	" 21	6,000
Courtright creek	Ada and Cannon	John J. Belknap	" 21	2,000
Silver creek	Wyoming	H. W. Davis	" 21	3,000
Trib. to Bear creek	Byron	Frank Narregang	" 21	3,000
Rush creek	"	" "	" 21	2,000
Butternut creek	Byron and Gaines	" "	" 21	3,000
Beaver Dam creek	Byron	" "	" 21	3,000
Stream on northern part of	Tyrone	J. S. Ingram	March 9	2,000
English creek	Sparta	Arthur A. Place	" 9	5,000
Camp creek	"	" " "	" 9	5,000
Hanley creek	"	" " "	" 9	5,000
Silver creek	Tyrone and Sparta	C. C. Darling	" 9	3,000
Ball creek	" " "	" "	" 9	3,000
Sparta creek	Sparta	" "	" 9	5,000
Lake:				
Avery creek	Cherry Valley	W. A. Avery	" 14	6,000
Danaher creek	Pleasant Plains	L. A. Carpenter	" 14	2,000
W. branch of Danaher	" "	J. F. Brand	" 13	2,000
Little Sweetwater creek	Elk	J. S. Stevens	" 13	10,000
Little Manistee creek	Not given	C. H. Bates	" 13	5,000
Buck creek	Lake and Branch	" "	" 13	5,000
Bowman creek	Lake	" "	" 14	5,000
Lacy creek	Yates	R. H. L'Hommedieu	" 13	5,000
Danaher creek	T. 17 N., 13 W.	James B. Peter	" 13	2,000
Sanborn creek	Three towns	B. B. Mitchell	" 13	9,000
Mid. branch Pere Marquette	" "	R. H. L'Hommedieu	" 13	10,000
Little Manistee	T. 19 N., 13 W.	A. Patriarche	" 14	5,000
Branch of Little Manistee	Ellsworth	A. H. Morley	" 14	5,000
North branch	T. 19 and 20 N., 12 W.	A. Patriarche	" 14	6,000
Lapeer:				
Branch of Farmer's creek	Metamora and Hadley	Jesse Lee	February 27	5,000
Livingston:				
Cedar creek	Marion	David O. Smith	February 10	15,000
Macomb:				
Frost's creek	Washington	H. W. Bradley	March 7	4,000
Stream on	Secs. 4 and 33—Bruce	" "	" 7	4,000
Streetor's creek	Bruce	" "	" 7	4,000
Smith's creek	Washington	" "	" 7	4,000
Troop's creek	Bruce	" "	" 7	4,000
Eldred's creek	"	" "	" 7	4,000
Mackinac:				
Carp river	St. Ignace	W. M. Spice	April 26	20,000
Manistee:				
Printing Office creek	Onekama	J. H. Shults	March 19	3,000
Big Kaiser creek	Bear lake & Maple river	A. K. Wilkinson	" 19	6,000
Geder creek	Maple Grove	Alfred H. Mills	" 19	12,000
Bear Creek branch	Cleon	W. R. Smith	" 16	5,000
Gable creek	"	" "	" 16	6,000
Kill or Kinnie creek	Brownstown	C. Stein	April 17	3,000
Marquette:				
Dead river	Marquette	Horatio Seymour	" 26	10,000
Chocolay river	Chocolay	" "	" 26	10,000
Rainey's creek	Marquette	John C. Fowle	" 26	6,000
Harlow creek	Marquette & Ishpeming	" " "	" 26	9,000
Garlic river	" " "	" " "	" 26	10,000
Campau's creek	Marquette	" " "	" 26	9,000
Carp river	Negaunee & Marquette.	" " "	" 26	20,000
Michigamme river	Republic	David T. Morgan	" 26	20,000
N. W. br. of Escanaba river	"	" " "	" 26	15,000
Huron creek	Ishpeming and Ely	Geo. A. Newett	" 26	6,000
Gold creek	Tilden	" " "	" 26	6,000
Mason:				
Welden creek	Branch	Farnham Lyon	March 13	6,000
Lincoln creek	T. 19 N., 15 W.	Geo. M. Brown	" 13	6,000
Big Sable creek	T. 20 N., 15 W.	W. H. Baldwin, jr.	" 14	2,000
Two inlets to Round lake	Sheridan	Charles O. Homes	" 14	3,000

Brook Trout Plants, 1894.—CONTINUED.

County and name of waters.	Town.	Depositor.	Date.	Number.
Bardy creek Cedar creek	Riverton	Harmon & Ramberger	March 16	6,000
Erne stream Cook creek	"	Erne & Ramberger	" 16	6,000
Burns creek	Amber	George Sinclair	" 16	5,000
New creek	"	" "	" 16	6,000
Gebolt's creek	"	Valentine R. Penny	" 16	6,000
Dan Whalen's creek	"	" " "	" 16	6,000
Upper Weldon creek	Branch	Henry C. Rawson	" 16	6,000
Mecosta:				
Mack's creek	Stanwood	W. B. Stimson	" 20	10,000
Janett creek	Grant	E. J. Marsh	February 6	5,000
Yellow Bottom creek	"	Sylvester Dusser	" 6	3,000
Marshfield creek	Colfax	J. W. Miller	" 9	15,000
Black creek	Millbrook & Belvidere.	H. Cogswell	" 9	6,000
Black Lake creek	" " "	Lorenzo D. Decker	" 9	3,000
Marsh creek Burton creek	Morton	Frank Barrey	" 9	10,000
N. branch of Pine river	Millbrook and Rolland	N. C. Mason	" 9	8,000
Paris creek	Green	J. W. Powers	March 30	5,000
Menominee:				
Hay creek	Stephenson	Paul Perimgo, jr.	July 14	6,000
Little Hay creek	Ingalston	Geo. A. Hanrahan	" 14	6,000
Holmes' brook	Stephenson	W. P. Kezar	" 14	2,500
Olson creek	"	Edward Sawbridge	" 14	5,000
Benjamin creek	Mellen	Ira Carley	" 14	3,000
Montcalm:				
Church creek	Winfield	S. C. Scott	March 30	6,000
Rice creek	Pierson and Reynolds	" "	" 30	3,000
Handy creek	Reynolds, Mayfield, and Cato	" "	" 30	15,000
Spring creek	Maple Valley	Sid V. Bullock	February 10	3,000
Black creek	" "	J. A. Dockery	" 10	9,000
Sackett's creek	Home	W. R. Jones	" 27	3,000
Giger creek	"	" "	" 27	12,000
Kirby creek	"	" "	" 27	5,000
Horseshoe Lake creek	Belvidere	S. J. Youngman	" 27	5,000
W. branch of Flat river	Pine	" "	" 27	5,000
Branch of Fish creek	Sidney	S. Benj. Young	" 27	3,000
Reed creek	Day	G. T. Howarth	" 27	3,000
Hooker creek	"	" "	" 27	3,000
Willet creek	Evergreen	" "	" 27	6,000
Hemmingway creek	Douglas	" "	" 27	3,000
Dickerson creek	Sidney	C. Ellis Elliot	" 27	12,000
Sucker creek	Pine and Douglas	" "	" 27	6,000
Spring creek	Pine	" "	" 27	3,000
Lucas creek	Douglas	" "	" 27	6,000
W. branch of Fish creek	Sidney and Douglas	" "	" 27	3,000
Cedar creek	Winfield	Sid V. Bullock	March 5	6,000
Montmorency:				
Little Black river	Wheatfield	H. L. Monroe	" 27	15,000
Muskegon:				
Belleview Trout creek & pond	Fruitland	W. C. Weige	" 9	3,000
Muma creek	Casnovia	E. Farnham	" 9	3,000
Fenton creek	Tyrone	" "	" 9	3,000
Moon Lake creek	Casnovia	" "	" 9	3,000
Little and Big Bear creeks Black creek Green's creek	Fruitland	E. D. Magoon	" 6	15,000
Duck creek	"	" "	" 6	3,000
Gulley's brook	Ravenna	Miles M. Bradford	" 5	5,000
Titatute creek	"	E. Bartholmew	" 5	3,000
Crockery creek	"	"	" 5	5,000
Norris creek	Fruitland	C. C. Tuxbury	" 5	9,000
Newaygo:				
Hay Lake creek	Monroe	Mich. Fish Com.	April 27	5,000
Pease creek	Barton and Monroe	" " "	" 27	10,000
N. branch Pere Marquette	Norwich and Monroe	" " "	" 27	15,000
Moore's creek Spring creek	Ensley	W. H. Wheeler	February 26	10,000
Cedar creek	Troy	T. A. Harvey	" 13	6,000
Pickerel creek	"	Chester Brown	" 13	10,000
Williams creek	Sheridan	Andrew Gerber	" 9	6,000

Brook Trout Plants, 1894.—CONTINUED.

County and name of waters.	Town.	Depositor.	Date.	Number.
Odell creek				
Soutier creek	Dayton	Frank Cole	February 9	9,000
Cole creek				
Brooks creek	Brooks	W. H. Kritzer	" 9	6,000
Tenewait creek	Croton	S. D. Thompson	" 9	6,000
Thompson's creek	Everett	S. D. Thompson	" 9	6,000
Oakland:				
Shiawassee river	Springfield	F. G. Ely	March 6	6,000
Shadbolt creek	Orion and Oakland	Simeon Grube	" 7	6,000
Paint creek	Orion, Oakland & Avon	Simeon Grube	" 7	9,000
Oceana:				
S. branch Pentwater creek	Eldridge, Hart & Weare	Ed. D. Richmond	" 9	15,000
Shigley creek	Hart	Ed. D. Richmond	" 9	6,000
Russell creek	Hart	Ed. D. Richmond	" 9	6,000
Cedar creek	Pentwater	D. C. Wickham	" 9	25,000
Aunly creek				
Stony creek	Benona	Henry J. Marsh	" 9	6,000
Ogemaw:				
Rifle river	Ogemaw	R. H. L'Hommedieu	" 31	20,000
Tittabawassee river	21 N., 1 E.	R. H. L'Hommedieu	" 31	20,000
E. br. of Tittabawassee river	Horton	C. N. Ashford	" 20	15,000
Brooks creek	Rose	Hiram Hodge	" 27	6,000
Wilkins creek	Klacking & Cummings	Hiram Hodge	" 27	6,000
Ontonagon:				
Trout creek	Watersmeet	C. L. Ryder	July 14	6,000
Town Line creek	Ontonagon	Willis F. Sawyer	April 27	6,000
Cranberry creek	Ontonagon	Willis F. Sawyer	" 27	6,000
Union river	Carp Lake	Willis F. Sawyer	" 27	6,000
Oscoda:				
South branch of Big creek	Mount Pinduo	John Anderson	March 27	18,000
Wolf creek	Menton	John J. McCarthy	" 27	6,000
Glennie creek	Comins	Joseph Sullivan	" 20	6,000
Osceola:				
Town line creek	Lincoln	W. B. Stimson	" 30	6,000
Snyder's creek	Lincoln	W. B. Stimson	" 30	3,000
Ghost creek	Marion	D. D. Fry	" 17	6,000
Dock and Tom creek	Hartwick and Sylvan	J. J. Reik	" 22	3,000
Hicks creek				
Otsego:				
Outlet of Woodin and Berryville lakes	Corwith	Thomas C. Woodin	" 27	9,000
West branch Sturgeon river	31 N., 3 W.	D. H. Fitzhugh	" 27	9,000
Sturgeon river	Livingston	J. B. Scott	" 27	10,000
Stream on S. W. ¼ Sec. 1, N. E. ¼ Sec. 11	29 N., 4 W.	Henry Stephens	" 27	6,000
Boyne river	Elmira	W. B. Stimson	" 30	15,000
Headwaters of Sturgeon river	31 N., 3 W.	R. H. L'Hommedieu	" 31	20,000
West branch Sturgeon river	32 N., 3 W.	R. H. L'Hommedieu	" 31	30,000
Ottawa:				
Pine creek	Holland	J. Van Dyke	February 14	3,000
Yonkers creek	Holland	Arthur G. Baumgartel	" 14	3,000
Wilds creek	Spring Lake	Frank S. Wilson	March 6	2,000
Robinson creek	Robinson	Frank S. Wilson	" 6	6,000
Roscommon:				
Sugar creek	21 N., 1 W.	R. H. L'Hommedieu	" 31	20,000
Sanilac:				
Mills creek	Worth	Rudolph Pabst	April 5	6,000
Ellis creek	Lexington	John W. Norman	" 5	6,000
Shiawassee:				
Coon creek	Sciota and Middleburg	James A. Valentine	March 6	9,000
Alder creek				
St. Clair:				
Mill creek	Brockway	Alex R. Avery	April 4	5,000
Silver creek	Greenwood	Paul Willey	" 5	6,000

Brook Trout Plants, 1894.—CONCLUDED.

County and name of waters.	Town.	Depositor.	Date.	Number.
St. Joseph:				
Spring creek	White Pigeon	L. N. LaGro	February 20	3,000
Stream on sections 21, 22, 28	Sherman	Frank Kenyon	" 21	6,000
Little Portage creek	Mendon, Leonidas & Wakeshma	C. L. Hasbroesck	" 21	9,000
Spring creek	Flowerfield and Park	Chas. N. Pratt	" 20	6,000
Rocky river				
Tuscola:				
Montague creek	Indian Fields	F. S. Wheat	" 27	9,000
Sucker creek	Ellington			
White creek	Indian Fields & Wells	F. S. Wheat	" 27	9,000
Butternut creek	Indian Fields			
Sucker creek	Ellington			
Butternut creek	Indian Fields	J. H. Howell	" 27	9,000
White river				
Van Buren:				
Headwaters of Paw Paw river	Antwerp	C. F. Dey	" 15	6,000
Crystal Spring creek	Porter	C. F. Dey	" 15	6,000
Maple creek branches	Bangor and Arlington	Wm. Broadwell, Jr.	" 14	6,000
Three Mile creek	Bangor and Geneva	Wm. Broadwell, Jr.	" 14	3,000
Spice Bush creek	Geneva	J. C. Merson	" 14	6,000
Mill creek	Geneva	J. C. Merson	" 14	6,000
Watkins creek	Almena	C. D. Stewart	" 20	3,000
Washtenaw:				
Stony creek	Augusta	F. H. Barnum	" 15	6,500
Paint creek	Ypsilanti and Augusta	Geo. H. Watterhouse, Jr.	" 15	4,500
No name	Pittsfield and York	Geo. H. Watterhouse, Jr.	" 15	3,000
Wayne:				
Wood's creek	Van Buren	George Witmire	" 10	6,000
Wexford:				
Stagel creek	Boon	C. Stein	April 17	6,000
Newton's creek	Hanover	C. Stein	" 17	6,000
Churchill creek	Springville	C. Stein	" 17	3,000
Fletcher creek	Antioch	C. Stein	" 17	6,000
Pottes creek	24 N., 9 W.	Samuel D. Mills	March 23	9,000
Black creek	Haring	E. L. Meatheary	" 16	16,000
Stream on sections 20, 28, 29, 33	Greenwood	E. B. Stanley	" 16	6,000
Stream on sections 5, 4 and 9	Colfax			
Bock creek	Springville	T. Gale	" 16	6,000
Fletcher creek	Springville	T. Gale	" 16	6,000
Fresh Water creek	Wexford	T. Gale	" 16	6,000
Slagle creek	Boon and Slagle	James Z. Stanley	" 16	9,000
Railroad creek	Slagle	James Z. Stanley	" 16	6,000
Bear creek	Slagle	James Z. Stanley	" 16	6,000
Cedar creek	Cedar Creek	W. B. Stimson	" 30	15,000
Total				2,853,000

Brown Trout Plants, 1893.

County and name of waters.	Town.	Depositor.	Date.	Number.
Crawford:				
AuSable river	Grayling	D. H. Fitzhugh	April 6	25,000
Gladwin:				
Prindle brook	Gladwin	F. L. Prindle	" 6	4,000
Lake:				
Middle branch of Pere Marquette river	Yates, Chase and Pleasant Plains	W. C. Rowley	March 27	25,000
Baldwin creek	Baldwin	E. N. Briggs	" 27	20,000
Star lake, Crooked lake	Lake	G. M. Brown	" 27	30,000
Baldwin creek, Pere Marquette river	Baldwin	W. F. Potter	" 27	25,000
Mason:				
Name not given		Mr. Harmon	April 18	10,000
Mecosta:				
Sanborn creek	Green	Mich. Fish Com.	February 23	10,000
Paris creek	"	" " "	March 6	15,000
Montmorency:				
Beaver creek	Rost	Philip Klein	April 10	12,000
Hardwood creek	"	Silas S. Cohoon	" 10	9,000
Stony creek	"	Conrad Weygarde	" 10	9,000
Montcalm:				
Church creek, Indian creek	Reynolds	Steve Scott	" 19	10,000
Newaygo:				
S. branch Pere Marquette	Several towns	A. B. Atwater	March 27	25,000
Oceana:				
Round Lake creek, Morris Near creek, Stream emptying into Pentwater creek	Several towns	R. M. Montgomery	April 18	10,000
Osceola:				
Grindstone creek	Sylvan and Hartwick	J. J. Reik	March 24	50,000
Stream between Hersey and Evart	Hersey	Mich. Fish Com.	" 17	50,000
Hersey creek	"	" " "	May 6	20,000
Oscoda:				
Big creek, East branch, Whitewater creek	Big creek, Atherton, Big Creek	Stewart Gorton	April 6	18,000
Hunt's creek, Frazer creek	27 N., 1 E.	W. H. Niles	" 6	18,000
Otsego:				
Feeder to middle branch of AuSable river	29 N., 4 W.	Henry Stephens	" 6	25,000
Presque Isle:				
Lake Esau	Presque Isle	Wm. A. French	" 10	24,000
Total				444,000

Brown Trout Plants, 1894.

County and name of waters.	Town.	Depositor.	Date.	Number.
Clare:				
Bear lake	17 N., 5 W.	Geo. M. Brown	March 22	10,000
Ionia:				
Kelsey's creek and pond	Ionia	E. P. Kelsey	February 10	15,000
Kalamazoo:				
Campbell's creek, Gunn creek, Whitford lake	Richland & Comstock, Charleston	H. Dale Adams	" 15	5,000
Lake:				
Baldwin creek	Pleasant Plains	E. N. Briggs	March 14	10,000
Middle Br. Pere Marquette	" "	W. C. Rowley	" 14	10,000
Wolf lake	Center	W. H. Baldwin	" 14	15,000
Star lake	Lake	Geo. M. Brown	" 12	25,000
Twin lakes	Webber	" "	" 14	15,000
Bray lake	Pleasant Plains	T. E. Borden	April 3	15,000
L. lake	" "	" "	" 3	15,000
Crandall lake	" "	" "	" 3	15,000
Marquette:				
Dead and Chocolay rivers	Marquette & Chocolay	Horatio Seymour	" 26	20,000
Mecosta:				
Blodget lake	Grant	Mich. Fish Com.		5,000
Lanburg creek	Green	" " "		10,000
Paris creek	Green and Barton	" " "		15,000
Clear lake	Colfax	George A. Roof	April 28	10,000
Newaygo:				
South branch Pere Marquette	Several	A. B. Atwater	March 14	25,000
Oceana:				
Colfax lake	Colfax	E. D. Richmond	" 9	25,000
Ontonagon:				
Flint Steel river	Ontonagon and Greenland	Willis F. Sayer	April 27	30,000
Slate river	Ontonagon	C. L. Ryder	July 14	10,000
Oscoda:				
East branch, West branch	Atherton, West Pindas	S. Gorton	March 20	25,000
Osceola:				
No name	Evart	Mich. Fish Com.		5,000
Two Mile creek	Hersey	" " "		10,000
Kinney creek	"	" " "		10,000
Cat creek	Hersey and Cedar	" " "		10,000
Cole creek	Evart	" " "		10,000
Total				

Lake Trout Plants, 1893.

County and name of waters.	Town.	Depositor.	Date.	Number.
Chippewa:				
Sault river	Sault Ste Marie	Mich. Fish Com.	April 10	5,000
" "	" " "	" " "	" 16	3,000
" "	" " "	" " "	" 27	7,000
" "	" " "	" " "	May 3	12,000
			" 8	9,000
Marquette:				
Sawyer lake	Town 41	Herbert Armstrong	" 6	20,000
Newaygo:				
Fremont lake	Sheridan	Mich. Fish Com.	" 9	45,000
Ontonagon:				
Lake Gogebic	Ontonagon	E. Vliet	" 2	40,000
Total				141,000

Lake Trout Plants, 1894.

County and name of waters.	Town.	Depositor.	Date.	Number.
Alcona:				
Clear lake	Haynes	Wm. Reynolds	March 20	15,000
Antrim:				
Central lake	Central Lake	O. P. Barber	" 14	15,000
Cass:				
Diamond lake	La Grange, Penn, Calvin, and Jefferson	James M. Shepard	February 23	25,000
Charlevoix:				
Bear lake	Evangeline, Bear Lake, Melrose, & Charlevoix	W. B. Stimson	March 20	25,000
Walloon lake	Bay, Resort, & Melrose	Wm. F. Weller	" 14	15,000
Chippewa:				
Trout lake	Trout Lake	N. A. Smith & Son	April 6	9,000
Clare:				
Crooked lake	Surrey	Geo. M. Brown	March 22	15,000
Town Line lake	Hayes	" " "	" 23	10,000
Houghton:				
Lake Anne	Franklin	Lawrence Corrigan		5,000
Misery lake	Adams	" "		10,000
Lake on sec. 17	T. 47 N., 35 W.	George H. Hauser		5,000
Iosco:				
Loon lake	Plainfield	Warren S. Hodges	March 20	15,000
Goodar lake	Thompson	J. T. Guilford	" 23	15,000
Kalamazoo:				
Wood's lake	Kalamazoo	Theo. P. Bailey	February 20	5,000
Paw Paw lake	Texas	Albert Newkirk	" 23	10,000
Lake:				
Star lake	Lake	Wm. H. Baldwin, jr.	April 3	10,000
Twin lake	Webber	" " "	" 3	5,000
Leelanaw:				
Davis lake	Kasson	T. J. Newman	March 19	5,000
Glen lake	Glen Arbor and Empire	D. H. Day	" 14	15,000
Livingston:				
Long lake	Genoa	J. W. Lawson	February 10	10,000
Mackinac:				
Brevoort lake	Brevoort	M. F. Mulcrome	April 6	9,000

Lake Trout Plants, 1894.—CONTINUED.

County and name of waters.	Town.	Depositor.	Date.	Number.
Marquette:				
Sawyer lake	T. 44 N., 30 W.	Herbert Armstrong	May 5	10,000
Witch lake	" "	" "	" 5	15,000
Mason:				
Lincoln lake	Lincoln	W. H. Baldwin, jr.	April 3	5,000
Gunn lake	Free Soil and Sherman	" "	" 3	5,000
Round lake	Sherman	Geo. M. Brown	" 3	5,000
Mecosta:				
Clear lake	Coalfax	Geo. A. Roof	March 8	5,000
Montcalm:				
Crystal lake	Crystal	De Young & Worden	February 27	20,000
Newaygo:				
Crystal lake	Sherman	J. Mayo	March 9	10,000
Bill's lake	Croton	Will H. Shinn	" 9	10,000
Fremont lake	Sheridan	F. P. Hopper	" 9	15,000
Baptist lake	Ensley	Thomas Oliver	February 20	10,000
Oakland:				
Bush lake	Holly and Groveland	T. D. Seely	March 6 }	10,000
Horton lake	" " "	" "	" 6 }	
Lake Elizabeth	Waterford	E. W. Abbott	" 6	15,000
Ontonagon:				
Lake Gogebic	Ontonagon	E. Vliet	April 27	50,000
Van Buren:				
Mud lake	Antwerp	C. F. Dey	February 23	10,000
Total				443,000

Rainbow Trout Plants, 1893.

County and name of waters.	Town.	Depositor.	Date.	Number.
Lake:				
Baldwin's creek	Baldwin	Mich. Fish Com.	May 6	10,000

Rainbow Trout Plants, 1894.

County and name of waters.	Town.	Depositor.	Date.	Number.
Crawford:				
Big creek	T. 2 N., 1 W.	R. H. L'Hommedieu	June 14	5,000
Newaygo:				
Pere Marquette rever	Troy	Mich. Fish Com.	May 26	16,000
Total				21,000

Wall-eyed Pike Plants, 1893.

County.	Name of waters.	To whom delivered.	Date.	Number.
Allegan	Gun lake	Frank Narregang	June 10	600,000
	" "	Charles Rice	" 10	600,000
Barry	Sugar Bush lake	Walter Burling	" 10	600,000
	Saddle Bag lake	W. J. Marble	" 3	520,000
	" " "	Thomas C. Downing	" 3	600,000
	Middle lake	W. D. Bennet	" 3	600,000
	Long lake	Homer G. Brown	" 3	600,000
	Round lake	J. A. Van Arman	" 3	600,000
	Leach lake	Bryan Dickinson	" 3	600,000
Bay	Saginaw bay	Mich. Fish Com.	May 26	5,000,000
Berrien	Barron lake	George W. Dongan	June 6	600,000
Cass	Huyck lake	L. B. Des Voegnes	" 6	400,000
	Morton lake	W. H. Murphy	May 31	400,000
	La Grange lake	" "	" 31	400,000
	James lake	" "	" 31	400,000
	Indian lake	" "	" 31	400,000
	Saddle Bag lake	C. S. Jones	" 31	400,000
	Diamond lake	B. L. Rudd	" 31	600,000
Clare	Lacey's lake	G. W. Sherwood	June 3	600,000
Clinton	Curtis lake	George W. Parkes	" 10	600,000
Hillsdale	Round lake	Chas. Van Schoick	" 6	400,000
	Crystal lake	W. F. Sawdey	" 6	400,000
Jackson	Duck lake	W. H. Leonard	May 31	600,000
	Vandercook's lake	Geo. E. Beebe	June 6	200,000
	Brown's lake	" " "	" 6	200,000
	Pleasant lake	" " "	" 6	200,000
	Mich. Center ponds	" " "	" 6	200.000
Kent	Sullivan's lake	J. P. Wilson	" 10	400,000
	O'Brien's lake	" "	" 10	400,000
	Monroe lake	" "	" 10	400,000
	Reardon's lake	" "	" 10	400,000
	Larkins lake	Wm. E. Davis	" 3	400,000
	Duncan lake	D. Buhtel	" 3	360,000
Lapeer	Bronson lake	R. B. Conklin	" 9	400,000
Lenawee	Round lake	Wm. Rexford	" 6	400,000
Oakland	Davison's lake	Peter Wallrath	" 9	400,000
Otsego	Otsego lake	M. R. Duscher	" 9	600,000
	Beaver lake	John D. Foster	" 9	300,000
	Foster's pond	" " "	" 9	300,000
	Gardiner lake	Andrew J. Booth	" 9	600,000
	Big lake	Alfred Savage	" 9	400,000
	Farm lake	Henry Stephens	" 9	600,000
	McCoy lake	Arthur W. Bates	" 9	600,000
St. Joseph	Thomson lake	James M. Pearson	" 6	400,000
	Crossman lake	K. C. Gray	" 6	400,000
Van Buren	Craek's lake	L. Stokes	May 31	600,000
	Three mile lake	Ray Mitchell	" 31	600,000
Wayne	Detroit river	Mich. Fish Com.	June 13	8,000,000
Total				34,280,000

Wall-eyed Pike Plants, 1894.

County.	Name of waters.	To whom delivered.	Date.	Number.
Alcona	Crystal lake	Wm. C. Reynolds	May 17	200,000
Antrim	Wetzell lake	Edson Whitmore	" 11	200,000
Barry	Wall lake	W. D. Hayes	" 8	200,000
	Poland pond	Frank Hoes	" 8	200,000
Bay	Saginaw bay	Mich. Fish Commission	" 16	8,000,000
	" "	Mercer Richardson	April 27	900,000
Benzie	Sharter's lake	R. W. Payne	May 10	200,000
	Lake Ann	Chas. F. Sancrainte	" 10	200,000
Berrien	Clear lake	C. C. Diggins	" 15	150,000
Calhoun	Ackley lake	J. E. Cook	" 15	150,000
Cass	Spring lake	Edgar Wetherbee	" 15	210,000
	Diamond lake	J. M. Shepard	" 15	450,000
	Fish lake	C. S. Devlin	" 15	150,000
	" "	Bert Loup	" 15	150,000
Charlevoix	Bear lake	W. B. Stimson	" 11	400,000
Cheboygan	Long lake	Everet J. Roos	" 11	200,000
Clare	Cranberry lake	Geo. M. Brown	" 11	720,000
Eaton	Round lake / Scipio pond	E. D. Barber	" 8	200,000
	Solby lake	Chas. M. Putnam	" 8	200,000
	Lacey's lake	G. W. Sherwood	" 8	200,000
	Tamarack lake	Chas. Scheidt	" 8	200,000
Emmet	Crooked lake	Wm. B. Stimson	" 11	600,000
	Carp lake	" " "	" 11	600,000
Grand Traverse	Fife lake	James Monteith	" 11	200,000
	Lone lake	Lester Lydell	" 11	400,000
Ionia	Grand river	Albert K. Roof	" 12	360,000
Iosco	Van Etten lake	Charles R. Henry	" 17	400,000
Jackson	Gillett's lake	Geo. E. Beebe	" 15	150,000
	Clark's lake	John L. DeLamater	" 15	200,000
	Round lake	Chas. Van Schoick	" 16	200,000
Kalkaska	Crooked lake	O. J. Smith	" 11	200,000
	Starvation lake	" "	" 11	200,000
Kent	Buck lake / Reed's lake	David Schoenfield	" 8	400,000
	Scram lake	Freeman Addis	" 11	200,000
	Round lake	" "	" 11	200,000
Lake	Star lake	Melvin H. Berridge	" 8	120,000
	Harper's lake	" " "	" 8	120,000
	Sand lake	" " "	" 8	120,000
	Mud lake	" " "	" 8	120,000
Leelanau	Glen lake	D. H. Day	" 9	200,000
Lenawee	Sand land	J. J. Putnam	" 16	200,000
Maniton	Lake Florence	Garden City Land Co.	" 9	400,000
Mecosta	Pickerd lake	Edwin J. Marsh	" 11	200,000
Monroe	Lake Erie	Mich. Fish Commission	" 14	2,500,000

Wall-eyed Pike Plants, 1894.—CONCLUDED.

Conuty.	Name of waters.	To whom delivered.	Date.	Number.
Newaygo	Big brook or Hen lake	W. H. Kritzer	May 8	400,000
Oakland	Davis lake	F. G. Ely	" 12	160,000
	Long lake	" "	" 12	160,000
	" "	T. D. Seeley	" 12	320,000
	Lotus lake Mace Day lake	Alfred Windiate	" 12	400,000
Otsego	Five lakes	F. Hayes	" 11	320,000
	Travers lake	Wm. O. Manes	" 11	120,000
Shiawassee	Hopkins lake	Hiram E. Oliver	" 12	820,000
Van Buren	Lake of the Woods	Frank Stapleton	" 15	4‹0,000
Washtenaw	Huron river	A. A. Bedell	" 15	300,000
	North lake	James Reilly	" 15	150,000
	Round lake Cavinaugh lake	R. S. Armstrong	" 15	180,000
Wayne	Detroit river	Mich. Fish Commission	" 7	5,000,000
	" "	" " "	" 16	10,500,000
Total				$5,550,000

Distribution of Carp, 1893.

County.	Depositor.	Location.	Number.
Alger	Schaffer Belknap	Onota and Belle river	50
Allegan	Charles Symons	Private pond	45
	C. B. Conger	" "	50
	Vine Harding	" "	30
Antrim	O. J. Smith	Sand lake	40
	S. D. Chapman	Lake of the Woods	40
	T. A. Price	" " " "	40
Barry	S. A. Crowell	Leach lake Law lake Barr lake Alling lake Carter lake	75
Cass	E. A. Smith	Pleasant lake	40
	W. H. Murphy	Mud lake and creek	40
	John W. Blanvelt	Holmes lake Pitcher lake Kirkwood lake	50
Clinton	J. C. Shaver	Round lake	40
	James A. Valentine	Bartram lake	40
	Mary M. Pennington	Lost creek	40
Crawford	Wm. H. Niles	Private pond	25
Eaton	George Wellman	Soby lake	40
	Mark King	King lake	40
Genesee	C. S. Brown	Thread pond	40

Distribution of Carp, 1893.—CONCLUDED.

Conuty.	Depositor.	Location.	Number.
Grand Traverse	L. L. Lydell	Round lake	40
Huron	Jacob Zcapp	Private pond	25
Ingham	C. Alsdorf	East Side park pond	50
	W. H. S. Wood	Industrial School pond	40
Ionia	E. D. Goodsell	Morrison lake	40
Iosco	Charles R. Henry	Van Etten lake	40
Kalamazoo	Albert Newkirk	Eagle lake	40
	Albert Newkirk	Pine Island lake	40
	Leeper & Brown	Leeper pond	40
	Hix Rawson	Rawson pond	40
Kent	Nelson Lewis	Mud lake	40
	Neal McMillan	Bostwick lake	40
	C. A. Green	Private pond	40
	George B. Kraft	" "	25
	Jacob Miller	" "	40
	M. M. Morse	" "	20
		Plaster creek	20
	E. J. Mosber	Scalley lake	40
Lapeer	Jesse Lee	Brownell's lake	25
	L. Bathrick	Private pond	25
Mackinac	Edward Londry	" "	
Marquette	Horatio Seymonr	Lake Sylvia	50
Monroe	Curtis Dunham	Raisin river	40
	R. B. Davis	" "	40
	Addison E. Gardner	Saline river	40
Montcalm	J. A. Dockery	Twin lakes	25
		Cody lake	25
Newaygo	W. H. Kritzer	Little Brooks lake	40
Oakland	Robert Cuthbertson	Private pond	40
Oceana	W. R. Colier	Evans lake	25
	E. T. Mugford	Private pond	100
Osceola	Chas. Marvin	Senter lake	40
Otsego	Henry Stephens	Heart lake	25
		Readhead lake	28
		Twenty-one lake	25
	Arthur W. Bates	Five lakes	40
	John D. Foster	Cranberry lake Foster's pond	40
Ottawa	Henry Tomms	Private pond	35
Sanilac	John W. Norman	" "	40
	J. D. Eastman	" "	40
St. Joseph	W. H. Major	" "	30
	Carl Dornke	" "	35
	R. Brayman	" "	30
Van Buren	A. E. Wildey	Forty-acre lake	100
Wayne	J. P. Sanger	Cherry Island bay	40
Wexford	J. W. Oatley	Jewett lake	40
	Charley Spencer	Jones lake	25
		Ferguson lake	40
		Jewett lake	25
	H. P. Hale	Boylan lake	40
	Enos Clark	Big Clam lake	40
Total			2,708

Distribution of Carp, 1894.

County.	Depositor.	Location.	Date.	Number.
Allegan	M. Norris	Kalamazoo river	August 20	300
Barry	Fred H. Barlow	Cole pond	" 17	200
Cass	Glenn Gould	Private pond	September 1	150
Charlevoix	F. C. Warne	South arm of Pine lake	August 21	200
Chippewa	J. A. McGinn	McGinn lake	October 6	100
Clinton	A. Schenk & Sons	Elsie mill pond	August 17	400
	Chas. Cowso	Colby lake	" 17	150
Eaton	G. B. Stone	Private pond	" 17	100
Genesee	Mert Clapp	Mill pond on Butternut cr'k	" 23	200
	L. J. Weekes	Long's lake	" 23	150
Grand Traverse	Francis S. Price	Private pond	" 21	150
Ionia	John Flater	" "	" 17	104
Jackson	B. Snylandt	" "	" 16	100
	D. L. Ball	" "	" 16	100
	Wm. Breitmeyer	" "	" 16	100
Kalamazoo	George Ellsworth	" "	" 16	100
Kent	Wm. Farrell	Private lakes	" 17	150
	John Green	Soft water lake	" 17	150
Lake	Melville H. Berridge	Perch lake	" 21	1,500
	" " "	Pickerel lake No. 1		
	" " "	" " No. 2		
	" " "	" " No. 3		
	" " "	Big Bass lake		
	" " "	Bass lake		
	" " "	Little bass lake		
	" " "	Horseshoe lake No. 1		
	" " "	" " No. 2		
	" " "	" " No. 3		
	" " "	Beaver lake		
	" " "	Fox lake		
	" " "	Cutler lake		
Livingston	Fred E. Wardell	Williamsville lake	" 16	100
Manistee	Hiram Hatch	Private pond	" 21	300
	Joseph Gambo	Butcher lake	" 21	250
Mecosta	N. C. Mason	W. branch of Pine river	" 17	100
	A. L. Hawk	Pine lake	" 17	100
	" "	Guy lake	" 17	100
	" "	Eldred lake	" 17	100
Montcalm	Jonah Low	Private pond	" 17	100
Muskegon	Charley Marten	Marten's pond	" 21	250
Oakland	Wm. J. Buckell	Private lake	" 17	100
	George Dunning	" "	" 17	100
	B. T. Richmond	Narrin lake	" 17	100
	Peter L. McIntire	Private pond	" 17	100
	Edmund Foster	" "	" 17	200
	S. Alexander	" "	" 17	100
Oceana	John Day	Morris lake	" 20	250
	" "	Wolf lake	" 20	
Ogemaw	Frank Smith	South Branch lake	" 22	100
Osceola	H. N. Babcock	Rose lake	" 22	450
	" "	Oldson's lake	" 22	
	" "	Hogback lake	" 22	
Ottawa	G. L. Guild	Private pond	" 17	150
Sanilac	James Monaghan	" "	" 22	150

Distribution of Carp, 1894.—Concluded.

County.	Depositor.	Location.	Date.	Number.
Tuscola	Howard E. Spence	Clarke's lake	August 22	150
Van Buren	C. Engle	Lamphere's lake	" 16	100
	"	Sherman lake	" 16	100
	"	Lemon pond	" 16	100
Washtenaw	James Reilley	Private pond	October 11	105
Wayne	D. Hineman	" "	September 14	15
Wexford	G. H. Wall	" "	August 22	150
Total				8,324

Black Bass Plants, 1894.

County and name of waters.	Town.	Depositor.	Date.	Number.
Allegan: Selkirk's lake	Wayland	John A. Turner	July 6	1,000
Barry: Crook lake	Barry	J. C. Bennett	" 6	2,000
Berrien: Weaver lake	Buchanan	C. C. Diggins	" 6	2,000
Calhoun: Notaway creek	Burlington	Geo. Bucanan	" 7	1,000
Cass: Outlet of Birch lake	Porter	J. Fred Merritt	" 6	2,000
Charlevoix: Bear lake	Melrose	W. B. Stimson	" 3	10,000
Eaton: Thornapple river	Vermontville	E. D. Barber	June 22	500
Emmet: Crooked lake	Littlefield	W. B. Stimson	July 4	5,000
Grand Traverse: Fife lake	Fife Lake	D. C. Ketchum	" 3	5,000
Jackson: Vandercook's lake	Summit	Geo. E. Beebe	June 22	1,500
Brown lake	"			
Michigan Center pond	Leoni	" "	" 22	1,000
Grass lake	Grass Lake	" "	" 22	500
Kent: Sand lake	Nelson & Pierson	James H. Brayman	July 3	5,000
Oakland: Lotus lake	Waterford	Alfred Windiate	June 23	4,000
Mace Day lake				
Big lake	Springfield	F. G. Ely	" 23	3,000
Mill pond	"	" "	" 23	1,000
Otsego: Otsego lake	Otsego Lake	R. H. L'Hommedieu	" 29	7,000
Washtenaw: Mud lake	Dexter	James Reilley	July 7	1,000
Total				52,500

Sturgeon Plants, 1894.

Name of water.	Location.	Depositor.	Date.	Number.
Detroit river	Grassy Island	J. P. Marks	June 11	40,000
" "	Clark's Point Fishery	" "	" 11	30,000
" "	Grassy Island	" "	" 14	40,000
	Clark's Point Fishery	" "	" 14	20,000
Total				130,000

TEMPERATURE OF WATER.

DETROIT STATION.

Temperature of water during whitefish and wall-eyed pike hatching season, from November 10, 1893, to May 16, 1894.

Date.	Temperature.
1893.	
Nov. 10-13	50°
14	49
15	47
16	46
17-18	45
19	43
20-22	42
23	41
24	40
25	37
26-27	38
28	37
29	38
30	39
Dec. 1	39
2-3	37
4-5	36
6-8	35
9-10	36
11-23	35
24-28	36
29	35
30-31	34
1894.	
Jan. 1-4	34
5-6	34½
7	34
8	35
9	33½
10-21	34
22-24	33½
25-30	33
31	33½
Feb. 1	33
2	33½
3-6	33
7-9	33½
10	33
11-12	33½
13	33
14	33½
15-22	32
23-24	32½
25-26	33
27	32½
Feb. 28	33°
Mar. 1-4	33
5	33½
6-7	34
8	35
9-11	34
12	35½
13	37
14-15	38
16	37½
17	38
18	39
19	41
20	42
21-23	41½
24	41
25	40
26	37½
27-29	36
30	35½
31	36
April 1-3	37
4	38½
5-7	39
8	38½
9-10	39
11-12	38
13-15	40
16	43
17-18	44
19	46
20	47½
21-28	47
29-30	52
May 1	53
2	55
3	54
4	55
5-6	56
7	57
8-9	55
10	54½
11-13	57
14-16	58

DETROIT STATION.—*Continued.*

Temperature of water during whitefish and wall-eyed pike hatching season, from November 9, 1892, to June 9, 1893.

Date.	Temperature.
1892.	
Nov. 9	44°
10-12	45
13	46
14	48
15	42
16-17	44
18	45
19-21	44
22	45
23-24	41
25	40
26	39
27	38
29-30	39
Dec. 1-4	39
5-9	40
10-11	39
12-13	38
14-17	39
18-19	38
20-22	36
23-24	35
25-31	36
1893.	
Jan. 1	35
2-16	33
17	34
18-26	33
27	34
28	33½
29-30	33
31	33½
Feb. 1	33½
2-5	33
6-8	33½
9-17	34
Feb. 18-28	33°
Mar. 1-5	33
6-7	33½
8-13	34
14-19	33
20-29	34
30-31	35
April 1-2	36
3-4	37
5	38
6-8	40
9-10	42
11	43
12	44
13-17	45
18-21	44
22-26	43
27-29	44
30	45
May 1-3	45
4-6	46
7-9	47
10	48
11-13	49
14	51
15-17	52
18-20	53
21-24	54
25-28	55
29-31	56
June 1-2	56
3	52
4-6	58
7	59
8-9	60

SAULT STE. MARIE STATION.

Temperature of water during trout and whitefish hatching season, from October 17, 1892, to May 23, 1893.

Date.	Temperature.
1892.	
Oct. 17-21	54°
22	53
23	52
24	51
25-28	50
29	49
30-31	48
Nov. 1	48
2-3	47
4	46
5-8	45
9-11	44
12-17	43
18-20	42
21	40
22	39
23-28	38
29	39
30	40
Dec. 1-3	40
4-7	39
8-10	38
11-14	40
15	38
16	40
Dec. 17	37°
18	39
19	38
20	37
21-24	35
25-26	34
27	35
28-29	33
30-31	36
1893.	
Jan. 1	38
2	37
3	34
4	32½
5-6	36
7-8	35
9-11	34
12-13	35
14	33
15	35
16	33
17-18	37
19	34
20-24	35
25	37

SAULT STE. MARIE STATION.—*Continued.*

1893.		
Jan.	26	35°
	27	34
	28	36
	29–30	34
	31	33½
Feb.	1	34½
	2–3	34
	4	32
	5–10	33
	11	34
	12	33
	13–16	34
	17	33
	18	34
	19–28	33
1893.		
Mar.	1–31	33°
April	1–12	33
	13	34
	14–15	33
	16	34
	17–18	33
	19–26	34
	27–28	35
	29	34
	30	35
May	1–10	35
	11–16	40
	17	41
	18–20	42
	21–23	44

Temperature of water during trout and whitefish hatching season, from October 10, 1893, to May 22, 1894.

1893.		
Oct.	10–14	52°
	15	48
	16	46
	17	50
	18	49
	19–21	50
	22	49
	23	48
	24–25	50
	26–27	48
	28–30	46
	31	45
Nov.	1–2	46
	3	45
	4	44
	5–14	46
	15	44
	16–17	42
	18–19	41
	20–22	40
	22–30	39
Dec.	1–6	36
	7	35
	8–9	33
	10	35
	11–31	34
1894.		
Jan.	1–31	34°
Feb.	1–28	34
Mar.	1–8	34
	9–13	35
	14–15	36
	16–17	37
	18–19	38
	20–22	39
	23–31	34
April	1–14	35
	15–18	36
	19–20	38
	21–24	40
	25–30	43
May	1	42
	2–3	43
	4–5	42
	6–7	43
	8	42
	9	43
	10	44
	11–12	43½
	13	44½
	14–16	44
	17–22	45

PARIS STATION.

Temperature of water during trout hatching season, from September 15, 1892, to May 14, 1893.

1892.		
Sept.	15–18	48°
	19–21	50
	22–25	52
	26	48
	27	46
	28	47
	29–30	48
Oct.	1	48
	2	46
	3	47
	4	46
	5	44
	6	42
	7–8	46
	9	47
1892.		
Oct.	10	44°
	11–12	47
	13–14	46
	15	48
	16	46
	17–18	48
	19	45
	20	48
	21	45
	22	44
	23–25	42
	26	43
	27	44
	28	43
	29	42

PARIS STATION.—*Continued.*

1892.		
Oct.	30	40°
	31	43
Nov.	1	46
	2–4	44
	5	40
	6	42
	7	45
	8	40
	9	42
	10	40
	11–13	41
	14–15	43
	16–17	44
	18–19	42
	20–22	41
	23	39
	24	40
	25–26	42
	27–28	41
	29–30	42
Dec.	1	43
	2–5	42
	6	43
	7	42
	8–10	41
	11–12	40
	13	41
	14	42
	15–16	41
	17–19	40
	20	38
	21	37
	22	38
	23–25	37
	26	36
	27	38
	28	39
	29–30	38
	31	40
1893.		
Jan.	1	41
	2	40
	3	36
	4–5	37
	6–9	38
	10–11	36
	12	38
	13	36
	14	37
	15	36
	16–17	38
	18	39
	19	36
	20	37
	21	38
	22–26	40
	27	38
	28–29	40
	30–31	38
Feb.	1	40
	2–3	37
1893.		
Feb.	4	36°
	5	37
	6	42
	7–8	36
	9	38
	10	40
	11–13	38
	14	40
	15	41
	16	39
	17	36
	18–19	38
	20	36
	21	37
	22	38
	23–25	39
	26–27	38
	28	39
Mar.	1	40
	2	37
	3	40
	4–5	37
	6	36
	7–8	39
	9	42
	10	41
	11–14	40
	15	37
	16	36
	17	38
	18	37
	19	39
	20	40
	21	38
	22–24	40
	25–27	38
	28	39
	29–31	40
April	1	39
	2	38
	3	44
	4–5	43
	6	40
	7	39
	8	44
	9–11	42
	12	46
	13	44
	14	41
	15–16	40
	17–19	42
	20–24	40
	25–27	42
	28	43
	29–30	44
May	1–9	44
	10	45
	11	46
	12–13	47
	14	46

PARIS STATION.

Temperature of water during trout hatching season from September 15, 1893, to June 14, 1894.

1893.		
Sept.	15-16	49°
	17	51
	18	52
	19	50
	20	51
	21	53
	22-23	52
	24-25	51
	26-27	49
	28	48
	29	50
	30-31	51
Oct.	1	50
	2-4	52
	5	53
	6	51
	7	49
	8-9	51
	10	50
	11	51
	12-13	48
	14	49
	15	43
	16	42
	17	44
	18	43
	19	46
	20	47
	21	44
	22	47
	23	46
	24	48
	25	43
	26	44
	27	45
	28	44
	29-30	42
	31	41
Nov.	2	46
	3	43
	4	41
	5-7	42
	8-9	43
	10	48
	11	47
	12-13	46
	14	44
	15	41
	16	40
	17	42
	18	45
	19	41
	20-22	43
	23	42
	24-25	41
	26	40
	27	41
	28	44
	29	46
	30	42
Dec.	1	39
	2-3	38
	4	37
	5	40
	6-7	38
1893.		
Dec.	8	40°
	9	42
	10	40
	11	38
	12-13	39
	14	38
	15	41
	16	40
	17	39
	18	38
	19	40
	20	38
	21	40
	22-23	42
	24	40
	25-26	37
	27	40
	28	41
	29	40
	30	39
	31	38
1894.		
Jan.	1	37
	2-3	42
	4-5	43
	6	40
	7	38
	8	36
	9	38
	10	40
	11	41
	12	38
	13	37
	14	40
	15-17	44
	18	45
	19	39
	20	41
	21-23	38
	24	37
	25-26	38
	27	37
	28-31	38
Feb.	1	39
	2	38
	3	41
	4-5	38
	6	40
	7	41
	8	42
	9	41
	10	40
	11	39
	12-13	38
	14	39
	15	38
	17-19	40
	20-21	36
	22-23	38
	24-25	35
	26	36
	27	40
	28	48
Mar.	1-3	40
	4-6	42

PARIS STATION—*Concluded.*

1894.		
Mar.	7	38°
	8	39
	9	40
	10	41
	11-12	40
	14	38
	15	39
	16	40
	17	42
	18	40
	19	44
	20	41
	21-22	42
	23-24	40
	25	38
	26-27	36
	28-29	37
	30	38
	31	40
April	1	40
	2-3	38
	4	40
	5	42
	6-7	40
	8-9	38
	10	38
	12	39
	13	40
	14	42
	15	43
	16	44
	17	42
	18	44
	19	45
1894.		
April	20	41°
	21-23	43
	24-27	42
	28	46
	29-30	45
May	1	48
	2-3	46
	4	45
	5	44
	6-7	45
	8	44
	9	45
	10	46
	11	45
	12	44
	13-15	45
	16-17	46
	18	48
	19	42
	20	45
	21	44
	22-26	46
	27	47
	28	43
	29	42
	30	43
	31	44
June	1-4	44
	5	43
	6-7	44
	8	45
	9	46
	10	47
	11-14	48

CHARLEVOIX RELIEF STATION.

Temperature of water during whitefish hatching season, from the time the eyed eggs were put in the jars February 17, 1894, to April 23, 1894.

1894.		
Feb.	17	33°
	18	32½
	19-23	33
	24	32
	25-28	33
Mar.	1-3	34
	4-6	35
	7	35
	8-10	36
	11	34
	12-16	35
1894.		
Mar.	17-21	36°
	22-24	34
	25-26	33
	27-31	34
April	1	34
	2-7	35
	8-11	36
	12-16	37
	17-19	38
	20-21	39
	23	40

INSURANCE.

DETROIT STATION.

On hatching house	$4,000 00	
On automatic jairs	1,600 00	
		$5,600 00

PARIS STATION.

On new hatching house	$2,500 00	
Trays, troughs, etc.	350 00	
Camp outfit	300 00	
Car house	125 00	
Overseer's residence	1,000 00	
Old hatchery	800 00	
Tanks, boxes, etc., in old hatchery	200 00	
Office and shop	200 00	
Office furniture, fixtures and tools	100 00	
Old overseer's residence	400 00	
Barn and shed	100 00	
Wagons and harness	50 00	
		5,625 00

SAULT STE. MARIE STATION.

New hatching house		2,000 00
Total		$13,225 00

INVENTORY.

PARIS STATION.

158 acres of land with overseer's dwelling and meander of Cheney creek		$4,740 00
Superintendent's house	$1,500 00	
Barn	315 00	
New ice house	25 00	
Old ice house	28 00	
Old hatchery	950 00	
New hatchery	4,000 00	
Car house	225 00	
Pump logs	490 00	
Windmill, tank, and connections	515 00	
Ponds, races and other repairs to ponds	4,200 00	
Storage shed	50 00	
Out houses	80 00	
Meat shop	50 00	
Refrigerator	25 00	
Apparatus, tools, and camp outfit	2,258 84	
		14,601 84
		$19,341 84
Car for transporting fish	$3,550 00	
Outfit, curtains, lamps, stores, bedding, etc.	181 05	
		3,731 05

DETROIT STATION.

Buildings	$8,375 00	
Automatic jars	1,629 00	
Storage tanks and connections	2,500 00	
Steam boiler, pump, and connections	850 00	
Apparatus, tools, furniture, fish houses, fishing outfits, etc.	4,911 36	
		18,265 36

SAULT STE MARIE STATION.

Whitefish tanks and connections	$200 00	
Trout tanks and connections	75 00	
Chase automatic jars, complete	432 00	
Fish and egg trays	75 00	
Tools and furniture	390 50	
		1,172 50

CHARLEVOIX STATION.

Two hundred and five Chase automatic jars with tubes, etc., complete	$406 00	
Whitefish tanks with connections	200 00	
Steam and water-pipe connections	70 00	
Steam pump	212 00	
Apparatus, tools, etc.	240 40	
		1,028 40
Scientific outfit, apparatus, chemicals, etc.		477 75

GLENWOOD STATION.

Fish house, tanks, and fixtures	$175 00	
Carp cans	30 00	
Tools, nets, and screens	16 50	
		221 50

CASCADE STATION.

Shanty, ponds, and permanent improvements	$225 00	
Tools, cans, seines, etc.	151 85	
		$376 85

SECRETARY'S OFFICE.

Furniture	$322 95	
Library	64 50	
Record books and stationery	95 75	
		483 20

RECAPITULATION.

Paris station	$19,341 84	
Car	3,731 05	
Detroit station	16,285 36	
Sault Ste Marie station	1,172 50	
Charlevoix station	1,028 40	
Scientific apparatus	477 75	
Glenwood station	221 50	
Cascade	376 85	
Secretary's office	483 20	
		43,098 45

TREASURER'S REPORT.

Report of Wm. A. Butler, Jr., treasurer Michigan Fish Commission.

1892.			
Oct. 1	Cash on hand	$3,020 69	
Nov. 1	Cash from State Treasurer	6,870 75	
	Cash from other sources	1,917 27	
	Vouchers paid		$9,992 71
Dec. 31	Balance		1,816 00
		$11,808 71	$11,808 71
1893.			
Jan. 1	Cash on hand	$1,816 00	
Feb. 6	Cash from State Treasurer	6,870 75	
	Cash from other sources	524 40	
	Vouchers paid		$5,908 69
Mar. 31	Balance		3,302 46
		$9,211 15	$9,211 15
April 1	Cash on hand	$3,302 46	
May 1	Cash from State Treasurer	6,870 75	
	Cash from other sources	18 17	
	Vouchers paid		$7,310 23
June 30	Balance		2,881 15
		$10,191 38	$10,191 38
July 1	Cash on hand	$2,881 15	
Aug. 1	Cash from State Treasurer	6,250 00	
	Cash from other sources	182 50	
	Vouchers paid		$7,636 07
Sept. 30	Balance		1,677 58
		$9,313 65	$9,313 65
Oct. 1	Cash on hand	$1,677 58	
14	Cash from State Treasurer	6,250 00	
	Cash from other sources	2,982 75	
	Vouchers paid		$10,451 83
Dec. 31	Balance		458 50
		$10,910 33	$10,910 33

Treasurer's report.—CONTINUED.

1894.			
Jan. 1	Cash on hand	$458 50	
8	Cash from State Treasurer	6,250 00	
	Cash from other sources	31 99	
	Vouchers paid		$5,077 10
Mar. 31	Balance		1,663 39
		$6,740 49	$6,740 49
April 1	Cash on hand	$1,663 39	
5	Cash from State Treasurer	6,250 00	
	Cash from other sources	2,003 30	
	Vouchers paid		$9,710 85
June 30	Balance		205 84
		$9,916 69	$9,916 69
July 1	Cash on hand	$205 84	
6	Cash from State Treasurer	7,225 00	
	Cash from other sources	1,744 28	
	Vouchers paid		$9,061 60
Sept. 30	Balance		113 52
		$9,175 12	$9,175 12

Bulletin of the Michigan Fish Commission

No 2

THE PLANTS OF LAKE ST CLAIR

BY A J PIETERS

WITH A MAP

RESULTS OF A BIOLOGICAL EXAMINATION OF LAKE ST CLAIR UNDERTAKEN FOR THE STATE BOARD OF FISH COMMISSIONERS IN THE SUMMER OF 1893 UNDER THE SUPERVISION OF J E REIGHARD

LANSING
ROBERT SMITH & CO STATE PRINTERS AND BINDERS
1894

THE PLANTS OF LAKE ST. CLAIR.

During the summer of 1893 the Michigan Fish Commission sent a party under the direction of Professor J. E. Reighard to study the flora and fauna of Lake St. Clair and to make other observations of value to the Commission. The writer accompanied the party as botanist and the following notes are the result of observations made at that time.

A laboratory was fitted up at New Baltimore, on Anchor Bay, and most of the work was done in the bay and the neighboring marshes. Towards the close of the summer various localities in the western part of the lake were studied and one trip was taken past the head of the ship canal into Canadian waters and thence up the south channel of the St. Clair River as far as Algonac. The time spent on the work was from the middle of July to the middle of September. The first four weeks were occupied in studying the microscopic forms found free in the bay. The material was obtained from the "tows" that were brought in, at first every morning, and later two and three times a week. The "tows" were taken in the following manner: Two nets, made of fine cloth, and provided at the bottom with screw caps similar to those used on oil cans, were drawn through the water by a sailboat at the rate of 4–10 kilometers an hour according to the strength of the wind. One net was attached to an iron frame and allowed to sink so that it was drawn along at about two inches from the bottom; the mouth of the other net was always kept partly out of the water so as to take in only surface forms. After sailing fifteen minutes the nets were taken in and, by throwing water against the outside of the nets, the contents were washed down into the caps at the bottom. The material thus collected was emptied into jars. In drawing up the bottom net a few surface forms were necessarily taken in with the others, but a comparison of many tows showed that these could have had no appreciable influence on the result, since the forms found at the surface and near the bottom were practically the same. For the study of the bottom of the lake, a drag made in the following manner was used: Pieces of heavy steel wire 15 inches long were bent in the middle and then thrust through a piece of one inch lead pipe about six inches in length. The ends of the wires were then bent back to form a circle of hooks each one about 2½ inches long while a number of loops, made by the bending of the wires, was left at the other end of the pipe. A rope was tied through these loops and the drag was ready for use. This was thrown out every two or three hundred feet; a good knowledge of the bottom was thus obtained for that part of the lake examined.

To the writer's knowledge the only work done in this country bearing upon the subject of the distribution of plants in lakes and rivers is that by Professor Douglas Campbell ('86) on the plants of the Detroit River, an unpublished report by Mr. W. H. Rush to the Michigan Fish Commission, for 1891, and a paper on the occurrence of sphagnum atolls in central Minnesota by Professor Conway McMillan ('93).

In Europe some attention has been paid to the study of fresh water plant and animal forms and interesting observations have been recorded by different workers. A. Magnin ('93) studied the distribution of plants in the lakes of the Jura. The orignal paper was not accessible, and the results given below were obtained from a review in Natural Science.[1] In the deep lakes Magnin found several well marked zones of plant life. Passing from the shore to the center, these zones are: *First*, a littoral zone, which he divides into Phragmitetum and Scirpetum, the former extending to a depth of 2–2½ meters, while the latter forms a second zone to the depth of 3 meters. The plants characteristic of this zone are: Phragmites communis, Scirpus lacustris, sedges, Equisetum limosum, Polygonum amphibium, Phellandrium, Nymphaea alba and Potamogeton natans. *Second*, beyond the bulrushes is the Nupharetum. Plants with large floating leaves as Nuphar luteum, are characteristic of this zone which extends to a depth of 3–5, usually 4 meters. *Third*, "the third zone, or Potamogetonetum, is formed by plants different according to the lake; sometimes pondweeds, chiefly Potamogeton perfoliatus, then P. lucens or P. crispus; less often Myriophyllum spicatum, or still more rarely the marestail (Hippurus vulgaris), all bearing their leafy or flowering stems at or near the surface on stems 4–6 meters long." *Fourth*, in the deepest water, 8–10 and 12 meters deep, the bottom is covered with Characeae, Naias major, and the mosses, Fontinalis antipyretica and Hypnum giganteum. This zone he calls the Characetum. "In deep lakes with rocky borders, plant life is absent or represented only at points where erosion or a falling [of the bank?] has occurred, by tufts of reeds or bulrushes, associated or isolated, and sometimes followed inside by the yellow water lily and Potamogeton perfoliatus. The turf lakes, with abrupt, sharply sloping margins, differ in having a very narrow littoral zone, * * *." Shallower lakes show a mixed vegetation.

Lake St. Clair is little more than an expansion of the St. Clair River. It is shallow throughout, not reaching, except in the channels, a depth greater than 7 meters, and averaging far below this. In Anchor Bay, where most of the work was done, the depth ranges from 2½ to 4½ meters, with a wide zone of more shallow water near the shore. At the head of the lake are the famous St. Clair Flats, great stretches of marsh formed by the deposit from the St. Clair River. Through this deposit the river finds its way by several channels, from some of which a strong current is perceptible some distance into the lake. The shore of the lake is bordered by many swamps, especially at New Baltimore and about the mouths of Salt Creek and Clinton River. (See accompanying map for these places.) At other points the shore is abrupt and without any low ground. The gradual slope of the bottom, especially from the swamps near New Baltimore, offers the best conditions for the study of the influence of depth on the distribution of plant forms. Besides the condition of depth, the flora is, in some respects, also influenced by the character of

[1] Natural Science, vol. 3; No. 20, 248; Oct., 1893.

the bottom, according as it is clay, sand or an alluvial deposit. This is particularly the case with Characeae, which were seldom found on sandy bottom.

The influence of these two conditions, more especially that of depth, has caused the distribution of the plants into more or less well marked zones, while at the same time the shallowness of the water and the gradual slope have given rise to a somewhat mixed flora. The boundaries between zones are not sharply marked; there is a mixture of forms on the edges of each zone and, in the case of the Potamogetonetum and the Characetum, an overlapping of the latter zone over the entire extent of the former. The strength of the currents in Lake St. Clair gives rise to a third condition, that of rapidly flowing water, which doubtless exerts a marked influence on the flora. It is to be regretted that the observations on this point are not sufficiently detailed to warrant general conclusions. Two other conditions, which may be considered independently, but which are really related to that of depth, are the mechanical action of the waves and currents and the amount of light. How plants accommodate themselves to these two conditions will be mentioned below.

Coming now to the consideration of the zones in order, it may be stated that for some distance west of New Baltimore the lake is bordered by a swamp which slopes gradually into the water. This low ground offers the best conditions for the study of the Phragmitetum. Owing to shallow inlets which everywhere indent the border of the swamp, the line between the Phragmitetum and the next deeper zone, the Scirpetum, is an irregular one. The plants of the former occupy the low ground and the very shallow water, which seldom exceeds 20–40 cm. in depth. The growth in this zone is luxuriant; the conspicuous plants are large and leafy, often attaining a height of 2 meters, while a thick growth of smaller forms occupies the wet ground at their bases. The following plants are characteristic of this zone: Phragmites communis Trin, Typha latifolia L., Acorus calamus L., Scirpus atrovirens Muhl., S. fluviatilis Gray; common. Zizania aquatica L.; common in water 30–40 cm. deep and in the more watery parts of the swamp. Sagittaria heterophylla Pursh, var. rigida Engelm.; in great patches in shallow water. S. variabils Engelm.; with the former species, but not so abundant. Sparganium eurycarpum Engelm.; common everywhere in shallow water. S. simplex Huds.; occasionally found with S. eurycarpum. Polygonum muhlenbergii Watson; abundant along both banks of Salt Creek for some distance above its mouth. Decodon verticillatus Ell.; abundant along Salt Creek. Pontederia cordata L.; common everywhere in shallow water. This was found, in one case, near the mouth of Salt Creek, growing among Scirpus pungens in 60 cm. of water and about 800 meters from the shore. Cyperus filiculmis Vahl, C. engelmanni Steud., C. diandrus Torr., var. castaneus Torr.; abundant in wet but not submerged places. Carex filiformis L., C. filiformis L., var. latifolia Boeckl.; abundant at the flats and common near New Baltimore. C. vulpinoidea Michx., Eleocharis ovata R. Br., E. palustris R. Br., E. acicularis R. Br., common. E. palustris R. Br. var. glaucescens Gray, Juncus nodosus L., common. J. canadensis J. Gay, var. longicaudatus Engelm., Alopecurus geniculatus L., var. aristulatus Torr., Nymphaea reniformis D. C., Nuphar advena Ait.; common in the shallow water at the flats, near New Baltimore and in Salt Creek. Elodea canadensis Michx.; common in the swamp pools and near the dock at New

Baltimore. Lemna trisulca L., Spirodela polyrhiza Schleid., Utricularia vulgaris L., abundant in quiet water.

In the shallow inlets above mentioned the flora is mixed. There is a thin growth of Scirpus pungens with a few plauts of Sagittaria and of Sparganium while Potamogeton lonchites Luck, with the variety novеboracencis Morong, and P. heterophyllus Schreb., also occur in these inlets.

Two species are characteristic of the Scirpetum, Scirpus pungens Vahl, and S. lacustris L. Of these S. pungens grows in the shallow water ½–1 meter in depth, while S. lacustris grows in water 1–2 meters deep. Although fairly well marked this zone suffers from the encroachments of species from both sides. Of the Phragmitetum, Sagittaria heterophylla, var. rigida and Pontederia cordata are often found with Scirpus pungens, and species of Potamogeton usually growing in deeper water encroach upon S. lacustris. Outside of the Scirpetum, towards the deeper water both the Potamogetonetum and the Characetum begin, the former occupying a zone of water 2–4 meters deep while the latter covers the bottom throughout the western part of the lake. Magnin's Nupharetum does uot exist. Our species of Nuphar, N. advena, grows in shallower water and belongs to the Phragmitetum where also belong all our plants with large floating leaves. Potamogeton natans and P. perfoliatus which Magnin sometimes found in the Nupharetum belong to our Potamogetonetum and are only occasionally found in the Scirpetum.

The plants of the Potamogetonetum are either wholly submersed or have only the upper leaves floating and the flowers elevated above the water. The species found in this zone are: Potamogeton natans L.; common in water 2-3 meters deep. P. fluitans Roth; also found with Scirpus lacustris on the edge of the Scirpetum. P. zizii M. & K.; common and variable. P. heterophyllus Schreb.; in the shallow parts of the Potamogetonetum and encroaching upon Scirpus lacustris. P. heterophyllus Schreb., var. longipedunculatus Morong; with the species. P. perfoliatus L.; the most abundant species in the lake. This is the prevailing species on the bars throughout the lake; sometimes apparently the only one. Ceratophyllum demersum L.; common. Valisneria spiralis L.; abundant near New Baltimore and found to some extent at nearly every station.

The plants of the Characetum cover the bottom from the line of the zone of rushes throughout the American part of the lake at a depth of 2–7 meters. The distribution of the Characeae is affected both by depth and by the character of the bottom. Wherever the bottom is clay or alluvial deposit the Charas abound; where it is sandy or where a thick layer of sand covers the clay, they are scarce or entirely absent. During our one trip into Canadian waters a few isolated tufts of Chara contraria A. Br. were found but generally the bottom was sandy and no Characeae were seen. Chara contraria A. Br., is the prevailing species of this family in Anchor Bay. In the deeper parts of the bay it is mixed with Tolypella intertexta Allen, which grows more abundant in the lake and finally displaces Chara contraria. Chara intermedia A. Br. (probably); This was found at the stations numberd XI, XIII, XIV, on the map. Nitella tenuissima Desv., var. incrustata; at stations IV, V, VI, VII, XVI. Chara sp. either a new species or an anomolous form of Chara coronata; not abundant but was found at stations III, V, VI, VII, VIII, IX, XV and XVI. Naias flexilis L.; abundant everywhere.

Throughout the lake species of Potamogeton occur among the Characeae but they are not abundant in water over four meters deep.

The study of the Algæ was mainly confined to the microscopic forms found in Anchor Bay. A few species were collected from other localities and some were identified later from material collected from Utricularia. Most of the microscopic forms found in the bay are mechanically suspended but a few, as Pandorina morum Bory, and perhaps some of the Diatoms are free swimming. It is doubtless owing to the shallow water that the minute forms of plant life are nearly the same at the surface and near the bottom. The individuals of a species are somewhat more numerous at the surface but the number of species does not materially vary.

With the exception of the Desmids, which were found only at the surface, nearly all the species were found in both surface and deep tow. The presence of the Desmids is perhaps accidental, they having probably been washed from Utricularia or out of some of the shallow pools near the shore. The following is a list of Algæ both free and attached that were found in Anchor Bay, at the stations in the lake and in the swamps near New Baltimore.

Spirogyra nitida[1] (Dilln.) Link; common in the marsh pools. Spirogyra sp.; a small species found in considerable abundance near New Baltimore but not in fruit. Vaucheria geminata (Vauch), D. C.; common in wet places. V. tuberosa A. Br.; this differs from the type. It was found only at Stations III and V in water 5–6 meters deep. Cladophora sp.; a coarse form growing thickly among Chara near New Baltimore and at station VII. Pithophora sp.; abundant in Salt Creek. Mesocarpus sp.; in the marsh pools. Tolypotrix lanata Wartman, in and near the mouth of Salt Creek and once near the dock at New Baltimore. Tolypotrix sp.; mixed with Pithophora in Salt Creek. Chaetophora cornu-damae (Roth) Ag. var. genuina; occasionally on sticks and mussel shells near the shore. Coleochaete scutata Breb.; on rush culms. Bulbochaete sp.; on rush culms. Gleotrichia pisum Thur.; common on water plants. Protococcus viridis Ag.; in surface and in deep tow. Merismopedia convoluta Breb., Pandorina morum (Muell?) Bory, Pediastrum boryanum (Turpin) Menegh., Sphaerozyga polysperma Kg.; in surface tow and deep tow, most frequent in surface tow. Clathrocystis aeruginosa Henr.; surface and deep tow, most often in surface tow and sometimes very abundant. Gomphosphaeria aponia Kg.; not abundant but found in both surface and deep tow.

DIATOMACEAE.

Gomphonema geminatum (Lyng.) Ag.; deep tow. Asterionella formosa Hass.; surface and deep tow, most frequent in surface tow. Tabellaria fenestra (Lyng.) Kuetz., T. flocculosa (Roth) Kuetz.; common in surface and deep tow. Nitzschia sigmoidea (Nitzsch.) Wm. Sm.; surface and deep tow. Synedra affinis Kuetz., var. tabulata (Ag.) V. H., Cystopleura gibba (Ehr.) Kunze, Cymbella gastroides Kuetz.; in surface tow. Synedra sp. (131); once in deep tow. Synedra sp. (120), Cystopleura sp.; surface and deep tow. Navicula viridis (Nitzsch.) Kuetz; on Utricularia vulgaris. Navicula sp. (102), Navicula sp. (130); once in deep tow. Pleurosigma sp.; occasionally in both surface and deep tow.

1 For the sake of uniformity the nomenclature of DeToni in the Sylloge Algarum has been adopted throughout.

DESMIDIEAE.

Cosmarium intermedium Delp.; seen once in surface tow. C. botrytis (Bory) Menegh., C. contractum Kirch., C. tetraophthalmum (Kuetz) Breb.; in the swamp. C. margaritiferum (Turpin) Menegh., Disphinctium connatum (Breb.) De Bary.; in masses of Vaucheria. Closterium moniliferum (Bory) Ehrb.; from old logs in the water. Cl. ehrenbergii Menegh., Cl. dianæ Ehrb., Cl. rostratum Ehrb.; in masses of Vaucheria. Staurastrum arctiscon (Ehrb.) Lund, St. dejectum Breb., St. brevispina Breb., St. aspinosum Wolle; in surface tow. St. gracile Ralfs, St. muticum Breb., St. furcigerum Breb., Euastrum elegans Kuetz., Desmidium swartzii Ag., Micrasterias rotata (Grev.) Ralfs, Mic. crux-melitensis (Ehrb.) Ralfs, Pleurotaenium trabecula (Ehrb.) Naeg.; in masses of Vaucheria.

Utricularia vulgaris abounds in quiet water and becomes the biding place for many minute forms. The following algæ were identified by Mr. L. N. Johnson from washings of Utricularia vulgaris.

PROTOCOCCACEAE.

Sorastrum spinulosum Naeg.
Pediastrum duplex Mayen.
Scenedesmus bijugatus (Turp.) Kuetz.
Pediastrum boryanum (Turpin) Menegh.
Scenedesmus cordatus Corda.
Nephrocytium agardhianum Naeg.
Coelastrum microporum Naeg.
Ophiocytium cochleare (Eichw.) A. Br.
Tetraëdron minimun (A. Br.) Hansg.

DESMIDIEAE.

Closterium rostratum Ehrb.
Cl. ehrenbergii Menegh.
Cl. gracile Breb.
Cl. dianae Ehrh.
Cl. moniliferum (Bory) Ehrb.
Cl. juncidum Ralfs.
Cl. venus Kuetz.
Cl. acerosum (Schrank) Ehrb.
Cl. leibleinii Kuetz.
Cl. lineatum Kuetz.
Euastrum elegans Kuetz.
E. binale (Turp.) Ralfs, var. insulare Wittr.
E. binale (Turp.) Ralfs, var. simplex (Wolle) Hansg.
E. verrucosum Ehrb.
Gonatozygon ralfsii De Bary.
Micrasterias rotata (Grev.) Ralfs.
Mic. truncata (Corda) Breb.
Mic. crux-melitensis (Ehrb.) Ralfs.
Mic. fimbriata. Ralfs.
Staurastrum furcigerum Breb.
St. arctiscon (Ehrb.) Lund.
St. polymorphum Breb.
St. gracile Ralfs.
St. teliferum Ralfs.
St. dejectum Breb.
St. avicula Breb.
St. aspinosum Wolle.
St. incisum Wolle, (rough var.).
Onychonema leve Nord., var. micracanthum Nord.
Hyalotheca dissiliens. (Smith) Breb.
Cosmarium broomei Thwaites.
C. portianum Arch.
C. contractum Kirch.
C. ornatum Ralfs.
C. botrytis (Bory) Mengh.
C. nitidulum De Not.
C. granatum Breb.
C. subcrenatum Hautzch.
C. margaritiferum (Turp.) Mengh.
C. impressulum Elv.
C. sulcatum Nord.
C. schliephacheanum Grun.
C. meneghinii Breb.
C. latium Breb.
Penium margaritaceum (Ehrb.) Breb.
Desmidium swartzii Ag.
D. aptogonium Breb.
D. baileyi (Ralfs) De Bary.
Sphaerozosma wallichii Jacobs.
Pleurotaenium trabecula (Ehrb.) Naeg.
St. dickiei Ralfs.
St. alternans Breb.
St. muticum Breb.
St. crenulatum Naeg.
St. margaritaceum (Ehrb.) Menegh.
St. echinatum Breb.
Disphinctium connatum (Breb.) De Bary.

Two conditions to which water plants must accommodate themselves, are the mechanical effects of the waves and currents and the small amount of light. The few observations made on this point tend to confirm the results of H. Schenck ('86), obtained by a study of the lakes of Europe. He divides the water plants into three classes—the typical hydrophytes; the submersed plants that can, under certain conditions, live as land plants; the more or less amphibions. He finds that they present the following characteristics:

1. The leaves are divided, thin, and have few mechanical elements. This enables them to withstand the movement of the water and permits easy access of the diffuse light.
2. The stem is usually long, thin and flexible.
3. The roots are reduced and serve more for attachment than as organs of absorption.
4. Vegetation is active, the stem grows rapidly at the apex while it dies away at the base.
5. Water plants vary in the form of the leaves and the length of the internodes, according as they grow in rapid, standing, or shallow water.

In Lake St. Clair, the plants growing on the edge of the lake, in water from 20–40 cm. deep, are nearly all stout, leafy plants, Sagittaria, Pontederia cordata, Sparganium and the like. In deeper water, one to two meters deep, we find Scirpus pungens and S. lacustris. These plants are slender and not burdened with a weight of leaves, present a small surface to the action of the water and are flexible. In water 3–7 meters deep, the second condition, the feebleness of the light, must be met as well as the first. The plants of this zone, the Potamogetonetum, are buoyed up by the water in which they are wholly or mostly immersed, and their slender stems and linear or lanceolate leaves enable them to accommodate themselves to its movements. Not only is the mechanical tissue reduced to a small amount, but the leaves are mostly thin and narrow, thus presenting a relatively large surface to the light, but a small resistance to the action of the water. In many Potamogetons the lower leaves die, while the stem grows rapidly and the green leaves are borne near the upper end. Those plants, as Characeae and Naias, that grow on the bottom, have many small leaves or finely divided ones.

SUMMARY.

1. The flora of Lake St. Clair is arranged in more or less well marked zones limited by the depth of the water, and having certain plants characteristic of each zone.
2. The shallow water and the gradual slope of the bottom give rise to a somewhat mixed flora.
3. The Characetum covers the bottom throughout that part of the lake studied. It is probable that this is true for most of the lake.
4. The distribution of the plants is dependent primarily upon the depth of the water.
5. The distribution of the Characeae is dependent also upon the character of the bottom, a sandy bottom being unfavorable and a clay or alluvial one favorable to their growth.
6. The structure of the submersed plants is such as to enable them to meet the two conditions present in the deeper water. These conditions

are the mechanical effects of the waves and currents and the feeble light.

The thanks of the writer are due to Mr. C. F. Wheeler, of Michigan Agricultural college, for determining the Potamogetons, and the more difficult Cyperaceae; to Dr. T. F. Allen for identifying the Characeae; and to Mr. L. N. Johnson for the identification of some algæ and help in identifying others.

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UNIVERSITY OF MICHIGAN,
April 3, 1894.

NOTE.

From material brought to the writer from stations XVIII and XIX the following species were identified.

Station XVIII. Elodea canadensis Michx., Potamogeton sp. P. perfoliatus L., P. natans L., Naias flexilis L., and Nitella sp.

Station XIX. Valisneria spiralis L., Naias flexilis L., Potamogeton sp. and Nitella sp.

In November, 1893, the writer collected Zannichellia palustris L., in the Detroit River at Belle Isle.

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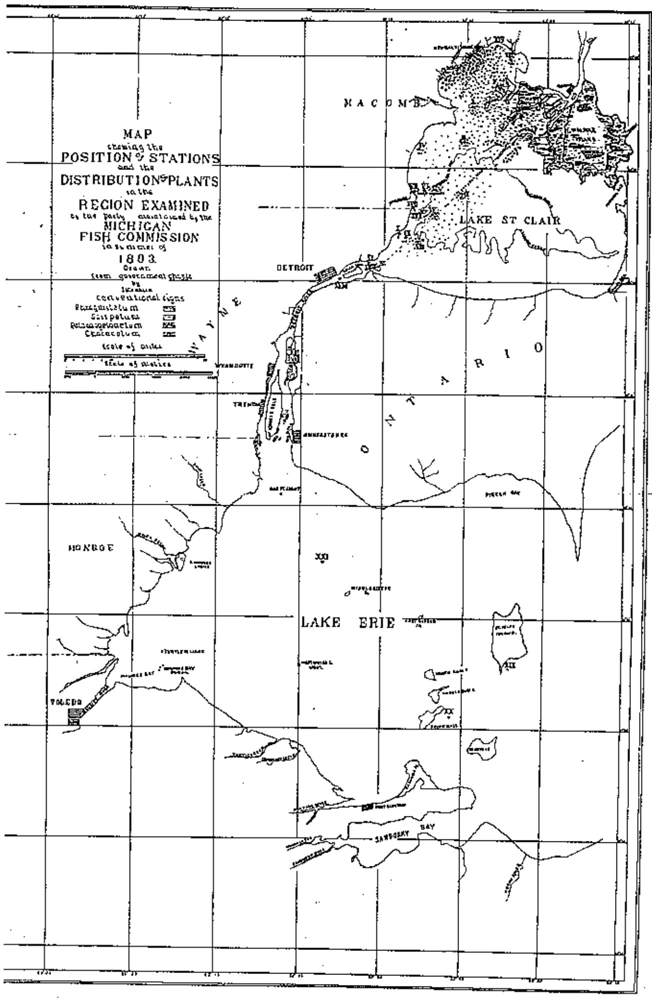
EXPLANATION OF THE MAP.

The different zones are indicated by conventional signs; these have been drawn only where the zone was actually observed. Further observation would doubtless have extended these areas. The sign for the Potamogetonetum has been used in two places in the lake to indicate the presence of a great quantity of Potamogetons. The surface covered by the sign for the Characetum represents the area over which this was actually found to be present. It is not to be understood, however, that any sharp boundary actually exists; further dredging would doubtless have extended this area, perhaps over the entire lake. A larger number of the signs has been drawn around those stations at which Characeae were found in greatest abundance, as in Anchor Bay which was studied more carefully than the other parts of the lake.

The stations are shown by a cross within a circle. The numbers of the stations are in Roman numerals, and the depth of each station (in feet) in Arabic numerals.


MAP
POSITION STATIONS
DISTRIBUTION PLANTS
REGION EXAMINED
MICHIGAN
FISH COMMISSION
1803
MACOMB
LAKE ST CLAIR
DETROIT
WAYNE
ONTARIO
LAKE ERIE
SANDUSKY BAY

Bulletin of the Michigan Fish Commission

No 3

A LIST OF

THE ROTATORIA OF THE GREAT LAKES

AND OF SOME OF THE INLAND LAKES OF MICHIGAN

With Two Plates and Descriptions of Six New Species

By H S Jennings

Results of a Biological Examination of Lake St Clair Undertaken for the State Board of Fish Commissioners in the Summer of 1893 under the Supervision of J E Reighard

LANSING
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ROTATORIA OF THE GREAT LAKES,

AND OF

SOME OF THE INLAND LAKES OF MICHIGAN.

The following is a list of the Rotatoria observed by me in Lake St. Clair and in some of the inland lakes of Michigan. The summer of 1892 was spent with a party of the employés of the State Fish Commission who were making a systematic examination of the inland lakes of Michigan, and I was able to determine some of the Rotifera of a number of the lakes in the western part of the State—in Muskegon, Newaygo, Oceana and Mecosta Counties. The summer of 1893 was spent in the State Fish Commission Laboratory at New Baltimore, on Lake St. Clair, and a more extended study was made of the Rotifera of this lake. The list makes no claim to completeness; scarcity of specimens or lack of time prevented accurate determination or complete description of many forms which I observed, and of course many have entirely escaped observation.

I have followed in the list the order used by Hudson and Gosse in their Monograph of the Rotifera and, except in two or three cases where they have been shown to be wrong, I have used their names and classification. For the species which have been described since the Mongraph was published (1889) I give the synonymy and references to the original descriptions. It has not seemed necessary to give synonymy or references for species described in Hudson and Gosse's work, except in cases where the synonymy here given differs from that of the Monograph. References are given by adding in parenthesis after the name of the author the date of the publication to which reference is made. At the end of the paper will be found the titles of the publications under an alphabetical list of the authors' names; to the titles are prefixed dates corresponding to those in the text.

Six of the 122 species noted are here described for the first time.

In the case of the smaller inland lakes, collections were made from the vegetation of the shore and bottom, but the tow net was little used, so that the pelagic Rotatoria of these lakes are not well represented in the list. In Lake St. Clair on the contrary the tow net was used systematically at various depths and at various distances from shore, so that for this lake the list of pelagic Rotifera may be considered nearly complete. The littoral rotatorial fauna of this lake was also examined with care, but no claim to

FAM. 3. PHILODINIDÆ.

Philodina, Ehrbg.

17. *P. roseola*, Ehrbg.

White L., Muskegon Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. One of the commonest of the Rotifera.

18. *P. citrina*, Ehrbg.

White L., Muskegon Co.; McLaren L., Oceana Co.; Crooked L., Newaygo Co.; L. St. Clair.

19. *P. megalotrocha*, Ehrbg.

L. St. Clair.

20. *P. aculeata*, Ehrbg.

McLaren L., Oceana Co.; L. St. Clair, in Vaucheria along the swampy shore; few.

21. *P. macrostyla*, Ehrbg.

SYN.—*P. tuberculata*, Gosse.

L. St. Clair, in water plants along the shore.

Rotifer, Schrank.

22. *R. vulgaris*, Schrank.

Found in most of the lakes that I have examined.

23. *R. tardus*, Ehrbg.

Occurring in very large numbers in Vaucheria from swampy shores of L. St. Clair.

24. *R. macroceros*, Gosse.

Few; in Vaucheria from swampy shore of L. St. Clair.

25. *R. trisecatus*, Weber.

L. St. Clair, amid Vaucheria; several specimens.

26. *R. mento*, Anderson (89).

Occurring in immense numbers in washings from Utricularia from the swampy shore of L. St. Clair, among the logs of a "log pen."

It is of great interest to find here this form, recently described from Calcutta, India. It has, I believe, not been reported since, except doubtfully and without notes in one of the lists of the Quekett Club collections in England (Journ. Quekett Club, July, 1893, p. 276). In Lake St. Clair it occurs by thousands, even in small quantities of the Utricularia washings.

As found here it is a large species, some specimens measuring .74 mm., and heavy in proportion to the length. In addition to the characteristics mentioned by Anderson, I note the following points.

The eyes are large and bear a distinct crystalline lens. The long antenna is composed of two joints, of which the proximal is much the longer; the terminal joint is broader at its distal end and bears three distinct bunches of setae, the middle one of which is elevated on a minute but distinct stalk. The foot is long and composed of five joints from toes to cloaca; it is generally telescopically retracted. The spurs are moderately short; the toes are minute and almost always retracted within the terminal joint of the foot; the middle toe is slightly longer than the others.

The material washed from the Utricularia is largely composed of the long brown tubes of this rotifer, turned together into great bunches. The tubes are very crooked, sometimes forked, and very long in proportion to the length of the animal; one which I measured was 2.5 mm. long. The rotifer remains always at the end of the tube, never so far as I have observed being found elsewhere than in this position, and continues to build out its tube apparently to an indefinite length. The process of forming the tube has I believe not been described. The animal stands with half or two-thirds of its body projecting from the tube, and unfolding its ciliary apparatus, a current of the minute particles in the water is driven down the ventral gap over the chin. Here the particles become imbedded in a gelatinous mass till a string of such particles imbedded in the gelatine is formed suspended from the chin. The animal then bends toward the ventral side and contracts till the mass is rubbed off on the edge of the tube. The process is somewhat different when the animal is starting a new tube, as it does at once after being dislodged from the old one. I have seen fourteen specimens thus engaged at the same time, under a single cover-glass. It attaches itself by the toes, unfurls its corona, and produces a current of particles as above described. About the neck is a ring of gelatinous material in which the particles are caught. This ring of gelatinous material is either shifted about by the contortions of the animal, or there is some means of distributing the particles which I could not observe, for the ring of gelatinous material soon becomes a collar of brown floccose, in which the particles are not heaped together at one point. The animal now retracts its corona, bends toward the ventral side and contracts strongly. The collar is thus forced back toward the foot, and by the formation of another collar in front of it, it is finally shoved back against the object to which the animal is attached. Besides the single stream from the gap of the coronal cup, particles are drawn in from all sides by the ciliary motion and just missing the edge of the corona, dash violently to the rear, where they are caught and held by the gelatinous collar. Flagellate infusoria of considerable size are sometimes in this way imbedded in the tube. Wandering rotifers sometimes become stuck in the forming tube also; I have seen Metopidia lepadella and Cathypna luna thus captured. The formation of the tube takes place very quickly at first, a tube of sufficient length to contain comfortably the whole animal being formed in half an hour.

27. *R. actinurus*, Ehrbg.

SYN.—*Actinurus neptunius*, Ehrbg.

L. St. Clair; rather common in the weeds along the shore and on the bottom.

I follow Janson (93), in placing this form in the genus Rotifer.

FAM. 5. MICROCODONTIDÆ.

Microcodon, Ehrbg.

28. *M. clavus,* Ehrbg.

Crooked L., Newaygo Co.; rare.

Microdides, Bergendal (92).

29. *M. orbiculodiscus,* Thorpe (91).

SYN.—*Rhinops orbiculodiscus,* Thorpe (91); *Microcodides dubius,* Bergendal (92).

Amid Cladophora from shores of L. St. Clair; a single gathering of this contained a considerable number, but I never found it again.

FAM. 6. ASPLANCHNADÆ.

Asplanchna, Gosse.

30. *A. priodonta,* Gosse.

Very abundant in L. St. Clair; taken in numbers in almost every tow, either surface or deep.

31. *A. Herrickii,* De Gnerne. (See Wierzejski, 92.)

Towings from L. St. Clair; not abundant.

Ascomorpha, Perty. (**Sacculus,** Gosse.)

32. *A. ecaudis,* Perty (50).

SYN.—*Sacculus viridis,* Gosse.

Swampy portion of shores of L. St. Clair; few. Also a single specimen in surface towings from Whitmore L., Washtenaw and Livingston counties.

I use the above specific name and reference on the authority of de Guerne (88).

33. *A. hyalina,* Kellicott.

L. St. Clair, among weeds from the bottom; also a single specimen in the surface tow, one mile from shore. Numerous in towings from Whitmore L., Washtenaw and Livingston counties.

Anapus, Bergendal (92 and 93). **Chromogaster,** Lauterborn (93).

34. *A. ovalis,* Bergendal (92 and 93). *C. testudo,* Lauterborn (93).

Very common in towings from L. St. Clair and among the plants of the bottom.

It is difficult to tell what this animal should be called; apparently Bergendal's name was the first published, but almost without description; the first description being published by Lauterborn with the name Chromogaster testudo.

In regard to a number of points my study of this animal has gone more into detail than does the account of either Bergendal, Lauterborn or Zacharias (94) and it seems best on the whole to give the description and figures which I had prepared before I had seen the papers of those authors.

Animal without a foot, and possessing a lorica composed of two separate plates, dorsal and ventral, which are similar in form; between these at the sides a distinct gap. Length (in my specimens) about .135 mm.

As a whole the animal is lenticular in form, appearing broadly ovate in a dorsal or ventral view, and narrowly oval in a side view, as shown in the figures (1 and 2). The dorsal and ventral plates of the lorica differ little in form and size; the ventral plate extends somewhat farther backward, the dorsal plate farther forward. The anterior edge of the dorsal plate has a broad shallow notch on the left side, which was constant in all the considerable number of specimens examined with reference to it. At each side in front, in the angle between the dorsal and ventral plates of the lorica, there seems to be a separate small triangular piece, perhaps only a stiffened portion of the integument of the head. To each of these is attached a muscle; the two muscles run along the sides just outside the viscera and are attached to the posterior end of the lorica at the sides of the opening of the contractile vesicle. The two muscles thus attached give almost exactly the appearance figured by Bergendal, which he was inclined to explain as the side walls of the intestine, the point of attachment of the muscles being interpreted as the anus. Neither intestine nor anal opening was to be observed, so far as I can judge. The entire lorica is covered with minute polygonal areas; in front these are arranged in rows. These are not prominent and were overlooked by both Bergendal and Lauterborn. In the reproduction of my drawing these are rendered too distinct.

The corona is composed of the following parts: (*a*) two curved lateral lobes extending nearly to the mid dorsal line and bearing the greater part of the cilia; (*b*) two small bunches of cilia on the ventral surface, at either side of the point of the trophi; (*c*) a similar pair situated on either side of the middle line on the dorsal surface of the corona; (*d*) two thick two-jointed styles, curved ventrad when fully extended, situated at the anterior edge or curve of the corona—where the dorsal and ventral surfaces pass into one another. In some cases these styles seemed to bear at the end a number of stiff setæ; in other cases no setæ were visible. (*e*) A second pair of more slender styles situated dorsad of these. In all cases examined the two members of this pair differed. Each consists of a short proximal and long terminal joint, but the left style curves inward then outward, so as to make an arc of about 120 degrees, whereas the right hand one is straight and generally extends slightly inward, so as to make an acute angle with its neighbor of pair (*d*). These four styles (*d* and *e*) are retractile; so that unless the corona is well expanded they are not visible; often the corona is unfolded to such an extent that one pair is visible while the other is not. The animal may be killed with a very weak cocaine solution so as to show all four at the same time. (*f*) The last and most peculiar portion of the corona is a large flattened organ on the dorsal edge. It consists of a short thick club-shaped proximal joint, attached slightly to the right of the middle line, and a large thin leaf-like terminal joint, broadening to its distal end and curved strongly dorsad. The proximal joint often appears granular, but the distal joint is so thin as to be transparent, so that it requires accurate focussing to get its outlines; in an edge view it appears only as a line. Besides being curved dorsad it is slightly spirally curved. I have never seen it show any movement, except to be slowly bent in closer to the corona. The side view (Fig. 2) shows this organ in its natural position; in the ventral view it is turned out of place. This organ is evidently to be compared to the "spatula-shaped apex" described by Kellicott (88) for Ascomorpha hyalina, and the "lippenförmigen Fortsatz" of Bartsch's Ascomorpha saltans (Bartsch, 70). I was able to examine the organ in *A. hyalina* and find it very similar to that of the present species.

The trophi are forcipate; the stomach lies transversely across the body and is divided into three principal portions—a transverse portion, and projecting forward from it at the sides two lateral lobes, so that the whole is somewhat U shaped. These lobes are constricted into many minor lobules, which contain large solid masses, orange, yellow and black in color, giving the animal a variegated appearance on a groundwork of light yellow. Concerning the origin and distribution of these colored bodies in the stomach, details are given by Lauterborn. Projecting forward from the two anterior lobes of the stomach are two small pointed colorless gastric glands.

The contractile vesicle lies at the posterior end of the body, nearer the ventral surface; it is somewhat pear shaped, the pointed end reaching to the opening on the dorsal surface, apparently between the plates of the lorica. Its period is about 15 seconds. Closure may be seen to take place by pushing in of the ventral wall of the vesicle, not by a contraction from all sides. A small oval opening to the outside is visible at the time of the collapse of the vesicle. The lateral canals are hidden by the lobes of the stomach; two flame cells may be seen on each side—one a little behind the middle of the anterior lobes of the stomach, the other behind the middle of the posterior lobe.

The brain is simple and bears at its caudo-dorsal angle a small dark eye.

The movement of the animal through the water is a quick spiral motion, turning on its axis and rapidly progressing forward. Its course is interrupted at intervals by short periods of rest, during which the corona is retracted. It is possible that the spiral motion is connected with the spiral turn of the spatula-shaped appendage of the corona.

Zacharias (94) considers this a member of the genus Ascomorpha, and the relationship is certainly very close. If that genus is to be divided, it seems probable that *A. ecaudis*, Perty, and *A. agilis*, Zacharias (93) on the one hand, should be separated from *A. saltans*, Bartsch, *A. hyalina*, Kellicott, and the present species on the other. The two former agree in the lack of a lorica and in the simple ciliary wreath, the latter in the presence of a lorica, and of a large dorsal process on the corona.

FAM. 7. SYNCHAETADÆ.

Synchaeta, Ehrbg.

35. *S. pectinata*, Ehrbg.

Abundant in towings from Whitmore L., Washtenaw and Livingston counties; taking the place here which is occupied in L. St. Clair by *S. stylata*, Wierzejski.

36. *S. stylata*, Wierzejski (93).

Very abundant in towings from L. St. Clair.

Wierzejski's account of this animal is brief and, as I have seen it, is in the Polish language, so that it may be well to give a description here.

In general appearance it resembles in some degree *S. pectinata*, but it is immediately distinguished by the long slender foot.

The corona differs from that of *S. pectinata* in that the two "club shaped prominences" or "Kämme" of *S. pectinata* are represented here by a single central prominence, bearing two bunches of setæ; also in some minor respects. It consists of the following parts: (*a*) a dorsal and a ventral row of cilia, not continuous with each other along the sides. Each of these is interrupted in the middle line. (*b*) A wreath of exceedingly minute immobile cilia-like processes on the dorsal border of the mouth; (*c*) a slight distance to each side of the mouth a group of four large setæ. These are arranged in two pairs, each pair coming from a single base and its two members differing in size. (Wierzejski figures these as five on each side, raised on an elevation, but his figure is apparently diagrammatic in this respect.) (*d*) Laterad of the cilia—between the ciliary crown and the auricle and about midway between the dorsal and ventral edges of the corona, a long style on each side. (*e*) A similar but shorter pair of styles arising from the dorsal edge of the corona, nearer the middle. (*f*) Two large rounded auricles in a similar position to those of *S. pectinata*. (*g*) A central conical projection bearing two brushes of stiff setæ, separated by a median space. The setæ stand at a considerable angle with the axis of the elevation, and are directed ventrad. (Wierzejski does not show these setæ forming two brushes.) Wierzejski figures in addition to these parts, two separate bunches of cilia at each side of the mouth and dorsad of it, somewhat as described by Plate (85) for *S. pectinata*; these after long study seem to me to be only incurved lateral portions of the ventral row of cilia, but I could not be certain.

The mastax is very large, the trophi complicated, of the ordinary Synchaeta type. A slender œsophagus connects the mastax with the stomach, which is provided with a pair of small gastric glands. The brain is ovate and bears a large red eye. The contractile vesicle is small and lies at the posterior end of the body. The lateral canals are distinct, passing along each side as a nearly straight tube, from the contractile vesicle nearly to the fore part of the stomach. Here it forms a coil, from which arise, by a common stalk, two flame cells. The canal passes thence to the base of the auricle, where there is another flame cell; farther than this I could not trace it.

The ovary is distinctly formed of two portions—one containing a number (about 8–12) of large nuclei; the other finely granular. The latter portion contains generally a small reddish orange, irregular, granular mass.

The whole body has generally a pinkish hue, the mastax is commonly violet, the stomach yellow. The outline in side view varies much in different specimens; in most the lateral diameter is considerably greater than the dorso-ventral, but sometimes the animal is swollen so that a section would be nearly a circle. A side view shows a dorsal antenna in the usual position.

The slender foot is about one-third the length of the remainder of the body; the toes are minute.

FAM. 8. TRIARTHRADAE.

Polyarthra, Ehrbg.

37. *P. platyptera*, Ehrbg.

Chippewa L., Mecosta Co., among weeds near shore; Whitmore L., Washtenaw and Livingston counties, in towings. Perhaps the commonest of all rotifers in L. St. Clair, occurring everywhere—in towings far from shore, among the plants of the bottom, and among those along the shore.

FAM. 9. HYDATINADAE.

Notops, Hudson.

38. *N. laurentinus*, *n. sp.* (Figs. 3 and 4.)

This animal bears considerable resemblance to *Triphylus lacustris*, Ehrbg., and to *Dinops longipes*, Western (91) but its structure places it in the genus *Notops*. The corona, like that of *N. hyptopus* is a single ciliary wreath, without styligerous prominences, and without styles or other processes of any kind.

In general form the animal resembles the two above mentioned species. But the foot is larger and less sharply set off from the body and the body is scarcely so distinctly "humped," coming thus nearer the Notommatadæ in form. The foot does not arise from the ventral surface, but at the posterior end of the body nearer the ventral surface; it is composed of a very short proximal and long distal joint, the latter bearing two very short conical toes, which are pressed together. The toes are retractile within the foot and the entire foot is retractile within the body. The body is dorsally arched, the height of the arch differing much in different specimens; the ventral line is slightly convex. The head is distinctly marked off from the body; its anterior surface is an oblique disk on which is a single marginal row of cilia. The head bears near its junction with the body a minute dorsal antenna, which is connected with the anterior part of the brain by two nerve threads, each of which has an enlargement close to the outer end.

The brain is an oblong body, bluntly pointed behind and bearing at the point a small round eye, which is generally red, but sometimes appears black and sometimes is nearly colorless, so that it might be overlooked.

The mastax is three lobed; the trophi are weak and forcipate, resembling those of *N. hyptopus* as figured by Hudson. The mastax is followed, without the intervention of an œsophagus by a long saccate stomach. This commonly fills about the dorsal two-thirds of the body cavity—though its size varies with the amonnt of contents. When it contains food it is distinctly separable into stomach proper and intestine. Two small flat oval gastric glands lie at the sides of the anterior end of the stomach.

The ovary is a broad, slightly curved band lying obliquely across the ventral surface—the left end lying farther to the rear than the right end. The form and size vary much with the condition of growth—absence or presence of developing eggs, etc.

There is a large contractile vesicle lying ventrad of the intestine; from it the lateral canals pass forward as a single fine tube on each side. At the side of the ovary each forms a complicated coil bearing a flame cell; it then passes to the front edge of the ovary, where there is another flame cell; crosses the gastric gland and passes on to the sides of the mastax, where another flame cell is found. There is another flame cell in the anterior part of the head.

The general appearance of this animal varies considerably owing to great differences in thickness of the body as compared with the length. The average length is about .22 to .25 mm.

Common among the plants of tbe bottom and shore of L. St. Clair.

39. *N. pygmaeus*, Calman (92).

SYN.—*Hudsonella picta*, Zacharias (93); *Gastropus stylifer*, Imhof (?) (88).

L. St. Clair; Whitmore L., in Washtenaw and Livingston counties; very abundant in towings and in the vegetation of the bottom.

Ploesoma, Herrick.

40. *P. lynceus*, Ehrbg.

SYN—*Euchlanis lynceus*, Ehrbg.; *Ploesoma lenticulare*, Herrick (85); *Gomphogaster areolatus*, Vorce (87); *Gastropus Ehrenbergii*, Imhof (88); *Gastroschiza lynceus* (Ehrbg.) Bergendal (92*a*); *Gastroschiza foveolata*, Jägerskiöld (92;) *Bipalpus lynceus*, (Ehrbg.) Wierzejski and Zacharias (93).

I have discussed the synonymy of tbis form at greater length in the Zoölogischer Anzeiger of Feb. 19, 1894.

This animal is fiercely predaceous in habits; I have seen *Synchaeta stylata*, *Notommata truncata*, and various other large rotifers fall a prey to *Ploesoma*. In every case the prey was seized by the side of the head, and the inner soft parts were drawn into the stomach of the captor, the remainder of the body being then dropped.

One of the commonest rotifers in L. St. Clair—in towings and among tbe weeds of the bottom and shore; also in Crooked L., Newaygo Co., and Chippewa L., Mecosta Co.; a few specimens from each.

41. *P. Hudsoni*, Imhof (88).

SYN.—*Gastroschiza flexilis*, Jägerskiöld (92); *Bipalpus vesiculosus*, Wierzejski and Zacharias (93); *Dictyoderma hypopus*, Lauterborn (?) (93).

L. St. Clair; rare, a few specimens in the bottom and surface tows and among the weeds of the bottom.

FAM. 10. NOTOMMATADAE.

Albertia, Dujardin.

42. *A. naidis*, Bousfield.

L. St. Clair; three specimens squirming about in the bottom of a dish that contained Nitella from the lake. There were many annelids in the dish and no doubt the rotifers came from some of these.

Taphrocampa, Gosse.

43. *T. annulosa*, Gosse.

McLaren L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Not uncommon in the algæ near the shore.

44. *T. Saundersiae*, Gosse.

L. St. Clair, in Nitella from the shore; rare.

45. *T. selenura*, Gosse.

Many in Vaucheria from the shore of L. St. Clair.

Pleurotrocha, Ehrbg.

46. *P. constricta*, Ehrbg.

From a small pool near L. St. Clair. True to its nature as figured by Ehrenberg, the specimen was attached by its jaws to a Stylaria and maintained its hold during the entire time it was under observation.

Notommata, Gosse.

47. *N. aurita*, Ehrbg.

L. St. Clair; in plants from the bottom; not common.

48. *N. tripus*, Ehrbg.

White L., Muskegon Co.; L. St. Clair. Among the plants of the shore; few.

49. *N. brachyota*, Ehrbg.

In Vaucheria from swampy shores of L. St. Clair; rare.

50. *N. lacinulata*, Ehrbg.

Abundant in nearly all waters.

51. *N. collaris*, Ehrbg. (?)

L. St. Clair, on Utricularia.

This is the form described under this name by Gosse, agreeing with his measurements as given in the Monograph.

52. *N. torulosa*, Dujardin.

Chippewa L., Mecosta Co.; very abundant among Utricularia. L. St. Clair, in Vaucheria from swampy portions of the shore.

53. *N. monopus*, n. sp. (Figs. 5 and 6.)

Fusiform, truncate in front, where the circular corona is surrounded by a crenate fringe, tapering behind to a single pointed toe. Two large spherical stalked auricles. On each side of the body, at about the middle of its length, a large rounded projection, with a small opening in the top. A single red eye. Two dorsal antennæ, one on each side of the eye, two minute lateral antennæ at the beginning of the posterior third of the body. Animal exceedingly versatile and larva like; of a deep slightly brownish red color. Length, .15 mm. Width across the lateral projections when the animal is moderately contracted .06 mm.

The above is a summary of the more important characteristics of this peculiar animal, which differs in several marked features I believe from any of the previously described *Notommatae*. The most notable of these peculiarities are, the single foot, the perforated lateral projections, and the crenate fringe surrounding the corona.

The corona is scarcely at all oblique. The two auricles are like those described by Cohn for *N. torulosa*; they arise from the circular ciliate face just on either side of the middle line. The crenate fringe seemed sometimes to be minutely ciliate, though I could not be certain of this.

The two large lateral projections are perhaps the most striking characteristic. They are rounded and bear an opening in the apex; in an animal which had been slightly compressed a portion of the internal contents was observed to project through these openings.

The single pointed toe is preceded by a single short joint.

The brain is large and is minutely striated longitudinally. The posterior border is pigmented, and imbedded in the black pigment is a large bright red eye. The two dorsal antennæ are situated at either side of the eye, in such way that a side view shows distinctly a single one of them, apparently in the median line, so that the fact that there are two is easily overlooked. Each bears a bunch of setæ. The lateral antennæ are exceedingly minute; they are situated in the ordinary position, considerably behind the large lateral projections above described.

The mastax is very small; I did not succeed in studying the trophi carefully. A short œsophagus leads from the mastax to a very large stomach. This is divided a little behind the middle by a deep constriction into two dissimilar portions. The anterior part is thick walled and lobulate, and its inner surface is covered with minute villous processes; it continually undergoes a sort of peristaltic contraction. The posterior part is a thin walled sack, always dilated, so far as I have observed, not partaking of the contractions of the front part. The two parts differ in color; the anterior in cases noted was orange red, the posterior cherry red.

At either side of the anterior portion of the stomach, just in front of the lateral projections, are a number—generally about ten to twelve—of small spherical orange brown strongly refractive bodies, imbedded in a transparent mass. This seems to be attached to the stomach and may represent the gastric gland.

Beneath the stomach is the long ovary, and behind this is the small contractile vesicle.

The animal, like most pelagic species, is generally in active motion, and incessantly changing its form. The drawings give the form when freely swimming and fairly extended; it is often much shorter and thicker. Almost any small part of the body may be much contracted, so as to leave two large parts connected by a narrow neck. Especially often the body is deeply constricted immediately behind the two lateral projections, less often just in front of them. Sometimes constriction takes place in both these regions at once, so that the projections sink deep below the level of the remainder of the body, giving the animal a strange wasp like form.

L. St. Clair; in towings, both surface and deep; not abundant, though a few occurred in almost every take.

54. *N. truncata*, n. sp. (Figs. 10 and 11.)

Cylindrical or somewhat club shaped in form, truncate in front, the last third tapering gradually to end abruptly with two short conical toes. Color of the entire animal a deep orange brown. The ciliate face is prone and very long (.10 mm. in an animal .28 mm. in length); it extends from the ventral surface over the anterior end and a very slight distance onto the dorsal surface. Two very large auricles are frequently exposed; these are produced in front each into a small clear rounded projection as shown in the figure. Posteriorly the body falls off suddenly at the cloaca to a short flattened portion that may be called the foot, lying along the ventral line of the body; to it are joined two short conical toes, which are commonly somewhat divergent in direction and separated by a distinct notch.

A striking feature is the brain; this in dorsal view is somewhat ovate; squarely truncate at its posterior end; in front tapering slightly to a rounded anterior end. All this portion is clear; immediately against the posterior end of the brain, and generally though not always marked off from it by a distinct line, is a large, often somewhat hemispherical, mass of granules, very dark red in color—almost black by transmitted light, bright red by reflected light. This mass is so opaque that in the majority of cases no eye is distinguishable, but in a single specimen out of perhaps forty examined as to this point, I could see by strong transmitted light a distinct clear red spherical body in the center of the mass, doubtless an eye. The dorsal antenna is represented by a minute bunch of very fine setæ situated on the top of the head just in front of the eye and connected with a slight elevation of the brain. No lateral antennæ could be seen.

The mastax and trophi are very large; the trophi are forcipate, thick and heavy, and are continually snapping, often reaching forward outside the buccal orifice. The mastax is followed by a short, narrow œsophagus, which lies immediately behind the brain and is rendered visible, in a dorsal view, by its marked ciliary motion. At the sides of this are the large gastric glands broader at the posterior end. The stomach is very large, crowded close up against the mastax and gastric glands, and fills the whole breadth of the body. The walls of the stomach are slightly wrinkled; they are very thick and are filled with yellowish granules. The inner surface is strongly ciliate. At about the anterior end of the contractile vesicle the intestine begins; it has thick but transparent walls which are ordinarily apposed, so that the cavity is obliterated. At the posterior end, behind the place where the contractile vesicle opens into it, there is a slight dilation to form a cloaca. It opens at the marked dorso-caudal angle of the body, above the foot.

The ovary is large, lying in the ordinary position. There is a large foot gland which extends into the body as far as the posterior end of the contractile vesicle.

The contractile vesicle is oblong and very large, filling a considerable portion of the posterior part of the body; its relation to the lateral canals shows some peculiar features. There is a flame cell in the head region, at the side of the mastax, but I could not trace its connection with the lateral canal. The next flame cell lies at the dorsal surface of the gastric gland. From this the lateral canal passes downward to the middle of the gland, then curves caudad and passes along the side of the ovary, near the anterior end of which is another flame cell. The lateral canal passes then straight back to the front end of the contractile vesicle, where there is on each side another flame cell. Thus far the canals of the two sides are alike, but posterior to this their courses differ. From the flame cell of the right side the right lateral canal passes to the dorsal surface of the vesicle, lying to the right of the middle line, and extends thus to a little behind the middle of the vesicle. Here it makes a sharp curve to the right and passes around to the ventral surface of the vesicle, then backwards and inwards nearly to the middle line, where it is joined by a canal coming on the ventral surface from the front of the vesicle—sometimes slightly on the left side of the middle line. The canal formed by the junction of these two passes back to the end of the vesicle, and curves about the end to the left side, where it is seen to be continuous with the left lateral canal. This passes from the left flame cell directly back along the ventro-lateral surface of the vesicle to the point of union. The point of origin of the ventral canal, which lies between these two and joins the right canal as above described, could not be determined; it could be traced to the anterior end of the vesicle, but no further; possibly it opens into the vesicle at that point.

In specimens observed the period of the contractile vesicle varied from two and a half to three and a quarter minutes. It opens into the intestine at some distance from the posterior end of the latter. The end of the intestine may be seen to dilate at the time of the contraction of the vesicle.

The animal is rather slow and clumsy in its movements.

Very common in the bottom vegetation of L. St. Clair.

Copeus, Gosse.

55. *C. labiatus*, Gosse.

Among the water plants of the swampy shore of L. St. Clair; few.

56. *C. Cerberus*, Gosse.

McLaren L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Among water plants near the shore.

Proales, Gosse.

57. *P. sordida*, Gosse.

Common among the bottom plants of L. St. Clair.

58. *P. felis*, Ehrbg.

In Vaucheria from L. St. Clair; few.

59. *P. Werneckii*, Ehrbg.

Inhabiting galls and filaments of Vaucheria, from the shores of L. St. Clair; (also from a rivulet at Ann Arbor).

Furcularia, Ehrbg.

60. *F. forficula*, Ehrbg.

McLaren L., Oceana Co.; Chippewa L., Mecosta Co.; Round L., Mecosta Co.; L. St. Clair.

In several specimens from L. St. Clair I observed that what seems in side view to be the proximal *one* of the apparently two teeth on the toe, really consisted of three minute points forming a transverse row across the

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base of the toe; and in a single very large specimen that it consisted of a row of five or six minute points. The distal tooth was single in all these cases.

61. *F. gracilis*, Ehrbg.
L. St. Clair; swampy shores.

62. *F. gibba*, Ehrbg.
Chippewa L., Mecosta Co.; L. St. Clair; rare.

63. *F. longiseta*, Ehrbg.
White L., Muskegon Co.; McLaren L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Very common.

Eosphora, Ehrbg.
64. *E. aurita*, Ehrbg.
In Utricularia and Nitella from L. St. Clair; not common.

Diglena, Ehrbg.
65. *D. grandis*, Gosse.
L. St. Clair, in Utricularia; not common.

66. *D. forcipata*, Ehrbg.
Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Rather common.

67. *D. circinator*, Gosse.
Chippewa L., Mecosta Co.; few.

68. *D. caudata*, Ehrbg.
McLaren L., Oceana Co.; not uncommon.

69. *D. biraphis*, Gosse.
Chippewa L., Mecosta Co.; L. St. Clair.

Many other species of this family, belonging especially to *Notommata*, *Copeus* and *Diglena*, were observed, but it seems to be necessary to observe great caution in identifying the species here with those described from Europe, as forms which are similar in a cursory view show great differences on a more exact study. I have mentioned only those in which the determination is certain; of those not identical with European forms, I have described but two (Nos. 52 and 53).

FAM. II. RATTULIDAE.

Mastigocerca, Ehrbg.
70. *M. carinata*, Ehrbg.
West Twin L., Muskegon Co.; Crooked L., Newaygo Co., (the ruby colored variety mentioned by Kellicott, 88); Chippewa L., Mecosta Co.; L. St. Clair. In algæ near the shore.

71. *M. bicornis*, Gosse.
Chippewa L., Mecosta Co.; L. St. Clair; littoral.

72. *M. bicuspes*, Pell (90).
A single specimen from among Utricularia; shores of L. St. Clair.

73. *M. capucina*, Wierzejski and Zacharias (93).
SYN.—*M. Hudsoni*, Lauterborn (93).
A single specimen from the bottom tow; L. St. Clair.

At least four other species of this genus were observed, none of which could be certainly identified with any described form. Only one of these was carefully studied; the description and figure are given herewith (No. 74). Of the others, one is a form with two large dorsal keels, like *M. bicristata*, Gosse, and perhaps it should be identified with that form. But the two ridges do not extend "nearly the whole length of the dorsum," only very slightly beyond the middle, and the animal as a whole is not of the shape shown in Gosse's figure, but is shorter and broader in proportion to the length; Gosse's description is so meager otherwise that it is impossible to determine whether or not this form is the same as his. It was observed in Crooked L., Newaygo Co.; Chippewa L., Mecosta Co., and in L. St. Clair; in the latter it was very abundant in the bottom vegetation. Another, from Crooked L., Newaygo Co., is a large form which I was inclined to call *M. scipio*, Gosse, but it is considerably larger than Gosse's specimens, is brightly colored instead of colorless, and differs in some other small particulars. The other two were very unlike any described form; the following is a description of one of these.

74. *M. lata, n. sp.* (Fig. 7.)

Lorica broadly ovate in dorsal or ventral view, the width being about five-eighths of the length. The dorso-ventral measurement is about half to two-thirds of the width, so that the animal is dorso-ventrally somewhat depressed. The dorsal line is a uniform curve from the *front* of the head to the *base* of the large *foot joint;* the ventral line is a similar but less convex curve from the *junction of the head and body* to the base of the *toe*, so that the two curves are not symmetrically placed. The lorica is peculiarly unsymmetrical in a dorsal or ventral view, for the posterior part of the body—what I have called the foot joint—is a thick truncate cone lying, not in the middle line, but on the left side, so that the outline of the left side of the body is a uniform curve, while the right side has a great break at the junction of this foot joint and the body (See Fig. 7). The lorica ends in front on the ventral side in a broad notch at the bottom of which is a projecting tooth. There is likewise a slight notch at the anterior dorsal margin.

The toe is a slender pointed rod continuing the curve of the left side of the lorica; it is about four-fifths the length of the body. It is accompanied by three short unequal styles, the longest about one-fifth the length of the toe, the others much shorter. The toe is united to the lorica in such a way that it can be turned to the right and ventrad, but cannot be turned to the left nor dorsad.

The corona consists of the following parts; (*a*) a dorsal and lateral fringe of cilia, forming about two-thirds the circumference of the head; (*b*) at the middle of the dorsal edge a flattened non-setigerons column, truncate at the end; (*c*) ventrad of *b* a similar flattened process, slightly narrower in the middle than at its two ends, and hearing at its free end a pair of minute curved processes. Ventrad and laterad of this are (*d*) a pair of slender, somewhat club-shaped processes, curving ventrad. At either side of the middle of the corona are (*e*) four small papillæ, the two inner of which, at least, bear long setæ. These are partially surrounded by (*f*) an incomplete circle of cilia.

The mastax is oblong, truncate at either end, and not so long as is common in the genus; its circular end appears in a ventral view in front of the broad pectoral notch of the lorica. The internal organs partake of the peculiar asymmetry that appears in the lorica. The stomach is curved and lies to the right of the middle; its walls contain many large spherical light yellowish refractive granules. But one of the small gastric glands is visible in dorsal or ventral view; whether another exists I cannot say. The ovary lies to the left of the stomach, not ventrad of it. The contractile vesicle is large, lying just behind the middle of the lorica. At the posterior end of the body, to the right of the attachment of the toe is another small clear vesicle, pear shaped in form, perhaps also connected with the excretory system. The lateral canals of the left side lie ventrad of the ovary and present three flame cells, one at the side of the posterior end of the mastax, one at the side of the front end of the stomach, and one just in front of the contractile vesicle. The lateral canals of the right side, if there are such, were not observed.

The brain is irregular and ill defined; in the specimen in which it was studied it ended behind in several apparently detached pieces—from one of which a small tube (perhaps representing a dorsal antenna) projected dorsad through the lorica. On the dorsal surface of the main body of the brain is the eye, formed of a large clear sphere imbedded in a deep red cup.

L. St. Clair; common among the algæ near the shore.

Rattulus, Ehrbg.

75. *R. sulcatus*, *n. sp.* (Fig. 8 and 8*a*.)

Body truncate in front, tapering slightly from about the middle to a pointed posterior end; curved so that the dorsal line forms nearly an arc of a circle. Lorica constricted by two deep grooves, passing around it about one-third the length of the animal from the head. The two toes very short, slender, tapering; curved ventrad, often to such an extent as not to be visible in a dorsal view; almost entirely retractile within the lorica. They are a slight distance apart at the base, and incline toward each other so that the distal ends generally touch. A fleshy lobe extends from the dorsal portion of the corona, rectangular in dorsal view, triangular as seen from the side.

The mastax is very large, reaching back nearly to the middle of the body, and is distinctly striated transversely. The trophi are of the type characteristic of this family. The stomach is a simple sac, tapering from the front to the cloaca, granular and often dark green in color; the gastric glands are small and clear. The ovary and contractile vesicle are in the ordinary position.

The brain extends backward nearly to the anterior of the two rings and bears on the ventral snrface of its obtusely pointed posterior end a large red eye.

The species is separated from any described form by the deep constrictions of the lorica and by the short slender toes.

Very common in vegetation from the bottom of L. St. Clair.

Coelopus, Gosse.

76. *C. porcellus*, Gosse.

Pool near shore of Stony L., Oceana Co.; Crooked L., Newaygo Co.; L. St. Clair. Common in algæ.

FAM. 12. DINOCHARIDAE.

Dinocharis, Ehrbg.

77. *D. pocillum*, Ehrbg.

McLaren L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Not uncommon among algæ.

78. *D. tetractis*, Ehrbg.

Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Rather more common in L. St. Clair than the last.

Polychaetus, Perty.

79. *P. subquadratus*, Perty.

L. St. Clair; a single specimen in the surface tow.

This animal has been carefully figured and described by Ternetz (92), which renders unnecessary a further account here. I follow Ternetz in considering *Polychaetus* and *Dinocharis* separate genera.

Scaridium, Ehrbg.

80. *S. longicaudatum*, Ehrbg.

McLaren L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Common in the vegetation of shore and bottom.

81. *S. eudactylotum*, Gosse.

Chippewa L., Mecosta Co., amid Utricularia. One specimen.

Stephanops, Ehrbg.

82. *S. muticus*, Ehrbg.

Pool near Stony L., Oceana Co.; Chippewa L., Mecosta Co.; L. St. Clair. Abundant in the latter lake in Nitella.

FAM. 13. SALPINADAE.

Diaschiza, Gosse.

Numerous species belonging to this genus were observed; all varied from described forms, except the following.

83. *D. semiaperta*, Gosse.

Common in the vegetation of the bottom of L. St. Clair.

Salpina, Ehrbg.

84. *S. brevispina*, Ehrbg.

McLaren L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Abundant in Utricularia and Lemna.

85. *S. ventralis*, Ehrbg.

Chippewa L., Mecosta Co.; L. St. Clair. Abundant in a swampy portion of the lake, containing Spirodela polyrrhiza.

86. *S. macrocera*, *n. sp.* (Figs. 12 and 13.)

This very striking form may be distinguished from any other species by the following combination of characters:

Occipital spines very long and broad, procurved, movably jointed to the lorica; pectorals about half as long; no spines at the posterior end of the lorica.

No other described species is without lumbar and alvine spines and no other is described as having the occipital spines movably jointed to the lorica. These occipital spines are about two-thirds the length of the lorica and are commonly held as shown in the figure (dorsal view), but I have seen them held for a long time *crossed*, and at such an angle sometimes that the crossing took place nearer the lorica than the middle of the length of the spines.

In general form the lorica is depressed and nearly triangular in section —the ventral side of the triangle convex, the other two flat and inclined toward one another so that they would meet above the median dorsal fissure. The posterior end of the lorica is entirely smooth. At the base of the great occipital spines the edge of the lorica projects upward in two small sharp points. Both ends of the lorica have a narrow collar, to the anterior one of which the spines are jointed. Both spines and collar are minutely stippled; the collars are continuous rings—not interrupted at the dorsal gap, like the rest of the lorica. The edges of the lorica are marked on each side by four clear spots at about equal distances apart.

The head is very large and may be protruded far outward and downward between the pectoral spines, the mastax being carried with it, or it may be retracted entirely within the lorica. Its natural position when the animal is at rest is slightly protruded, about as shown in the dorsal view. A dorsal antenna projects between the bases of the occipital spines, and just behind it on the brain lies a large red eye. The foot is long, composed of five to seven joints, and contains two long foot glands; to it are joined two long, tapering toes. The foot may be completely retracted within the lorica.

When not protruded in feeding the mastax lies behind the brain, just in front of the middle of the lorica. The stomach is formed of many lobes and pouches; on either side in front it bears two large gastric glands. The ovary is in the ordinary position. No contractile vesicle could be distinguished.

The animal is slow, rarely swimming freely, but creeping about in the algæ.

Length of lorica, including spines, about .25 mm.

The very distinct and striking characteristics of this form seem to justify its description from a single example.

A single specimen from among Utricularia in a marshy portion of Chippewa L., Mecosta Co.

FAM. 14. EUCHLANIDAE.

Euchlanis, Ehrbg.

87. *E. lyra*, Hudson.

L. St. Clair, among plants from the bottom; few.

This is such a well marked species that I can hardly hesitate to identify my specimens with it, even though they differ from Hudson's description in one marked particular—there is a distinct though shallow notch in the posterior edge of the dorsal plate of the lorica. In other respects the agreement is complete.

88. *E. dilatata*, Ehrbg.

West Twin L., Muskegon Co.; White L., Muskegon Co.; pool near shore of Stony L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Common in the vegetation of the bottom and shores.

89. *E. deflexa*, Gosse.

Chippewa L., Mecosta Co.; L. St. Clair, in Chara from the bottom.

90. *E. triquetra*, Ehrbg.

McLaren L., Oceana Co.; Chippewa L., Mecosta Co.; L. St. Clair, in the vegetation of the shores and bottom.

91. *E. oropha*, Gosse.

L. St. Clair; several specimens in the bottom tow, a mile and a half from shore.

92. *E. parva* Rousselet (92).

L. St. Clair; common in the vegetation of the shores and bottom.

FAM. 15. CATHYPNADAE.

Cathypna, Gosse.

93. *C. luna*, Ehrbg.

McLaren L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Very common.

94. *C. ungulata*, Gosse.

L. St. Clair; not rare among algæ of the shore, especially common in Vaucheria.

95. *C. leontina*, Turner (92).

This is a large species, of about the same size as *C. ungulata*, the total length being .30 mm., the whole length of the lorica, .20 mm. The form of the lorica is that of the other species of *Cathypna*, almost exactly that of *C. luna*, except that the posterior end extends in a broad quadrate plate over the foot. A further specific distinction is found in the toes, which are very long (the total length being .11 mm.), narrow and straight; each ends in a distinct claw on the inner side and a minute point on the outer side.

L. St. Clair; not abundant, yet not especially rare in Vaucheria and other algæ near the shore.

Distyla, Eckstein.

96. *D. Ludwigii*, Eckstein.

L. St. Clair, in Vaucheria from swampy shores; rare.

97. *D. ohioensis*, Herrick (85).

Crooked L., Newaygo Co.; L. St. Clair. Not uncommon in Chara and Vaucheria of the shores.

98. *D. Stokesii*, Pell (90).
(*Cathypna Stokesii*, Pell.)

Chippewa L., Mecosta Co.; L. St. Clair, in Utricularia and Vaucheria.

This by its general form seems to me to belong unquestionably rather to *Distyla* than *Cathypna*.

There are other species of *Distyla* to be found in the algæ of our lakes, differing from each other and from various described forms in characters often minute—demanding more time to separate and determine them than I have had at command.

Monostyla, Ehrbg.

99. *M. lunaris*, Ehrbg.

West Twin L., Muskegon Co.; pool near shore of Stony L., Oceana Co.; McLaren L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Very common in algæ of the bottom and shores.

100. *M. cornuta*, Ehrbg.

West Twin L., Muskegon Co.; White L., Muskegon Co.; L. St. Clair. In bottom and shore vegetation.

101. *M. bulla*, Gosse.

McLaren L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Common with the last.

102. *M. quadridentata*, Ehrbg.

Crooked L., Newaygo Co.; L. St. Clair. Common in the bottom and shore vegetation.

103. *M. mollis*, Gosse.

L. St. Clair; swampy shore, amid Spirodela polyrrhiza.

104. *M. closterocerca*, Schmarda. (?) (Fig. 9.)

Not uncommon in Vaucheria and other algæ from the bottom of L. St. Clair.

As shown in the figure the general form is similar to that of *M. lunaris*, the lorica being perhaps slightly longer in proportion to the breadth. The characteristic point is the broadly spindle shaped foot, bearing a short claw at the end. As this is also the characteristic feature in Schmarda's *M. closterocerca*, my specimens are probably identical with his; some minor disagreements being due to the general inaccuracy and incompleteness of Schmarda's work. Thus the form of the foot is not exactly the same as will be seen by comparing the two figures; the eye is not "very small" for an animal of this size, and of course the trophi are not "triangular maxillæ"—though by dividing the mastax lengthwise they might easily be imagined to be such, as they might in almost any *Monostyla*.

Fam. 16. COLURIDAE.

Colurus, Ehrbg.

Species of this genus are abundant, but most differ in minute characters from described forms; I give herewith the only one which I observed to show perfect agreement with a described form.

105. *C. bicuspidatus*, Ehrbg.

Chippewa L., Mecosta Co., in Utricularia.

Metopidia, Ehrbg.

106. *M. lepadella*, Ehrbg.

McLaren L., Oceana Co.; L. St. Clair. Very abundant.

107. *M. acuminata*, Ehrbg.

Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. In the vegetation of the shores and bottom, not uncommon in L. St. Clair.

108. *M. rhomboides*, Gosse.

Chippewa L., Mecosta Co.; a single specimen in Utricularia.

109. *M. bractea*, Ehrbg.

McLaren L., Oceana Co.; L. St. Clair.

110. *M. triptera*, Ehrbg.

Pool near shore of Stony L., Oceana Co.; McLaren L., Oceana Co.; Crooked L., Newaygo Co.; L. St. Clair. Abundant in water from about the St. Clair Flats.

111. *M. Ehrenbergii*, Perty (52).

SYN.—*Notogonia Ehrenbergii*, Perty (52); *Metopidia angulata*, Anderson (89); *M. Notogonia*, Ternetz (92).

McLaren L., Oceana C.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. In algæ near the shores; rare.

Cochleare, Gosse.

112. *C. turbo*, Gosse.

Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. In shore vegetation; rare.

FAM. 17. PTERODINADAE.

Pterodina, Ehrbg.

113. *P. patina*, Ehrbg.

McLaren L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. Common among the plants of the shores.

In L. St. Clair I found a form like *P. patina* but smaller, the length of the lorica being .158 mm.; the dorsal plate has a rounded projection in front, forming an arc of about 120 degrees—like that of *P. intermedia*, Anderson (89) but not so marked.

114. *P. reflexa*, Gosse.

McLaren L., Oceana Co.; Crooked L., Newaygo Co.; Chippewa L., Mecosta Co.; L. St. Clair. One of the commonest of the Rotifera in the vegetation of the shores.

115. *P. bidentata* Ternetz (92). *P. emarginata*, Wierzejski (92*a*).

L. St. Clair; in Nitella from near the shore. The animals were abundant in this one gathering; otherwise I have never seen them.

Which of the two names given above has the priority, I am not able to say.

FAM. 18. BRACHIONIDAE.

Brachionus, Ehrbg.

116. *B. Bakeri*, Ehrbg.

Chippewa L., Mecosta Co.; L. St. Clair. A variety with very long lateral spines behind; also, there are *three* teeth or small spines about the foot orifice, one dorsal and two lateral.

117. *B. militaris*, Ehrbg.

L. St. Clair; rather common among the plants along the shore.

Noteus, Ehrbg.

118. *N. quadricornis*, Ehrbg.

Chippewa L., Mecosta Co.; L. St. Clair, in Lemna and Utricularia near the shore.

FAM. 19. ANURAEADAE.

Anuraea, Gosse.

119. *A. aculeata*, Ehrbg.

Four empty loricas, in surface towings from L. St. Clair. A single living specimen from Whitmore L., Washtenaw and Livingston counties.

120. *A. serrulata*, Ehrbg.

L. St. Clair, in Nitella from near the shore; few.

121. *A. cochlearis*, Gosse.

McLaren L., Oceana Co.; Crooked L., Newaygo C.; Chippewa L., Mecosta Co.; L. St. Clair. One of the most abundant of the Rotifera in towings from the latter lake.

Notholca, Gosse.

122. *N. longispina*, Kellicott.

Chippewa L., Mecosta Co.; a single specimen. In L. St. Clair, very abundant in towings; a few in towings from Whitmore L., Washtenaw and Livingston counties.

Of the 122 rotifers named in the list, 110 are found in L. St. Clair, while 12 were found in the smaller inland lakes and not in L. St. Clair. Forty-nine were found in L. St. Clair and not elsewhere; sixty-one were noted both in L. St. Clair and in other lakes.

As to the distribution within the lakes, detailed observations were made only on L. St. Clair. Here the species may be separated with some distinctness into two classes; (1) strongly swimming forms, commonly found in the open water at a distance from shore; (2) littoral or bottom forms, which are found among the vegetation of the shores and bottom. The first may be conveniently designated as pelagic, the second as littoral. It is to be noted that the pelagic rotifers are to be found also with the others amid the vegetation of the bottom and near the shores, except in swampy places. The littoral species also are not confined to the region of the shore, but owing perhaps to the shallowness of L. St. Clair, are many of them to be found among the plants of the bottom in almost any part of the lake; they are not however to be found like the pelagic species, swimming freely in the open water or near the surface.

Of the 110 named species from L. St. Clair, nineteen may be distinguished as pelagic; to these may be added an undetermined species of *Synchaeta*; so that the total number of pelagic species observed in L. St. Clair is twenty. These are the following:

Floscularia mutabilis, Bolton.
Floscularia pelagica, Rousselet.
Apsilus lentiformis, Metschn. (young.)
Conochilus volvox, Ehrbg.
Conochilus unicornis, Rousselet.
Asplanchna priodonta, Gosse.
Asplanchna Herrickii, DeGuerne.
Ascomorpha hyalina, Kellicott.
Anapus ovalis, Bergendal, Chromogaster testudo, Lauterborn.
Synchaeta stylata, Wierzejski.
Synchaeta (species undetermined).
Polyarthra platyptera, Ehrbg.
Ploesoma lynceus, Ehrbg.
Ploesoma Hudsoni, Imhof.
Notops pygmaeus, Calman.
Notommata monopus, n. sp.
Mastigocerca capucina, Wierz. and Zach.
Anuraea aculeata, Ehrbg.
Anuraea cochlearis, Gosse.
Notholca longispina, Kellicott.

The most abundant pelagic species are Polyarthra platyptera, Ehrbg., Anuraea cochlearis, Gosse, and Asplanchna priodonta Gosse, so that in this respect there is a general agreement with the condition found in European lakes. These three species occur in great numbers and their presence is almost constant in towings taken at a considerable distance from shore. Little less abundant are Notholca longispina, Kellicott, Synchaeta stylata, Wierz., Notops pygmaeus, Calman, Ploesoma lynceus, Ehrbg., and Anapus ovalis, Bergendal (Chromogaster testudo, Lauterborn).

The remainder are less frequent. Ascomorpha hyalina, Kellicott, and Mastigocerca capucina, Wierz. and Zach. were each observed but once in the towings; Anuraea aculeata, Ehrbg., is admitted to the list only on the strength of the occurrence of four empty loricas in the tow; the living animal was not seen at all. A noteworthy circumstance is the occurrence of young specimens of Apsilus lentiformis, Metsch.; these were met several times though the adult attached form was never seen. A single dead specimen of Polychaetus subquadratus, Perty—the only specimen seen—was taken in one of the surface towings, but this is hardly sufficient data for giving this as a pelagic form. The undetermined species of Synchaeta is not S. pectinata, and probably not S. tremula; it is a very small species and is rare, so that I did not study it.

The remaining ninety-one species from L. St. Clair may be classified as littoral or bottom forms; regarding their distribution the accounts of the different species may be consulted.

In so far as it is possible to judge from my incomplete studies of the inland lakes (those not in direct connection with the Great Lakes) their littoral Rotatorial fauna is identical with that of L. St. Clair.

The pelagic rotifers of the inland lakes were not studied, except in the case of Whitmore Lake, in Washtenaw and Livingston counties. Here some towings were taken in the spring of 1894, for comparison with the condition found in L. St. Clair. Whitmore L. is a small inland lake, about two miles long and one mile wide, with a greatest depth of about fifty-five feet. The water is very clear, the bottom of sand or gravel, and at the time the towings were taken, almost entirely without bottom vegetation. It is unconnected with the Great Lakes, and indeed has no visible inlet or outlet. In this lake the following pelagic rotifers were found:

Ascomorpha ecaudis, Perty; a single specimen.
Ascomorpha hyalina, Kellicott; rather numerous.
Synchaeta pectinata, Ehrbg.; very abundant.
Synchaeta (species undetermined, the same as in L. St. Clair); few.
Polyarthra platyptera, Ehrbg.; few.
Notops pygmaeus, Calman; very abundant.
Anuraea aculeata, Ehrbg.; a single specimen.
Notholca longispina, Kellicott; few.

Leaving out of account the perhaps accidental occurrence of the single specimen of Ascomorpha ecaudis, Perty, this list, as far as it goes, contains the same species as that for L. St. Clair, with one peculiar exception. In place of the very abundant Synchaeta stylata, Wierz. of L. St. Clair, there is found here in equal abundance the common European species Synchaeta pectinata, Ehrbg. What may be the meaning of this peculiar variation I am unable to indicate; it will be interesting to observe whether this distinction between the Great Lakes and the inland lakes is maintained throughout, or whether this is only an isolated case, or whether again the difference in the time of the year in which the towings were taken has any connection with the variation.

Distinctively pelagic rotifers were met accidentally also in some of the other inland lakes; I have recorded the occurrence of Conochilus volvox, Ehrbg.; Ploesoma lynceus, Ehrbg., Polyarthra platyptera, Ehrbg., Anuraea cochlearis, Gosse, and Notholca longispina, Kellicott, in Chippewa L., Mecosta Co.; of Ploesoma lynceus, Ehrbg. and Anuraea cochlearis, Gosse, in Crooked L., Newaygo Co.; and of Anuraea cochlearis, Gosse, in McLaren L., Oceana Co. As the tow net was not used in these lakes, lack of observation of other species does not indicate their absence.

A circumstance worthy of note is the fact that Lacinularia socialis, Ehrbg. and Hydatina senta, Ehrbg., two of the commonest rotifers almost everywhere, according to all reports, were never observed in any of the waters examined by me. Both however have been reported from Michigan by Kellicott (88), though not as lacustrine.

It may be well, in order to facilitate reference, to give here a list of the new species described in this paper, with their numbers in the text. These are the following:

Notops laurentinus. (38.)
Notommata monopus. (53.)
Notommata truncata. (54.)
Mastigocerca lata. (74.)
Rattulus sulcatus. (75.)
Salpina macrocera. (86.)

Morphological Laboratory,
University of Michigan,
April 23, 1894.

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Journ. Quekett Micr. Club, Vol. 4, p. 367.

93. On Floscularia pelagica, sp. n., and notes on several other Rotifers.
Journ. Roy. Micr. Soc., Aug., 1893.

TERNETZ, CARL.

92. Rotatorien der Umgebung Basels.
Basel, 1892.

THORPE, V. GUNSON.

91. New and foreign Rotifera.
Journ. Roy. Micr. Soc., 1891, pp. 301-306.

TURNER, C. H.

92. Notes upon Cladocera, Copepoda, Ostracoda and Rotifera of Cincinnati, with descriptions of new species.
Bulletin of the scientific laboratories of Denison University, Vol. 6. Part 2. 1892.

VORCE, C. M.

87. Gomphogaster areolatus.
Proc. Amer. Soc. Micr., 1887.

WESTERN, G.

91. On Lacinularia and a new Rotifer from Guildford.
Journ. Quekett Micr. Club, Jan. 1891, Vol. 4, p. 254.

WIERZEJSKI, A.

92. Zur Kenntnis der Asplanchna-Arten.
Zool. Anz., Bd. 15, p. 345.

92*a*. Rotatoria (Wrotki) Galicyi.
Akademie d. Wiss. in Krakau, 1892.

93. **Under Synchaeta stylata (No. 36) the above paper (92a) is cited as Wierzejski (93), the reprint having appeared in 1893.**

WIERZEJSKI UND ZACHARIAS.

93. Neue Rotatorien des Süsswassers.
Zeitschrf. f. wiss. Zool., Bd. 56, 1893.

ZACHARIAS, O.

93. Forschungsberichte aus der Biol. Station zu Plön. I Theil. 1893.

94. Ibid. II Theil. 1894.

Of these papers, that referred to under Perty (50) I have not seen; the others I have had at hand.

EXPLANATION OF THE FIGURES.

The following abbreviations are common to several of the figures:

br.=brain.
cv.=contractile vesicle.
da.=dorsal antenna.
e.=eye.
fg.=foot gland.
gg.=gastric gland.
la.=lateral antenna.
lc.=lateral canal.
m.=muscle.
mx.=mastax.
ov=ovary.
tr.=trophi.

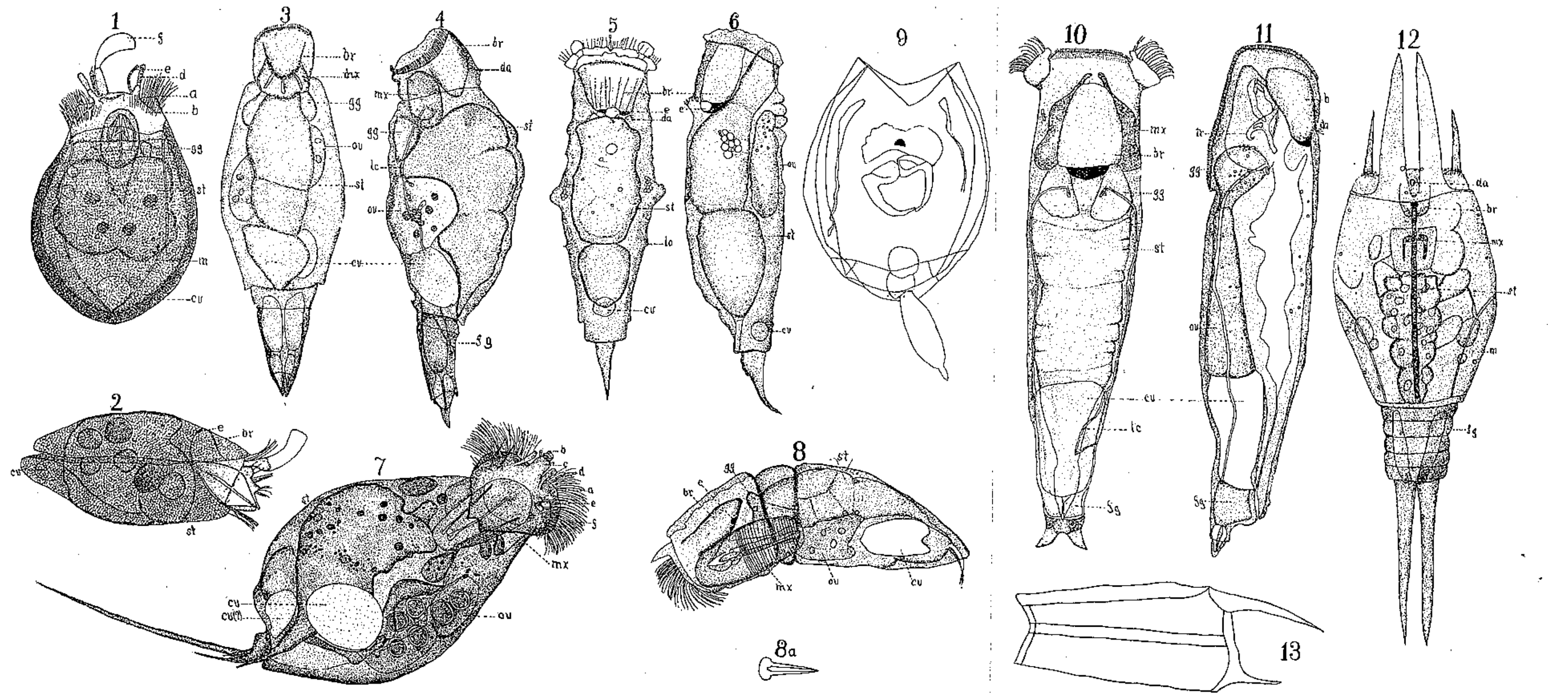
For explanation of the lettering of the corona in figures 1 and 7, see the description of those forms in the text.

PLATES 1 AND 2.

Through an error the two plates have been combined into one.

Fig. 1. Anapus ovalis, Bergendal—Chromogaster testudo, Lauterborn, ventral view.
Fig. 2. The same, side view.
Fig. 3. Notops laurentinus, n. sp. dorsal view.
Fig. 4. " " side view.
Fig. 5. Notommata monopus, n. sp., dorsal view.
Fig. 6. " " side view.
Fig. 7. Mastigocerca lata, n. sp., ventral view.
Fig. 8. Rattulus sulcatus, n. sp., side view.
Fig. 8*a*. " " ventral view of toes.
Fig. 9. Monostyla closterocerca, Schmarda (?), ventral view.
Fig. 10. Notommata truncata, n. sp., dorsal view.
Fig. 11. " " side view.
Fig. 12. Salpina macrocera, n. sp., dorsal view.
Fig. 13. " " side view of lorica.

Figs. 1, 2, 7, 8, 8*a*, and 9 with camera lucida; the others free-hand. The drawings were made in pencil by the author; they were afterward enlarged by the aid of the pantagraph and inked by Mr. J. I. Conklin. From these enlargements the photographic reproductions were made.



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ERRATA.

p. 1, line, 12, for *have* read *had*.
p. 17, line 6, for *these* read *the species observed in Lake St. Clair.*
" " line 21, for *etoro* read *stave*.
p. 28, § 3, line 8, second word from end of line for water read *plankton*.
p. 59, in the table, column 3, for 19.25 read 19.55.

Bulletin of the Michigan Fish Commission

No 4

A BIOLOGICAL EXAMINATION OF LAKE ST CLAIR

PRELIMINARY ACCOUNT OF WORK DONE DURING THE SUMMER OF 1893 BY THE PARTY MAINTAINED BY THE MICHIGAN FISH COMMISSION

BY J E REIGHARD

WITH THE FOLLOWING APPENDICES

LANSING
ROBERT SMITH & CO STATE PRINTERS AND BINDERS
1894

A BIOLOGICAL EXAMINATION OF LAKE ST. CLAIR.

PRELIMINARY ACCOUNT OF WORK DONE DURING THE SUMMER OF 1893 BY THE PARTY MAINTAINED BY THE MICHIGAN FISH COMMISSION.

In an undertaking like the present one, in which it is proposed to devote public funds to the prosecution of what might appear to be a purely scientific enterprise, it may be reasonably expected that some justification be offered for such a course. The following quotation from an address made by the writer before the International Fisheries Conference at Chicago, in October, 1893, is believed to meet this expectation:

"The history of the whitefish industry of the Great Lakes is well known to the members of this conference. It is presumably the history of a diminishing production in spite of a very large annual outlay for artificial propagation. The enthusiasm with which the fish culturists of twenty years back undertook the restocking of the Great Lakes was born of success in many similar enterprises. Trout and shad have been made to swarm in depleted waters. Similar results were therefore to be expected in the application of similar methods to the Great Lakes. These expectations have not been realized and fish culturists are casting about for an explanation.

"On the one hand it is asserted that the expected increase in the yield of whitefish has not been realized because of the destructive methods of fishing. The ravages of the pound net, it is said, are more than sufficient to wipe out the gain due to artificial propagation. It is maintained that if fishing methods were properly regulated the results of artificial breeding would at once make themselves felt and that, while the planting of whitefish has not resulted in increasing the supply of adult fish, it has prevented any large reduction in that supply, so that many grounds, which now pay for the fishing, would have been utterly exhausted but for artificial propagation. The remedy for the present condition of things is believed to lie both in legislation controlling fishing methods, and in a still greater extension of artificial propagation.

"On the other hand, it is claimed that if the artificial propagation of whitefish were successful, it should result in an increasing yield in spite of existing methods of fishing. The remedy does not lie in restrictive legislation; it lies rather in an increasing of the effectiveness of methods of artificial propagation and perhaps also in an increase of the annual output of artificially hatched fish.

"The first view is held for the most part by fish culturists, who favor restrictive legislation and increased facilities for artificial propagation.

"The second view is held for the most part by fishermen, many of whom are not yet convinced of the value of artificial propagation.

"When one who is neither fish culturist nor fisherman attempts to discover the grounds upon which the various opinions are based, he very soon finds that there are but few recorded facts.

"In order to know whether the number of whitefish is increasing or diminishing for any locality or for all localities, it is necessary to have statistics extending over a term of years. Statements based on statistics which are taken in two years separated by an interval of five or ten years, are nearly valueless for purposes of comparison for the reason that such statistics do not and cannot take into account the climatic conditions which make one year favorable and another year unfavorable. The fact that in the year 1880 the number of whitefish marketed was greater than in 1890, does not prove that the number of whitefish has diminished in this interval; it proves only that the number *caught* in 1890 was less than the number *caught* in 1880. This may have been due to a diminution in the number of fish, but it may also have been due to storms during the fishing season of 1890. Statistics to be conclusive should enable us to compare the *average* yield for the ten years 1870 to 1880 with the average yield for the ten years 1880 to 1890.

"No such continuous series of statistics is in existence, so that the assertions concerning a diminishing yield of whitefish rest either on a comparison of these statistics of isolated years or on the statements of fishermen concerning certain localities.

"If we inquire into the facts concerning the sufficiency of the present methods of artificial propagation, we find that so far as concerns the whitefish there is no question as to the success of the earlier stages of the process. Several hundred million ova are taken annually and placed in the hatcheries and of these usually from 80 to 90 per cent are hatched and placed in the waters of the Great Lakes—165,000,000 in Lake Erie alone in 1888.

"This is very nearly all that is known about these young whitefish. About their food habits we know only that in captivity that they eat certain species of Crustacea. Whether in their natural habitat they eat other animals in addition to these Crustacea or in preference to them we do not know. It is uncertain at what age they begin to take food or how much they require. We do not know their natural enemies. We do not know whether they thrive best in running water or in standing water, in shallow water or in deep water, whether at the surface or near the bottom. What changes of habitat or of food habits the fish undergo as they grow older is a still deeper mystery.

"Our problem is to place young whitefish in the Great Lakes under such conditions that as large a number as possible of them shall grow into adult fish. It is clear that of one of the elements in this problem namely, the whitefish, we know but little.

"What, then, do we know of the other elements of the problem, the Great Lakes themselves? Individual naturalists have made efforts from time to

time to study one or another of the groups of animals living in the lakes. These efforts have always been circumscribed by the facilities at hand, by the time that could be devoted to the subject, by the small area examined, or by the small number of animals taken into account. Although much excellent work has resulted from these efforts it remains true that there has been thus far no attempt to secure an accurate knowledge of all the conditions existing in any one locality, and no attempt to study exhaustively a single group of the animals and plants of the lakes. We are still at the beginning so far as concerns a knowledge of life conditions in these lakes, the conditions with which we surround our young whitefish. If we could assume that the conditions are uniform over the whole area of the Great Lakes, then since the young whitefish are native to these lakes, it might be a safe conclusion that they will find the conditions in one locality as well for them as in another. But there are no facts which support the view that the conditions are uniform over the lakes.

"We are thus in the position of bringing together under unknown conditions, two things, both of unknown character; and we expect as a result to get a third thing, marketable whitefish. Should we not pursue our object more intelligently by first determining the characteristics of the materials with which we have to work? It was with this object in view that the Michigan Fish Commission in the summer of 1893 established a scientific laboratory on Lake St. Clair. This lake is readily accessible from the Detroit hatchery at the season when whitefish are planted. Whitefish are caught in certain parts of the lake in considerable numbers in the spawning season, so that it is probable that spawning grounds of this fish are found along the west shore of the lake near its outlet. In establishing a laboratory on the lake, the Fish Commission hoped, therefore, to accomplish two things.

"(1) To study carefully and in the broadest possible way the life of the lake. After examining the physical characteristics of the lake, such as the color, transparency and chemistry of the water, a study of this sort should include a determination of the kinds of animals and plants in the lake. Every species should be sought out, carefully described and figured, and a specimen of it preserved. Then the habits of each species should be known, its habitat, its food, its enemies and its parasites. The numbers of animals and plants of each species in a given volume of water should be determined and the variations in these numbers iu different parts of the lake and at different seasons of the year. Such a collection of data would form a complete picture of the biology of the lake.

"(2) It was hoped that young whitefish might be captured in the lake by suitably arranged nets, and that it might thus be possible to determine the food habits of the young fish, and the other conditions under which they are found in nature.

"Should both these objects be accomplished, we should be in a position to determine where in the Great Lakes are to be found the conditions favorable to the whitefish fry."

An enterprise of this sort cannot, of course, be carried very far in a single season. No very large body of facts can be collected in so short a time, nor has it been possible in the six months since the close of the season, to thoroughly work over the data at hand, so as to get out of them all the conclusions which they may be supposed to yield.

The following report is therefore preliminary. Effective fish culture and the regulation of the fishing industries of the lakes, must depend upon a *complete* knowledge of the life of these lakes and of the physical conditions that encompass and maintain that life. To acquire this knowledge is a labor of many men and of many years. He is the most successful farmer who knows the value of different sorts of soil and how to fertilize them most economically, who knows how and where and in what quantities his seeds should be planted, who knows when and how and with what apparatus his crops should be gathered, who knows what food should be fed to his stock and in what quantity. The fisherman is almost wholly ignorant of the corresponding facts in his own calling. Of his soil—the lake—he knows but little, that it could be fertilized has not occurred to him, he never plants, while the planting that is done for him is at random and without knowledge of the soil upon which the seeds fall; he reaps continuously without restraint and with every possible form of deadly apparatus. The remedy for all this, the only remedy is, I believe, untramelled and extended investigation of the lakes from every point of view. It was with the purpose of carrying on such an investigation that an examination of Lake St. Clair was undertaken.

EQUIPMENT AND METHODS.

A laboratory was located at New Baltimore, near the head of Anchor Bay which is the northeastern part of Lake St. Clair. Through the kindness of Mr. Gilbert Hatheway, the party had the use of the second story of a large warehouse situated on his pier. By the use of temporary sheathing of heavy paper this was transformed into a comfortable room. Four large and very rigid laboratory tables, especially designed for their portability, were placed at the windows and accommodated two workers each. The spaces on the wall were filled with temporary shelving for books and apparatus and two large tables were provided for general work. At one of the windows was placed a large zinc topped table arranged to hold a dozen small aquaria to which running water was supplied from a tank outside the building. On the wharf without was erected a shed which sheltered three large aquaria supplied with water from a special tank. In these aquaria the largest fish of the lake could be kept under observation.

The laboratory was supplied with small boats. For more extended trips and for use with the heavier collecting apparatus there was a small steamer, the Ben Hur of Detroit, a boat of about ten tons burden. She has a very roomy cabin and was found to serve every purpose admirably.

A considerable collection of pertinent literature, as well as microscopes and the other usual laboratory apparatus, was loaned by the University of Michigan. A liberal supply of the usual glassware and reagents and of the minor apparatus was provided by the Fish Commission. The collecting apparatus included the usual hand nets, tow nets and dredges. Besides these there were some forms of nets not in common use. The ordinary form of deep sea dredge was found to slip over the hard clay bottom or over the thick matting of Characeæ which covers this bottom, so that it usually came up empty. In its place was used a dredge made as follows: An iron band 2 inches broad, $\frac{5}{8}$ of an inch thick and 4 feet 6 inches long is cut along one edge into a row of triangular teeth each an inch broad and an inch high. These teeth are sharpened and bent so as to form an angle of about 15 degrees with the rest of the band, which is provided with holes into which a net may be laced. The band is then bent on the broad side into the form of an equilateral triangle with the teeth inclined outward.

In each angle is welded a stout ring for the dredge rope, and also an iron rod $2\frac{1}{2}$ feet long which projects at right angles to the plane of the triangle and from the edge of the band opposite the teeth. A flat net of inch mesh is supended from the triangle and its bottom is lined for about a foot with coarse cotton cloth. The whole net frame has thus the form of a triangular prism and when dragged along the bottom always rests upon one side, so that the teeth at the edge of the frame act with great effectiveness in loosening objects imbedded in the hard clay bottom. This net is modeled from one exhibited among the apparatus of the Plankton Expedition in the German University Exhibit at the World's Fair.

Another piece of apparatus of great value is the net designed by Prof. E. A. Birge for collecting Cladocera, described in Trans. Wis. Acad., vol. viii, 1891. It is indispensable on weedy bottoms or shores.

It is well known that the ordinary tow net when weighted so as to be used on the bottom either runs at an unknown distance from the bottom, or if it reaches the bottom fouls in the weeds or fills with mud or sand. We therefore make use of the tow net supported on four flat iron runners which are welded to the iron net ring. These runners extend for about 30 inches at right angles to the plane of the net ring and are then bent toward one another and riveted together at a point opposite the center of the net ring and three feet from it. The net thus hangs within the frame formed by the runners and its mouth is held about two inches from the bottom. This proved an excellent device for collecting bottom forms free from weeds or mud.

For quantitative work we used a vertical net which is more fully described in another place.

Six persons worked in the laboratory from July 15 to Sept. 15. They were:

Prof. J. E. Reighard, director; quantitative work, Crustacea and vertebrates.

Dr. H. B. Ward, associate professor of zoölogy, University of Nebraska, Lincoln, Neb.; worms.

Mr. Frank Smith, instructor in zoölogy, University of Illinois, Champaign, Ill.; Protozoa and Mollusca.

Dr. Robert H. Wolcott, Ann Arbor, Michigan; Insecta and Hydrachnida.

Mr. H. S. Jennings, assistant in animal morphology, University of Michigan; Rotatoria, sponges, and Bryozoa.

Mr. A. J. Pieters, assistant in botany, University of Michigan; plants.

Two employès of the Fish Commission, Mr. Dwight Lydell and Mr. Jesse P. Marks, rendered valuable service in collecting, fishing, and in otherwise furthering the interests of the laboratory.

Each person had charge of that portion of the subject set opposite his name. These gentlemen worked enthusiastically and without compensation, in the interest of science, so that whatever results have been reached are largely due to their unselfish devotion.

In addition to the work which has been done by the laboratory staff, the following gentlemen have undertaken to work up the groups set opposite the names.

Dr. R. Blanchard, Paris, France; the leeches.

Dr. E. A. Birge, University of Wisconsin; the Cladocera.

Dr. G. Eisen, San Francisco; the Oligochæta.

Prof. C. Dwight Marsh, Ripon, Wis.; the Copepoda.

Dr. W. M. Woodworth, Harvard University, Cambridge, Mass.; the planarians.

Mr. Bryant Walker, Detroit, has identified most of the Mollusca.

Aid has also been received in the identification of the Characeæ from Dr. T. F. Allen of New York City, and in the Desmidaceæ and unicellular algæ from Mr. L. N. Johnson of the botanical department of the University of Michigan.

The first six weeks were spent in qualitative work, that is in making a list of the animals and plants of the lake, in noting their habits and the way in which they were associated, and in preserving specimens, drawings and records of observations. Every morning and frequently again in the afternoon a man was sent out into the bay with the different sorts of nets. With the tow nets were obtained the smaller animals and plants floating in the water, at the surface, in mid-water, and near the bottom. The forms attached to the bottom or concealed among the water plants were collected by means of the toothed dredge and the Birge net. Collections were also made near the shore with the same apparatus. All the materials were brought to the laboratory and were ready for examination upon the arrival of the laboratory force. Each worker then sorted out from the collection the materials belonging to him. This method of working was kept up until it was felt that all the inhabitants of the lake, except possibly a few rare or occasional ones had become familiar. The living specimens were studied in all cases and material was preserved for future study. Final identifications were attempted only in the cases where the original literature in the laboratory was ample for the purpose.

At the same time that collections were being made of the smaller inhabitants of the lake, gill nets were set for the capture of fish, while other fish were purchased from the fyke-net fishermen who landed their catch every day at the laboratory dock. The stomachs of several hundred of these fish were examined and the contents preserved with the purpose of determining the food habits of the fish. At the same time the fish were systematically searched for parasites and many important biological data were collected concerning these forms. A more detailed report on them is in preparation by Dr. Ward.

In order to keep a continuous and systematic record of the material examined, use was made of blank forms in which each person entered the species observed by him. These blanks are of two sorts, one intended to give the more important data concerning the individual animals and plants, and the other intended to show how these animals and plants are associated together under different conditions. The following is a sample of what may be called the individual blank:

NAME *Sida crystallina O. F. M.*

No. .... Drawing .... Specimen .... Notes ....

Locality *middle of Anchor Bay.*

Habitat

Pelagic .... Depth ....

Littoral .... " .... Bottom .... Vegetation ....

Bottom *×* " *13 ft* " *clay* " *Characeae*

Food *Dinobryon, Diatoms, shells of both in excreta.*

Abundance *moderate.*

Breeding Habits { *♀♀ with embryos & larvae in brood sac.* / *♂♂ not found.*

Remarks *Greenish transparent color noteworthy. The grinding surface of mandibles suggests crushing of diatoms.*

Date *Aug 11/93* Hour *7 a.m.* Signt. *J. E. Reighard*

This blank gives the results of the observations of a single day on a single species of Sida, the name of which appears at the top of the card. Whenever this same species was observed under different circumstances a new card was made for it. By sorting out all the cards referring to a single species, one has at hand in condensed form all the facts recorded concerning it.

These blanks did not take the place of note books, but were meant merely to condense and systematize the records made in the note books.

The other form of blank may be called the *collective* blank. A sample of it appears below. It is a modification of a form used at Mr. Agassiz's Newport laboratory.

No. 22 RECORD OF COLLECTIONS.

Made at New Baltimore – 3 miles N. E. of dock.
Tow at ~~bottom~~ Dredged at 11 ft. on weedy bottom
With wire dredge ~~net~~, along shore
Jan. Feb. Mar. Apr. May. June. July. Aug. Sept. Oct. Nov. Dec. | 9:45 A.M.
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 18, 19, 20,
21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31. 189 ... P.M.
Water: rough, Wind: south, Sky: clear
Temp. air: 72° F., Temp. water: 68° F., Barometer: —
Remarks: This tow was taken with Birge net attached to small wire dredge.

D. Lydell. Observer.

NAME.	Very Many	Many	Scarce	NAME.	Very Many	Many	Scarce
Chara contraria A. Br.	×			Notops [laurentinus, n. sp.] 140			×
Naias flexilis L.	×			Nais elinguis O. F. M.			×
Elodea canadensis Michx			×	Planaria maculata Leidy			×
Nitzschia sigmoidea (Nitzsch)			×	Stentor 1	×		
Pediastrum boryanum (Turp.)			×	Ceratium longicorne Perty			×
Pleurosigma strigilis S.			×	Difflugia globosa Duj.			×
Tabellaria flocculosa (Roth)			×	Vorticella campanula Ehrbg		×	
Hydra grisea L.		×		Camptocercus macrurus O. F. M.	×		
Hydra viridis L.			×	Ostracoda		×	
Notops pygmaeus Calman		×		Sida crystallina O. F. M.		×	
Anuraea cochlearis Gosse.	×			Bosmina longirostris Müll	×		
Euchlanis deflexa Gosse.		×		Hyalella dentata Smith.	×		
Monostyla lunaris Ehrbg.			×	Cyclops juv.			×
Monostyla closterocerca Schm (?)		×		Cyclops serrulatus Fischer.			×
Metopidia lepadella Ehrbg.			×	Atax crassipes Müll.		×	
Metopidia acuminata Ehrbg			×	Nesaea n. sp. 1.			×
Polyarthra platyptera Ehrbg.	×			Baetis sp. nymphs 38		×	
Conochilus volvox Ehrbg.			×	Chironomus larvae 62		×	
Philodina citrina Ehrbg.			×	Valvata tricarinata Say	×		
Rotifer vulgaris Schrank.			×	Physa heterostropha Say		×	
Noteus quadricornis Ehrbg.			×	Planorbis parvus Say			×
Synchaeta 128			×	Goniobasis livescens Menke			×

The blank given enumerates only a part of the haul of that number and date; but forty-four out of seventy-six entries recorded in the original have been reproduced here. Without being selected to present an average of the hauls, it is still a fair sample of the record. The numbers appended to the name of a genus refer to the note-book of the investigator who made the record and mark a species which is either new or not yet identified.

Blanks of this form were passed from one worker to another and each person entered in them the forms which he had found as taken in a certain net at a certain time and in a certain location. The blanks thus serve to show the way in which the forms are associated together and their relative numbers under different conditions at different times. To properly fill one of these blanks was usually the work of six observers for the greater part of a day.

For the records of parasites there was a third form of blank designed by Dr. Ward, and shown in the report on the parasites, contained in the appendix. It is intended to bring together certain data concerning the animal infected and the numbers and kinds of parasites.

A similar record was kept of the contents of the fish stomachs, but no special blank was used for this purpose. It is desirable to use a blank for this also.

Detailed reports are now in preparation by the various members of the laboratory staff and by others who have undertaken to work up special subjects. The report on the plants and that on the Rotatoria have been published as Bulletins of the Michigan Fish Commission. Other reports of similar scope will be published as soon as completed. Some which are briefer or preliminary in character are appended to this paper.

STATEMENT OF RESULTS.

Lake St. Clair stretches from 42° 18′ to 42° 42′ north latitude and from 82° 25′ to 82° 55′ west longitude and lies at an elevation of about 580 feet above the sea. It has roughly the form (see map at end of report) of an equilateral triangle with rounded angles. Each side of the triangle, measured in a straight line, is from twenty-five to thirty miles. The southern and shortest side of the triangle is nearly straight and runs east and west. From its western end the western side inclines toward the east as it extends northward. It is broken at about the junction of its northern and middle thirds by the projecting delta of the Clinton river. The third side of the triangle looks toward the northeast. In the middle of this northeastern shore the lake receives the waters of the St. Clair river which carries the overflow of the three upper lakes. At its entrance into Lake St. Clair the river breaks up into several channels, each of which again divides once or twice so that the water of the river enters the lake through nine well-defined mouths of varying sizes. These mouths are scattered for a distance of twenty miles along the northeast shore and discharge their waters into the lake at a considerable velocity. Between the channels which diverge from the main river to these mouths, is swampy shifting ground, which forms an enormous delta overgrown with rushes and covered usually by a foot or more of water. These are the celebrated St. Clair Flats. The banks of the channels only are usually formed of moderately firm ground and it is upon them that numerous summer residences and hotels have been built. By the projecting delta of the Clinton river and that of the St. Clair river the northwest corner of the lake is partly isolated to form Anchor Bay.

The lake has an area of 410 square miles (Schermerhorn 87). The shore line of the whole lake measured on the government chart, is about 187 miles. Of this the shore line of the delta[1] of the St. Clair river contributes 104 miles, while that of the remainder of the lake contributes but 83 miles. Seligo (90) has expressed the absolute shore development of lakes by dividing the length of the shore line by the square root of the surface. The absolute shore development of Lake St. Clair is thus $187 \div \sqrt{410} = 9.23$. Seligo further expresses the relative shore development by using the circle as a unit. The absolute shore development of a circular lake is $\frac{2\pi r}{\sqrt{\pi r^2}}$ which, in case $r = 1$, is 3.54. The relative shore development of Lake St. Clair is thus $9.23 \div 3.54$ or 2.607. The greater part of the shore line is that belonging to the delta of the St. Clair river. If this stretch of delta shore were replaced by a portion of shore such as extends from Milk River Point to New Baltimore, the total shore line of the lake would be but 109 miles. The absolute shore development reckoned on the basis of a shore line of 109 miles is 5.38 while the relative shore development becomes 1.519.

The water poured into the lake at the rate of 225,000 cubic feet per second through the many mouths of the St. Clair river, converges to the southwest corner of the lake, whence it flows toward the west through the Detroit river. There is thus produced a current in nearly all parts of the lake. In most places this current is slight, but near the mouths of channels it reaches a very considerable velocity.

The shore of the deltas of the St. Clair and Clinton rivers and of the many smaller deltas which occur about the shore of the lake at the mouths of smaller streams, are of course low and marshy and formed of a characteristic spongy loam. The remainder of the shore is formed by a bluff of clay (the sea cliff) which contains a considerable admixture of sand or gravel. The sea cliff varies in height from 2 or 3 to 15 or 20 feet. It is being continually eroded by the action of the waves so that it is customary to protect it by sea walls or by a covering of brushwood. The erosion washes away the fine clay composing the cliff. This clay is carried by currents and waves into the deeper water where it is either deposited on the bottom or removed by the current. The coarser particles of sand and gravel which are mixed with the clay are deposited along the shore and help to form little stretches of sandy or gravelly beach. The bottom of the lake is composed of fine blue clay—like that of the shore. The clay has been washed out of the superficial layer of the bottom by the long continued action of the waves and currents so that there is left nearly everywhere a stratum of fine sand or gravel which separates the clay of the bottom from the overlying water. This stratum is not usually more than one or two inches thick, and is often composed of particles of such fineness as to warrant its popular name of mud. A microscopical examination has not revealed in it any organic remains.

In most lakes the particles eroded from the shore by the action of the waves are deposited near the shore in the form of a terrace, called by geologists the "lake terrace." The lake terrace is a nearly level zone of the lake bottom which extends on all sides from the shore for a considerable distance towards the center of the lake. At its lakeward margin the terrace slopes sharply to the bottom of the central part of the lake—forming that which is known as the lakeward slope of the terrace. Since the terrace is formed by the erosive action of the waves it is composed of sand, gravel and fine loam or clay washed from the sea cliff. Large boulders of coarse gravel, on account of their weight, are deposited near the shore, finer gravel and sand are carried out to some distance from the shore, while the finest sand, the mud and clay are carried to the lakeward margin of the terrace. Passing from the shore to the lakeward slope of the terrace, the latter is found to be made up of successive particles of continually diminishing size. In lakes of this sort the water covering the lake terrace is shallow and of nearly uniform depth. On the lakeward slope of the terrace the water deepens abruptly, and as one proceeds from the bottom of this slope toward the center of the lake the water gradually deepens, reaching its greatest depth near the center of the lake. This is expressed in the section of an ordinary lake shown in figure 1.

[1] The delta varies greatly in extent and form of its shore according to the stage of the water. The measurements are therefore only approximate. They are carried directly across the mouths of the channels.

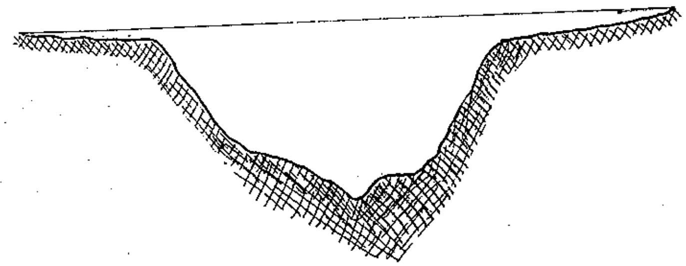


Fig. 1.—Typical Lake.

Lake St. Clair has no well-defined terrace. The depth of the water, therefore, increases gradually from the shore to the central area of the lake. Over this central area, which is perhaps a fifth of the whole lake area, there is a nearly uniform depth of about twenty feet. The unusual shallowness of the lake may be realized from the following statement. On a chart drawn to a scale of 1–50,000, the width of the lake at latitude 42° 25′ is about 30 inches. On the same scale the greatest depth would be represented by a line 1–200 of an inch in length. Thus a line 30 inches long and departing from a straight line at its middle by 1–200 of an inch would represent a cross section of the lake. To the eye such a line appears perfectly straight.

The absence of a terrace in Lake St. Clair is to be accounted for by the comparatively recent formation of the lake (in a geological sense). Within recent times the lake, like the other great lakes, covered a much larger area than it now occupies. The water subsequently receded until the lake reached its present size. The present lake bottom is, therefore, only the central more level portion of the original lake basin and is without a terrace. The time that has elapsed since the lake reached its present size has not been sufficient to form a new terrace. The currents further work against the rapid formation of a terrace by carrying out into the center of the lake or removing from it entirely the material which would be otherwise deposited to form a terrace.

No attempt has been made to measure the transparency of the water of the lake. It has not that remarkable transparency that characterizes the waters of the northern lakes. This is to be accounted for by its meagre depth. The shallow water near shore is always much roiled even by moderate waves, apparently on account of the fine particles of clay in suspension. A zone of this roiled water extends for perhaps a quarter of a mile from the shore and disappears only in very quiet weather. Probably in very rough weather the bottom is affected by the wave action in even the deepest water. The whole lake would then be roiled. We had no opportunity to observe this.

The temperature of the water in September varied from 18° to 21° C (65° to 70° F.) and there was but little difference between the temperature at the bottom and that at the top. In the deepest water this difference was not more than 1°C.

I know of no chemical analysis of the lake water.

The salient physical characters of Lake St. Clair are: *The existence of currents, the great shallowness, the lack of transparency in the water, the absence of a terrace, the contrast between the shore line on the northeast shore of the lake and that of the remainder of the lake.*

THE FAUNA AND FLORA OF THE LAKE.

The first six weeks of our stay on the lake were spent in an attempt to make a record of the animals and plants occurring in it, and to gather such data as was possible concerning them. The following summary will indicate what was accomplished in this direction. For a fuller discussion consult the various appendices to this report and the bulletins of the Michigan Fish Commission, which deal more exhaustively with the individual groups.

Plants: The plants of a lake may be roughly divided into two groups, (1) the larger plants which grow near the shore in shallow water and which cover the bottom in water of moderate depth, and (2) the microscopic plants, which are either attached to the larger plants or float free in the water. In the open water in the middle of a lake where no plants are visible to the naked eye, all vegetation appears to be absent. Such water nevertheless contains great numbers of minute floating algæ, so that the vegetation borne by it is equal in amount to that growing on a sparsely covered meadow (Seligo 90). The plants occurring in Lake St. Clair are enumerated in the report of Mr. Pieters, which has been published as Bulletin No. 2 of the Michigan Fish Commission. (Among the minute floating plants I desire to call particular attention to the occurrence in quantity of *Clathrocystis æruginosa*, as reported by Mr. Pieters.) The list includes 158 species, of which 106 are microscopic. Mr. Pieters points out that the plants which grow in the shallow water along the shore are arranged in well marked zones, each characterized by the presence of certain genera. Owing to the absence of a terrace and the consequent very gradual ncrease in the depth of water, these zones overlap or pass into one another ore gradually than is the case in lakes with a well defined terrace.

The bottom of the lake, wherever examined, was found to be covered by growth composed mostly of *Chara*. The *Chara* encroaches upon the ne of plants which borders the shore. It is probable that it also covers e bottom of the whole lake. In most parts of the lake the plants comsing this bed of *Chara* are as numerous as those in a thrifty field of over.

At least three factors influence the abundance of plants in a lake:

1. The amount of matter in solution in the water. Just as the productive capacity of a field is dependent on the richness of its soil, so is the productive capacity of a lake dependent on the richness of its water, that is, upon the amount of material in solution in the water and suitable for the nourishment of water plants. The microscopic plants are wholly dependent on this material for their food supply, while even those plants that are rooted to the bottom are largely, but in different degrees, dependent on the same source of food. The food material is brought into the lake by the action of the waves in eroding its shore, by the streams which drain its basin, by floods, winds and rains. It consists in part of substances washed from the soil or air and in part of dead animals and plants, or fragments of them. A part of it reaches the lake in solution, while another part is in suspension. The part in suspension settles to the bottom of the lake and there, if organic, it slowly decays and its products pass into solution. Its amount is dependent on the extent of the drainage basin of the lake and upon the richness of the soil of this basin. It is also dependent on the length of the shore line of the lake, since the longer shore line presents more material to the erosive action of the waves. Thus the supply of plant nutrition in a lake is continually added to from without. It is also continually lost through the outlet of the lake, so that the amount of it in the lake remains constant. The amount of this material in the water of Lake St. Clair has not, to the knowledge of the writer, been determined by chemical analysis. Susta (87) has found it possible, and profitable, to increase the yield of plants in fish ponds by manuring and otherwise fertilizing the pond. He was thus enabled to largely increase the yield of fish in his ponds.

2. *The yield of the larger plants* in a lake is dependent *on the amount of shallow water*. It is only in such shallow water as occurs on the lake terrace that these plants find soil for attachment and sufficient light. A great relative shore development (Seligo '90) such as we find on the northeast shore of Lake St. Clair, therefore furnishes a large yield of water plants, while the slight shore development of the rest of the lake is unfavorable. The absence of a terrace is also unfavorable. Although there is no terrace in Lake St. Clair, yet the shallowness of the whole lake compensates for this, since it gives an opportunity for a more extended growth of *Chara* than could find place on the lakeward border of a narrow terrace.

3. *The transparency of the water*. Aquatic plants, like others, are dependent on the light for their growth. If the water is transparent so that it admits the light to considerable depth, such plants as the Charas which grow upon the bottom are able to exist in deeper water and thus to cover a larger area of the lake bottom. The minute floating plants are also able to exist at greater depths and consequently in greater numbers over the whole lake. The turbidity of the water of Lake St. Clair, due to the fine soil of the shore and bottom, is thus a factor unfavorable to the growth of aquatic plants. This is, however, compensated for, as already pointed out, by the unusual shallowness of the lake—which permits light to reach all parts of the bottom in sufficient amount to support an abundant growth of *Chara*.

We find, then, that the greater development of the northwest shore along the delta of the St. Clair river gives support to an abundant littoral vegetation, while the lesser shore development of the remainder of the lake yields support to a very scanty littoral vegetation. The shallowness of the lake favors the bottom vegetation and results in an abundant bed of *Chara*, while the turbidity of the water is one element in resisting the development of the minute floating plants. It would seem to me that the great development of the bottom vegetation more than compensates for the poor development of minute floating plants and of littoral plants along much of the shore. *The total yield of the lake in plants is therefore probably greater than would be the case in a deeper lake of the same size, with more transparent water and greater shore development.* It should be understood, however, that this statement is not the result of any accurate measurements.

The Animals: Representatives of the following groups of animals are found in the lake.

Protozoa.
Cœlenterata (Sponges, Hydroids).
Turbellaria (Non-parasitic, fresh water, flat worms).
Trematodes } Parasitic flat worms.
Cestodes }
Nematodes (Thread worms, some free, others parasitic).
Hirudinei (Leeches).
Oligochæta (Earth worms and related forms).
Bryozoa ("Moss" animals).
Rotatoria ("Wheel" animalcules).
Crustacea.
Acarina (Hydrachnidæ or water mites and Oribatidae).
Insecta.
Mollusca (Snails and mussels).
Vertebrata (Birds, turtles, Amphibia and fishes).

The following summaries indicate briefly what is known with regard to each group. A report on the Rotatoria has been issued as Bulletin No. 3 of the Michigan Fish Commission. Reports on other groups are expected to be issued as soon as ready. Preliminary reports and such others as are not sufficiently extended to warrant their publication as separate bulletins, are appended to this paper.

1. The Protozoa: From the notes of Mr. Frank Smith, which are appended to this report, it appears that he recorded altogether thirty-two species. Of these, ten were taken at a distance from the shore at the surface with a tow net. Six were taken in the same localities at the bottom with the tow net and dredge. Of these six, four were found also at the surface so that but two species were at or on the bottom which do not also occur at the surface. Of these two, one, a *Vorticella*, is a fixed form. Practically, therefore, the protozoan fauna of the bottom at a distance from shore does not present any species, with the exception of *Amphileptus gigas*, which do not occur also at the top.

Of the ten species occurring at the surface—the *Difflugia globulosa* was found regularly and apparently belonged at the surface as much as at the bottom. The *Arcella*, of which only empty shells occurred, ought, perhaps, to be excluded from the list. *Actinophrys* was not found elsewhere than at the surface. The *Vorticella* was attached to other forms (passively limnetic) while the *Stentor* was doubtless a wanderer from the bottom. If we exclude *Arcella, Actinophrys*, and *Stentor*, there are left seven species which are undoubtedly pelagic in this lake in midsummer, and it is possible that *Actinophrys* should be added to this class.

The list of Protozoa occurring in the surface and bottom collections is doubtless nearly or quite complete, since the observations were many times repeated without revealing additional forms. During July and August Zacharias, (94) records 13 forms as pelagic in Plöner See. Of these, five, (2 species of *Dinobryon, Peridinium, Ceratium, Codonella*) are the same species observed by Zacharias or closely related. The other species observed by Zacharias were not reported from Lake St. Clair. Thus, evidently *the number of pelagic (limnetic) species in Lake St. Clair at this season is relatively small.* As this is the season at which this portion of the pelagic fauna reaches its highest development in Plöner See, it is not likely that a greater number of species occurs in Lake St. Clair at any other season.

In addition to the twelve species thus occurring twenty species are reported from shallow water among algæ. Further observation would doubtless have greatly extended this list.

2. Cœlenterata:

a. **The Sponges:** A fresh water sponge (the species could not be determined owing to the absence of gemmules) occurs frequently attached to the floating logs within the "boom" of the store mill at New Baltimore. Sponges (a species of *Ephydatia*) attached to the bottom were also occasionally brought up in considerable quantities by the dredge. They do not occur usually nor abundantly on the lake bottom.

b. **Hydras:** Both *Hydra viridis* and *Hydra grisea* are reported commonly attached to the vegetation and were not infrequently taken in tow net, where their presence was no doubt accidental.

3. Worms:

a. **Turbellaria** (non-parasitic flat worms): The collection of these worms is now being studied by Dr. Woodworth, but no detailed report can be given at this time.

b. **Nemathelminthes** (thread worms, hair snakes, Acanthocephala): Free nematodes were frequently encountered, but the species remain to be identified. The parasitic Nemathelminthes are mentioned in Appendix III.

c. **Hirudinei** (Leeches): Twelve vials have been sent to Dr. R. Blanchard for identification, but his report has not yet reached me.

d. **Oligochaeta** (Earthworms and related forms): These have been sent to Dr. Gustav Eisen, but his final report is not yet received. He reports in a preliminary way "8 or 9 species principally belonging to purely fresh water forms." "It is safe to say that most of these species are new to science."

e. **Parasitic Worms** (Nematodes, Trematodes, Cestodes): For an account of these, and for further details concerning the other worms, see Appendix III on the worms.

f. **The Rotatoria:** One hundred and ten species of the Rotatoria have been identified from Lake St. Clair. Twenty may be distinguished as pelagic (or limnetic), the rest as littoral or bottom forms. As compared with the list of eighteen pelagic species given by Zacharias (94) ten pelagic forms are found both here and in Plöner See; ten species found in Lake St. Clair are not reported from the European lake, while eight of the species listed by Zacharias have not been observed here.

In addition to the pelagic forms ninety species of distinctively littoral or bottom Rotatoria have been observed in Lake St. Clair. Zacharias (94) reports in Plöner See but twenty-four in addition to the pelagic forms. Probably the littoral Rotatoria of that lake have not been specially investigated.

Five species from Lake St. Clair have been described as new to science. A complete list of the Rotatoria observed in Lake St. Clair and in some of the inland lakes of Michigan, with more extended notes as to distribution and other biological data, as well as descriptions of the new forms, is given in the special report on the Rotatoria (Bulletin of the Michigan Fish Commission No. 3).

g. **Bryozoa:** A single species was found in small quantities on the aquatic plants in Anchor Bay. We did not find any Bryozoan occurring in great masses.

4. **Crustacea:** The Crustacea of the lake belong, as elsewhere in fresh water, to the groups Cladocera, Ostracoda, Copepoda, Amphipoda, Isopoda, and Astacidæ. Those belonging to the first three groups are minute and serve largely as food for young fish (Forbes). Those of the last three groups are larger forms living on the bottom and among the plants and entering to a considerable extent (especially the crayfish) into the food of adult fishes.

a. **Cladocera:** In an appendix to this paper is given a report on the Cladocera by Prof. E. A. Birge. From this I extract the following: "Twenty-two species are represented in the collection. This probably includes all the pelagic and bottom forms present at this season, but doubtless more extended collections in the littoral vegetation and on the delta of the St. Clair river would greatly extend the list of littoral forms." Nevertheless the list contains two more species than reported by Zacharias (94) from Plöner See. The lake is characterized by the abundance of *Sida crystallina* and *Monospilus tenuirostris* and by the constant presence of *Bosmina longispina* and the absence of all other species of *Bosmina*. I wish to call particular attention to the almost constant presence of *Chydorus sphæricus* O. F. M. in the material taken in the vertical net. This species which is thus pelagic throughout the lake is represented by individuals which are smaller than usual but otherwise not peculiar.

b. **Copepoda:** The collection of Copepoda is in the hands of Prof. C. Dwight Marsh, who is at work upon a report which will be published as a bulletin of the Michigan Fish Commission. He sends me the following list of species found in our collection from Lake St. Clair, the Detroit river and Lake Erie.

From Lake St. Clair:

Diaptomus sicilis Forbes
" *Ashlandi* Marsh.
" *minutus* Lillj.
" *oregonensis* Lillj.
Epischura lacustris Forbes.
Limnocalanus macrurus Sars.
Cyclops brevispinosus Herrick.
" *pulchellus* Koch.
" *parcus* Herrick.
" *ater* Herrick.
" *albidus* Jur.
" *fluviatilis* Herrick.
" *serrulatus* Fischer.
" *bicolor* Sars.

From the Detroit river:

Diaptomus sicilis Forbes.
" *Ashlandi* Marsh.
" *minutus* Lillj.
Limnocalanus macrurus Sars.
Cyclops brevispinosus Herrick.
Cyclops pulchellus Koch.

From Lake Erie:

Diaptomus oregonensis Lillj.
Epischura lacustris Forbes.
Cyclops brevispinosus Herrick.
" *Leuckarti* Sars.
" *fluviatilis* Herrick.

Thus the preliminary examination shows in Lake St. Clair fifteen species of free swimming Copepoda. Among these the *Cyclops ater* of Herrick is noteworthy. It occurs in considerable numbers on the bottom. The species was insufficiently described by Herrick and has not, to the knowledge of the writer, been recorded by any subsequent observer. A detailed description prepared by the writer from living specimens will appear with figures in the forthcoming report of Prof. Marsh. One interesting fact concerning this species may here be recorded. In color, form, size and movements it closely resembles a species of *Arrenurus* (one of the water mites) with which it is constantly associated. This resemblance is so close that it requires long practice to distinguish the two forms. This is possibly a case of "protective mimicry."

To the fifteen free living Copepoda must be added two other species of that group. 1. A species of *Ergasilus*. This semiparasitic form was frequently found free in the bottom tow, but never attached. It appears to be a new species. 2. A parasitic form probably one of the Lernæopoda, a single specimen of which was found attached to *Acipenser*. There are thus recorded seventeen species of Copepoda. The Plöner See list contains thirteen.

c. **The Ostracoda** occur in abundance over the whole lake among the plants of the bottom and shore. The species have not beeen determined.

d. **The Amphipoda** (fresh water shrimps) are represented by numerous individuals in the vegetation of the shore and bottom. The well known *Hyalella dentata* Smith occurs everywhere. The collection has not been studied so that it is not known whether other species are present.

e. **The Isopoda** are represented by large numbers of the genus *Asellus* which occur in the vegetation of bottom and shore. The species has not been determined. There may be several species or even genera.

f. **The Astacidæ** (crayfishes) are very abundant in certain parts of the lake in the neighborhood of the St. Clair Flats. We did not take them elsewhere, though the stomachs of fish taken in other parts of the lake often contained very many of them. We found only *Cambarus propinquus* Girard, though other species may be present in the lake. It forms an important element of the food of certain species of fish (e. g. *Amia*). A new species of *Distoma* (*D. opacum*) encysted in this crayfish has been recently described by Dr. Ward in the Proceedings of the American Microscopical Society, 1893, where some points in its life history are also given.

5. Hydrachnidæ: The water mites of the lake are being worked up by Dr. R. H. Wolcott, and it is intended to issue a special report upon them. A very brief summary of the facts collected concerning the members of this group is given in Appendix IV. From this it appears that eighteen genera containing thirty-six species have been recognized, of which probably three genera and a score of species are hitherto undescribed. The species are widely distributed over the lake. In addition to the water mites proper, Dr. Wolcott records the presence of a species of horny mites (family Oribatidæ).

6. Insecta: An account of these is given in Appendix IV. The list shows seventy-two species, but as these (most of them immature forms) can be identified only by rearing them, they have remained for the most part undetermined. The number of individuals in the lake is very great, owing doubtless to the broad expanse of bottom vegetation, and they form a most important element of the food of the fishes.

7. Mollusca: Snails are abundant on the vegetation of the bottom and shore, while mussels probably occur over nearly the whole lake bottom. Appendix I contains a list of the species and should be consulted for details. The identifications are most of them due to the kindness of Mr. Bryant Walker, of Detroit. From this it appears that twenty-three species of Gastropoda (snails) occur. It is not likely that any have been overlooked. They form an important element of the food of fishes. Of the Lamellibranchs (mussels) twenty-two species are reported—fifteen of the genus *Unio*, two of *Margaritina*, three of *Anodonta*, and two of *Sphaerium*. Although spread over a large area of the lake bottom, these forms are much more abundant in certain localities than in others. The *Sphaeria* are small, and important as fish food. The other Lamellibranchs are large, protected by a heavy shell and have the habit of living partly imbedded in the bottom. They do not therefore in their mature condition appear to possess any importance as fish food. In their immature condition they may enter into the food of fishes, but I do not know that this has been observed. Our list thus contains forty-five Mollusca. The Plöner See list, already so often quoted, contains twenty-one. Owing to the often ill-defined limits of our species of Mollusca, the number of them contained in any collection necessarily varies with the point of view and experience of the specialist to whom they are submitted. Personal knowledge of Mr. Walker's methods enables the writer to say that he has probably not recognized too many species, he is rather more likely to have recognized too few.

8. Vertebrata: Many gulls and terns frequent the lake. Two or three species of turtles are also present—*Chelydra serpentina* (L.), *Chrysemys marginata* (Ag.)—but turtles are not abundant and were never seen in deep water nor taken in the gill nets. Many frogs also frequent the St. Clair Flats and other similar portions of the lake shore. On the whole, however, the shore development is not favorable to either Amphibia or Reptilia.

The following species of fish were taken in the lake. (The names are from Jordan's Manual of the Vertebrata, 5th Edition, 1890):

Acipenser rubicundus Le Sueur, Lake sturgeon.
Amia calva L., dog fish.
Lepidosteus osseus (L.) Ag., Gar pike.
Ambloplites rupestris (Raf.), Rock bass.
Ameiurus natalis (Le Sueur), Yellow cat.
Ictalurus punctatus (Raf.), White cat.
Aplodinotus grunniens (Raf.), Sheepshead.
Catostomus teres (Mitch.), Common sucker.
Moxostoma aureolum (Le Sueur), Lake red horse.
Cyprinus carpio L., Carp (introduced).
Esox lucius L., Pike.
Esox masquinongy (Mitch.), Muskallunge.
Hiodon tergisus Le Sueur, Moon eye.
Lepomis gibbosus (L.), Pumpkin seed.
Micropterus dolomieu (Lacép.), Small-mouthed black bass.
Perca flavescens (Mitch.), Yellow perch.
Roccus chrysops (Raf.), White bass.
Stizostedion canadense (C. H. Smith), Sauger.
Stizostedion vitreum (Mitch.), Wall-eyed pike.

To these nineteen easily recognized species must be added at least two species of minnows not yet determined and a small Teleost, probably an *Etheostoma*, found feeding voraciously on the Crustacea of the bottom vegetation. The whitefish, *Coregonus clupeiformis* (Mitch.), also enters the lake in November. There are thus at least twenty-two species (three Ganoids, nineteen Teleosts) in the lake in the summer and one more in November—twenty-three species in all. We found no fish eggs, prabably owing to the time of year. We found frequently in the surface tow a small and very delicate larva of a bony fish—but were unable to rear it or to determine the species.

The contents of 113 fish stomachs belonging to sixteen species were collected and are undergoing examination. It is expected that a bulletin will be issued on this subject when the work is completed. A collection of 291 stomachs from fishes of the inland lakes is also being examined.

A summary of the animals and plants of the lake is therefore as follows:

I. PLANTS.

Phanerogams		47	
Characeæ		5	
Algæ (exclusive of Diatoms and Desmids) (fixed 13, free 14)	27		
Diatoms	15		
Desmids	64–106		— 158

II. ANIMALS.

Protozoa		32	
Coelentera		3	
Turbellaria, at least		5–6	
Nemertini		1	
Trematoda, probably		30	
Cestoda, probably		25	
Nemathelminthes, probably		20	
Hirudinei, probably		10	
Oligochæta, probably		8	
Bryozoa		1	
Rotatoria		110	
Crustacea: Cladocera	22		
Crustacea: Copepoda	17		
Crustacea: Ostracoda	1		
Crustacea: Amphipoda	1		
Crustacea: Isopoda	1		
Crustacea: Astacidæ	1	—43	
Acarina		37	
Insecta		72	
Mollusca		45	
Vertebrata (fishes)		23	— 465
			623

A mere catalogue of the animals and plants of the lake, such as has just been given, is not in itself of great interest. Such a collection of facts becomes of interest and of value in so far as it has a meaning. To understand how a certain group of animals or plants comes to be in the lake, how it maintains itself there, and what changes are produced in it by the interaction between it and its surroundings—these are the things of interest. To know such things concerning any fish is to be able to act intelligently in any matter concerning that fish; not to know them is to act in the dark and to risk every chance of failure.

For the most part these things are still to be learned, but it has seemed to me worth while to make here a somewhat broad statement of the relationships existing between the animals and plants in such a lake as St. Clair.

In the first place it is to be said that all the plants draw their nourishment from the water. They are floating in a nutrient fluid. Even in the case of plants rooted to the bottom, the roots serve largely or wholly as anchoring organs and not as organs for absorption. The amount of nutrient substances in solution in the water is then, as already pointed out, probably the most important element in determining the yield of the lake in

plants. The amount of such substances is in its turn dependent upon the form of the lake, its shore development and upon the character and extent of the lake basin.

In the second place all animals are dependent upon the plants for their food. They may be directly dependent, using plants exclusively as food, or they may be indirectly dependent, using as food other animals, which are in their turn dependent on plants.

I bring together here a few statements as to the food relations of some fresh water animals taken largely from Seligo (90).

Insect Larvæ: *Chironomus larvæ* are common on the bottom; there is one, the large red Chironomus larva, very common on the bottom in deep water, which is eaten by certain fish. The larva itself feeds upon minute plants (*Protococcus*, Diatoms) and upon the remains of decayed plants. It is eaten by carnivorous insect larvæ of the following groups: Ephemeridæ; Perlidæ; Sialadæ; Libellulidæ; Phryganid larvæ without tubes; water beetles; and also by Planarian worms.

Phryganid larvæ with tubes (Caddis-fly larvæ) feed mostly on living plants, but have been seen eating dead fish and snails. They are eaten by fish and crayfish.

Bugs: *Nepa* is a plant eater; *Notonecta* and *Naucoris* attack fish larvæ.

Hydrachnids are for the most part carnivorous.

Crustacea: The *Crayfishes* eat almost any vegetable or animal matter whether dead or living. They are largely eaten by fish.

Amphipoda (*Gammarus*) frequently eat Copepoda (*Cyclops*). They are eaten by fish.

Asellus, lives on the organic constituents of the bottom ooze.

The *Copepoda* live mostly on unicellular algæ (diatoms and Chroococcaceæ). DeGuerne and Richard make such a statement for Calanidæ.

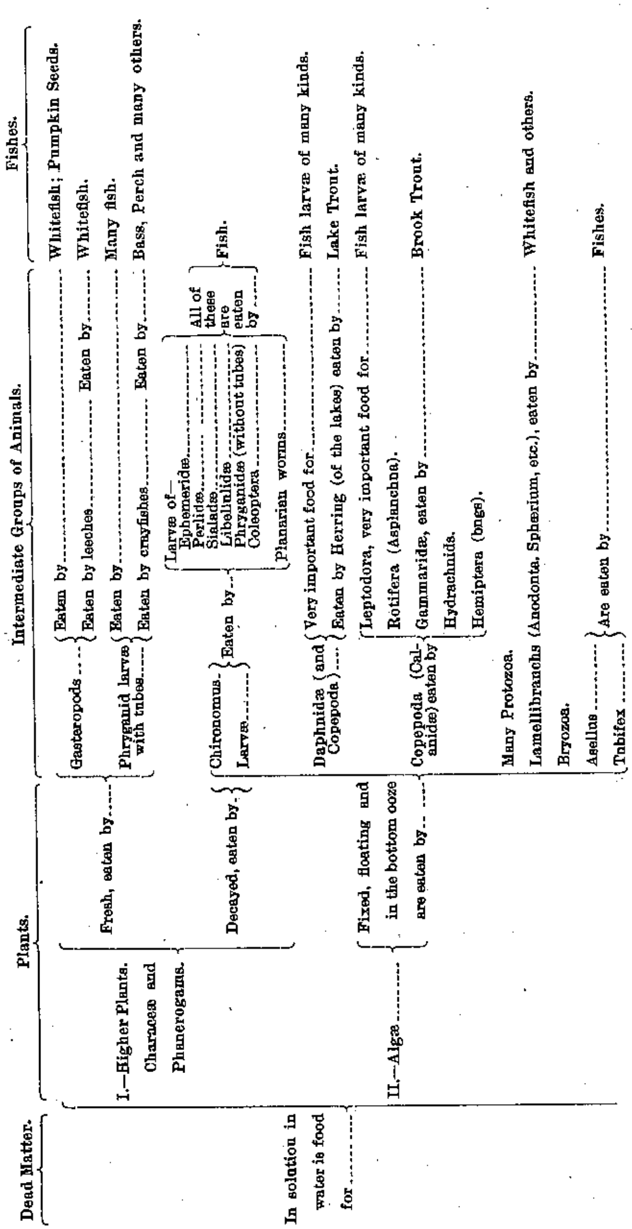
The *Cladocera* live also principally on unicellular algæ. (Apstein 92, makes the statement for Daphnidæ.) Both Copepoda and Cladocera are taken as food by most fish larvæ (fry). The Cisco or herring of our inland lakes also feeds upon the Cladocera and Copepoda of the plankton; I have observed this in Wabasis Lake, Kent Co., Mich. Probably the herring of the Great Lakes has the same habit. The herring of the Great Lakes in its turn is stated by fishermen to form a large part of the food of the lake trout.

Mollusca: *Snails* eat the living tissues of higher plants. They are in turn eaten by leeches (*Nephelis, Clepsine*). These leeches are in turn food for fishes.

Lamellibranchs (*Anodonta, Cyclas, Pisidium*): live on the organic constituents of the bottom water and bottom ooze.

Worms: Tubifex lives on the organic constituents of the bottom ooze. No doubt this list could be largely extended by a careful examination of the literature, but it is sufficient for the purpose.

In the following table (p. 24) I have attempted to express a part of the imperfectly known relationships existing between the various groups of plants and the invertebrate animals on the one hand and the fishes on the other hand. I do not know that any of our native fish live directly upon plants.



It is quite impossible to understand a fish so as to know how to deal with it intelligently without knowing its food. We are thus led back step by step until we come to the plants and from them we go to the chemistry of the water and from this to the character of the lake basin and its geological history. From the merest practical point of view I am unable to see where we can stop in our investigation short of a *complete knowledge of all the chain of relations* which extend from soil of the lake basin upward to the mature fish.

QUANTITATIVE PLANKTON WORK.

After six weeks spent in the determination of the lake fauna and flora the attention of the laboratory staff was turned in a large part toward the question of the distribution of these forms and toward measurements of the total volume of minute animals and plants found in a given volume of water. For this purpose twenty-one stations were selected. Fifteen of these were in Lake St. Clair. Since the time was limited these fifteen stations were located on the American half of the lake and were more numerous in the neighborhood of the fishing grounds. Their distribution is shown on the accompanying chart. It will be noticed that while they are not scattered over the entire lake, they represent all the conditions of bottom, shore, and depth that are to be found in the lake. Any conclusions concerning them probably hold for the entire lake. Three stations were located near the head of the Detroit river, while for the purpose of comparison three others were located in the western end of Lake Erie.

At each station the various forms of nets were used and the collections made were preserved. Their study will determine the distribution of the animals and plants. In so far as this distribution has been determined it appears in the special reports appended to this article and in the bulletins already referred to.

An attempt was also made to measure at each station the quantity of minute animals and plants floating free in the water under each square metre of surface.* No methods have yet been devised for determining the quantity of the animals or plants that are attached to the bottom or that live upon it. Measurements are therefore to be made only upon those forms that are found floating free in the water. There is reason to believe that whitefish fry (and probably the fry of many other young fish) feed for a time upon the minute animals (Crustacea) floating free in the water (Forbes 83). Thus it becomes at once a question of great practical importance to know where these crustacea are to be found in greatest numbers, so that the whitefish fry may be planted in such localities. Such measurements have also a very high scientific interest.

Quantitive determinations of the living forms in the water have not been previously undertaken in this country and its methods are almost unknown among us. They have been carried out on a large scale by Prof. Victor Hensen of the University of Kiel. Hensen has examined the

*The name *plankton* has been given by Hensen to all those animals and plants which are found floating free in the water, and subjected to the action of waves, currents or tides. Thus adult fish do not belong to the plankton, since they are able to move about independently of waves or currents. Fish eggs and young fish fry are reckoned as a part of the plankton. The constitution of the plankton varies, since occasionally forms which belong on the shore or bottom wander into the free water and become a part of the plankton.

waters of the North Sea and more recently those of the Atlantic Ocean and has perfected very ingenious apparatus for the purpose. Apstein, a pupil of Hensen, has adapted this apparatus for use in fresh water and has made a careful study of several fresh water lakes in the neighborhood of Kiel.

As it was found necessary for work in the Great Lakes to modify the apparatus and methods used by Hensen and Apstein, I give here a somewhat detailed account of our procedure.

The net used for this purpose is shown in the accompanying plate (Pl. figs. 1 and 2). The upper part of the net consists of a truncated canvas cone (cn.) supported on an iron framework. This cone is about 40 cm. high; the smaller end has a diameter of 40 cm. and the larger end a diameter of 60 cm. It is impervious to water and serves two purposes. When the net is let to the bottom it prevents the mud which may be upon the bottom from getting into the net and while the net is being drawn up it prevents its contents from spilling over the edge, a thing which might otherwise happen with a boat pitching in a heavy sea.

From the iron ring which supports the broader end of the cone depends the net proper (nt). The net is a cone with a slant height of about 100 cm. It consists of No. 20 silk bolting cloth, a very strong fabric which contains many very small openings nearly uniform in size.* This cloth or gauze has the further advantage of not undergoing changes in water and of not yielding any lint to contaminate the plankton. The outside of the gauze net is protected by a twine net of inch mesh which serves to take up the strain on the gauze net when it is drawn through the water. The lower end of the gauze net does not run to a point, but is truncated and attached to a flat metal ring. To this ring there is attached a bucket (bk.) which is shown separated from the net in fig. 2 A. In order that the weight of the bucket may not be borne by the net six stout cords (crd.) run from the upper net ring to the lower net ring and are made of such length that they support the weight of the bucket. The bucket is essentially a metal cylinder about 6 cm. in diameter inside and 6 cm. deep. It is supported on three legs. At the top it is arranged to be attached to the bottom ring of the net by means of three binding screws. The sides of the bucket are cut away as much as possible so as to leave only six narrow strips of metal and the windows thus formed are filled with gauze like that of the net. The bottom of the bucket is conical and has at its middle an outlet tube, closed by an accurately fitted plug which may be removed from the inside. This plug is shown separately at fig. 2 B.

The whole net is suspended by means of three cords from a support consisting of three radiating arms. At the junction of the three arms is a strong iron ring from which runs a rope by means of which the net is drawn up. The rope is divided into feet or fractions of a metre so that one may read off the depth to which the net descends. By holding in the hand the triradiate support from which the net hangs the latter may be kept from twisting on the supporting rope.

In working a spar is lashed to the upper deck of the steamer, so that its end extends about four feet beyond the side of the vessel. To the end of the spar is lashed a pulley through which the net rope runs. The net is then allowed to sink. In going down it takes in no water except that which is filtered through the gauze. It is sometimes let to the bottom and

*See appendix v.

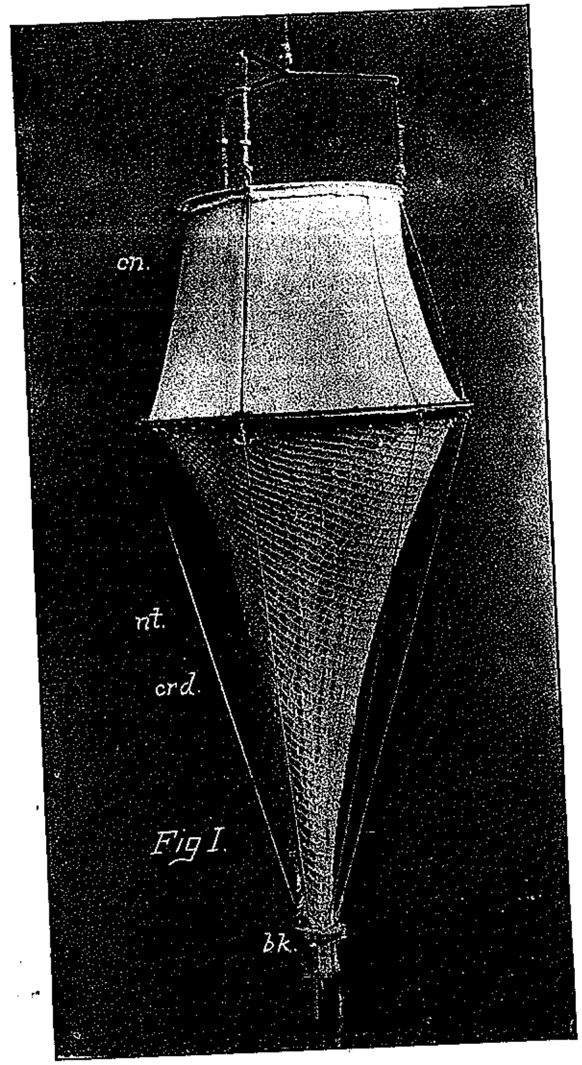


PLATE I.

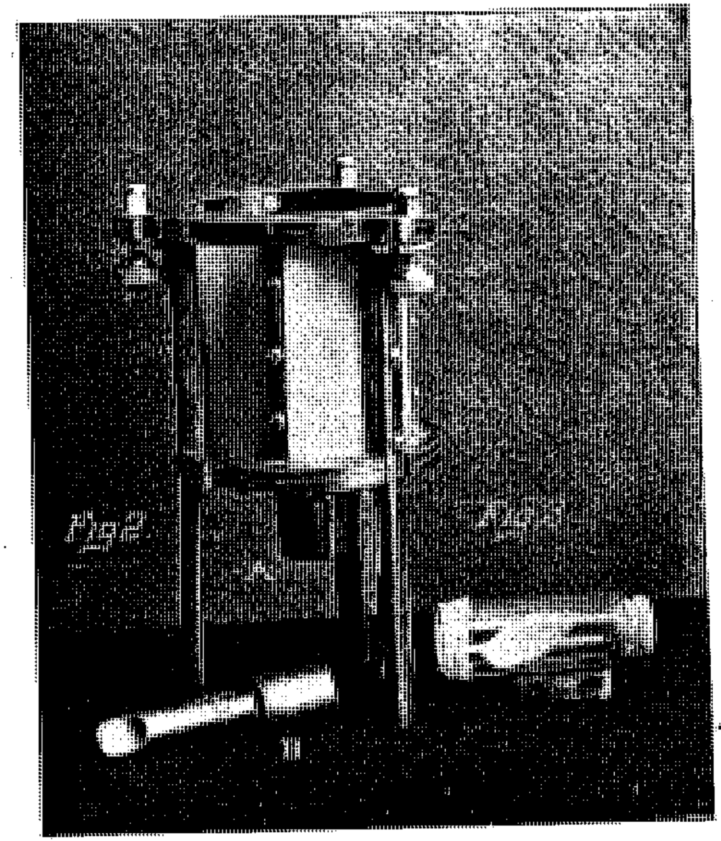


PLATE II.

sometimes to a depth of only 1½, 3, 4, or 6 metres. It is then drawn up by hauling in the rope hand over hand. The net is always hauled up by the same person, while another person makes note of the number of seconds between the time it leaves the bottom and the time the top of the canvas cone reaches the surface. From this time the velocity of the net is determined. The net has thus strained a vertical column of water. The base of this column has an area equal to the area of the net opening, while the height of the column is the distance through which the net was drawn. The net is now drawn out of the water and allowed to hang at the end of the spar while the water drains out of it. At the same time a stream of water from a hose is turned onto the outside of the net. This water passes through the net gauze to the inside of the net. It is thus strained by the gauze so that it does not add anything to the material captured in the net. This water washes down all the plankton into the bucket beneath.

After the water has partly drained out of the bucket the binding screws are loosened and the bucket is removed and taken into the cabin. Here nearly all the water is allowed to drain out through the gauze sides of the bucket and the plankton adhering to the inside is washed down into the conical bottom by means of a stream of filtered water from a wash bottle. All the material taken in the net is thus collected into the conical bottom of the bucket. A small glass beaker is then placed beneath the tube in the bottom of the bucket, the plug is removed and the plankton falls into the beaker. The inside of the bucket and the plug are then rinsed several times in filtered water, and the rinsing water is added to the material in the beaker. The small quantities of material obtained necessitates great care in handling it lest some of it be lost. The substitution of a plug in the bottom of the bucket for the stopcock used by Apstein is believed to be an advantage in that it allows the inside of the tube to be rinsed with greater thoroughness.

The small quantity of material now in the beaker contains very minute forms. If this material be turned into a bottle of some fixing or killing fluid, and if this fluid be afterward poured off and alcohol substituted for it, some part of the material is likely to be poured off and lost. After much experimenting we finally hit upon the following device for preserving the material.

A short 6-drachm homeopathic vial has its bottom removed and edges annealed. The bottom is then closed by tying over it with fine silk thread a piece of the No. 20 gauze such as is used for the net. The contents of the beaker are poured into this tube, and by a gentle tapping of the tube with the forefinger of one hand while holding it between the thumb and forefinger of the other hand, the water is made to filter very rapidly through the gauze bottom leaving the plankton in the tube. Before all the water has filtered away a label is placed in the tube and the open end is closed by tying over it a piece of the gauze. The tube (see Fig. 3) is then placed with other tubes in a large bottle of fixing fluid (we use alternately Flemming's solution and Kleinenberg's picro-sulphuric acid). The tube is then passed through successive grades of alcohol (preceded by water in the case of the use of Flemming's solution) and is finally preserved in 82 per cent alcohol. In passing the tube from one fluid to another it may be emptied of its fluid by forcing the air into it by means of a pipette held against the gauze at either end. When the tube emptied of its fluid is placed in the next fluid it may be filled by immersing it in the fluid and removing with a pipette the air previously forced in. The material does not pass through the gauze used in closing the ends of the tube. This method prevents the loss of plankton in the manipulation and it also saves much time and enables one to pack many tubes of plankton in a single large vessel.

When the plankton has been preserved in the tubes they are taken to the laboratory in order to continue the work. Here the contents of each plankton tube are measured in the following manner: The gauze is removed from one end of a tube and carefully rinsed free from any adhering plankton. The alcohol used in rinsing is placed in a beaker and the contents of the tube poured into the beaker. The tube and the other gauze are thoroughly rinsed and the rinsings placed in the beaker. The contents of the beaker are now turned into a tube graduated to tenths of a cubic centimetre. This tube is allowed to stand twenty-four hours in order that the lighter constituents of the plankton may settle, and the volume is then read off and recorded.

The area of the opening of our net (the upper end of the canvas cone) is 1,237.86 square centimetres. If the net has been drawn a distance of one metre (100 centimetres[1]) it has passed through a column of water containing 1,237.86 x 100, or 123,786 cubic centimetres of water. If the net actually strained the whole of this column of water, the plankton contained in the tube would be the amount of plankton contained in 123,786 cubic centimetres of water—or if the net has been drawn from the bottom and the water is but one metre deep it would be the amount of water contained under 1,237.86 square centimetres of the surface. The net does not, however, strain the whole of the column of water through which it passes. A part of this water is strained, while another part is forced aside by the resistance of the net. The net may thus strain only one-half of the column of water through which it passes and the plankton taken would then be that contained in one-half the column of water traversed by the net. In order to get the volume of plankton in the whole column of water traversed by the net, it would be necessary in this case to multiply the volume taken by 2. This number is called the coefficient of the net. The coefficient varies with the velocity of the net. The method of determining the coefficient of such nets has been very ingeniously worked out by Hensen (87) and is discussed in an appendix of this paper, in which there is given a table showing the coefficient of our net at different velocities and the total correction to be applied in using it. The coefficient of our net for velocities between 50 and 75 centimetres per second, varies from about $2\frac{1}{3}$ to about 2.

The volume of plankton taken multiplied by the net coefficient gives the volume under 1,237.86 square centimetres of the surface, reckoning from the depth from which the net is drawn. In order to make comparisons with the work of other observers it is customary to state the results in terms of the volume of plankton under one square metre of the surface. The area of our net is about one-eighth of a square metre, so that the volume of plankton under one square metre is obtained by multiplying by 8 (more accurately by 8.08). Thus the volume of plankton taken multiplied by a number (about 2) representing the coefficient of the net, and also by another number (about 8) gives the total volume of plankton under one square metre of surface. It is more convenient to make the two corrections at one time and to multiply the volume of plankton taken by a number (about 16) which represents the *total correction* to be made.

The following table shows the results obtained by us:

[1] A centimetre is .3936 of an inch linear. A metre is 100 centimetres, or 39.36 inches linear.

Schedule of the Hauls of the Plankton Net.

Date, 1893. Mo.	Day.	Hour.	Number of haul.	Depth of water in metres.	Depth of haul in metres.	Velocity of net in metres per second.	Temperature of water in degrees centigrade. Top.	Bottom.	Temperature of air in degrees centigrade.	Wind, strength and direction.	Current.	Sky.	Condition of water.	Volume taken in cubic centimetres.	Volume under one sq. metre of surface.	Volume per cubic metre of water.
IX	7	11:15 A. M.	I	4,11	3,71	,53	18,1	—	22,8	N W h N	—	Hazy and cloudy	Slightly rough	,92	18,44	4,97
		11:30	I^2	4,11	2,50	,65	18,1	—	22,8	N W b N	—	(Clear and hazy with slight clouds)	Slightly rough	,48	8,45	3,38
		12:10 P. M.	I^3	4,11	1,50	((,80) ,65)	18,1	—	22,8	N W h N	—	Clear and hazy	Slightly rougher than I^2	,47	5,28	5,52
		2:30	IIQ	5,41	5,00	,71	18,1	—	25,6	N W b N	—	Clear, slightly hazy	Slightly rough	,48	7,19	1,44
		2:30	II	5,41	5,00	,71	18,1	—	25,5	N W b N	—	Clear and hazy	Slightly rough	,80	13,38	2,68
		3	II^2	5,41	3,00	(,71)	18,1	—	25,6	N W b N	—	Clear and hazy	Slightly rough	,71	11,88	3,96
		3:30	II^3	5,41	1,50	,61	18,1	17,7	25,6	N W b N	—	Sunny and hazy	Slightly rough	,57	10,82	6,88
	8	11:10 A. M.	IIIQ	5,94	5,54	,69	17,2	17,2	19,2	N E 1	—	Cloudy	Swell and slight waves	,90	15,27	2,76
		11:10	III	5,94	5,54	,69	17,2	17,2	19,2	N E 1	—	Cloudy	Swell and slight waves	1,27	21,55	3,89
		11:45	III^2	5,94	4,50	,70	17,2	17,2	19,2	N E 1	—	Cloudy	Swell and slight waves	,80	13,49	2,99
		1:15 P. M.	III^3	5,94	3,00	,61	17,2	17,2	19,8	N E 2	—	Cloudy and sunny	Swell and slight waves	,98	17,74	5,91
		1:30	III^4	5,94	1,50	,61	17,2	17,2	19,8	N E 1	—	Cloudy and sunny	Swell and slight waves	,87	15,75	10,50
		3:30	IVQ	2,91	2,50	,71	18,1	17,7	19,2	N E 1	—	Cloudy	Slight waves	,80	5,02	2,01
		3:30	IV	2,91	2,50	,71	18,1	17,7	19,2	N E 1	—	Cloudy	Slight waves	,30	5,02	2,01
		3:45	IV^2	2,91	1,50	,61	18,1	17,7	19,2	N E 1	—	Cloudy	Slight waves	,19	3,44	2,29
	9	10:40 A. M.	VQ	5,86	5,26	,81	18,2	17,9	19,8	S E 1	—	Sunny, slightly cloudy	Moderate swell	,90	14,40	2,74
		10:40	V	5,68	5,26	,81	18,2	17,9	19,8	S E 1	—	Sunny, slightly cloudy	Moderate swell	1,19	19,04	3,62
		11:15	V^2	5,64	4,50	,76	18,2	17,9	19,8	S E 1	—	Sunny, slightly cloudy	Slight swell and waves	,83	13,55	3,01
		11:30	V^3	5,64	3,00	,68	18,2	17,9	19,8	S E 1	—	Sunny, slightly cloudy	Slight swell and waves	,63	10,79	3,60
		11:45	V^4	5,64	1,50	,51	18,2	17,9	19,8	S E 1	—	Sunny, slightly cloudy	Not so rough as V^3	,54	11,08	7,39
		1:15 P. M.	VIQ	5,18	4,77	,76	17,7	17,5	—	N E b N 1	—	Sunny and cloudy	Slight waves	,67	10,93	2,29
		1:15	VI	5,18	4,77	,76	17,7	17,5	—	N E b N 1	—	Sunny and cloudy	Slight waves	,90	14,69	3,08
		1:30	VI^2	5,18	3,00	,70	17,7	17,7	—	N E b N 1	—	Sunny and cloudy	Slight waves	,93	15,63	5,21
		1:30	VI^3	5,18	1,50	,61	17,7	17,5	—	N E b N 1	—	— — — — —	Slight waves	,44	7,96	5,31
		2:30	VIIQ	1,52	1,17	,67	18,9	18,9	19,8	N E b N 1	1	Sunny and cloudy	Slight waves	,25	4,32	3,69
		2:30	VII	1,52	1,17	,67	18,9	18,9	19,8	N E b N 1	1	Sunny and cloudy	Slight waves	,25	4,32	3,69
	10	11:55 A. M.	VIIIQ	4,85	4,44	,63	18,4	18,1	—	N 1	2	Sunny and cloudy	Moderate waves & swell	,70	11,99	2,70
		11:55	VIII	4,85	4,44	,68	18,4	18,1	—	N 1	2	Sunny and cloudy	Moderate waves & swell	,78	13,36	3,01
		12 M.	VIII^2	4,85	3,00	(,68)	18,4	18,1	25	N 1	—	Sunny and cloudy	Swell and slight waves	,64	10,96	3,65
		12:30 P. M.	VIII^3	4,85	1,50	,55	18,4	18,1	25	N 1	—	Sunny and cloudy	Dead swell	,48	9,38	6,26
		1:45	IXQ	4,69	4,28	,74	18,4	18,1	25	N 1	3	Sunny and cloudy	Slight waves	,66	10,38	2,54
		1:45	IX	4,69	4,28	,74	18,4	18,1	25	N 1	3	Sunny and cloudy	Slight waves	,62	10,22	2,39
		2:10	IX^2	4,69	3,00	,68	18,4	18,1	22,8	N 1	—	Sunny and cloudy	Moderate waves	,68	11,65	3,88
		2:30	IX^3	4,69	1,50	,61	18,4	18,1	22,8	N 1	—	Sunny and cloudy	Slight waves	,42	7,60	5,07
		3:20	XQ	1,90	1,50	,50	19,2	18,9	20,9	N 1	—	Sunny and cloudy	Slight waves	,30	6,23	4,15
		3:20 P. M.	X	1,90	1,50	,50	19,2	18,9	20,9	N 1	—	Sunny and cloudy	Slight waves	,30	6,28	4,15
	11	10:45 A. M.	XIQ	1,68	1,27	,51	18,1	17,7	20,5	N E b N 3	—	Hazy and sunny	Quiet	,76	15,60	12,28
	12	3 P. M.	XIIIQ	2,62	2,21	,60	17,7	17,7	24,2	S E b E 3	—	Cloudy, weak sunlight	Moderate waves	,58	10,59	4,79
		3	XIII	2,62	2,21	,60	17,7	17,7	24,2	S E b E 3	—	Cloudy, weak sunlight	Moderate waves	,48	8,76	3,97

Schedule of the Hauls of the Plankton Net.—Continued.

Date, 1893. Mo.	Day.	Hour.	Number of haul.	Depth of water in metres.	Depth of haul in metres.	Velocity of net in metres per second.	Temperature of water in degrees centigrade. Top.	Bottom.	Temperature of air in degrees centigrade.	Wind, strength and direction.		Current.	Sky.	Condition of water.	Volume taken in cubic centimetres.	Volume under one sq. metre of surface.	Volume per cubic metre of water.
IX		3:30	XIII^2	2,62	1,50	,61	17,7	17,7	24,2	S E b E		—	Cloudy	Slight waves	,39	7,06	4,71
		4:20	XIVQ	3,30	2,89	,60	17,7	17,5	24,2	S E b E		—	Cloudy	Slight waves	,57	10,41	3,60
		4:20	XIV	3,30	2,89	,58	17,7	17,5	24,2	S E b E		—	Cloudy	Slight waves	,51	9,56	3,31
		4:45	XIV^2	3,30	1,50	,61	17,7	17,5	24,2	S E b E		—	Cloudy	Slight waves	,49	8,87	5,91
		8	XIV^n	2,62	2,21	,52	18,6	18,4	20,7	E S E	3	—	Raining	Rough	,40	8,11	3,67
		8:15	XIV^{n,2}	2,62	1,50	,36	18,6	18,4	20.7	E S E	3	—	Cloudy, very dark	Rough	,34	11,68	7,78
		9	XIV^{n,3}	2,62	,91	,40	18,6	18,4	20,7	E S E	3	—	Cloudy, very dark	Rough	,35	9,56	10,50
		9	XIV^{n,3a}	2,62	,91	,40	18,6	18,4	20,7	E S E	3	—	Cloudy, very dark	Rough	,35	9,56	10,50
		8:30 P. M.	XIV^{n,4}	2,62	,46	,46	18,6	18,4	20,7	E S E	3	—	Cloudy, very dark	Rough	,33	7,71	16,75
		8:30	XIV^{n,4a}	2,62	,46	,46	18,6	18,4	20,7	E S E	3	—	Cloudy, very dark	Rough	,22	5,14	11,17
	13	11:45 A. M.	XVQ	5,58	5,17	(,63)	18,4	18,1	21,4	E S E		—	Cloudy	Rough	,52	9,29	1,80
		11:45	XV	5,58	5,17	(,63)	18,4	18,1	21,4	E S E		—	Cloudy	Rough	,70	12,50	2,42
		12:35 P. M.	XV^2	5,58	4,50	(,63)	18,4	18,1	21,4	E S E		—	Slightly cloudy	Rough	,78	13,93	3,10
		12:55	XV^3	5,58	3,00	(,63)	18,4	18,1	21,2	E S E		—	Slightly cloudy	Rough	,56	10,00	3,33
		1:10	XV^4	5,58	1,50	(,63)	18,4	18,1	21,2	E S E		—	Slightly cloudy	Rough	,42	7,50	5,00
		2:25	XVIQ	4,95	4,55	,76	18,4	18,1	21,4	E S E		—	Cloudy	Slightly rough	,53	8,65	1,90
		1:55	XVI	4,95	4,55	,76	18,4	18,1	21,4	E S E		—	Cloudy	Slightly rough	,65	10,61	2,33
		2:15	XVI^2	4,95	3,00	,76	18,4	18,1	21,4	E S E		—	Cloudy	Slightly rough	,57	9,30	3,10
		2:35	XVI^3	4,95	1,50	,61	18,4	18,1	21,4	E S E		—	Slightly cloudy	Slightly rough	,39	7,06	4,71
	15	8 A. M.	XVIIIQ	1,68	1,27	,56	18,9	18,9	22,8	N W	1	—	Foggy	Smooth	,37	7,09	5,58
		8	XVIIIQ^a	1,68	1,27	,56	18,9	18,9	22,8	N W	1	—	Foggy	Smooth	,32	6,13	4,83
		8	XVIII	1,68	1,27	,56	18,9	18,9	22,8	N W	1	1	Foggy	Smooth	,41	7,85	6,18
	17	10:30 A. M.	XIXQ	4,78	4,37	,73	18,1	18,1	—	N W	3	—	Clear	Rough	2,43	40,24	9,21
		10:30	XIX	4,78	4,37	,73	18,1	18,1	—	N W	3	—	Clear	Rough	4,50	74,52	17,05
		11:30	XIX^2	4,78	3,00	(,73)	18,1	18,1	—	N W	3	—	Clear	Rough	3,29	54,48	18,16
		11:45	XIX^3	4,78	1,50	,43 (,73)	18,1	18,1	—	N W	3	—	Clear	Rough	2,66	44,05	29,37
		3:15 P. M.	XX	8,84	8,43	,75	18,9	18,6	17,7	N	1	—	Hazy	Smooth	2,47	40,51	4,81
		3:15	XXQ	8,84	8,43	,75	18,9	18,6	17,7	N	1	—	Hazy	Smooth	2,50	41,00	4,86
		4	XX^2	8,84	6,00	,87	18,9	18,6	17,7	N	1	—	Hazy	Smooth	1,75	27,86	4,64
		4:15	XX^3	8,84	3,00	,51*	18,9	18,6	17,7	None		—	Hazy	Smooth	1,97	40,42	13,47
		4:30	XX^4	8,84	1,50	,43	18,9	18,6	17,7	None		—	Foggy	Smooth	1,43	36,28	24,19
		8:30	XXI	9,83	9,42	,78	—	—	—	N	3	—	Cloudy, weak moonlight	Rough	,67	10,77	1,14

* Net slipped in drawing up.

In hauls I^3 and XIX^3 the recorded velocities were 30 and 43 centimeters. These very low velocities were not only very much less than the other velocities at the same station, but they required total corrections of about 44 and 25. I have therefore corrected these velocities so as to make them equal to those immediately preceding them at the same station. The corrected velocities of these two stations appear in parentheses and the observed velocities appear just above them. The other velocities included in parentheses were estimated, not observed. It is possible that other velocities should have been corrected.

At each station, with the exception of XIV, the velocity has been measured for one only of the two bottom hauls—the velocity of the two bottom hauls being assumed to be equal.

The hauls marked XIV^n and XIV^{na} were made at night, the former by the light of a lantern, the latter in darkness. The low velocities are perhaps due to the difficulty of observing the time interval accurately in the insufficient light. For a fuller discussion of velocities see the appendix. Haul XIQ was made among water plants and contained much that does not belong to the plankton. Hauls IIIQ, III, XVIQ and XVI were made near the path of the great steamers. They were contaminated by filamentous algæ from the bottom. Before measurements were made of the plankton from these hauls the filamentous algæ were carefully removed under a lens by the use of fine forceps.

The first column contains the dates, the second the arbitrary number given to each haul of the net. The Roman numerals in the second column indicate the number of the station. Two hauls were always made from the bottom, one of these distinguished by the letter "Q" is intended to be used for qualitative work. The other bottom haul is indicated by the number of the station only. The small arabic numerals affixed to the remaining station numbers serve to indicate the different hauls which do not reach the bottom, the number 2 indicating the haul made from the greatest depth. These differ from one another usually by a metre and a half.

The third column gives the depth of water and the fourth the depth from which the net was hauled. When the net is hauled from the bottom the depth from which it is hauled is reckoned from the top of the canvas cone. It equals the depth of water minus the height of this cone. The fifth column gives the velocity of the net. The sixth, seventh, and eighth columns give the temperature of air and water. The ninth and tenth the condition of sky and water. The last three columns give in turn the volume actually taken, the volume under one square metre of surface and the volume per cubic metre of water, all expressed in cubic centimetres. The numbers in the last column are obtained by dividing the volume per square metre of surface by the depth of the haul as shown in the fourth column.

The table includes all the data recorded at the time of making the haul. I have been unable to see any effect on the distribution or amount of plankton, arising from the very slight variations in temperature, or from the variations in the condition of the sky and water. The record of these variations appears in the table for the reason that they may in the future be found to have some meaning.

An examination of the table yields the following general statements:

1 *The volume of plankton in Lake St. Clair is relatively small.* We made altogether 27* hauls from the bottom in Lake St. Clair, two hauls being made at every station after the first.

Number of station	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XIII.	XIV.	XV.	XVI.	Ave.
Volume of Plankton in cubic centimetres per cubic metre of water	4,97	1,44 2,68	2,76 3,89	2,01 2,01	2,74 3,62	2,29 3,08	3,69 3,69	2,70 3,01	2,54 2,39	4,15 4,15	4,79 3,97	3,60 3,31	1,80 2,42	1,90 2,83	3,03

The above table shows the amount of plankton per cubic metre of water for the bottom hauls at these stations—as shown in the last column of the general table. From this it appears that there is an average at this time of year of 3,03 c. c. of plankton to each cubic metre of water in the lake.

I know of no measurements of the volume of plankton in other North American lakes. In Europe we have the very careful work of Apstein. He has recently summarized the results of an examination of eleven lakes in Holstein (see Apstein 94). On the second page of this article the volume of plankton per square metre of surface is given for each of these lakes at approximately their deepest points. He divides the lakes into two groups, the plankton-rich and the plankton-poor. Dobersdorfer See is an example of the plankton-rich lakes. In September, 1892, it contained 1242

* Haul XI^a was made among water plants and is therefore not available.

c. c. of plankton per square metre of surface at a depth of 20 metres, i. e., 62.1 c. c. per cubic metre of water. This is more than twenty times the amount contained in Lake St. Clair at the same season. Great Plöner See may be taken as an example of the plankton-poor lakes. In September it contained at a depth of 40 metres as the average of two hauls, 200 c. c. of plankton per square metre of surface. That is 5 c. c. per cubic metre of water or considerably more than is contained in Lake St. Clair. Apstein does not record observations in the month of September in any of the other lakes. The smallest haul that he records was made in Behler See in June at a depth of 40 metres and yielded 1.9 c. c. of plankton per cubic metre of water. In July this lake yielded about 3 c. c. per cubic metre of water and in September its yield would probably have been still greater. The smallest bottom haul recorded in Lake St. Clair is II^Q which yielded 1.44 c. c. per cubic metre of water. *It is thus evident not only that Lake St. Clair is plankton-poor, but that it contains less plankton than any other lake yet examined.* As pointed out by Apstein the plankton production of a lake does not seem to be a question of temperature simply. Thus the temperature of Lake St. Clair in September is 17° to 18° C. and this is also the temperature of most European lakes at this season. The causes of differences in plankton production are obscure, but I am inclined, with Apstein, to seek them in large part in the composition of the water.

II. *The plankton is distributed over Lake St. Clair with great uniformity.* To determine the question as to whether the mass of organisms in a lake are, considering them as a whole, distributed uniformly over the whole area of the lake, it is desirable to make a large number of hauls of the plankton net from the bottom and in as short a space of time as possible. The ideal arrangement would be to have a large number of nets hauled at the same instant in different parts of the lake. Since this is not practicable, the next best arrangement is to haul the same net several times in one place and then to repeat this procedure at other places within as short a time as possible. We made always two bottom hauls in succession and all our work with the plankton net in Lake St. Clair was done between the 6th and 14th of September, that is, within a period of seven days. We have thus, as it seems to me, fulfilled the conditions as nearly as is possible by the use of a single net.

If local accumulations, "swarms," of the plankton are numerous it should happen that, of two hauls made at one place and at about the same time, one of the two would often include such an accumulation while the other would not.* The volumes yielded by the two hauls would thus differ widely. For purposes of comparison the differences may be best expressed by finding by what per cent of itself each of the two hauls differs from the average of the two.

In the following table I have brought together the volumes per square metre of surface for the bottom hauls made at each of the Lake St. Clair stations and that at Station XVIII in the Detroit river. Following Apstein, I

* It should be noted, however, that an accumulation of the individuals of one or more species may be present and not produce any variation in the total volume, since such accumulations of individual species may be compensated for by a corresponding absence of other species. Such accumulations of individuals could be best made evident by counting. It should be further noted that bottom hauls of the vertical net cannot detect the presence of plankton accumulations if these are formed by vertical migration from a condition of uniform distribution; since in such case all vertical columns of water of equal dimensions and extending from surface to bottom must contain equal volumes of plankton. For the detection by the vertical net of plankton accumulations formed by vertical migration it is necessary to compare nearly contemporary hauls which do not reach the bottom; even in this case such accumulations may be so located and so formed as to remain undetected.

have found the average of the hauls made at each station and then calculated the percentage of variation of each of the hauls from this average. These percentages are given in the last column of the table.

Number of haul.	Depth.	Volumes per square metre of surface.	Average.	Percentage of difference from the average.
II^Q	5,	7,19	10,29	43,1
II	5,	13,38		23,1
III^Q	5,54	15,27	18,41	20,6
III	5,54	21,55		14,6
IV^Q	2,50	5,02	5,02	0
IV	2,50	5,02		0
V^Q	5,26	14,40	16,72	16,1
V	5,26	19,04		12,2
VI^Q	4,7	10,93	12,81	17,1
VI	4,7	14,69		12,8
VII^Q	1,17	4,32	3,32	0
VII	1,17	4,32		0
VIII^Q	4,44	11,99	12,68	5,7
VIII	4,44	13,36		5,1
IX^Q	4,28	10,88	10,55	3.0
IX	4,28	10,22		3,3
X^Q	1,50	6,23	6,23	0
X	1,50	6,23		0
XIII^Q	2,21	10,59	9,68	8,6
XIII	2,21	8,76		10,4
XIV^Q	2,89	10,41	9,99	4,1
XIV	2,89	9,56		4,4
XV^Q	5,17	9,29	10,895	17,3
XV	5,17	12,50		12,8
XVI^Q	4,55	8,65	9,63	11,3
XVI	4,55	10,61		9,3
XVIII^Q	1,27	7,09	7,023	,9
XVIII^Qa	1,27	6,13		14,6
XVIII	1,27	7,85		10,5

Excluding II^Q the remaining hauls show the following variations:

The variation in 11 hauls lies between	0 and 5%	26 hauls, or 90% of 29 hauls.	between 0—20%
" " " 4 " " "	5.1 and 10%		
" " " 8 " " "	10.1 and 15%		
" " " 3 " " "	15.1 and 20%		
" " " 2 " " "	20.1 and 25%		

Total 28

Thus 90 per cent of the hauls show a variation of not more than 20 per cent from the average, while none of the twenty-eight shows a greater variation than 25 per cent. This result agrees very well with that of Apstein (92). The opening of the net used was sufficient (1,238 square centimetres) so that if swarms had been present in any of these hauls they should have made themselves evident in the volumes. The variation of 43 per cent which appears in haul II_Q is, possibly, sufficient to be referable to a "swarm."

We have not undertaken to count the organisms in the hauls and cannot therefore say whether the number of individuals of each species showe as great uniformity of horizontal distribution as the volumes.

This lake is peculiar in the existence in it of currents produced by the large volume of water flowing through it. It may be urged that the absence of "swarms" in it is due to the existence of these currents which would have a tendency to break up these "swarms" and distribute their constituent individuals. It seems to me, however, that this objection cannot be urged, and for two reasons:

1. There is almost every possible variation in velocity of current from a velocity which at the mouths of the channels may be four miles an hour to one which, in Anchor Bay and near the center of the lake, is only to be detected by the use of instruments. Yet under none of these conditions did we find "swarms," produced by horizontal migration.

2. The mechanical effect of the numerous and varying currents present in this lake would seem to me to favor the accumulation of any floating matter, as the plankton, in eddies and other similar places. Such accumulation of both floating and submerged objects is a familiar sight in rivers. In the ocean Haeckel (91) has pointed to currents as the causes of "swarms." In spite of the existence of diverse currents in Lake St. Clair, we have not found "swarms," of horizontal migration.

On the other hand, the large area of the lake, coupled with its shallowness, gives opportunity for the development of large waves, which probably agitate the water to the bottom. Such agitation doubtless favors the breaking up of "swarms" and the uniform distribution of plankton.[1]

III. *There is much more plankton in the surface stratum* of water *than in any deeper layer of equal volume.* In all of our hauls in Lake St. Clair, where the water was deep enough, we distinguish three or four strata as follows:

1. A superficial stratum from 1.5 metres to the surface.
2. An upper middle stratum from 3 metres to 1.5 metres.
3. A lower middle stratum from 4.5 metres to 3 metres.
4. A deep stratum from bottom to 4.5 metres.

In the following table I have brought together the volumes per square metre of surface made at each[2] of the stations in Lake St. Clair and at the two in Lake Erie. All volumes in this and the following tables are expressed in cubic centimetres:

Number of station	II.	III.	V.	VI.	VIII.	IX.	XV.	XVI.	XIX.	XX.	Depths at station XX.
1,5 m.—O	10,3	15,8	11,1	8,	9,4	7,6	7,5	7,1	44,1	36,3	—
3 m.—O	11,9	17,7	10,8	15,6	11,	11,7	10,	9,3	54,5	40,4	—
4,5 m.—O	10,3[3]	13,5	13,6	12,8[4]	12,7[5]	—	13,9	9,6[6]	—	} 27,9	6—0 m.
5,5 m. or bottom—O	—	18,4	16,7	—	—	—	10,9	—	—		
	—	—	—	—	—	—	—	—	—	40,8	8,43—0 m.

In the horizontal columns are given the volumes contained in columns of water from 1.5 metres to the surface (1.5—0), from 3 metres to the surface (3—0), from 4.5 metres to the surface (4.5—0), and from 5.5 metres, or the bottom, to the surface (5.5—0). If, now, following the method of Hensen and of Apstein, I subtract the plankton of the column 1.5—0 from that of the column 3—0, I obtain the plankton of the column 3—1.5—that is of the upper middle stratum, as above defined. Similarly, the subtraction of the plankton of column 3—0 from that of the column 4.5—0 gives that of the column 4.5—3, or that of the lower middle stratum. The subtraction of the column 4.5—0 from that of the column 5.5—0 gives the plankton of the deep stratum as above recognized.

[1] See note on page 40.

[2] Station I is omitted because the strata at this station were not made uniform with those at the other stations.

[3, 4, 5, 6].—These hauls are from the bottom; the depths in the order named are 5, 4,77, 4,44 and 4,55 metres.

In the following table these subtractions are carried out and the volumes for the stratum 1.5—0 are taken directly from the preceding table.

Number of station	II.	III.	V.	VI.	VIII.	IX.	XV.	XVI.	XIX.	XX.	Thickness of deep strata Station XX.
1,5 m.—O.	10,3	15,8	11,1	8,	9,4	7,6	7,5	7,1	44,1	36,3	
3—1,5 m.	1,6	1,9	—,3	7,6	1,6	4,1	2,5	2,2	10,4	4,1	
4, 5—3 m.	—1,6	—4,2	2,8	—2,8	1,7	—	3,9	,3	—	—12,5	6—3 m.
5, + —4, 5 m.	—	4,9	3,1	—	—	—	—3,0	—	—	12,9	8,43—6 m.

From this table it appears: (1) That the upper stratum contains a much larger volume of plankton than any of the others. (2) That there are no constant differences between the volume contained in the upper middle, lower middle, and the deep strata as here defined. Thus in V the result for the stratum 3—1.5 is negative, and the same result appears in the stratum 4.5—3 under III and VI. The numbers representing the volumes in each of the lower strata also vary greatly. At some stations the figures indicate an increase of volume as we approach the bottom, in others a decrease.*

In order to analyze the difference which exists between the superficial stratum and the sum of those beneath, I have brought together in the following table the volumes per square metre of surface at all the Lake St. Clair and Lake Erie stations having a depth of more than 1.5 metres. I have used all the figures to the nearest tenth. The horizontal column 1.5—0 gives the volumes obtained by hauling the net from the depth of 1.5 metres, while the column bottom —0 gives the volumes obtained by hauling from the bottom. In this column I have used the average volumes as shown in the table of averages.

No. of station	I.	II.	III.	IV.	V.	VI.	VIII.	IX.	XIII.	XIV.	XV.	XVI.	XIX	XX.
1,5—O.	8,3	10,3	15,8	3,4	11,1	8,	9,4	7,6	7,1	8,9	7,5	7,1	44,1	36,3
Bottom—O.	18,4	10.3	18,4	5.	16,7	12,8	12,7	10,6	9,7	10,	10,9	9,6	57,4	40,8
Depth of bottom haul in metres	3,7	5.	5,5	2,5	5,3	4,8	4,4	4,3	2,2	2,9	5,2	4,6	4,4	8,4

If, now, I subtract the volumes of the column 1.5—0 from those of the column bottom —0, I shall obtain the volumes contained in columns of water extending from the bottom to a depth of 1.5 metres (bottom —1.5). By so doing I distinguish two strata, a *superficial* as before (1.5—0) and a *deep* (bottom to 1.5).

*The negative numbers for the deeper strata of this table tempt to the further discussion of swarms, especially those of vertical migration. The numbers show clearly inequalities of distribution, but the greatest of these does not necessarily involve a variation of more than 2% (as between hauls III[2] and III[3])—certainly not a considerable swarm. The data do not seem to me sufficient to warrant an extended discussion.

In the following table this subtraction is carried out and the volumes contained in the superficial stratum are transferred directly from the preceding table.

No. of station...	I.	II.	III.	IV.	V.	VI.	VIII.	IX.	XIII.	XIV.	XV.	XVI.	XIX.	XX.
1,5—O	8,3	10,3	15,8	3,4	11,1	8,	9,4	7,6	7,1	8,9	7,5	7,1	44,1	36,3
Bottom—1,5.....	10,1	,0	2,6	1,6	5,6	4,8	3,3	3,0	2,6	1,1	3,4	2,5	13,3	4,5
Thickness in metres of deep stratum.......	2,2	3,5	4,	1,	3,8	3,3	2,9	2,8	,7	1,4	3,7	3,1	2,9	6,9

The lower horizontal column gives for each station the thickness of the deep stratum in metres, as obtained by subtracting from the depth of the bottom haul the thickness (1.5) of the superficial stratum. In this table the superficial stratum is 1.5 metres thick while the thickness of the deep stratum varies as shown in the lower horizontal column.

In order to compare the strata with one another, I must express the quantity of plankton in volumes per cubic metre of water. To do this I divide the volumes as given in the line 1.5—0 by 1.5 and those given in the line bottom to 1.5 by the numbers which are given in the lower line and which express the thickuess of the deep strata at the various stations. The results of this division to the nearest tenth appear in the following table:

No. of station...	I.	II.	III.	IV.	V.	VI.	VIII.	IX.	XIII.	XIV.	XV.	XVI.	XIX.	XX.
1, 5—O...........	5,5	6,9	10,5	2,3	7,4	5,3	6,3	5,1	4,7	5,9	5,	4,7	29,4	24,2
Bottom—1,5.....	4,6	,0	,65	1,6	1,5	1,5	1,1	1,1	3,7	,8	,9	,8	4,6	,65
Depth in metres.	3,7	5,	5,5	2,5	5,3	4,8	4,4	4,3	2,2	2,9	5,2	4,6	4,4	8,4

It thus appears that there is a much larger volume of plankton in the superficial stratum than in any equal part of the deep stratum. It is also evident from this table that, in the superficial stratum, the absolute volume of plankton per cubic metre of water is nearly the same at all the deeper Lake St. Clair stations. With the exception of station III this volume does not vary greatly from 5 c. c. This uniformity is remarkable in view of the variations in the conditions of light and weather for the different hauls.

In order to avoid fractions I may multiply each of the volumes in the above table by 1000 and the figures thus obtained express the volume in cubic millimetres instead of in cubic centimetres. This multiplication is carried out in the following table:

No. of station...	I.	II.	III.	IV.	V.	VI.	VIII.	IX.	XIII.	XIV.	XV.	XVI.	XIX.	XX.
1,5—O	5500	6900	10500	2300	7400	5300	6300	5100	4700	5900	5000	4700	29100	24200
Bottom—1,5.....	4600	0	650	1600	1500	1500	1100	1100	3700	800	900	800	4600	650
Depth in metres.	3,7	5,	5,5	2,5	5,3	4,8	4,4	4,3	2,2	2,9	5,2	4,6	4,4	8,4

In order to see the relation between the volume in the superficial stratum and that in the deep stratum, the volume given for the deep stratum at each station may be taken as 1 and both volumes given for that station may be divided by it. The results of such divisions appear in the following table:

No. of station...	I.	II.	III.	IV.	V.	VI.	VIII.	IX.	XIII.	XIV.	XV.	XVI.	XIX.	XX.
1,5—O	1,2	∞	16,	1,4	4,9	3,5	5 7	4,6	1,3	7,4	5,5	5,9	6,4	37,2
Bottom—1,5.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Depth in metres.	3,7	5,	5,5	2,5	5,3	4,7	4,4	4,3	2,2	2,9	5,2	4,6	4,4	8,4

From this table it appears that at Station I there was 1.2 times the volume of plankton in each cubic metre of the surface stratum as in an equal part of deep stratum, while at Station III there was 16 times as much. Station II shows an enormously greater quantity in the superficial stratum. These two stations were in deep and comparatively clear water and they are also the stations in which the deep hauls show the greatest amount of difference from the average. Whether there was at these two stations a *local* accumulation of plankton at the surface, i. e., a swarm, due to vertical migration or whether at this time the plankton was accumulated at the surface uniformly over the whole lake, can not be satisfactorily determined from our observations. The observations at Station IV were made on the same day, but the water is here much shallower and there is therefore, not so much plankton to be accumulated at the surface. It would require more observations than we made at these two stations and others in the immediate neighborhood to determine the cause of the enormous difference between the surface and deep plankton. The differences at the other Lake St. Clair stations do not cover a very wide range, running from 1.3 to 7.4.

IV. *There is about three times as much plankton in Lake Erie in the neighborhood of Put-in-Bay Islands, as in Lake St. Clair.* The average of the Lake St. Clair stations is 3.03 c. c. per cubic metre of water. The four bottom hauls made in Lake Erie in the neighborhood of the islands, are as follows:

XIX ♀	9.21	Average 8.98
XIX	17.05	
XX	4.81	
XX ♀	4.86	

These hauls were made on a day following a severe gale. As a result of this the water of the lake was nearly everywhere roiled as far as one could see. The wind was from the northwest and the hauls were made in the lee of islands, in situations where the water had not been roiled by the waves, but was as clear as usual.

At Station XXI, which was selected so as to be at a distance from the land, there was found in water 9.4 metres deep, 1.14 cubic centimetres of plankton per cubic metre.

It seems thus that the relative abundance of plankton in Lake Erie does not extend over the whole lake but is confined probably to the region of islands or favorable shores. Possibly the places at which our hauls were made are usually protected from wave action and are therefore favorable, but this does not seem to me likely.

The amount of plankton taken at these two Lake Erie stations is not sufficient to raise them above the category of plankton-poor lakes. To be called plankton-rich, the lake should yield perhaps ten times the plankton found in it at the most favorable place.

Our knowledge of the plankton of the Great Lakes may be thus summarized:

I. The volume of plankton in Lake St. Clair and Lake Erie in September is relatively small. They are *plankton-poor lakes*.

II. The plankton of Lake St. Clair is distributed with great uniformity. Swarms of horizontal migration, if they exist, are of rare occurrence.

III. There is constantly much more plankton in the superficial stratum of water, 1.5 metres thick, than in any equal portion of the deeper water.

IV. There are no constant differences to be detected in the distribution of the plankton at the different depths in a stratum of water extending from a depth of 1.5 to a depth of 5.5 metres.

V. The plankton of Lake St. Clair contains large numbers of individuals of *Clathrocystis æruginosa* and also of *Dinobryon* of two species. The individuals of these two species are so abundant as to have been usually recorded in our tow blanks as "many."

VI. *Chydorus sphæricus* O. F. M. is pelagic in considerable numbers in Lake St. Clair.

The statements as to quantity, under V and VI are estimates, not measurements. Apstein (94) calls the plankton-rich lakes Chroococcaceæ lakes and the plankton-poor lakes Dinobryon lakes and assigns to them the following characters:

	Chroococcaceæ Lakes.	*Dinobryon Lakes.*
Chroococcaceæ,	numerous,	scarce.
Dinobryon,	scarce or lacking,	numerous.
Chydorus,	pelagic,	littoral.
Plankton,	rich,	poor,
Water,	turbid,	clear.

A similar list of the characters of Lake St. Clair stands as follows:

	Lake St. Clair.
Chroococcaceæ (Clathrocystis),	*numerous.*
Dinobryon,	numerous.
Chydorus,	*pelagic.*
Plankton,	poor.
Water,	*turbid* (probably through inorganic particles in suspension.

The characters in italics are those of Apstein's Chroococcaceæ lakes, those in Roman are those of his Dinobryon lakes. From this it appears that Lake St. Clair unites in about equal parts the characters of the two classes of lakes recognized by Apstein.

I turn now to the question of final "utility" of our work. I have already said that, as it seems to me, the only satisfactory solution of the many perplexing problems of the fisheries and fish culture must arise out of

an untramelled investigation of all the facts involved with a view to the fixing of *principles*. These principles will, then, guide and unify practice. It should be remembered that such work is slow, that it requires the co-operation of many specialists and that is expensive. I believe it to be nevertheless, an inexorable condition of progress.

I take up the practical bearings of our work, under several heads which refer to the general conclusions reached by us.

1. The lake is very poor in plankton. There are in the lake no fish, at least none of marketable size, that feed upon the plankton. The "herring" of our inland lakes (*Coregonus artedi*) feed upon the plankton and perhaps the herring of the great lakes have the same habit. It is not likely that the herring could thrive at all in Lake St. Clair; it certainly could not exist there in considerable numbers. No fish feeding upon plankton could thrive in this lake, so that the question of introducing such fish is at once answered in the negative.

If the lake were smaller it might be possible to fertilize it by the use of manures and other fertilizers so as to greatly increase its yield of plankton. The relatively large volume of water flowing through it will probably always prevent the use of fertilizers, since these would be speedily carried out of the lake through the Detroit river.

2. The bottom flora and fauna of the lake are abundant. From this it follows that if any fish are to be introduced they should be such as thrive on the minute animals which inhabit the bottom vegetation (snails, Sphæriums, Amphipoda, etc). Carp have been planted in ponds connected with the rivers which empty into Lake St. Clair and have made their way into the lake. They are already being taken by the fishermen in paying quantities and are of unusually fine quality. They probably feed on some of the minute bottom forms in the lake. It seems to me likely that these fish will be of increasing commercial importance. Other fish of similar food habits should be looked for with a view of testing their adaptability to this lake.

3. Although, so far as I know, no whitefish fry or whitefish eggs have ever been taken in the lake, nevertheless there is good reason to believe that these fish spawn there. The whitefish pass up the Detroit river in November for the purpose of spawning and were formerly taken in the lake and in the St. Clair river in considerable numbers. This affords ground for the assertion that the fish spawn here. But the method or place has not been observed.

Borne (87) has collected the observations made by various persons on the spawning habits of the European *Coregoni*. From this it appears that some species spawn on *Chara* beds, others on gravel or sand. Considering the great expanse of the *Chara* beds in Lake St. Clair it seems to me likely that our Lake Erie whitefish spawns upon these beds. It is not impossible that it should spawn on the gravel or sandy strip of bottom which in some places, as at Grosse Pointe, extends along the shore in water shallower than that in which *Chara* grows. This, however, seems to me unlikely, for the reason that the current is rather rapid in such places and would tend to carry the eggs away unless they were covered by the sand or gravel of the bottom. It is known, however, that the whitefish spawn in water of considerable depth and that the eggs are cast while the fish leap above the water in pairs. (For a collection of such instances, see the paper by the writer in the report of the Michigan Fish Commission for 1891-92, on "The Ova and the Spermatoza, etc.") The eggs thus cast would be spread over a considerable area of the bottom and could not be very well buried by the adult fish.

If then, the eggs are laid over the *Chara* bed, the young fish would probably feed among the *Chara*, as is the habit of one of the European species (see Borne 87). It would not then feed upon the plankton, as suggested by Forbes (83).

The best practice in planting the whitefish would then consist in scattering the eggs, just before they are ready to hatch, over a considerable area of the lake bottom. The newly hatched fish would then find themselves at once in congenial surroundings. Instead of planting eggs, the fry themselves might be spread over the bottom by suitable devices.

Of course the only safety lies in determining by observation the character of the bottom in the place in which the whitefish deposits its eggs. This may differ in different lakes. But in the meantime, we cannot do better than to guide ourselves by such light as we have. Thus it seems to me that for Lake St. Clair the *Chara* beds are indicated as the spawning ground and that the method of planting above referred to is the most promising.

The "practical conclusions" may thus be summarized:

I. Lake St. Clair is unfavorable for plankton eating fish, such as the inland lake herring.

II. It is favorable for bottom feeding fish.

III. The whitefish eggs are probably deposited in the lake on the *Chara* beds. The eggs or recently hatched fry should, until further investigation, be "planted" by scattering them over a considerable area of the *Chara* covered bottom.

NOTE.—Owing to the absence of Prof. Reighard in Europe, the Mss. of this report was left in my charge with the very generous provision that changes should be made to any extent necessary to express the views of the writer or the evident conclusions to be deduced from his observations. Most changes have been purely verbal; but to avoid misunderstanding and possible charge of oversight, it seems best to add some further words in regard to the distribution of the plankton as shown by the tables on pages 34 and 35 of this report. The very variable amount of plankton in the lower strata as shown by the subtraction method, e. g., in the stratum 4.5—3 m. as —4.4 cc. for station III. and as 3.9 cc. for station XV., both of nearly equal depth, and the reverse relation of 5.4 cc. to —3.0 cc. in the next deeper stratum of the same stations,—this variation of nearly 50 per cent of the total amount of the haul within less than one-fourth of its depth does show clearly an unequal, and as further examination of the tables proves, *variable* distribution of the total plankton.

Thus far no one has attempted to define the word "swarm" nor show how far such a phenomenon as he conceives a "swarm" to be would affect the volume of the plankton; especially is this true of the limnoplankton where the forms concerned are throughout minute and the modifying effect will depend absolutely on the idea in mind. In other words, if one conceives the swarm to be a small, not very crowded aggregation of a few dozen individuals, the total volume might not be largely affected by its inclusion in the net; if, however, it is thought to be a crowded mass of thousands, the result will be different. Now while the evidence in the table will clearly permit of the first view, it will not in Prof. Reighard's mind support the second, since the considerable differences are the rare exception. Hence "swarms," if so defined, are the exception, not the rule; and it is unexpected to find so close agreement in the masses of the hauls as the table on page 33 shows. Moreover, the varying amount of the plankton in the different (artificial) strata below the top can by no means be regarded as evidence of the existence of swarms; it may be equally well explained on the ground of the partial or total absence of all forms at that particular zone, a phenomenon due to migration, to the effect of light, currents, or food supply at that point. It seems clear that there is great need of evidence in the shape of accurate enumeration of each species in each particular haul and in hauls with a closable net in order to establish the limits and vertical movements of each species for itself. The problem is by no means so simple and so uniform as some would have us believe.

HENRY B. WARD.

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APPENDIX I.

LIST OF THE PROTOZOA AND MOLLUSCA OBSERVED IN LAKE ST. CLAIR IN THE SUMMER OF 1893.

BY FRANK SMITH, INSTRUCTOR IN ZOÖLOGY, UNIVERSITY OF ILLINOIS, CHAMPAIGN, ILL.

I. Protozoa.

Protozoa occurring in surface collections:

Difflugia globulosa Duj., abundant.
Arcella vulgaris Ehr., scarce, only empty shells.
Actinophrys sol Ehr., scarce.
Dinobryon sertularia Ehr., abundant.
Dinobryon sp., frequent.
Peridinium tabulatum Ehr., scarce, only empty curiasses.
Ceratium hirundinella O. F. Müll, abundant.
Stentor sp., scarce.
Codonella cratera Leidy, frequent.
Vorticella sp., on *Diatom* sp. and on *Sphaerozyga polysperma*, abundant.

Protozoa occurring in bottom tow and dredgings:

Difflugia globulosa Duj , scarce.
Peridinium tabulatum Ehr , scarce.
Ceratium hirundinella O. F. Müll, frequent.
Amphileptus gigas C. & L., scarce.
Stentor sp., abundant.
Vorticella campanula Ehr., frequent.

Protozoa occurring in shallow water among algæ.

Amoeba proteus Leidy, scarce.
Difflugia acuminata Ehr., scarce.
D. corona Wallich, frequent.

D. globulosa Duj., frequent.
D. lageniformis Wall. (*urceolata* Carter), scarce.
D. pyriformis Perty, frequeut.
Lecquereusia spiralis Lecl., scare.
Centropyxis aculeata Ehr., abundant.
Arcella, dentata Ehr., scarce.
A. vulgaris Ehr., abundant.
Stylobyron petiolatum Duj., scarce.
Euglena acus Ehr., scarce.
E. oxyuris Schmarda, frequent.
Phacus longicauda Ehr., frequent.
Nassula ornata Ehr., frequent.
Amphileptus gigas C. & L., frequent.
Stichotricha Mülleri Lach., scarce.
Epistylis plicatilis Ehr., frequent.
Vaginicola gigantea D'Udk., scarce.
Cothurnia operculata Grub., scarce.
Pyxicola constricta Stokes, frequent.
Ophrydium versatile O. F. Müll., frequent.
Podophrya cyclopum C. & L., scarce.

II. Mollusca.

Limnea stagnalis L. Rushes near stave mill, St. Clair Flats; Salt Creek, abundant.
L. reflexa Say. Rushes, logs near stave mill, abundant.
L. reflexa zebra Tryon. Rushes, abundant.
L. palustris Müll. Rushes, logs near stave mill, frequent.
L. catascopium Say. Rushes, logs near stave mill. Sta. XVII, frequent.
L. humilis Say. Logs near stave mill, scarce.
L. galsana Say.
Physa gyrina Say. Logs near stave mill, frequent.
P. heterostropha Say. Rushes, logs near stave mill. Lake bottom generally, abundant.
P. integra Hald. Logs, stave mill, scarce.
Planorbis trivolvis Say. Rushes, logs near stave mill. Lake bottom generally, abundant.
P. bicarinatus Say. Rushes, Sta. XVI and XVII, frequent.
P. campanulatus Say. Rushes, logs near stave mill, abundant.
P. Parvus Say.
P. albus Müll. Logs near stave mill, frequent.
Ancylus parallelus Hald. Rushes, abundant.
Valvata tricarinata Say. Dredgings, abundant.
Campeloma decisa Say. Dredgings, occasional.
Amnicola limosa Say. Dredgings and bottom tow, abundant.
Pleurocera subulare Lea. Rushes, logs near stave mill. Dredgings and bottom tow, abundant.
P. elevatum Say. Dredgings, scarce.
Goniobasis depygis Say. Station VIII.
G. livescens Mke. Rushes, logs near stave mill. Dredgings, abundant.
Unio alatus Say. In rushes near stave mill. Sta. IV and XVII, abundant.

U. circulus Lea. In rushes near stave mill. Sta. IX, frequent.
U. coccineus Hild. In rushes near stave mill. Sta. XVII, abundant.
U. ellipsis Lea. Sta. IX, scarce.
U. gibbosus Bar. In rushes near stave mill. Sta. IV, XVI and XVII, abundant.
U. gracilis Bar. In rushes near stave mill, scarce.
U. luteolus Lam. In rushes near stave mill. Sta. I, II, III, IV, XVI, and XVII. Dredgings everywhere, abundant.
U. nasutus Say. In rushes near stave mill. Sta. XVI and XVII, abundant.
U. novi-eboraci Lea. Scarce.
U. occidens Lea. In rushes near stave mill, frequent.
U. phaseolus Hild. Sta. IV, scarce.
U. rectus Lam. In rushes near stave mill. Sta. IV, IX, and XVII, abundant.
U. triangularis Lea. In rushes near stave mill. Sta. XVII, scarce.
U. undulatus Bar. In rushes near stave mill, scarce.
U. ventricosus Bar. In rushes near stave mill. Sta. III, IV, and XVII, abundant.
Margaritina deltoidea Lea. In rushes near stave mill, scarce.
M. rugosa Bar. In rushes near stave mill. Sta. IV, scarce.
Anadonta Footiana Lea. In rushes near stave mill. Sta. III, IV, XIII, XV and XVII, abundant.
A. Footiana subangulata Auth. In rushes near stave mill. Sta. II and one mile south of Lab., frequent.
A. subcylindracea Lea. Sta. III, scarce.
Sphaerium simile Say. In rushes near stave mill. Quite generally on bottom, abundant.
S. striatinum Lam. In rushes near stave mill. Quite generally on bottom, abundant.

APPENDIX II

A REPORT ON A COLLECTION OF CLADOCERA, MOSTLY FROM LAKE ST. CLAIR, MICHIGAN.

WITH A TABLE OF SPECIES.

BY E. A. BIRGE, PROFESSOR OF ZOÖLOGY, UNIVERSITY OF WISCONSIN, MADISON, WIS.

The collection of Cladocera which was given me for examination by Prof. J. E. Reighard, of the University of Michigan was contained in seventy-two bottles, of which fifty-two were from Lake St. Clair and the rest from various localities in Michigan. Of the 20 scattering specimens, thirteen contained no Cladocera and one bottle from Lake St. Clair was without any specimens.

The collection as a whole presents few noteworthy peculiarities. There are no new species and many of the forms usually found in our smaller and larger lakes are absent. The table, which comprises most of the report, must be construed as a report on the collection and not as representing, either in quality or quantity, the fauna of the region from which it came.

In addition to the bottles there was a collection of slides of mounted specimens. They contained a specimen of *Polyphemus pediculus*, which was not found in the bottles and a large species of *Chydorus*, apparently new but which is not described at present, as I wish to see fresh specimens.

The most striking features of the Lake St. Clair collection are: 1, the abundance of *Sida crystallina* which occurs in twenty-eight of the fifty-two bottles; 2, the constant presence of *Bosmina longispina* and the absence of all other species of the genus; 3, the abundance of *Monospilus tenuirostris*, which occurs in more than one-third of the bottle, and which was found in both sexes. I believe that no other collector has reported such an abundance of this species. The mode of collecting is probably the cause of this plenty, rather than any peculiar distribution of the species. Considering the shallow nature of the lake, it is surprising that no more forms of Lynceidæ were captured. The number of species is small and the number of individuals is still more scanty. It is also strange that no representatives of the genera *Ceriodaphnia*, *Simocephalus*, and *Scapholeberis*, were found.

NOTES ON INDIVIDUAL SPECIES.

Daphnia pulex var. pulicaria. This variety, established by Prof. Forbes include transparent forms of *D. pulex*, is of wide distribution. It is found in pools and in clear water as well, and the forms are hardly distinguishable. I have found it also in cisterns and wells. Morphologically it is very close to *D. pulex* but it is never yellow. In muddy waters it is sometimes grayish and somewhat opaque, but in color grades into perfectly clear forms. *D. schoedleri* is a very closely allied species if not identical.

D. kahlbergiensis Schldr, var. *intexta*, Forbes. This variety with smaller crest than the true *retrocurva* was present in many bottles. It was, however found to grade into *retrocurva* and very possibly is not a valid variety. The species is everywhere extraordinarily variable.

Acropreus leucocephalus Koch. This species varied a little from the regular form. It approaches somewhat toward *A. harpæ* Baird, but there seemed no good reason for separating it as a distinct species or even variety. The same may be said of *Camptocercus rectirostris*.

Alona lineata Fischer. The species which I have thus described is evidently the same that others have called *A. intermedia*. In terming it *lineata*, I have followed Matile, whose figure of the post-abdomen exactly agrees with my specimens. These species of *Alona* need careful revision, as indeed do all the larger genera of the *Cladocera*.

Chydorus sphaericus O. F. M. This species was always present and in a very small variety, probably that called *C. minor* Lillj. by Sars. I have not been able to find any constant distinction between this and the regular *C. sphaericus* except in size.

Monospilus tenuirostris Fischer.

This species is evidently widely distributed in the United States. It has been found from localities as far separated as Isle Royale and Easthampton, Mass., a distance of about 1,000 miles. The limicolous habit of the animal renders it a rare form in any collection. It was, however, unusually abundant in the Lake St. Clair bottles and both sexes were present. The male has not been described before and is therefore described in detail.

Male.—Length, 0.35 mm.; height, 0.23 mm. The general shape is oval, recalling that of an *Alona*. The dorsal regions of the carapace is marked by oval depressions as in the female. The cast shells remain attached to the animal, as many as three having been seen in one case. The post-abdomen is more slender than in the female and is armed by fine hairs only. The teeth found in the female are wanting. The vas deferens terminates in a projection in front of the caudal claws, somewhat similar to that seen in *Alona guttata* Sars. The first foot is armed with a stout hook, not dissimilar to that found in most of the Lynceidæ. The macula nigra is large and triangular in form. There is no trace of the eye.

In another paper I called attention to the resemblance between *Monospilus* and *Alona*. The male shows this resemblance in a still more striking way. Were it not for the absence of the eye it might easily be taken for an *Alona*, especially in small individuals where there are no adherent old shells. It seems therefore very probable that we are right in regarding *Monospilus* as an *Alona*, altered in structure for a limicolous mode of life.

Species	3-Tow, Reed's Lake, Mich.	17-Daphnia, Round Lake.	23-Surface, Crooked Lake.	30-Wabasis Lake, 12 feet.	45-Long Lake, 10 feet.	46-Long Lake, Leptodora.	53-Long Lake, near Fentonville, 10 ft.	2-Tow, Frankfort, 8 ft.	3-Tow, Frankfort, 35 ft.	3-Tow, Frankfort, 35 ft.	4-Tow, Manitou Id., 23 ft.	5-Tow, Manitou Id., 1 ft.	6-Tow, bet. Man & Fox, Ids., 65 ft.	7-Tow, bet. Man & Fox, Ids., 14 ft.	8-Tow, Ludington, 11 ft.	9-Tow, Ludington, 1 ft.	10-Tow, Ludington, 14 ft.	11-Tow, Ludington, 7 ft.	(1)-Tow, Surface, Detroit R.	(2)-Tow, 10 ft., Detroit.
Holopedium gibberum Zad.																				
Sida crystallina O. F. M.	+		+																	
Daphnella brachyura Liev.	+		+		+															
Latona setifera O. F. M.																				
Daphnia pulex DeGeer, var. pulicaria Forbes		+																		
Daphnia hyalina Leyd.			+	+	+		+													
D. kahlbergensis Schdlr. var retrocurva Forbes			+	+	+	+														
Do. var. intexta Forbes							+													
Simocephalus serrulatus Koch	+																			
Simocephalus vetulus O. F. M.	+																			
Ceriodaphnia lacustris Birge	+		+					No Cladocera.	Mostly copepods.	Mostly copepods.	No Cladocera.	No Cladocera.	No Cladocera.	No Cladocera.	No Cladocera.	No Cladocera.	No Cladocera.	No Cladocera.	No Cladocera.	No Cladocera.
Scapholeberis mucronata O. F. M.	+																			
Ilyocryptus longiremis Sars																				
Ophryoxus gracilis Sars																				
Bosmina longirostris O. F. M.	+																			
Bosmina longispina Leyd.			+						+											
Eurycercus lamellatus O. F. M.	+																			
Camptocercus rectirostris Schdlr.																				
Acroperus leucocephalus Koch			+																	
Alona lineata Fisch.									C. S.?											
Alona guttata Sars																				
Alona affinis Leyd.			+																	
Alona sp?																				C. S.?
Alonella rostrata Koch																				
Graptoleberis testudinaria Fisch																				
Monospilus tenuirostris Fisch.																				
Pleuroxus denticulatus Birge																				
Pleuroxus procurvatus Birge	+																			
Pleuroxus nanus Baird																				
Pleuroxus gracilis Hud. var. unidens Birge																				
Chydorus sphaericus O. F. M.	+		+																	
Chydorus globosus Baird			+																	
Polyphemus pediculus DeGeer*																				
Leptodora hyalina Lillj.	+				+	+	+													

Species	I-Bottom Tow B.	II-Bottom Tow A.	I-Birge Net A.	II-Birge Net A.	II-Plankton ii QA.	III-Bottom Net A.	III-Birge Net behind Dredge A.	III-Wire Dredge B.	IV-Bottom Tow A.	IV-Plankton iv QA.	V-Bottom Tow A.	V-Birge Net B.	V-Birge Net D.	VI-Bottom Tow.	VI-Plankton vi Q.	VII-Bottom Tow.	VII-Birge Net C.	VIII-Birge Net A+
Holopedium gibberum Zad.																		
Sida crystallina O. F. M.		+	+	+					+	+		+						
Daphnella brachyura Liev.																	+	
Latona setifera O. F. M.			+	+														
Daphnia pulex DeGeer, var. pulicaria Forbes																		
Daphnia hyalina Leyd.	+				+	+												
D. kahlbergensis Schdlr. var retrocurva Forbes		+				+				+								
Do. var. intexta Forbes	+									+	+			+				
Simocephalus serrulatus Koch																		
Simocephalus vetulus O. F. M.																		
Ceriodaphnia lacustris Birge																		
Scapholeberis mucronata O. F. M.																		
Ilyocryptus longiremis Sars																		
Ophryoxus gracilis Sars																		
Bosmina longirostris O. F. M.																		
Bosmina longispina Leyd.	+		+	+	+	+	+		+	+	+	+		+	+	+		
Eurycercus lamellatus O. F. M.			+	+														Practically nothing.
Camptocercus rectirostris Schdlr.		+	+	+	+				C. S.		+							
Acroperus leucocephalus Koch		+	+	+	+			+							+	+		
Alona lineata Fisch.							+		C. S.?							+		
Alona guttata Sars		+																
Alona affinis Leyd.						?				+								
Alona sp?																		
Alonella rostrata Koch										+							+	
Graptoleberis testudinaria Fisch									+									
Monospilus tenuirostris Fisch.								+	+	+							?	
Pleuroxus denticulatus Birge			+	+	+					+								
Pleuroxus procurvatus Birge				+														
Pleuroxus nanus Baird																		
Pleuroxus gracilis Hud. var. unidens Birge																		
Chydorus sphaericus O. F. M.		+	+	+	+	+	+	+	+		+	+		+	+	+		?
Chydorus globosus Baird					L. C. S.													
Polyphemus pediculus DeGeer*																		
Leptodora hyalina Lillj.	+								+							+		

Species	VIII-Bottom Tow A—	VIII-Wire Dredge, Tri. Net B.	IX-Bottom Tow A.	IX-Plankton ix Q—	X-Bottom Tow A.	XI-Birge Net B.	XI-Plankton xi QA.	XII-Bottom Tow A.	XIII-Bottom Tow A.	XIII-Birge Net B.	XIII-Wire Dredge & Tri. Net B.	XIII-Plankton xiii Q.	XIV-Birge Net A.	XIV-Bottom Tow A.	XIV-Wire Dredge & Tri. Net B.	XV-Bottom Tow.	XV-Birge Net A.
Holopedium gibberum Zad.	+		+	+				+						+			
Sida crystallina O. F. M.	+	+	+	+		+	+	+	+		+		+	+	+		+
Daphnella brachyura Liev.																	
Latona setifera O. F. M.														+			
Daphnia pulex DeGeer, var. pulicaria Forbes																	
Daphnia hyalina Leyd.		?		+				?						+			
D. kahlbergensis Schdlr. var retrocurva Forbes				+			+	?						+			
Do. var. intexta Forbes														+			
Simocephalus serrulatus Koch																	
Simocephalus vetulus O. F. M.																	
Ceriodaphnia lacustris Birge																	
Scapholeberis mucronata O. F. M.																	
Ilyocryptus longiremis Sars																	
Ophryoxus gracilis Sars														+			
Bosmina longirostris O. F. M.																	
Bosmina longispina Leyd.	+	+	+	+	+	+	+	+	+		+	+		+		+	+
Eurycercus lamellatus O. F. M.										+			+				
Camptocercus rectirostris Schdlr.			+			+				+	+		+		+	+ C. S.	+
Acroperus leucocephalus Koch			+														
Alona lineata Fisch.									+					+			
Alona guttata Sars							+				+		+				
Alona affinis Leyd.														+			
Alona sp?		+			+												
Alonella rostrata Koch					+									+			
Graptoleberis testudinaria Fisch									+		+					+	
Monospilus tenuirostris Fisch.		+			+	+	+	+									
Pleuroxus denticulatus Birge											+		+		+		
Pleuroxus procurvatus Birge											+						
Pleuroxus nanus Baird									+		+						
Pleuroxus gracilis Hud. var. unidens Birge																	
Chydorus sphaericus O. F. M.	+	+	+	+	+		+	+	+	+	+	+					+
Chydorus globosus Baird																	
Polyphemus pediculus DeGeer*																	
Leptodora hyalina Lillj.	+			+	+	+	+									+	

Species	XV-Plankton xv Q.	XVI-Bottom Tow.	XVI-Birge Net XB.	XVI-Wire Dredge & Tri. Net B.	XVII-Birge Net B.	XVII-Bottom Tow A.	XVII-Dredge B.	XVIII-Birge Net A.	XVIII-Bottom Tow A.	XVIII-Wire Dredge & Tri. Net B.	XVIII-Plankton xviii Q.	XIX-Bottom Tow A.	XIX-Birge Net A.	XIX-Wire Dredge & Tri. Net A.
Holopedium gibberum Zad.														
Sida crystallina O. F. M.			+	+		+			+	+	+	+		
Daphnella brachyura Liev.												+	−	+
Latona setifera O. F. M.														
Daphnia pulex DeGeer, var. pulicaria Forbes														
Daphnia hyalina Leyd.		?				+								
D. kahlbergensis Schdlr. var retrocurva Forbes												+		+
Do. var. intexta Forbes						+					+	+		
Simocephalus serrulatus Koch														
Simocephalus vetulus O. F. M.														
Ceriodaphnia lacustris Birge													Practically nothing.	
Scapholeberis mucronata O. F. M.														
Ilyocryptus longiremis Sars			+											
Ophryoxus gracilis Sars														
Bosmina longirostris O. F. M.														
Bosmina longispina Leyd.		+	+	+		+					+	+		+
Eurycercus lamellatus O. F. M.														
Camptocercus rectirostris Schdlr.			+			+				+				
Acroperus leucocephalus Koch		+								+				
Alona lineata Fisch.						+								
Alona guttata Sars				+		+				+				
Alona affinis Leyd.							+							
Alona sp?														
Alonella rostrata Koch						+	+							
Graptoleberis testudinaria Fisch			+											
Monospilus tenuirostris Fisch.			+		+	C. S. +	+			+			?	
Pleuroxus denticulatus Birge						+			+	+				
Pleuroxus procurvatus Birge														
Pleuroxus nanus Baird														
Pleuroxus gracilis Hud. var. unidens Birge				+										
Chydorus sphaericus O. F. M.		+		+		+			+	+	+			
Chydorus globosus Baird														
Polyphemus pediculus DeGeer*														
Leptodora hyalina Lillj.												+		+

*In slides.

C. S. Cast shells.

EXPLANATION OF THE TABLE OF SPECIES.

A cross (+) following a specific name indicates a specimen mounted on a glass slide. Other specimens were in alcohol.

C. S. indicates that cast shells only were observed.

The columns in which the Roman numerals appear in the headings show the Cladocera taken in the summer of 1893 in Lake St. Clair, Detroit river and Lake Erie. The Roman numerals indicate the stations. The words following the station number indicate the net used in making the haul. These nets are described in the report. The word plankton following the station number indicates the use of the vertical plankton net. Of the hauls not indicated by Roman numerals, those contained in the first seven columns are from certain inland lakes of Michigan, the names of which are given. They were made in July, 1891. Those in columns 8-18, inclusive, are from hauls made at the north end of Lake Michigan in April, 1893, at the localities indicated. In all these cases, an ordinary muslin tow net was used. The number of feet given in each column indicates the depth at which the tow net was run. When no number is given it was run at the surface.

APPENDIX III.

A PRELIMINARY REPORT ON THE WORMS (MOSTLY PARASITIC) COLLECTED IN LAKE ST. CLAIR, IN THE SUMMER OF 1893.

BY H. B. WARD, ASSOCIATE PROFESSOR OF ZOÖLOGY, UNIVERSITY OF NEBRASKA.

In the work done on the fauna and flora of Lake St. Clair during the summer of 1893, the group of Vermes was entrusted to the writer. The following is submitted as a preliminary report on the ground covered, the material obtained, and the results of this branch of the work so far as they can be seen at this stage.

Excluding the Rotifera, which were studied by another member of the party, the Vermes are represented in fresh water by three great classes: the Plathelminthes (Flat-worms), Nemathelminthes (Round or Thread-worms), and the Annelida (Segmented-worms). A synopsis of these classes gives the following orders occurring in fresh water:

Plathelminthes	Turbellaria. *Trematoda (Flukes). *Cestoda (Tape-worms).
Nemathelminthes	*Nematoda (Thread-worms). *Gordiacea (Hair-snakes). *Acanthocephala.
	Nemertini.
Annelida	Oligochaeta ("Earth-worms"). Hirudinea (Leeches).

The orders starred are found exclusively or very largely as endo-parasites, and the importance for fish culture of a full knowledge of these forms seemed to warrant the special attention which was paid to them; for it soon became evident that the amount of material was too great for one worker, so that the non-parasitic worms were collected only as occasion offered, while the parasitic forms were made the subject of special study.

To speak of the non-parasitic forms first: Of the *Turbellaria* only one vial with a dozen specimens was preserved, and these have been sent to Dr. W. McM. Woodworth of Harvard for determination. The following forms were found in the tow and entered in the blanks without being preserved: *Mesostoma Ehrenbergii*, *Vortex* sp. Aug. 6; *Planaria maculata* Leidy, Sept. 1.

The group of Nemertini, which is represented in the ocean by numerous large worms great value as fish food, yields in fresh water only a very few small forms. One species about 3 to 5 mm. in length and 0.5 mm. in breadth, was found rarely on the plants collected from the shallow water of Lake St. Clair. Of the fifteen so-called species of fresh water Nemertini listed by various authors, hardly one can he recognized from the data given, and probably all may be reduced to two or three.* More accurate descriptions of these forms are necessary before any identification can be made.

Of the *Hirudinea* twelve vials were put up and afterwards sent to Prof. R. Blanchard of Paris for study.

The *Oligochaeta* were entrusted to Dr. G. Eisen of the California Academy of Sciences who has made the following preliminary report:

"The collection of *Oligochaeta*, contained in 17 vials, comprises about 8 or 9 species principally belonging to purely fresh water forms. There is one specimen of a genus related to *Thamnodrilus*, and about a dozen specimens of a new genus belonging to the family of the *Lumbriculidæ*. The collection contains besides two species of *Stylaria*, one of *Bohemilla*, one related to *Pristina*, one to *Naidium*, and one *Chætogaster*. These can only be properly determined, however, after dissection and sectioning. It is safe to say that most of the species are new to science. All the material is in first-class order well preserved with a view to anatomical and histological study. The collection was accompanied by many careful field notes and four sheets of detail drawings. A complete report will be made as soon as time permits."

My own attention was devoted particularly to the parasitic worms, both while collecting during the summer and in study then and since. In the tow was found but one helminth, a form which challenged attention the first of our stay. It is a free swimming *Cercaria*, closely allied to *C. mirabilis* Braun, having a prominent tail terminating in two flat blades at right angles to the main body. The *Distoma* is enclosed within the tail of the *Cercaria* which has then more or less the appearance of an anchor with wide flukes. From one to four of these were taken from both top and bottom tow every day from July 27 to August 5 when it suddenly ceased to be found. Efforts to find the intermediate and primary host were alike unsuccessful. This form differs considerably in size from those described by R. R. Wright and M. Braun and is probably a new species.

In shore collecting and dredging among the rushes in shallow water, immense numbers of *Gordius* were obtained. They belong to not more than two species. One specimen of *Mermis* was also found.

The bulk of the material collected consisted of fish parasites. Every day the fish brought from the nets were examined, and the parasites found were transferred to dishes of normal salt solution and provided with labels containing full details as to the host and the organ inhabited. This part of the work which I did personally at first was afterwards entrusted to D. Lydell who proved a most satisfactory assistant, and by whom the larger part of the collecting was subsequently done. The results of this examination of the fish were entered in a special blank which is here reproduced.

* Compare Vaillant in the Zoölogischer Anzeiger, vol. xv, p. 125.

No.---------

Name ---

Size----------------------- *Age* ---------------------

Locality ---

Examined by--*189*-----

PARASITES FOUND.

NAME.	No.	Organ Inhabited.	Condition.	Remarks.

Notes:

Each of the parasites was then subject to superficial examination, notes of evident peculiarities in shape or color made on the blank, and the worms then preserved. For this purpose an alcoholic solution of corrosive sublimate or picro-sulphuric acid was employed, followed by treatment in grades of alcohol. Forms which could be identified at once were entered by name, others referred to by number, and all were put up in vials for future study. Those which were peculiar were studied at the time so far as possible, and notes and drawings kept for reference.

The total amount of this material collected was *Trematoda* 59 vials, *Cestoda* 43 vials, *Nematoda* 15 vials, *Gordiacea* 9 vials, *Acanthocephala* 39 vials; in which one vial represents one order of parasites from one organ of one host at one date, so that two species may be in one vial or two vials may contain the same species collected on different days or from different hosts or organs of the same host. The examination of the bottles has gone far enough to show that a few of the forms represent new genera, many are new species probably, and nearly all are new in this country or in these hosts. When worked up the entire collection will form a valuable contribution to American helminthology.

The parasites from each host were counted and the results entered in the blanks. This was naturally laborious and demanded considerable time; but it is believed that it will furnish important evidence on the frequence of the parasites such as is lacking in previous lists which, so far as I know, rarely contain information even as to the number of infected hosts among those examined. The subjoined table presents in concise form the results of this study. From the list of hosts given it will be seen that nearly or quite all the important food fish of the lakes were examined. As it was not possible at that time of year to obtain whitefish in Lake St. Clair, Professor Reighard was kind enough to make a special trip to Belle Isle in the fall when he examined ten of them and forwarded me the parasites obtained. They came in good condition and add materially to the completeness of the collection. In addition to the fish, a large number of fresh water mollusks were examined as well as a few gulls and turtles from the immediate vicinity. The results of this examination are appended to the table below. It may be mentioned that some well known parasites were not found, among others the thread worm which infests the muscles of the black bass; it does not seem to occur at this season in the bass from Lake St. Clair.

As might be expected, most of the parasites were found in some part of the alimentary canal; not a few occur encysted in the liver, and the body cavity and air-bladder harbored occasional specimens. In one instance (*Hiodon*) the only parasites found were in the body cavity; they are probably new to science and are *Trematoda* with the mouth and the single sucker at the middle of the ventral surface, in this like the *Gasterostomidæ*, but differing from that family in numerous particulars, especially the sexual organs and the absence of any modification of the anterior end. The structure of this form will be described in detail in another place.

Some interesting facts appear on examination of the table given. The number of hosts examined is in some cases too small for general statements but such are only tentatively included in general statements. In considering the abundance of parasites it may be said that those fish which contain less than ten parasites each may be regarded as practically free; these are species 2, 5, 8, 9, 12, 13, 14 (see note), 17, 19. On the other hand those containing more than one hundred are to be considered as badly infected. Such are 4, 6 and 15. Of 18, only one specimen was examined and the number cannot stand as an average. Three specimens of 6 were examined; two had about forty parasites each, the third contained 285 *Acanthocephala*, bringing the average above the hundred limit, but the number examined was evidently too small to warrant conclusions as to which was the exceptional occurrence, and this form may be set aside for the present. Of the others 4 and 15, *Amia* is not a food fish; the second, the small-mouth black bass, was, as the table shows, the most seriously infected of any fish.

It will be noticed in this connection that a comparison by number only is somewhat misleading. Not only is there a wide difference in volume, and hence in effect on the host, between different species of the same order, as e. g. one *Distoma* collected measured 17 x 1 mm., while the smallest was 1 x 0.2 mm., where the volume of the larger is more than 85 times that of the smaller; but it is also evident that one adult *Cestode* of moderate size is equal in volume to more than a hundred *Distomata*. A comparison by number omits also the important factor of the size of the host, and one can easily see that the 42 parasites of each sturgeon play a smaller part in its economy than do the six of each perch or pumpkin-seed. Having regard, then, to the size of the parasites and to the size of the hosts, the table gives a relative idea of the degree of infection.

Comparing the parasites within one host it appears that the *Cestodes* are most important only in 19 and 20; the *Acanthocephala* are distinctly most prominent in 6, 7, 15, and 16 while the *Trematodes* ruled in 4 and the

Nematodes in 17. In the other cases the number of parasites is either so small as to be unimportant or so nearly evenly divided that no one group could be called predominent. *Trematodes* alone were harbored by 10, 11, 13, *Acanthocephala* alone by 8 and 16. External parasites were rare, being obtained only in one instance, from the gills of the whitefish.

In the food of the fish is to be found of course the key to the distribution and frequence of parasites, and considerable time was spent in the study of this subject. The only extensive articles on the food of the American fresh water fish are those of S. A. Forbes in the Bulletin of the Illinois State Laboratory of Natural History, 1878–88. After collating the results given there it was evident that there is variation enough in the food of the same fish in different localities to influence materially the question at issue. Some of the statements given there directly contradict observations made last summer at New Baltimore so that it will be necessary to await the result of study on the fish foods collected by our own party.

All of the parasites found were obtained from organs which are removed in cleaning the fish so that they are not directly dangerous to man. Any influence must be indirect on the health of the food or in reducing the supply of the fish. As to the effect of the parasites on the host a few words may be said. In most cases the number is so small that they could not noticeably diminish the food supply of the host, especially in a season of abundant nourishment like the summer; and it is also probable that the irritation produced by movements of the parasites is immaterial. In a few cases, however, this is not true, and the great number found in *Micropterus dolomieu* must be a serious draft on the organism. The *Acanthocephala*, moreover, which are present here in such large numbers, are especially dangerous since they collect in such masses as to obstruct the alimentary canal and make their way out into the body cavity and up into the liver, in both of which places they were found repeatedly. The host would then be affected in more than one way and it may be seriously. At any rate the subject deserves the fullest investigation since it is one of the finest of our food fish which is threatened. I hope to be able to present further evidence on the influence of the parasites on the host at a later date.

Reference number.	Fish examined.					Parasites found.				
	Scientific name.	Common name.	No. infected.	No. free.	Total No. examined.	Total No.	No. of Trematoda.	No. of Cestoda.	No. of Acanthocephala.	No. of Nematoda.
1	Acipenser rubicundus Le Sueur	Lake Sturgeon	2	0	2	85	75	0	0	10
2	Ambloplites rupestris (Raf.)	Rock Bass	2	0	2	88	1	1	6	0
3	Ameiurus natalis [d] (Le Sueur)	Yellow Cat	1	0	1	19	17	1	1	0
4	Amia calva L.	Dog Fish	4	0	4	[a] 3521	[a] 3469	13	7	32
5	Aplodinotus grunniens (Raf.)	Sheep's Head	12	0	12	30	26	4	0	0
6	Catostomus teres (Mitch.)	Common Sucker	3	0	3	364	0	7	357	0
7	Coregonus clupeiformis (Mitch.)	White Fish	10	0	10	263	[c] 5	15	226	17
8	Cyprinus carpio L.	German Carp	2	0	2	5	0	0	5	0
9	Esox lucius L.	Pike	3	0	3	24	8	8	8	0
10	Esox masquinongy (Mitch.)	Muskallunge	1	0	1	15	15	0	0	0
11	Hiodon tergisus Le Sueur	Moon Eye	2	4	6	52	52	0	0	0
12	Ictalurus punctatus (Raf.)	White Cat	2	0	2	12	8	4	0	0
13	Lepidosteus osseus (L.)	Gar Pike	1	1	2	1	1	0	0	0
14	Lepomis gibbosus (L.)	Pumpkin Seed	4	0	4	[b] 24	6	[b] 1	6	[b] 11
15	Micropterus dolomieu (Lacép.)	Smallmouthed Black Bass	6	0	6	[c] 1489	[c] 272	20	1194	3
16	Moxostoma aureolum (Le Sueur)	Lake Red Horse	2	2	4	154	0	0	154	0
17	Perca flavescens (Mitch.)	Yellow Perch	28	0	28	155	5	23	1	126
18	Roccus chrysops (Raf.)	White Bass	1	0	1	105	94	11	0	0
19	Stizostedion canadense (C. H. Smith)	Sauger	3	0	3	25	0	23	2	0
20	Stizostedion vitreum (Mitch.)	Wall Eye	6	0	6	227	0	96	130	1
	Total number of species, 20. Total number of individuals		95	7	102					
	Total number of species free from the parasite at the head of the column					......	5	6	7	13
	Total number of individuals free from the parasite at the head of the column					......	41	45	44	62
	Also examined:									
	Merula migratoria (L.)	Robin	1	0	1	7	[f] 7	0	0	0
	Larus philadelphia Ord.	Bonaparte's Gull	13	0	13	[g] 51	28	11	0	0
	Chelydra serpentina (L.)	Snapping Turtle	2	0	2	[h] 250	0	0	0	[h] 250
	Chrysemys marginata (Agassiz)	Mud Turtle	1	0	1	[i] 16	[i] 16	0	0	0
	Anodonta ovata Barnes; Unio gracilis Lea	Mussel	[h] 33	[h] 17	50	[k]	[k]			

Names after Jordan, Manual of the Vertebrates, fifth edition, 1890.

a The number of Distomata in one specimen was estimated at 3,000; only one-third was counted with a result of 1,023.

b Also an indefinite number of cysts in the liver.

c The total number is too small since there was also an unknown (large) number of a very small Distoma, of which only a few were preserved and included in the figures given.

d Intermediate between A. natalis and A. nebulosus, having 23 rays in the anal fin.

e From gills of two specimens only.

f Distoma macrourum Rudolphi.

g Including 12 which cannot be assigned to any order at present.

h Estimated.

i Monostoma n. sp.

k The foot was filled with encysted Cercariae which have not been identified as yet. The number present in each specimen was almost incalculable. About two-thirds of the mussels were infected.

APPENDIX IV.

THE INSECTA AND ACARINA OF LAKE ST. CLAIR. A PRELIMINARY REPORT.

BY DR. R. H. WOLCOTT, ANN ARBOR, MICH.

The insect life of Lake St. Clair, as shown by the investigations carried on during the summer, is exceedingly abundant and of a very varied character, notwithstanding the fact that the larger number of individuals obtained in the various tows and dredgings belonged to a comparatively small number of common and widely diffused forms. Nearly every order of the Insecta was represented in the collections, as well as three of the families of Acarina or mites.

The species of Insecta of which specimens were preserved, are distributed as follows:

Pseudo-neuroptera—Odonata (Dragon-flies)	11
Ephemeridae (May-flies)	6
Perlidae (Stone-flies)	1
Neuroptera—Phryganidae (Caddis-flies)	15
Hemiptera (Bugs)	8
Coleoptera (Beetles)	5
Lepidoptera (Butterflies and Moths)	1
Diptera (Flies)	25

A total of 72 species represented by over 600 specimens, living either as adults or during their immature stages in the waters of the lake.

The single Lepidopterous larva collected was taken off the mouth of Salt Creek, is a species of *Hydrocampa*, one of the Noctuidae or owlet-moths, and probably fed on the water lilies, which abounded in the creek. The Diptera were largely of the families Culicidae and Chironomidae or mosquitos and gnats.

The number of specimens could have been materially increased had the object been the formation of a full collection. But the desire being more to study the life-habits of the various species, many opportunities to obtain specimens were sacrificed in the attempt to carry them through their transformations in the aquaria. This latter attempt was successful in so far that many valuable notes and drawings were secured, and specimens illustrating nearly the whole life-history of many species preserved. The identification of this material has proceeded but slowly and very incompletely owing to the lack of literature on the subject which renders the task exceedingly difficult.

Of the Acarina, a single specimen of the cheese mite (*Tyroglyphus*) was taken in a surface tow, its occurrence being, without doubt, accidental. Nine specimens of a species of horny mite (family Oribatidae), were found in bottom and surface towings in different parts of the lake. Of the Hydrachnidae or water mites proper, a very large number were secured, doubtless more than have ever before been collected in this country, the group being one which, so far as American forms are concerned, have been almost entirely neglected. The collection embraces 18 genera, 36 species, and 1,369 specimens, of which probably 3 genera and a score of species are undescribed.

The whole collection, therefore, includes 110 species and over 2,000 specimens, beside a few pinned specimens of dragon-flies, aquatic Coleoptera, etc.

The distribution of these throughout the lake is very general, its shallowness rendering it possible for many species to live anywhere that suitable conditions other than depth of water exist. This fact together with the gradual slope of the shores precludes the establishment of any well-defined faunal zones, and yet a general distinction may be observed between the littoral and pelagic faunas, the latter including those forms living in and over the growth of vegetation included in the Characetum, as defined by Mr. Pieters in his report upon the flora of the lake, the littoral species being found between this area and the shore line.

Among the littoral forms may be mentioned the majority of the larvæ of the dragon-flies, most of the Hemiptera, the larger part of the coleopterous forms, many Diptera, and a few phryganid and ephemerid larvae. The pelagic fauna is characterized by an abundance of ephemerid and phryganid species, a very few colepterous and hemipterous forms, a great number of Diptera, and the representatives of one genus of dragon-flies, *Gomphus*, together with a few of the other dragon-fly larvæ. It is interesting to note the greater abundance of predatory or carnivorous forms in the littoral fauna. The water-mites were distributed everywhere in the lake, except that a few of the forms whose swimming powers are feeble, were only detected in the marshy tracts along the shore.

The great abundance of insect life throughout the lake, and especially in the Characetum which carpets the bottom, and in which certain species are exceedingly abundant, would seem to render it probable that insect forms should constitute a considerable percentage of the animal food of the fish inhabiting the waters. And an examination of a number of fish stomachs collected by the expedition bears out this probability, as in them were detected an immense number of insect larvæ, especially of those forms living in the Characetum over which a large majority of the fish had apparently been feeding.

All the conditions of the lake, including the small depth of the water, the uniformity of its temperature throughout the year, and the abundance of vegetation, tend to favor the production and future continuance of this great abundance of insect life and thus to furnish food for a correspondingly great abundance of fish within the waters of the lake.

APPENDIX V.

SUGGESTIONS FOR AN EXPERIMENTAL METHOD OF DETERMINING THE EFFICIENCY OF QUANTITATIVE NETS.

BY J. E. REIGHARD.

The cloth used for our vertical net is the No. 20 bolting cloth manufactured by Dufour & Co. The net was constructed essentially like the one used by Hensen and described by Apstein in Zacharias' well known "Thier-und Pflanzenwelt des süssen Wassers."

The only essential modification was in the bucket, and is sufficiently clear from the illustration.

It was my purpose to determine the coefficient of the net by the use of the table given by Hensen (87). For the purpose of seeing whether the cloth used in our net was the same as that used by Hensen, I undertook to measure it. Pieces of the cloth were placed under a compressor and the image of 30 to 70 openings was projected onto cardboard by means of an Abbe camera. The openings were then cut out of the cardboard and the pieces thus obtained were weighed. By comparison of the weight thus obtained with that of a piece of cardboard of known area, it was easy to determine the areas of the openings in the cloth. The method is very accurate. Measurements made in this way resulted as follows:

	Av. areas of opening in fractions of a square centimetre.
1. On cloth as received from the dealer	.00003596
2. On cloth wetted and then dried	.00002808
3. On cloth that had been used for 40 hauls of a net	.00002336
4. On cloth of net used in summer, 1893	.00002548

I then asked Dr. H. B. Ward to make some further measurements for me. His first experiments on the net used in the summer of 1893 gave as the average area of the openings in square centimetres .00002637 and .00002235, which vary but little from the measurement given above for the same cloth. The third measurement, however, gave an average for the area of each opening of but .00001651 square centimetres, so different that he at once set about finding the cause of the variations. He observed on experimenting that slight changes in the tension of the cloth, or in the pressure exerted by the cover of the compressor in which the cloth was measured, produced immediate and considerable variations in the size of the openings. These results were instantly apparent if the changes were made while the observer was watching the cloth, and showed in the measurements as well.

It thus became evident that in order to compare two pieces of cloth they must be measured under identical conditions of tension, pressure, moisture, etc. Hensen (87) gives the average area of the openings in his No. 20 cloth as .000028387 of a square centimetre, but he does not state the conditions under which the cloth was measured. Without a knowledge of those conditions any accurate comparison of our cloth with his seemed quite impossible.

I, therefore, set to work to find some method by which I could measure the coefficient of my net by direct experiments and finally hit upon the following.

I had constructed a model of our large plankton net on a scale of .3 linear. This was an accurate copy of the original net in every particular and should therefore have the same coefficient. It was large enough so that the difference in the friction of the water at the various openings of it and the original net could be neglected.

A rectangular wooden tank about 2 metres high and 80 cm. on each side was constructed. Three openings 35 by 45 centimetres were cut in one side of this tank and three others at corresponding places on the opposite side. These windows were filled with plate glass. The tank was filled with water from a Pasteur filter and held about 622,000 c. c. of water. In this water was placed 30 grams of *Lobelia* seeds. These seeds had been previously cleaned of all impurities by decantation and had been boiled in water, then dried and weighed. They were thus thoroughly freed from soluble constituents aud were of constant weight when dry. The seeds were well soaked in water before placing in the tank. They were found to be so nearly the specific gravity of the water that they remained in suspension in it for a considerable time; they are further about the size of the small Crustacea in the plankton. A long wooden paddle was prepared and to each side of this were tacked six zinc pieces which were so bent as to stand out at right angles to the surface of the paddle for a distance of six inches. By moving this paddle up and down in the water and by occasionally moving it sidewise it was found to be possible to keep the seeds uniformly distributed in the water of the tank. The distribution could be observed through the windows in the sides of the tank. There were usually more seeds near the bottom than near the top, but the horizontal distribution was uniform. Each cubic centimetre of water in the tank then contained on the average .0000471 grams of seed. While the seeds were thus uniformly distributed, the model net was drawn from the bottom of the tank to the surface of the water. It had an area of 100 square centimetres and traversed a distance of 160 centimeters in ascending. It thus passed through a column of water containing 160 by 100 or 16,000 cubic centimetres. This column would contain, therefore, 16,000 times .0000471 gram of seeds which is .7536 gram. The seeds taken in the net were dried and weighed. If the net had strained the whole column of water it should in the case assumed

contain .7536 gram of seeds. It was found, however, to contain usually .4 to .5 gram. Hence the efficiency of the net is expressed by $\frac{.4}{.7536}$ or the coefficient is expressed by $\frac{.7536}{.4}$. The cord by which the net was raised was provided with two buttons which could be so set as to open an electric circuit when the net started from the bottom and to close the circuit when the net reached the surface of the water. The opening and closing of the circuit were recorded on a revolving drum and at the same time intervals of one-fifth of a second were marked upon the drum. There was thus kept an accurate record of the time of ascent of the net.

The coefficients obtained in this way varied from 1.5 to 2. They were found to be practically identical for any given velocity if the experiments were made on the same day. Slight clogging of the cloth, due to minute fragments of the seeds adhering to it, raised the coefficient considerably. The cloth was then washed by rubbing between the hands with soap and warm water. The result of the washing was to change the cloth visibly so as to reduce the size of the openings in it and to make the coefficient rise from 1.5 to 2.1.

The experiments were found to consume so much time that I was compelled to drop them. I believe the method to be accurate. It would be necessary during the course of experiments with it to measure the cloth by some method which would yield uniform results and such a method should be devised.

Having thus failed, for lack of time, to satisfactorily determine the coefficient of our net experimentally, I have assumed our cloth to be identical with that used by Hensen. I have no doubt that this assumption is correct, since the cloth is of the same number as Hensen's (No. 20) and does not agree at all with his No. 19. Furthermore the average area of the openings as determined by the experiments noted above, is not far different from that given by him for No. 20 and very unlike that of No. 19 in his list. On this assumption I had Mr. E. A. Lyman calculate the coefficients of our net at the different velocities used by us and give below the results.

Velocity cm.	Coefficient.	Total correction = coefficient x 8.08.	Velocity cm.	Coefficient.	Total correction = coefficient x 8.08.
30	5.557	44.92	65	2.18	17.61
36	4.25	34.34	67	2.14	17.29
40	3.38	27.31	68	2.12	17.13
43	3.14	25.37	69	2.10	16.97
46	2.89	23.35	70	2.08	16.81
50	2.57	20.76	71	2.07	16.73
51	2.54	20.52	73	2.05	16.56
52	2.51	20.28	74	2.04	16.48
53	2.48	20.04	75	2.03	16.40
55	2.42	19.25	76	2.02	16.32
56	2.37	19.15	78	1.99	16.08
58	2.32	18.75	80	1.98	16.00
60	2.26	18.26	81	1.979	16.00
61	2.24	18.10	87	1.97	15.92

These corrections I have made use of in calculating the volume of plankton per square metre of surface. It is quite possible that an average correction based on an average velocity of 63 cm. per sec. would have answered equally well. Indeed in two cases where recorded velocity was low, 30 and 43 cm., the application of the correction resulted in an absurdity as pointed out in the note appended to the schedule of hauls.

The hauls made through short distances yielded low velocities. At first I was inclined to attribute this to the fact that the time interval read off from the second hand of a watch would be likely to be overestimated, if the interval were short (2 seconds or less). The velocity would thus be made to appear less than it really was. If this were the case the application of the large correction demanded by low velocities would make the results too great for all the 1.5 metre hauls. If this were true, it would be better to make an average correction for all hauls. On reflection, however, I decided that the net traveling a short distance probably actually travels at a lower average velocity since it must start slowly. I have therefore corrected the volumes taken in all the hauls for the observed velocities except in the two cases already pointed out.