The Food of the Fishes of Winona Lake

BY

WILLIS DERYKE

With a General Introduction by

WILL SCOTT

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The Food of the Fishes of Winona Lake in Kosciusko County During the Months of June, July and August

By

Willis DeRyke

CONTENTS

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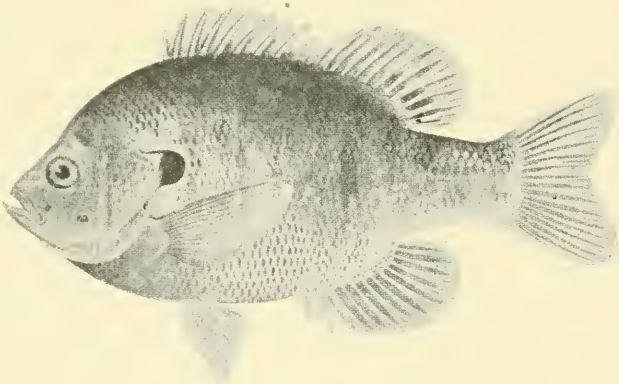
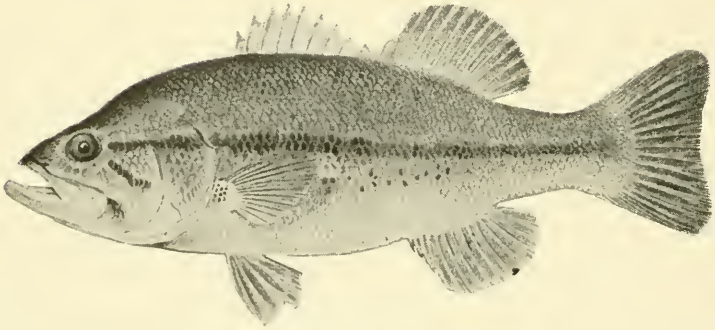
Perca flavescens Mitchill (Yellow perch)



Lepomis pallidus Mitchill (Bluegill)



Micropterus salmoides Lacepede (Large mouth black bass)

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GENERAL INTRODUCTION

By Will Scott

I have been asked by the Division of Fish and Game of the Department of Conservation, State of Indiana, to write an introduction to Mr. DeRyke's paper on the "Food of Fishes" to show the relation of such work to the production of fish.

First of all, I want to emphasize the fact that our streams and lakes are not waste areas. Aside from the great values that they have as places for recreation and their important relation to drainage and water power they are capable of producing crops equal to, if not greater, than those produced on the land. Without discussing this in detail the fact may be pointed out, that in pre-war days the carp ponds of China rented for thirty dollars per acre cash rent. This is an income of 10 per cent on a $300 valuation or 6 per cent on a $500 valuation. Not much farm land is worth more than that. The crops from our waters are harvested for the most part as sport, which makes us sometimes forget that these crops must be produced.

In order to raise any crop of plants or animals economically it is necessary to know many things. This knowledge is more nearly complete for land crops than for water crops, or to put it technically, agriculture is more nearly a science than is aquiculture. In agriculture we know something of soils, the things needed to maintain their fertility, and the kind and amount of seeds that will produce the best results.

When stockraising is added, we know something of breeds, the amount and kind of food they require, and their general care.

To cite a few specific instances: we know the amount of seed wheat or seed corn required per acre to produce the best results. In general, we expect 100 pounds of pork for each 13 bushels of corn, etc.

There is this difference between land and water crops. Land crops can be produced by pure culture methods, that is, when we raise corn nothing else is permitted to grow in that field. The hogs that are to eat the corn do not touch it until it is mature. This is because the crops can be marketed and fed dry.

Water crops on the other hand must be grown in mixed culture. For instance, a black bass may feed chiefly on minnows, the minnows feed on small crustacea, worms, and insect larvae, and these feed on still smaller animals, plants, and plant debris. This food chain may be varied and is different for the different fishes. Many fishes are supported by very complex food chains. In order to produce the end product the whole chain must be looked after, and be kept going at its best all of the time. The minnows must have suitable places to breed, there must be an adequate supply of plants, etc. If one part of this food chain becomes reduced everything in the food chain above it is either checked in its growth or reduced in numbers.

In order to raise fishes it is necessary that we know, not only what fishes eat but also how much they eat, and the number of pounds of fish a given amount of each of these foods will produce. Not only that but we must know how much of these foods is present in the various waters of the state. The

next step in this analysis is to determine the life history of each of the forms concerned in each food chain.

By life history I mean the number of broods a form will produce, the number of young in each brood, and the age at which the organisms begin to reproduce. This is necessary in order that the turnover may be determined.

An investment on which a 50 per cent dividend is declared once a century is not so good as one which declares a 5 per cent dividend annually. Nor is a $500 bond yielding 1 per cent as productive as a $100 bond yielding 6 per cent. So a small organism producing large broods at short intervals may be a much more valuable member of a food chain than a large form whose reproductive rate is slow.

We have just determined that one of the little crustaceans known as scuds (the amphiopod, Hyalella) contributes at a maximum approximately 100 pounds of fish food per acre during the growing months which may be reckoned at seven months. We know that fish eat these but we do not know how many one fish will eat or how many of these crustacea it would take to make a pound of fish.

The fundamental reason why fish can be produced more cheaply than the common land animals used for food is that much of the food eaten by mammals and birds is used to keep up the temperature of the body. A young bird must eat nearly its weight in food every twenty-four hours in order to hold its own in weight. It is a matter of common knowledge that cattle during severe weather scarcely hold their own in spite of careful feeding.

Fishes use none of their energy to keep up their temperature. It all goes for swimming or reproductive energy and for growth. This enables them to go for rather long periods without food. In this latitude most of our fish do not eat during the colder months. They may not lose much but they certainly do not gain. During the warmer months they can feed but it is probable that in most situations they eat their limit only occasionally. Scant food supply and intermittent food supply are things that we must attempt to remedy if we are to raise large fish in a short time.

There is a direct relation between the amount of fish a given body of water will produce and the amount of fish food it will produce. No cattle raiser would think of putting 1,000 calves into a ten acre pasture lot. If he did do this, at the end of two or three years he might have three to five stunted cattle that had survived the terrible competition of the early months of the feeding.

Of course carniverous fish eat each other when there develops sufficient difference in size, but independent of this factor, the reduction in fishes in number or size or both to that which a lake or stream can support, is just as certain as in the case of the calves cited above.

May I illustrate the effect that plenty of food will have on the size of fish? Probably there are as many bass in Florida that weigh 9 or 10 pounds as there are in Indiana that weigh 5 or 6 pounds, but in Florida the bass can eat 12 months in the year.

Rainbow trout in Spencer Creek, Oregon, have never been known to reach a length greater than 17 inches. These same trout when transplanted to Diamond Lake reach a length of 40 inches and a weight of 27 pounds.

The Division of Fish and Game of the Indiana Department of Conservation, under the very efficient management of Mr. George N. Mannfeld, in 1921

raised a walleyed pike from the green egg to a length of 17 inches in 7 months by supplying it with an excess of food. This was the maximum, many others were 10 inches or over.

As I have suggested before, many classes of food are available for short periods only. For instance there is a little insect larva (the larva of the fly Chironomus) that is found at the bottom of most of our lakes. In Winona Lake it produces about 70 pounds dry weight of fish food per acre per year. However, most of them live below the feeding level of our fishes. When they wiggle to the surface to transform they become available and are eaten in large numbers. But this period lasts only for about two or three weeks in autumn. In order to keep fish feeding conditions up to maximum efficiency other forms should be available in like amounts during the other six months of the feeding season. In the present state of our knowledge this would be a very difficult thing to do. It seems that a more practical way of using this supply of fish food would be to introduce the Cisco. This fish feeds at the deeper levels during the summer.

The hatching of fish and raising them to the eyed, fry, or fingerling stage has been developed to a very efficient level. The methods of transporting them to the place selected for planting are such that the loss is negligible. If the production and planting of young fish were the only things needed to increase the yield of legal sized fish in our streams, then the amount of fish in our streams and lakes would be limited only by the output of our hatcheries and that in turn only by the amount of money that we cared to expend on them.

We have a law that protects our game fish while on the breeding ground. The closed season should extend to July first as the bass are not all off the nest in the lake region before that time but the law is a good beginning. Many of our citizens contribute time and money to fish hatching.

Yet in spite of all of this work there remains this limiting factor of fish foods that determines the number and size of fish that we can produce in our waters. Often the damage done a stream or lake through drainage or pollution has not killed the fish directly but has made it impossible to grow much fish food and thus the fishes have been reduced indirectly.

An illustration may make this point clear. The Tippecanoe river was formerly a black bass stream for its entire length. In its upper course the bottom was a luxuriant meadow of water plants. This was filled with fish foods culminating in the minnows. Dredged ditches made tributary to the Tippecanoe have covered this natural bottom with sand for some miles below their mouths. This would not kill the bass directly, but there is little to support a fish fauna and consequently few if any fish.

When a lake is lowered few if any fish are killed directly, but the marginal plants which support and protect the organisms that form the basic elements in some of the food chains are destroyed.

But I have said enough to indicate the importance of the problems connected with fish food. Some of them are extremely difficult and their solution will take much time and energy. But they must be solved if we are to increase not only the number of fish *planted* but the number of fish *caught*. Mr. DeRyke's paper is a partial answer to one of these basic questions, "What do fish eat?"

FOODS OF THE COMMON FISHES OF WINONA LAKE, IN KOSCIUSKO COUNTY, INDIANA, DURING THE MONTHS OF JUNE, JULY, AND AUGUST

WILLIS DeRYKE

INTRODUCTION

In order to ascertain the kind of food utilized by the different common fishes of Winona Lake during the summer months, and the important ecological relations collections of fishes were made during the months of June, July, and August of the years of 1919, 1920, and 1921. In all, thirty-five collections were made and these from twenty-seven different locations on the lake, each location presenting a particular type of environment.

Two methods were used in securing the fish, the hook and line, and the seine; more frequently the latter. Several unsuccessful attempts were made to secure fishes from deep water by means of lines with hooks spaced at three and four meter intervals.

After a catch was made the stomachs of the large fish were removed immediately and placed in ninety-five per cent alcohol. In removing the stomachs care was taken not to lose the contents by the contraction of the muscular walls of the stomach. Before severing the stomach from the intestine and oesophagus, both ends were tied off with stout thread. The stomach was then freed and plunged into ninety-five per cent alcohol where it remained until examination could be made. The very large stomachs were injected with ninety-five per cent alcohol by using a hypodermic needle.

At the laboratory the stomachs were carefully opened and the contents removed, placed in a watch crystal or small vessel and examination made with a binocular microscope, the food then teased apart with needles or washed apart by means of a pipette. The very small food was examined under a compound microscope. The contents were identified as nearly as possible and a count was made of the specimens of each kind present and the number recorded.

The fish were identified and measured in millimeters the length being recorded as the distance from the tip of the nose to the base of the caudal fin. After the examination of the fish and stomach contents, both were preserved for future reference.

THE DATA

The following are the data for the thirty-five collections. The collections are numbered and are located on the map by corresponding numbers. Following the "date of the collection" the following seven points are always given in this order; vegetation in the vicinity, character of the bottom, depth of water, condition of water, weather conditions, time of day, and method of taking.

In each collection a species is named but once. Each individual is indicated by its length in millimeters and this is followed by its stomach contents.

Collection 1

June 25, 1919. Rushes, Chara, Potamogeton; sand and marl; two feet; clear; semi-cloudy; 1:00 p. m.; seine.

Fishes examined in this collection

Lepomis pallidus Mitchill (bluegill).
47 mm. 2812 Bosmina longirostris.
53 mm. 653 Bosmina longirostris; 3 Cyclops.
58 mm. 2 Cyclops; 3 small snails; 8 Bosmina longirostris; numerous diatoms.
Notropis sp. (species of minnow).
52 mm. A mass of undigested material that I was unable to identify.

Collection 2

June 28, 1919. Sparse growth of Chara and a very heavy growth of Potamogeton; blue mud very miry and oozy; ten to fifteen feet; clear; clear; 3:00 p. m.; hook and line.

Fishes examined in this collection

Lepomis pallidus Mitchill (bluegill).
141 mm. 306 Daphnia pulex; 1 Spinitectus gracilis.
113 mm. 3 Parasitic round worms; 50 Bosmina longirostris; Hyalella knickerbockeri; 1 large beetle unidentified; 3 pieces of encrusted plant tissue 1 cm. long and 1 mm. in diameter.

Collection 3

July 16, 1919. Potamogeton and Chara; sand; two and one-half feet; clear; clear; 3:00 p. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
Length, 85 mm. 6 ephemerida larvae; 10 Hyalella knickerbockeri; 1 amphiopod; 1 back-swimmer; 1 haliplid; 1 piece of plant tissue 2x5 mm.; 3 Chironomus larvae.
Micropterus salmoides Lacepede (large mouth black bass).
39 mm. 12 beetle larvae; 6 Leuceruthrus micropteri.
93 mm. 3 Leuceruthrus micropteri.
122 mm. Mass of macerated fish flesh; some algal filaments; 6 Leuceruthrus micropteri.
98 mm. 1 fish 15 mm. long; 1 fish 19 mm.; 1 fish 20 mm.; one piece of macerated fish flesh; a few algal filaments; a large mass of scales, bones and pigment cells; 15 Leuceruthrus micropteri.
43 mm. 2 amphipods; a macerated mass of fish flesh; 11 Leuceruthrus micropteri; 8 ephemerida larvae.
33 mm. 48 Hyalella; 15 Alonella; 1 Stylaria.
45 mm. 1 fish 23 mm.; 1 piece macerated fish flesh 64 mm. long; 6 Leuceruthrus micropteri.

38 mm. 15 Hyalella.
39 mm. 5 ephemerida larvae; 3 Hyalella.
51 mm. 1 fish 8 mm.; 1 fish 9 mm.; 1 fish 8 mm.; 3 Leuceruthrus.
42 mm. 30 ephemerida larvae.
47 mm. 15 ephemerida larvae.
32 mm. 16 ephemerida larvae; 3 Leuceruthrus.
44 mm. 10 ephemerida larvae; 1 Chironomus larvae.
42 mm. 1 fish 7 mm.; 1 fish 10 mm.

Catostomus nigricans Le Sueur (hog-molly).
142 mm. Mass of animal tissue; heads and appendages of several beetle larvae were distinguishable, but not clearly enough for identification.

Collection 4

July 22, 1919. Potamogeton, Chara, Vallisneria, spatter-dock, algae and duck weed; sand; one foot; clear; clear; 10:00 a. m.; seine.

Fishes examined in this collection

Lepomis pallidus Mitchill (bluegill).
15 mm. 6 Pleuroxus denticulus; 41 Cyclops.

Collection 5

July 24, 1919. Potamogeton, rushes; sand; one to two feet; clear; clear; 2:30 p. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
84 mm. 61 Sida crystallina; 6 tricoptera larvae; 3 Chironomus larvae; 2 nematoda.
72 mm. Fragments of insects or insect larvae.
86 mm. 25 Chironomus larvae; some insect fragments; 4 Planorbis; 3 Physa; algal fragments and silt.
77 mm. Small mass of animal tissue, otherwise empty.
70 mm. Fragments of insect larvae.
44 mm. 8 Chironomus larvae and a few algal filaments.
58 mm. One-half of the contents consists of algal filaments; the rest consisted of 8 Chironomus larvae; 5 ostracoda; 2 Planorbis; 1 Physa.
49 mm. 1 Planorbis; 3 Chironomus.
48 mm. 1 Ceratopogon larva; 5 Chironomus larvae; 2 ostracoda.
53 mm. 3 Chironomus larvae; 2 ostracoda; parts of a large beetle; 1 Planorbis.
46 mm. Mass of animal tissue.
53 mm. 3 large fragments of insect larvae.
51 mm. 1 Chironomus larvae; head of Dytiscus larvae; 5 Tanypus larvae.
75 mm. 4 Hyalella; 2 Chironomus larvae; 1 nematoda; 3 ostracoda.
54 mm. 1 Ceratopogon larvae and a few fragments of a beetle larvae.

Micropterus salmoides Lacepede (large mouth black bass).
67 mm. 1 bluegill 24 mm.; 1 bluegill 27 mm.; 1 damsel-fly; 1 spider; 64 cm. of fish flesh; 12 Leuceruthrus.

51 mm. Partially digested mass of fish flesh.
40 mm. 5 odonata larvae.

Eupomotis gibbosus L. (sunfish).
55 mm. 25 Chironomus larvae; some insect fragments; 4 Planorbis; 3 Physa; a few algal filaments; some silt.
65 mm. 1 Tanapus larvae; 1 Planorbis; a few insect fragments.
25 mm. 7 Chironomus larvae; 1 nematoda; 3 ostracoda; 1 Ceratopogon; a few pieces of plant tissue.
64 mm. 48 Chironomus larvae; 1 Ceratopogon; 1 ephemerid larvae; 3 Physa.

Notropis heterodon Cope (variable-toothed minnow).
50 mm. Unicellular algae; filamentous algae; 1 microscopic beetle.

Esox vermiculatus Le Sueur (grass pike).
95 mm. 3 Leuceruthrus.

Collection 6

August 2. 1919. Rushes; sand; three feet; clear; cloudy and foggy; 10:00 a. m.; seine.

Fishes examined in this collection

Lepomis pallidus Mitchill (bluegill).
90 mm. 3 Ephemerida larvae; 4 Tanypus; 2 rotifera; 1 damsel-fly; 5 Chironomus larvae; 2 cladocera; 3 Physa.

Labidesthes sicculus (skipjack) Cope.
77 mm. Empty.
76 mm. Empty.
76 mm. Fragments of small insects.
68 mm. Empty.
75 mm. Empty.
80 mm. Fragments of plant tissue.

Collection 7

August 7, 1919. Potamogeton, Elodea, rushes; peat very soft; three feet; clear; cloudy; 3:00 p. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
115 mm. 10 Ephemerida larvae; 5 Hyalella.
75 mm. 1 Physa; some plant tissue.
80 mm. 3 odonata larvae; 1 tricoptera.
82 mm. 2 Dytiscus larvae; 1 Hyalella; 1 Physa; some insect fragments; 1 ostracoda; 1 Chironomus larvae; 1 odonata nymph.
83 mm. 2 tricoptera larvae; 4 Chironomus larvae; 1 Physa; 3 ephemerida larvae; 10 tricoptera cases; several insect legs and pieces of plant tissue.
84 mm. About one-third of the content consists of Potamogeton; 7 Tricoptera larvae; 2 Hyalella; 1 ostracoda; 5 Chironomus larvae; mass of macerated insect larvae.

Lepomis pallidus Mitchill (bluegill).

81 mm. 14 Hyalella.

80 mm. Stomach empty.

98 mm. 12 tricoptera larvae and cases; 1 ceratopogon larva; small amount of plant tissue.

Micropterus salmoides Lacepede (large mouth black bass).

110 mm. Cephalothorax of cray-fish 20 mm. long.

59 mm. 1 fish 29 mm.; fragments of a neuropterus insect.

Etheostoma caprodes Raf. (log perch).

81 mm. 14 Hyalella; 2 Tanypus; 3 Chironomus larvae; 1 macerated insect; small amount of plant tissue.

84 mm. 10 Hyalella; 2 Nematoda, parasitic; fragment of a large beetle.

Collection 8

August 7, 1919. Potamogeton, Chara; marl and soft peat; two and one-half feet; turbid; clear; 2:30 p. m.; seine.

Fishes examined in this collection

Lepomis pallidus Mitchill (bluegill).

84 mm. 1 round worm; a small amount of plant tissue apparently Potamogeton; 1 ephemerid larva; 1 odonatid nymph; 1 Dytiscus larva (head); 2 chironomid larvae; 2 Physa; 3 water mites; 3 tricoptera larvae and cases; fragments of an odonatid larva and a few algae filaments.

55 mm. Stomach empty.

114 mm. 1 adult saw-fly (tenthredinidae); 10 Hyalella; 2 Ceratopogon; 2 ephemeridae larvae; 1 Spinitectus gracilis; 2 Chironomus larvae; 1 plecopteron nymph.

120 mm. 1 ephemerid larva; 1 tricopteron larva; the remainder of the stomach completely filled with Potamogeton tissue.

110 mm. 1 odonatid nymph; 5 ostracods; 6 Chironomus larvae; 1 hymenopteron; several small pieces of plant tissue.

Micropterus salmoides Lacepede (large mouth black bass).

102 mm. 8 small fish, lengths 15 mm., 17 mm., 25 mm., 23 mm., 18 mm., 20 mm., 16 mm., 20 mm.; a mass of about 5 cc. of fish flesh; 12 Leuceruthrus micropteri.

55 mm. 2 fish, lengths 11 mm. and 20 mm.

50 mm. A 125 cmm. piece of fish flesh; Leuceruthrus micropteri.

51 mm. A 216 cmm. of fish flesh; 5 trematodes, Leuceruthrus micropteri.

60 mm. 2 fish, 2 mm. each in length.

47 mm. 1 fish 27 mm. long; 3 Leuceruthrus micropteri; a small mass of partially digested fish flesh.

95 mm. 1 fish, length 18 mm.; 1 fish, length 12 mm.; 1 fish, length 20 mm.; 1 fish, length 30 mm. These fish are apparently bluegills. 15 trematodes (Leuceruthrus micropterus).

52 mm. 1 fish, partially digested, 12 mm. long; 1 trematode, Leuceruthrus micropteri.

Etheostoma caprodes Raf. (log perch).
55 mm. 10 Hyalella; 1 chironimid larva; 6 tricoptera cases; 2 parasitic nematoda; 1 rotifer.
Ambloplites rupestris Raf. (rock bass).
113 mm. Diatoms; a few pieces of plant tissue resembling Potamogeton and a few algae filaments.

Collection 9

August 11, 1919. Spatter-dock, Elodea, Ceratophyllum and Myriophyllum; soft mud; ten feet; clear; clear; 9:30 to 10:30 a. m.; hook and line.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
90 mm. 1 young cray-fish 20 mm. long; 2 odonata nymphs.
97 mm. 1 piece of fish flesh, about 125 cmm.
77 mm. Empty.
Lepomis pallidus Mitchill (bluegill).
108 mm. Stomach well filled with plant tissue; 2 Chironomus larvae; 1 water mite; 1 Sida crystallina; 3 Planorbis.
117 mm. With the exception of 1 Planorbis the stomach was entirely filled with plant tissue.
95 mm. 3 nematoda.

Collection 10

August 12, 1919. Spatter-dock, Elodea, Ceratophyllum, Myriophyllum, and Potamogeton; vegetable debris and marl; eight feet; clear; clear; 5:30 to 7:00 p. m.; hook and line.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
94 mm. 2 Physa.
Lepomis pallidus Mitchill (bluegill).
95 mm. 1 Chironomus larva; a mass of plant tissue; 5 nematoda; 2 ephemerida larvae; 2 Dytiscus larvae; 5 tricoptera cases and some macerated parts of an insect which I was unable to identify.
Eupomotis gibbosus Linnaeus (sunfish).
109 mm. 22 Gyraulus; 1 Chironomus larva and three nematoda.
132 mm. 40 Gyraulus.
Chaenobryttus gulosus Cuvier & Valenciennes (Warmouth bass).
110 mm. 1 large ephemerid larva; 1 small fish apparently just off the egg.
95 mm. Stomach empty.

SUMMER 1920

Collection 11

June 17, 1920. Potamogeton, Chara and rushes; sand and marl; three feet; clear; raining; 9:30 a. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).

69 mm. 9 heads of amphipods; 10 Chironomus larvae; 1 Notonecta.

113 mm. 2 odonata nymphs; 1 small fish 10 mm. long; 1 back-swimmer; 1 amphipod; Hyalella; a mass of fish eggs; 7 small Physa; 1 unidentified insect larva.

110 mm. Empty.

136 mm. 78 haliplidae larvae; 3 Chironomus larvae; a small amount of plant tissue.

Lepomis pallidus Mitchill (bluegill).

120 mm. 2 nematoda; and some encrusted plant tissue.

130 mm. 83 haliplidae larvae; 15 Physa 1 mm. in diameter; 6 water mites and 7 Chironomus larvae.

122 mm. Fish eggs, some of them showing well developed embryos; small amount of plant tissue; 3 small snails 1 mm. in diameter; 46 haliplidae larvae; 3 Hyalella; 28 Chironomus larvae; 5 ostracods and several fragments of a large insect.

Etheostoma caprodes Raf. (log perch).

71 mm. 26 haliplidae larvae; 1 fish egg and 6 cladocerans mutilated beyond possibility of identification.

Labidesthes sicculus Cope (skipjack).

65 mm. 3 small snails 1 mm. in diameter; 1 cladocera; 3 Chironomus larvae; 3 haliplidae larvae.

Collection 12

June 22, 1920. Potamogeton, Chara and rushes; sand and marl; three feet; clear; clear; 3:00 p. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).

88 mm. 1 small piece of plant tissue.

113 mm. 6 ephemerida larvae; 2 haliplidae larvae; 3 snails; 2 nematoda; a piece of plant tissue.

Lepomis pallidus Mitchill (bluegill).

45 mm. 8 Simulium larvae; 5 cladocerans; 1 large fragment of an insect.

110 mm. 15 odonata nymphs; 1 water mite; 1 fish egg; a few fragments haliplidae larvae; some yellow tissue apparently Potamogeton and a large mass of fragments of adult odonatas and odonata larvae.

69 mm. A mass of 51 fish eggs containing embryos; 8 Chironomus larvae and several fragments; 1 Hyalella; the head of a small insect larvae.

74 mm. 6 fish eggs; Sida crystallina, mutilated so much it was impossible to count, probably about 200; 8 Chironomus larvae.

44 mm. 12 Sida crystallina; 7 Chironomus larvae; 3 water mites; a few algae fragments; Spirogyra; 2 ostracods; 1 plant seed; many diatoms and a piece of plant tissue, apparently root, 1 mm. x 10 mm.

Micropterus salmoides Lacepede (large mouth black bass).

88 mm. 1 fish 20 mm. long; and 1 Leuceruthrus.

Etheostoma caprodes Raf. (log perch).

94 mm. 1 amphipod; Hyalella knickerbockeri; 6 Chironomus larvae; 1 tricopteron and case, and 1 Simulium larva.

Eupomotis gibbosus Linnaeus (sunfish).
82 mm. 2 small fragments of animal tissue and a very small piece of plant tissue.
154 mm. 4 haliplidae larvae; 35 small snails; 1 fragment of snail shell; a leg of a large insect.

Collection 13

June 26, 1920. Spatter-dock; Potamogeton and rushes; sand and marl; two feet; clear; clear; 3:00 p. m.; seine.

Fishes examined in this collection

Catostomus nigricans Le Sueur (hog-molly).
153 mm. Silt; sand and marl; 2 Stylaria.
159 mm. 61 ephemerida larvae; 20 aquatic oligochaetae; 6 Chironomus larvae; sand and silt.
153 mm. A large portion of neuropteron insect; 8 ephemerida larvae; 15 Chironomus larvae; sand and silt.
118 mm. Empty.

Collection 14

June 26, 1920. Chara, Potamogeton and rushes; sand and marl; three feet; clear; clear; 2:00 p. m.; seine.

Fishes examined in this collection

Catostomus nigricans Le Sueur (hog-molly).
187 mm. 3 Stylaria; 2 Ceratopogon; 2 Hyalella knickerbockeri; fine sand and silt.

Collection 15

June 26, 1920. Potamogeton, Chara and rushes; sand and marl; 3 feet; clear; clear; 4:00 p. m.; seine.

Fishes examined in this collection

Lepomis pallidus Mitchill (bluegill).
77 mm. 36 Chironomus larvae; 3 Chironomus pupae; 1 snail; 1 Hyalella knickerbockeri and the wings of a beetle.
40 mm. 4 water mites; 7 cladocerans and 2 ostracods.
Eupomotis gibbosus Linnaeus (sunfish).
70 mm. Empty.
Ambloplites rupestris Raf. (rock bass).
110 mm. 1 gyrinid and a few fragments.
Notropis heterodon Cope (variable-toothed minnow).
74 mm. Fragments of an adult neuropterus insect; wings and portion of abdomen, unable to identify.
Lepisosteus osseus Linnaeus (long-nosed gar).
542 mm. 2 snails.

Collection 16

June 30, 1920. Rushes and Chara; sand and gravel; four feet; clear; cloudy; 8:30 a. m.; seine.

Fishes examined in this collection

Etheostoma caprodes Raf. (log perch).
70 mm. 14 chironomidae larvae; 1 cladoceran.
77 mm. 49 Hyalella knickerbockeri; 2 chironomidae larvae; a small piece of stem resembling Equisetum.
Labidesthes sicculus Cope (skipjack).
70 mm. A portion of macerated winged insect, unable to identify.
66 mm. 2 adult insects, very small and torn so much I was unable to identify them.

Collection 17

June 30, 1920. Potamogeton and Chara; gravel; four feet; rippling; cloudy; 9:30 a. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
112 mm. 1 ephemerida larvae and a mass of Potamogeton.
80 mm. 1 Hyalella knickerbockeri; several fragments of insect larvae, unable to identify.
66 mm. Macerated insect larvae, unable to identify.

Collection 18

June 30, 1920. Algae, Chara, Ceratophyllum, Potomogeton, and dense growth; soft mud; two and one-half feet; clear; cloudy; 10:45 a. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
89 mm. 13 snails; 1 odonatid nymph; 2 ephemerida larvae; 1 tricopteron larva case; 4 Chironomus larvae; 3 Hyalella knickerbockeri; 2 haliplidae larvae.
127 mm. 2 Hyalella knickerbockeri; 1 haliplidae larva; 1 small cray-fish 15 mm. long.
73 mm. 5 Hyalella knickerbockeri; 2 Chironomus larvae; 118 Sida crystallina; numerous cladocera eggs.
116 mm. Portions of a small cray-fish and 1 Chironomus larva.
95 mm. 1 fish egg; 1 Chironomus larva; nematoda; debris.
113 mm. 31 tricoptera with cases; 1 snail; 1 Chironomus larva; small amount of plant tissue; 1 ephemerid nymph.
128 mm. A very small amount of fish flesh.
75 mm. 2 Chironomus larvae.
74 mm. 1 fish egg; portion of Haliplus beetle larva; the head of a Chironomus larva.

Lepomis pallidus Mitchill (bluegill).

97 mm. 2 haliplidae larvae; 1 tricopteron larva; 3 complete Chironomus larvae; 2 Hyalella knickerbockeri; about 5 cmm. of macerated, half-digested animal tissue consisting of fragments of a large insect larva; snail shells and portions of Chironomus larvae, and 1 round worm.

Lepomis megalotis Raf. (long-eared sunfish).

95 mm. 1 badly torn haliplidae beetle; 9 tricoptera larvae and cases; 3 Chironomus larvae; 1 Planorbis (snail).

Micropterus salmoides Lacepede (large mouth black bass).

25 mm. 20 Cyclops; 3 Chironomus larvae; 1 celled algae; 50 Bosmina.

31 mm. Empty.

Eupomotis gibbosus Linnaeus (sunfish).

100 mm. 1 larva not identified; 27 snails; 11 Chironomus larvae; 11 Hyalella; plant tissue, about 3 cmm.; sand and broken snail shells.

Notropis heterodon Cope (variable-toothed minnow).

45 mm. Empty.

55 mm. 14 fish eggs.

Etheostoma caprodes Raf. (log perch).

80 mm. 18 Chironomus larvae; 36 Hyalella.

80 mm. 5 Hyalella knickerbockeri; 4 Chironomus larvae.

Labidesthes sicculus Cope (skipjack).

84 mm. 2 half-digested haliplidae larvae.

Collection 19

July 12, 1920. Potamogeton, Vallisneria spiralis; gravel and mud; fifteen feet; turbid and roily; clear; 8:00 a. m.; hook and line.

Fishes examined in this collection

Lepomis pallidus Mitchill (bluegill).

132 mm. 1 snail; 2 nematoda; 9 Chironomus larvae; 4 heads of Chironomus larvae; fragments of an adult insect; a few pieces of plant tissue, probably Potamogeton; grains of sand and debris.

80 mm. Stomach well filled with plant tissue and 6 fish eggs.

101 mm. 2 snails; 15 Bosmina; small fragments of ephemerida larvae; 5 fish eggs; 2 Ceratopogan larvae and insect fragments.

121 mm. Empty.

100 mm. A mass of 35 filamentous fish eggs; 1 Chironomus larva.

83 mm. 1 damsel-fly nymph; 2 nematoda; 12 fish eggs; 1 snail; a mass of adult insect fragments, unable to identify; several heads of Chironomus larvae; a large portion of half-digested material.

93 mm. 2 snails; portions of cladocerans and adult insects.

75 mm. 1 Hyalella; 4 tricoptera larvae and cases; 2 large portions of Potamogeton leaves; 12 Chironomus larvae; 4 very minute snails; 3 water mites; many small grains of sand.

93 mm. 1 snail 2 mm. in diameter; 3 tricoptera cases and contents; Potamogeton plant tissue 25 mm. long and 3 mm. wide; 2 water mites; 3 ostracods; grains of sand and debris.

103 mm. Stomach fairly well filled with a portion of a large adult insect so macerated that identification cannot be made.

Collection 20

July 12, 1920. Potamogeton, Vallisneria spiralis and Chara; marl; twelve feet; roily; clear; 9:45 a. m.; hook and line.

Fishes examined in this collection

Lepomis pallidus Mitchill (bluegill).

92 mm. A mass of about 100 fish eggs; 5 nematoda; head and fragments of an adult beetle.

96 mm. 8 fish eggs; 3 water mites; 3 Chironomus larvae; 6 ostracods; 2 small pieces of Potamogeton 20 mm. long by 2 mm. wide; grains of sand; half-digested insect tissue.

102 mm. 6 snails 1 mm. in diameter; 1 Chironomus larvae, and several heads of Chironomus larvae; about 5 cmm. of plant tissue, apparently Potamogeton.

97 mm. A mass of about 200 fish eggs.

Collection 21

July 14, 1920. Chara, Potamogeton, Vallisneria spiralis, Myriophyllum; marl; twelve feet; roily; clear; 10:30 a. m.; hook and line.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).

112 mm. 3 Chironomus larvae; 2 odonata nymphs; 8 snails.

95 mm. 1 snail; Amnicola limnosa, variety porata; Goniobasis.

78 mm. 6 fish eggs.

88 mm. 4 cladocera and 2 tricoptera cases.

Collection 22

July 17, 1920. Myriophyllum, Vallisneria spiralis, Chara, Potamogeton; marl; ten feet; clear; clear; 10:30 a. m.; hook and line.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).

100 mm. 3 tricoptera; 2 cmm. of plant tissue; a few fragments of tricoptera larvae.

113 mm. 3d or 4th walking leg of a large cray-fish; 1 damsel-fly nymph; the partially-digested abdomen of a large insect.

92 mm. 1 Bosmina; 1 cladocera; macerated neuropteron or dipteron.

118 mm. 1 odonatid nymph.

114 mm. Empty.

115 mm. Empty.

110 mm. 1 small fish 25 mm. long; 5 cmm. of fish flesh; 1 odonatid nymph; 5 snails 2 mm. in diameter.

Lepomis pallidus Mitchill (bluegill).

82 mm. 1 adult tricopteron; 1 tricopteron case; 1 very small snail.

98 mm. 5 cmm. of Potamogeton plant tissue.

Micropterus salmoides Lacepede (large mouth black bass).

180 mm. Fish (Labidesthes sicculus Cope) 80 mm., 70 mm., 78 mm., and

65 mm. long; a mass of about 15 cmm. of portions of damsel-flies; heads; about 15 pairs of wings, legs and abdomen.

175 mm. 5 fish (Labidesthes sicculus Cope) 82, 77, 85, 63 and 76 mm. long; fragments of 3 damsel-flies.

344 mm. 2 chelipeds; 20 mm. x 5 mm. of a large cray-fish.

Pomoxis sparoides Lacepede (black crappie).

162 mm. About 72 cmm. of half-digested macerated fragments of adult insects and insect larvae, unable to identify the insects to which the fragments belong but most of them appear to be parts of tricoptera; 2 tricoptera; the abdomen and wings of a dipteron; 1 insect.

136 mm. Stomach well filled with fragments of tricoptera larvae; remainder fragments of adult insects and insect larvae, stomach well filled.

131 mm. Stomach well filled with fragments of adult insects and tricoptera larvae; 1 rhyncophora beetle very small.

129 mm. Head portion of a tricoptera larva.

Dorosoma cepedianum Raf. (hickory shad).

368 mm. Stomach completely filled with mud containing very small animals and plants such as algal filaments, ostracods, and fragments of cladocera.

374 mm. Stomach completely filled with mud containing very small animals and plants such as algal filaments, ostracods, and fragments of cladocera.

Esox lucius Lacepede (pike).

399 mm. Empty.

Chaenobryttus gulosus Cuv. and Val. (Warmouth bass).

86 mm. Small portion of encrusted plant tissue.

Collection 23

July 20, 1920. Algae, Chara, and Potamogeton; blue mud very oozy; twelve feet; muddy; clear; 3:00 p. m.; seine.

Fishes examined in this collection

Lepomis pallidus Mitchill (bluegill).

120 mm. Stomach filled with plant tissue and elytra 6 mm. long of a beetle. The plant tissue apparently Myriophyllum.

113 mm. 1 Dytiscid larva; 3 tricoptera larva worms; small mass of plant tissue; 4 Simulium larvae; 6 Chironomus larvae; a mass of half-digested insect and larvae fragments.

111 mm. Stomach well filled with a conglomerated mass of half-digested plant and animal tissue; many fragments of insect legs; pieces of chitinous covering.

117 mm. 2 Chironomus larvae; 1 piece of plant tissue 15 mm. x 2 mm.; remainder of stomach filled with partially digested fragments of a grasshopper.

119 mm. A few fragments of odonata nymphs; tricopteron larva; head of adult damsel-fly; 1 Chironomus larva; fragments of haliplidae beetle larvae; 4 complete larvae; a portion of a very small water beetle 2 mm. in diameter; 4 cmm. of Potamogeton plant tissue; numerous insect legs and leg fragments.

112 mm. About 8 cmm. of Potamogeton plant tissue.
114 mm. Head of Chironomus larva; stomach well filled with plant tissue and 2 round worms.
112 mm. Small portion of Myriophyllum plant tissue; the wings of an adult damsel-fly; 1 odonatid nymph; 1 Chironomus larva; 1 tricopteron; 3 tenthredinidae.
115 mm. Stomach well filled with portions of Potamogeton plant tissue and fragments of damsel-flies; Chironomus larvae and water mites.
94 mm. 8 fish eggs; 1 water mite; about 4 cmm. of animal tissue, unable to identify.
112 mm. Badly macerated, half-digested mass of animal tissue.
125 mm. 1 adult odonatid; 7 fish eggs.

Collection 24

July 27, 1920. Potamogeton, Elodea, algae, Vallisneria spiralis, Chara, duckweed, Myriophyllum, Ceratophyllum; marl, peat and vegetable debris; four feet; clear; clear and cool; 11:00 a. m.; seine.

Fishes examined in this collection

Lepomis pallidus (bluegill) Mitchill.
128 mm. Stomach well filled with Spirogyra and aquatic annelida averaging 3 mm. in length; about 300 aquatic annelida and 5 Chironomus larvae.
111 mm. 3 dragon-fly larvae and 10 large fragments; Spirogyra filaments; small piece of Nais 3 mm. long; 1 tricopteron larva and 5 aquatic annelida.

Collection 25

July 27, 1920. Potamogeton, dense growth of algae, Elodea, Vallisneria spiralis; sand and marl; two feet; clear; clear; 11:30 a. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
36 mm. 2 Chironomus larvae; 1 pupa; 193 cladocera; 24 Cyclops.
39 mm. 464 cladocera.
Lepomis pallidus Mitchill (bluegill).
16 mm. 21 Cyclops; diatoms and desmids.
13 mm. 6 cladocera; a few algae filaments.
11 mm. 3 cladocera; 12 Cyclops.
142 mm. Partially-digested animal tissue; grains of sand and debris; 1 aquatic annelida; 1 dipteron larva; 1 dipteron pupa; 3 mutilated flies and many small portions of flies.
21 mm. 115 cladocera; 1 Cyclops.
140 mm. 2 nematoda; about 6 cmm. of algae and Potamogeton plant tissue; 23 aquatic oligochaeta, sand and debris; 1 fly; 1 hymenopterus insect 5 mm. long.
68 mm. 3 mutilated flies; many small portions of flies.
82 mm. 3 nematoda; 1 midge pupa; 1 Planorbis; 1 stone-fly nymph; a few Spirogyra filaments; 316 cladocera; 91 Cyclops; 4 Chironomus larvae; 3 ostracods; 7 water mites.

68 mm. 111 cladocera; 14 Cyclops; 1 Ceratopogon; 2 Chironomus larvae; 1 mite; grains of sand and debris.
65 mm. 1 ceratopogomae; 3 Chironomus larvae; 4 water mites; 1 Phyra 1 mm. in diameter; 370 cladocéra; 37 Cyclops.
25 mm. 175 cladocera; 81 Cyclops.

Micropterus salmoides Lacepede (large mouth black bass).
40 mm. Spirogyra filament; 1 cladocera; diatoms and desmids.
48 mm. 4 Chironomus larvae; 107 cladocera; 28 Cyclops.
38 mm. 2 midge pupae; Spirogyra filaments; 4 Chironomus larvae; 1 piece of fish flesh 7 x 3 mm.; 16 cladocera.
40 mm. 1 small minnow, length 11 mm.; 97 cladocera; 38 Cyclops; 1 Dytiscus beetle larva.
38 mm. 2 ephemerida nymphs; 86 cladocera; 40 Cyclops.
338 mm. Empty.
32 mm. 185 cladocera; 8 Cyclops.
34 mm. 1 fish 12 mm. long.
35 mm. 130 cladocera and 30 Cyclops.

Etheostoma caprodes Raf. (log perch).
28 mm. 111 cladocera; 1 Cyclops; large number of diatoms; 1 desmid.

Labidesthes sicculus Cope (skipjack).
62 mm. 6 cladocera; diatoms, desmids; a few short pieces of algae.

Collection 26

August 4, 1920. Potamogeton, rushes, Chara, Elodea; sand; four feet; clear; clear and warm; 2:30 p. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
34 mm. 4 Chironomus larvae; 2 Chydorus; debris.
40 mm. 4 Chironomus larvae; 4 Chydorus; 2 Pleuroxus striatus; 3 ephemerida nymphs.
35 mm. 1 Chydorus; 2 Pleuroxus striatus; 3 Chironomus larvae.
39 mm. 3 Chironomus larvae; 1 water mite; 12 mutilated cladocera.
84 mm. 3 Hyalella.
35 mm. 4 Chironomus larvae; 5 partially-digested cladocera; debris.
38 mm. 7 Chironomus larvae; 2 fish eggs; 3 cladocera, Acroperus harpae; diatoms.
38 mm. 6 Chironomus larvae; 2 water mites; 3 Chydorus.
38 mm. 8 Chydorus; 9 Pleuroxus striatus; 2 Chironomus larvae; 1 damsel-fly nymph; 1 copepod.
36 mm. 3 Hyalella knickerbockeri; 6 Chironomus larvae; 10 cladocera; 3 Cyclops; 1 Ceratopogon.
40 mm. 10 Chironomus larvae; 2 Chydorus; 1 Pleuroxus striaties; 1 copepod; 4 cladocera mutilated so that identification is impossible.
37 mm. 2 tricoptera larvae; 1 Hyalella knickerbockeri; 1 Chironomus larva; 1 Chydorus; 4 mutilated cladocera.

Lepomis pallidus Mitchill (bluegill).
23 mm. 6 Chironomus larvae.

Micropterus salmoides Lacepede (large mouth black bass).
50 mm. 25 Leuceruthrus micropteri; 8 ephemerida larvae; 1 Hyalella knickerbockeri; 1 minute piece of fish flesh; 4 Chironomus larvae.
39 mm. 6 Hyalella; 3 Chironomus larvae; 2 Leuceruthrus micropteri.
35 mm. 18 Daphnia longispina; 11 Daphnia retrocurva; 4 Bosmina longirostris; 110 copepods.
31 mm. 2 Hyalella knickerbockeri; 3 Chironomus larvae; 2 Leuceruthrus micropteri; 4 mutilated, partially-digested cladocera; 1 ephemerid larva; 5 Cyclops.
45 mm. 17 Leuceruthrus micropteri.
40 mm. 1 Leuceruthrus micropteri, mutilated and partially digested; fragments of a small adult insect.
Catostomus nigricans Le Sueur (hog-molly).
24 mm. 1 may-fly nymph.
184 mm. 27 Chironomus larvae; 9 may-fly larvae.

Collection 27

August 13, 1920. Potamogeton, Elodea, algae, Vallisneria, Chara, duckweed, Myriophyllum and Ceratophyllum; sand; two feet; clear; fair and warm; 11:00 a. m.; seine.

Fishes examined in this collection

Micropterus salmoides Lacepede (large mouth black bass).
329 mm. Empty.
140 mm. 1 piece of fish flesh 10 mm. x 40 mm.
46 mm. 1 damsel-fly nymph; 3 Chironomus larvae; 1 Hyalella knickerbockeri and 3 cladocera.
48 mm. Odonata nymphs; 4 Hyalella knickerbockeri; 3 Chironomus larvae and 2 Ceratopogon.
Esox vermiculatus Le Sueur (grass pike).
252 mm. Cray-fish cheliped 13 x 40 mm.
272 mm. 1 piece of fish flesh 50 mm. x 15 mm.

Summer 1921

Collection 28

June 20, 1921. Chara, Potamogeton, spatter-dock, Elodea, Ceratophyllum; marl and vegetable debris; six feet; clear; clear and hot; 11:30 a. m.; hook and line.

Fishes examined in this collection

Lepomis pallidus Mitchill (bluegill).
113 mm. Very small fragments of animal tissue unable to determine.
83 mm. 1 beetle 5 mm. long.

Collection 29

June 21, 1921. Chara; sand and mud; three feet; clear; clear; 10:00 a. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).

70 mm. 12 tricoptera larvae and cases.

62 mm. 6 tricoptera larvae and cases; 10 Hyalella; 1 Dytiscus larva.

69 mm. 1 Hyalella; 1 cray-fish 11 mm. long; several masses of macerated, half-digested animal tissue.

28 mm. 1 cladoceran, Pleuroxus denticulatus; a small piece of animal tissue.

Lepomis pallidus Mitchill (bluegill).

43 mm. 1 Chironomus larva, 1 Simulium larva and 1 ostracod.

43 mm. Head of Dytiscus beetle larva; 1 Chironomus larva; 2 Hyalella; 2 ostracods; 2 water mites; 21 cladocera; fragments of abdomen of cray-fish.

45 mm. Empty.

38 mm. 5 Chironomus larvae; 115 cladocerans, Pleuroxus denticulatus.

48 mm. 1 Hyalella.

Micropterus salmoides Lacepede (large mouth black bass).

30 mm. Well filled with fish flesh.

24 mm. 2 Leuceruthrus micropteri.

Labidesthes sicculus Cope (skipjack).

82 mm. Fragments of a small hymenopterus insect.

62 mm. Macerated insect fragments.

62 mm. A few fragments of a Hyalella knickerbockeri; 450 Pleuroxus denticulatus; 1 beetle, Patrobus longicornus.

Collection 30

June 24, 1921. Potamogeton, Chara, Ceratophyllum; sand and marl; two and one-half feet; clear; clear; 9:00 a. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).

110 mm. 5 small fish, 6 mm. each in length.

116 mm. 3 small perch, 27 mm., 19 mm. and 12 mm.

112 mm. 9 small fish, length 12 mm. each.

115 mm. 3 fish, 13 mm. each.

108 mm. 1 fish 20 mm. long; 1 fish 18 mm. long; 1 fish 12 mm. long; 1 fish 10 mm. long.

61 mm. Empty.

117 mm. 1 fish 18 mm. long; 4 fish 11 mm. each; 1 fish 8 mm. long.

130 mm. 3 Physa 3 mm. diameter; 2 fish, each 18 mm. long; 2 fish, each 10 mm. long.

118 mm. 2 damsel-fly nymphs; head and thorax of damsel-fly nymph 5 mm. long; 3 fish 10 mm. each.

124 mm. 8 Pleuroxus denticulatus; 3 Physa; 1 fish 20 mm. long; 4 fish 10 mm. each.

114 mm. 1 piece of fish flesh 2 x 10 mm.

113 mm. 2 fish 11 mm. each; 2 fish 6 mm. each.

115 mm. 1 fish 8 mm. long; 1 Physa 2 mm. in diameter.

154 mm. Empty.

115 mm. 2 fish 10 mm. each; 2 fish 7 mm. each.
118 mm. A piece of fish flesh 6 x 20 mm.
125 mm. 1 Chironomus larva; 5 Pleuroxus denticulatus; 1 piece of fish flesh 3 x 10 mm.
117 mm. 1 fish 23 mm. long; 2 fish 20 mm. each; 3 fish 15 mm. each; 2 fish 8 mm. each.
118 mm. 1 odonatid larva; 1 fish 10 mm. long; 4 fish 8 mm. long; debris.
72 mm. 1 damsel-fly larva; 1 Hyalella; 1 Haliplus larva; 2 Peltodytes larvae.
102 mm. 1 log perch 24 mm. long; 4 fish 12 mm. long; 2 Pleurocera snails 3 mm. in diameter; 1 Leuceruthrus micropteri.
110 mm. 1 log perch 25 mm. long; 1 fish 11 mm. long; 2 small masses of fish flesh.
76 mm. 1 fish 15 mm long; 12 snail bodies 3 mm. in diameter.
122 mm. 1 fish 23 mm. long; 9 fish, average 10 mm. in length.
66 mm. 1 Chironomus larva; 1 Hyalella knickerbockeri; 3 small masses of partially-digested snails.
59 mm. Several minute pieces of fish flesh.
105 mm. 2 fish 13 mm. long; 1 ephemerid larva.
98 mm. 2 fish 13 mm. long; 2 fish 9 mm. long.
99 mm. 4 fish, average 18 mm. long.
110 mm. 1 fish, 10 mm. long.
117 mm. 2 portions of fish flesh 4 mm. in diameter.
60 mm. 28 Pleuroxus denticulatus.
100 mm. 2 fish 12 mm. each; a mass of fish bones.
118 mm. 1 fish 12 mm. long; 2 masses of fish flesh, each 3 mm. in diameter.
118 mm. 1 Chironomus larva; 1 fish 22 mm. long.
113 mm. 1 fish 10 mm. long; 2 masses of fish flesh 2 x 10 mm. each.
71 mm. 2 fish 11 mm. each; 1 fish egg; 4 Pleuroxus denticulatus.
123 mm. 1 fish 25 mm. long; 7 fish 12 mm. long; 2 fish 9 mm. long; 3 small portions of Chara tissue 1 x 6 mm.
182 mm. 1 cray-fish 25 mm. long; 2 cray-fish 20 mm. each; 1 fish 20 mm. long.
116 mm. 1 fish 25 mm. long; 15 Pleuroxus denticulatus.
154 mm. 1 fish 15 mm. long; about 5 cmm. of fish flesh.
60 mm. 5 Chironomus larvae; 3 Hyalella knickerbockeri; 1 tricopteron larva; small portions of plant tissue and debris.
112 mm. 1 fish 7 mm. long.
147 mm. 1 fish 20 mm. long; 2 fish 10 mm. each.
111 mm. 2 tricoptera larvae; 1 piece of fish flesh 3 x 9 mm.
59 mm. 7 small Pleurocera snails, 1 mm. in diameter; several very small macerated insect fragments.
127 mm. 1 Physa (snail) 2 mm. in diameter; 3 small fish, average 3 mm.; 2 minute fish flesh fragments.
115 mm. 2 small fish, length 13 mm. each; 2 very small masses of fish flesh.
67 mm. Well filled with fragments of an adult odonata.
117 mm. 2 pieces of fish flesh 3 x 10 mm. and 1 x 5 mm.
90 mm. 3 Chironomus larvae; 1 fish 20 mm. long; 7 fish eggs;; 2 very small pieces of plant tissue.

46 mm. 2 cladocerans; Pleuroxus denticulatus; 1 Pleurocera.
125 mm. 6 fish, average 10 mm. long; 5 tricoptera larvae and cases.
162 mm. 2 haliplidae larvae.
65 mm. 1 fish 14 mm. long.
128 mm. 3 log perch, 20 mm. each; 2 fish 10 mm. each; abdomen of a large odonata larva.
102 mm. 1 water mite; 1 piece of fish flesh 2 x 4 mm.; 1 Leuceruthrus micropteri.
72 mm. 1 Chironomus larva; 1 small piece of fish flesh 1 x 3 mm.; 13 partially digested snails 2 mm. in diameter; several shell fragments.
104 mm. 3 small fish, average 11 mm. long.
122 mm. 8 small fish, average length 8 mm.; 2 tricoptera cases and larvae; a very small amount of plant tissue.
63 mm. 3 Hyalella knickerbockeri; 2 ostracods; 1 Chironomus larva.
106 mm. Empty.
118 mm. 4 small fish, average 10 mm. long.
122 mm. 1 haliplidae beetle larvae; 1 Chironomus larva; 4 small fish, average 8 mm. long; several fish fragments.
100 mm. 2 water mites; 2 tricoptera larvae; 2 tricoptera cases; 23 half-digested snails, Pleurocera.
60 mm. 5 water mites; 7 Lymnaea, 1 mm. in diameter.
66 mm. 8 haliplidae beetle larvae.
104 mm. Very small mass of half-digested fish flesh.
57 mm. Empty.
79 mm. Practically empty except for a very small mass of half-digested animal tissue.
103 mm. 1 small fish 10 mm. long.
106 mm. 2 small fish, 12 mm. each.
103 mm. 9 Physae, 3 mm. in diameter; 7 small fish, average 11 mm. long; 4 tricoptera cases.
108 mm. Empty.
119 mm. 16 Pleurocera; 2 small fish, average 12 mm. long; a mass of sand and debris.

Lepomis pallidus Mitchill (bluegill).
65 mm. 2 water mites; 1 small fish 14 mm. long; 1 adult midge-fly.
41 mm. 18 octracods; 1 water mite; about 500 Bosmina obtusirostris.
35 mm. 1 ostracod; 2 Chironomus larvae.

Micropterus salmoides Lacepede (large mouth black bass).
24 mm. 1 small fish 9 mm. long.

Etheostoma caprodes Raf. (log perch).
63 mm. 1 ostracod; 1 Pleurocera.
57 mm. 1 snail body 2 mm. in diameter.
68 mm. 4 Chironomus larvae; 5 heads of Chironomus larvae; 2 Hyalella knickerbockeri.
62 mm. 1 Hyalella knickerbockeri; 5 snail bodies; several grains of sand; pieces of shell and debris.
62 mm. 10 Chironomus larvae; 7 Hyalella knickerbockeri; 15 cladocerans; Bosmina; 3 tricoptera; 2 tricoptera cases; 1 Physa, 1 mm. in diameter; 1 Pleurocera, 1 mm. in diameter.
59 mm. 2 damsel-fly larvae; 8 Chironomus larvae; 7 Planorbis.

55 mm. 3 heads of Chironomus larvae; 3 badly torn cladocerans; 2 macerated Hyalella.
62 mm. 1 snail body, 3 mm. in diameter.
60 mm. 2 Chironomus larvae; 2 cladocerans.
65 mm. 18 Haliplus beetle larvae; grains of sand and debris.
69 mm. 5 fragments of partially-digested snails; 1 Hyalella; 3 ephemerida larvae.
65 mm. 6 snail bodies; small piece of plant stem.
60 mm. Empty.

Labidesthes sicculus Cope (skipjack).
71 mm. 1 tricoptera larva and case; 1 adult chironomidae; 5 very small aphids.
75 mm. 10 aphids.
53 mm. 1 small half-digested insect.
58 mm. 1 small wasp; 2 ephemerida larvae.
84 mm. 3 tricoptera cases; 3 aphids; several grains of sand.
56 mm. A very small, half-digested mass of insect tissue.
74 mm. 13 very small cladocerans.

Collection 31

July 6, 1921. Potamogeton, Chara, Myriophyllum, Ceratophyllum, spatterdock; fine sand; two feet; clear; clear; 10:00 a. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
79 mm. Fragments of odonatid nymph; 3 odonata nymphs; a small piece of plant tissue.

Lepomis pallidus Mitchill (bluegill).
43 mm. 4 ostracods; 1 water mite; 881 cladocerans, Bosmina obtusirostris and Pleuroxus denticulatus.
39 mm. 5 Chironomus larvae; 1 cladocera.
40 mm. Chironomus larvae; 4 ostracods; 3 Hyalella knickerbockeri; 2 cladocera; sand and debris.
50 mm. 1 tricopteron and case; 8 water mites; 9 Chironomus larvae; 1 Hyalella; Spinitectus gracilis.

Micropterus salmoides Lacepede (large mouth black bass).
38 mm. 2 Chironomus larvae; 1 small piece of fish flesh.
46 mm. Stomach well filled with fish flesh.
44 mm. 1 Chironomus larva; stomach well filled with fish flesh.
108 mm. Well filled with fish flesh and 24 Leuceruthrus micropteri.
32 mm. Stomach well filled with fish flesh.

Eupomotus gibbosus Linnaeus (sunfish).
77 mm. 1 Spinitectus gracilis; stomach well filled with partially-digested insect tissue.

Catostomus nigricans Le Sueur (hog-molly).
85 mm. 6 Chironomus larvae; 1 tricopteron case; grains of sand and debris.
90 mm. 42 Chironomus larvae; grains of sand and debris.
108 mm. 9 Chironomus larvae; sand and debris.

80 mm. Empty.

Ambloplites rupestris Raf. (rock bass).

50 mm. 3 Chironomus larvae; fragments of a large insect, apparently hymenopterous, filled the stomach.

49 mm. 3 Hyalella; 15 Chironomus larvae.

Collection 32

July 9, 1921. Chara; sand and fine gravel; 3 feet; clear; cloudy and windy; 9:00 a. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).

34. mm. 1 Hyalella.

Lepomis pallidus Mitchill (bluegill).

51 mm. 4 Chironomus larvae; 2 water mites; 3 Hyalella.

Micropterus salmoides Lacepede (large mouth black bass).

51 mm. 2 fish eggs; 1 fish 25 mm. long; 7 cmm. of fish flesh.

58 mm. 1 fish 10 mm. long; 1 fish 18 mm. long; 1 fish 8 mm. long.

37 mm. 1 ephemerid larva; 15 Hyalella.

28 mm. 2 Hyalella.

30 mm. 3 Hyalella; 2 Chironomus larvae.

33 mm. 1 ephemerid larva; 16 Hyalella.

37 mm. 2 Chironomus larvae; 19 Hyalella; 4 cmm. of fish flesh.

34 mm. Thorax and abdomen of 2 ephemeridae larvae; 3 Hyalella; 2 heads of Chironomus larvae.

55 mm. 1 fish 7 mm. long; 5 cmm. of fish flesh; 1 Leuceruthrus micropteri.

32 mm. 6 Hyalella; 2 Chironomus larvae.

35 mm. 19 Hyalella; abdomen of ephemerida larva.

38 mm. 14 Hyalella.

51 mm. 1 fish 20 mm. long; 1 fish 10 mm. long.

46 mm. 6 cmm. of fish flesh.

44 mm. 1 fish 15 mm. long; 2 ephemerida larvae; 6 Hyalella; 1 fish fin; 2 buds from Chara.

49 mm. 1 fish 18 mm. long; 3 cmm. of fish flesh.

36 mm. 2 ephemerida larvae; 7 Hyalella.

35 mm. 10 Hyalella.

54 mm. 1 Chironomus larva; 14 Hyalella.

40 mm. 1 insect pupa, 1 Chironomus larva; 8 Hyalella.

36 mm. 3 ephemerida larvae; 13 Hyalella.

35 mm. 6 haliplidae larvae; 1 fish 15 mm. long.

33 mm. 2 ephemerida larvae; 12 Hyalella.

40 mm. 1 fish 17 mm. long; 1 fish 10 mm. long; 1 Leuceruthrus micropteri; 2 cmm. fish flesh.

55 mm. 2 Leuceruthrus micropteri.

63 mm. 1 Peltodytes larva; 3 Leuceruthrus micropteri; 2 fish 20 mm. each.

52 mm. 1 fish 22 mm. long; 5 Leuceruthrus micropteri.

58 mm. Very small fragments of insect.

42 mm. Eye stalks and antennae of a very young cray-fish; 14 Hyalella.
35 mm. 1 haliplidae larva; 10 Hyalella.
53 mm. 1 fish 15 mm. long; 1 piece of fish flesh 3 cmm.; 2 Leuceruthrus micropteri.
31 mm. 3 Hyalella; 4 partially digested cladocera; 1 Leuceruthrus micropteri.
37 mm. 1 Hyalella.
52 mm. 4 cmm. of fish flesh; 2 Leuceruthrus micropteri.

Etheostoma caprodes Raf. (log perch).
70 mm. 11 Hyalella; 1 ephemerid nymph; 1 tricopteron larva.
75 mm. 1 Chironomus larva; 4 caddis worms and cases; 25 Hyalella; several grains of sand.
77 mm. 1 neuropteron larva; 2 ephemerida larvae; 29 Hyalella; 8 Chironomus larvae; 1 ostracod; several grains of sand.
62 mm. 1 Chironomus larva; 1 ephemerid larva; 3 caddis worms and cases; 22 Hyalella; sand and debris.
66 mm. 12 Hyalella; 3 tricoptera larva; 1 tricopteron case.
69 mm. 12 Hyalella; 2 ephemerida larvae; 1 Chironomus larva; 1 tricopteron and case.
64 mm. 9 Hyalella; 1 tricopteron and case; several legs of a small insect.
62 mm. 24 Hyalella.
70 mm. 3 tricoptera and cases; 17 Hyalella; grains of sand and debris.
62 mm. 10 Hyalella; 4 cmm. of animal tissue.
62 mm. 11 Hyalella; 4 tricoptera larvae.
61 mm. 1 ephemerid; 17 Hyalella.
43 mm. 1 ephemerid larva; 15 Hyalella; grains of sand and debris.
70 mm. 31 Hyalella.
72 mm. 2 Chironomus larvae; 4 Hyalella.

Labidesthes sicculus Cope (skipjack).
67 mm. Empty.

Collection 33

July 16, 1921. Algae, Ceratophyllum, Potamogeton; sand and marl; three feet; clear; extremely hot and clear; 10:30 a. m.; seine.

Fishes examined in this collection

Lepomis pallidus Mitchill (bluegill).
101 mm. 25 Chironomus larvae; 3 ostracods; mass of partially-digested animal tissue; sand and debris.
75 mm. 6 Chironomus larvae; other contents digested beyond possibility of identification.
61 mm. 1 small snail; 1 tricopteron case; 10 Chironomus larvae; 9 ostracods.
59 mm. 17 cladocera; 42 ostracods; 8 Chironomus larvae; 3 Physa; 1 Planorbis snail; 1 tricopteron and case.
111 mm. 41 Chironomus larvae; 2 tricoptera larvae; 3 ephemeridae larvae; 7 ostracods; 3 Chironomus larvae; 2 Hyalella; algae; sand; silt and debris.

90 mm. 20 Chironomus larvae; 2 tricoptera larvae; 4 ostracods; plant tissue; sand and debris.

79 mm. 8 Chironomus larvae; 4 ostracods; mass of plant tissue.

99 mm. 38 Chironomus larvae; 4 Chironomus pupa; 8 ostracods; 1 Physa; algae; debris and sand.

96 mm. 5 Chironomus larvae; 4 ostracods; 3 Planorbis; 2 tricoptera larvae; Potamogeton plant tissue; sand and silt.

94 mm. 28 Chironomus larvae; 5 tricoptera larvae; mass of partially-digested animal tissue; algae; sand and silt.

82 mm. 17 Chironomus larvae; 2 Ceratopogon; 1 Physa shell; a small mass of half-digested plant and animal tissue; a few grains of sand and debris.

69 mm. 9 Chironomus larvae; 3 ostracods; rest of contents consists of algae, diatoms and small pieces of Potamogeton.

75 mm. 12 Chironomus larvae; stomach well filled with half-digested masses of algae.

59 mm. 5 tricoptera and cases; 1 Chironomus larva; 3 ostracods; 1 Physa; 1 water mite; 3 odonata nymphs; 2 Ceratopogon; 2 Chironomus larvae heads; grains of sand and debris.

100 mm. 2 tricoptera larvae and cases; 23 Chironomus larvae; 2 fish eggs; 7 ostracods; 1 Planorbis; small masses of half-digested algae and animal tissue.

66 mm. 5 Chironomus larvae; 1 water mite; masses of partially-digested animal tissue and debris.

65 mm. 8 ostracods; 4 Hyalella; 18 Chironomus larvae; 3 aquatic oligochaetae; 10 tricoptera larva; algae and debris.

66 mm. 6 tricoptera; 9 ostracods; 15 Chironomus larvae; Volvox; Zygnema; Oscillatoria; debris.

79 mm. 6 ostracods; 3 Cyclops; 3 cladocera; mass of algae and debris; stomach well filled.

111 mm. 72 Chironomus larvae; 12 ostracods; 2 midge pupa; algae and debris.

86 mm. 1 Spinitectus gracilus; 11 Chironomus larvae; 1 tricopteron larva; 3 ostracods; 1 Physa; algae; sand and debris.

86 mm. 16 Chironomus larvae; 5 tricoptera larvae; 9 cladocera; 8 ostracods; 2 Physa; algae and debris.

97 mm. 25 Chironomus larvae; 3 ostracods; 1 Physa; 1 tricopteron larva and case; 1 Planorbis; masses of partially-digested animal tissue; sand and debris.

90 mm. 19 Physa; 4 ephemerida larvae; 1 cladocera; 3 Planorbis; algae; sand and debris.

64 mm. 3 Chironomus larvae; 2 ostracods; 1 caddis-fly larva and case; partially-digested fragments of insect larvae.

50 mm. 6 Chironomus larvae; 1 ostracod; algae and debris.

83 mm. 6 caddis-fly larvae; 40 Chironomus larvae; 7 ostracods; sand and debris.

90 mm. 1 odonatid nymph; 28 Chironomus larvae; partially-digested insect tissue and debris.

57 mm. 1 Hyalella; 8 Chironomus larvae; 1 caddis-fly larva and case.
93 mm. 18 Chironomus larvae; 9 ostracods; mass of partially-digested animal tissue; a mass of plant tissue; sand and debris.
77 mm. 45 Chironomus larvae; 17 cladocera; 5 Cyclops; 11 ostracods; 1 Physa; algae; sand and debris.
106 mm. 1 Planorbis; 37 Chironomus larvae; 1 Chironomus pupa; 8 Physa; 2 tricoptera larvae; 7 ostracods; 2 odonata nymphs; 1 Hyalella knickerbockeri; debris.
92 mm. 7 ostracods; 15 Chironomus larvae; 2 Simulium larvae; algae; partially-digested animal tissue; debris.
93 mm. 2 Physa; 10 Chironomus larvae; partially-digested insect larva; algae and debris.
94 mm. 1 ephemerid larva; 22 Chironomus larvae; 8 ostracods; 1 Cyclops; 5 cladocera; 2 tricoptera larvae; 1 Physa; algae; sand and debris.
98 mm. 3 Cyclops; 5 ostracods; 25 Chironomus larvae; 8 tricoptera larvae; algae; silt and debris.
82 mm. 1 Cyclops; 23 Chironomus larvae; 1 snail; 1 Chironomus pupa; algae; sand and debris.
97 mm. 1 Cyclops; 12 Chironomus larvae; 1 Simulium; 4 tricoptera larvae; algae and sand.

Micropterus salmoides Lacepede (large mouth black bass).
311 mm. 1 tricopteron and case; about 7 cmm. of plant tissue (Ceratophyllum); 3 Leuceruthrus micropteri; a few fish bones and scales.
61 mm. 1 fish 15 mm.; 2 cmm. fish flesh.

Etheostoma caprodes Raf. (log perch).
62 mm. 2 ephemerida larvae; 29 Hyalella.

Collection 34

July 21, 1921. Chara, algae, Potamogeton, rushes; marl; two feet; clear; clear; 11:00 a. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
139 mm. 1 fish 13 mm. long.
90 mm. Plant tissue; fragment of insect.
118 mm. Empty.
109 mm. 1 large odonatid nymph.
66 mm. 1 odonata larva.
71 mm. 2 ephemerida larvae; 1 Chironomus larva; 1 damsel-fly larva.
65 mm. 5 cladocerans; 1 Hyalella; 2 Chironomus larvae; 1 tricopteron larva; 1 ephemerid larva; 4 ostracods.
84 mm. 1 large odonatid nymph.
40 mm. 5 Hyalella; 1 ostracod; 1 ephemerid nymph.
67 mm. 1 Hyalella knickerbockeri; 1 tricopteron larva; 2 Haliplus larvae.
48 mm. 1 Physa 1 mm. in diameter; small fragments of fish.
64 mm. 3 tricoptera larvae; 1 earthworm, 14 mm. long; 1 ephemerid larva.

71 mm. Filled with partially-digested fish flesh.
71 mm. 25 Physa, average 1 mm. in diameter.
40 mm. 38 partially-digested cladocerans; 7 Hyalella; 1 Chironomus larva; 25 cladocera eggs; 1 may-fly larva.
80 mm. 1 ephemerid larva.
70 mm. Empty.
80 mm. 1 full grown odonatid larva; 3 fragments of a dragon-fly larva.
94 mm. 2 large odonata larvae.
66 mm. 26 Chironomus larvae; 3 ephemerida larvae; 2 Hyalella; 3 tricoptera larvae; 1 cladoceran.
72 mm. 12 Physa, average 2 mm. in diameter.

Lepomis pallidus Mitchill (bluegill).

72 mm. 4 tricoptera larvae.
64 mm. 1 cladoceran; 2 tricoptera larvae; 1 Physa; 1 Planorbis; plant tissue.
59 mm. 2 ephemerida larvae; 2 Chironomus larvae; 1 Physa snail; 15 tricoptera larvae.
20 mm. 5 cladocerans; 1 ostracod.

Micropterus salmoides Lacepede (large mouth black bass).

43 mm. 6 Hyalella; 2 Chironomus larvae; 1 odonatid larva; 2 ephemerida nymphs; 1 damsel-fly head; 1 may-fly head; several insect fragments.
43 mm. 1 ephemerida nymph; 4 ephemerida larvae; 3 cladocerans; 2 Hyalella knickerbockeri; 3 Chironomus larvae.
35 mm. 2 ephemerida nymphs; 3 Chironomus larvae.
60 mm. 1 fish 30 mm. long; 1 Leuceruthrus micropteri.
60 mm. 1 fish 30 mm. long; 1 Leuceruthrus micropteri.
60 mm. 1 odonatid larvae; 1 dipteron; 1 dipteron larva; fragments of insects.
47 mm. 1 ring perch 15 mm. long.
60 mm. 1 fish 20 mm. long; abdomen and leg of an insect; 2 Leuceruthrus micropteri.
69 mm. 1 fish 30 mm. long; 1 fish 12 mm. long; a few small fragments of fish flesh.
49 mm. 3 cmm. of fish flesh; 1 may-fly larva.
68 mm. Mass of fish flesh; 1 Leuceruthrus micropteri.
67 mm. 1 fish 13 mm. long; 1 large odonatid nymph; 2 Leuceruthrus micropteri.
40 mm. 2 ephemerida nymphs.
39 mm. 2 odonata nymphs; 2 cladocerans.
58 mm. 2 Leuceruthrus micropteri; 2 Hyalella; 1 small piece of plant stem; remainder consisted of fish flesh, stomach well filled.
45 mm. 1 plecopteron nymph; 3 odonata nymphs; 4 ephemerida nymphs; 2 Hyalella.
50 mm. 1 fish 18 mm. long.
45 mm. 1 ephemerid nymph; 1 Leuceruthrus micropteri.
56 mm. 1 ephemerid nymph.
52 mm. 1 fish 11 mm. long; 2 Leuceruthrus micropteri.
60 mm. 1 fish 21 mm. long; 1 odonatid nymph; Chara; 5 Leuceruthrus micropteri.

57 mm. 1 fish 15 mm. long; 1 fish 10 mm. long.
52 mm. Stomach well filled with fish flesh.
48 mm. 3 odonata larvae; 2 Hyalella knickerbockeri.
50 mm. Stomach well filled with fragments of 3 may-fly larvae.
38 mm. 1 bluegill 14 mm. long; several small pieces of fish flesh.
56 mm. 1 bluegill 15 mm. long; about 5 cmm. of fish flesh.
51 mm. 1 fish 15 mm. long; 1 ephemerid nymph; 2 very small pieces of plant stem.
41 mm. 3 odonata larvae; 2 Hyalella knickerbockeri; 1 cladoceran; 2 ephemerida larvae.
66 mm. Well filled with fish flesh.
57 mm. 1 fish 30 mm. long; 3 Leuceruthrus micropteri.
39 mm. 1 odonatid nymph.

Etheostoma caprodes Raf. (log perch).
67 mm. 25 Hyalella; 1 tricopteron larva; abdomen of Haliplus beetle larva.
78 mm. 2 odonata nymphs; 13 Hyalella; 2 Chironomus larvae.
70 mm. 4 Chironomus larvae; 1 Chironomus pupa; 1 Hyalella knickerbockeri.
42 mm. 1 Hyalella knickerbockeri; 3 cladocerans; 7 Chironomus larvae; 1 may-fly larva.
90 mm. 7 Hyalella knickerbockeri; 1 ostracod; 2 tricoptera larvae; 1 Planorbis.
44 mm. 3 cladocera; 3 Hyalella knickerbockeri; 2 ephemerida larvae; 2 Physa.
46 mm. 4 ephemerida larvae; 4 Hyalella knickerbockeri; 1 ostracod; 1 tricopteron larva.

Eupomotis gibbosus Linnaeus (sunfish).
68 mm. 8 partially-digested snails.

Collection 35

July 27, 1921. Chara, rushes and Potamogeton; marl; two feet; clear; clear; hot; 3:00 p. m.; seine.

Fishes examined in this collection

Perca flavescens Mitchill (yellow perch).
145 mm. Fragments of a cray-fish; 11 Physa, average 2 mm. in diameter; 1 Chironomus larva; small pieces of plant tissue.
147 mm. 1 tricopteron larva; 1 cray-fish 25 mm. long.
121 mm. 9 Physa, average 3 mm. in diameter.
172 mm. 1 cray-fish 40 mm. long; 1 Chara bud.
103 mm. 4 Physa, diameter of each was 3 mm.
115 mm. 1 fish 10 mm. long; 11 Physa, average 2 mm. in diameter; 2 Chara buds.
87 mm. 1 cray-fish 30 mm. long.

Lepomis pallidus Mitchill (bluegill).
55 mm. 502 Chydorus and Pleuroxus striatus; 51 ostracods; 1 tricopteron larva; a few algal filaments.

Micropterus salmoides Lacepede (large mouth black bass).

54 mm. 1 Labidesthes sicculus 22 mm. long.

54 mm. 1 fish 15 mm. long; 3 Leuceruthrus micropteri.

53 mm. 2 Labidesthes sicculus 27 mm. long; 1 Labidesthes sicculus 25 mm. long; 2 Labidesthes sicculus 14 mm. long; 3 Leuceruthrus micropteri.

Etheostoma caprodes Raf. (log perch).

85 mm. 8 Chironomus larvae; head of tricoptera larva; silt and debris.

73 mm. 3 tricoptera larvae; 5 Chironomus larvae; 18 cladocerans; 1 water mite.

76 mm. 88 Chydorus and Pleuroxus striatus; 5 ostracods; 8 Hyalella; 1 ephemerid nymph.

71 mm. 69 Chydorus and Pleuroxus striatus; 9 tricoptera larvae; 3 Chironomus pupae; 2 Chironomus larvae; 6 Hyalella.

102 mm. 11 tricoptera larvae; 3 Chironomus larvae; 5 cladocerans.

Eupomotis gibbosus Linn. (sunfish).

65 mm. 38 Hyalella; 6 ephemerida nymphs; 6 Chironomus larvae; 2 tricoptera larvae; sand, silt and debris.

The number of species examined during the three summers was seventeen, comprising a total of 575 specimens. In tables I, II, III, and IV the fish are arranged in groups of ten mm. difference in length. The number in the second column indicates the number of fish in the group and the numbers in the following columns are the sum of the various foods found in all of the fishes in the group.

In tables V, VI, and VII the fishes are arranged separately in the order of their length.

A number of parasitic nematoda and trematoda were found and are recorded in these tables.

Perca flavescens Mitchill (Yellow perch). Table I.

Length of Fish in mm.	Number of fish.	Cladocera.	Copepoda.	Ostracoda.	Amphipoda.	Crayfish.	Chironomus.	Tricoptera larvae.	Dytiscus larvae.	Haliplidae larvae.	Odonata.	Odonata nymphs.		Ephemerida nymphs.	Tanypus larvae.	Notonecta.	Haliplidae adult.	Insect fragments.	Perca flavescens.	Lepomis pallidus.	Unidentified fish.	Fish eggs.	Fish flesh.	Gastropoda.	Hydrachnida.	Potamogeton.	Myriophyllum	Alga.	Unidentified plant.	Trematoda.	Nematoda.
28- 39	13	439	36		5		40	2					1					+			1	2			3			+			
40- 49	6	53	1	1	12		15							5									+	2							
50- 59	3																	+					+	7							
60- 69	14	34		6	32		45	14	1	10	1	1		5		1		+			1			10	5			+	+		
70- 79	22	122			16		7	12		4		3		5				+			3	8		63					+		
80- 89	17	65		1	23	3	21	29	2	2		10		12	2	1	1	+		1				16		+		+	+		2
90- 99	12	1					4		2	2		1						+			9	8	+	4					+		3
100-109	16						9					1	1					+			27		+	38	3				+	1	
110-119	43	15			9	2	11	15		4	1	9		116		1		+	3		68	+	4	71		+			+		2
120-129	12	13			4	1	4	7		2	1										19		+	13					+		
130-139	3				3					78											5										
140-149	3					2		1													3			11							
150-159	2									2											1		+								
160-169	1									2																					
172	1					1															1								+		
182	1					3															3										

Lepomis pallidus Mitchill (Bluegill). Table II.

Length of Fish in mm.	Number of fish.	Cladocera.	Amphipoda.	Copepoda.	Ostracoda.	Odonata (imagoes).	Odonata (nymphs).	Chironomus larvae.	Simulium larvae.	Other diptera larvae.	Other diptera pupa.	Tricoptera larvae.	Plecoptera larvae.	Ephemerida nymphs.	Hymenoptera.	Dytiscid larvae.	Haliplid larvae.	Insect fragments.	Hydrachnida.	Fish eggs.	Aquatic oligochaeta	Snails.	Nematoda.
11- 19	4	15	...	74	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20- 29	4	295	...	82	1	...	...	6	...	...	...	...	...	...	...	...	...	...	11	...	...	...	...
30- 39	3	116	...	...	1	...	...	12	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...
40- 49	15	240	5	2	35	...	...	28	9	...	...	22	...	2	...	1	...	...	11	...	...	14	...
50- 59	16	480	5	2	50	...	...	28	...	...	...	20	...	...	...	...	...	...	8	57	3	4	...
60- 69	13	482	...	1	1	...	...	67	...	...	...	8	...	...	...	...	...	...	3	6	6	4	1
70- 79	10	220	6	8	24	...	...	87	...	...	...	15	1	1	...	1	...	...	10	18	9	4	7
80- 89	14	325	14	92	21	...	...	126	...	...	...	48	...	...	...	2	2	...	6	316	...	4	14
90- 99	24	8	2	5	50	...	...	276	3	...	...	4	...	...	...	...	...	...	7	...	...	35	...
100-109	6	15	1	...	17	...	...	90	...	...	...	7	1	1	3	2	4	...	1	1	5	17	6
110-119	21	51	13	...	24	2	20	141	4	...	...	4	...	3	...	...	46	...	...	25	300	4	2
120-129	8	...	3	5	...	1	...	33	...	...	...	...	...	...	...	...	83	...	6	...	...	3	2
130-139	2	...	...	...	...	...	...	20	...	...	...	...	...	...	...	...	...	...	...	...	...	16	...
140-149	3	306	...	...	...	...	...	1	...	1	1	...	...	1	1	...	...	...	...	...	24	...	4

Micropterus salmoides Lacepede (Large Mouth black bass). Table III.

Length of Fish in mm.	Number of fish.	Cladocera.	Amphipoda.	Copepoda	Crayfish.	Ephemerida (Nymphs).	Chironomus larvae.	Chironomus pupae.	Other diptera larvae.	Other diptera pupa.	Odonata Imagoes.	Odonata Nymphs.	Dytiscidae larvae.	Haliplidae larvae.	Plecoptera.	Neuroptera.	Notonecta.	Insect fragments.	Arachnida (spiders).	Aquatic annelida.	Labidisthes sicculus.	Lepomis pallidus.	Unidentified fish.	Algae.	Unidentified plant.	Trematoda.
20- 29	4	50	2	20	5	...	3	...	10	...	...	...	15	...	...	...	...	20	...	...	...	...	...	1	30	2
30- 39	37	477	127	193	...	50	18	...	...	...	...	7	...	7	...	...	...	...	...	1	...	3	...	...	...	14
40- 49	33	212	49	66	1	82	20	...	...	...	...	15	11	1	...	...	...	...	...	...	...	...	10	...	...	38
50- 59	32	...	16	...	...	5	...	1	...	...	...	...	...	1	...	...	...	...	1	...	7	1	24	...	...	40
60- 69	12	...	...	...	...	...	...	...	1	1	1	3	...	1	...	...	...	1	...	...	...	2	10	...	...	26
80	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
90- 99	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	4	...	...	33
100-110	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9	...	8	...	...	74
300-400	4	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3

Etheostoma caprodes Cope (Log perch). Table IV.

Length of Fish in mm.	Number of fish.	Cladocera.	Amphipoda.	Copepoda.	Ostracoda.	Chironomus larvae.	Tricoptera larvae.	Simulium larvae.	Tanypus larvae.	Haliplidae larvae.	Neuropterus larvae.	Ephemerida nymphs.	Odonata nymphs.	Insect fragments.	Gastropoda.	Hydrachnids.	Fish eggs.	Plant tissue.	Sand and debris.	Nematoda.
28- 49	5	117	23	1	1	7	1	...	...	...	...	8	...	...	...	2	...	...	...	2
50- 59	4	3	12	...	...	12	6	...	...	...	...	...	2	...	...	8	...	...	...	2
60- 69	20	17	182	...	1	23	19	...	...	18	...	9	...	...	...	20	...	...	...	...
70- 79	14	183	194	...	6	45	20	...	...	26	1	4	2	...	...	...	1	1	...	...
80- 89	5	...	65	...	...	25	1	...	2	...	...	...	...	...	...	...	...	...	...	2
90-102	3	5	8	...	1	9	14	1	...	...	...	...	...	...	...	1	...	...	...	...

Labidesthes sicculus Cope (Skipjack). Table V.

Length of Fish in mm.	Cladocera.	Aphids.	Beetles, adult.	Chironomidae, adult.	Wasp.	Insect fragments.	Caddisfly larvae.	Haliplidae larvae.	Chironomus larvae.	Mayfly larvae.	Snails.	Plant tissue.
53						+						
56						+						
58					1					1		
62	6											+
62						+						
62	450		1			+						
65	1							3	3		3	
66						+						
67												
68												
70												
71		5		1			1					
74	13											
75												
75		10										
76						+						
76						+						
77												
80												+
82												
84						+		2				
84		3					3					

Eupomotis gibbosus L. (Sunfish). Table VI.

Length of Fish in mm.	Amphipods.	Ostracods.	Insect fragments.	Chironomus larvae.	Tanypus larvae.	Caddisfly larvae.	Mayfly larvae.	Haliplidae larvae.	Snails.	Algae.	Unidentified plant.	Sand and debris.	Round worms.
25		3		8							+		1
55			+	25					7	+		+	
56		1		3	4				11	+			
64				49	1		1		3				
65			+		1				1			+	
65	38			6		2	6						
68									8				
70													
77			+										1
82			+								+		
100	2			2					27		+	+	
109				1					25				3
132									40				
154			+					4	35				

Table VII.

	Length of fish.	Amphipods	Crayfish.	Chironomus larvae.	Caddisfly larvae.	Haliplidae larvae.	Mayfly larvae.	Beetle, adult.	Whirligig beetle.	Insect fragments.	Snails.	Aquatic earthworms.	Fish.	Fish flesh.	Fish eggs.	Algae.	Unidentified plant	Blue mud.	Sand, silt and debris.	Trematodes.
Catostomus nigricans LeS. (Hog-molly)	80																			
	85			6	1														+	
	90			42															+	
	108			9																
	118																			
	142									+										
	153											2							+	
	153			15			8			+									+	
	159			6			61					20							+	
	184			27			9													
	187	2		2								3							+	
Notropis Raf. (Variable-toothed minnow)	45																			
	50							1								+				
	52									+										
	55														14					
	74									+										
Ambloplites rupestris Raf. (Rock bass)	49	3		15																
	50			3						+										
	110						1		1	+			1							
	113															+	+			
Esox vermiculatus LeSueur (Grass pike)	95																			3
	252		1																	
	272													+						
Chaenobryttus gulossus Cuv. and Val. (Warmouth bass)	86																+			
	95																			
	110						1						1							
Pomoxis sparoides Lacepede (Black Crappie)	129				1															
	131				+			1		+										
	136				+					+										
	162				2					+										
Dorosoma cepedianum LeS (Hickory shad)	368																	+		
	374																	+		
Lepomis megalotis Raf. (Long eared sunfish)	95			3	9	1					1								+	
Etheostoma nigrum Raf. (Johnny Darter)	24																			
Lepisosteus osseus L. (Long-nosed gar)	542										2									
Essex lucius L. (Pike)	399																			

DISCUSSION OF THE DATA

Of the fishes of Winona Lake, the yellow perch, the large mouth black bass, and the bluegill, seem to be the most abundant. During the entire period of investigation, examination was made of the following fishes:

Perca flavescens Mitchill (yellow perch) 173
Lepomis pallidus Mitchill (bluegill) 144
Micropterus salmoides Lacepede (large mouth black bass) . 133
Etheostoma caprodes Raf. (log perch) 52
Labidesthes sicculus Cope (skipjack) 22
Eupomotis gibbosus L. (sunfish) 14

Catostomus nigricans Le Sueur (hog-molly)	11
Esox vermiculatus Le Sueur (grass pike)	4
Ambloplites rupestris Raf. (rock bass)	4
Pomoxis sparoides Raf. (black crappie)	4
Notropis Raf. (variable-toothed minnow)	5
Chaenobryttus gulosus Cuv. and Val. (Warmouth bass)	3
Dorosoma cepedianum Raf. (hickory shad)	2
Esox lucius L. (pike)	1
Etheostoma nigrum Raf. (Johnny darter)	1
Lepomis megalotis Raf. (long-eared sunfish)	1
Lepisosteus osseus L. (long-nosed gar)	1

Perca flavescens Mitchill (Yellow Perch)—Table I

The perch is a very active fish possessing marked agility and a well developed habit of jumping above the surface of the water to secure adult winged insects. It is usually found in water ranging from two to twenty feet in depth, among water plants, chiefly rushes and Potamogeton. The younger perch feed on Chironomus larvae, entomostracha and amphipods, all directly dependent on plant life for food; while the principal food of the larger perch consists of fish.

By examining Table I, it is very apparent that the food of the young perch is decidedly different from that of the older perch. The major part of the food of the young perch or the perch from 28 mm. in length up to about 40 or 50 mm. consists chiefly of cladocerans, copepods, amphipods and Chironomus larvae. From the 40 to 50 mm. period to the period of about 90 mm. in length they seem to be at the height of indiscriminate feeding, the food consisting principally of cladocerans, amphipods, ostracods, Chironomus larvae, caddis-fly larvae, Haliplus larvae, odonata larvae, may-fly larvae, snails and a few fish. After reaching a length of about 90 mm. another change takes place. They confine themselves to fewer and larger foods. The chief items of the food are now fish and snails with a general eating of small amounts of insect larvae and plant tissue.

These facts correspond very closely with the findings of S. A. Forbes ('80), who found the food of the perch up to one inch in length to consist wholly of entomostraca, while the larger perch had taken a greater variety. He sums up his findings as follows: "It will then be seen that the common perch has a food history of three periods—the periods of infancy, youth and old age. In the first it lives wholly on Entomostraca and the minutest larvae of Diptera; in the second commencing when the fish is about an inch and a half in length it takes up first the smaller and then the larger kinds of aquatic insects in gradually increasing ratio, the entomostracan food at the same time diminishing in importance; and in the third it appropriates, in addition, mollusks, crawfishes and fishes—in the lake specimens depending almost wholly on the last two elements."

Again in ('88), he has the following to say: "The food of six common perch (perca lutea) from an inch to an inch and a quarter long, consisted wholly of entomostraca ninety-two per cent, and minute larvae of chironomus. Forty-three sunfishes (centrarchidae) from five-eighths of an inch to two inches long, had made ninety-six per cent of their food of entomostraca and

the small larvae of gnats (chironomus) already mentioned, seventy per cent of the first and twenty-six per cent of the second."

The chief foods of the perch during the summer months are fish, chironomus larvae, snails, cladocera, amphipods, caddis-fly larvae, odonata larvae, may-fly larvae, insects and plant tissue. The most favored food is fish, sixty-five fish out of a total of one hundred sixty-two having eaten fish. Chironomida larvae and snails appear to be next, thirty-four fish having eaten snails, while forty were found to have taken chironomidae larvae. The cladocera, amphipods, ostracods and copepods are mostly utilized by the smaller fish, twenty-seven fish eating cladocera, twenty-seven eating amphipods, five eating copepods and four eating ostracods. Twenty-three fish had eaten caddis-fly larvae, seventeen may-fly larvae, thirteen beetle larvae, twenty odonata larvae, twenty-six insects, twelve cray-fish and twenty-one plant tissues. Eleven of the fish had empty stomachs.

The food of the perch in Winona Lake during the summer months seems to differ materially from those of Douglas Lake, Michigan, as reported by Jacob Reighard ('13). Reighard found that of nineteen perch examined "eleven contained insects only, one contained insects together with a cray-fish, three contained cray-fish only and four contained fish only. The relative importance of the three kinds of food is perhaps indicated by the frequency of the occurrence of each, which is the ratio: insects 3, fish 1, cray-fish 1."

Hankinson ('07), in his report on Walnut Lake, Michigan, in examining the stomachs of thirty-two perch, found thirteen eating midges and eleven eating cray-fish. Others had taken may-fly larvae in small quantities and "a variety of other insects besides snails, leeches and entomostracans. The few fry opened contained chiefly entomostracans among which were copepods and ostracods."

The food of the perch of Winona Lake more nearly corresponded with the food of the perches of the Wisconsin lakes as reported by A. S. Pearse ('18). However, as Pearse used volumetric percentages I am unable to compare the foods as to the number of individuals eaten.

Lepomis pallidus Mitchill (Bluegill)—Table II

The bluegill with its deep, short, thin shape and its small upturned mouth is best adapted to wend its way among the water plants of quiet water searching for entomostracans and larvae clinging to plants.

Here, too, we find the small fish depending upon the smaller animals and plants for food. By inspection of Table II, it will be seen that the fish from 11 mm. in length to about 40 or 45 mm. in length have eaten principally entomostracans and chironomidae larvae. The entomostracans consist chiefly of cladocera, copepods and a few ostracods. Those larger than 40 or 45 mm. in length have taken larger food and a greater variety. These depend chiefly on entomostracans, chironomidae larvae, caddis-fly larvae, adult insects, snails, algae and higher plants. The vegetation when found in adult stomachs was usually in masses and quite compact, distending the stomach to its capacity. This was also found by S. A. Forbes ('88), who writes "Certain of the sunfishes evidently take plant food purposely, on occasion, this making, for example, nearly a tenth of the food of forty-seven specimens of Lepomis."

The food found for this species compares very favorably with that found by S. A. Forbes ('80), who, in examining specimens of Lepomis pallidus Mitchill, found that those measuring three-quarters to one inch contained fifty-seven per cent entomostraca, thirty-seven per cent chironomus larvae and six per cent water spiders and amphipods. For those measuring two to three inches he found the food to consist of eight per cent neuroptera and eighty-one per cent Chironomus larvae and entomostraca. For the adult he found the food to be neuropterus insects, caddis-fly larvae, dragon-fly larvae, vegetation, mollusks, a small fish, Planorbis, Physa, Amnicola and Vivipara.

Micropterus salmoides Lacepede (Large Mouth Black Bass)—Table III

The large mouth black bass is a very abundant fish in Winona Lake. The small bass keep very close in shore and may be taken at almost any location around the lake where there is a protected spot and vegetation of any kind. The larger bass are found farther out, lying at the edge of dense growths of Potamogeton and spatterdock.

By examining Table III, two changes in the kind of the food used may be seen to occur. Small bass measuring from 24 mm. to a length near 38 or 40 mm. were found to feed mostly on small crustaceans, chiefly amphipods and cladocerans, ephemerida larvae and pupae and Chironomus larvae. Six had eaten a small amount of fish and three had taken a small amount of algae. With an increase in size, the bass utilizes a larger number of foods until a length of approximately 50 mm. is reached, when the variety decidedly decreases and we find the fish depending principally on the small fish of the lake for food supply. From approximately 39 or 40 mm. lengths to about 50 mm. lengths, the principal foods are still small crustaceae, ephemerida larvae and pupae, and Chironomus larvae with an increase in the number eating fish and insects. Of the 62 bass measuring more than 48 mm. in length we find that 47 of them had taken fish as the chief food. Also, of the 62 examined, only two of them had taken small crustaceae and very few had eaten insects or insect larvae. The bass ate about the same food throughout the entire summer.

Incidentally we may note the inroads of the parasitic trematodes upon the bass. Of the 133 black bass examined 32 were infected by the trematode, Leuceruthrus micropteri or about 25 per cent of the entire number.

The food of the large mouth black bass of Winona Lake corresponds very closely with the food found in the stomachs of black bass examined by S. A. Forbes ('80). Forbes found the food of the young to consist chiefly of entomostraca, principally cladocera, minute fishes and insects. In the adult he found a total disappearance of entomostraca, and an accidental occurrence of insects. The main food was fishes, 86 per cent, with 7 per cent cray-fish.

Comparing the food of the bass found at Winona Lake during the summer months with that found by Hankinson ('07), at Walnut Lake from April 11 to June 10, we find a great difference. Hankinson found on examination of 24 large mouth black bass, all ate cray-fish, 5 ate fish, 1 ate 350 midge larvae and pupae besides Sialis and damsel-fly larvae, cray-fish apparently being the most important food. This difference may be due to the different seasons during which the examinations were made or due to different environments.

Etheostoma caprodes Raf. (Log Perch)—Table IV

Etheostoma caprodes is apparently one of the most regular feeders of all the species examined. There seems to be little or no change in the food used as the fish increases in size. The chief foods used are small crustacea, principally amphipods and cladocera, Chironomus larvae, tricoptera larvae, ephimerida larvae and small snails.

Forbes ('88), after investigating foods of Etheostoma and Phenacobius found Chironomus larvae, Corethra larvae and allied genera of remarkable importance, making, in fact, nearly one-tenth of the food of all fishes studied and most abundant in these species. While I can not say as to the exact percentage of Chironomus it is true that this is one of the chief foods of Etheostoma caprodes.

Labidesthes sicculus Cope (Skipjack)—Table V

Twenty-two Labidesthes sicculus (skipjack) were examined during the three summers. Of these, six were found to contain nothing, while the other sixteen contained chiefly insects and insect fragments. The majority of these were taken in shallow water and usually in places free from heavy vegetation. They seem to feed near the top of the water, jumping up to get any winged insect which comes near the surface. This statement is borne out by the fact that one specimen had taken a wasp, three had taken aphids and eight had taken insects unidentified. Forbes ('83), referring to the food of twenty-five specimens dissected, says: "Spiders and terrestrial insects, accidentally washed or fallen into the water (the latter including chalcididae, various diptera, plant lice, lettigonidae, thrips and Podura) amounted to twelve per cent of the food."

Eupomotis gibbosus L. (Sunfish)—Table VI

Examination of the fourteen specimens of Eupomotis gobbosus showed the principal food to consist of snails, Chironomus larvae and insects. Of the fourteen examined, one was found empty while nine of the remaining thirteen had eaten snails, seven had eaten Chironomus larvae and five contained insect fragments. The amount of snails eaten greatly exceeds any other food taken.

The food of this particular fish in Winona Lake seems to differ considerably from the food ascertained for the same species in Walnut Lake, Michigan, by Hankinson ('07). Hankinson found the chief food to be mayfly larvae, but also found cray-fishes, amphipods, snails, leeches, midge larvae in small quantities and caddis-worms.

The type of food taken by this fish indicates the habitat in which it was taken, comparatively deep water, among the Potamogeton, eel grass and Myriophyllum. Since this fish seems to depend for food principally upon snails, it may be that this fact limits its numbers in the lake. There seems to be very few Eupomotis gibbosus compared with perch, bluegills and bass.

Catostomus nigricans Le Sueur (Hog-molly)—Table VII

Catostomus nigricans (hog-molly) is usually found on mud bottom. The downturned mouth and the fact that the fish usually lies near the bottom would indicate the food to be found on or near the bottom. This fact is borne out in the data collected from eleven specimens. Two of these were empty,

while seven out of the nine contained Chironomus larvae, three had eaten aquatic oligochactae, three had taken ephemerida larvae and six contained silt, sand and debris.

The ten other species in Table VII are not sufficient in number to arrive at a definite conclusion as to the foods utilized by the species.

The food of the five specimens of Notropis consists of insects, insect fragments and one had eaten fish eggs.

Ambloplites rupestris (rock bass) fed on plant tissue, insects, Chironomus larvae and one had eaten a snail.

Of the three specimens of Esox vermiculatus (grass pike) one was empty except for a parasitic trematode; one had eaten a cray-fish and one fish eggs.

Of the Chaenobryttus gulossus (Warmouth bass) one was empty, one had taken plant tissue and one had taken an ephemerid larva and a fish.

Pomoxis sparoides (black crappie) used as food chiefly insects and tricoptera larvae.

The two specimens of Dorosoma cepedianum (hickory shad) were taken at the outlet of the lake and both stomachs were completely filled with blue mud.

One Lepomis megalotis (long-eared sunfish) had sand, silt and debris, Chironomus larvae, one snail, one haliplidae larvae and one tricoptera larvae.

One gar pike had two snails.

SOME ECOLOGICAL CONSIDERATIONS

Influence of advance of season on the food of fish.

In order to determine the changes taking place in the kinds of foods eaten at different periods during the summer, the following tables have been arranged showing the per cent of fish eating a particular food during each of the three months, June, July and August.

Perca flavescens Mitchill (Yellow perch)—Table VIII.

	Cladocera.	Copepods.	Ostracods.	Amphipods.	Crayfish.	Chironomus larvae.	Caddisfly larvae.	Mayfly larvae.	Beetle larvae.	Adonata larvae.	Insects and Insect Fragments.	Snails.	Fish.	Plants.
June	.10	....	....	.15	.03	.19	.12	.10	.10	.10	.13	.18	.52	.10
July	.17	.03	....	.10	.17	.17	.17	.07	.03	.21	.28	.28	.10	.24
August	.48	.13	.04	.26	.04	.61	.17	.17	.09	.17	.13	.17	.04	.17

Lepomis pallidus Mitchill (Bluegill)—Table IX.

	Cladocera.	Copepods.	Ostracods.	Amphipods.	Adonata larvae	Chironomus larvae.	Caddisfly larvae.	Mayfly larvae.	Beetle larvae.	Insects and Insect Fragments.	Water Mites.	Snails.	Plants.
June	.18	.06	.29	.26	.03	.39	.13	.03	.16	.29	.23	.19	.23
July	.20	.12	.34	.10	.05	.62	.29	.03	.02	.42	.11	.28	.49
August	.15	....	.15	.15	.23	.62	.31	.31	....	.31	.15	.31	.45

Micropterus salmoides Lacepede (Large mouth black bass)—Table X.

	Cladocera.	Copepods.	Amphipods.	Crayfish.	Chironomus larvae.	Mayfly larvae.	Adonata larvae.	Insects and Insect Fragments.	Fish.	Plants.
June	.14	.03	.19	.....	.11	.30	.24	.08	.57	.11
July	.13	.07	.33	.03	.13	.21	.01	.09	.47	.08
August	.10	.05	.30	.05	.25	.10	.10	.10	.55	.....

Etheostoma caprodes Linn. (Log perch)—Table XI.

	Cladocera.	Ostracods.	Amphipods.	Chironomus larvae.	Caddisfly larvae.	Mayfly larvae.	Insects and Insect Fragments.	Snails.	Plants.
June	.26	.11	.56	.52	.19	.15	.....	.37	.11
July	.19	.10	.81	.38	.52	.38	.05	.....	.05
August	.....	.....	.75	.50	.25	.25	.50	.....	.25

The perch show a decided tendency to feed more generally on foods other than fish flesh, as those foods become more abundant with the advance of the season. Whether this condition is due to the fact that they become selective in their feeding or whether the increase is due to the fact that those foods are easier to obtain at that particular time I can not say. Nevertheless, we find a decided drop in the per cent of perch eating fish during the months of July and August and an increase in the per cent of fish eating the other abundant foods.

The bluegill shows a considerable decrease in the per cent eating crustaceans during the months of July and August. This fish also shows an increase in the number eating insects and insect larvae. This is probably due to the fact that these foods become more abundant.

The percentage of bass eating fish, their chief food, remains about the same throughout the three months. They show a slight decrease in the number eating cladocera, ephemerida larvae, odonata larvae and plants, and an increase in the number eating amphipods, cray-fish, Chironomus larvae and insects.

In Etheostoma we find a decrease in the number using Entomostraca and snails and an increase in the use of amphipods, insects, insect larvae and plants.

In general we may say that the per cent of the four species eating insects, insect larvae and plants, increases as the season advances and these foods become more abundant. With the exception of the bluegill there is also a general increase in the per cent eating amphipods and cray-fish. All have shown a decrease in the use of entomostraca except the perch; it showing an increase in the use of this food.

INFLUENCE OF VEGETATION ON FOODS UTILIZED

The following tables have been arranged to show the per cent of fish eating a particular food when living in adverse vegetational environments. Groups were made of fish living in an environment where there was no vegetation or very scant vegetation, and where there was a heavy vegetation.

Perca flavescens Mitchill (Yellow perch)—Table XII.

	Cladocera.	Copepods.	Ostracods.	Amphipods.	Crayfish.	Chironomus larvae.	Caddisfly larvae.	Mayfly larvae.	Beetle larvae.	Odonata larvae.	Insects and Fragments.	Snails.	Fish.	Plants.
Scant vegetation	.166	....	....	.666	.166	.166	.333	.166	.333	....	.500	....	....	.166
Heavy vegetation	.155	.023	.017	.137	.053	.245	.125	.095	.071	.125	.131	.203	.033	.131

Lepomis pallidus Mitchill (Bluegill)—Table XIII.

	Cladocera.	Copepods.	Ostracods.	Amphipods.	Chironomus larvae.	Caddisfly larvae.	Mayfly larvae.	Beetle larvae.	Odonata larvae.	Insects and Fragments.	Mites.	Snails.	Plants.
Scant vegetation	.555	....	.222	.555	.555	....	.111	.111	.111	.111	.222	.111	.111
Heavy vegetation	.237	.103	.313	.111	.570	.270	.050	.044	.059	.450	.133	.270	.466

Micropterus salmoides Lacepede (Large mouth black bass)—Table XIV.

	Cladocera.	Copepods.	Amphipods.	Crayfish.	Chironomus larvae.	Mayfly larvae.	Odonata larvae.	Insects and Fragments.	Plants.	Fish.
Scant vegetation	.019	.....	.480	.019	.153	.287	.....	.076	.057	.404
Heavy vegetation	.212	.087	.162	.025	.137	.175	.150	.100	.087	.587

Etheostoma caprodes Raf. (Log perch)—Table XV.

	Cladocera.	Ostracods.	Amphipods.	Chironomus larvae.	Caddisfly larvae.	Mayfly larvae.	Insects and Fragments.	Snails.	Plants.
Scant vegetation	.055	.055	.888	.388	.440	.388	.055	.....	.055
Heavy vegetation	.294	.117	.588	.500	.230	.176	.058	.294	.117

Labidesthes sicculis Cope. (Skipjack)—Table XVI.

	Cladocera.	Caddisfly larvae.	Mayfly larvae.	Insects and Fragments.	Snails.	Plants.
Scant vegetation	.085	.....	.....	.500	.....	.085
Heavy vegetation	.163	.163	.085	.330	.085	.085

The foregoing tables indicate at a glance that the greatest variety of food has been taken in the region of the heavy vegetation. We find general gains in heavy vegetation in the use of entomostraca, snails, and plant tissue. There has been a loss in the per cent using beetle larvae and may-fly larvae, while the per cent using the other insect larvae remains about the same in both scant vegetation and heavy vegetation. The use of insects remains about the same in both. A decided decrease in the use of amphipods and cray-fish has occurred among the fish in heavy vegetation.

It is interesting to note that the gains made in the use of particular foods are all gains in use of food which is dependent upon the plants for their food. This suggests that the fish are not extremely selective in food habits but avail themselves of the food present at a particular time in their environment. In this respect we may note that the bluegills when feeding among scant vegetation have the per cent using mites (an undesirable food) about doubled.

Labidesthes sicculus (skipjack) also shows remarkable corroboration of this statement. Among the scant vegetation not one has taken insect larvae or snails, but the percentage of those eating these foods among the heavy vegetation is rather high. However, they do show a degree of selection in foods where an abundant supply of many kinds exist. They seem to choose foods suitable to their needs from the foods present. As an example of this we find where there are perch and common sunfish in the same environment, the sunfish live almost wholly on snails while the perch depend upon other available foods. The selective food habits of the perch have been ably discussed by Pearse and Achtenbery ('17 and '18).

INFLUENCE OF BOTTOM ON FOODS UTILIZED

The following tables have been arranged to show the per cent of fish eating a particular food on a sand or marl bottom as compared with the per cent of fish eating the same food on a mud bottom.

Perca flavescens Mitchill. (Yellow perch)—Table XVII.

	Cladocera.	Copepods.	Ostracods.	Amphipods.	Crayfish.	Chironomus larvae.	Caddisfly larvae.	Mayfly larvae.	Insects and Fragments.	Fish.	Snails.	Plants.	Beetle larvae.	Odonata larvae.
Sand and Marl	.172	.026	.012	.132	.046	.205	.112	.079	.132	.430	.178	.112	.052	.112
Mud	.045	....	.045	.318	.136	.500	.272	.227	.227	.190	.318	.272	.272	.181

Lepomis pallidus Mitchill (Bluegill).—Table XVIII.

	Cladocera.	Copepods.	Ostracods.	Amphipods.	Chironomus larvae.	Caddisfly larvae.	Mayfly larvae.	Odonata larvae.	Beetle larvae.	Insects and Fragments.	Mites.	Snails.	Plants.
Sand and Marl	.333	.140	.420	.150	.650	.260	.050	.040	.030	.259	.150	.260	.390
Mud	.090	....	.068	.113	.386	.250	.068	.113	.090	.568	.113	.204	.568

Micropterus salmoides Lacepede (Large mouth black bass).—Table XIX.

	Cladocera.	Copepods.	Amphipods.	Crayfish.	Chironomus larvae.	Mayfly larvae.	Odonata larvae.	Insects and Fragments.	Fish.	Plants.
Sand and Marl	.144	.051	.322	.008	.152	.245	.101	.076	.487	.076
Mud	.066	.066	.....	.133	.066	.....	.....	.200	.733	.066

Etheostoma caprodes Raf. (Log perch)—Table XX.

	Cladocera.	Ostracods.	Amphipods.	Chironomus larvae.	Caddisfly larvae.	Mayfly larvae.	Insects and Fragments.	Snails.	Plants.
Sand and Marl	.234	.107	.659	.423	.340	.276	.021	.212	.085
Mud	.....	.....	1.000	.800	.200	.....	.400	.....	.200

A small per cent of perch on the mud bottom have taken cladocera, copepods and fish as compared with those on a sand bottom.

The per cent of fish eating all other foods is greater on the mud bottom than on the sand bottom.

A larger per cent of the bluegills were found to have eaten ephemerida larvae, odonata larvae, beetle larvae, insects and plants on a mud bottom than on a sand bottom. A smaller per cent used all other foods on a sand bottom than on a mud bottom.

The per cent of bass eating copepods, cray-fish, insects and fish was greater on a mud bottom than on sand bottom. The general use of the other foods showed a decrease.

Etheostoma caprodes (log perch) showed a greater general use of amphipods, Chironomus larvae, insects and plant tissue on a mud bottom and a decrease of the use of all other foods on sand bottom. Generally we may say a smaller per cent of the fish used entomostraca as food on a sand bottom

than on a mud bottom; the use of insect larvae was about the same in both environments and the per cent using amphipods, cray-fish, insects, snails and plants as food was greater on a mud bottom than on a sand bottom.

GENERAL CONSIDERATIONS

From the data collected during this period of investigation it is very evident that the foods of young fishes as a rule are widely different from the foods of the adult. It is not only different in the extremes between youth and adult, but very marked periods in growth may be correlated with very definite changes in food. In some species, as the perch and bass, there are three very noticeable food periods.

In the bluegills there are two such periods, while in the Etheostoma caprodes (log perch), Labidesthes sicculus (skipjack) and Eupomotis gibbosus (sunfish) we find a rather steady food habit of few changes.

This fact of the relation of food to the age of the fish was pointed out as early as 1880 by S. A. Forbes. The following extract from one of his papers states very clearly his views on this point: "It was early apparent in the course of investigation that the food of many fishes differs greatly according to age, and it was soon found that the life of most of our fishes divides into at least two periods, and of many into three, with respect to the kinds of food chiefly taken. Further, in the first of these periods, a remarkable similarity of food was noticed among species and families whose later food habits were widely different."

Many attempts have been made to provide artificial food for fishes. This seems to have been a great outstanding problem which demanded solution before the success of the fish culturalists could be assured. The American Fisheries Society has spent much time and money on the problem trying to solve it for economical purposes. Many investigators have worked on the problem attacking it rather from the point of "what fishes will eat" than from that of "what fish do eat." Many foods such as liver and prepared foods have been tried regardless of the kind or size of fish to be fed, and failure has resulted. This was experienced by Dwight Lydell ('06) at Mill Creek Station, who attempted to feed a Chicago fish food preparation, and by several others who have used liver and other foods in many different ways.

Many successful attempts to feed fish have also been made but in practically every case the food that has been provided has been that to which the fish was naturally accustomed. Mather ('96) was successful in raising entomostraca for young fish, his only difficulty being to provide enough as they used an enormous amount of this food. Large mouth black bass were fed by O'Brien ('98) who used carp fry for the young bass and whose chief difficulty seemed to be the rapid growth of the carp. Lydell ('02) used Daphnia, Bosmina and Corixa and other small aquatic forms as food for bass fry. Liver was fed to the adults during the summer, but "in order to bring the fish through the winter in good condition it is necessary to begin feeding minnows in September and to continue this until the fish go into winter quarters." (1) In 1911 he successfully fed sucker meat, cray-fish and clam meat.

One of the chief factors entering into the problem is apparently the difficulty of providing a balanced pond so that all the fish, old and young,

may have an adequate supply of food. The natural environment and the food fish naturally eat should furnish an index to the requirements to be met. Many studies have been made in regard to natural environment. Birge ('97) gives us a clue as to the environment of some of the fish foods, especially the foods of young fish. Quoting from his paper, "The bottom of the warm water forms the lower limit of the plankton life and this life closely follows that limit as the warm water gradually increases in thickness during the summer and early autumn—in late August and September."

Parker ('01) believes the scarcity of fish, now where once they were plentiful, is due largely to lowering of water line so that plants are killed. He advocates sowing seeds and producing plants on which the fish food may live.

Bartlett ('08) points out that "not enough care is used by those making the attempt to cultivate bass in small ponds to get a proper balance in the ponds in the way of good producing facilities."

It is evident that the environment is a great factor in determining the food of fishes. The fish may or may not be able to subsist on the food furnished by the environment because they must have a variety of foods suitable to the different periods of the fish's development.

In conclusion, I wish to express my thanks to Dr. Will Scott who has aided me in many ways with advice and suggestions. I also wish to express my appreciation to Mr. Ira T. Wilson for identifying the snails and to Mr. Lowell T. Coggeshall and Mr. John E. Owen who so very kindly assisted me in making the collections.

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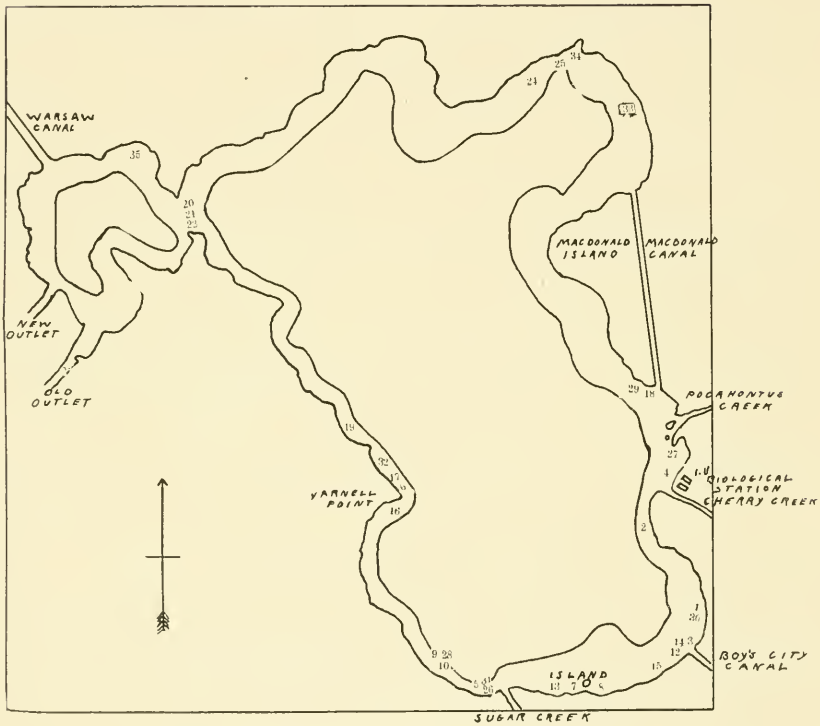

MAP OF WINONA LAKE, INDIANA

The inner line indicates the five meter depth.
The numbers indicate the points at which the respective collections were made.

Date Due