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THE FOOD OF THE SHORE FISHES OF CERTAIN  
WISCONSIN LAKES



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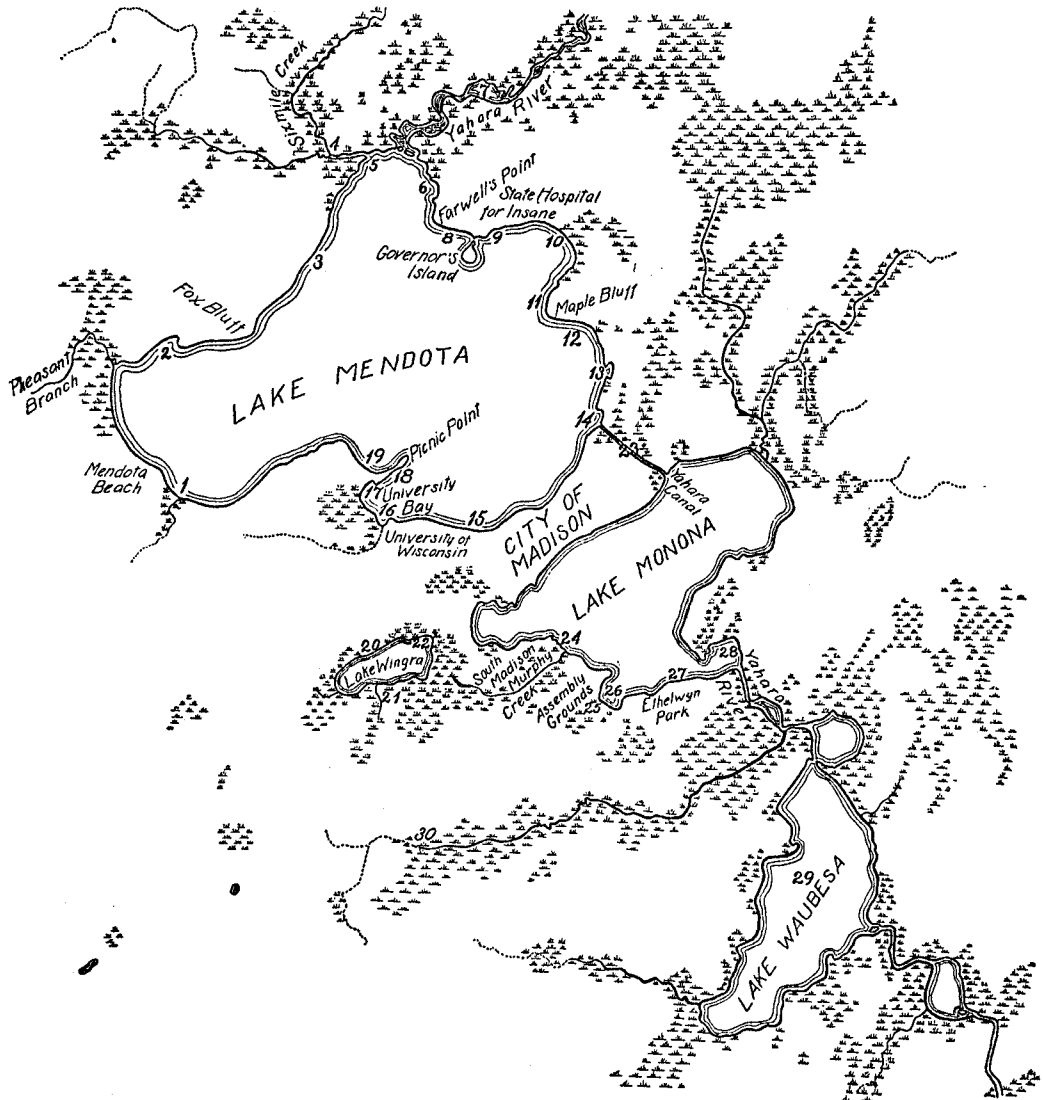
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## I. INTRODUCTION.

Since the excellent work of Forbes (1880, 1883, 1888) in the eighties no thorough study has been made of the food of fresh-water fishes in the United States. The data for the present paper were collected during 1914, 1915, and 1916 near Madison, Wis. They relate primarily to the shore fishes of lakes, though the food habits of many from other habitats were studied. Small fishes were more often examined than large, because their food habits are less well known. During the first year 383 fishes were examined; during the second, 1,111; and in the third, 125. The summaries for 1914 have already been published (Pearse, 1915). Collections were made at 30 different stations, which are shown in the chart. They may be described briefly as follows:

1. Lake shore at Merrill Springs. A small stream enters a little bay; three large springs flow directly into the lake; shore, sandy and pebbly.
2. Lake shore near Pheasant Branch. Muddy, weedy bottom in mouth of creek; pebbles and a little sand on either side.
3. Lake shore at Maypest. Sandy in shallow water; weedy and soft mud farther out.
4. Six-Mile Creek at fork. Bottom very soft mud; current sluggish.
5. Mouth of Six-Mile Creek. Bottom very soft mud; weedy.
6. Bar across mouth of Catfish Bay. Bottom pebbly.
7. Yahara River above Catfish Bay. Bottom soft mud; current sluggish.
8. Lake shore at Farewells Point. Bottom stony.
9. Small bay near State Insane Asylum. Bottom clay, with water plants.
10. Lake shore in bay. Bottom sandy and pebbly in shallow water; firm mud with weeds in deeper water.
11. Lake shore at Maple Bluff. Beach of rocks and pebbles from the cliff above.
12. Pebble beach east of Maple Bluff.
13. Small bay choked with vegetation; bottom very soft mud.
14. Pebbly beach at mouth of Yahara Canal.
15. Lake in front of University of Wisconsin. In shallow water, sand and bowlders; in deeper water, mud and vegetation followed by soft ooze.
16. Southeast end of University Bay behind bar. Bottom soft mud; abundant vegetation, both floating and attached.
17. Beach outside bar on east side of base of Picnic Point. Bottom pebbly and sandy in shallow water; muddy with weeds at greater depths. Behind bar, soft mud and much vegetation.
18. Beach along southeast side of Picnic Point. Bottom pebbly in shallow water, then sandy, and in deeper water muddy with thick vegetation.
19. Beach northwest of Picnic Point. Bottom of pebbles or sand.

20. Small spring pools on the north shore of Lake Wingra. Bottom soft mud with abundant vegetation.
21. Small creek on south side of Lake Wingra. Bottom clay and mud.
22. Muddy bottom near outlet of Lake Wingra.
23. Yahara Canal, connecting Lake Mendota with Lake Monona. Bottom muddy with thick vegetation; pebbles along shores.
24. Pebble and sand beach on southwest shore of Lake Monona.



Thirty stations where collections were made.

25. Swamp behind Chicago, Milwaukee and St. Paul Railroad near Lake Monona.
26. Turvill Bay. Bottom very soft mud with considerable vegetation.
27. Pebble and sand beach near mouth of Lake Monona.
28. Vegetation filled bay at outlet of Lake Monona. Bottom sand and mud.
29. Catches from power seines of commercial fishermen in Lake Waubesa.
30. Brook near State fish hatchery, 4 miles south of Madison. Bottom clay, stones, and very soft mud.

Collections were made with a miniature fyke net, dip net, minnow seine, and gill net. When they could not be examined within an hour or two, the fishes were placed in 95 per cent alcohol and kept until examined. In examining the food, the entire contents of the alimentary canal were pressed out on a strip of glass, moistened, and then teased apart with needles under a binocular microscope. Insect fragments were turned over to an expert entomologist for identification. As the constituents of the food were identified, they were written in the permanent record. As each fish was completed, the percentage by volume of each constituent was estimated. All figures in this paper refer to such volumetric percentage estimates.

During the work assistance was rendered by a number of persons, and it is a pleasure to acknowledge this indebtedness. Dean E. A. Birge and Mr. Chancey Juday, of the Wisconsin Geological and Natural History Survey, loaned equipment and extended other courtesies. Miss Henrietta Achtenberg worked four months computing averages and rewrote part of the manuscript. Dr. John Lowe and Mr. Alvin Cahn furnished some rare fishes for examination. Mr. A. F. Shira and Mr. Juday read the manuscript and made a number of helpful suggestions. Invaluable assistance was rendered by Dr. R. A. Muttkowski, who identified all the insects.

## II. DESCRIPTION OF FOODS.

All figures following foods are given in volumetric percentages; + indicates a trace. The lengths are given in millimeters and exclude the caudal fin. The species are arranged alphabetically according to their scientific names. Under each species the records are arranged according to dates, and the stations (see chart) where collections were made are given in each case.

**Abramis crysoleucas** (Mitchill). Golden shiner, roach, bream.

Station 5; August 18, 1915; number examined, 2. Length: Maximum, 94; minimum, 92.5; average, 93.2. Food: Hyalella, 42.5; Bosmina, 0.5; Camptocerus, 1.5; filamentous algæ, 40.5; fine silt and débris, 15.

Station 5; August 18; number examined, 5. Length: Maximum, 31.3; minimum, 23.5; average, 28.1. Food: Helea larva, 1; Tanypus carneus larva, 4; insect, 3; water mites, 1.2; ostracods, 4; Cyclops, 33; Canthocamptus, 2; Cladocera unidentified, 14; Bosmina, 14; Pleuroxus, 1.4; Chydorus, 3; Simocephalus, 7; rotifers, 0.8; plant tissue, 4.8; seeds, 0.8; Wolffia, 3; Volvox, 2.2; Closterium, 0.4; Pandorina, 0.4.

*Summary.*—Food: Dipterous larvæ, 5; insects, 3; water mite, 1.2; ostracods, 4; copepods, 35; Cladocera, 39.4; rotifers, 0.8; plants, 8.6; flagellates, 3.

Station 18; August 18; number examined, 23. Length: Maximum, 75; minimum, 34; average, 39.3. Food: Tanypus monilis pupæ, 12.4; Cyclops, 20; Daphnia longispina hyalina, 65; Simocephalus, 2.1.

Station 5; August 25; number examined, 10. Length: Maximum, 68; minimum, 27.5; average 33.2. Food: Chironomus lobiferus larvæ, 5.5; water mites, 2; Cyclops, 0.2; Bosmina, 88.5; Ceriodaphnia, 3.5; algal filaments, 0.1; Volvox, 0.1.

Station 22; April 1, 1916; number examined, 1. Length: 152. Food: Caddis-fly case, 0.5; ostracods, 90; Cyclops, 0.5; Daphnia pulex, 1; filamentous algæ, 8.

*Summary.*—Insect larvæ, 0.5; Entomostraca, 91.5; plants, 8.

Station 18; April 13; number examined, 3. Length: Maximum, 137; minimum, 114; average, 122.6. Food: Larvæ sp., 6.6; Chironomus sp. larvæ, 2.3; C. lobiferus larvæ, 0.3; Orthocladus flavus larvæ, 0.3; Copotomus interrogatus adult, 1; Chironomus sp. adult, 38.3; Hyalella, 15; Cyclops, 1; snail remains, 1.6; Valvata tricarinata, 15; Lemna, 15; débris, 3.3.

*Summary.*—Food: Insect larvæ, 9.5; adult insects, 39.3; amphipods, 15; copepods, 1; Mollusca, 16.6; plants, 15; débris, 3.3.

Station 22; April 22; number examined, 10. Length: Maximum, 133; minimum, 112; average, 123.4. Food: Chironomus decorus larvæ, 3.5; Chironomus sp. larvæ, 2; Cricotopus trifasciatus larvæ, 2.6; May-fly nymphs, 2; chironomid pupæ, 1; Cricotopus trifasciatus pupæ, 1.5; Hyalella, 0.1; ostracod, 0.2; Canthocamptus, 1.5; Cyclops, 33.8; Daphnia pulex, 19.3; Chydorus sphaericus, 5.1; Bosmina, 1.5; Physa, 2; Oscillatoria, 4.7; flagellates, 0.2; Volvox, 0.7; plant remains, 9; algæ, 0.1; fine débris, 9.1.

*Summary.*—Food: Insect larvæ, 10.1; insect pupæ, 2.5; amphipods, 0.1; Entomostraca, 61.4; Mollusca, 2; Protozoa, 0.2; plants, 14.5; débris, 9.1.

Station 22; June 10; number examined, 5. Length: Maximum, 150; minimum, 115; average, 125. Food: Ostracods, 0.1; Daphnia pulex, 99.9.

*Grand summary for 1915 and 1916.*—Number examined, 59. Length: Maximum, 152; minimum, 23.5; average, 67.6. Food: Insect larvæ, 4.4; insect pupæ, 5.7; adult insects, 2.2; mites, 0.4; amphipods, 2.2; Entomostraca, 76.1; rotifers, +; protozoans, 1; plant remains, 3.1; algæ, 1.5; débris, 2.2.

From these summaries it is apparent that the chief food of the golden shiner was microscopic crustaceans (76.1 per cent). More than half the food of 10 of the fish consisted of other organisms—81 per cent filamentous algæ, 85 per cent Hyalella, 55 per cent Chironomus lobiferus larvæ, 51 per cent silt and fine débris, etc. All other individuals had eaten 50 per cent or more Entomostraca; some had eaten nothing but Daphnia or Bosmina. Forbes and Richardson (1908) state that the food of this species varies greatly in different situations and mention mud, molluscs, insects, entomostracans, and plants as appearing in the dietary. Hankinson (1908) found midge larvæ and filamentous algæ in the fish he examined. The fish examined by Baker (1916) had eaten a small percentage of molluscs, and about 97 per cent insects, chiefly caddis-fly larvæ. Considering all things, it appears that when young the golden shiner feeds chiefly on entomostracans, and mature fish on almost any available organisms.

*Ambloplites rupestris* (Rafinesque). Rock bass, red-eye, goggle-eye.

*Data for 1914* (Pearse, 1915).—Number examined, 5. Average length: 61.4. Food: Insects, 68; mites, 0.4; Hyalella, 5.6; ostracods, 1; Cladocerans, 15; plants, 4; algæ, 0.2; silt and débris, 0.4.

Station 15; May 27, 1915; number examined, 1. Length: 99. Food: Chironomus fulviventris larvæ, 3; C. decorus larvæ, 10; Procladius sp. larvæ, 10; Molanna uniophila larvæ, 69; Ecdyurus maculipennis nymphs, 2; Chironomus fulviventris pupæ, 5; Valvata tricarinata, 1.

*Summary.*—Food: Chironomid larvæ, 23; caddis-fly larvæ, 69; May-fly larvæ, 2; chironomid pupæ, 5; snail, 1.

Station 15; June 9; number examined, 1. Length: 115. Food: Siphylurus nymph, 2; Chironomus fulviventris pupa, 3; water mite, 0.5; crayfish, 94.5.

Station 5; June 24; number examined, 1. Length: 188. Food: Enallagma hageni and E. antennatum nymphs, 10; Cambarus propinquus, 90.

Station 15; July 24; number examined, 1. Length: 168. Food: Cambarus propinquus, 100.

Station 18; July 3; number examined, 19. Length: Maximum, 81; minimum, 35.6; average, 53.6. Food: Chironomus lobiferus larvæ, 0.7; C. digitatus larvæ, 1; Cricotopus trifasciatus larvæ, 3.1; Palpomyia longipennis larvæ, 23.1; Leptocerus dilutus larvæ, 2.7; Ichthytricha larva, 0.1; damsel-fly nymphs, 4.2; Ecdyurus maculipennis nymphs, 0.7; Enallagma hageni nymphs, 2.7; E. antennatum nymphs, 25; caterpillar, 1; Chironomus lobiferus pupæ, 5.4; Palpomyia longipennis pupæ, 5; same, adult, 11.4; Corixa, 0.7; mites, 0.6; ostracods, 0.3; Eurycerus, 7.6; oligochætes, 2.6; filamentous algæ, 1.

*Summary.*—Food: Dipterous larvæ, 27.9; caddis-fly larvæ, 2.8; damsel-fly nymphs, 32.6; caterpillar, 1; dipterous pupæ, 10.4; adult insects, 12.1; mites, 0.6; ostracods, 0.3; cladocerans, 7.6; oligochætes, 2.6; algæ, 1.

Station 23; June 14; number examined, 1. Length: 45.5. Food: Chironomus tenellus larvæ, 100.

Station 23; July 23; number examined, 5. Length: Maximum, 99; minimum, 61; average, 76.8. Food: Chironomus fulviventris larvæ, 17.4; Palpomyia longipennis larvæ, 0.4; Cænis diminuta nymphs, 8.5; Enallagma antennatum nymph, 7; parnid beetle larva, 1; Chironomus fulviventris pupæ, 23; Tanytus monilis pupæ, 1.8; Palpomyia longipennis pupæ, 0.4; Probezzia pallida pupa, 5; Simulium vittatum pupa, 1.8; Corixa adults, 2; Berosus, 3.4; Agabus, 2; Halipilus ruficollis, 2.6; crayfish, 12.4; Hyalella, 6; oligochætes, 3; seeds, 0.2; Elodea, 2.

*Summary.*—Food: Dipterous larvæ, 17.8; caddis fly larvæ, 8.5; damsel fly nymphs, 7; beetle larva, 1; dipterous pupæ, 32; adult insect, 10; crayfish, 12.4; Hyalella, 6; oligochætes, 3; plants, 2.2.

Station 23; August 19; number examined, 1. Length: 66. Food: Carabid-beetle larva, 2; insect remains, 3; plant remains, 75; sand, 20.



Station 18; August 18; number examined, 1. Length: 59. Food: Chironomus viridis larvæ, 20; Bætica nymphs, 20; Chironomus lobiferus pupæ, 60.

Station 23; August 19; number examined, 1. Length: 22.5. Food: Chironomus lobiferus larvæ, 75; Cyclops, 10; oligochætes, 15.

Station 10; August 20; number examined, 2. Lengths: 31.5, 29. Food: Labidesthes sicculus, 45; Chironomus lobiferus larvæ, 2.5; Chironomus digitatus larvæ, 12.5; Bætica nymphs, 40.

Station 23; September 21; number examined, 1. Length: 109. Food: oligochætes, 50; plant remains, 20; sand and mud, 30.

Station 15; September 25; number examined, 1. Length: 112. Food: Cambarus propinquus, 100.

Station 15; November 20; number examined, 2. Lengths: 160, 121. Food: Labidesthes sicculus, 42.5; Bætis nymphs, 2.5; Sialis infumata larva, 50; Chironomus lobiferus pupæ, 5.

Station 25; December 4; number examined, 1. Length: 230. Food: Crayfish, 100.

*Grand summary for 1914 and 1915.*—Number examined, 45. Length: Maximum, 230; minimum, 22.5; average, 72.9. Food: Fish, 2; dipterous larvæ, 19.1; May-fly nymphs, 3.5; Odonata nymphs, 14.4; caddis-fly larvæ, 2.8; Sialis infumata larvæ, 2.2; beetle larvæ, 0.5; unidentified insect larvæ, 0.5; dipterous pupæ, 9.6; Diptera, 4.8; Hemiptera, 1.2; Hymenoptera, 1.3; Coleoptera, 1.1; unidentified insects, 5.3; hydrachnids, 0.2; crayfish, 16.1; amphipods, 1.4; ostracods, 0.3; copepods, 0.3; cladocerans, 4.3; gastropods, +; oligochætes, 3; plant remains, 2.8; algæ, 0.5; silt and débris, 1.2.

The summaries show that the food of the young rock bass consists largely of insects (larvæ, 43 per cent; pupæ, 9.6 per cent; adults, 13.7 per cent), which constitute more than three-fourths of the food. The adult fish feed mostly on crayfish, though they also capture insects in considerable numbers. Forbes and Richardson (1908) state that this bass eats insects, small crustaceans, and a few fish. Hankinson (1908) found that it fed chiefly on crayfish, with smaller percentages of dragon-fly nymphs, midge larvæ, small fishes, and May-fly nymphs. Reighard (1915) found fish, insects, and crayfish in those he examined. According to Baker (1916) about three-quarters of the food is Crustacea and the remainder plants, algæ, insects, and débris.

**Ameiurus melas** (Rafinesque). Black bullhead.

*Data for 1914* (Pearse, 1915).—Number examined, 2. Length: Maximum, 123; minimum, 38.2; average, 80.6. Food: Dipterous larvæ, 40; Diptera, 2.5; ostracods, 12; Cyclops, 2.5; unidentified cladocerans, 1; Bosmina, 25; plant remains, 17.5.

Station 5; August 18, 1915; number examined, 1. Length: 274. Food: Enallagma hageni nymphs, 2; Gyrinus larva, 6; dytiscid larva, 2; Leptocerus larva, 3; Phryganea interrupta larva, 5; caterpillar, 20; Chironomus fulviventris pupa, 16; Chironomus fulviventris adult, 11; Enallagma hageni adult, 13, Psychoda adult, 1; Corixa adult, 10; crayfish claw, 1; Hyalella, 1; leech, 5; Lemna, 3.

*Summary.*—Food: Insect larvæ, 38; insect pupæ, 16; adult insects, 35; crayfish, 1; Hyalella, 1; leech, 5; Lemna, 3.

Station 5; September 14; number examined, 1. Length: 275. Food: Chironomus decorus larvæ, 30; C. lobiferus larvæ, 20; C. digitatus larvæ, 5; Enallagma hageni nymphs, 5; Chironomus decorus pupa, 30; C. lobiferus pupa, 8; Hyalella, 2.

*Summary.*—Food: Dipterous larvæ, 60; dipterous pupæ, 38; Hyalella, 2.

Station 28; September 17; number examined, 1. Length: 280. Food: Proboezzia glaber larvæ, 4; P. pallida larvæ, 4; Tipula abdominalis larva, 1; Planorbis, 25; Physa, 30; plants, 10; Lemna, 1; Nostoc, 15; silt and débris, 10.

*Summary.*—Food: Dipterous larvæ, 9; snails, 55; plants, 26; silt and débris, 10.

Station 16; September 20; number examined, 10. Length: Maximum, 190; minimum, 35; average, 79.3. Food: Chironomus decorus larvæ, 6.3; C. fulviventris larvæ, 10; C. tentans larvæ, 0.5; Chironomus sp. larvæ, 11.5; Protenthes culiciformis larva, 0.1; Proboezzia glaber larvæ, 1.6; P. pallida larva, 4.5; Chironomus decorus pupæ, 0.6; C. fulviventris adults, 5.4; crayfish, 9.2; Cyclops, 0.5; leech, 4; oligochætes, 32.1; plants, 4.7; silt and fine débris, 8.5.

*Summary.*—Food: Chironomid larvæ, 24.5; chironomid pupæ, 0.6; chironomid adults, 5.4; crayfish, 9.2; Cyclops, 0.5; leech, 4; oligochætes, 32.1; plants, 4.7; silt and débris, 8.5.

*Grand summary for 1914 and 1915.*—Number examined, 15. Length: Maximum, 280; minimum, 35; average, 118.8. Food: Dipterous larvæ, 32.6; damselfly nymphs, 0.4; beetle larvæ, 0.4; caddis-fly larvæ, 0.5; caterpillar, 1.3; dipterous pupæ, 4.2; adult insects, 5.7; Hyalella, 0.2; crayfish, 6.1; ostracods,

1.6; Cyclops, 0.7; cladocerans, 0.5; snails, 3.7; leech, 3; oligochaetes, 21.4; plants, 6.4; algæ, 0.9; silt and débris, 6.3.

The food of the black bullhead, according to the summary, contains 45.1 per cent insects (larvæ, 35.2; pupæ, 4.2; adults, 5.7) and 21.4 per cent oligochaetes. Young fish apparently eat more oligochaetes than adults. Forbes and Richardson (1908) examined 34 individuals of this species and found the food to be one-fourth plants, and one-fifth bivalve molluscs, snails, aquatic insects, crayfishes, and other crustaceans.

**Ameiurus nebulosus** (Le Sueur). Common bullhead, brown bullhead, speckled bullhead.

Station 5; May 21, 1915; number examined, 16. Length: Maximum, 94; minimum, 54.5; average, 64.7. Food: Unidentified insect larvæ, 1; Chironomus decorus larvæ, 0.2; C. viridicollis larvæ, 1; C. fulviventris larvæ, 0.9; C. tentans larvæ, 8.6; C. lobiferus larvæ, 5.2; Helea larva, 0.3; Cricotopus trifasciatus larvæ, 7.1; Ptychoptera larva, 1; May-fly nymphs, 0.6; Callibætis nymphs, 0.7; beetle larva, 1.2; carabid-beetle larva, 0.3; unidentified pupa, 0.3; Probezzia pupa, 0.6; unidentified insect fragments, 2.2; midges, 0.1; mites, 1.2; Hyalella, 0.6; ostracods, 21; Cyclops, 11; Chydorus sphaericus, 22; Eurycercus lamellatus, 2; Ceriodaphnia, 0.1; cladoceran ephippia, 0.7; snail, 0.5; plants, 2.3; sand and fine débris, 7.3.

*Summary.*—Food: Insect larvæ, 28.1; insect pupæ, 0.9; adult insects, 2.3; mites, 1.2; ostracods, 21; Cyclops, 11; cladocerans, 24.8; snail, 0.5; plants, 2.3; silt and débris, 7.3.

Station 6; June 24; number examined, 1. Length: 86. Food: Palpomyia longipennis larvæ, 10; Callibætis nymphs, 5; Cænis diminuta nymphs, 10; Enallagma hageni nymphs, 25; fragments of adult insects, 50.

Station 5; August 9; number examined, 33. Length: Maximum, 47.6; minimum, 25; average, 36.2. Food: Unidentified chironomid larvæ and cases, 2.8; Chironomus fulviventris larvæ, 5; C. lobiferus larvæ, 6.3; Protenthes culiciformis larvæ, 7.3; Probezzia glaber larvæ, 1.3; P. pallida larvæ, 0.6; Bætis nymphs, 2; Enallagma hageni nymphs, 1.3; insect pupæ, 0.8; chironomid pupæ, 1; Chironomus lobiferus pupæ, 6; adult midges, 2.3; Anax junius, 0.2; gyrenid beetle, 0.5; Collembola, 0.5; mites, 0.1; Hyalella, 18; ostracods, 2; Cyclops, 6; Bosmina, 0.1; Chydorus sphaericus, 9; Eurycercus, 0.3; Camptocercus, 17; Pleuroxus procurvatus, 4; Acroperus, 0.5; Ceriodaphnia, 1.6; Scapholeberis, 0.3; oligochaetes, 4.7.

*Summary.*—Food: Insect larvæ, 26.6; insect pupæ, 7.8; adult insects, 3.4; mites, 0.1; Hyalella, 18; ostracods, 2; Cyclops, 6; cladocerans, 32.3; oligochaetes, 4.7.

*Grand summary.*—Number examined, 50. Length: Maximum, 94; minimum, 25; average, 46.3. Food: Insect larvæ, 28.2; dipterous pupæ, 2.1; adult insects, 4.4; mites, 0.4; amphipods, 11.4; ostracods, 6.7; copepods, 8.4; cladocerans, 33.1; snails, 0.1; oligochaetes, 2.1; rotifers, +; protozoans, +; plants, 0.9; algæ, +; silt and débris, 2.3.

Of the food of this bullhead 42.1 per cent consists of microscopic Crustacea, 34.7 per cent of insects. It apparently feeds more on Entomostraca than the black bullhead. Forbes and Richardson (1908) found the food to consist chiefly of small bivalve molluscs, insect larvæ, distillery slops, and a few adult insects and snails. Hankinson (1908) states that this species is an omnivorous feeder, taking crayfish, fish, molluscs, entomostracans, leeches, beetles, May-fly and dragon-fly nymphs. Tracy (1910) found "all kinds of animal life," including the young and eggs of fishes. Reighard (1915) records small fishes and a bumblebee as food. Crustaceans formed the chief food of the young individuals examined by Baker (1916), while the older fish had eaten 10 per cent Mollusca and 90 per cent vegetation and mud.

The brown bullhead feeds mostly on Entomostraca and insect larvæ while it is young, and when mature takes almost anything in the shape of animal food.

**Amiatus calva** (Linnæus). Bowfin<sup>a</sup>, grindle.

Station 17; August 24, 1915; number examined, 1. Length: 545. Food: Crayfishes, 100.

Station 28; September 14; number examined, 6. Length: Maximum, 438; minimum, 383; average, 406. Food: Fish remains, 37.5; Lepomis incisor, 59.3; crayfish, 3.

Station 28; September 17; number examined, 4. Length: Maximum, 543; minimum, 388; average, 470. Food: Fish remains, 48.5; sunfish, 43.5; crayfish, 7.5.

Station 22; July 1, 1916; number examined, 3. Length: Maximum, 465; minimum, 440; average, 452.6. Food: Fish remains, 96.6; crayfish remains, 3.3.

*Summary.*—Food: Fish remains, 96.6; crayfish remains, 3.3.

<sup>a</sup> Locally known as dogfish.

Station 22; July 8; number examined, 1. Length: 420. Food: Fish remains, 100.

Station 22; July 15; number examined, 1. Length, 412. Food: Fish remains, 100.

*Summary for 1915 and 1916.*—Number examined, 16. Length: Maximum, 465; minimum, 383; average, 467.4. Food: Fish remains, 90.1; crayfish remains, 9.4.

It will be observed that no young dogfish were examined. Forbes and Richardson (1908) examined 20 fish and found the food to be entirely animal—one-third fishes, one-fourth small molluscs, and about 40 per cent crayfishes. A few amphipods, isopods, and entomostracans were also noted (Forbes, 1883).

*Boleosoma nigrum* (Rafinesque). Johnny darter.

Station 14; July 9, 1915; number examined, 1. Length, 15. Food: *Cricotopus trifasciatus* larvæ, 10; oligochætes, 55; *Cyclops*, 20; *Chydorus*, 15.

Station 5; August 18; number examined, 1. Length, 30. Food: *Helea* larvæ, 15; *Tanypus carneus* larvæ, 25; May-fly nymphs, 10; oligochætes, 15; ostracods, 15; *Chydorus*, 20.

Station 19; August 18; number examined, 10. Length: Maximum, 34.5; minimum, 23; average, 28.7. Food: *Tanypus monilis* larvæ, 2.4; *Chironomus digitatus* larvæ, 53.3; *C. viridis* larvæ, 2.4; *C. lobiferus* larvæ, 2.5; *C. tentans* larvæ, 1.5; *Ecdyurus maculipennis* nymphs, 6.5; *C. digitatus* pupæ, 1.5; oligochætes, 15; *Hyaella*, 2.8; *Cyclops*, 4.7; *Chydorus*, 1.3; *Pleuroxus*, +; *Ceriodaphnia*, 1.6; sand, 4.7.

*Summary.*—Food: Chironomid larvæ, 63.1; May-fly nymphs, 6.5; chironomid pupæ, 1.5; oligochætes, 15; amphipods, 2.8; copepods, 4.7; cladocerans, 2.9; sand, 4.7.

Station 19; August 20; number examined, 20. Length: Maximum, 32; minimum, 21.5; average, 27.5. Food: *Proboezzia pallida* larvæ, 0.7; *Tanypus monilis* larvæ, 1.2; *Chironomus digitatus* larvæ, 46; *C. viridis* larvæ, 3.5; *C. lobiferus* larvæ, 8.1; *Leptocerus dilutus* larvæ, 0.2; *C. digitatus* pupæ, 2; adult midge, 0.2; oligochætes, 22.4; mite, +; *Hyaella*, 0.2; ostracods, 0.2; *Cyclops*, 8.1; *Chydorus*, 0.1; *Pleuroxus*, +; *Ceriodaphnia*, 1.5; *Eurycerus*, 0.7; *Daphnia*, 1; sand, 1.9.

*Summary.*—Food: Chironomid larvæ, 59.5; caddis-fly larvæ, 0.2; chironomid pupæ, 0.2; adult midge, 0.2; oligochætes, 22.4; mites, +; amphipods, 0.2; ostracods, 0.2; copepods, 8.1; cladocerans, 0.4; sand, 1.9.

Station 10; August 20; number examined, 1. Length: 30. Food: *Chironomus digitatus* larvæ, 20; oligochætes, 42; *Hyaella*, 10; *Cyclops*, 15; *Chydorus*, 3; *Ceriodaphnia*, 10.

Station 12; August 20; number examined, 1. Length: 32.5. Food: *Chironomus digitatus* larvæ, 60; *Hyaella*, 30; *Eurycerus*, 10.

Station 5; August 25; number examined, 1. Length, 38.2. Food: *Chironomus digitatus* larvæ, 47; *C. lobiferus* larvæ, 40; oligochætes, 5; ostracods, 3; *Cyclops*, 5.

Station 5; August 30; number examined, 1. Length: 41.5. Food: *Chironomus lobiferus* larvæ, 10; *Protenthes culiciformis* larvæ, 10; oligochætes, 47; *Cyclops*, 30; diatoms, 3.

Station 14; August 31; number examined, 3. Lengths: 41, 36.5, 29; average, 35.6. Food: Chironomid larva, 5; *Cricotopus trifasciatus* larva, 2.3; *Chironomus digitatus* larvæ, 35; *C. viridis* larvæ, 2.3; *Protenthes culiciformis* larvæ, 2.3; mites, 0.3; *Hyaella*, 15; *Cyclops*, 8; *Chydorus*, 18; sand, 10.

*Summary.*—Food: Chironomid larvæ, 46.9; mites, 0.3; amphipods, 15; copepods, 8; cladocerans, 18; sand, 10.

Station 1; September 1; number examined, 10. Length: Maximum, 48.5; minimum, 27.5; average, 34.9. Food: *Cricotopus trifasciatus* larvæ, 1.4; *Chironomus digitatus* larvæ, 41.5; *C. viridis* larvæ, 1.1; *C. lobiferus* larvæ, 7.4; *C. tentans* larvæ, 3.5; *Corethra* larvæ, 0.2; *Cænis diminuta* nymphs, 0.5; *C. digitatus* pupæ, 1.5; oligochætes, 13.7; *Hyaella*, 13.9; *Cyclops*, 5; *Chydorus*, 0.1; *Pleuroxus*, 0.2; *Eurycerus*, 6.3; cladoceran, 0.1; sand, 3.5.

*Summary.*—Food: Chironomid larvæ, 55.1; May-fly nymphs, 0.5; chironomid pupæ, 1.5; oligochætes, 13.7; amphipods, 13.9; copepods, 5; cladocerans, 6.7; sand, 3.5.

Station 5; September 2; number examined, 2. Lengths: 41, 31. Food: Insect eggs, 2.5; *Proboezzia pallida* larvæ, 11; *Chironomus digitatus* larvæ, 5; *C. lobiferus* larvæ, 45.5; *C. tentans* larvæ, 21.5; adult midge, 0.5; oligochætes, 5; *Cyclops*, 5; cladoceran, 1; sand, 3.

*Summary.*—Food: Chironomid larvæ, 85.5; midge, 0.5; oligochætes, 5; copepods, 5; cladocerans, 1; sand, 3.

*Grand summary.*—Number examined, 50. Length: Maximum, 48.5; minimum, 21.5; average, 30.9. Food: Insect larvæ, 59.2; insect pupæ, 1.4; adult insects, 0.1; oligochætes, 18.4; amphipods, 5.1; ostracods, 0.5; copepods, 7.4; cladocerans, 5.6; diatoms, +; sand, 3.1.

The chief food of the Johnny darter is chironomid larvæ, with oligochætes forming the second largest item. Forbes and Richardson (1908) stated that the food of the fish they examined consisted of two-thirds chironomid larvæ, 12 per cent small May flies, and 7 per cent gnat larvæ. Hankinson (1908) reported chiefly midge larvæ, with some filamentous algæ and Entomostraca. Reighard (1915) found midge larvæ and entomostracans.

**Catostomus commersonii** (Lacépède). Common sucker, fine-scaled sucker.

Station 24; July 2, 1915; number examined, 23. Length: Maximum, 24.3; minimum, 13; average, 19.9. Food: *Chironomus lobiferus* eggs, 0.1; *C. lobiferus* larvæ, 5.2; *C. digitatus* larvæ, 5.6; *C. viridis* larvæ, 1.3; *C. flavus* larvæ, 1.3; *C. tentans* larvæ, 2.4; *Cricotopus trifasciatus* larvæ, 41.3; *C. tentans* pupæ, 3.4; bug, +; midge, 0.3; ostracods, 17.5; Cyclops, 3.7; Cladoceran, 2.2; *Bosmina*, 1.1; *Chydorus*, 1.5; *Eurycercus*, +; oligochætes, 13.5; rotifers, 0.1; *Closterium*, +; *Pediastrum*, +; diatoms and desmids, +; *Aphanothece*, 0.1.

*Summary*.—Food: Chironomid larvæ, 55.9; chironomid pupæ, 3.4; adult insects, 0.3; ostracods, 17.5; copepods, 3.7; cladocerans, 3.9; oligochætes, 13.5; rotifers, 1; Protozoa, +; algæ, 0.1.

Station 5; August 25; number examined, 6. Length: Maximum, 60; minimum, 38.5; average, 47.9. Food: *Chironomus lobiferus* larvæ, 0.5; *Proboezzia glaber* larvæ, 0.8; ostracods, 12.3; Cyclops, 48.4; cladocerans, 0.3; oligochætes, 7; *Arcella*, 0.1; *Diffugia*, 8.5; *Closterium*, 1.6; desmids and diatoms, 2.5; fine silt and débris, 16.9.

*Summary*.—Food: Chironomid larvæ, 1.3; ostracods, 12.3; copepods, 48.4; cladocerans, 0.3; oligochætes, 7; protozoans, 8.6; algæ, 4.1; silt and débris, 16.9.

Station 5; August 30; number examined, 3. Length: 58, 53.6, 44; average, 51.8. Food: *Chironomus lobiferus* larvæ, 4; *Corethra* adult, 2.3; *Dytiscus*, 2.3; mite, +; ostracods, 27; Cyclops, 14; chydorid, 6.3; oligochætes, 10; rotifers, 1.3; *Arcella*, 0.3; *Diffugia*, 1; *Closterium*, 10.3; desmids and diatoms, 14; silt and débris, 4.3.

*Summary*.—Food: Chironomid larvæ, 4; adult insects, 4.6; ostracods, 27; copepods, 14; cladocerans, 6.3; oligochætes, 10; rotifers, 1.3; protozoans, 1.3; algæ, 24.3; silt and débris, 4.3.

Station 5; September 2; number examined, 1. Length: 44. Food: *Enallagma* eggs, 25; Cyclops, 56; *Chydorus*, 1; oligochætes, 10; rotifers, 1; *Diffugia*, 1; desmids and diatoms, 1; silt and débris, 5.

*Grand summary*.—Number examined, 34. Length: Maximum, 60; minimum, 13; average, 29.2. Food: Insect eggs, 0.7; chironomid larvæ, 40.6; chironomid pupæ, 2.4; adult insects, 0.6; mites, 0.1; ostracods, 16.8; copepods, 14.8; cladocerans, 3.6; oligochætes, 11.5; rotifers, 0.2; Protozoa, 1.3; algæ, 3; silt and débris, 3.6.

The common sucker when young feeds mostly on chironomid larvæ (40.6 per cent), entomostracans (35.2 per cent), and oligochætes (11.5 per cent). Tracy (1910) described the young as feeding on diatoms, desmids, and black-fly larvæ; the adults on insects, worms, molluscs, young fishes, and fish eggs. Reighard (1915) found that the young ate mostly cladocerans, 2,000 being found in one individual. He told how the adults mouth over plants from one end to the other, and stated that they ate the eggs of the log perch. Hankinson (1908) found the food of adults to consist of caddis-fly larvæ and cases, *Sphæridæ*, amphipods, insects, marl, midge larvæ, and *Daphnia*. Baker (1916) reported his examinations as follows: Mud and plant remains, 49 per cent; molluscs, 30 per cent; insecta, 21 per cent.

The sucker is remarkable for the fineness of the food it is able to select. No other fish shows such a high percentage of protozoans, unicellular algæ, and rotifers in its food.

**Cottus ictalops** (Rafinesque). Miller's thumb, common sculpin.

*Data for 1914* (Pearse, 1915).—All from station 11; number examined, 10. Average length, 45. Food: May-fly nymphs, 66; chironomid larvæ, 7.1; adult midge, 1.5; *Hyalella*, 13.5; ostracods, 0.5; Cyclops, 1.5; leech, 9; filamentous algæ, 0.9.

Station 14; July 9, 1915; number examined, 2. Lengths: 21.7, 20.5. Food: *Cricotopus* adults, 7.5; *Hyalella*, 60; ostracods, 2.5; Cyclops, 10; chydorid, 2.5; oligochætes, 10; filamentous algæ, 7.5.

Station 23; July 23; number examined, 1. Length: 57.5. Food: *Chironomus fulviventris* larvæ, 10; *Diamesa waltii* larvæ, 10; *Hyalella*, 60; oligochætes, 15; plant remains, 5.

Station 19; August 18; number examined, 1. Length: 31. Food: *Chironomus lobiferus* larvæ, 40; *Hyalella*, 60.

Station 19; August 20; number examined, 2. Lengths: 33, 32.5. Food: *Chironomus digitatus* larvæ, 21.5; *Hyalella*, 75; sand, 3.5.

Station 19; August 30; number examined, 2. Lengths: 33.5, 41. Food: Hyalella, 96; oligochaetes, 4.  
 Station 19; August 31; number examined, 2. Lengths: 30.5, 30.5. Food: Chironomus digitatus larvæ, 10; C. viridis larvæ, 10; Cænis diminuta nymphs, 8.5; Hyalella, 68.5; Cyclops, 1; oligochaetes, 0.5; sand, 1.5.

Station 14; August 31; number examined, 1. Length: 35.5. Food: Chironomus digitatus larvæ, 10; Bætisca nymphs, 30; Hyalella, 60.

Station 1; September 1; number examined, 1. Length: 35. Food: Chironomus digitatus larvæ, 5; Bætisca nymphs, 15; Hyalella, 80.

Station 11; September 2; number examined, 5. Length: Maximum, 46; minimum, 31.5; average, 40. Food: Chironomus digitatus larvæ, 0.4; Heptagenia interpunctata larvæ, 0.6; Hyalella, 98; ostracods, 1.

Station 11; September 11; number examined, 2. Lengths: 49, 39. Food: Hyalella, 95; ostracods, 1; Nostoc, 4.

Station 1; October 2; number examined, 1. Length: 48. Food: Dikerogammarus fasciatus, 100.

*Grand summary for 1914 and 1915.*—Number examined, 30. Length: Maximum, 57.5; minimum, 20.5; average, 39.6. Food: Chironomid larvæ, 7.5; caddis-fly larvæ, 0.1; May-fly nymphs, 24; adult midges, 1; amphipods, 59.1; ostracods, 0.6; copepods, 1.2; cladocerans, 0.1; oligochaetes, 0.7; leeches, 3; plant remains, 0.1; algæ, 1; sand, 0.2.

The miller's thumb subsists mostly on amphipods and insect larvæ. It evidently lurks under stones and rushes out to capture small things which swim by. Forbes and Richardson (1908) examined six individuals, and 25 per cent of the food consisted of small fishes, 40 per cent of insect larvæ, and the remainder mostly Asellus. They also stated that this fish was said to be very destructive to the eggs and fry of trout.

#### **Cyprinus carpio** Linnæus. German carp.

Station 23, in a little inland pool connected with Yahara Canal by a ditch; July 12, 1915; number examined, 4. Length: Maximum, 21.7; minimum, 18; average, 20.1. Food: Unidentified chironomid larvæ, 5.2; Proboezzia pallida larvæ, 2.5; Tanytarsus agrayoloides larvæ, 10; Gyrrinus larvæ, 2.5; Dytiscus hybridus larvæ, 2.5; Diamesa waltii larvæ, 4.2; D. waltii pupæ, 2.7; Palpomyia longipennis pupæ, 0.7; Leptocella uwarowii adult, 17.5; Collembola, 2.5; ostracods, 28.7; Cyclops, 2.5; Chydorus 1.2; rotifers, 13.7; colonial algæ, 0.7; desmids, 0.2; Wolffia, 2.5.

*Summary.*—Food: Chironomid larvæ, 21.9; beetle larvæ, 5; chironomid pupæ, 3.2; adult insects, 20; ostracods, 28.7; copepods, 2.5; cladocerans, 1.2; rotifers, 3.7; plants, 2.5; algæ, 0.9.

Station 5; August 9; number examined, 18. Length: Maximum, 64; minimum, 15; average, 31.8. Food: Helea larvæ, 0.8; Chironomus fulviventris larvæ, 7; C. lobiferus larvæ, 2; Cricotopus trifasciatus larvæ, 0.3; Proboezzia pallida larvæ, 0.8; May-fly nymphs, 0.8; Cænis diminuta nymphs, 3; Berosus larvæ, 0.3; Haliphus larvae, 0.1; Corixa nymph, 2.7; Palpomyia longipennis adults, 0.3; C. fulviventris adults, 2.5; Corethra adults, 2.5; Dytiscus adults, 2.5; Hyalella, 16.3; ostracods, 9.4; Cyclops, 14; Canthocamptus, 0.5; mites, 1.7; Ceriodaphnia, 1.4; Chydorus, 3.7; Camptocercus, 0.8; Pleuroxus, 0.7; unidentified cladocerans, 0.8; ephippial eggs, 0.5; unidentified snails, 6.4; Physa, 1.6; Planorbis, 2; oligochaetes, 6.3; Pleurococcus, 1.4; Wolffia, 4.7; plant remains, 1.6.

*Summary.*—Food: Insect larvæ, 17.7; adult insects, 7.8; mites, 1.7; Hyalella, 16.3; ostracods, 9.4; copepods, 14.5; cladocerans, 7.9; snails, 9; oligochaetes, 6.3; algæ, 1.4; plants, 6.3

Station 23, in a little inland pool connected with Yahara Canal by a ditch; August 11; number examined, 18. Length: Maximum, 44.6; minimum, 21; average, 29.5. Food: Insect eggs, 0.6; Chironomus fulviventris larvæ, 53.1; C. lobiferus larvæ, 5; C. tentans larvæ, 2.5; Palpomyia longipennis larvæ, 0.5; May-fly nymphs, 1; Cænis diminuta nymphs, 4.9; Naucoris larvæ, 0.1; Chironomus fulviventris pupæ, 7.2; adult insects, 1; Haliphus maculatus adults, 1.5; Chironomus fulviventris adults, 0.3; Corethra adults, 1.5; mites, 2.8; ostracods, 0.3; Cyclops, 8.9; Ceriodaphnia, 0.3; Chydorus, 0.5; Cladoceran, 0.1; snails, 0.8; Physa, 0.8; Planorbis, 4.3; rotifers, +; Diffugia, +; filamentous algæ, 0.3; plant remains, 0.2; silt, 0.3.

*Summary.*—Food: Insect larvæ, 67.6; insect pupæ, 7.2; adults, 4.3; mites, 2.8; ostracods, 0.3; copepods, 8.9; cladocerans, 0.9; snails, 5.9; rotifers, +; protozoans, +; algæ, 0.3; plants, 0.2; silt, 0.3.

Station 28; September 14; number examined, 1. Length: 460. Food: Chironomid larvæ, 1; ostracods, 1; Cyclops, 2; plant remains, 61; duckweed, 7; blue grass, 8; fine silt and débris, 20.

Station 22; April 22, 1916; number examined, 1. Length: 120. Food: Chironomid sp. larvæ, 30; ostracods, 4.8; Cyclops, 24; chydorid, 0.1; Chydorus, 0.1; plant remains, 1; bottom débris, 40.

*Summary*.—Food: Insect larvæ, 30; Entomostraca, 29; plants, 1; débris, 40.

*Grand summary for 1915 and 1916*.—Number examined, 42. Length: Maximum, 460; minimum, 15; average 41.7. Food: Insect larvæ, 39.7; insect pupæ, 6.8; adult insects, 3.5; mites, 1.8; amphipods, 6.9; entomostracans, 20.9; snails, 6.9; oligochaetes, 2.8; rotifers, 1.1; protozoans, +; algæ, 0.8; plant remains, 4.9; silt and débris, 1.5.

The German carp during its first few weeks after hatching from the egg feeds largely on entomostracans and rotifers; after that it turns more to insect larvæ. The adult carp is rather omnivorous, but vegetation forms a large part of its food. Forbes and Richardson (1908) stated that the carp eats principally vegetable matter, also insect larvæ, crustaceans, molluscs, and other small aquatic animals. Tracy (1910) said it is omnivorous and chiefly vegetarian in its diet. Cole (1905) stated that the food was mostly vegetable and mentioned many other things he found, including the eggs of whitefish.

***Esox lucius* Linnæus.** Common pike, pickerel.

Station 17; April 17, 1915; number examined, 1. Length: 730. Food: *Micropterus salmoides* (165 mm. long), 55; *Perca flavescens* (160 mm.), 45.

Station 17; April 25; number examined, 1. Length: 765. Food: *Perca flavescens* (185 mm.), 100.

Station 15; June 12; number examined, 1. Length: 164.5. Food: *Perca flavescens* (95 mm.), 100.

Station 23; July 23; number examined, 1. Length: 143. Food: *Diamesi waltii* adult, 5; *Hyalella*, 95.

Station 15; June 26; number examined, 1. Length: 420. Food: Fish remains, 100.

Station 15; August 7; number examined, 1. Length: 155.5. Food: Fish remains, 90; *Sphæridæ*, 10.

Station 15; August 21; number examined, 1. Length: 587. Food: *Perca flavescens* (134 mm.), 100.

Station 17; August 23; number examined, 2. Lengths: 362, 400. Food: *Perca flavescens* (140 mm., 105 mm.), 100.

Station 17; August 24; number examined, 1. Length: 317. Food: Fish remains, 90; *Corixa* nymphs, 4; *Naucoris* larvæ, 4; ephippial eggs, 2.

Station 28; September 17; number examined, 4. Length: Maximum, 555; minimum, 455; average, 487. Food: Small sunfish, 50; fish remains, 50.

Station 29; November 16; number examined, 2. Lengths: 876, 563. Food: *Perca flavescens* (200 mm.), 50; fish remains, 50.

Station 22; April 1, 1916; number examined, 1. Length: 233. Food: Fish remains, 100.

Station 18; April 13; number examined, 4. Length: Maximum, 238; minimum, 200; average, 217.5. Food: Fish remains, 100.

Station 18; April 17; number examined, 1. Length, 227. Food: *Notropis heterodon* and other fish remains, 100.

Station 18; April 18; number examined, 2. Lengths: 293, 203; average, 248. Food: *Chydorus*, 50; leech, 50.

Station 27; May 30; number examined, 2. Lengths: 320, 295; average, 305. Food: *Pimephales notatus*, 50; *Perca flavescens*, 50.

Station 18; June 29; number examined, 1. Length: 220. Food: Fish remains, 100.

Station 18; June 12; number examined, 1. Length: 45. Food: Minnow, 50; chironomid larvæ, 20; *Cænis diminuta* nymphs, 30.

Station 18; July 7; number examined, 2. Length: Maximum, 100; minimum, 90; average, 95. Food: Fish remains, 50; *Perca flavescens*, 50.

Station 17; July 10; number examined, 6. Length: Maximum, 100; minimum, 81; average, 88.8. Food: *Micropterus salmoides*, 66.6; *Perca flavescens*, 16.6; *Cænis diminuta* nymphs, 10; midge pupæ, 6.6.

*Grand summary for 1915 and 1916*.—Number examined, 36. Length: Maximum, 876; minimum, 45; average, 293.4. Food: Fish, 84; insect larvæ, 2.9; insect pupæ, 1; adult insects, 2.5; amphipods, 2.5; Entomostraca, 2.6; Hirudinea, 2.5; Mollusca, 0.2; silt and débris, 1.2.

The small pickerel apparently eats a few insects and molluscs; the adults live nearly altogether on fish. Other observers have found the food to be as follows: Forbes and Richardson (1908)—fishes and frogs, crayfishes, larger insects, and occasionally even mice, reptiles, and young ducks; Hankinson (1908)—perch, darters; Reighard (1915)—perch and fish remains.

**Etheostoma flabellare** Rafinesque, var. *lineolatum* Jordan and Evermann. Fan-tailed darter.

*Data for 1914.*—Station 11; September 4; number examined, 2. Lengths: 29.6, 31.3. Food: Chironomid larvæ, 75; adult midge, 0.5; Hyalella, 24.5; Camptocercus, +.

Station 19; December 3; number examined, 1. Length: 38.7. Food: Chironomus lobiferus larvæ, 35; C. viridis larvæ, 40; Hyalella, 25.

Station 23; July 12, 1915; number examined, 1. Length: 48.3. Food: Hyalella, 80; oligochætes, 15; plant remains, 5.

Station 14; August 31; number examined, 1. Length: 38.7. Food: Agraylea multipunctata larvæ, 13; Hyalella, 86; chydorid, 1.

*Grand summary for 1914 and 1915.*—Number examined, 5. Length: Maximum, 48.3; minimum, 29.6; average, 37.3. Food: Chironomid larvæ, 42; caddis-fly larvæ, 4.8; adult midge, 0.2; Hyalella, 48; cladocerans, 0.2; oligochætes, 3; plant remains, 1.

The fan-tailed darter lives mostly on chironomid larvæ and amphipods. Forbes and Richardson (1908) examined six fish and found two-thirds chironomid larvæ, one-fourth May-fly nymphs, and the remainder copepods.

**Etheostoma iowæ** Jordan and Meek. Iowa darter.

Station 23; July 9, 1915; number examined, 4. Length: Maximum, 55; minimum, 45.5; average, 48.5. Food: Unidentified chironomid larvæ, 12.5; Chironomus fulviventris larvæ, 11.2; C. tentans larvæ, 2.5; Berosus larvæ, 9; Gyrynus larvæ, 11.2; Hyalella, 47.5; Physa heterostropha, 3.7; oligochætes, 2; fine débris, 0.5.

Station 23; August 31; number examined, 1. Length: 45. Food: Hyalella, 100.

*Grand summary.*—Number examined, 5. Average length, 47.8. Food: Chironomid larvæ, 21; beetle larvæ, 16; amphipods, 58; snails, 3; oligochætes, 1.6; fine débris, 0.4.

This beautiful little darter subsists nearly altogether on amphipods and insect larvæ.

**Eucalia inconstans** (Kirtland). Brook stickleback.

*Data for 1914* (Pearse, 1915).—Number examined, 50. Length: Maximum, 48.5; minimum, 22; average, 31.7. Food: Dipterous larvæ, 13.2; May-fly nymphs, 1.4; Corixa nymphs, +; caddis-fly larvæ, 1.3; unidentified adult insects, 2.2; midges, 13.6; podurans, 0.7; mites, 0.5; Hyalella, 0.2; ostracods, 3.6; copepods, 28.5; cladocerans, 14.9; snails, 6.3; Sphæridæ, 0.1; oligochætes, 0.3; nematodes, +; rotifers, +; Diffugia, +; plants, 5.4; algæ, 1.7; fine débris, 4.6.

Station 21; April 28, 1915; number examined, 10. Length: Maximum, 51; minimum, 30.1; average, 40.6. Food: Chironomid larvæ, 2.5; Pelopia flavifrons larvæ, 1.5; Chironomus fulviventris larvæ, 2; C. flavus larvæ, 3; C. lobiferus larvæ, 0.6; C. modestus larvæ, 0.2; C. digitatus larvæ, 0.2; Tanytarsus dissimilis larvæ, 0.2; Orthocladius sp. larvæ, 0.7; Cricotopus exilis larvæ, 0.4; Cricotopus trifasciatus pupæ, 0.2; Chironomid adults, 3.8; Hyalella, 11.5; Dikerogammarus fasciatus, 15.2; young amphipods, 5.5; ostracods, 5; Cyclops, 12; Canthocamptus, 1; oligochætes, 7.3; rotifers, 4.3; diatoms, +; algæ, 0.5; filamentous algæ, 0.2; gelatinous algæ, 0.5; plant remains, 8.5; silt and fine débris, 16.6.

*Summary.*—Food: Chironomid larvæ, 11.3; chironomid pupæ, 0.2; adult midges, 3.8; amphipods, 32.2; ostracods, 5; copepods, 13; oligochætes, 7.3; rotifers, 4.3; algæ, 1.2; plants, 8.5; silt and débris, 16.6.

Station 20; April 28; number examined, 10. Length: Maximum, 44; minimum, 31; average, 40.6. Food: Fish eggs and embryos, 2.5; Pelopia flavifrons larvæ, 0.3; chironomid larvæ, 0.9; C. flavus larvæ, 0.7; C. lobiferus larvæ, 0.7; C. dorsalis larvæ, 0.2; C. tentans larvæ, 0.6; C. viridicollis larvæ, 0.2; Tanytarsus exiguus larvæ, 3.4; Orthocladius nivoriundus larvæ, 0.9; adult midge, 0.5; insect, 1.5; Asellus communis, 14; Dikerogammarus fasciatus, 3; ostracods, 3.7; Cyclops, 16.8; Canthocamptus, 7.3; Chydorus sphaericus, 32.2; Physa, 7.5; Physa eggs, 1; oligochætes, 1; filamentous algæ, 0.1; silt and débris, 0.6.

*Summary.*—Food: Chironomid larvæ, 10.4; adult insects, 2; amphipods, 17; ostracods, 3.7; copepods, 21.1; cladocerans, 32.2; snails, 8.5; oligochætes, 1; algæ, 0.1; silt and débris, 0.6.

Station 20; June 12; number examined, 30. Length: Maximum, 43.5; minimum, 9.4; average, 19.1. Food: Caddis-fly larvæ, 1.1; chironomid larvæ, 7.1; *Chironomus tentans*, 8.9; psychodid larvæ, 0.3; *Tanytarsus exiguus* larvæ, 6.4; *Orthocladius* sp. larvæ, 0.5; *O. nivoriundus* larvæ, 0.8; *Cricotopus exilis* larvæ, 1.9; *C. trifasciatus* larvæ, 5; *C. trifasciatus* pupæ, 11.4; *Chironomus tentans* pupæ, 17.3; *C. fulviventris* pupæ, +; *Aedes* adults, 1; leaf hopper, 1; ostracods, 2.5; Cyclops, 4.8; *Canthocamptus*, 1.5; nauplii, 0.1; *Chydorus sphaericus*, 20; *Ceriodaphnia*, 0.9; rotifers, 4.3; diatoms, 0.1; filamentous algæ, 0.1; plant remains, 0.1.

*Summary*.—Food: Chironomid larvæ, 30.9; caddis-fly larvæ, 1; chironomid pupæ, 28; adult insects, 2; ostracods, 2.5; copepods, 6.4; cladocerans, 20.9; rotifers, 4.3; algæ, 1.1; plants, 0.1.

Station 21; June 12; number examined, 6. Length: Maximum, 42; minimum, 30; average, 37. Food: Chironomid larvæ, 0.2; *Chironomus fulviventris* larvæ, 64.6; *Tanytarsus exiguus* larvæ, 4.3; *Chironomus fulviventris* pupæ, 20; *Aedes* adults, 5.8; *Hyaella*, 3.6; Cyclops, 1.3; amphipods, 3.6; copepods, 1.3.

*Summary*.—Food: Chironomid larvæ, 69.1; chironomid pupæ, 20; adult mosquitoes, 5.8; amphipods, 3.6; copepods, 1.3.

Station 25, from a ditch beside the road; July 2; number examined, 4. Length: Maximum, 28.6; minimum, 13.2; average, 19.6. Food: Chironomid larvæ, 2.5; *Tanytarsus exiguus* larvæ, 6.2; *Tanytarsus monilis* larvæ, 28.2; adult midge, 1.2; *Hermannia bistriata*, 11.2; ostracods, 13.7; Cyclops, 22.5; *Ceriodaphnia*, 1.2; oligochætes, 7.2; rotifers, 4.7; diatoms, 1; gelatinous algæ, 1.2.

*Summary*.—Food: Chironomid larvæ, 36.9; midge, 1.2; terrestrial mite, 11.2; ostracods, 13.7; copepods, 22.5; cladocerans, 1.2; oligochætes, 7.2; rotifers, 4.7; algæ, 2.2.

*Grand summary for 1914 and 1915*.—Number examined, 110. Length: Maximum, 51; minimum 9.4; average, 29.3. Food: Fish eggs, 0.2; dipterous larvæ, 21.5; hemipterous larvæ, +; May-fly larvæ, 0.6; caddis-fly larvæ, 0.9; chironomid pupæ, 9.1; adult Diptera, 7.3; hemipterous adults, 0.3; podurans, 0.3; unidentified insects, 1.1; mites, 0.6; amphipods, 3.4; *Asellus*, 1.2; ostracods, 3.2; copepods, 19.3; cladocerans, 16; snails, 3.6; Sphæridæ, 0.1; oligochætes, 1.1; rotifers, 1.1; nematodes, +; algæ, 1.2; plants, 3.2; silt and débris, 3.7.

The brook stickleback ate over 41 per cent insects (larvæ, 23; pupæ, 9.1; adults, 9) and 38.5 per cent entomostracans. Forbes and Richardson (1908) examined five fish and found about equal parts of plant and animal food—filamentous algæ, insects, chironomid larvæ, and entomostracans.

#### *Eupomotis gibbosus* Linnæus. Pumpkinseed.

Station 17; April 10, 1915; number examined, 3. Lengths: 155, 148, 145. Food: *Protenthes choreus* larvæ, 0.6; *Chironomus fulviventris* larvæ, 0.6; *Enallagma hageni* nymphs, 2.6; *Sialis* larvæ, 1.6; *Colymbetis* adults, 20; leeches, 8.3; *Planorbis*, 40; plant remains, 22.6; fine débris, 3.3.

Station 17; April 13; number examined, 2. Lengths: 133, 126. Food: Toad eggs, 42.5; *Planorbis*, 30; plant remains, 5; algæ, 15; fine débris, 7.5.

Station 28; August 19; number examined, 1. Length: 116. Food: *Chironomus lobiferus* larvæ, 15; *Chrysops* larvæ, 1; *Chironomus lobiferus* pupæ, 2; *Corixa* adults, 5; *Probozzia glaber*, 3; *Hyaella*, 74.

Station 28; August 24; number examined, 2. Lengths: 187, 142. Food: *Micronecta* nymph, 1.5; *Cænis diminuta* nymphs, 2.5; *Enallagma antennatum* nymphs, 0.5; *Sialis* larvæ, 2.5; *Stratiomyia discalis* larvæ, 2.5; *Notonecta* nymph, 3.5; *Corixa* adults, 4.5; *Hyaella*, 1.5; *Physa*, 1.5; sponge, 10; *Lemna*, 7.5; *Ceratophyllum*, 48.5.

Station 15; October 1; number examined, 1. Length: 160. Food: *Chironomus lobiferus* larvæ, 35; *Leptocella uwarowii* adult, 10; *Hyaella*, 5; crayfish, 12; *Valvata tricarinata*, 10; *Ammicola limosa*, 10; *Ancylus*, 3; plant remains, 5; *Vallisneria*, 10; *Myriophyllum*, 2; filamentous algæ, 3.

*Grand summary*.—Number examined, 9. Length: Maximum, 187; minimum, 116; average, 145.7. Food: Toad? eggs, 9.4; insect larvæ, 11.6; insect pupæ, 0.9; adult insects, 9.3; amphipods, 9; crayfish, 1.3; leeches, 2.8; snails, 25.8; sponge, 2.2; plants, 21.9; algæ, 3.6; fine débris, 2.8.

The food of the pumpkinseed was made up of insects (22.1 per cent), large Crustacea (10.3 per cent), snails (25.8 per cent), plants (25.5 per cent), and other things. Forbes and Richardson (1908) found that more than half the food of the fish they examined was molluscs; the rest was amphipods, isopods, and insects. Hankinson (1908) reported midge larvæ, May-fly nymphs, crayfishes, amphipods, snails, leeches, and caddis-fly larvæ. Reighard (1915) found snails, insect larvæ, and *Chara*. Insects formed the chief food of those fish examined by Baker (1916).



**Fundulus diaphanus menona** (Jordan and Copeland). Menona top minnow.

*Data for 1914* (Pearse, 1915).—Number examined, 49. Length: Maximum, 49.5; minimum, 27.5; average, 35.4. Food: Dipterous larvæ, 6.1; beetle larvæ, 0.6; hemipterous larvæ, 0.7; dragon-fly nymphs, +; May-fly nymphs, 1.7; podurans, +; insects, 3.2; mites, 1; Hyalella, 16.2; ostracods, 25.2; copepods, 1.2; cladocerans, 27; Planorbis, 0.1; plant remains, 0.1; Wolffia, 14.7; filamentous algæ, 0.1.

Station 17; December 3; number examined, 1. Length: 37. Food: Chironomus viridicollis larvæ, 5; C. viridis larvæ, 5; Chydorus sphaericus, 10; Ceriodaphnia, 40; Eurycerus lamellatus, 40.

*Summary*.—Food: Chironomid larvæ, 10; cladocerans, 90.

Station 19; December 3; number examined, 1. Length: 38. Food: Cricotopus trifasciatus larvæ, 92; Hyalella, 8.

Station 17; April 6, 1915; number examined, 10. Length: Maximum, 42.1; minimum, 27.9; average, 31.6. Food: Dipterous larvæ, 7; Chironomus tentans larvæ, 5.8; C. fulviventrus larvæ, 10; C. decorus larvæ, 8; Corethra larvæ, 6; adult Diptera, 14; ostracods, 6.5; Cyclops, 5.5; Canthocamptus, 2.5; Chydorus sphaericus, 4; oligochætes, 14.3; nematodes, 0.2; unknown eggs, 10; plants, 0.2; algæ, 3; fine débris, 3.

*Summary*.—Food: Dipterous larvæ, 36.6; adult Diptera, 14; ostracods, 6.5; copepods, 8; cladocerans, 4; oligochætes, 14.3; nematodes, 0.2; unknown eggs, 10; plants, 3.2; fine débris, 3.

Station 17; April 13; number examined, 4. Length: Maximum, 45.5; minimum, 30; average, 39.5. Food: Chironomid larvæ, 5; Chironomus fulviventrus larvæ, 0.5; C. decorus larvæ, 0.9; C. lobiferus larvæ, 14.2; ostracods, 15.5; Cyclops, 9.2; Canthocamptus, 3.7; Ceriodaphnia, +; oligochætes, 3.7; nematodes, 1.2; plant remains, 4.2; Wolffia, 10.7; algæ, 1.5; fine débris, 29.2.

*Summary*.—Food: Chironomid larvæ, 20.6; ostracods, 15.5; copepods, 12.9; oligochætes, 3.7; nematodes, 1.2; plants, 16.4; fine débris, 29.2.

Station 21; April 28; number examined, 10. Length: Maximum, 46; minimum, 27; average, 38.6. Food: Young fish with yolk sacs, 6.9; chironomid larvæ, 0.6; Chironomus fulviventrus larvæ, 3.6; C. flavus larvæ, 2; Tanyptus decoloratus larvæ, 0.8; Tanytarsus exiguus larvæ, 2; T. dives larvæ, 2; Orthocladus sp. larvæ, 0.4; O. nivoriundus larvæ, 4; Palpomyia longipennis larvæ, 1; Tabanus larvæ, 1.1; podurans, 0.7; midges, 9.2; Dikerogammarus fasciatus, 19.7; Cyclops, 3.1; Canthocamptus, 1.3; Sphæridæ, 4; oligochætes, 1.5; eggs, 1.1; plant remains, 7.2; fine débris, 17.1.

*Summary*.—Food: Dipterous larvæ, 17.5; adult insects, 9.9; amphipods, 19.7; copepods, 4.4; Sphæridæ, 4; oligochætes, 1.5; eggs, 1.1; plants, 7.2; fine débris, 17.1.

Station 21, along shore of Lake Wingra; April 28; number examined, 10. Length: Maximum, 39; minimum, 33; average, 38. Food: Tanyptus decoloratus larvæ, 0.3; T. d. pupæ, 16; Cricotopus trifasciatus pupæ, 1; adult Diptera, 0.5; terrestrial mites, 1.4; ostracods, 46.5; Cyclops, 15.7; Canthocamptus, 1.5; Chydorus sphaericus, 5.1; Eurycerus, 8.1; nematodes, 0.3; algæ, 3.5.

*Summary*.—Food: Dipterous larvæ, 0.3; dipterous pupæ, 17; adult insects, 0.5; mites, 1.4; ostracods, 46.5; copepods, 17.2; cladocerans, 13.2; nematodes, 0.3; algæ, 3.5.

Station 5; May 12; number examined, 10. Length: Maximum, 59; minimum, 34; average, 47.4. Food: Fish eggs, 4.5; Cricotopus trifasciatus larvæ, 4.4; Chironomus viridis larvæ, 1; C. viridicollis larvæ, 5.6; Tanyptus decoloratus larvæ, 2.2; Pelopia monilis larvæ, 1; Orthocladus sordidellus larvæ, 2.5; Proboezia pallida larvæ, 0.1; Cænis diminuta nymphs, 6.4; May-fly nymphs, 0.5; Orthocladus sordidellus pupæ, 2.4; Tanyptus decoloratus pupæ, 0.8; Collembola, 0.5; midges, 1; terrestrial mites, 0.8; Hyalella, 3.5; ostracods, 26.2; Cyclops, 5.8; Chydorus sphaericus, 21.2; Eurycerus lamellatus, 2.9; Sphæridæ, 1; Planorbis, 1.2; plant remains, 0.7; algæ, 1.3; fine débris, 0.5.

*Summary*.—Food: Fish eggs, 4.5; insect larvæ, 20.1; pupæ, 3.2; adult insects, 1.5; mites, 0.8; amphipods, 3.5; ostracods, 26.2; copepods, 5.8; cladocerans, 25.1; molluscs, 2.2; plants, 2; fine débris, 0.5.

Station 16; May 15; number examined, 8. Length: Maximum, 52; minimum, 32; average, 39.5. Food: Helea larvæ, 2; Cricotopus trifasciatus larvæ, 20.7; Tanyptus decoloratus larvæ, 0.5; Orthocladus sordidellus larvæ, 5.5; Palpomyia larvæ, 5; Cænis diminuta nymphs, 2.1; Cricotopus trifasciatus pupæ, 5; mites, 3; ostracods, 7; Cyclops, 18.5; Chydorus sphaericus, 2; Pleuroxus procurvatus, 1.5; Planorbis, 11.7; oligochætes, 12; plant remains, 0.2; algæ, 0.1.

*Summary*.—Food: Insect larvæ, 35.7; pupæ, 5; mites, 3; ostracods, 7; copepods, 18.5; cladocerans, 3.5; snails, 11.7; oligochætes, 12; plants, 0.3.

Station 5; June 1; number examined, 10. Length: Maximum, 49; minimum, 30; average, 38. Food: Beetle larvæ, 6; May-fly nymphs, 1; Helea larvæ, 1; Chironomus decorus larvæ, 2.7; C. lobiferus larvæ, 4.8; Orthocladius sordidellus larvæ, 37.7; Probozzia glaber larvæ, 0.4; C. digitatus pupæ, 0.1; Hyalella, 1.5; ostracods, 12.5; Cyclops, 0.5; Chydorus sphaericus, 3.3; Eurycerus, 5.7; snails, 0.5; Planorbis, 12.5; Limnæa, 9; Physa, 0.8.

*Summary*.—Food: Insect larvæ, 54.6; pupæ, 0.1; amphipods, 1.5; ostracods, 12.5; copepods, 0.5; cladocerans, 9; snails, 23.2.

Station 6; June 24; number examined, 10. Length: Maximum, 58.8; minimum, 37; average, 48.4. Food: Helea larvæ, 0.5; Chironomus plumosus larvæ, 0.4; C. lobiferus larvæ, 1.2; Orthocladius sordidellus larvæ, 0.5; Probozzia glaber larvæ, 2; Ecdyurus maculipennis nymphs, 16.8; Orthocladius sordidellus pupæ, 0.2; Tanytus monilis pupæ, 0.1; C. decorus pupæ, 0.5; C. digitatus pupa, 1; Corixa adults, 0.4; Hyalella, 30.1; ostracods, 7.9; Cyclops, 2.2; Chydorus sphaericus, 7.9; Pleuroxus procurvatus, 0.2; Planorbis, 14.4; Physa, 3.8; oligochætes, 2.5; fine débris, 5.

*Summary*.—Food: Insect larvæ, 21.4; pupæ, 1.8; adult insects, 0.4; amphipods, 30.1; ostracods, 7.9; copepods, 2.2; cladocerans, 8.1; snails, 20.2; oligochætes, 2.5; fine débris, 5.

Station 3; June 24; number examined, 10. Length: Maximum, 67.5; minimum, 53; average, 57.9. Food: Insect larva, 1; Helea larvæ, 0.3; Cricotopus trifasciatus larvæ, 1.4; Chironomus plumosus larvæ, 2.1; Tanytus monilis larvæ, 3.6; Orthocladius sordidellus larvæ, 43; Probozzia glaber larvæ, 0.3; P. pallida larvæ, 1.3; Sialis larva, 0.1; Ecdyurus maculipennis nymphs, 8.3; Orthocladius sordidellus pupæ, 0.4; Chironomus digitatus pupæ, 0.2; Hyalella, 11.4; ostracods, 0.3; Cyclops, 0.1; Chydorus, 1; fine débris, 26.

*Summary*.—Food: Insect larvæ, 61.4; pupæ, 0.6; amphipods, 11.4; ostracods, 0.3; copepods, 0.1; cladocerans, 1; fine débris, 26.

Station 18; July 3; number examined, 11. Length: Maximum, 55; minimum, 41; average, 47.3. Food: Helea larvæ, 0.2; chironomid larvæ, 3; Chironomus lobiferus larvæ, 3.6; C. abbreviatus larvæ, 0.2; Probozzia glaber larvæ, 0.5; Protenthes culiciformis larvæ, 0.3; Procladius sp. larvæ, 19.7; Hyalella, 49.1; Dikerogammarus fasciatus, 0.1; Eurycerus, 22.6; algæ, +.

*Summary*.—Food: Insect larvæ, 27.5; amphipods, 49.2; cladocerans, 22.6; algæ, +.

Station 23; August 9; number examined, 3. Lengths: 32.5; 30.5; 25.4. Food: Chironomid larvæ, 11.6; Chironomus fulviventris larvæ, 3.3; C. viridis larvæ, 3.3; C. lobiferus larvæ, 6.3; Tanytarsus exiguus larvæ, 6.3; Hyalella, 40; ostracods, 5; Cyclops, 1.3; Chydorus sphaericus, 3.3; Ceriodaphnia, 3.3; Eurycerus, 8.3; oligochætes, 6.3.

*Summary*.—Food: Insect larvæ, 30.8; amphipods, 40; ostracods, 5; copepods, 1.3; cladocerans, 14.9; oligochætes, 6.3.

*Grand summary for 1914 and 1915*.—Number examined, 149. Length: Maximum, 67.5; minimum, 25.4; average, 40.4. Food: Fish embryos, 0.8; insect eggs, 0.8; insect larvæ, 23.4; pupæ, 1.7; adult insects, 2.7; mites, 3; amphipods, 14.1; ostracods, 15.7; copepods, 4.9; cladocerans, 15.3; Sphæridæ, 0.4; snails, 3.5; oligochætes, 2; nematodes, +; plant remains, 5.5; algæ, 0.9; silt and débris, 4.2.

The top minnow ate 36 per cent entomostracans and 28 per cent insects, as well as amphipods, plant remains, the débris from the bottom and the surface of plants, molluscs, etc. Forbes and Richardson (1908) reported the food of this species to be insects, amphipods, snails, and plant seeds. The large percentages of ostracods, oligochætes, and Chydoridae and the species of insect larvæ found in the present investigation indicate that the top minnow frequently feeds near the bottom or among vegetation.

*Labidesthes sicculus* (Cope). Brook silverside.

*Data for 1914* (Pearse, 1915).—Number examined, 50. Length: Maximum, 47.9; minimum, 15.4; average, 35.7. Food: Insect larvæ, 5.1; pupæ and adult insect, 42.4; mites, 0.1; ostracods, +; copepods, 8.1; cladocerans, 27.3; rotifers, +; protozoans, +; plant remains, 2.5; algæ, 8; silt and débris, 3.3.

Station 23; August 11, 1915; number examined, 1. Length: 25.3. Food: Tanytarsus adults, 40; Cyclops, 15; Chydorus sphaericus, 37; Ceriodaphnia, 8.

Station 18; August 14; number examined, 10. Length: Maximum, 27; minimum, 11.5; average, 20.5. Food: Chironomus eggs, 9.5; chironomid larvæ, 5; Probozzia pallida adult, 11.5; ostracods, 0.3; Cyclops, 24.7; Chydorus sphaericus, 0.4; Ceriodaphnia, 37.4; Bosmina, 7.3; Pleuroxus procurvatus, 0.1; Camptocercus, 0.2; ephippial eggs, 3.5.

*Summary*.—Food: Insect eggs, 9.5; insect larvæ, 5; adult insects, 11.5; ostracods, 0.3; cladocerans, 48.9.

Station 19; August 18; number examined, 9. Length: Maximum, 36; minimum, 22; average, 28.2. Food: Chironomid larvæ, 2.2; Chironomus viridis pupæ, 44.6; C. tentans, pupæ, 5.3; Tanytarsus adult, 2.2; Chironomus viridis adult, 2.7; Cyclops, 5.6; Ceriodaphnia, 37.

*Summary.*—Food: Insect larvæ, 2.2; pupæ, 49.9; adults, 4.9; copepods, 5.6; cladocerans, 37.

Station 18; August 18; Number examined, 5. Length: Maximum, 33; minimum, 25; average, 28. Food: Corethra larvæ, 0.6; Chironomus viridis adult, 28.8; spider, 0.2; Cyclops, 11; Chydorus, 0.4; Ceriodaphnia, 58; Daphnia hyalina, 1.

*Summary.*—Food: Insect larvæ, 0.6; adult insects, 28.8; spider, 0.2; copepods, 11; cladocerans, 59.4.

Station 23, west of mouth of Yahara Canal in Lake Monona; August 19; number examined, 5. Length: Maximum, 38.5; minimum, 21.5; average, 31.2. Food: Caterpillar, 1.4; Chironomus viridis pupæ, 23; Tanytarsus adult, 3.5; Chironomus viridis adult, 33; C. digitatus adult, 2.6; C. tentans adult, 6; spider, 5; Cyclops, 0.6; Chydorus, 4.4; Pleuroxus, +; Daphnia hyalina, 20.4.

*Summary.*—Food: Insect larvæ, 1.4; pupæ, 23; adults, 45.1; spider, 5; copepods, 0.6; cladocerans, 24.8.

Station 24; August 19; number examined, 5. Length: Maximum, 41.5; minimum, 20.5; average, 28. Food: Chironomus viridis larvæ, 5; Chironomus viridis pupæ, 82.8; Chironomus viridis adults, 5.2; C. tentans adults, 3.8; spider, 0.2; Cyclops, 2.6; Chydorus, 0.4.

*Summary.*—Food insect larvæ, 0.5; pupæ, 82.8; adults, 9; spider, 0.2; copepods, 2.6; cladocerans, 0.4.

Station 23, at mouth of river; August 19; number examined, 5. Length: Maximum, 41.5; minimum, 21.5; average, 31.5. Food: Corethra larvæ, 3; Chironomus viridis pupæ, 45; Tanytarsus adult, 5; Chironomus viridis adult, 6; C. digitatus adult, 21; spider, 1; Cyclops, 1; Ceriodaphnia, 7; Eurycerus, 11.

*Summary.*—Food: Insect larvæ, 3; pupæ, 45; adults, 32; spider, 1; copepods, 1; cladocerans, 18.

Station 5; August 25; number examined, 4. Length: Maximum, 80.5; minimum, 30.3; average, 54.4. Food: Cyclops, 15.5; Chydorus, 7; Bosmina, 74.4; Camptocercus, 2.2; rotifers, 0.2; Closterium, 0.2.

*Summary.*—Food: Copepods, 15.5; cladocerans, 83.6; rotifers, 0.2; algæ, 0.2.

Station 6; August 25; number examined, 6. Length: Maximum, 77; minimum, 25.5; average, 41.6. Food: Chironomus viridis pupæ, 52.5; C. tentans pupæ, 14.4; Tanytarsus adult, 2.8; Chironomus viridis adult, 6.6; Cyclops, 3; Ceriodaphnia, 19.6; Bosmina, 1.6.

*Summary.*—Food: Insect pupæ, 66.9; adults, 9.4; copepods, 3; cladocerans, 21.2.

*Grand summary for 1914 and 1915.*—Number examined, 100. Length: Maximum, 77; minimum, 11.5; average, 40.9. Food: Insect eggs, 1.4; insect larvæ, 5.2; insect pupæ, 16.4; adult insects, 28.3; spiders, 0.3; mites, +; ostracods, +; copepods, 8.7; cladocerans, 32; rotifers, +; protozoans, +; algæ, 4.

The silverside is more of a "top-minnow" than the top-minnow (*Fundulus diaphanus menona*) itself. The fact that its food contains 44.6 per cent adult insects and pupæ, 40.7 per cent entomostracans, and only a trace of ostracods can be interpreted in no other way. Forbes and Richardson (1908) stated that this species feeds on animal plankton, chironomid larvæ, land insects, and spiders. One fish they examined had eaten a very small minnow. Baker (1916) found the stomachs of the fish he examined to contain a large percentage of insects and small amounts of Crustacea, Acarina and Bryozoa.

**Lepisosteus osseus** (Linnæus). Long-nosed gar, billfish.

Station 28; September 14, 1915; number examined, 1. Length: 650. Food: Lepomis incisor, 100.

Station 23; September 21; number examined, 1. Length: 218. Food: Lepomis incisor, 98; Simulium vittatum larvæ, 2.

Station at Oconomowoc Lake; number examined, 1. Length: 180. Food: Labidesthes sicculus, 90; Chironomus adults, 10.

Station 22; July 1, 1916; number examined, 5. Length: Maximum, 652; minimum, 480; average, 577. Food: Fish, 40; minnow remains, 40; Enallagma antennatum nymphs, 20.

Station 20; July 3; number examined, 1. Length: 600. Food: Johnny darter, 100.

Station 22; July 8; number examined, 1. Length: 416. Food: Fish, 100.

*Summary for 1915 and 1916.*—Number examined, 10. Length: Maximum, 652; minimum, 180; average, 494.9. Food: Fish, 88.8; insect larvæ, 10.2; adult insects, 1.

The youngest gars examined fed somewhat on insects and larvæ, but the chief food of all was small fishes. Forbes and Richardson (1908) reported nothing but small fish for the food of this species.

*Lepomis incisor* Cuvier and Valenciennes. Bluegill, blue sunfish.

*Data for 1914* (Pearse, 1915).—Number examined, 49. Average length, 30.8. Food: Insect larvæ, 22.8; adult insects, 26; mites, 1.2; amphipods, 23.1; copepods, 16.4; cladocerans, 31; oligochætes, 0.2; nematodes, +; rotifers, +; plants, 1.3; algæ, 0.4.

Station 13; April 10, 1915; number examined, 7. Length: Maximum, 108; minimum, 53; average, 87.7. Food: *Chironomus fulviventris* larvæ, 9.9; *C. decorus* larvæ, 0.4; *Leptocella uwarowii* larvæ, 0.4; *Heptagenia interpunctata* larvæ, 0.4; *Hyalella*, 18.5; *Chydorus sphaericus*, 0.3; plant remains, 27.1; fine débris, 42.1.

*Summary*.—Food: Insect larvæ, 11.1; amphipods, 18.5; cladocerans, 0.3; plants, 27.1; fine débris, 42.1.

Station 13; April 13; number examined, 14. Length: Maximum, 105; minimum, 46; average, 80.1. Food: Insect eggs, 0.3; chironomid larvæ, 0.7; *Tanytus monilis* larvæ, 0.7; *Chironomus viridis* larvæ, 0.7; *C. digitatus* larvæ, 4; *C. palliatus* larvæ, 3.1; *C. lobiferus* larvæ, 0.7; *C. fulviventris* larvæ, 2.1; *C. decorus* larvæ, 2.2; *Cricotopus trifasciatus* larvæ, 0.2; *Orthocladus sordidellus* larvæ, 1; *Procladius* larvæ, 6.2; *Hydroptila* larvæ, 2.8; *Agraylea* larvæ, 0.3; May-fly nymphs, 2.3; *Heptagenia interpunctata* larvæ, 2.4; *Enallagma hageni* nymphs, 14.2; *Chironomus lobiferus* pupæ, 0.7; *C. tentans* pupæ, 0.8; *Hyalella*, 3.5; ostracods, 0.2; Cyclops, 8; *Canthocamptus*, 2.7; snail eggs, 5.7; plant remains, 8.5; algæ, 5.3; *Aphanothece*, 17.1; silt and débris, 2.4.

*Summary*.—Food: Insect larvæ, 43.6; pupæ, 1.5; amphipods, 3.5; ostracods, 0.2; copepods, 10.7; snail eggs, 5.7; plants, 8.5; algæ, 22.4; silt and débris, 2.4.

Station 21, on south shore of Lake Wingra; April 28; number examined, 1. Length: 27.5. Food: *Chironomus lobiferus* larvæ, 5; Cyclops, 84; *Chydorus sphaericus*, 11.

Station 5; May 12; number examined, 5. Length: Maximum, 58; minimum, 32; average, 47.1. Food: Insect larvæ, 1; chironomid larvæ, 15; *Chironomus lobiferus* larvæ, 1.2; *C. decorus* larvæ, +; *C. fulviventris* larvæ, 4; *Pelopia monilis* larvæ, 0.1; *Cricotopus trifasciatus* larvæ, 5.9; *Corethra* larvæ, 6.4; May-fly nymphs, 17; *Siphilurus* nymphs, 7; chironomid pupæ, 2.4; *Cricotopus trifasciatus* adults, 5; adult midges, 5; mites, 1.8; *Arrhenurus*, 2; *Hyalella*, 24.2; ostracods, 0.7; *Eurycerus*, 0.8; *Chydorus sphaericus*, 0.5; algæ, 0.1.

*Summary*.—Food: Insect larvæ, 56.6; pupæ, 2.4; adult insects, 10; mites, 3.8; amphipods, 24.2; ostracods, 0.7; cladocerans, 1.3; algæ, 0.1.

Station 16; May 15; number examined, 7. Length: Maximum, 56; minimum, 41; average, 48.8. Food: Insect larvæ, 0.7; *Cricotopus trifasciatus* larvæ, 77.4; *Orthocladus sordidellus* larvæ, 7; *Proboezzia pallida* larvæ, 0.9; *P. glaber* larvæ, 0.7; chironomid pupæ, 7; *Hyalella*, 5.6; ostracods, 0.4; *Planorbis*, 0.1; algæ, 0.1.

*Summary*.—Food: Insect larvæ, 86.7; pupæ, 7; amphipods, 5.6; ostracods, 0.4; *Planorbis*, 0.1; algæ, 0.1.

Station 3; June 4; number examined, 2. Lengths: 115, 117. Food: *Helea* larvæ, 1.5; chironomid larvæ, 1; *Chironomus lobiferus* larvæ, 1; *Simulium vittatum* larvæ, 10; *Peltodytes edentulus* larvæ, 2.5; *Tabanus* pupæ, 5; *Hyalella*, 3.5; ostracods, 0.4; *Eurycerus*, 52.5; *Physa*, 0.5; leech, 17.5; plants, 5.

*Summary*.—Food: Insect larvæ, 16; pupæ, 5; amphipods, 3.5; cladocerans, 52.5; snails, 0.5; leech, 17.5; plants, 5.

Station 23; June 14; number examined, 2. Lengths: 44, 42. Food: *Chironomus tentans* larvæ, 5; *Orthocladus sordidellus* larvæ, 5; *Chironomus lobiferus* pupæ, 5; *Orthocladus sordidellus* pupæ, 7.5; chironomid pupæ, 4; *Hyalella*, 73.5.

*Summary*.—Food: Insect larvæ, 10; pupæ, 16.5; amphipods, 73.5.

Station 2; June 15; number examined, 7. Length: Maximum, 58; minimum, 43.5; average, 50.1. Food: *Helea* larvæ, 0.4; chironomid larvæ, 3.5; *Chironomus fulviventris* larvæ, 4.4; *Orthocladus sordidellus* larvæ, 4.5; *Orthocladus* sp. larvæ, 1.2; *Protenthes monilis* larvæ, 1.4; *Proboezzia pallida* larvæ, 2.5; caddis-fly larva and case, 1.4; *Cænis diminuta* nymphs, 13; *Callibaëtis* nymphs, 11; *Enallagma hageni* nymphs, 9; *E. antennatum* nymphs, 1; *Chironomus lobiferus* pupæ, 17; mites, 1; *Hyalella*, 16; ostracods, 2; Cyclops, 2; *Eurycerus*, 1; *Chydorus*, 0.1; ephippial eggs, 0.1; *Planorbis*, 6.8.

*Summary*.—Food: Insect larvæ, 53.3; pupæ, 17; mites, 1; amphipods, 16; ostracods, 2; copepods, 2; cladocerans, 1.2; snails, 6.8.

Station 27; June 17; number examined, 8. Length: Maximum, 124; minimum, 69; average, 100.9. Food: *Chironomus lobiferus* larvæ, 13.1; *Palpomyia longipennis* larvæ, 8; *Orthocladus sordidellus* larvæ, 12; *Proboezzia pallida* larvæ, 10.2; caddis-fly larvæ in cases, 7.2; *Chironomus lobiferus*

pupæ, 15; *Orthocladius sordidellus* pupæ, 9.8; *Palpomyia longipennis* pupæ, 1; *Probezzia pallida* pupæ, 0.2; adult midges, +; *Corixa* adults, 11.4; *Camponotus* adult, 0.1; mites, 0.2; *Lebertia*, 2; *Hyalella*, 8.1; ostracods, 0.1; *Eurycerus*, 2.5.

*Summary*.—Food: Insect larvæ, 50.5; pupæ, 26; adult insects, 11.5; mites, 2.2; amphipods, 8.1; ostracods, 0.1; cladocerans, 2.5.

Station 28; June 17; number examined, 10. Length: Maximum, 83; minimum, 39.5; average, 58.9. Food: Insect larvæ, 0.5; *Chironomus tentans* larvæ, 5.8; *C. lobiferus* larvæ, 1.4; *Orthocladius sordidellus* larvæ, 26; *Probezzia pallida* larvæ, 1.5; *Corethra* larvæ, 0.5; May-fly nymphs, 3.6; *Ecdyurus maculipennis* nymphs, 11.5; *Cænis diminuta* nymphs, 3.5; *Enallagma antennatum* nymphs, 2; chironomid pupæ, 5; *Chironomus lobiferus* pupæ, 1.1; *C. tentans* pupæ, 0.2; *Orthocladius sordidellus* pupæ, 20.9; *Corixa* adults, 10.7; mites, 0.2; *Cyclops*, 0.5; *Eurycerus lamellatus*, 4.8; *Camptocercus*, 0.1.

*Summary*.—Food: Insect larvæ, 55.7; pupæ, 27.2; adult insects, 10.7; mites, 0.2; copepods, 0.5; cladocerans, 4.9.

Station 3; June 24; number examined, 10. Length: Maximum, 68.5; minimum, 44; average, 54.8. Food: *Tanypus monilis*, 1.6; *Chironomus tentans* larvæ, 6.3; *C. digitatus* larvæ, 0.4; *C. lobiferus* larvæ, 14; *Palpomyia longipennis* larvæ, 4.5; *Orthocladius sordidellus* larvæ, 25.8; *Probezzia pallida* larvæ, 13.8; *Leptocella* larva and case, 2.8; May-fly nymphs, 2.3; *Ecdyurus* nymphs, 6.2; *Peltodytes edentulus* larvæ, 0.3; Chironomid pupæ, 1.5; *Chironomus digitatus* pupæ, 0.5; *Orthocladius sordidellus* pupæ, 3.4; *Probezzia pallida* pupæ, 0.7; sawfly adult, 0.2; *Chironomus lobiferus* adults, 7.7; mites, 0.1; *Hyalella*, 0.9; ostracods, 0.1; *Eurycerus*, 0.3; *Planorbis*, 5.2; *Physa*, 0.3.

*Summary*.—Food: Insect larvæ, 78; pupæ, 6.1; adult insects, 7.9; amphipods, 0.9; ostracods, 0.1; cladocerans, 0.3; snails, 5.5.

Station 18; July 3; number examined, 10. Length: Maximum, 65; minimum, 33.8; average, 45.4. Food: *Tanypus monilis* larvæ, 0.3; *Chironomus viridis* larvæ, 0.3; *C. digitatus* larvæ, 4.4; *C. palliatus* larvæ, 6.3; *Cricotopus trifasciatus* larvæ, 0.2; *Orthocladius sordidellus* larvæ, 3.4; *Procladius* larvæ, 12; May-fly nymphs, 0.2; *Peltodytes edentulus* larvæ, 0.2; *C. lobiferus* pupæ, 2.7; *C. tentans* pupæ, 1.2; mites, 3.2; *Hyalella*, 9.8; cladocerans, 8.4; *Eurycerus*, 47.1.

*Summary*.—Food: Insect larvæ, 27.3; pupæ, 3.9; mites, 3.2; amphipods, 9.8; cladocerans, 55.5.

Station 23; July 9; number examined, 5. Length: Maximum, 80; minimum, 54; average, 65.7. Food: Insect larvæ, 15; *Chironomus tentans* larvæ, 4.2; *C. fulviventris* larvæ, 3.4; *Leptocella uwarowii* larvæ, 3.6; May-fly nymphs, 0.4; chironomid pupa, 12; *Chironomus viridis* pupæ, 0.6; *Corixa* adults, 2; leaf-hopper, 2; mites, 0.2; *Hyalella*, 19.4; *Physa*, 28.2; leech, 11.

*Summary*.—Food: Insect larvæ, 26.6; pupæ, 12.6; adult insects, 4; mites, 0.2; amphipods, 19.4; snails, 28.2; leech, 11.

Station 13; July 23; number examined, 2. Lengths: 60, 37. Food: Insect larvæ, 1; *Probezzia glaber* larvæ, 25; chironomid larvæ, 1; *C. tentans* larvæ, 3; *C. lobiferus* larvæ, 12; *Probezzia glaber* pupæ, 2.5; *Hyalella*, 44; *Chydorus sphaericus*, 1.5; *Physa*, 32.5.

*Summary*.—Food: Insect larvæ, 19.5; pupæ, 2.5; amphipods, 44; cladocerans, 1.5; snails, 32.5.

Station 23; July 23; number examined, 3. Lengths: 73, 71, 65. Food: *Chironomus viridis* larvæ, 11.3; *C. vulviventris* larvæ, 37.6; *C. tentans* larvæ, 8.3; *Pelopia monilis* larvæ, 6; *Probezzia glaber* larvæ, 0.6; *Hydroptila* larvæ, 0.3; *Simulium vittatum* larvæ, 1.6; *Peltodytes edentulus* larvæ, 0.6; *Chironomus viridis* pupæ, 4.3; *Arrhenurus*, 0.1; *Hyalella*, 5; *Ancylus*, 0.3; *Planorbis*, 0.3; *Physa*, 21.6; snail eggs, 0.6.

*Summary*.—Food: Insect larvæ, 66.3; pupæ, 4.3; mites, 0.1; amphipods, 5; snails, 22.8.

Station 7, in swamp along shore; August 25; number examined, 4. Lengths: 30, 27.5, 17.8, 15. Food: *Tanypus monilis* larvæ, 3.7; *Cænis diminuta* nymphs, 1.2; *Corixa* adult, 1.2; *Cyclops*, 30.1; *Canthocamptus*, 2.5; *Bosmina longirostris* cornuta, 28.4; *Camptocercus*, 5; *Eurycerus*, 20; algæ, 9.

*Summary*.—Food: Insect larvæ, 4.9; adult insects, 1.2; copepods, 30.1; cladocerans, 53.4; algæ, 9.

*Grand summary for 1914 and 1915*.—Number examined, 149. Length: Maximum, 115; minimum, 15; average, 51.1. Food: Insect larvæ, 38; pupæ, 6; adult insects, 2.2; mites, 0.7; aquatic isopods, +; amphipods, 14.4; ostracods, 0.4; copepods, 7.9; cladocerans, 16.6; gastropods, 4.5; oligochaetes, 0.1; leeches, 0.6; nematodes, +; rotifers, +; plants, 2.9; algæ, 2.3; silt and débris, 2.2.

The bluegill feeds mostly on insects (46.2 per cent) and entomostracans (24.9 per cent). Its shape and its food indicate that it feeds much among water plants. Forbes and Richardson (1908) found the food to consist of a trace of fishes, some snails, 45 per cent insects, and many medium-sized crustaceans. They state that this species eats more large insect larvæ than any other sunfish. Hankinson (1908),

found insect larvæ, midges, and crayfish; after the middle of May, crayfishes, grasshoppers, crickets, beetles, and entomostracans. Reighard (1915) found the bluegill only in shallow water among vegetation. Its food was plants, bryozoans, insects, mites, and ostracods.

**Micropterus dolomieu** Lacépède. Smallmouth black bass.

*Data for 1914* (Pearse, 1915).—Stations 19 and 24; number examined, 2. Lengths: 78, 59. Food: Dipterous larvæ, 10; adult Diptera, 5; Corixa, 85.

Station 28; August 19, 1915; number examined, 1. Length: 181. Food: Minnow, 40; Chironomus lobiferus larvæ, 5; Corixa adults, 15; plant remains, 5; algæ, 10; silt and débris, 25.

Station 24; August 19; number examined, 3. Lengths: 175, 148, 132. Food: Fish remains, 29.9; Lepomis incisor, 30; May-fly nymphs, 5; Corixa adults, 32.6; plant remains, 1.3; filamentous algæ, 1.

Station 12; August 20; number examined, 8. Length: Maximum, 48.5; minimum, 29; average, 36. Food: Chironomus digitatus larvæ, 20; Bætisca nymphs, 22.5; Cænis diminuta nymphs, 0.3; Ecdyurus maculipennis nymphs, 9; Chironomus lobiferus pupæ, 2; C. digitatus pupæ, 7; C. flavescens adults, 5.6; Limnephilus adult, 2; Corethra adult, 17; Daphnia longispina hyalina, 4; Eurycercus lamellatus, 0.2; Ceriodaphnia, 1.8; Bosmina, +; oligochætes, 8.6.

*Summary*.—Food: Insect larvæ, 51.8; pupæ, 9; adult insects, 25.2; cladocerans, 6; oligochætes, 8.6.

Station 14; August 31; number examined, 1. Length: 33.5. Food: Protenthes culiciformis larvæ, 40; Chironomus viridis pupæ, 18; C. lobiferus pupæ, 19; Tanytarsus monilis pupæ, 18; Eurycercus, 5.

*Summary*.—Food: Insect larvæ, 40; pupæ, 55; cladocerans, 5.

*Grand summary for 1914 and 1915*.—Number examined, 15. Length: Maximum, 181; minimum, 29; average, 72.5. Food: Fish, 14.7; insect larvæ, 33.1; pupæ, 7.6; adult insects, 32.1; cladocerans, 3.4; oligochætes, 4.6; plants, 0.6; algæ, 0.8; silt and débris, 1.5.

The food of the young smallmouth black bass apparently consists largely of insects and their larvæ. Adults eat fish, crayfish, frogs, and plants as well. Forbes and Richardson (1908) examined only three specimens and found one-third fishes and two-thirds crayfishes. Tracy (1910) reports small fish, insects and their larvæ, and crustaceans. Reighard (1915) examined eight and found crayfish, a frog, and fishes.

**Micropterus salmoides** Lacépède. Largemouth black bass.

*Data for 1914* (Pearse, 1915).—Number examined, 25. Length: 64.4. Food: Fish, 17.8; insect larvæ, 31.6; adult insects, 40.6; Hyalella, 3.8; copepods, +; cladocerans, 2.5; plants, 1.6.

Station 71; April 17, 1915; number examined, 1. Length: 225. Food: Fish 95; leech, 5.

Station 17; April 25; number examined, 1. Length: 470. Food: Ostracods, 0.1; diatoms, 0.4; Aphanothece, 20; filamentous algæ, 24.5; plant remains, 50; débris, 5.

*Summary*.—Food: Ostracods, 0.1; algæ, 44.9; plant remains, 50; débris, 5.

Station 3; June 24; number examined, 1. Length: 81. Food: Ecdyurus maculipennis nymphs, 10; Enallagma antennatum nymphs, 20; dipterous adult, 5; Corixa adult, 30; crayfish, 20; Hyalella, 15.

Station 23; July 9; number examined, 3. Lengths: 32, 30.3, 29.5. Food: Chironomid larvæ, 10; Chironomus fulviventris larvæ, 6.3; C. tenellus larvæ, 17; C. tentans larvæ, 0.6; May-fly nymphs, 1; Dytiscus hybridus larvæ, 5; Chironomus tenellus pupæ, 16; adult midges, 6.6; Simulium vitatum adults, 8.3; Cyclops, 20; Chydorus sphaericus, 2; ephippial eggs, 0.2; oligochætes, 6.6; Oscillaria, 0.3.

*Summary*.—Food: Insect larvæ, 39.9; pupæ, 16; adult insects, 8.3; copepods, 20; cladocerans, 2.2; oligochætes, 6.6; algæ, 0.3.

Station 23; July 12; number examined, 1. Length: 33. Food: Chironomus fulviventris larvæ, 35; Anax junius nymphs, 8; C. fulviventris pupæ, 20; Corixa adult, 7; oligochætes, 30.

Station 5; August 9; number examined, 1. Length: 41.6. Food: May-fly nymphs, 65; Hyalella, 35.

Station 17; August 23; number examined, 1. Length: 147. Food: Adult dragon fly, 100.

Station 23, in pool in Tenney Park; August 11; number examined, 1. Length: 62. Food: Cyclops, 65; Simocephalus, 10; Eurycercus lamellatus, 25.

Station 3; August 18; number examined, 12. Length: Maximum, 62; minimum, 38.3; average, 50.8. Food: Chironomus fulviventris larvæ, 0.3; Bætisca nymphs, 23.2; Cænis diminuta nymphs, 3.6; Corixa nymphs, 1.1; C. lobiferus pupæ, 0.8; Corixa adults, 30; Micronecta adult, 0.4; Hyalella, 25; ostracods, 0.3; Eurycercus lamellatus, 12.4; ephippial eggs, 1.2; seeds, 0.2.

*Summary*.—Food: Insect larvæ, 29.4; pupæ, 0.8; adult insects, 30.4; Hyalella, 25; ostracods, 0.3; cladocerans, 13.6; plants, 0.2.

Station 5; August 18; number examined, 3. Lengths: 68.5, 58, 49.5. Food: May-fly nymphs, 20; Corixa adults, 55; Hyalella, 25.

Station 18; August 18; number examined, 15. Length: Maximum, 64; minimum, 36; average, 46.4. Food: Fish remains, 5.3; chironomid larvæ, 0.6; Chironomus viridis larvæ, 1; Protenthes choreus larvæ, 1.3; Corethra larvæ, 1.3; May-fly nymphs, 0.6; Bætisca nymphs, 4.3; Naucoris nymphs, 2.4; Corixa nymph, 0.6; Chironomus viridis pupæ, 3; adult midges, 3.3; adult Diptera, 2; Chironomus viridis adults, 2.3; adult Corixas, 0.6; Halictus adults, 0.6; Platyphylax subfasciatus adults, 4; Hyalella, 17; ostracods, 0.3; Diaptomus, 0.4; Cyclops, 7.5; Ceriodaphnia, 21.6; Eurycerus, 0.4; Daphnia longispina hyalina, 18.6; Bosmina, +; Pleuroxus, +; Camptocercus, 0.3; Scapholeberis, +; Aphanothece, 0.3.

*Summary.*—Food: Fish remains, 5.3; insect larvæ, 12.1; pupæ, 3; adult insects, 7.4; amphipods, 17; ostracods, 13; cladocerans, 40.9; algæ, 0.3.

Station 8; August 20; number examined, 5. Length: Maximum, 64; minimum, 47; average, 52.6; Food: Proboezzia glaber larvæ, 0.2; Bætisca nymphs, 12; Ecdyurus maculipennis nymphs, 0.8; Enallagma antennatum nymphs, 1; Naucoris nymph, 1; Corixa adults, 30.8; Agraylea multipunctata adult, 1; Lepidid adult, 7; Tabanid fly, 3; Hyalella, 29.8; Ceriodaphnia, 8.6; Eurycerus, 4.4; Aplexa hypnorum, 0.4.

*Summary.*—Food: Insect larvæ, 14; adult insects, 41.8; amphipods, 29.8; cladocerans, 13; snail, 0.4.

Station 14; August 31; number examined, 3. Lengths: 44, 42.6, 42. Food: Bætisca nymphs, 15; Cænis diminuta nymphs, 3.3; Chironomus adults, 6.6; Agraylea multipunctata adults, 13.3; Hyalella, 26.3; Chydorus sphericus, 1.6; Ceriodaphnia, 33; chydorid, 0.3; Camptocercus, 0.3.

*Summary.*—Food: Insect larvæ, 18.3; adult insects, 19.9; amphipods, 26.3; cladocerans, 35.2.

Station 1; September 1; number examined, 2. Lengths: 46, 38. Food: Bætisca nymphs, 16.5; chironomid pupæ, 1.5; Chironomus viridis pupæ, 6; C. v. adults, 6.5; Hyalella, 1.5; ostracods, 0.5; Chydorus, 1; Simocephalus, 41.5; Eurycerus, 25.

*Summary.*—Food: Insect larvæ, 16.5; pupæ, 2.1; adult insects, 6.5; amphipods, 1.5; ostracods, 0.5; cladocerans, 67.5.

Station 29; November 16; number examined, 3. Lengths: 338, 327, 270. Food: Frog, 6.6; fish, 33.3; crayfish, 60.

*Grand summary for 1914 and 1915.*—Number examined, 78. Length: Maximum, 470; minimum, 29.5; average, 66.8. Food: Frogs, 0.2; fish, 8.7; insect larvæ, 23; pupæ, 3.1; adult insects, 28.1; crayfishes, 2.6; amphipods, 13.9; ostracods, 0.1; copepods, 2.9; cladocerans, 15.1; snails, +; oligochaetes, 0.7; leech, +; plant remains, 1.2; algæ, 0.7; fine débris, 0.1.

The largemouth black bass feeds more on insects and their larvæ (34.2 per cent) than anything else, though amphipods (13.9 per cent), entomostracans (18.1 per cent), and fish (8.7 per cent) are also taken in considerable quantities. Young individuals eat more small insects and entomostracans than adults. The largest bass examined ate nothing but fish, crayfish, and frogs. Forbes and Richardson (1908) found the food of this species to consist of fish and crayfishes. Hankinson (1908) stated that crayfishes and insect larvæ are the most important foods. Tracy (1910) mentioned small fish, crayfishes, frogs, insects, and all other aquatic animals of suitable size. Reighard (1915) found perch and crayfish in those he examined.

#### *Notropis heterodon* (Cope). Shiner, minnow.

Data for 1914 are not reliable and therefore not included in this paper.

Station 17; April 6, 1915; number examined, 10. Lengths: Maximum, 49.6; minimum, 18.7; average, 34.4. Food: Pelopia larvæ, 2.5; Chironomus larvæ, 13; adult midges, 13; ostracods, 1; Cyclops and nauplii, 19.5; Camptocamptus, 4.5; Chydorus, 6.5; cyst, 0.5; rotifers, 9.3; plant remains, 2; filamentous algæ, 10; Pleurococcus, 5.9; desmids and diatoms, 0.1; fine débris, 11.2.

*Summary.*—Food: Insect larvæ, 16; adult insects, 13; ostracods, 1; copepods, 24; cladocerans, 6.5; rotifers, 9.3; plants, 2; algæ, 16; fine débris, 11.2.

Station 17; April 7; number examined, 7. Length: Maximum, 50; minimum, 24.5; average, 34.7. Food: Chironomus larvæ, 1.4; adult midges, 2; mites, 10; ostracods, 3; Cyclops, 33; Canthocamptus, 8; Chydorus, 4; cladocerans, 1.4; ephippial eggs, 4.7; rotifers, 12; Pandorina, 0.6; plant remains, 7; Wolffia, 10; filamentous algæ, 3.1; desmids and diatoms, 0.1; fine débris, 8.2.

*Summary.*—Food: Insect larvæ, 1.4; adult insects, 2; mites, 1.4; ostracods, 3; copepods, 41; cladocerans, 10.1; rotifers, 12; plants, 17; algæ, 3.8; débris, 8.2.

Station 5; May 12; number examined, 8. Length: Maximum, 47.5; minimum, 28.6; average, 36.3. Food: Chironomus larvæ, 2.5; Camptocercus, 0.1; Chydorus, 27.8; cladocerans, 1.2; plant remains, 1; filamentous algæ, 49.5; fine débris, 17.7.

*Summary.*—Food: Insect larvæ, 2.5; cladocerans, 29.1; plants, 1; algæ, 49.5; débris, 17.7.

Station 16; May 15; number examined, 6. Length: Maximum, 54; minimum, 26; average, 31.9. Food: Insect eggs, 8; Orthocladius sordidellus larvæ, 6.6; Chironomus larvæ, 14.1; ostracods, 0.5; Cyclops, 11.6; Canthocamptus, 20.5; Pleuroxus, +; Chydorus, 0.1; oligochætes, 29.1; Oscillaria, 3.3; desmids and diatoms, 4.5.

*Summary.*—Food: Insect larvæ, 28.7; ostracods, 0.5; copepods, 32.1; cladocerans, 0.1; oligochætes, 29.1; algæ, 7.8.

Station 5; June 1; number examined, 1. Length: 47.5. Food: Chironomus larvæ, 85; Cyclops, 9; chydorids, 6.

Station 5; June 24; number examined, 9. Length: Maximum, 42.6; minimum, 32.2; average, 36.2. Food: Orthocladius sordidellus larvæ, 2.5; Tanytarsus dives larvæ, 2.5; Chironomus larvæ, 0.1; C. tentans larvæ, 10; Heptagenia interpunctata larvæ, 6.1; Orthocladius sordidellus pupæ, 21.5; Chironomus pupæ, 11.1; Tanytarsus dives adults, 1.6; Hydroptilus undulatus adults, 4.3; Stenelmis crenatus adult, 2.6; ehippial eggs, 2.2; Wolffia, 14; sand, 21.5.

*Summary.*—Food: Insect larvæ, 21.2; pupæ, 32.6; adult insects, 8.5; cladocerans, 2.2; plants, 14; sand, 21.5.

Station 19; July 3; number examined, 11. Length: Maximum, 45; minimum, 35; average, 39.9. Food: Chironomus lobiferus larvæ, 3.4; Cricotopus trifasciatus larvæ, 4.5; adult insects, 1.3; mites, 1; Eurycercus, 5; Bosmina, 1; Ceriodaphnia, 0.5; Daphnia longispina hyalina, 42.6; Daphnia, 5.4; Pleuroxus, 0.1; Chydorus, 13.5; chydorids, 1.4; Wolffia, 3.2; filamentous algæ, 16.8.

*Summary.*—Food: Insect larvæ, 7.9; adult insects, 1.3; mites, 1; cladocerans, 69.5; plants, 3.2; algæ, 16.8.

Station 18; August 18; number examined, 8. Length: Maximum, 49; minimum, 24; average, 35.7. Food: Chironomus larvæ, 0.6; Corethra adults, 6.3; Triænodes flavescens adults, 5.6; sapromyzid fly, 2; Ceriodaphnia, 25.5; Daphnia longispina hyalina, 58.8; Chydorus sphaericus, 1.2.

*Summary.*—Food: Insect larvæ, 0.6; adult insects, 13.9; cladocerans, 85.5.

Station 18; August 21; number examined, 10. Length: Maximum, 30.5; minimum, 16.8; average, 24.5. Food: Chironomus larvæ, 1; Corethra adults, 7; Chironomus tantans adults, 6; C. viridis adults, 25; Probezzia glaber adults, 6.2; chalcid fly, 4.3; Hyalella, 0.8; Cyclops, 8.5; Camptocercus, 1; Bosmina, 5.5; Ceriodaphnia, 27; Daphnia longispina hyalina, 3; ehippial eggs, 3.5; Hydrodictyon, 1.2.

*Summary.*—Food: Insect larvæ, 1; adult insects, 48.5; amphipods, 0.8; copepods, 8.5; cladocerans, 39; algæ, 1.2.

Station 17; August 23; number examined, 10. Length: Maximum, 33; minimum, 19.8; average, 24.5. Food: Probezzia larvæ, 2.5; Chironomus lobiferus larvæ, 33.3; parnid larvæ, 0.3; hemipterous nymph, 1; Chironomus pupæ, 2; Tanytarsus dives adults, 1; mites, 2.4; ostracods, 0.5; Cyclops, 7.8; Canthocamptus, 0.5; Acroperus, 0.2; Camptocercus, 0.4; Bosmina, 0.5; Simocephalus, 41.2; Chydorus, 3.9; oligochætes, 2.

*Summary.*—Food: Insect larvæ, 36.1; pupæ, 1.2; adult insects, 1; mites, 2.4; ostracods, 0.5; copepods, 8.3; cladocerans, 46.2; oligochætes, 2.

*Grand summary.*—Number examined, 80. Length: Maximum, 54; minimum, 16.8; average, 34. Food: Insect eggs, 0.7; insect larvæ, 12.8; pupæ, 4; adult insects, 9.2; mites, 0.5; amphipods, 0.1; ostracods, 0.5; copepods, 11; cladocerans, 33.4; oligochætes, 2.1; rotifers, 2.2; plants, 3.9; algæ, 11.7; débris, 4.1; sand, 2.4.

The food of this minnow consists for the most part of entomostracans (44.9 per cent), aquatic plants and algæ (15.6 per cent), and insects (26.7 per cent). The sparcity of ostracods and oligochætes indicates that it does not feed on the bottom. The abundance of Canthocamptus, chydorids, algæ, and rotifers make it probable that the food is secured among aquatic vegetation. Forbes and Richardson (1908) found the food to be mostly entomostracans, also insect larvæ, amphipods, flowers, seeds, and algæ. Hankinson (1908) reported adult midges, algæ, and a few entomostracans.



*Perca flavescens* (Mitchill). Yellow perch; ring perch, American perch.

*Data for 1914* (Pearse, 1915).—Number examined, 16. Average length: 92.5. Food: Insect larvæ, 19.5; adult insects, 2.7; mites, 0.5; Hyalella, 32.8; ostracods, 0.3; copepods, 0.2; cladocerans, 36.6.

Station 6; June 24, 1915; number examined, 10. Length: Maximum, 127; minimum, 76; average, 111.4. Food: Fish eggs, 3; Chironomus plumosus larvæ, 0.3; C. lobiferus larvæ, 2.5; Orthocladius larvæ, 8; Cricotopus trifasciatus larvæ, 1.5; Proboezzia larvæ, 1.2; Enallagma antennatum nymphs, 0.5; Cænis diminuta larvæ, 4.1; Heliopsyche borealis larvæ, 5.1; Leptocella uwarowii larvæ, 11; Agraylea larvæ, 0.1; Cricotopus trifasciatus pupæ, 0.4; Chironomus pupæ, 0.2; C. lobiferus pupæ, 1; mites, 0.2; Hyalella, 40.6; Planorbis, 0.8; Sphæridæ, 0.8; oligochætes, 3; seeds, 0.1; plant remains, 2.5; fine débris, 7.

*Summary*.—Food: Insect larvæ, 43.3; pupæ, 1.6; mites, 0.2; amphipods, 40.6; snails, 0.8; clams, 0.8; oligochætes, 3; plants, 2.6; débris, 7.

Station 5; August 18; number examined, 2. Lengths: 135, 113.5. Food: Cænis diminuta larvæ, 10; Bætisca larvæ, 5; Chironomus adult, 2.5; Corixa adults, 51.5; Hyalella, 30.7; Arcella, 0.1; filamentous algæ, 0.3.

*Summary*.—Food: Insect larvæ, 15; adult insects, 54; amphipods, 30.7; protozoans, 0.1; filamentous algæ, 0.3.

Station 15; August 21; number examined, 2. Lengths: 138, 132. Food: Daphnia longispina hyalina, 100.

Station 17; August 23; number examined, 10. Length: Maximum, 187; minimum, 123; average, 156.5. Food: Tadpoles, 3.5; Chironomus digitatus larvæ, 1.1; C. tentans larvæ, 2.5; C. modestus larvæ, 1; Palpomyia longipennis larvæ, 0.2; Aeschna umbrosa nymphs, 12; Enallagma hageni nymphs, 9.6; Celithemis eponina nymphs, 1.8; Cænis diminuta nymphs, 3.4; Bætisca nymphs, 25.6; neuropteron larvæ, 2.2; Chironomus digitatus pupæ, 2.4; Gryllus nymphs, 0.1; Corixa adults, 4; Dytiscid beetle, 0.3; Naucoris adult, 0.1; Scirtes adult, 0.2; Hyalella, 8.3; ostracods, 0.1; Cyclops, +; Eurycerus, 0.1; Planorbis, 2.2; Physa, 17.1; Arcella, 0.1; fine débris, 1.

*Summary*.—Food: Insect larvæ, 63.9; pupæ, 2.6; adult insects, 4.6; amphipods, 8.3; ostracods, 0.1; cladocerans, 0.1; snails, 19.3; protozoans, 0.1; débris, 1.

Station 18; August 18; number examined, 3. Lengths of each: 100. Food: Chironomus lobiferus larvæ, 1.1; C. digitatus larvæ, 1.2; Proboezzia larvæ, 0.3; Bætisca nymphs, 1.3; Chironomus digitatus pupæ, 2; Triænodes flavescens adults, 1; mites, 1.6; Hyalella, 90.8; Cyclops, 0.1; filamentous algæ, 0.3.

*Summary*.—Food: Insect larvæ, 3.9; pupæ, 2; adult insects, 1; mites, 1.6; amphipods, 90.8; copepods, 0.1; algæ, 0.3.

Station 18; September 22; number examined, 2. Lengths: 146, 180. Food: Fish, 80; Hyalella, 17.5; Myriophyllum, 5.

Station 15; October 2; number examined, 1. Length: 124. Food: Daphnia longispina hyalina, 95; D. pulex, 5.

Station 29; October 11; number examined, 2. Lengths: 63.5, 63.5. Food: Chironomus lobiferus larvæ, 15.5; C. decorus larvæ, 25; Enallagma antennatum nymph, 40; ostracods, 1; Cyclops, 2.5; Daphnia pulex, 7.5; oligochætes, 7.5; diatoms, 1.

*Summary*.—Food: Insect larvæ, 80.5; ostracods, 1; copepods, 2.5; cladocerans, 7.5; oligochætes, 7.5; algæ, 1.

Station 26; December 4; number examined, 8. Length: Maximum, 280; minimum, 245; average, 265. Food: Fish, 10; Chironomus decorus larvæ, 84; Sialis larvæ, 5.6.

Station 28; May 30, 1916; number examined, 5. Length: Maximum, 229; minimum, 160; average, 186. Food: Fish eggs, 0.2; Chironomus lobiferus larvæ, 5.4; C. sp. larvæ, 3.2; Enallagma hageni nymphs, 16.4; Atax turgidus nymphs, 1; Corixa sp. nymphs, 17.6; Chironomus sp. pupæ, 7; Hyalella, 15.6; ostracods, 0.2; Physa, 4; filamentous algæ, 11.6; plant remains, 3; mud, 7.6; débris, 3.

*Summary*.—Food: Fish eggs, 0.2; insect larvæ, 43.6; insect pupæ, 7; amphipods, 15.6; ostracods, 0.2; Mollusca, 4; algæ, 11.6; plants, 3; débris, 10.6.

Station in Oconomowoc Lake; June 14; number examined, 13. Length: Maximum, 67; minimum, 54; average, 57.8. Food: Chironomus sp. larvæ, 8.4; Proboezzia glaber larvæ, 3.4; Procladius sp. larvæ, 0.3; Enallagma antennatum nymphs, 7; Chironomus sp. pupæ, 4.7; Hyalella, 18.7; ostracods, 0.3; Cyclops, 32.7; Daphnia, 18.8; Chydorus sphaericus, 2.3; Eurycerus, 0.5; Physa, 0.6; filamentous algæ, 1.4.

*Summary*.—Food: Insect larvæ, 19.1; insect pupæ, 4.7; amphipods, 18.7; entomostracans, 54.6; Mollusca, 0.6; algæ, 1.4.

Station 16; June 30; number examined, 10. Length: Maximum, 173; minimum, 139; average, 149.6. Food: Chironomus sp. larvæ, 7; Pelocaris femoratus larvæ, 2; Stratiomyia sp. larvæ, 1; Enallagma antennatum nymphs, 4.1; Enallagma hageni nymphs, 5.5; Atax turgidus nymphs, 1.5; Corixa sp. nymphs, 30.6; Limnesia, 0.7; Hyalella, 5; Cyclops, 0.2; Eurycerus, 17; Physa, 5; snails, 16.2; plant remains, 4.9; débris, 0.5.

*Summary.*—Food: Insect larvæ, 51.7; mite, 0.7; amphipods, 5.; entomostracans, 17.2; Mollusca, 21.2; plants, 4.9; débris, 0.5.

Station 17; July 7; number examined, 10. Length: Maximum, 33; minimum, 25; average, 29.6. Food: Chironomus fulviventris larvæ, 1.6; Tanypus decoloratus larvæ, 6.9; Plea minutissima larvæ, 0.1; Corixa sp. nymphs, 1.5; Chironomid adult, 0.1; Hyalella, 15.3; ostracods, 0.1; Cyclops viridis, 2.9; Cyclops, 40.4; Nauplii, 2.7; Daphnia, 0.1; Chydorus sphaericus, 8.9; Eurycerus, 11.8; Acroperus, 0.2; Ceriodaphnia, 0.1; Pleuroxus procurvatus, 0.5; Bosmina, 6.5.

*Summary.*—Food: Insect larvæ, 10.1; adult insects, 0.1; amphipods, 15.3; Entomostraca, 74.2.

Station 17; July 19; number examined, 9. Length: Maximum, 38.5; minimum, 34; average, 36.8. Food: Chironomus fulviventris larvæ, 9.1; Chironomus sp. larvæ, 1.1; Procladius sp. larvæ, 0.9; Cricotopus trifasciatus larvæ, 3.7; May-fly nymphs, 5.5; Hyalella, 55.4; ostracods, 2.5; Cyclops, 0.2; Chydorus sphaericus, 0.7; Eurycerus, 17.2; Ceriodaphnia, 4.6; Pleuroxus procurvatus, 0.3.

*Summary.*—Food: Insect larvæ, 20.3; amphipods, 55.4; Entomostraca, 25.5.

Station 18; August 7; number examined, 10. Length: Maximum, 54.5; minimum, 45.6; average, 50.4. Food: Chironomus fulviventris larvæ, 16.2; May-fly nymphs, 24.9; Enallagma antennatum nymphs, 4.5; Corixa sp. adult, 0.3; Hyalella, 39.6; ostracods, 0.8; Cyclops, 0.4; Daphnia, 0.5; Ceriodaphnia, 13.9; filamentous algæ, 0.9; plant remains, 0.2.

*Summary.*—Food: Insect larvæ, 45.6; adult insects, 0.3; amphipods, 39.6; Entomostraca, 15.6; algæ, 0.9; plants, 0.2.

Station 18; September 13; number examined, 2. Length: Maximum, 185; minimum, 182, average, 183.5. Food: Minnow remains, 50; Daphnia, 50.

*Grand summary for 1914, 1915, and 1916.*—Number examined, 115. Length: Maximum, 280; minimum, 25; average, 99.9. Food: Tadpoles, 0.3; fish eggs, 3; insect larvæ, 34.7; insect pupæ, 1.7; adult insects, 1.8; mites, 0.1; amphipods, 24.5; Entomostraca, 25.8; molluscs, 3.8; oligochætes, 0.4; protozoans, +; plant remains, 0.8; algæ, 0.7; silt and débris, 1.1.

The perch apparently feeds mostly on insects (38.2 per cent), amphipods (24.5 per cent), and entomostracans (25.8 per cent). Even large adults often have nothing in the alimentary canal except a great number of cladocerans. Forbes and Richardson (1908) stated that the perch is wholly carnivorous. Its food in rivers consisted of fish, molluscs, insect larvæ, amphipods, shrimps, isopods, and crayfishes, and of fish and crayfish in lakes. Hankinson (1908) found midges in all stages of development, crayfish, insects and larvæ, snails, leeches, and entomostracans. Tracy (1910) reports small fishes, insects, etc. Reighard (1915) found the perch in Douglas Lake eating each other.

All these observations show that the perch is a versatile feeder. At any age it may feed largely on entomostracans, insects, molluscs, or almost anything else that is edible.

*Percina caprodes* (Rafinesque) var *zebra* Agassiz, log-perch.

*Data for 1914* (Pearse, 1915, *Boeleichthys fusiformis*).—Station 24; October 3; number examined, 7. Average length, 65.6. Food: Insect larvæ, 84; adult insects, 6.7; amphipods, 2.4; ostracods, 0.1; copepods, 0.3; cladocerans, +; silt and débris, 6.

Station 23, in rapids; April 28, 1915; number examined, 14. Length: Maximum, 94; minimum, 60; average, 76.3. Food: Fish eggs, 51.6; Chironomus larvæ, 5.3; Hydropsyche alternans larvæ, 10.3; Hyalella, 14.2; Cyclops, 0.2; leech, 1.8; plant remains, 4.8; filamentous algæ, 3.4; silt and débris, 7.8.

Station 24; July 2; number examined, 2. Lengths: 79, 63. Food: Chironomus viridis larvæ, 5; C. lobiferus larvæ, 5; C. tentans larvæ, 7.5; Protenthes culiciformis larvæ, 4; Cricotopus trifasciatus larvæ, 27.5; May-fly nymphs, 3.5; Ecdyurus maculipennis nymphs, 1.5; Callibætis nymphs, 1; Cricotopus trifasciatus pupæ, 15; Chironomus lobiferus pupæ, 10; C. tentans pupæ, 5; leech, 15.

*Summary.*—Food: Insect larvæ, 55; pupæ, 30; leech, 15.

Station 23, on beach at mouth of river; August 19; number examined, 1. Length: 44. Food: Chironomus viridis larvæ, 25; C. flavicingula larvæ, 15; C. tentans larvæ, 50; C. tentans pupæ, 6; cladocerans, 4.

Station 24; September 17; number examined, 1. Length: 56. Food: Chironomus digitatus larvæ, 95; May-fly nymphs, 5.

Station 23, in rapids by locks; June 20, 1916; number examined, 2. Lengths: 100 and 98. Food: Simulium larvæ, 42.5; diptera pupæ, 25; Hyalella, 32.5.

*Grand summary for 1914, 1915, and 1916.*—Number examined, 27. Length: Maximum, 100; minimum, 44; average, 72.9. Food: Fish eggs, 27.8; insect larvæ, 45.5; insect pupæ, 3.7; adult insects, 1.7; amphipods, 6.6; Entomostraca, 0.3; leeches, 2; plant remains, 3.4; algæ, 1.7; silt and debris, 5.7.

This summary shows that the log-perch fed mostly on insects and fish eggs. This agrees in part with the results of Forbes and Richardson (1908), who found that two-thirds of the food was insects, but the other third mostly entomostracans. This fish evidently feeds by choice on the aquatic insects and their larvæ found among vegetation.

**Pimephales notatus** (Rafinesque). Blunt-nosed minnow.

Station 15; November 21, 1914; number examined, 4. Length: Maximum, 32.2; minimum, 23.6; average, 27.7. Food: Cyclops, 22.5; Chydorus sphaericus, 2.5; cladoceran fragments, 62.5; filamentous algæ, 12.5.

Station 19; December 3; number examined, 4. Length: Maximum, 30; minimum, 26.4; average, 28.4. Food: Chironomid larvæ, 25; Cyclops, 10; Chydorus sphaericus, 15; Eurycerus lamellatus, 22.5; cladoceran fragments, 25; diatoms, 2.5.

*Summary.*—Food: Copepods, 10; cladocerans, 62.5; algæ, 2.5.

Station 23; June 14, 1915; number examined, 1. Length: 70. Food: Chironomus tenellus adults, 95; Cyclops, 5.

Station 27; June 17; number examined, 29. Length: Maximum, 62; minimum, 34; average, 46. Food: Orthocladius sordidellus larvæ, 9; Proboezzia pallida larvæ, 2.6; Chironomus lobiferus larvæ, 4; C. l. pupæ, 7.1; adult midges, 6; ostracod, +; Cyclops, 0.2; Chydorus sphaericus, 3; Bosmina longirostris cornuta, 30.7; ephippial eggs, 0.2; Eurycerus lamellatus, 0.5; cladocerans, 0.1; filamentous algæ, 8.2; plant remains, 1.9; fine debris and silt, 24.2.

*Summary.*—Food: Insect larvæ, 15.6; pupæ, 7.1; adult insects, 6; ostracods, +; copepods, 0.2; cladocerans, 34.5; algæ, 8.6; plants, 1.9; silt and debris, 24.2.

Station 28; June 17; number examined, 10. Length: Maximum, 36.5; minimum, 26.2; average, 30.2. Food: Chironomid larvæ, 19.5; Chironomus lobiferus pupæ, 4.1; mite, 0.1; ostracods, 0.5; Cyclops, 2.1; oligochætes, 6; flagellates, 0.1; diatoms, 0.5; Pedicellaria, 0.1; filamentous algæ, 49.8; plant remains, 0.2; silt and debris, 17.

*Summary.*—Food: Insect larvæ, 19.5; pupæ, 4.1; mite, 0.1; ostracods, 0.5; copepods, 2.1; oligochætes, 6; protozoans, 0.1; algæ, 50.4; plants, 0.2; silt and debris, 17.

Station 3; June 24; number examined, 3. Lengths: 43, 41.7, 32.5. Food: Chironomid larvæ, 1.7; Orthocladius sordidellus pupæ, 1.3; adult midges, 3.3; Chydorus sphaericus, 2.7; oligochætes, 28; Closterium, 0.3; filamentous algæ, 50; plant remains, 0.3; silt and debris, 12.3.

Station 24; July 2; number examined, 2. Lengths: 48.5, 28. Food: Chironomid larvæ, 25; chironomid pupæ, 25; ostracods, 0.5; oligochætes, 49; sand, 0.5.

Station 23; July 3; number examined, 1. Length: 58.5. Food: Chydorus sphaericus, 1; filamentous algæ, 60; silt and debris, 39.

Station 23; July 9; number examined, 4. Length: Maximum, 54.5; minimum, 34; average, 44.6. Food: Chironomid larvæ, 12.5; Chironomus fulviventris larvæ, 0.5; C. tentans larvæ, 0.8; Chydorus sphaericus, 0.1; oligochætes, 39.9; desmids, 1.2; filamentous algæ, 29; silt and debris, 16.

*Summary.*—Food: Insect larvæ, 13.8; cladocerans, 0.1; oligochætes, 39.9; algæ, 30.2; silt and debris, 16.

Station 5; August 18; number examined, 2. Lengths: 41, 35. Food: Chironomid larvæ, 5; ostracods, 3.5; Cyclops, 2.5; Eurycerus lamellatus, 4; plant remains, 2.5; silt and debris, 82.5

*Grand summary.*—Number examined, 60. Length: Maximum, 70; minimum, 23.6; average, 40. Food: Insect larvæ, 14.5; pupæ, 5.8; adult insects, 4.5; ostracods, 0.3; copepods, 2.6; cladocerans, 25.1; oligochætes, 7; algæ, 19.3; plant remains, 0.9; silt and debris, 20.

As would be expected from its long intestine, the blunt-nosed minnow eats a good deal of silt, bottom debris, and plants, though entomostracans and insects constitute more than half of its food. Certain individuals had taken foods as follows: Chironomus lobiferus pupæ, 100; Bosmina longirostris

cornuta, 100; oligochætes, 98; filamentous algæ, 90; silt and débris, 100. These figures show that the minnow is a versatile feeder. The food in the stomach has always been chewed into fine pieces.

Forbes and Richardson (1908) stated that the stomach of this species is commonly packed with mud containing filamentous algæ and miscellaneous vegetable débris. Hankinson (1908) found the food varies greatly, but consists chiefly of small organisms taken from the bottom, from water plants, and from the water. These fish eat the eggs of the black bass, Johnny darter, miller's thumb, and sunfish. Sometimes they devour the newly hatched fry of their own species. Other foods mentioned consisted of filamentous algæ, desmids, entomostracans, and insects. Reighard (1915) said this minnow is a "mud eater."

**Pimephales promelas** (Rafinesque.) Black-head minnow, fathead.

Station 17; September 18, 1915; number examined, 3. Lengths: 51, 50.5, 45. Food: Tanytarsus gregarius larvæ, 79.3; mites, 1.6; amphipods, 0.3; Cyclops, 2.6; oligochætes, 6; diatoms and other algæ, 1.3; sand and débris, 8.3.

**Pomoxis sparoides** (Lacépède). Black crappie, calico bass, silver bass.

Station 17; April 10 and 13, 1915; number examined, 4. Lengths: 145, 130, 132, 75. Food: Minnows, 12.5; chironomid larvæ, 1.2; May-fly nymphs, 22.5; Siphylurus nymphs, 0.7; Enallagma hageni, 12.5; Smithiurus, 0.5; Corixa adults, 24.5; Hyalella, 8.7; Chydorus sphaericus, 0.2; plant remains, 11.5; filamentous algæ, 2.3; fine débris, 1.2.

*Summary.*—Food: Fish, 12.5; insect larvæ, 36.9; adult insects, 25; amphipods, 8.7; cladocerans, 0.2; plants, 11.5; algæ, 2.3; débris, 1.2.

Station 21, along south shore of Lake Wingra; number examined, 4. Lengths: 154, 140, 70, 55. Food: Fish, 6.2; Chironomus nigricans larvæ, 0.1; Tanytus monilis larvæ, +; Probezzia larvæ, 10; caterpillar, 11; Bætis nymphs, 4.5; Chironomus fulviventris pupæ, 38.5; mites, 1.3; Dikerogammarus fasciatus, 0.5; Hyalella, 10; ostracods, 2.5; Cyclops bicuspidatus, 21.1; Chydorus sphaericus, 1.8; filamentous algæ +.

*Summary.*—Food: Fish, 6.2; insect larvæ, 24.3; pupæ, 38.5; mites, 1.3; amphipods, 10.5; ostracods, 2.5; copepods, 21.1; cladocerans, 1.8; algæ, +.

Station 17; August 24; number examined, 1. Length: 186. Food: Cænis diminuta nymph, 8; moth, 81; Eurycercus lamellatus, 1; Wolfia, 10.

Station 6; August 25; number examined, 1. Length: 100. Food: Chironomus viridis larvæ, 10; C. lobiferus pupæ, 10; Hyalella, 15; Simocephalus, 61.9; Ceratophyllum, 3; seed, 0.1.

Station 28; September 15; number examined, 3. Lengths: 116, 105, 104. Food: Fish, 79; Chironomus viridis larvæ, 0.3; Cænis diminuta nymph, 1; Corixa adult, 3.3; Cyclops, 0.3; Chydorus, 0.2; Daphnia, 11.7; plant remains, 3.3.

Station 24; September 17; number examined, 1. Length: 45. Food: Insect larvæ, 15; chironomid larvæ, 10; Hyalella, 60; Cyclops, 3; Chydorus sphaericus, 2; Daphnia, 10.

Station 22; October 27; number examined, 36. Length: Maximum, 48; minimum, 36; average, 40.4. Food: Fish, 0.3; insect larvæ, 1; chironomid larvæ, 3.6; Tanytus gregarius larvæ, 9; Bætisca nymph, 4.3; Chironomus lobiferus pupæ, 0.4; Smithiurus, 0.6; moth, 0.4; adult midges, 2.5; Probezzia pallida adults, 5.8; Cordylura adults, 0.6; Hyalella, 3.5; ostracods, 21.7; Diaptomus, 0.2; Canthocamptus, 20.7; Cyclops, 18.6; Chydorus, 1.5; Pleuroxus, 1; Simocephalus, +; seeds, 0.4.

*Summary.*—Food: Fish, 0.3; insect larvæ, 17.9; pupæ, 0.4; adult insects, 9.9; amphipods, 3.5; ostracods, 21.7; copepods, 29.5; cladocerans, 1.5; plants, 0.4.

Station 26; November 27; number examined, 7. Length: Maximum, 221; minimum, 160; average, 184.1. Food: Insect larvæ, 0.8; Chironomus viridis larvæ, 8.9; C. tentans larvæ, 4.3; Bætisca nymphs, 2.1; Ischnura verticalis nymphs, 2.1; Canthocamptus, +; Daphnia, 54.7; Leptodora, 27.1.

*Summary.*—Food: Insect larvæ, 18.2; copepods, +; cladocerans, 81.8.

Station 18; April 29, 1916; number examined, 3. Length: Maximum, 188; minimum, 159; average, 172.3. Food: Minnow, 13.3; Chironomus fulviventris larvæ, 3.3; C. lobiferus larvæ, 3.3; Ephemerella sp. nymphs, 1.6; Celithemis eponina nymph, 6.6; Setodis grandis larvæ, 0.3; Corixa adult, 1.6; Hyalella, 69; filamentous algæ, 0.3; leaf 0.1; plant remains, 0.1.

*Summary.*—Food: Fish, 13.3; insect larvæ, 15.1; insect adults, 1.6; amphipods, 69; plants, 0.5.

Station 18; May 13; number examined, 1. Length: 200. Food: Chironomus fulviventrīs larvæ, 5; Notonecta nymphs, 1; Chironomus decorus pupæ, 1; Corixa adults, 3; adult beetles, 28; Hyalella, 50; Eurycerus, 2; filamentous algæ, 10.

*Summary.*—Food: Insect larvæ, 6; insect pupæ, 1; insect adults, 31; amphipods, 50; Entomostraca, 2; plants, 10.

Station 28; May 30; number examined, 2. Length: Maximum, 183; minimum, 170; average, 176.5. Food: Fish eggs, 1; Chironomus fulviventrīs larvæ, 12.5; C. lobiferus larvæ, 16.5; C. decorus larvæ, 2.5; Proboezzia glaber larvæ, 5; Notonecta nymphs, 2.5; Chironomus sp. pupæ, 35; C. fulviventrīs pupæ, 5; C. decorus pupæ, 5; mites, 10; Hyalella, 10.

*Summary.*—Food: Fish eggs, 1; insect larvæ, 39; insect pupæ, 45; mites, 10; amphipods, 10.

Station 26; July 13; number examined, 3. Length: Maximum, 183; minimum, 142; average, 169.3. Food: Minnow, 3.5; Chironomus lobiferus larvæ, 25; Enallagma hageni nymphs, 3.3; Chironomus sp. pupæ, 12.6; Corixa adults, 0.3; Hyalella, 0.3; Daphnia, 6.3; D. pulex, 16.6.

*Summary.*—Food: Fish, 3.5; insect larvæ, 28.3; insect pupæ, 12.6; insect adults, 0.3; amphipods, 0.3; cladocera, 22.9.

*Grand summary for 1915 and 1916.*—Number examined, 66. Length: Maximum, 221; minimum, 35; average, 90.5. Food: Fish eggs, 0.1; fish, 7.1; insect larvæ, 19.1; insect pupæ, 4.6; adult insects, 8.8; mites, 0.4; amphipods, 10.6; Entomostraca, 47.4; plants, 1.5; silt and débris, +.

The black crappie depends on entomostracans (47.4 per cent), insects (33.5 per cent), amphipods, and small fish for its food. Its form fits it to live among aquatic plants, and in general its food comes from such situations. The largest fish examined (November 27, 1915), however, had eaten over three-fourths pelagic entomostracans. Forbes and Richardson (1908) stated that the crappies are strictly carnivorous, living mainly on insects, crustaceans, and fish.

#### **Roccus chrysops** (Rafinesque). White bass.

Station 15; June 6, 1915; number examined, 1. Length: 165. Food: Chironomus decorus larvæ, 40; Protenthes culiciformis larvæ, 39.9; Corethra larvæ, 10; Hyalella, 0.1.

*Summary.*—Food: Chironomid larvæ, 99.9; amphipods, 0.1.

Station 5; August 18; number examined, 1. Length: 29. Food: Cyclops, 65; Bosmina longirostris cornuta, 35.

Station 5; August 25; number examined, 1. Length: 35. Food: Corixa adults, 100.

Station 5; August 25; number examined, 2. Lengths: 35, 29. Food: Chironomus adults, 5; Cyclops, 60; Bosmina longirostris cornuta, 30; Simocephalus, 5.

*Summary.*—Food: Adult insects, 5; copepods, 60; cladocerans, 35.

Station 5; August 30; number examined, 6. Length: Maximum, 44; minimum, 32; average, 37.9. Food: Insect eggs, 20; chironomid larvæ, 0.8; Chironomus decorus larvæ, 1.6; Bætica nymphs, 13.1; Enallagma hageni nymphs, 6.6; Chironomus lobiferus pupæ, 10; C. viridis pupæ, 1.6; Hyalella, 9.1; Cyclops, 27; Cyclops serrulatus, 6.6; chydorids, 1.8; Simocephalus, 1.

*Summary.*—Food: Insect larvæ, 42.1; pupæ, 11.6; amphipods, 9.1; copepods, 33.6; cladocerans, 2.8.

Station 5; September 2; number examined, 1. Length: 33. Food: Chironomus decorus larvæ, 5; Protenthes culiciformis pupæ, 5; Hyalella, 15; ostracods, 5, Cyclops, 65; cladocerans, 5.

Station 5; September 22; number examined, 1. Length: 220. Food: Fundulus diaphanus menona, 55; Chironomus decorus larvæ, 8; Corethra larvæ, 20; Chironomus decorus pupæ, 8; C. d. adult, 7; Leptocerus dilutus adult, 2.

*Summary.*—Food: Fish, 55; insect larvæ, 28; pupæ, 8; adult insects, 9.

Station 15; depth, 13 meters; November 13; number examined, 1. Length: 145. Food: Daphnia, 60; Leptodora, 40.

*Grand summary.*—Number examined, 14. Length: Maximum, 220; minimum, 29; average, 65.6. Food: Fish, 4.2; insect eggs, 8.6; larvæ, 22.2; pupæ, 5.8; adult insects, 8.4; amphipods, 5; ostracods, 0.4; copepods, 29.6; cladocerans, 16.3.

The white bass feeds primarily on entomostracans (46.3 per cent) and insects (45 per cent). The adults eat insects more than anything else, but also take fish. Forbes and Richardson (1908) mentioned insects, crustaceans, and fishes as constituents of the food of this species. Two adults examined by the writer in 1914 were filled with adult midges.

**Salmo irideus** (Jordan and Evermann). Rainbow trout.

Station 30; August 26, 1915; number examined, 1. Length: 126.5. Food: Chironomus fulviventris larvæ, 5; Tanypus decoloratus larvæ, 5; Psychoda larvæ, 5; Phryganea larvæ, 8; Odontomyia larvæ, 10; Chironomus fulviventris pupæ, 1; C. lobiferus pupæ, 2; lepidid adult, 4; Peltodytes 12-punctipennis adult, 3; Julus, 10; Gammarus limnæus, 42; Physa, 5.

*Summary.*—Food: Insect larvæ, 33; pupæ, 3; adult insects, 7; millipeds, 10; amphipods, 42; snails, 5.

**Salvelinus fontinalis** (Mitchill.) Brook trout.

Station 30; August 26, 1915; number examined, 18. Length: Maximum, 160; minimum, 87; average, 103.2. Food: Dipterous larvæ, 3.5; Chironomus fulviventris larvæ, 13.2; Tanypus decoloratus larvæ, 1; Psychoda larvæ, 0.3; Phryganea larvæ, 11.5; Agabus larvæ, 1.8; Odontomyia larvæ, 1.1; Dytiscus hybridus larvæ, 0.5; Dixia larvæ, 1; Chironomus fulviventris pupæ, 18.2; C. lobiferus pupæ, 0.2; lepidid flies, 0.8; Peltodytes 12-punctipennis adult, 0.2; Agabus adult, 1.1; Corixa adults, 0.3; Camponotus adult, 0.1; Melanoplus femurrubrum adult, 3; jassid bug, 0.1; Julus, 0.4; Limnesia histrionica, 0.4; Gammarus limnæus, 35.5; Asellus communis, 0.5; Procellio rathkei, 0.8; Physa, 1.4; seeds, +; Polygonium seeds, 0.1.

*Summary.*—Food: Insect larvæ, 33.9; pupæ, 18.4; adult insects, 5.6; millipeds, 0.4; mites, 0.4; amphipods, 35.5; aquatic isopods, 0.5; terrestrial isopods, 0.8; snails, 1.4; plant seeds, 0.1.

This trout feeds largely on insects and other arthropods. The Fish Manual (1900) has this statement: "The brook trout has a voracious appetite and takes advantage of every opportunity to satisfy it, except in the spawning season, when it takes no food at all. It is strictly a carnivorous fish, its food consisting chiefly of crustacea, mollusca, and various forms of insects and worms. When pressed with hunger, it does not hesitate to devour its own kind." Tracy (1910) said this fish will eat nearly any small living creature—insects, fish, its own eggs and young, tadpoles, newts, etc.

**Schilbeodes gyrinus**. (Mitchill.) Tadpole cat.

*Data for 1914* (Pearse, 1915).—Station 4; August 6; number examined, 5. Length: Maximum, 26.8; minimum, 17.6; average, 22.3. Food: Insect larvæ, 8; adult insects, 4; Hyalella, 0.4; ostracods, 0.4; copepods, 62; cladocerans, 1.6; algæ, 4.2; silt and débris, 15.

Station 5; May 12; number examined, 14. Length: Maximum, 76; minimum, 30.3; average, 42.8. Food: Insect larvæ, 1.4; chironomid larvæ, 2; Chironomus lobiferus larvæ, 7; C. fulviventris larvæ, 1.8; Pelopia monilis larvæ, 3; Orthocladius soldidellus larvæ, 2; May-fly nymphs, 12; Bætis pygmaea nymphs, 10; Callibætis nymphs, 10; Corixa nymphs, 1.3; Neuronina postica pupæ, 2.4; Chironomus lobiferus pupæ, 2; grasshopper, 1.4; Enallagma antennatum adults, 5; adult dipteran, 2; Hyalella, 7; ostracods, 6.5; Cyclops, 2; chydorus sphaericus, 11; Simocephalus, 0.5; Eurycerus lamellatus, 6.3; oligochætes, 1.4; fine débris, 2.

*Summary.*—Food: Insect nymphs and larvæ, 50.5; pupæ, 4.4; adult insects, 8.4; amphipods, 7; ostracods, 6.5; copepods, 2; cladocerans, 17.8; oligochætes, 1.4; débris, 2.

Station 5; June 1; number examined, 9. Length: Maximum, 45; minimum, 38.5; average, 42.6. Food: Chironomus lobiferus larvæ, 4; Orthocladius sordidellus larvæ, 16; damsel-fly nymphs, 1.1; beetle larvæ, 33.2; Naucoris nymphs, 8.3; Chironomus lobiferus pupæ, 2.7; C. decorus pupæ, 7.2; Odontomyia pupæ, 0.5; Lachnosterna adult, 1.9; ostracods, 8.5; Cyclops, 9; oligochætes, 5.5; filamentous algæ, 0.1; fine débris, 2.

*Summary.*—Food: Insect larvæ, 62.6; pupæ, 10.4; adult insects, 1.9; ostracods, 8.5; copepods, 9; oligochætes, 5.5; filamentous algæ, 0.1; fine débris, 2.

Station 5; August 9; number examined, 2. Lengths: 21.5, 21. Food: Protenthes culiciformis larvæ, 15; Callibætis nymphs, 17.5; mite, 1; Hyalella, 12.5; ostracods, 1; Chydorus sphaericus, 0.5; Camptocercus, 17.5; oligochætes, 12.5; seeds, 17.5; fine débris, 5.

*Summary.*—Food: Insect larvæ, 32.5; mites, 1; amphipods, 12.5; ostracods, 1; cladocerans, 18; oligochætes, 12.5; seeds, 17.5; débris, 5.

Near Station 5, on lake shore; August 18; number examined, 14. Length: Maximum, 63; minimum, 14; average, 25.8. Food: Chironomus lobiferus larvæ, 1.4; damsel-fly nymphs, 1.4; May-fly nymphs 0.7; Ecdyurus maculipennis nymphs, 1.3; Cænis diminuta nymphs, 27.7; Hyalella, 6.7; ostracods, 1; Camptocercus, 0.2; cladocerans, 0.2; Planorbis, 0.3; oligochætes, 42.7; seeds, 15; duckweed, 1.4.

*Summary.*—Food: Insect larvæ, 32.5; amphipods, 6.7; ostracods, 1; cladocerans, 0.4; snails, 0.3; oligochætes, 42.7; plants, 16.4.

Station 5; August 18; number examined, 10. Length: Maximum, 27.8; minimum, 18; average, 22.3. Food: *Chironomus fulviventris* larvæ, 3; *C. digitatus* larvæ, 1.5; *Tanytus decoloratus* larvæ; 2.5; *Orthocladus sordidellus* larvæ, 2.5; May-fly nymphs, 3.5; *Bætica* nymphs, 1.5; *Cænis diminuta* nymphs, 10.5; *Enallagma antennatum* adult, 3.5; *Hyaella*, 27.3; ostracods, 3; Cyclops, 2; *Chydorus phæricus*, 0.5; *Simocephalus*, 0.7; *Camptocercus*, 2.3; oligochætes, 31.4; seeds, 1; *Myriophyllum*, 3; sand, 0.3.

*Summary*.—Food: Immature insects, 25; adult insects, 3.5; amphipods, 27.3; ostracods, 3; copepods, 2; cladocerans, 3.5; oligochætes, 31.4; plants, 4; sand, 0.3.

Station 5; September 15; number examined, 1. Length: 59. Food: Insect larvæ, 7; *Hyaella*, 55; ostracods, 8; cladocerans, 15; fine débris, 15.

*Grand summary for 1914 and 1915*.—Number examined, 55. Length: Maximum, 76; minimum, 14; average, 34.3. Food: Insect larvæ, 36; pupæ, 4.4; adult insects, 3.6; mites, +; amphipods, 10.3; ostracods, 4; copepods, 7.9; cladocerans, 6.1; snails, 0.1; oligochætes, 18.3; plants, 5.9; algæ, 0.1; silt and débris, 3.

The tadpole cat feeds chiefly on insects (44 per cent), oligochætes (18.3 per cent), and small crustaceans (28.3 per cent). The items in its diet show that it gets its food on the bottom and among aquatic plants. The smaller individuals apparently depend upon crustaceans and oligochætes, larger fishes turn more to insects. Forbes and Richardson (1908) found this species feeding on amphipods isopods, entomostracans, insect larvæ, and small fish. Hankinson (1908) found insect fragments.

***Stizostedion vitreum* (Mitchill).** Wall-eyed pike, pike perch, jack-salmon.

Station 28; September 15, 1915; number examined, 2. Lengths: 448, 425. Food: Fish, 100.

Station 29; November 14; number examined, 9. Length: Maximum, 520; minimum, 375; average, 441. Food: *Rana pipiens*, 11.1; fishes (one a sunfish), 88.9.

*Grand summary*.—Number examined, 11. Average length: 440. Food: Frogs, 9.1; fishes, 90.9.

Forbes and Richardson (1908) stated that this species feeds chiefly on fish, sometimes varying its diet with crayfishes.

***Umbra limi* (Kirtland).** Mud minnow, mudfish.

*Data for 1914* (Pearse, 1915).—Number examined, 60. Average length: 33.5. Food: Insect larvæ, 21; adult insects, 16.3; mites, 0.3; amphipods, +; ostracods, 33.9; copepods, 0.5; cladocerans, 1.2; snails, 0.7; Sphæridæ, 0.2; oligochætes, 1; nematodes, 0.7; protozoans, 0.1; plant remains, 1.9; algæ, 15.1.

Station 21; April 28, 1915; number examined, 9. Length: Maximum, 80; minimum, 31; average, 51.1. Food: Insect larvæ, 3; *Platyphylax designatus* larvæ, 4.5; *Chironomus viridis* larvæ, 1; *Tanytus decoloratus* larvæ, 3.3; *Pelopia flavifrons* larvæ, 3.3; *Odontomyia* larvæ, 4.5; *Haliphus* adult, 0.2; *Corixa* adult, 4; mites, 2; *Hyaella*, 12; *Dikerogammarus fasciatus*, 26; Cyclops, 0.3; *C. viridis*, 5.8; *C. fimbriatus*, 5; cladocerans, 0.3; *Chydorus sphaericus*, 0.5; leech, 5.5; oligochætes, 12; plant remains, 1.5; *Pleurococcus*, 2.5; diatoms, 0.5; silt, 1; fine débris, 1.

*Summary*.—Food: Insect larvæ, 19.6; adult insects, 4.2; mites, 2; amphipods, 38; copepods, 11.1; cladocerans, 0.8; leech, 5.5; oligochætes, 12; plants, 1.5; algæ, 3; silt and débris, 2.

Station 16; May 15; number examined, 1. Length: 68.7. Food: Adult midges, 10; earthworm, 79; diatoms, 1; silt and débris, 10.

Station 5; June 1; number examined, 4. Lengths: 68, 60, 54, 49.5. Food: Insect larvæ, 11; chironomid larvæ, 0.5; *Chironomus lobiferus* larvæ, 2.2; *Orthocladus sordidellus* larvæ, 20.4; chironomid pupæ, 9.6; *Probezzia* pupæ, 0.6; adult weevil, 1; adult midges, 6.2; ostracods, 4; *Dikerogammarus*, 1.2; Cyclops, 1; *Chydorus*, 0.2; *Eurycercus lamellatus*, 1.2; *Physa*, 1.7; seeds, 14; *Wolfia*, 2.5; plants, 0.2; filamentous algæ, 0.3; *Pleurococcus*, 20; silt and débris, 2.5.

*Summary*.—Food: Insect larvæ, 34.1; pupæ, 10.2; adult insects, 7.2; ostracods, 4; amphipods, 1.2; copepods, 1; cladocerans, 1.4; snails, 1.7; plants, 16.7; algæ, 20.3; silt and débris, 2.5.

Station 21; June 12; number examined, 10. Length: Maximum, 179; minimum, 35; average, 63.9. Food: Insect larvæ, 1.5; chironomid larvæ, 0.7; *Chironomus* larvæ, 1; *Chironomus fulviventris* larvæ, 25; *Palpomyia longipennis* larvæ, 3; *Cricotopus trifasciatus* larvæ, 2.5; *C. t.* pupæ, 8.7; chironomid pupæ, 4.3; adult midges, 11; mites, 0.3; ostracods, 0.1; *Dikerogammarus*, 26.9; Cyclops, 2.7; *Physa*, 0.8; *Pleurococcus*, 3.5; silt and débris, 7.

*Summary.*—Food: Insect larvæ, 33.7; pupæ, 12.1; adult insects, 11; mites, 0.3; ostracods, 0.1; amphipods, 26.9; copepods, 2.7; snails, 0.8; algæ, 3.5; silt and débris, 7.

Station 25; June 17; number examined, 10. Length: Maximum, 84; minimum, 42.5; average, 49.3. Food: Chironomid larvæ, 2; *Libellula luctuosa* nymphs, 10; chironomid pupæ, 2.5; *Haliphus* adults, 2.5; *Corixa* adults, 5; mites, 3; ostracods, 32.2; *Cyclops*, 7; *Chydorus*, 1.5; *Simocephalus*, 4.6; *Planorbis*, 5.5; *Limnæa*, 3.5; oligochætes, 6; filamentous algæ, 1.2; *Pleurococcus*, 9; silt and débris, 4.5.

*Summary.*—Food: Insect larvæ, 12; pupæ, 2.5; adult insects, 7.5; mites, 3; ostracods, 32.2; copepods, 7; cladocerans, 6.1; snails, 9; oligochætes, 6; algæ, 10.2; silt and débris, 4.5.

Station 28; July 2; number examined, 1. Length: 47.5. Food: *Oxyethira* larvæ, 10; carabid-beetle larvæ, 10; *Odontomyia* vertebrata larvæ, 10; ostracods, 5; *Hyaella*, 60; *Cyclops*, 5.

*Summary.*—Food: Insect larvæ, 30; ostracods, 5; amphipods, 60; copepods, 5.

Station 25, in ditch along road; number examined, 14. Length: Maximum, 25.2; minimum, 15.1; average, 20.6. Food: Insect larvæ, 0.3; chironomid larvæ, 5; Chironomid tentans larvæ, 5.3; *Palpomyia longipennis* larvæ, 0.3; *Cricotopus trifasciatus* larvæ, 7; *Cænis diminuta* nymphs, 0.7; beetle larvæ, 3.5; dasyllid larvæ, 8.5; midge pupæ, 3.5; adult bug, 1.8; insect remains, 0.3; adult midges, 4.6; *Naucoris* adult, 4.4; *Collembola*, 0.8; mites, 0.3; *Hermannia bistriata*, 5.6; ostracods, 12.2; *Cyclops*, 11; *Canthocamptus*, 1; chydorid, 0.1; *Planorbis*, 2; *Limnæa*, 5.2; oligochætes, 7; rotifers, 1.3; *Oscillaria*, 0.7; *Volvox* and other algæ, 0.3; filamentous algæ, 0.1; *Pleurococcus*, 4.3; sand, 1.4.

*Summary.*—Food: Insect larvæ, 30.6; pupæ, 3.5; adult insects, 11.9; mites, 5.9; ostracods, 12.2; copepods, 12; cladocerans, 0.1; snails, 7.2; oligochætes, 7; rotifers, 1.3; algæ, 54; sand, 1.4.

Station 23; August 14; number examined, 1. Length: 51. Food: *Hyaella*, 25; *Cyclops*, 1; *Chydorus*, 1; plant remains, 73.

*Grand summary for 1914 and 1915.*—Number examined, 110. Length: Maximum, 179; minimum, 15.1; average, 41.9. Food: Insect larvæ, 21.9; pupæ, 2.1; adult insects, 10.9; spiders, 0.1; mites, 1.2; amphipods, 6.5; ostracods, 23.1; copepods, 3.6; cladocerans, 1.3; snails, 2.3; Sphæridæ, 0.1; oligochætes, 2.9; leeches, 1.1; nematodes, 0.4; rotifers, 2; protozoans, 0.2; plants, 2.5; algæ, 11.1; silt and débris, 1.4; unidentified, 3.8.

The mud minnow is a rather versatile feeder, with the chief constituents of its food, insects (35 per cent), entomostracans (31.3 per cent), and vegetation (13.6 per cent). Forbes and Richardson (1908) found that *Wolffia* and unicellular algæ formed three-fourths of the food of this species, insects and crustaceans making up the rest. Hankinson (1908) reported entomostracans, algæ, mites, midge larvæ, snails, and insects.

### III. FOODS UTILIZED BY FISHES.

#### DIFFERENT SPECIES OF FISHES HAVE DIFFERENT FOOD HABITS.

Table 1 shows the different kinds of food eaten by the shore fishes of lakes. If more complete information is desired it may be obtained from the preceding section, where the food of the fishes in each catch is given in considerable detail.

Most fishes are not indiscriminate feeders, but select specific things from the available food supply. A good illustration of this point is furnished by the fishes caught together at station 18, July 3, 1915. The foods taken by each of these fish are shown in Table 3, and it will be noted that the different species were about the same average size. The black bass is the most versatile, having taken 21 different items of food, the bluegill comes next with 16, the shiner has 14, and the top minnow 11. Each fish has taken a different item in the largest quantity—i. e., the black bass, 25 per cent *Enallagma antennatum* nymphs; the top minnow, 49 per cent *Hyaella*; the bluegill, 47 per cent *Eurycercus*; and the shiner, 42.6 per cent *Daphnia longispina hyalina*. All the fishes had eaten *Eurycercus*, which must have been abundant, and two had taken *Hyaella*. The other two items taken in largest amount (*Daphnia hyalina* and *Enallagma antennatum*) were each eaten by only a single species. In Table 4 (which resembles Table 3) three of the species have eaten more fish than any other kind of food, but the fourth has taken none. Table 2 shows the Johnny darter feeding largely on chironomid larvæ and oligo-



chætes; the bream and white bass on Cyclops and other entomostracans; the perch and black bass on the larger insect larvæ, adult insects, and amphipods; the blunt-nosed minnow on mud; the tadpole cat on oligochætes.

An examination has been made of Tables 2, 3, and 4 and ten others similar to them. Each of these tables concerned four or more species of fishes captured at the same time and place. The following 22 species (506 individuals) appear one or more times in them: *Abramis crysoleucas*, *Ambloplites rupestris*, *Amiatus calva*, *Ameiurus melas*, *Ameiurus nebulosus*, *Boleosoma nigrum*, *Catostomus commersonii*, *Cyprinus carpio*, *Esox lucius*, *Etheostoma iowæ*, *Fundulus diaphanus menona*, *Labidesthes sicculus*, *Lepomis incisor*, *Micropterus salmoides*, *Notropis heterodon*, *Perca flavescens*, *Percina caprodes*, *Pimephales notatus*, *Pomoxis sparoides*, *Roccus chrysops*, *Schilbeodes gyrinus*, and *Umbra limi*. The different figures in the bottom line of all tables were added to ascertain whether specific foods were likely to be eaten by one or more fish. The results were as follows: Items appearing once in any one table, 356; twice, 93; thrice, 45; four or more times, 11. This shows that, though fishes may feed on the available foods, different species captured at the same time and place have not eaten the same things.

All things, then, indicate that fishes select food from their environment. In some cases the powers of selecting and rejecting are remarkable. A perch may have its whole alimentary canal packed full of *Daphnias*, when the surrounding water contains *Daphnias* mixed with greater quantities of algæ. Only the animal plankton is taken. The young sucker is able to take such minute living objects as *Diffugia*, *Arcella*, and rotifers from a muddy bottom, rejecting fine particles of silt.

#### CLASSES OF FOODS UTILIZED BY FISHES.

The foods found in fishes occurring along the shores of Wisconsin lakes fall into nine classes. In order of their importance these rank as follows: (1) Insect larvæ, oligochætes and leeches, 28.7 per cent; (2) entomostracans, 19.1 per cent; (3) fishes and frogs, 13.8 per cent; (4) insect pupæ and adults, 11.7 per cent; (5) amphipods, isopods, and mites, 12.7 per cent; (6) plants, including algæ, 4.2 per cent; (7) mud, silt, and fine débris, 2.6 per cent; (8) molluscs, 2 per cent; and (9) crayfishes, 1.1 per cent. The percentages were obtained from the last line of Table 1.

In the following paragraphs fishes are arranged under each class in the order of their importance. Every species taking food in a particular class is not always recorded but they all appear in Table 1. It must be remembered that there is a preponderance of young fishes in the data from which these results are figured. An examination of more adults would doubtless increase classes 3, 6, 8, and 9.

1. *Fishes feeding upon insect larvæ, oligochætes, and leeches.*—*Boleosoma nigrum*, 77.6 per cent; *Ameiurus melas*, 59.6 per cent; *Schilbeodes gyrinus*, 57.9 per cent; *Percina caprodes*, 54 per cent; *Catostomus commersonii*, 51.5 per cent; *Etheostoma flabellare*, 50.5 per cent; *Ambloplites rupestris*, 46 per cent; *Cyprinus carpio*, 42.5 per cent; *Etheostoma iowæ*, 38.6 per cent; *Micropterus dolomieu*, 37.7 per cent; *Lepomis incisor*, 35.7 per cent; *Cottus ictalops*, 35.3 per cent; *Perca flavescens*, 35.1 per cent; *Roccus chrysops*, 30.8 per cent; *Ameiurus nebulosus*, 30.2 per cent; *Fundulus diaphanus menona*, 26.4 per cent; *Umbra limi*, 25.9 per cent; *Eucalia inconstans*, 24.1 per cent; *Micropterus salmoides*, 23.7 per cent; *Pimephales notatus*, 21.5 per cent; *Pomoxis sparoides*, 18.4 per cent; *Eupomotis gibbosus*, 16.2 per cent; *Notropis heterodon*, 15 per cent.

2. *Fishes feeding upon entomostracans.*—*Abramis crysoleucas*, 76 per cent; *Pomoxis sparoides*, 53.7 per cent; *Notropis heterodon*, 44.9 per cent; *Ameiurus nebulosus*, 42.1 per cent; *Labidesthes sicculus*, 40.1 per cent; *Eucalia inconstans*, 38.5 per cent; *Fundulus diaphanus menona*, 36 per cent; *Umbra limi*, 31.3 per cent; *Pimephales notatus*, 28 per cent; *Lepomis incisor*, 24.9 per cent; *Micropterus salmoides*, 18.1 per cent; *Schilbeodes gyrinus*, 18 per cent; *Perca flavescens*, 16.9 per cent.

3. *Fishes feeding upon fishes and frogs.*—*Stizostedion vitreum*, 100 per cent; *Amiatus calva*, 90.1 per cent; *Lepisosteus osseus*, 88.8 per cent; *Esox lucius*, 84 per cent; *Percina caprodes*, (eggs) 27.8 per cent; *Micropterus dolomieu*, 14.7 per cent; *Eupomotis gibbosus*, (eggs) 9.4 per cent; *Micropterus salmoides*, 8.2 per cent; *Pomoxis sparoides*, 5.7 per cent; *Perca flavescens*, 3.5 per cent; *Roccus chrysops*, 4.2 per cent; *Ambloplites rupestris*, 2 per cent.

4. *Fishes feeding upon insect pupæ and adult insects.*—*Labidesthes sicculus*, 44.6 per cent; *Micropterus dolomieu*, 39.7 per cent; *Micropterus salmoides*, 31.2 per cent; *Ambloplites rupestris*, 23.3 per cent; *Eucalia inconstans*, 18.1 per cent; *Roccus chrysops*, 14.2 per cent; *Notropis heterodon*, 14.1 per cent; *Umbra limi*, 13 per cent; *Pomoxis sparoides*, 12.7 per cent; *Eupomotis gibbosus*, 10.3 per cent; *Pimephales notatus*, 10.3 per cent; *Ameiurus melas*, 9.9 per cent; *Cyprinus carpio*, 9.6 per cent; *Lepomis incisor*, 9.2 per cent; *Schilbeodes gyrinus*, 9 per cent; *Ameiurus nebulosus*, 6.5 per cent; *Fundulus diaphanus menona*, 4.8 per cent; *Percina caprodes*, 3.9 per cent; *Perca flavescens*, 3 per cent.

5. *Fishes feeding upon amphipods, isopods, and mites.*—*Cottus icталops*, 59.1 per cent; *Etheostoma iowæ*, 58 per cent; *Etheostoma flabellare*, 48 per cent; *Perca flavescens*, 24.6 per cent; *Lepomis incisor*, 15.1 per cent; *Fundulus diaphanus menona*, 14.1 per cent; *Micropterus salmoides*, 13.9 per cent; *Ameiurus nebulosus*, 11.8 per cent; *Schilbeodes gyrinus*, 10.3 per cent; *Eupomotis gibbosus*, 9 per cent; *Cyprinus carpio*, 8.7 per cent; *Umbra limi*, 7.8 per cent; *Pomoxis sparoides*, 7.5 per cent; *Eucalia inconstans*, 5.2 per cent; *Boleosoma nigrum*, 5.1 per cent; *Roccus chrysops*, 5 per cent; *Percina caprodes*, 4.6 per cent; *Esox lucius*, 2.5 per cent.

6. *Fishes feeding upon plants, including algæ.*—*Eupomotis gibbosus*, 25.5 per cent; *Pimephales notatus*, 20.2 per cent; *Notropis heterodon*, 15.6 per cent; *Umbra limi*, 13.6 per cent; *Ameiurus melas*, 7.3 per cent; *Fundulus diaphanus menona*, 6.4 per cent; *Schilbeodes gyrinus*, 6 per cent; *Lepomis incisor*, 5.2 per cent; *Abramis crysoleucas*, 4.5 per cent; *Eucalia inconstans*, 4.4 per cent; *Labidesthes sicculus*, 4 per cent; *Ambloplites rupestris*, 3.3 per cent.

7. *Fishes feeding upon mud, silt, and fine debris.*—*Pimephales notatus*, 20 per cent; *Notropis heterodon*, 6.5 per cent; *Ameiurus melas*, 6.3 per cent; *Percina caprodes*, 5.7 per cent; *Fundulus diaphanus menona*, 4.2 per cent; *Eucalia inconstans*, 3.7 per cent; *Catostomus commersonii*, 3.6 per cent; *Boleosoma nigrum*, 3.1 per cent; *Schilbeodes gyrinus*, 3 per cent.

8. *Fishes feeding upon molluscs.*—*Eupomotis gibbosus*, 25.8 per cent; *Cyprinus carpio*, 6.9 per cent; *Lepomis incisor*, 4.5 per cent; *Fundulus diaphanus menona*, 3.9 per cent; *Ameiurus melas*, 3.7 per cent; *Perca flavescens*, 3.7 per cent; *Eucalia inconstans*, 3.7 per cent; *Etheostoma iowæ*, 3 per cent; *Umbra limi*, 2.4 per cent.

9. *Fishes feeding upon crayfish.*—*Ambloplites rupestris*, 16.1 per cent; *Amiatus calva*, 9.4 per cent; *Ameiurus melas*, 6.1 per cent; *Micropterus salmoides*, 2.6 per cent.

## IV. ADAPTABILITY OF FOOD HABITS.

## ALTERNATIVE FOODS.

Fish prefer certain foods and select from their environment. If the largest single items are picked out from the dietaries of the fishes shown in Table 1, the following results are obtained: Nine species eat more dipterous larvæ than any other single kind of food; six, amphipods; five, cladocerans; four, fishes; two, adult hemipterous insects (*Corixa*); two, *Cyclops*; and one species takes its chief food from gastropods, dipterous pupæ, May-fly nymphs, and ostracods. The next question to be answered is: What will the different fishes eat if their favorite food is not available?

To answer this, the three foods taken in largest quantity (i. e., first, second, and third choice) were selected for each of the 32 species shown in Table 1. For example, the golden shiner, *Abramis crysoleucas*, ate 57.6 per cent cladocerans, 16.5 per cent copepods, 5.7 per cent dipterous pupæ, and other foods. This species was, therefore, put in a class "Cladocera—copepods—dipterous pupæ." The classes and the number of species of fish taking the same three chief items of food were as follows:

Diptera larvæ—Copepoda—Cladocera.....	3
Cladocera—Diptera larvæ—Amphipoda.....	3
Diptera larvæ—Ostracoda—Copepoda.....	2
Cladocera—adult Diptera—Diptera pupæ.....	1
Cladocera—Copepoda—Diptera pupæ.....	1
Cladocera—Diptera larvæ—algæ.....	1
Diptera larvæ—crayfishes—Odonata nymphs.....	1
Diptera larvæ—Ostracoda—Cladocera.....	1
Diptera larvæ—Oligochæta—plant remains.....	1
Diptera larvæ—fish eggs—Trichoptera larvæ.....	1
Diptera larvæ—Oligochæta—Copepoda.....	1
Fish—crayfish.....	1
Fish—adult Diptera—Diptera larvæ.....	1
Fish—frogs.....	1
Amphipoda—Ephemera nymphs—Diptera larvæ.....	1
Fish—Amphipoda—Hemiptera nymphs or Sphæridæ.....	1
Amphipoda—Diptera larvæ—Millipeds.....	1
Amphipoda—Diptera larvæ—Trichoptera larvæ.....	1
Amphipoda—Diptera larvæ—Diptera pupæ.....	1
Amphipoda—Diptera larvæ—Coleoptera larvæ.....	1
Gastropoda—plant remains—toad eggs.....	1
Adult Hemiptera—Ephemera nymphs—Diptera larvæ.....	1
Adult Hemiptera—Ephemera nymphs—Cladocera.....	1
Diptera pupæ—silt and débris—Copepoda.....	1
Cladocera—silt and débris—algæ.....	1
Ephemera nymphs—Oligochæta—Amphipoda.....	1
Ostracoda—Diptera larvæ—Amphipoda.....	1

Thirty-two species of fishes thus show 27 classes. If only the two chief food items are considered, the number of classes is reduced to 19, as follows:

Amphipoda—Diptera larvæ.....	4
Diptera larvæ—Copepoda.....	4
Diptera larvæ—Ostracoda.....	3
Cladocera—Diptera larvæ.....	3
Diptera larvæ—Oligochæta.....	2

Adult Hemiptera—Ephemera nymphs.....	2
Cladocera—Copepoda.....	1
Cladocera—Adult Diptera.....	1
Cladocera—silt and débris.....	1
Diptera larvæ—crayfishes.....	1
Diptera larvæ—fish eggs.....	1
Fish—Odonata nymphs.....	1
Fish—frogs.....	1
Fish—Ephemera nymphs.....	1
Amphipoda—Ephemera nymphs.....	1
Amphipoda—Cladocera.....	1
Gastropoda—plant remains.....	1
Diptera pupæ—silt and débris.....	1
Ephemera nymphs—Oligochæta.....	1

Both these comparisons give further support to the statements made under section III, showing that different kinds of fishes have specific preferences for certain foods. Nine species make their chief food the larvæ of dipterous insects, which are far more abundant than anything else. When these eat something different from their favorite food, they do not all take the same kind of food but select five to seven new things. It is difficult to group fishes into large classes on the basis of similarity in food. Essentially the same conclusions were reached by Forbes <sup>a</sup> from a study of 1,221 Illinois fishes.

#### VARIATION IN FOOD OF FISHES COLLECTED IN DIFFERENT LOCALITIES AND AT DIFFERENT TIMES.

In order to ascertain how much each species of fish varied in the selection of its principal food at different times and in different places, a study of the data for 1915 presented in section II was made. The chief foods taken at the different stations were summarized as far as possible. If a species took a different kind of food each time it was collected, it will of course be rated as one of versatile food habits; if its chief food was the same in all collections, it is considered as having a limited range of diet. The results of the comparison are shown in Table 5.

It will be noted that some species, like the rock bass, bluegill, and black bullhead, are rather versatile feeders; others (Johnny darter, miller's thumb, pickerel, gar) stick to one food. All the species taken together show a change in the chief food with time and place in about half the collections. These estimates, however, do not consider the diversity in size among the fishes examined.

#### VARIATION OF FOOD AT DIFFERENT PERIODS OF THE LIFE CYCLE.

The data collected for this paper are not complete enough to make very satisfactory comparisons possible between young and adult fish of each species. Of the 32 species studied, in only 20 were enough individuals of different sizes collected so that comparisons can be made.

Eight species feed more on amphipods, insect larvæ, and adult insects and less on entomostracans as they increase in size. Six change from insect larvæ to fishes or crayfishes. Each of the following changes is characteristic of a single species of fishes: Snails and amphipods to plants; oligochætes to molluscs; Hyalella to fish; insect larvæ

<sup>a</sup> Forbes, S. A.: On the food relations of fresh-water fishes: A summary and discussion; pp. 497-504, 1888.

to earthworms and leeches. Some of the small fishes (Johnny darter, stickleback) show little change. Others which attain larger size (crappie) are versatile and sometimes feed as adults on the same foods used when young. The two fishes which are largely vegetarian when adult (carp, sucker) both make their first food largely from entomostracans, then change to insect larvæ, and finally to plants.

Though the data from which these conclusions are made are by no means full enough to make very definite generalizations, the general course of events is indicated. The most important foods for young fishes are entomostracans, insects and their larvæ, and amphipods. Forbes<sup>a</sup> discussed changes in foods correlated with increase of age fully.

#### V. INFLUENCE OF FOOD ON THE SELECTION OF HABITATS.

Shelford (1911a) said "An animal should be associated, first, with breeding conditions; second, with the feeding conditions; third, with conditions affording shelter." Of course no species of fish could persist in a body of water that did not have places suitable for breeding. Most fishes during the breeding season give up feeding more or less and become more bold, thus being less protected. If there must be a choice between reproductive activities and something else, reproduction usually comes first. There is considerable variation in the length of time during which breeding activities dominate all others. Many species lay their eggs and take no more care of the young; some even eat their own eggs or young. Other fishes look after the young until they are able to shift for themselves. A cisco finishes its spawning in a few days; the young of the dogfish are watched by the parents for a couple of months. Aside from the actual time spent in breeding, some antecedent activities are doubtless influenced by preparation for reproduction, but in any of the fishes discussed in this paper breeding and its associated activities do not occupy more than a fourth of each year, usually much less.

Reproductive activities are, then, transitory, but food and shelter are more or less constant necessities. During the greater part of the year the dominant activity of a fish is finding food, and habits of feeding play a considerable part in keeping fishes in particular habitats. Any organism must have a continued supply of materials to furnish substance and energy. If shelter is close to the food supply, so much the better; but if it is not, food must still be sought.

According to the data discussed in section II of this paper, the habitat that affords the largest and most varied food supply is the aquatic vegetation along the shore, and it also furnishes good shelter. More species of fishes frequent the shore vegetation than any other habitat, and they together take a greater variety of food than those in any other place. The habitat most favored by fishes next to the general shore vegetation is the weedy mouths of streams; the third choice is sand and pebble beaches; the fourth, rivers and small streams; and the fifth, the little weedy ponds along shore. The number of fishes occurring in different habitats and their chief foods are shown in Table 6.

The habitats having the greatest variety of food and shelter have the most species of fishes. If there must be a choice between food and shelter, the former is taken. For example, a pebble and sand beach has less shelter and more available food than a rocky beach and is visited by five times as many species of fishes. Forbes (1888) has discussed the dependence of the food of fishes on their structural equipment in a mas-

<sup>a</sup> Forbes, S. A.: On the food relations of fresh-water fishes: A summary and discussion, pp. 492-497, 1888.

terly way. It is apparent that structure is of great importance, but behavior must also be considered. If not influenced by other factors, fishes will persistently select certain habitats and foods. The most potent influences in changing foods and feeding habits come with the seasonal cycle and with changes in age. The annual succession of seasons brings breeding, changes in gases and minerals in the water, variations in temperature, fluctuations in food supply and shelter, and other things which require variations in behavior. Young fishes do not have to breed and require different foods from adults. Through all these changing influences, food is in general more important than any other single factor in causing fish to select particular habitats.

#### VI. GENERAL CONSIDERATIONS OF THE FOODS ON THE SHORE FISHES OF LAKES.

The food of the 30 lake fishes reported in this paper shows that most species feed along the shore. Young fishes are found more or less in shallow water everywhere, but most of the adults are more specific in their selection of habitats and for the most part frequent the aquatic vegetation, which furnishes food and shelter. The fishes which are not usually associated with shore vegetation live near the bottom (perch, sucker), on rocky or pebbly shores (miller's thumb, Johnny darter), at the surface (silversides), or in the open water (cisco).

Competition between species for the different kinds of food is usually not very keen. When a particular sort of food is abundant, a number of different fishes may feed upon it, but if it becomes scarce the fishes do not all turn to the same diet for a second choice. This specificity in the selection of food enables different species to live together in the same habitats.

It is important in considering fish foods and the feeding of fishes to keep in mind that habits change as age increases. Forbes (1888) said, "One-celled organisms and Entomostraca are the natural, and practically the only, food of an undifferentiated small fish; and to be at liberty to grow, the fish must either change its food (as is usually done) or must develop a special apparatus (commonly a set of fine gill rakers) for the separation of Entomostraca from the waters in which they swim. A few apparently become vegetarians at once; most pass into or through an insectivorous stage. After this a few become nearly omnivorous, like the bullheads; others learn to depend chiefly on molluscan food—the sheephead and the redhorse species—but many become essentially carnivorous." The great dependence of many species of young fishes on entomostracans makes them rivals to some extent for the same foods, but, as Forbes pointed out, this is offset in part by the seasonal differences in the time of hatching. Some fishes also begin to eat small dipterous larvæ as soon as they are able to feed. From the data presented in this paper it appears that insect larvæ are of as much importance for young fishes as entomostracans.

Adult fishes fall readily into classes, according to their chief foods—vegetarians, piscivores, insectivores, those that eat entomostracans, and those that feed on mud and sediment. The chief vegetarians in Wisconsin lakes are the carp and sucker. It is an axiom in biology that, in any particular part of the earth, the vegetarians must greatly exceed in numbers the carnivorous animals which feed upon them, and in general this law is fulfilled among the fishes. The insectivorous fishes (basses, darters, etc.) usually secure their food when it is in the larval condition, and, in lakes, adult

insects are of much less importance than immature stages. The fishes feeding on entomostraca (cisco, bream, crappie, perch, carp, etc.) are partly adults and partly young fishes which will later turn more to other foods. In spite of the fact that these little crustaceans are an important element in the food of most young fishes, they do not rival insects. The total amount of insect food (36.3 per cent) in Table 1 is nearly twice as great as the total amount of entomostracans (19.1 per cent). The piscivorous species (pike, gar, pickerel, bowfin) depend on small fishes which get their food from plants directly or indirectly through entomostracans or insect eaters. Scavengers (sucker, blunt-nosed minnow, etc.) get organic remains from the mud and débris at the bottom of the lake or among the aquatic plants. Doubtless, fishes affect each other to a considerable extent by eating spawn. The perch in Lake Mendota follow the breeding suckers and ciscoes inshore and eat their eggs. Table 1 shows that four species eat the spawn of other fishes. Without doubt this number could be increased by more extended examinations during breeding seasons.

The nature of the food influences the flavor of fishes, thus enhancing or decreasing their desirability as food for man, and some particular kinds of food seem to make fishes more or less palatable. One of the best food fishes in Wisconsin lakes is the wall-eyed pike, which feeds on fish and frogs. The pickerel is also of good flavor and likewise eats fish, but the bowfin and gar, though they feed mostly on fish, are most undesirable for food. All fishes feeding largely on entomostracans or insects (and which attain sufficient size to be eaten) are of good flavor. Feeders on vegetation or mud are in general less desirable than carnivorous or insectivorous species.

Little is known concerning the amount and variety of food required by fishes. Pütter (1909) did some work along this line, and rations on which certain species thrive have been worked out in hatcheries, but there is no general satisfying knowledge concerning the amount of food required, the variety necessary, the value of different kinds of foods for metabolism, the rate of digestion, the percentage of foods digested, and other matters relating to the value of foods.

In its broad relations the matter presented in this paper is preliminary to more important studies which should be made on the food requirements of fishes. The problem for the fish culturist and scientific investigator involves work in a number of different fields. The food and feeding habits of fishes must be thoroughly known. The work of Forbes and that presented in this paper contribute in this connection to a knowledge of the fishes in the United States. Another line of investigation must be in the chemical nature of foods. Studies are now being carried out by the Wisconsin Geological and Natural History Survey in which adequate quantities of different species of aquatic organisms are being analyzed. It will also be necessary to determine many things relating to the general metabolism of fishes—amount of food necessary, kinds of food necessary, rate of digestion and assimilation, what proportion of food eaten is digested, etc. When all these things are known, it will be possible to ascertain definitely why fishes thrive on certain kinds of foods and fail to do so on others. It will also be possible to prescribe proper rations with some confidence. The recent work on the etiology of beri-beri and the illuminating researches of McCollum and Davis (1915) on the causes of growth open up new possibilities. These investigators have made very exact determinations of the substances and amounts necessary for proper rations, and the methods employed may be applied to fishes with profit.

But the day when we shall know enough to figure out proper rations is far in the future, and in the meantime every effort should be made to find better foods for growing fishes. There is no reason why we should feed flour and liver forever without knowing why. The recent work of Atkins (1908) in which trout were reared on fly larvæ is very suggestive and should be extended. There is no reason why other "natural" foods should not be fed to growing fishes in hatcheries. Entomostracans are easily collected in quantities with a pump or tow net. At some hatcheries (Lyell, 1902) they have been collected at intervals and fed to fry with good results. There is no reason why insect larvæ, snails, amphipods, earthworms, and other abundant living foods should not be more generally collected or reared as food for young fishes.

TABLE I.—SUMMARY OF FISH FOODS.

[All figures concerning food mean percentages by volume. In the "habitat" column the significance of the numbers is as follows: 1, aquatic vegetation along shore; 2, sand and pebble beaches; 3, rock beaches; 4, bottom of lake everywhere; 5, surface of lake along shore; 6, surface of lake everywhere; 7, open lake; 8, swamp; 9, mouths of streams; 10, river; 11, small ponds; and 12, small streams. These numbers refer to places where collections were actually made; not to the habitats as indicated by the food. The habitats occurring with the greatest frequency are placed first.]

Name.	Number examined. <sup>a</sup>	Average length in mm.	Toad eggs.	Tadpoles.	Frogs.	Fish eggs.	Fish.	Insect eggs.	Diptera larvæ.	Ephemeropterid nymphs.	Hemiptera nymphs.	Odonata nymphs.	Trichoptera larvæ.
Abramis crysoleucas	57	67.6							3.1	0.3			
Ambloplites rupestris	45	72.9					2		19.1	3.5		14.4	2.6
Ameiurus melas	15	118.8							32.6			.4	.5
Ameiurus nebulosus	50	46.3							24.3			1.4	
Amiatus calva	16	467.4					90.1						
Boleosoma nigrum	50	30.9						0.1	57.1	1.6			
Catostomus commersonii	34	29.2						7	39.9				
Cottus ictalops	30	39.6							7.5	24			1
Cyprinus carpio	42	41.7						3	33.6	4.1	1.2		
Esox lucius	39	293.4					84		.4	8.1	2		
Etheostoma flabellare	5	37.3							42.7				4.8
Etheostoma iowæ	5	47.8							21				
Eucalia iuconstans	110	29.3				0.2			21.5	.6	+		.9
Eupomotis gibbosus	9	145.7	9.4						9	.5		1	
Fundulus diaphanus menona	149	40.4				.8			19.7	2.8	2	+	
Labidesthes sicculus	100	33.3						1.4	3.2		7		
Lepisosteus osseus	10	494.9					88.8		.1			10.2	
Lepomis incisor	149	51							27.2	6.1	1	2.8	1.2
Micropterus dolomieu	19	72.5					14.7		15	18.1			
Micropterus salmoides	80	66.8			0.2		8.7		5.2	15.3	.9	1.3	
Notropis heterodon	80	34						.7	12.2	.6			
Perca flavescens	115	99.9		0.3		.2	3		17.3	6.4	3.4	4.0	3
Percina caprodes	27	72.9							42.2	1.4	3.4		5
Pimephales notatus	60	40							14.5				
Pimephales promelas	3	48.8											
Pomoxis sparoides	66	90.5				1			14.3	4.6		1.5	
Roccus chrysops	14	65.6					7.1	1	19.4			2.8	
Salmo irideus	1	126.5					4.2	8.6					8
Salvelinus fontinalis	18	103.2							20.1				11.5
Schilbeodes gyrinus	55	32.7							10	18.7		1	.5
Stizostedion vitreum	11	440			9.1		90.9						
Umbra lima	110	38.9							15	.5		1	1.5
Average, all species			.3		.3	.9	12.3	.4	17.4	2.8	.3	1.4	1.2

<sup>a</sup> Total number of fishes examined, 1,576; Toad eggs, 0.3; fishes, 13.5; insect larvæ, 24.8; insect pupæ, 6.3; adult insects, 5.2; hydrachnids, 0.5; large Crustacea, 13.3; Entomostraca, 19.1; Mollusca, 2; Oligochaetes, 3.5; leeches, 0.4; rotifers, 0.2; plants, 4.2; debris, etc., 2.6.



TABLE I.—SUMMARY OF FISH FOODS—Continued.

Name.	Number examined.	Average length in mm.	Sialis larvæ.	Coleoptera larvæ.	Unidentified larvæ.	Diptera pupæ.	Trichoptera pupæ.	Coleoptera pupæ.	Adult Diptera.	Adult Ephemera.	Adult Hemiptera.	Adult Orthoptera.
Abramis crysoleucas	57	67.6			0.3	5.7			0.1			
Ambloplites rupestris	45	72.9	2.2	0.5	0.5	9.0			4.8		1.2	
Ameiurus melas	15	118.8		.4	1.3	4.2			4.3		.6	
Ameiurus nebulosus	50	46.3		.5		2.1			1.7			
Amiatus calva	16	467.4		.5								
Boleosoma nigrum	50	30.9			.3	1.4			.1			
Catostomus commersonii	34	29.2				2.4			.4		+	
Cottus ictalops	30	39.6										
Cyprinus carpio	42	41.7		.5		3.5	1.6	1.6	1			
Esox lucius	39	293.4							1			
Etheostoma flabellare	5	37.3							.2			
Etheostoma lowæ	5	47.8		16								
Eucalia inconstans	110	29.3				9.1			7.3		.3	
Eupomotis gibbosus	9	145.7	1.1		+	.2			.3	0.7	1.5	
Fundulus diaphanus menona	149	40.4		.6	.1	1.7			2.7		+	
Labidesthes sicculus	100	33.3			1.3	16.4			25.2			
Lepisosteus osseus	10	494.9							1			
Lepomis incisor	149	51			.6	.6			1.3		1.4	
Micropterus dolomieu	19	72.5				7.6			10.7		18.2	
Micropterus salmoides	80	66.8			.1	3.1			6.3	.1	18.5	
Notropis heterodon	80	34		+	.1	3.9			8.3		18.5	
Percæ flavescens	115	99.9	.4			1.2			1.2		1.4	
Percina caprodes	27	72.9							.4		.1	
Pimephales notatus	60	40				3.2			4.5			
Pimephales promelas	3	48.8				79.3						
Pomoxis sparoides	66	90.5			.1	4.6			4.8		1.7	
Roccus chrysops	14	65.6				5.0			1.2		7.1	
Salmo irideus	1	126.5				7.7						
Salvelinus fontinalis	18	103.2		.3		18.4			.8		.4	1.7
Schilbeodes gyrimus	55	32.7		5.4	.4	4.4			.5			1.7
Stizostedion vitreum	11	440										
Umbra limi	110	39.9		1.6	2.3	2.1			5		1.8	.1
Average, all species			.1	.9	.3	6.3	+	+	2.6	+	1.1	

Name	Number examined.	Average length in mm.	Adult Hymenoptera.	Adult Odonata.	Adult Trichoptera.	Adult Lepidoptera.	Adult Coleoptera.	Aptera.	Unidentified insects.	Spiders.	Mites.	Millipeds.
Abramis crysoleucas	57	67.6							0.2		0.4	
Ambloplites rupestris	45	72.9	1.3				1.1		5.3		2.2	
Ameiurus melas	15	118.8		0.8								
Ameiurus nebulosus	50	46.3	.4	.1					1.7		.4	
Amiatus calva	16	467.4										
Boleosoma nigrum	50	30.9									+	
Catostomus commersonii	34	29.2									.1	
Cottus ictalops	30	39.6										
Cyprinus carpio	42	41.7							.6		1.8	
Esox lucius	39	293.4										
Etheostoma flabellare	5	37.3										
Etheostoma lowæ	5	47.8										
Eucalia inconstans	110	29.3							1.4		.6	
Eupomotis gibbosus	9	145.7			1.1		6.4					
Fundulus diaphanus menona	149	40.4					.1	0.3	1.3	0.3	+	
Labidesthes sicculus	100	33.3	3.1									
Lepisosteus osseus	10	494.9										
Lepomis incisor	149	51	+						.5		.7	
Micropterus dolomieu	19	72.5			3.2							
Micropterus salmoides	80	66.8	.6	1.3	1.3							
Notropis heterodon	80	34	.5		.5						.5	
Percæ flavescens	115	99.9			+						.1	
Percina caprodes	27	72.9							1.2			
Pimephales notatus	60	40									+	
Pimephales promelas	3	48.8									1.6	
Pomoxis sparoides	66	90.5				1.4					.3	
Roccus chrysops	14	65.6			.1						.3	
Salmo irideus	1	126.5					3					10
Salvelinus fontinalis	18	103.2	.1			1.3			.3		.4	.4
Schilbeodes gyrimus	55	32.7		.6			.3		.4			
Stizostedion vitreum	11	440										
Umbra limi	110	39.9					3	.4	.6	.1	1.2	
Average, all species			.2	.1	.1	+	.5	+	.4	+	.2	.3

TABLE I.—SUMMARY OF FISH FOODS—Continued.

Name.	Number examined.	Average length in mm.	Crayfishes.	Isopods.	Amphipods.	Ostracods.	Copepods.	Cladocerans.	Gastropods.	Sphaeriæ.	Oligochaetes.	Leeches.
Abramis crysoleucas	57	67.6			2.2	1.9	16.5	57.6	0.4	0.7		
Ambloplites rupestris	45	72.9	16.1		1.4	.3	4.3				3	
Ameiurus melas	15	118.8	6.1		.2	1.6	.7	3.5	3.7		21.4	3
Ameiurus nebulosus	50	46.3			11.4	6.7	8.4	33.1	.1		2.1	
Amiatus calva	16	467.4	9.4									
Boleosoma nigrum	50	30.9			5.1	.5	7.4	5.6			18.4	
Catostomus commersonii	34	29.2				16.8	14.8	3.6			11.5	
Cottus ictalops	30	39.6			59.1	6	1.2	.1			.7	3
Cyprinus carpio	42	41.7			6.9	7	10.4	3.6	6.9		2.8	
Esox lucius	39	293.4			2.5			2.6		.2		2.5
Etheostoma flabellare	5	37.3			48			.2			3	
Etheostoma iowæ	5	47.8			58						1.6	
Eucalia inconstans	110	29.3	3.4		1.2	3.2	19.3	16	3.6	.1	1.1	
Eupomotis gibbosus	9	145.7			9	1.3			25.8			2.8
Fundulus diaphanus menona	149	40.4			14.1	15.8	4.9	15.3	3.5	.4	2	
Labidesthes sicculus	100	33.3				+	8.7	3.2				
Lepisosteus osseus	10	494.9										
Lepomis incisor	149	51		+	14.4	.4	7.9	16.6	4.5		.1	.6
Micropterus dolomieu	19	72.5						3.4			4.6	
Micropterus salmoides	80	66.8	2.6		13.9	.1	2.9	15.1	+		.7	+
Notropis heterodon	80	34			.1	.5	11	33.4			2.1	
Percia flavescens	115	99.9			24.5	4	7.8	17.6	3.7	.1	.4	
Percina caprodes	27	72.9			6.6	+						2
Pimephales notatus	60	40				3	2.6	25.1			7	
Pimephales promelas	3	48.8			.3			2.6			6	
Pomoxis sparoides	66	90.5			10.6	12	21.6	13.6				
Roccus chrysops	14	65.6			5	4	29.0	16.3				
Salmo irideus	1	126.5			42				5			
Salvelinus fontinalis	18	103.2	1.3		35.5				1.4			
Schilbeodes gyrinus	55	33.7			10.3	4	7.9	6.1	.1		18.3	
Stizostedion vitreum	11	440										
Umbra limi	110	39.9			6.5	23.1	3.6	1.3	2.3	.1	2.9	1.1
Average, all species			1.1	.1	12.1	3	6	10.1	2	+	3.5	.4

Name.	Number examined.	Average length in mm.	Nematodes.	Rotifers.	Sponges.	Protozoans.	Unidentified eggs.	Plant remains.	Algae.	Silt and debris.	Unidentified.	Habitats.
Abramis crysoleucas	57	67.6		+		1.0		2.9	1.6	2.2		9, 1
Ambloplites rupestris	45	72.9						2.8	.5	6.3		1, 10
Ameiurus melas	15	118.8						6.4	.9			9, 1
Ameiurus nebulosus	50	46.3		+		+		.9	+	2.3		1, 9
Amiatus calva	16	467.4										1
Boleosoma nigrum	50	30.9							+	3.1		2
Catostomus commersonii	34	29.2		0.2		1.3			3	3.6		9, 2
Cottus ictalops	30	39.6						.1	1	.2		3, 2
Cyprinus carpio	42	41.7		1.1		+		4.9	.8	1.5		1, 11
Esox lucius	39	293.4								1.2		1
Etheostoma flabellare	5	37.3						1				3
Etheostoma iowæ	5	47.8								.4		10, 2
Eucalia inconstans	110	29.3	+	1.1				3.2	1.2	3.7		11, 12
Eupomotis gibbosus	9	145.7			0.8			21.9	3.6	2.8		1
Fundulus diaphanus menona	149	40.4	+				0.8	5.5	.9	4.2		1, 10, 12, 2
Labidesthes sicculus	100	33.3		+		+			4	1.6		5
Lepisosteus osseus	10	494.9										1, 10
Lepomis incisor	149	51	+	+				2.0	2.3	2.2		1, 10
Micropterus dolomieu	19	72.5						.6	.8	1.5		
Micropterus salmoides	80	66.8						1.2	.7	.1		1, 2, 9, 10
Notropis heterodon	80	34		2.2				3.9	11.7	6.5		1, 2, 12
Percia flavescens	115	99.9				+	+	.8	.7	1.1		4, 1, 9
Percina caprodes	27	72.9						3.3	1.7	5.7		2
Pimephales notatus	60	40				+		.9	19.3	20		1, 2, 9, 10
Pimephales promelas	3	48.8							1.3	8.3		12
Pomoxis sparoides	66	90.5						1.3		.1		1, 2, 9
Roccus chrysops	14	65.6										6, 1, 4, 7
Salmo irideus	1	126.5										12
Salvelinus fontinalis	18	103.2							1			12
Schilbeodes gyrinus	55	33.7						5.9	.1	3		1
Stizostedion vitreum	11	440										1
Umbra limi	110	39.9	0.4	.2		.2		2.5	11.1	1.4	3.8	8, 11, 12, 1
Average, all species			+	.2	+	+	+	2.2	2	2.5	.1	

TABLE 2.—SHOWING FOODS EATEN BY SEVEN SPECIES OF FISHES COLLECTED TOGETHER AT STATION 5, AUGUST 18, 1915.

Name.	Number examined.	Average length.	Dipterous larvæ.	Chironomid larvæ.	Proteozia larvæ.	Tanyptus carneus larvæ.	Tanyptus decoloratus larvæ.	Protenthes culiciformis larvæ.	Chironomus fulviventris larvæ.	Chironomus lobiferus larvæ.	Chironomus digitatus larvæ.	May-fly nymphs.	Baetisca nymphs.	Ecdyurus maculipennis nymphs.
Abramis crysoleucas.....	7	46.7			0.7	2.9								
Boleosoma nigrum.....	1	30			15	25						10		
Micropterus salmoides.....	15	52.4	1						0.3			4	18.6	
Perca flavescens.....	2	124.3												
Pimephales notatus.....	2	38		5										
Schilbeodes gyrinus.....	24	24.3					1	1	2.3	0.8	0.6	1.9	3.6	0.7
Number of fish eating.....			1	1	2	2	1	1	2.3	1.8	1.6	3	3	1.7

Name.	Number examined.	Average length.	Caenis diminuta nymphs.	Corixa nymphs.	Damselfly nymphs.	Enallagma antennatum nymphs.	Chironomus lobiferus pupa.	Adult insects.	Chironomus adults.	Corixa adults.	Micronecta adults.	Mites.	Hyalasfa.
Abramis crysoleucas.....	7	46.7						2.1					12.1
Micropterus salmoides.....	15	52.4	2.9	0.9			0.7			35	0.3		25
Perca flavescens.....	2	124.3	10.9						2.5	51.5			30.7
Schilbeodes gyrinus.....	24	24.3	20.5	1	0.6	1.5	1	1	1	2	1	1	15.7
Number of fish eating.....			3	1	1	1	1	1	1	2	1	1	4.5

Name.	Number examined.	Average length.	Ostracods.	Cyclops.	Carthocamptus.	Cladocera.	Bosmina.	Camptocercus.	Pleuroxus.	Chydorus.	Eurycerus.	Simoccephalus.	Planorbis.
Abramis crysoleucas.....	7	46.7	2.9	23.6	1.4	10	10.1		1			5	
Boleosoma nigrum.....	1	30	15							20.1			
Micropterus salmoides.....	15	52.4										11	
Perca flavescens.....	2	124.3		2.5									
Pimephales notatus.....	2	38	3.5	2.5							4		
Roccus chrysops.....	1	29	65	7			35						
Schilbeodes gyrinus.....	24	24.3	1.9	1.7	1	1	2	1.1	1	3	1	3.3	0.2
Number of fish eating.....			4	5	1	1	2	1	1	3	1	3	1

Name.	Number examined.	Average length.	Oligochaetes.	Rotifers.	Protozoa.	Plant remains.	Myriophyllum.	Wolfia.	Seeds.	Free-swimming algae.	Filamentous algae.	Sand.	Silt and debris.
Abramis crysoleucas.....	7	46.7		0.6					0.6				4.3
Boleosoma nigrum.....	1	30	15			3.4							3
Micropterus salmoides.....	15	52.4											3
Perca flavescens.....	2	124.3			1								3
Pimephales notatus.....	2	38					2.5						2.5
Schilbeodes gyrinus.....	24	24.3	37.9	1	1	1	1.2	2.8	2.2	2	1	0.1	2
Number of fish eating.....			2	1	1	1	2	2	3	2	1	1	2



TABLE 4.—SHOWING FOODS EATEN BY FOUR SPECIES OF FISHES COLLECTED TOGETHER AT STATION 28, SEPTEMBER 17, 1915.

Name.	Number examined.	Average length.	Fish remains.	Sunfish.	Minnows and fish.	Probezzia glaber larva.	Probezzia pallida larva.	Tipula abdominalis larva.	Cænis diminuta nymph.	Corixa adult.	Crayfish.
Ameiurus calva.....	4	469.7	48.5	43.5							7.5
Ameiurus melas.....	13	124.7				4	4	1			
Esox lucius.....	14	451.8	50	50							
Pomoxis sparoides.....	57	77.2			50				3	10	
Number of fish eating.....			2	2	1	1	1	1	1	1	1

Name.	Number examined.	Average length.	Cyclops.	Chydorids.	Daphnia.	Planorbis.	Physa.	Plant remains.	Lemna.	Nostoc.	Fine débris.
Ameiurus melas.....	13	124.7				25	30	10	1	15	10
Pomoxis sparoides.....	57	77.2	1	1	35	1	1	1	1	1	1
Number of fish eating.....			1	1	1	1	1	1	1	1	1

TABLE 5.—VARIATION OF FOODS AT DIFFERENT PLACES AND TIMES, IN COLLECTIONS MADE DURING 1915.

Species.	Chief items of food eaten.	Number localities.	Number times collected.	Number of chief foods.
Abramis crysoleucas.....	Cladocera (2), Hyalella, Cyclops.....	3	4	3
Ambloplites rupestris.....	Crayfish (5) May-fly nymphs, oligochaetes, caddis-fly larvæ, chironomid larvæ (3), chironomid pupæ (2).	7	13	6
Ameiurus melas.....	Chironomid larvæ, caterpillar snails, oligochaetes.....	3	4	4
Ameiurus nebulosus.....	Ostracods, adult insects, amphipods.....	3	4	3
Ameiurus calva.....	Crayfish, fish remains (2).....	2	3	2
Boleosoma nigrum.....	Chironomid larvæ (8), oligochaetes (3).....	8	11	2
Catostomus commersonii.....	Chironomid larvæ, Ostracods, Cyclops (2).....	2	4	2
Cottus icталops.....	Hyalella (10), Dikerogammarus.....	8	11	2
Cyprinus carpio.....	Chironomid larvæ, Ostracods, Hyalella, plant remains.....	3	4	4
Esox lucius.....	Hyalella (2), fish remains.....	5	11	2
Etheostoma flabellare.....	Chironomid larvæ, Hyalella.....	3	3	2
Etheostoma iowæ.....	Hyalella.....	1	2	1
Eucalia inconstans.....	Chironomid larvæ (2), Chydorus, fine débris.....	3	5	3
Eupomotis gibbosus.....	Toad eggs, Sialis larvæ, chironomid larvæ, Hyalella, Ceratophyllum.....	3	5	5
Fundulus diaphanus mexicana.....	Chironomid larvæ (5), amphipods (4), Ostracods (2), oligochaetes, cladocera, fine débris.....	11	14	6
Labidesthes sicculus.....	Chironomid pupa (2), Cladocera (2), Chironomid adult (2).....	8	9	3
Lepisosteus osseus.....	Fish remains.....	3	3	1
Lepomis incisor.....	Chironomid larvæ (6), amphipods (3), chironomid pupæ (2), snails, fine débris, Aphanothece, copepods, cladocera.....	15	17	8
Micropterus dolomieu.....	Insect larvæ (2), fish remains, adult insect.....	4	4	3
Micropterus salmoides.....	Adult insects (4), amphipods (2), copepods, cladocera, fish remains, insect larvæ, plant remains, crayfish.....	12	15	8
Notropis heterodon.....	Chironomid larvæ (2), copepods (2), cladocera (2), chironomid pupæ, chironomid adult, oligochaetes, filamentous algæ.....	6	10	7
Perca flavescens.....	Hyalella (3), cladocerans (3), insect larvæ (3), insect adults, fish remains.....	7	11	5
Percina caprodes.....	Chironomid larvæ (3), fish eggs.....	3	4	2
Pimephales notatus.....	Filamentous algæ (3), oligochaetes, chironomid larvæ, chironomid adult, cladocerans, fine débris.....	8	10	6
Pimephales promelas.....	Chironomid larvæ.....	1	1	1
Pomoxis sparoides.....	Fish remains, chironomid pupæ, adult insect, Ostracods, daphnia.....	9	10	5
Roccus chrysops.....	Copepods (4), chironomid larvæ, insect adult, fish remains, cladocera.....	3	7	5
Salmo irideus.....	Amphipods.....	1	1	1
Salvelinus fontinalis.....	Chironomid pupæ, amphipods.....	2	2	2
Schilbeodes gyrimus.....	Insect larvæ (2), adult insect, amphipods, cladocera, oligochaetes.....	2	6	5
Schizostedium vitreum.....	Fish remains (2), fish, and frogs.....	2	3	2
Umbra limi.....	Ostracods (2), amphipods (2), chironomid larvæ (2), earthworm, plant remains.....	7	8	5
Total.....		159	215	117

TABLE 6.—NUMBER OF SPECIES OF FISHES FOUND IN DIFFERENT HABITATS AND THE CHIEF ITEMS OF DIET EATEN IN EACH IN 1915.

Habitat.	Number of species.	Chief items of diet, and number of species eating each.
Shore vegetation.....	22	Dipterous larvæ, 5; fish, 4; cladocerans, 4; adult Hemiptera, 2; copepods, 2; dipterous pupæ, 1; ephemerid nymphs, 1; gastropods, 1; amphipods, 1; ostracods, 1.
Sand and pebble beaches.....	11	Dipterous larvæ, 4; adult Hemiptera, 2; amphipods, 2; cladocerans, 2; copepods, 1.
Mouths of streams.....	11	Dipterous larvæ, 4; cladocerans, 3; ephemerid nymphs, 1; adult Hemiptera, 1; amphipods, 1; copepods, 1.
Rivers.....	7	Dipterous larvæ, 3; fish, 1; adult Hemiptera, 1; amphipods, 1; cladocerans, 1.
Small streams.....	7	Dipterous larvæ, 2; amphipods, 2; dipterous pupæ, 1; cladocerans, 1; ostracods, 1.
Shore ponds.....	3	Dipterous larvæ, 2; ostracods, 1.
Swamps.....	2	Cladocerans, 1; ostracods, 1.
Rocky beaches.....	2	Amphipods, 2.
Bottom anywhere.....	2	Amphipods, 1; copepods, 1.
Surface of shore water.....	1	Cladocerans, 1.
Surface of open lake.....	1	Copepods, 1.

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