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DISTRIBUTION, FOOD AND FISH ASSOCIATES OF YOUNG PERCH IN THE BASS ISLAND REGION OF LAKE ERIE.

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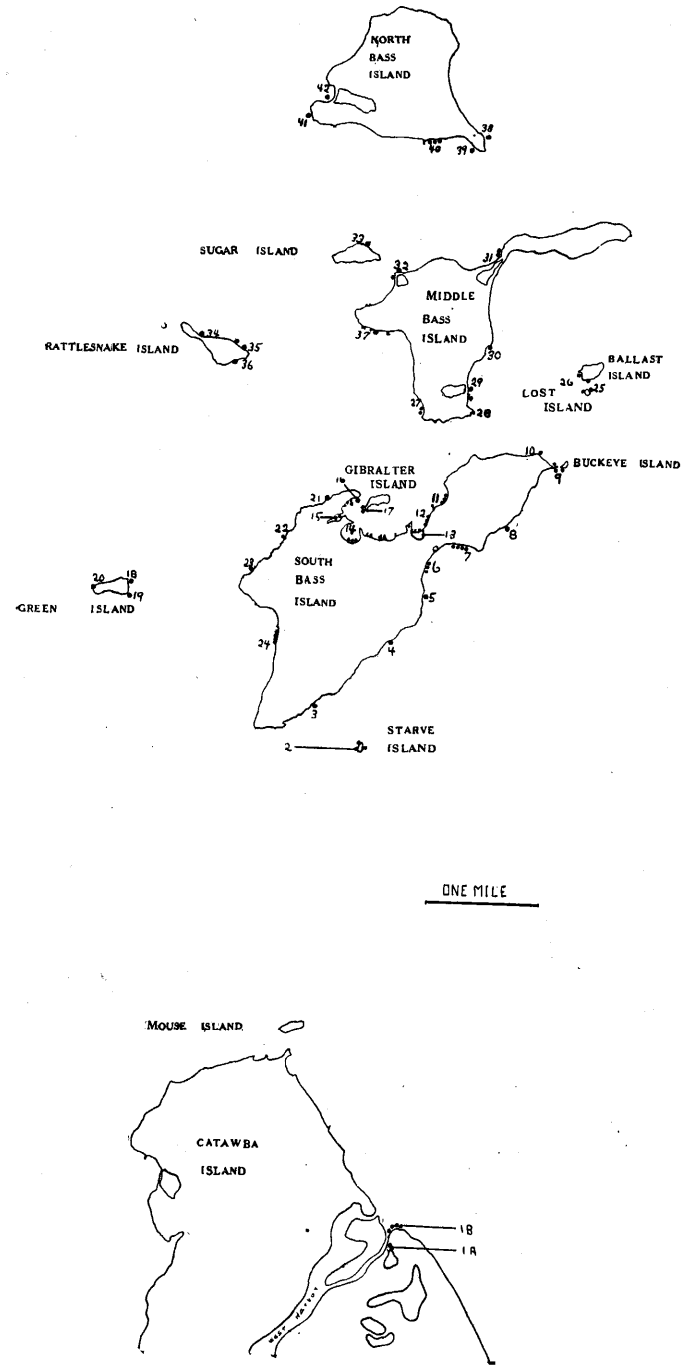
1. INTRODUCTION AND ACKNOWLEDGMENTS.

It is the purpose of this paper to outline part of the results of work upon the young fishes taken around the shores of the Bass and neighboring islands, with special reference to the habitat, associations, diet and changes in diet in the young perch. The field work was done in July, 1919, with the aid of equipment and facilities provided by the Ohio State Fish Hatchery located at Put-in-Bay and by the Lake Laboratory of the Ohio State University. It is a pleasure to acknowledge the courtesies extended to me by the staff of the hatchery and by Director R. C. Osburn of the Lake Laboratory. Mr. A. C. Baxter, Chief of State Fish and Game Protectors, kindly permitted the use of a seine in taking the specimens.

2. MATERIALS AND METHODS.

A dip net was first employed in capturing specimens but the method proved too slow to be practicable and of no value whatever in obtaining a representative association from a locality and the use of a twenty foot seine was soon substituted. Several hauls were made in each locality and care was taken to get


NORTH BASS ISLAND
SUGAR ISLAND
MIDDLE BASS ISLAND
RATTLESNAKE ISLAND
BALLAST ISLAND
LOST ISLAND
GIBRALTER ISLAND
BUCKEYE ISLAND
SOUTH BASS ISLAND
GREEN ISLAND
STARVE ISLAND
ONE MILE
MOUSE ISLAND
CATAWBA ISLAND

specimens from the deeper as well as the shallow bottoms and from the top. No attempt was made to seine in water deeper than five feet. Because of the presence of stiff vegetation and numerous isolated boulders it was found quite impossible to use the seine in some localities and this was equally true along shore having precipitous sides and deep water. The paucity of data from some localities, notably Starve Island and Green Island, is to be attributed chiefly to this cause.

Before and during the operation of seining, notes were made of the character of the localities, i. e., the depths of the water, the character and slope of the bottom, the presence and character of vegetation, etc. The catch was fixed immediately in 10 per cent formalin or 90 per cent alcohol and labelled with the locality. A note of the different species included in the catch was made in a field note book and the locality mapped at once. There was consequently little confusion in tabulating the results.

The total number of perch taken was between three and four hundred of which two hundred were fixed and one hundred and thirty-eight examined for their length and stomach contents. The specimens varied in length from twenty-six to one hundred and twenty millimeters.

3. Fish Fauna of Localities Examined.

Forty-two localities, representing as many types of habitat as could be distinguished and offering a considerable range in distance, were examined. These localities have been charted on the accompanying map. Following is a description of each locality with its fish fauna so far as determined:

Locality 1, *a*. West Harbor, Catawba Island. Flat, sandy beach with no aquatic vegetation except spike rushes (Eleorchus) along the water line.

Fauna: Adults of carp, sunfish, perch, white bass, golden shiner, top minnow (Fundulus Diaphanus menona), and unidentified minnows. Fry of white bass, rock bass, perch, log perch (Percina caprodes zebra), brook silversides and unidentified minnows.

Locality 1, *b*. Reedy marsh connected by narrow channel with West Harbor channel.

Fauna: Adults of perch, sunfish and mud minnows. Fry of sunfish and large mouthed bass.

In locality *a* all specimens, with the exception of the brook silversides and minnows, were taken in the rushes along the shore. The brook silversides and minnows were taken at the surface at some distance from the shore. The fry of the brook silversides, minnows and perch were most abundant at *a*. The fry of the large mouthed bass were most abundant at *b*.

LOCALITY 2. Starve Island. All sides of the small island characterized by precipitous and irregular limestone walls and jagged rock masses. Aquatic vegetation was lacking.

Fauna: The only specimens taken here were ten darters (Cottogoster coplandi) and a few fry of the brook silversides and unidentified minnows.

LOCALITY 3. Clean steeply sloping pebble beach with little vegetation.

Fauna: Cottogaster coplandi, one fry of Percina caprodes and two fry of the small mouthed bass.

LOCALITY 4. Shallow beach with flat rock bottom strewn with stones and small boulders. No aquatic vegetation.

Fauna: Only four darters (Cottogaster coplandi) and a few minnows were taken.

LOCALITY 5. Shallow water with flat rock bottom. Depressions in the rock formed deep pools.

Fauna: Adults of Cottogaster coplandi and minnows and the fry of Dyslesion blennioides and Percina caprodes zebra taken here.

LOCALITY 6. Steeply sloping rubble beach with no vegetation except filamentous algæ.

Fauna: Adults of Percina caprodes zebra, Cottogaster coplandi, minnows and fry of Percina caprodes zebra, perch large mouthed bass and white bass.

The perch fry were relatively abundant here.

LOCALITY 7. Shallow sandy and gravel beach with spike rushes along waters edge. Some submerged vegetation.

Fauna: A varigated association. Adults of perch, carp, Percina caprodes zebra and Notropis hudsoni. Fry of carp, brook silversides, perch, Percina caprodes zebra, small mouthed bass, large mouthed bass and white bass.

LOCALITY 8. Shallow beach with flat rock bottom strewn with gravel; no vegetation.

Fauna: Adults of Percina caprodes zebra and Notropis hudsoni. Fry of Percina caprodes zebra, perch, brook silversides, small mouthed bass.

The slender fry of the brook silversides were exceedingly abundant at the surface in this locality.

LOCALITY 9. Level rubble beach with trees along the water's edge affording shade and attachment for moss patches. Spike rushes were plentiful from the water's edge to thirty feet from shore. The beach was so situated as to be subject to constant wave action.

Fauna: Adults of Cottogaster coplandi, Percina caprodes zebra and minnows and fry of small mouthed bass were taken along the beach in three feet of water. Adults of Cottogaster coplandi, Etheostoma flabellare and fry of Etheostoma flabellare and millers thumb (Cottus ictalops) were taken in the moss patches and under stones along the water's edge.

LOCALITY 10. Clean rubble beach with steep slope.

Fauna: Adults of Percina caprodes zebra and a five inch pickerel. Fry of perch, Percina caprodes zebra, small mouthed bass and minnows.

The fry of the small mouthed bass were very abundant here.

LOCALITY 11. Flat, sandy beach with a few large isolated boulders; water from one to four feet deep for one hundred yards from shore; spike rushes and pond weeds along shore.

Fauna: Adults of sunfish, Percina caprodes zebra, brook silversides, and Notropis hudsoni. Fry of perch, small mouthed bass, large mouthed bass, and Percina caprodes zebra.

The single adult of the brook silversides taken here was the only one taken in forty-two localities.

LOCALITY 12. Character of the locality same as that of locality 11 with the exception of a solid concrete wall along the shore.

Fauna: Adults of minnows were taken at the surface of the water but no other fish.

The concrete wall along the shore line and the total absence of vegetation would make this a very unfavorable locality for fish and their fry.

LOCALITY 15. Shallow pond at Perry Monument with mud bottom; much submerged and floating vegetation.

Fauna: Adult mud minnows (Umbra lima) and Notropis hudsoni and fry of carp.

LOCALITY 14. Southern margin of Squaw Harbor. Water from one to four feet deep; fine sand and mud bottom; spike rushes and other vegetation growing in the water.

Fauna: Adults of Percina caprodes zebra, Cottogaster coplandi and perch. Fry of perch, small mouthed bass, large mouthed bass, and brook silversides.

Most of the specimens here were taken in the vegetation.

LOCALITY 15. Terwilliger Pond. Marshy pond enclosed by land except for a narrow fifteen foot channel. Water from one to seven feet deep; fine mud bottom with occasional large boulders; rank floating and submerged begetation.

Fauna: Terwilliger Pond was not examined exhaustively, consequently the following list is by no means complete: adults of the common catfish, gold fish, carp, several species of sunfish and perch were taken also the fry of the perch, green sunfish, carp, goldfish, large-mouthed bass and rock bass.

It is very probable that this pond serves as a breeding ground for several species as eggs in different stages of development were sometimes found lodged in the vegetation and successive waves of fry belonging to different species were observed at different dates.

LOCALITY 16. Peach Point. Flat, stony bar covered by two feet of water; no vegetation.

Fauna: Adults of Cottogaster coplandi, Boleicthys fusiformis, minnows and perch. Fry of rock bass, small-mouthed bass, large-mouthed bass perch, Percina caprodes zebra, Diplesin blennioides and minnows.

LOCALITY 17. Gibraltar Island. Flat, stony bar, with considerable submerged vegetation on both sides at the junction with the shore.

Fauna: Adults of rock bass (yearlings), sunfish, Cottogaster coplandi and perch. Fry of rock bass, perch, small-mouthed bass, large-mouthed bass and sunfish.

The fry of the rock bass were more abundant at this locality than at any other.

LOCALITIES 18 AND 20. Green Island. Short, sharply sloping, gravel and stone beaches in protected parts of shore; shore made up largely of perpendicular limestone walls.

LOCALITY 19. Long gravel bar covered by shallow water; no vegetation.

Fauna: (18, 19 and 20). The catch from these localities was very small, consisting of adults of Cottogaster coplandi and some minnows and the fry of the large mouthed bass, small-mouthed bass, perch and Percin caprodes zebra.

The fry of the small-mouthed bass were the most plentiful and those of the perch and large-mouthed bass very scarce.

LOCALITIES 21, 22 AND 23. Like localities 18 and 20.

Fauna: The catch here resembled that of localities 18, 19 and 20 in its paucity of material. At locality 21 three yearling small-mouthed bass were taken.

LOCALITY 24. Near Hotel Victory site. Stony beach with short slope and no vegetation except small quantities of filamentous algae clinging to stones.

Fauna: Adults of Percina caprodes zebra, Cottogaster coplandi, Notropis hudsoni were taken here and fry of perch, large-mouthed bass, small-mouthed bass, Percina caprodes zebra and unidentified minnows.

LOCALITY 25. Lost Island. Low island partly awash surrounded by steep gravel beach. Small quantities of pond weed found on western side.

Fauna: Adults of minnows and fry of white bass, small-mouthed bass and Percina caprodes zebra.

LOCALITY 26. Ballast Island. Steep rubble and gravel beach with little aquatic vegetation.

Fauna: Adults of Percina caprodes zebra, Cottogaster coplandi and Notropis hudsoni and fry of small-mouthed bass, perch, white bass and brook silversides.

LOCALITY 27. Middle Bass Island. Steep rubble beach with no vegetation.

Fauna: Adults of minnows and young of Percina caprodes zebra and small-mouthed bass.

LOCALITY 28. Short, protected beach along precipitous, rocky shore. Beach of stone and large boulders; no vegetation.

Fauna: Adults of Cottogaster coplandi and fry of small-mouthed bass and Percina caprodes zebra.

LOCALITY 29. Shallow, flat, rock bottom, partly awash and partly scooped out to form depressions; rock floor either bare or covered by sand; patches along water's edge and submerged vegetation in places.

Fauna: Adults of Percina caprodes zebra, Cottogaster coplandi and Notropis hudsoni taken here. Fry of Diplesion

blennioides and Cottus ictalops taken in a mossy patch covered by a few inches of water. Fry of perch, Percina caprodes zebra, Ammocrypta pellucida and minnows.

Perch fry were found more abundantly in this locality than in any other and the only sand darter (Ammocrypta pellucida) taken was captured here on a sandy bottom in three feet of water.

LOCALITY 30. Like locality 29 but with the addition of some large boulders.

Fauna: Fry of millers thumb, fantailed darter (Etheostoma flabellare) and Diplesion blennioides taken in a mossy patch similar to that at locality 29.

LOCALITY 31. Shallow gravel beach with few boulders; submerged vegetation out to a depth of four feet.

Fauna: Adults of Percina caprodes zebra, perch and minnows. Fry of small-mouthed bass, large-mouthed bass, rock bass, white bass, perch, carp and brook silversides.

LOCALITY 32. Steep, sand beach with submerged water weeds.

Fauna: Adults of Percina caprodes zebra, Cottogaster coplandi and Notropis hudsoni. Fry of small-mouthed bass, perch and Percina caprodes zebra.

LOCALITY 33. Sugar Island. Flat gravel and boulder beach with no vegetation but bordering an area with abundant submerged weeds.

Fauna: Adult minnows and fry of small-mouthed bass.

LOCALITY 34. Rattlesnake Island. Level, sand and gravel beach with some large boulders; a little aquatic vegetation.

LOCALITY 35. Short, steep, gravel beaches in protected places along precipitous shores.

LOCALITY 36. Stone and boulder beach with gradual slope.

Fauna: (Localities 34, 35 and 36). These localities gave a uniform catch of small-mouthed bass, Percina caprodes zebra, (young and adults), adult Cottogaster coplandi, perch fry and minnows.

LOCALITY 37. Like Locality 36.

Fauna: Fry of small-mouthed bass, brook silversides and minnows were the ones taken here.

LOCALITY 38. North Bass Island. Long sand bar, partly awash.

Fauna: This shallow bar gave minnows, two perch fry and some young Percina caprodes zebra.

LOCALITY 39. Sand and boulder bottom with three feet of water; no vegetation.

Fauna: Fry of small-mouthed bass were added to the list of Locality No. 38.

LOCALITY 40. Long beach with steep slope; fine sand bottom; no vegetation.

Fauna: Adults of Percina caprodes zebra and minnows. Fry of small-mouthed bass, large-mouthed bass, Percina caprodes zebra and perch.

Adults of Percina caprodes zebra were very abundant here.

In the mouth of an inlet to a swamp in this locality the fry of the rock bass and carp were added.

LOCALITY 41. Rubble beach with gradual slope; considerable aquatic vegetation.

Fauna: Adults of Percina caprodes zebra, Cottogaster coplandi, Diplesian blenioides and minnows. Fry of perch, small-mouthed bass, rock bass and Percina Caprodes zebra.

LOCALITY 42. Protected sand and gravel beach with no vegetation.

Fauna: Adults of Cottogaster coplandi and minnows. Fry of small-mouthed bass.

4. DISTRIBUTION OF YOUNG PERCH AND ITS ASSOCIATES.

Within the limits of the region studied the young fry has a general and rather uniform distribution. In only a few of the above localities does the perch fail to appear and in such localities there is a scarcity of other species as well. Little can be said of the vertical range beyond a depth of five feet but practically all the specimens taken were found at a depth of between two and four feet.

There seems to be a little choice in the character of habitat, a slightly greater number being found in localities having flat, sandy bottoms and some submerged vegetation. The larger perch fry were all taken in such localities and all yearlings and adults taken were also found there. The character of the bottom and the presence or absence of vegetation appear to have no effect upon the younger perch in its distribution, for as it is feeding mainly upon Entromostraca in its younger stages its distribution would be limited only by its physical capacities to

migrate and by the abundance of its food supply. Consequently it may be found anywhere in moderately shallow water. Later its food consists mainly of insect larvæ. These are more apt to be found in localities with considerable vegetation and it may be that the slightly greater numbers and larger sizes of the fry are found in places containing vegetation because the change in food drives them from the clean beaches where insect larvæ are few to the richer vegetation-bearing shallows.

As regards the fish associates of the young perch, there are none that put any serious obstacle in the way of its existence. The only adults taken in the same habitats were carp, sunfish, minnows, brook silversides, several species of darters, and an occasional white bass or small-mouthed bass. None of these are fish eaters to any great extent except the basses and only seven adults were taken in the forty-two localities. An examination of the stomachs of three of these showed only a small fish content. Considering the other fish fry with which the young perch is associated, the small-mouthed bass, large-mouthed bass, white bass, sunfishes, log perch and minnows—there are none which are pisciverous to any extent. The largest fry of the small mouthed bass were eating the very young fry of other fish, but these were mainly the fry of minnows and darters. The young perch keeps pace with the small-mouthed bass in growth so that it is doubtful if the young small-mouthed bass ever becomes a menace to the young perch. All the young fish mentioned are using the same food (Entomostraca) at this time and so are in a sense competitors but the waters examined swarmed with Entomostraca so that all the young fish were abundantly supplied.

In point of numbers the young perch fry were surpassed by the fry of the small-mouthed bass and of the log perch in a ratio of about four to one while the young minnows were most abundant. Locally, the young brook silversides, white bass and sunfish were more abundant than the perch, but they, like the fry of the rock bass, small-mouthed bass, fantailed darter, Diplesion blennioides and miller thumb had a local distribution.

The association and constant occurrence of the young of the four species, minnows, small-mouthed bass, log perch and perch may be attributed to three causes: (1) A wide distribution of the adults. (2) A generalized food habit with a general distribution of the food supply. (3) A generalized type and large number of breeding places.

5. Diet of the Perch.

In the present study the articles of diet found are classified as follows:

1. Copepods
2. Cladocera
3. Ostrocods
4. Chironomid larvae
5. May fly larvae
6. Caddis fly larvae and tubes
7. Larvae and adults of other insects
8. Mites
9. Annelid worms
10. Nematode worms
11. Trematode worms
12. Amphipods
13. Isopods
14. Snails
15. Crayfish
16. Fish eggs
17. Fish remains
18. Algae
19. Vegetable debris (leaves, roots, etc.)
20. Inorganic debris.

The proportion which each article of diet forms of the whole, the length of each fish examined and the number of each length have been set down in the accompanying table while the quantitative variation of the principal items of diet is shown in graphic form. Algæ, plant remains, the different worms, ostrocods, isopods, adult insects, mites, fish eggs, fish remains, and inorganic debris are purposely excluded from the graph because they form such a small proportion of the entire diet.

Specimens of 26 and 27 millimeters in length are found to have eaten copepods only but the pure diet is soon given up for one composed almost wholly of copepods but with a slight admixture of cladocera and minute chironomid larvæ. May fly larvæ are soon added and an occasional adult insect. From 30 to 40 millimeters, cladocera become increasingly important while copepods drop below fifty per cent of the total. Medium sized crustacea are first taken at this stage and form a small but rather consistent article of food. Insect larvæ, other than chironomids and may flies are also taken at this time and together with the may flies and chironomids constitute the chief food up to a length of 120 millimeters. The larger snails and crayfish are not used till the fish has reached a length of about 100 millimeters although some smaller snails are eaten earlier.

Forbes (1880,2) reports the food of the adult perch to consist of crayfish and fish in the larger specimens and of fish, crayfish, molluscs, amphipods, isopods, and insect larvæ in the others.

TABLE OF ARTICLES OF DIET.

Length in mm	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40 — 45	45 — 50	50 — 55	55 — 60	60 — 70	70 — 80	80 — 90	90 — 100	100 — 110	110 — 120
No. Examined	2	2	1	8	4	8	12	6	16	7	4	7	4	4	12	4	4	1	2	4	8	4	2	2
No. with Pure Diet	2	2	0	4	2	3	4	2	6	4	4	2	0	0	2	0	0	0	0	0	0	0	0	0
Articles of Diet:																								
Algae										86		10.2		2.5			25						10	
Other plant remains												15			11.7					7.5	21.2			10
Trematode worms					1.5	1.2	15									2.5	25		2	2				
Nematode worms						2.5						2.7												
Annelid worms																		8						
Snails																				10		20		30
Copepods	100	100	98	99	92.5	89	76.3	96.7	67.6	89.6	67.5	62	50	66.5	68.3	26.5	37.5	41	40		1.2			
Cladocerans			2	.3	2.5		.3	2.2	22.7		30.3		41	11	1.7						.7			
Ostrocods																				2.5		2.5		
Amphipods									3.7				6	10		9		22		25	5	15		
Isopods																+								
Crayfish																						45		
Chironomid larvae				.6				.7					2.5		.8		29	18	15	5	5	10.5		20
Chironomid pupae									2															
May fly larvae						5			1.9	2.9						10	5	18		12.5	5			
Other insect larvae												1		12.5		10	10	2	15	17.5	32.8	12	70	10
Adult insects					3.5						1.4					2.5								
Mites															+				+					
Fish remains						1.1		.2			3.6	7.5							20	20			20	
Fish eggs																					7.5			
Inorganic debris																	10				1.2			

In an examination of six very young perch he finds the food to consist almost wholly of entomostraca, cladocera and copepods being in about equal quantities, and a few minute midge larvæ.

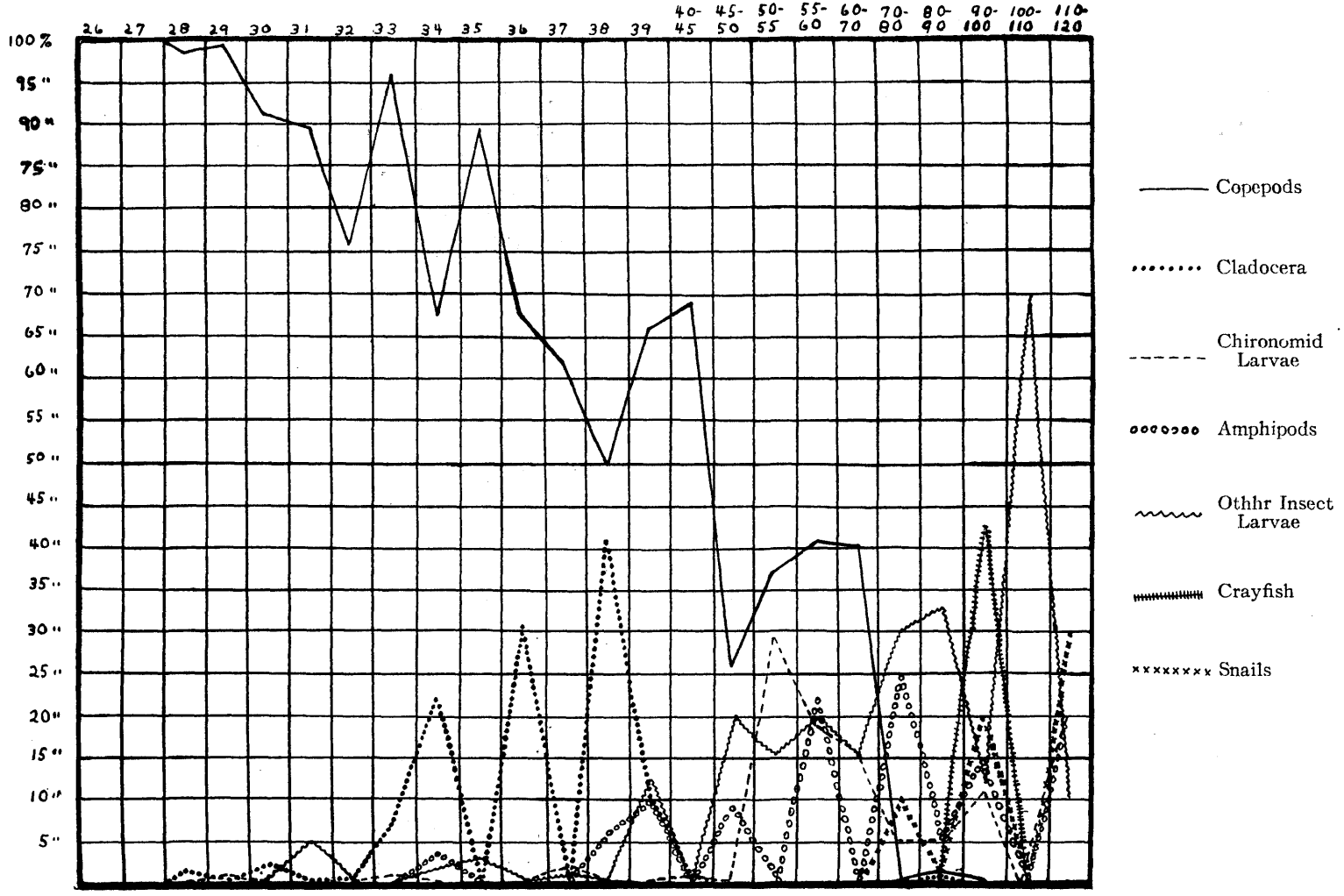
Hankinson (1908) finds that the stomachs of a few fry (of perch) contain chiefly entomostraca.

Hankinson (1916) finds the stomachs of perch from one to one and a half inches in length to contain only cyclops and diaptomus.

Pearse (1918) finds that the perch is in general a versatile feeder and that at any age it may feed largely upon entomostracans, insects, molluscs or almost anything else that is edible.

In the present study of 138 specimens of the young perch the results are generally in agreement with those of Forbes who reported upon less than twenty fish of this age. Forbes concluded that there are three periods to be recognized as expressed in the food habits of the perch, infancy, in which the fish takes only entomostraca and minute dipteran larvæ, youth, in which mainly larger insect larvæ are eaten and maturity in which crayfish and fish constitute the food. In his younger specimens, however, he finds the entomostracan food to be about equal parts of copepods and cladocera while in the present study a pure diet of copepods is encountered in the youngest fish. Apparently the age classified as maturity by Forbes has just been reached by the oldest specimens included in this report. The statement of Pearse that perch are versatile feeders at all ages is born out here except in the case of the youngest specimens which have a pure diet of Entomostraca.

Two reasons suggest themselves for the gradual but definite change in the total diet of the young perch. (1) There is a gradual increase in the size of the animals eaten which keeps pace with the increase in size of the fish and it seems probable that the perch would take larger animals as food unless it were especially equipped for straining the water for smaller objects. (2) The perch in its youngest stages is not a bottom feeder as it is when adult. A gradual change results by its turning to the bottom for food whereas it had formerly taken its food at the surface or in the middle waters. The perch in its earlier stages might be termed a generalized feeder becoming later a "versatile feeder" (Pearse, 1918), but deriving most of its food along


26 27 28 29 30 31 32 33 34 35 36 37 38 39 40-45 45-50 50-55 55-60 60-70 70-80 80-90 90-100 100-110 110-120
100 %
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25 "
20 "
15 "
10 "
5 "
Copepods
Cladocera
Chironomid Larvae
Amphipods
Othhr Insect Larvae
Crayfish
Snails

the bottom. The young fry of two fish which are strictly bottom feeders (Etheostoma flabellare and Cottus ictalops) were taken with the young of the perch and their diet consisted mainly of large larvæ of insects, fish eggs, and amphipods while the young perch were eating only entomostraca and a few chironomid larvæ. The young perch were clearly not deriving their food from the bottom at this time. Consequently it seems that the change in the behavior of the perch fry as it changes from a generalized feeder to a bottom feeder contributes to the change in the diet.

6. Summary.

1. The young perch of from 26 to 50 millimeters in length is found generally distributed in the shore waters at a depth of two to five feet in July in the vicinity of the Bass Islands.

2. The diet of the young perch consists wholly of copeopds in its younger stages but gradually changes to insect larvæ.

3. The change in diet is apparently associated with a change in feeding behaviour, changing from a generalized or surface feeder to a bottom feeder.

4. The young perch is associated at this time with a great number of the adults of minnows, several species of darters (Percina caprodes zebra, Cottogaster coplandi, Diplesion blennioides, and Etheostoma flabellare) a few adults of rock bass, small-mouthed bass, white bass, sunfish, perch and brook silversides and with the fry of the small-mouthed bass, large-mouthed bass, rock bass, sunfishes, darters (Percina caprodes zebra, Etheostoma flabellare), minnows, brook silversides and perch.

5. The perch fry studied here have few enemies among their fish associates.

LITERATURE CITED.

Baker, F. C. 1916. The relation of molluscs to fish in Oneida Lake. Technical publication No. 4, New York State College of Forestry, Syracuse University.

Forbes, S. A. 1880. (1) The food of fishes. Acanthopteri. Bulletin Illinois State Laboratory of Natural History, Volume I, p. 19.

1880. (2) On the food of young fishes. Ibid. Volume I, p. 71.

1883. The food of the smaller fresh water fishes. Ibid. Volume I, p. 65.

1888. Studies of the food of freshwater fishes. Ibid. Volume II, p. 433.

1888. On the food relations of fresh water fishes. Ibid. Volume II, p. 475.

Hankinson, T. L. 1908. A Biological survey of Walnut Lake, Michigan. Michigan State Biological Survey Report, p. 156.

1916. Result of the Shiras Expedition to Shiras Point, Mich. Fishes. Michigan Geological and Biological Survey, Publication 20, Biological Series, 4.

Pearse, A. S. 1915. On the food of the small shore fishes in the waters near Madison, Wisconsin. Bulletin Wisconsin Natural History Society, Volume 13, p. 7.

1918. The food of the shore fishes of certain Wisconsin Lakes. Bulletin of Bureau of Fisheries, Volume 35, (1915–1916), p. 249.

Biological Laboratory, College of Wooster.
Wooster, Ohio.