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THE FOOD OF BLUEGILLS, PERCH, AND PUMPKINSEEDS FROM WINTERGREEN LAKE, MICHIGAN, FOR 1935-1938.

by

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Stomach examinations were made of bluegills (Lepomis macrochirus Rafinesque), perch (Perca flavescens Mitchill), and pumpkinseeds (Lepomis gibbosus Linnaeus), a large series of which were collected, summer and winter, from Wintergreen Lake, near Battle Creek, Michigan, during the years 1935-1938. Collections were made under the direction of Dr. M. D. Pirnie of the W. K. Kellogg Bird Sanctuary of Michigan State College. The stomachs were sent to the Institute for Fisheries Research for examination and in the beginning of the study Dr. J. W. Leonard sorted and identified the contents. Later this work was taken over by Dr. J. W. Moffett who also tabulated much of the bluegill material. The analyses were continued by the author after Dr. Moffett left the Institute staff.

Although the literature abounds with food studies, few deal with pan fish and still fewer extend over more than one season or year. It was, therefore, considered an opportunity to study the food utilized by these fish at all seasons and for a three-year period.

Methods

All fish were taken by angling except for one collection (May, 1936) made by the Institute with seines and gill nets. A limited number of

fishermen were permitted to use the lake on condition that their catch be submitted to be weighed, measured, and have the stomachs removed. All of these fish were therefore of legal size (6 inches) or over and were taken during the open season (June 25-March 31).

Stomachs were placed in 95 per cent alcohol as soon as they were removed from the fish. Later the contents were removed from the stomach and the total volume measured by water displacement. The organisms were then sorted and identified. The number of individuals in each category was counted and their volume taken.

Identifications were carried to only relatively large groups (genus, sub-family, or family in most cases). This was done, first, because limitations of time would not permit more exact identification and, second, specific determination is thought to be of little value in such a food study. The numbers given are actual counts except in cases of numerous plankton organisms and excessive fragmentation (Mollusca, etc.) where conservative estimates were made. The water displacement method of measuring volumes is far from satisfactory but is still the most generally used. A centrifuge tube calibrated in 0.1 cubic centimeters was employed. Smaller volumes were estimated. Blotting paper was used to absorb excess moisture before measurement.

Description of Lake

Wintergreen Lake (T. 1 S., R. 9 W., Sec. 8) is located on the W. K. Kellogg Bird Sanctuary of Michigan State College in Ross Township, Kalamazoo County, Michigan. The lake has an area of approximately 20 acres and a maximum depth of 20 feet. In most of the area the water is shallow enough to permit plant growth. The predominant bottom material is pulpy peat with more or less marl intermixed.

Previous Institute investigations showed the most important game fishes in the lake to be pumpkinseeds, bluegills, largemouth bass (Huro salmoides (Lacepede)), and perch. Forage fish were also abundant, the most important being the black-chinned shiner (Notropis heterodon (Cape)), black-nosed shiner (Notropis heterolepis heterolepis Eigenmann and Eigenmann), golden shiner (Notemigonus crysoleucas auratus (Rafinesque)), and the blunt-nosed minnow (Hyborhynchus notatus (Rafinesque)). The lake is used by large numbers of water fowl especially during the spring and fall migrations.

From a fisheries standpoint the lake is probably one of the richest in Southern Michigan. The extent to which the bird droppings are responsible for this fertility is not known. It seems probable, however, that the amount of plankton and rooted vegetation might be greatly increased. The unusually rapid growth of the fish (Table 1) is certainly an indication of an abundance of fish food.

Food Records

In the consideration of the data the results for each year were divided into a summer period and a winter period. The winter period may be defined as that part of the year when the ice was of sufficient thickness to permit fishing through it (usually December-March). The summer period is the period when fishing was done in the open water. Roughly this would be from April through November except that the lake was closed to fishing from April 1 to June 24. Actually most of the fishing was done in July, August, and September. The number of collections made by periods and months is shown in Table 2. The number of stomachs with and without contents is given for the three species.

A list of the groups of organisms found in the stomachs is given by periods for each species, also the number of stomachs with contents, the total number of organisms, and the total volume of contents. Data are presented on the average number and volume of each kind of organism in the stomachs which contained that particular group, the per cent of the total number of stomachs (with contents) which contained each group, and the per cent of the total volume made up by the group of organisms.

Bluegills

In the summer periods, midge larvae (Chironomidae) were present in all or nearly all of the 93 bluegill stomachs in fairly large numbers (Table 3). Other organisms important in the diet for all three years were plankton crustaceans (Cladocera), midge larvae (Ceratopogonidae), mayflies (Caenis), caddisflies (Trichoptera), phantom midge larvae (Chaoborus), and snails (Heliosoma). The table shows, however, that the number of fish stomachs containing any one of these organisms varied greatly from year to year.

Some food organisms were common in the stomachs certain years but were absent in others. Moss animalcules (Bryzoa) were found in 52.0 per cent in 1927 but were not present any other year. No damselfly nymphs (Zygoptera) were found in 1935 although they were present in a large part of those stomachs taken in 1936 and 1937. The snails (Physa) and the fingernail clams (Pisidium) were found frequently in 1937 collections but were not observed in the stomachs from other years. Several other similar examples are shown in the table.

In volume, midge larvae were most important the first two years but were displaced by moss animalcules in 1937. Cladocerans made up a small but consistent part of the volume each year. Few other organisms were

present in sufficient quantity to be significant. Debris, chiefly unidentified animal material, made up a rather large part of the volume every year.

Leonard (1940) found that bluegills of somewhat comparable size from Ford Lake, Michigan, contained dragonfly and damselfly nymphs (82 per cent). Smaller specimens contained plankton crustaceans (20.9-51.7 per cent), fly larvae (20 per cent), and small amounts of mayfly, dragonfly and damselfly nymphs. These fish were collected in late October. Ewers and Boesel (1936) found that small bluegills (21-37 mm. total length) in Buckeye Lake, Ohio, had eaten plankton crustaceans (86.21 per cent) and insects, chiefly midge larvae (13.23 per cent). This information was obtained from specimens collected during July and August.

The winter food of 250 bluegills (Table 4) varied quantitatively and qualitatively from period to period and from the corresponding summer periods. In 1935-36 the more important organisms in order of frequency found in the stomachs were damselfly nymphs, midge larvae (Chironomidae), various mayflies (Hexagenia, Caenis, Baetis, miscellaneous Baetidae, and miscellaneous Ephemeroptera), Cladocerans, Copepods, and scuds (Hyalella). About one-fourth of the stomachs contained debris. In 1936-37, the stomach contents of the fish examined were much less varied. Cladocerans and phantom midge larvae were by far the most numerous items. No other organisms were observed in significant numbers and debris was not found in measurable amounts. Phantom midge larvae were the predominant organism in the stomachs collected in 1937-38. Cladocerans and copepods were also important. The mayflies (Baetis), midge larvae (Chironomidae), and damselfly nymphs were present in some of the stomachs. Very few other organisms were observed and none in significant numbers. Debris was found in only 4.5 per cent.

By volume, each year one kind of organism was found to be of primary and one of secondary importance. The volume of most of the other organisms was too small to be significant. In 1935-36, damselfly nymphs were first and the mayflies (Hexagenia) second in importance. In 1936-37, most of the volume consisted of Cladocerans and phantom midge larvae and in 1937-38, of phantom midge larvae and damselfly nymphs.

Moffett and Hunt, in an umpublished study of the winter food of bluegills of Cedar Lake, Michigan (Report No. 791), found that fish 140-199 mm. in total length contained Mollusca (3.74-24.23 per cent), Cladocera (6.38-25.51 per cent), Ephemeroptera (11.77-43.07 per cent), Trichoptera (5.33-24.18 per cent) and Diptera, chiefly Chironomus larvae (7.12-10.67 per cent).

Perch

So few perch were taken in the summer period that it was not thought advisable to separate the data by years. Therefore the results for all three years are lumped together (Table 5). The more important organisms, in order of frequency of occurrence in the 24 stomachs, were midge larvae (Chironomidae), phantom midge larvae, fish, and midge larvae (Ceratopogonidae). Chironomidae were also most important by volume, with fish in the secondary position. The small amount of debris was chiefly animal remains.

In a study of the stomach contents of 100 male and 100 female perch taken from Ford Lake, Michigan, on September 9, 1936, Eschmeyer (1938) found that 31 males and 24 females contained Corethra (Chaoborus). Fourteen males and 22 females contained Chironomidae, and 3 males and 25 females contained minnows. Nurnberger (1931) found that the food of perch 100-390 mm. long from Big Sandy Lake, Minnesota, consisted chiefly of fish and crayfish. Langford and Martin (1941) state that fish and the plankton crustacean Leptodora were especially important in the diet

of perch 102-119 mm. in standard length from Costello Lake, Ontario. Sibley and Rimsky-Korsakoff (1930) found that in perch over 70 mm. long from the St. Lawrence watershed in New York the stomachs contained mainly insects, scuds, and water sowbugs. Large fish from certain waters had fed mainly on plankton. Only 9 of the 463 perch examined contained fish. Turner (1920) found that small perch from western Lake Erie as they grow change their diet from plankton crustaceans to insect larvae and medium-sized crustaceans and, after reaching 100 mm., to larger snails and crayfish. Perch 45-162 mm. in total length from Buckeye Lake, Ohio, examined by Ewers and Boesel (1936) contained Cladocera (24.07 per cent), Hyalella (18.54 per cent), Copepoda (17.26 per cent), Chironomidae (14.81 per cent), and Zygoptera (4.64 per cent). All of the above information was obtained from specimens collected during the summer months.

The food of perch taken during the winter periods is shown in Table 6. In 1935-36, the majority of the stomachs examined contained fish. Of the fish remains in identifiable condition, bluegills were most numerous and minnows (Cyprinidae) second. Midge larvae (Chironomidae) and damselfly nymphs were the only other organisms present in the stomachs in important numbers. In 1936-37, almost all of the stomachs examined contained Cladocerans. Some phantom midge larvae and midge larvae (Chironomidae) were also found. None of the stomachs contained fish. Phantom midge larvae were predominant in the 1937-38 collections. Midge larvae (Chironomidae) and Cladocerans were also present in important numbers. A rather large number of fish were found in the stomachs. Half of them were identifiable as minnows.

It is of interest that, although the perch stomachs in 1936-37 and 1937-38 contained plankton, only Cladocerans were present. During the same

periods the bluegills had taken both Cladocerans and Copepods, which shows that both were present in the lake. Perhaps large perch are unable to feed on Copepods. The gill rakers of bluegills are, of course, much better adapted to straining out plankton organisms than are those of perch.

By volume, fish made up 89.6 per cent of the total stomach contents in 1935-36. No other organisms were present in significant amounts. In 1936-37, most of the volume was composed of Cladocerans with midge larvae (Chironomidae) second. In 1937-38, fish accounted for 67.8 per cent of the volume and midge larvae (Chironomidae) were again of secondary importance.

Moffett and Hunt (manuscript) found that perch of Cedar Lake, Michigan, 140-199 mm. in total length, had a diet composed almost entirely of fish in winter, and that over 80 per cent of the total stomach contents was made up of small bluegills.

The results of this investigation and those of other workers seem to indicate that perch may feed on a great variety of organisms. The great variation in quality and quantity of stomach contents from year to year, from season to season, and from water to water may indicate that the availability of the food organism is the chief factor in determining what is eaten.

Pumpkinseeds

Pumpkinseeds were obtained in sufficient numbers for purposes of comparison only during the summer periods of 1936 and 1937. The stomachs of thirty-four pumpkinseeds caught during the winter periods were all empty.

In the summer period of 1936 midge larvae (Chironomidae), snails (Heliosoma), fingernail clams, and scuds were present in a large part of the stomachs. Mayflies (Caenis) and midge larvae (Ceratopogonidae)

also occurred frequently. In 1937 almost all of the stomachs contained some midge larvae (Chironomidae). Snails, mayflies, caddisflies, and phantom midge larvae were of lesser importance.

By per cent of total volume of stomach contents, fingernail clams, snails, and midge larvae (Chironomidae) ranked in the order mentioned in the 1936 collections. In 1937 midge larvae (Chironomidae) made up over one-half and fingernail clams over one-fourth of the total volume.

General Discussion

The collections for this investigation, as well as general fishing experience, have shown that, of any group of fish caught, a large per cent will contain no food. In an attempt to throw more light upon the feeding habits of the fish, the number of empty as well as full stomachs were considered in determining averages of total numbers and volumes (Table 8).

There was a great deal of variation in the ratio between full and empty stomachs, especially in the winter period. Tables 4 and 6 show that during the year of greatest variation (1935-36), the bluegills and perch contained chiefly insect larvae. These organisms would probably tend to be relatively limited in numbers and distribution and so would not be equally available to all fish. In 1936-37 when few of either perch or bluegills were empty, plankton crustaceans were the principal organisms in the diet. Plankton was presumably abundant and about equally available to all.

There is little correlation between the total number and total volume of stomach contents from period to period. This is due to the great variety of organisms in the diet and the great variation in the size of organisms. The volume of an average food organism for the bluegills in the winter period 1936-37 was 0.00022 cc. In 1935-36, the volume of

the average organism from perch stomachs was 0.132 cc., or 600 times the size of the bluegill food item. Plankton was predominant in the diet in the first case and fish of relatively large size in the second.

It would seem that the average volume of stomach contents for a species should be about the same for any lake or season. If enough properly distributed samples were taken, it should be possible to approximate this amount. In the present instance the average volume per stomach with contents (Line g in Table 8) varies greatly from period to period for any given species. However, if the empty stomachs are also considered, (Line h, Table 8), the variation in most cases is not nearly so great. This figure may be nearer the true average volume of stomach contents for species and period.

In the summer periods the average volume of stomach contents of the bluegills is relatively large but in the winter periods it was much reduced.[*] Perch, on the other hand, show little variation in average volume of stomach contents from period to period. By inspection it seems probable that the bluegills in a year eat about as much on the average as the perch but that the amount is more uniformly distributed in the case of the perch.

Summary

1. The growth rate of the fish indicates that fish food conditions in Wintergreen Lake must be better than average for Michigan.

2. Constituents of the diet of a species vary with the year and season, possibly because of the availability of the food organisms.

3. Large perch can feed on Cladocerans but may be unable to take Copepods.

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[*] Moffett and Hunt (manuscript) found that the average volume of stomach contents for the larger Cedar Lake bluegills varied in winter from 0.26-0.112 cc. per stomach.

4. When plankton organisms are abundant they are probably available to most fish capable of taking them so that few go without food.

5. The volume of stomach contents of Wintergreen Lake bluegills is much greater in the summer than in the winter period.

6. There does not seem to be a consistent seasonal variation in the volume of food in the perch of Wintergreen Lake.

7. A better figure for the true average volume of stomach contents is obtained when empty, as well as full, stomachs are considered.

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INSTITUTE FOR FISHERIES RESEARCH

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Table 1

Growth rate, Wintergreen Lake

Age* group	Summer of life	Bluegills			Perch			Pumpkinseed		
		Number of specimens	Average total length in inches	Tentative state average total length	Number of specimens	Average total length in inches	Tentative state average total length	Number of specimens	Average total length in inches	Tentative state average total length
0	1	...	...	1.7	...	...	2.9	...	...	1.9
I	2	...	...	3.0	...	...	4.7	...	...	2.7
II	3	4	7.2	4.3	...	...	6.2	1	5.6	4.4
III	4	76	8.0	5.6	3	7.8	7.1	44	6.9	5.8
IV	5	16	8.8	6.7	...	...	7.8	10	7.6	6.4
V	6	23	9.1	7.4	1	9.8	9.4	16	8.2	6.8
VI	7	26	9.2	7.8	8	10.2	10.2	16	8.2	7.1
VII	8	15	9.2	7.9	4	11.1	10.4	2	8.0	7.8
VIII	9	10	9.4	8.3	4	11.3	11.3	...	...	...

* Age determinations and tentative state averages by W. C. Beckman.

Table 2

Wintergreen Lake, Fish Collections

Season	Month - Year	Bluegills			Perch			Pumpkinseed		
		Number of collections	Number with contents	Number empty	Number of collections	Number with contents	Number empty	Number of collections	Number with contents	Number empty
Summer 1935	July, 1935	...	...	...	1	6	...	...	...	...
	Aug., "	4	10	5	2	9	2	...	...	...
	Sept., "	1	19	...	...	...	...	...	...	...
Winter 1935-36	Dec., "	1	13	6	...	...	...	1	...	1
	Jan., 1936	16	115	340	14	35	89	7	...	22
	Feb., "	6	24	45	5	11	29	1	...	1
	March, "	2	1	7	3	2	10	1	...	2
Summer 1936	May, " *	2	39	4	...	...	...	2	29	1
	June, "	...	...	...	...	...	...	1	1	4
Winter 1936-37	Dec., "	4	43	10	...	...	...	...	...	...
	Jan., 1937	...	...	...	1	1	3	...	...	...
	Feb., "	...	...	...	1	3	...	...	...	...
	March, "	2	10	...	3	18	1	...	...	...
Summer 1937	June, "	1	1	...	...	...	...	...	...	...
	July, "	1	4	...	...	...	...	1	10	...
	Aug., "	1	1	...	...	...	...	1	5	...
	Sept., "	2	20	...	1	9	8	1	4	...
Winter 1937-38	Dec., "	5	23	63	2	21	4	1	...	3
	Jan., 1938	2	10	4	...	...	...	...	...	...
	Feb., "	...	...	...	2	14	...	1	...	5
	March, "	1	11	7	...	...	...	...	...	...

* Collections made by I. F. R. party.

Table 3

Bluegills, summer, Wintergreen Lake

Organisms	1935: 29 stomachs with contents, 4,142 organisms, 29.0 cc. of contents				1936: 39 stomachs with contents, 10,359 organisms, 26.70 cc. of contents				1937: 25 stomachs with contents, 11,639 organisms, 25.32 cc. of contents			
	Average number of individuals	Per cent of stomachs containing organisms	Average volume in cubic centimeters	Per cent of total volume	Average number of individuals	Per cent of stomachs containing organisms	Average volume in cubic centimeters	Per cent of total volume	Average number of individuals	Per cent of stomachs containing organisms	Average volume in cubic centimeters	Per cent of total volume
Bryzoa	...	...	...	...	...	...	...	...	...	52.0	0.613	31.5
Annelida												
Hirudinea	...	...	...	...	1.0	2.6	tr.	tr.	...	...	...	...
Mollusca												
Gastropoda	...	...	...	...	...	...	...	...	...	...	...	...
Heliosoma	1.0	3.4	tr.	tr.	10.8	66.7	0.068	6.6	8.8	24.0	0.033	0.8
Ammicola	...	...	...	...	1.0	2.6	tr.	tr.	...	...	...	...
Physa	...	...	...	...	...	...	...	...	4.6	28.0	0.016	0.4
Pelecypoda	...	...	...	...	1.6	17.9	tr.	tr.	...	...	...	...
Pisidium	...	...	...	...	...	...	...	...	44.0	28.0	0.258	7.1
Arthropoda												
Crustacea	...	...	...	...	...	...	...	...	...	...	...	...
Cladocera	93.6	31.0	0.253	7.9	193.2	51.3	0.095	7.1	1,315.0	28.0	0.257	7.1
Ostracoda	...	...	...	...	4.0	5.1	tr.	tr.	7.5	8.0	tr.	tr.
Copepoda	...	...	...	...	6.3	7.7	tr.	tr.	37.5	24.0	0.008	0.2
Amphipoda	...	...	...	...	4.6	23.1	0.011	0.4	...	...	...	...
Hyalella	2.0	20.7	tr.	tr.	13.0	51.3	0.026	1.9	...	...	...	...
Insecta	...	...	...	...	...	...	...	...	...	...	...	...
Ephemeroptera	...	...	...	...	...	...	...	...	1.0	4.0	0.005	tr.
Baetidae	...	...	...	...	4.9	17.9	0.018	0.5	...	...	...	...
Caenis	1.5	13.8	tr.	tr.	9.1	82.1	0.037	4.4	6.8	48.0	0.007	0.3
Baetis	6.0	3.4	0.008	0.2	...	...	...	...	1.3	12.0	0.003	tr.
Odonata	...	...	...	...	...	...	...	...	...	...	...	...
Zygoptera	...	...	...	...	5.2	33.3	0.068	3.3	1.2	16.0	0.206	3.3
Anisoptera	...	...	...	...	1.0	2.6	0.200	0.7	...	...	...	...
Hemiptera	...	...	...	...	1.0	2.6	0.050	0.2	1.0	12.0	tr.	tr.
Coleoptera	1.0	3.4	0.050	0.2	1.3	17.9	0.023	0.6	2.5	8.0	0.012	0.1
Trichoptera	7.7	10.3	0.033	0.3	1.8	25.6	tr.	tr.	6.8	56.0	0.175	1.0
Diptera	...	...	...	...	1.7	7.7	0.008	0.1	...	...	...	...
Ceratopogonidae	3.3	24.1	0.007	0.2	2.5	43.6	tr.	tr.	2.2	40.0	tr.	tr.
Chironomidae	111.1	100.0	0.582	58.2	141.6	97.5	0.296	42.1	57.7	100.0	0.221	21.8
Tanypodinae	...	...	...	...	...	...	...	...	7.8	44.0	0.007	0.3
Chaoborus	1.3	10.3	tr.	tr.	1.0	5.1	0.012	0.1	5.5	32.0	0.008	0.3
Arachnida	...	...	...	...	...	...	...	...	1.0	8.0	tr.	tr.
Araneida	...	...	...	...	1.0	7.7	tr.	tr.	1.0	4.0	tr.	tr.
Hydracarina	2.0	3.4	tr.	tr.	1.4	12.8	tr.	tr.	2.2	20.0	tr.	tr.
Terrestial insects	...	...	...	...	...	...	...	...	...	...	...	...
Coleoptera	...	...	...	...	2.0	7.7	0.283	3.3	...	...	...	...
Hymenoptera	...	...	...	...	1.0	10.3	0.025	0.4	...	...	...	...
Debris	...	89.7	0.369	33.1	...	71.8	0.278	29.1	...	84.0	0.311	25.8

Table 4

Bluegills, Winters,
Wintergreen Lake

Organisms	1935-1936 153 stomachs with contents 12,220 organisms 39.44 cc. of contents				1936-1937 53 stomachs with contents 26,192 organisms 5.785 cc. of contents				1937-1938 44 stomachs with contents 1,635 organisms 1.42 cc. of contents			
	Average number of individuals	Per cent of stomachs containing organisms	Average volume in cubic centimeters	Per cent of total volume	Average number of individuals	Per cent of stomachs containing organisms	Average volume in cubic centimeters	Per cent of total volume	Average number of individuals	Per cent of stomachs containing organisms	Average volume in cubic centimeters	Per cent of total volume
Mollusca												
Gastropoda	...	...	...	...	...	...	...	...	...	...	...	...
Heliosoma	1.0	2.6	0.012	0.1	...	...	...	...	...	...	...	...
Arthropoda												
Crustacea	...	...	...	...	...	...	...	...	...	...	...	...
Cladocera	590.0	10.4	0.124	5.0	562.6	86.8	0.112	88.9	40.2	43.2	0.005	7.0
Copepoda	2.2	13.7	tr.	tr.	...	...	...	...	4.7	15.9	tr.	tr.
Amphipoda	2.0	3.3	tr.	tr.	...	...	...	...	...	...	...	...
Hyalella	3.0	17.6	0.002	0.1	...	...	...	...	2.0	2.3	tr.	tr.
Insecta	1.1	5.9	0.077	1.7	...	...	...	...	...	...	...	...
Ephemeroptera	1.3	11.1	0.085	3.7	...	...	...	...	...	...	...	...
Hexagenia	1.4	13.7	0.254	13.5	...	...	...	...	...	...	...	...
Baetidae	2.2	13.7	0.016	0.9	...	...	...	...	...	...	...	...
Caenis	1.7	7.8	0.001	tr.	...	...	...	...	2.0	6.8	0.007	1.4
Baetis	1.5	7.2	0.010	0.3	1.2	7.5	0.004	0.3	1.8	20.5	0.001	0.7
Odonata	...	...	...	...	...	...	...	...	...	...	...	...
Zygoptera	25.7	57.5	0.261	58.2	1.0	3.8	0.005	0.2	7.0	11.4	0.040	14.1
Anisoptera	1.0	0.6	0.020	tr.	...	...	...	...	...	...	...	...
Trichoptera	1.4	5.9	0.044	1.0	1.0	1.9	0.025	0.4	...	...	...	...
Diptera	...	...	...	...	...	...	...	...	...	...	...	...
Chironomidae	2.0	30.7	0.033	4.0	2.5	3.8	0.005	0.2	3.4	15.9	0.013	6.3
Chaoborus	3.3	23.5	0.010	0.9	8.6	66.0	0.016	9.8	20.4	84.0	0.026	67.6
Chordata												
Fish, specie?	1.0	2.0	0.533	4.1	1.0	1.9	0.015	0.3	...	...	...	...
Debris	...	28.8	0.058	6.5	...	...	...	...	...	4.5	0.020	2.8

Table 5

Perch, Summer, Wintergreen Lake

Organisms	1935-1937 24 stomachs with contents 471 organisms 8.095 cc. of contents Average number of individuals	Per cent of stomachs containing organisms	Average volume in cubic centimeters	Per cent of total volume
Annelida				
Oligochaeta	4.0	4.2	0.200	2.5
Mollusca				
Pelecypoda	3.0	4.2	tr.	tr.
Arthropoda				
Insecta (misc.)	1.0	8.3	tr.	tr.
Odonata				
Zygoptera	1.0	4.2	tr.	tr.
Diptera				
Chironomidae	23.3	66.7	0.309	61.1
Ceratopogonidae	4.7	16.7	0.019	0.9
Chaoborus	6.8	37.5	0.024	2.7
Chordata				
Fish, species?	1.0	33.3	0.249	24.6
Debris	...	58.3	0.047	8.2

Table 6

Perch, Winter, Wintergreen Lake

Organisms	1935-1936: Average number of individuals	1935-1936: Per cent of stomachs containing organisms	1935-1936: Average volume in cubic centimeters	1935-1936: Per cent of total volume	1936-1937: Average number of individuals	1936-1937: Per cent of stomachs containing organisms	1936-1937: Average volume in cubic centimeters	1936-1937: Per cent of total volume	1937-1938: Average number of individuals	1937-1938: Per cent of stomachs containing organisms	1937-1938: Average volume in cubic centimeters	1937-1938: Per cent of total volume
	48 stomachs with contents; 299 organisms; 40.18 cc. of contents				22 stomachs with contents; 14,020 organisms; 4.410 cc. of contents				35 stomachs with contents; 1,310 organisms; 12.03 cc. of contents			
Arthropoda												
Crustacea	...	...	...	...	...	...	...	...	...	...	...	...
Cladocera	...	...	...	...	657.7	95.5	0.179	85.0	42.3	20.0	0.014	0.8
Amphipoda	...	...	...	...	...	...	...	...	...	...	...	...
Hyalella	1.0	3.6	tr.	tr.	...	...	...	...	...	...	...	...
Insecta (misc.)	1.0	3.6	tr.	tr.	...	...	...	...	...	...	...	...
Ephemeroptera	...	...	...	...	...	...	...	...	...	...	...	...
Hexagenia	1.0	5.5	0.233	1.7	...	...	...	...	...	...	...	...
Caenis	1.0	3.6	tr.	tr.	...	...	...	...	...	...	...	...
Baetis	1.5	7.3	0.007	tr.	...	...	...	...	1.0	5.7	tr.	tr.
Odonata	...	...	...	...	...	...	...	...	...	...	...	...
Zygoptera	11.0	16.4	0.181	4.0	5.0	4.5	0.015	0.3	6.0	2.9	0.025	0.2
Anisoptera	1.0	1.8	tr.	tr.	...	...	...	...	...	...	...	...
Diptera	...	...	...	...	...	...	...	...	...	...	...	...
Chironomidae	9.7	25.5	0.126	4.4	16.8	45.5	0.059	13.4	32.4	51.4	0.155	23.2
Chaoborus	5.0	1.8	tr.	tr.	2.9	54.5	0.003	0.9	15.7	74.3	0.034	7.3
Pisces (species?)	1.4	34.6	0.944	44.6	...	...	...	...	1.0	17.1	0.433	21.6
Cyprinidae	1.0	5.5	0.675	5.0	...	...	...	...	1.0	11.4	0.862	28.7
Notropis	...	...	...	...	...	...	...	...	1.0	2.9	0.200	1.7
Notemigonus	...	...	...	...	...	...	...	...	2.0	2.9	1.900	15.8
Centrarchidae	1.0	7.3	0.762	7.6	...	...	...	...	...	...	...	...
Huro (Micropterus?)	1.0	1.8	3.400	8.5	...	...	...	...	...	...	...	...
Lepomis macrochirus	1.1	14.6	1.200	23.9	...	...	...	...	...	...	...	...
Debris	...	12.7	0.008	0.1	...	9.1	0.007	0.3	...	22.9	0.011	0.7

Table 7

Pumpkinseeds, Summer, Wintergreen Lake

Organisms	1936 30 stomachs with contents 1,123 organisms 6.195 cc. of contents				1937 19 stomachs with contents 2,404 organisms 8.510 cc. of contents			
	Average number of individuals	Per cent of stomachs containing organisms	Average volume in cubic centimeters	Per cent of total volume	Average number of individuals	Per cent of stomachs containing organisms	Average volume in cubic centimeters	Per cent of total volume
Bryzoa	...	...	...	...	...	5.3	tr.	tr.
Annelida								
Oligochaeta (terr.)	1.0	23.3	0.044	5.0	1.0	5.3	tr.	tr.
Hirudinea	1.5	6.7	tr.	tr.	...	...	...	...
Mollusca								
Gastropoda	...	...	...	...	6.6	57.9	0.029	3.7
Heliosoma	9.1	90.0	0.050	21.8	...	...	...	...
Physa	...	...	...	...	...	...	...	...
Amnicola	...	...	...	...	...	...	...	...
Pelecypoda	...	...	...	...	...	...	...	...
Pisidium	9.2	86.7	0.097	40.7	126.5	21.1	0.600	28.2
Arthropoda								
Crustacea	...	...	...	...	...	...	...	...
Cladocera	1.5	20.0	tr.	tr.	...	...	...	...
Ostracoda	...	...	...	...	25.0	5.3	tr.	tr.
Amphipoda	...	...	...	...	...	...	...	...
Hyalella	4.3	83.3	0.006	2.3	...	...	...	...
Insecta	1.0	6.7	tr.	tr.	1.0	5.3	tr.	tr.
Ephemeroptera	2.0	3.3	0.005	tr.	1.5	10.5	tr.	tr.
Caenis	2.8	53.3	0.013	3.3	9.1	47.4	0.016	1.7
Odonata	...	...	...	...	...	...	...	...
Zygoptera	1.0	13.3	0.019	1.2	1.0	10.5	0.020	0.5
Trichoptera	...	...	...	...	1.9	36.8	0.006	0.5
Diptera	...	...	...	...	...	...	...	...
Ceratopogonidae	1.7	53.3	tr.	tr.	2.6	42.1	tr.	tr.
Chironomidae	14.8	96.7	0.027	12.4	93.3	94.7	0.252	53.4
Chaoborus	...	...	...	...	1.0	31.6	tr.	tr.
Chordata								
Fish species	1.0	6.7	tr.	tr.	...	...	...	...
Debris	...	63.3	0.043	13.2	...	84.2	0.064	12.0

Table 6

Gross numbers and volumes,
Wintergreen Lake

	Bluegills						Perch				Pumpkinseed	
	Summer			Winter			Summer	Winter			Summer	
	1935	1936	1937	1935-36	1936-37	1937-38	1935-37	1935-36	1936-37	1937-38	1936	1937
(a) Number of stomachs with contents	29	39	25	153	53	44	24	48	22	35	30	19
(b) Number of empty stomachs	5	4	...	398	10	74	10	128	4	4	5	...
(c) Total number of organisms	4,142	10,359	11,639	12,220	26,192	1,635	471	299	14,020	1,310	1,123	2,404
(d) Total volume of organisms (cc.)	29.0	26.70	25.32	39.44	5.785	1.42	8.095	40.18	4.410	12.03	6.195	8.510
(e) Average number of organisms per stomach (with contents)	142.8	265.6	465.6	79.8	494.2	37.2	19.6	6.2	637.3	37.4	37.4	126.5
(f) Average number of organisms per stomach (of all stomachs)	121.3	240.9	465.6	22.2	415.7	13.9	13.9	1.7	539.2	33.6	32.1	126.5
(g) Average volume per stomach (with contents)	1.000	0.685	1.013	0.258	0.109	0.032	0.337	0.837	0.200	0.344	0.206	0.448
(h) Average volume per stomach (of all stomachs)	0.853	0.621	1.013	0.072	0.092	0.012	0.238	0.228	0.170	0.308	0.177	0.448