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FURTHER OBSERVATIONS ON THE FEEDING HABITS OF THE MONTANA GRAYLING (THYMALLUS MONTANUS) AND THE BLUEGILL (LEPOMIS MACROCHIRUS) IN FORD LAKE, MICHIGAN[1]

[1] Contribution from the Michigan Institute for Fisheries Research.

Justin W. Leonard

Michigan Department of Conservation

Abstract

The feeding habits of a small population of Montana grayling in a small landlocked lake in northern Michigan are detailed on the basis of stomach analyses of specimens taken in April, May, July and October, 1938, and March, 1939.

The progress of the experiment based on these grayling was complicated by the unauthorized stocking of bluegills in the lake which, prior to the planting of the grayling, had been freed of all fish by treatment with rotenone.

As was noted in an earlier report on this experiment, immature and adult stages of certain predaceous aquatic insects, notably Odonata and Coleoptera, continued to occupy a most important place in the diet of the grayling. An interesting result of the presence of bluegills in the lake was the fact that by the time the grayling had attained an

average standard length of 246.5 mm. they began to prey upon small bluegill fingerlings.

Data are presented to show that all but fingerling bluegills are direct food competitors of the grayling. Observations indicate that the effects of this competition are already resulting in a reduction of the grayling population. It is suggested as probable that the non-reproducing grayling will be unable to maintain satisfactory growth and viability in the face of continued competition from the prolific bluegills.

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In an earlier report the writer (Leonard, 1939) presented an account of an experiment with Montana grayling (Thymallus montanus Milner), 5,000 of which were introduced as 4-inch fingerlings into Ford Lake, a small landlocked lake in northern Michigan. This report included a brief discussion of the physical, chemical and biological characters of the lake, a series of observations on the feeding habits of the grayling, and a summary of all information available in the literature of grayling feeding habits. It was noted that one of the most unusual aspects of the diet of the Ford Lake grayling was the dominant position occupied by various groups of predacious insects, notably Odonata and dytiscid Coleoptera.

The grayling, which were hatched on June 24, 1936, are completing the third year of their life at the time of this writing. The first report covered collections made in May and October of 1937. The present report deals with collections made in April, May, July and October, 1938, and March, 1939.

One aspect of the conditions under which the Ford Lake grayling population exists has undergone a significant alteration since the first

observations were recorded. Owing to a misunderstanding, a planting of bluegills (presumably fingerlings) was made in the lake during the summer of 1937. This was most unfortunate, because all fish had been removed by rotenone treatment prior to the introduction of the grayling, in order that they might be free from the possible competition or predatory activities of any other fishes. The progress of the experiment was not halted, however, and certain discoveries have resulted from the presence of the bluegills. One of the most interesting of these is that by the time grayling had attained an age of sixteen months and an average standard length of 246.5 mm. (average total length 11.5 inches) they began to prey upon young bluegills. Consumption of fish by Montana grayling has been reported only once (Brown, 1938), and in this instance the prey were small trout fry taken where they were concentrated just below a hatchery outlet, the situation not being a natural one. The position of bluegill fingerlings in the grayling diet rose from 3.5 per cent of the total in October, 1938, to 34.0 per cent in March, 1939. Continued utilization of this food will undoubtedly depend largely upon the degree of success attending reproduction of the bluegills, since it is obvious that physical limitations would prevent the grayling from feeding upon any but the smaller individuals.

In the ensuing tabulations determinations of food organisms encountered in the grayling stomachs are carried as far as is feasible. Lack of knowledge of life histories of many of our aquatic insects has prevented specific determinations in many cases, notably those of the midges and caddisflies. Lengths, weights and collection data for each series of fish are recorded in the text.

All fragments of animal and plant matter too finely comminuted for recognition have been considered as debris. Because the proportions of

the various organisms represented in the debris appeared to be in direct ratio to their abundance among the recognizable organisms, the debris has not entered in the tabular calculations; but the relative percentages of animal debris, plant debris and identifiable organisms are listed in the text. Unless specifically indicated otherwise, all aquatic insects were taken in immature stages, terrestrial insects as adults. In instances of specific growth-stage indication, "L" stands for larva, "P" for pupa, "N" for nymph and "A" for adult.

Table 1 shows the diet of the grayling for each collection summarized by major taxonomic categories of food organisms. Table 2 provides the same information for the bluegills, except that these latter were collected on the same date and are recorded by size groups. It appears certain that the three size groups recognized represent only two age classes, and that the two smaller groups are composed of specimens of the same age separated by different rates of growth, probably because of varying success in competitive feeding,—a condition commonly encountered among centrarchids. Since this paper was prepared a collection of over 100 bluegills of this age class was made (May 24, 1939), using artificial flies. The two size classes persisted at this time. Individuals of the larger groups could be recognized as soon as hooked by their greater vigor and endurance, and by their more vivid coloration. The smaller specimens appeared distinctly pale and "washed out."

Collection No. 1.: On April 21, 1938, five male and four female grayling were taken on artificial flies. The specimens had the following size ranges: Standard length, 183 to 198 mm., average 190.0 mm.; total length, 204 to 231 mm., average 218.0 mm.; weight, 58.4 to 83.1 g., average 72.3 g. (Table 3). The ratio of identifiable organisms to debris was:

identifiable organisms, 62 per cent; animal debris, 34 per cent; plant debris, 4 per cent.

During the late afternoon a large number of chironomids began to transform over shallow shoal areas. Their emergence attracted a large part of the grayling population, and for about half an hour, or until a sudden shower began, the water literally boiled with rising fish. A No. 18 Black Gnat fly was used, and so avid were the grayling that almost every cast drew a strike. It is not surprising that the Diptera as a group composed 30.6 per cent by volume of the food taken. The large amounts of Odonata nymphs (33.3 per cent) and aquatic Coleoptera (13.9 per cent) probably indicate that the grayling had been occupying and feeding over the shoal areas for some time prior to the peak of the midge emergence.

Collection No. 2.: Eleven males and seven females were taken by means of artificial flies on May 8, 1938. Size ranges of these specimens were as follows:—Standard length, 172 to 216 mm., average 199.8 mm.; total length, 220 to 253 mm., average 233.6 mm.; weight, 57.6 to 112.0 g. average 91.5 g. (Table 4). The ratio of identifiable organisms to debris was: identifiable organisms, 64.6 per cent; animal debris, 30.2 per cent; plant debris, 5.2 per cent.

When this collection was made, great numbers of empidids, or dance-flies, were swarming over the water. Their ready availability, coupled with the gregarious habits of feeding grayling, doubtless explains the fact that the empidids alone accounted for over two-thirds of the total volume of Diptera consumed. Nymphs of Enallagma hageni, although bulking slightly smaller than the empidids, were taken more generally, and were

encountered in all but three stomachs. Corixidae were even more prevalent and, although making up only four per cent of the total volume, occurred in all eighteen stomachs. Of the terrestrial insects, only the Hymenoptera made a significant contribution to the diet. The group was almost wholly represented by large winged females of the common carpenter ant, Camponotus herculaneus pennsylvanicus. Adults of the minute dytiscid beetle, Bidessus sp., found commonly in the grayling stomachs previously reported on, occur only in the May 8 collection.

Collection No. 3.: A series of seventeen males and eleven females was collected by means of a graded gill net set at 9:30 p.m., July 5, and lifted at 10:00 a.m., July 6, 1938. The size range of these individuals was as follows: Standard length, 214 to 250 mm., average 226.5 mm.; total length, 254 to 295 mm., average 268.9 mm.; weights not available. (Table 5). The ratio of identifiable food organisms to debris was: identifiable organisms, 52.7 per cent; animal debris, 40.3 per cent; plant debris, 7.0 per cent.

Stomachs from this collection contained a higher percentage of plankton (4.3 per cent composed almost entirely of Bosmina) than any others reported on here. The Odonata, although still well represented, were at their lowest point, probably because the peak of the emergence season had just passed. The extraordinarily large amount of Diptera, made up almost wholly of larvae and pupae of a chironomine midge tentatively determined as Limnochironomus modestus, is almost certainly due to increased activity in anticipation of emergence on the part of these organisms, resulting in their being more readily detected and captured by the grayling than is usual. The same conclusion is even more certainly justified in the instance of the Trichoptera which, represented almost entirely by pupae of Oecetis inconspicua, make

the first significant contribution to the diet by this group since the inception of the study.

It is possible that an explanation of the small amounts of water beetles and all terrestrial insects present in these stomachs lies in the fact that the collection was made at night, when few terrestrial insects were available, and by means of a gill net, which might tend to exclude individuals feeding at or very near the surface. A collection made just at dusk might have revealed a larger proportion of terrestrial and surface-inhabiting aquatic insects.

Another, perhaps more probable explanation, is that the surface waters, which warmed to 76° F. during the afternoon preceding the net-set may have held a temperature high enough to exclude the grayling from them.

Collection No. 4: On October 29 and 30, 1938, nine males and seven females were taken on artificial flies. The size ranges of these specimens were as follows: Standard length, 230 to 258 mm., average 246.5 mm.; total length, 275 to 311 mm., average 292.8 mm.; weight, 154.4 to 224.8 g., average 185.3 g. (Table 6). The ratio of identifiable food organisms to debris was: identifiable organisms 63.4 per cent; animal debris, 28.3 per cent; plant debris, 8.3 per cent

In this collection the diet was dominated by adult aquatic Coleoptera, especially Dytiscidae (Acilius and Coptotomus) and Gyrinidae, each family represented by two species. The Odonata were next in importance; almost all of their volume was due to nymphs of Anax junius. Cooling of the surface waters is reflected in the marked increase in the diet of a wide variety of terrestrial insects, demonstrating a willingness on the part of the grayling to feed at the surface when temperature conditions are favorable.

For the first time fish appear in the diet. It may be concluded that the grayling were at this time just attaining a size sufficient to enable them to prey upon the small bluegills. Svetvidov (1931) states that the white grayling from Lake Baikal feeds on fish and amphipods; Heckel and Kner (1858) and von Siebold (1863) list minnows and fry as regular items in the food of the European grayling. As has been pointed out above, there are no known records of the Michigan grayling feeding upon fish, and the only record of Montana grayling feeding on fish is based on a rather unnatural situation where trout fry were abnormally abundant, just below the outlet of a fish hatchery.

Collection No. 5: On March 1 and 2, 1939, four males and six females were secured by angling through the ice, using burrowing mayfly nymphs as bait. The size ranges of the specimens were: Standard length, 230 to 269 mm., average 252.2 mm.; total length, 272 to 314 mm., average 298.3 mm.; weight, 179 to 240.5 g., average 212.0 g. (Table 10). The ratio of identifiable food organisms to debris was: identifiable organisms, 71.8 per cent; animal debris, 17.0 per cent; plant debris, 11.2 per cent.

Aside from the large amount of bluegill fry consumed, the most interesting feature of this collection was the occurrence, for the first time, of significant amounts of snails. Dragonfly nymphs and adult water beetles were abundant, as usual. Aquatic Diptera, represented by chironomine larvae, were present in negligible quantity.

A comparison of the figures listed in Tables 2, 8, 9, and 10, shows at a glance that bluegills and grayling in Ford Lake feed largely upon the same groups of invertebrates. There is apparent a considerable disparity between the diets of each of the three size groups of bluegills.

Members of the smallest group fed almost exclusively on plankton, small mayfly nymphs and chironomids. In the middle size group plankton, chironomids and aphids bulked about the same, but the Odonata loom almost as large, and many other organisms show in smaller amounts. The largest specimens fed on anisopteran dragonfly nymphs almost to the exclusion of other groups. It would appear that members of the middle size group fed at the surface more readily than the smallest or largest individuals.

Some workers believe that competition from more aggressive, introduced species of fish is the principal cause for the extinction of the Michigan grayling and for the decrease in numbers of Montana grayling in their native waters many of which, in recent years, have been stocked with brown, cutthroat, rainbow, and eastern brook trout.

There exists a strong likelihood that the grayling will fail rapidly in Ford Lake, due to the competitive food habits of the prolific bluegill. Already there have been noted indications of a marked drop in the Ford Lake grayling population and although definite figures will not be available until the population has been removed it is hardly open to question that the great increase in the number of bluegills has already had a serious effect upon the grayling. Completion of the Ford Lake experiment should provide an answer to the question of whether or not a non-reproducing population of Montana grayling can live and grow successfully in a lake which contains such a fecund and highly competitive species as the bluegill.

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TABLE 1. RESULTS OF STOMACH ANALYSES OF FIVE COLLECTIONS OF MONTANA GRAYLING SUMMARIZED BY MAJOR GROUPS

Organism	April 21 1938	May 8 1938	July 5-6 1938	Oct. 29-30 1938	March 1-2 1938
Mollusca	...	...	trace	...	11.0
Entomostraca	trace	trace	4.3	...	...
Malacostraca	9.7	trace	2.4	trace	...
Ephemeroptera	6.5	2.0	2.2	0.1	6.5
Odonata	38.7	19.4	13.2	18.0	17.2
Hemiptera	3.2	12.0	3.2	2.8	2.7
Coleoptera	16.1	13.9	2.4	53.8	28.0
Trichoptera	...	0.6	12.8	0.1	0.3
Diptera	19.3	20.4	57.9	trace	0.3
Hydracarina	...	trace	...	...	...
Orthoptera	...	...	1.2	3.9	...
Hemiptera	...	0.6	...	0.7	...
Homoptera	...	...	...	0.3	...
Coleoptera	...	3.9	0.2	11.7	...
Diptera	...	trace	...	1.0	...
Hymenoptera	6.5	27.2	0.2	4.1	...
Araneae	trace	...	...	...	...
Fish	...	...	...	3.5	34.0

TABLE 2. RESULTS OF STOMACH ANALYSES OF THREE SIZE GROUPS OF BLUEGILLS, SUMMARIZED BY MAJOR GROUPS

Organism	Ave. Standard Length 21.8 mm.	Ave. Standard Length 40.4 mm.	Ave. Standard Length 117.8 mm.
Annelida	...	...	4.0
Mollusca	...	1.9	2.6
Entomostraca	51.7	20.9	...
Malacostraca	6.6	4.7	trace
Ephemeroptera	21.7	8.5	...
Odonata	...	13.5	82.4
Hemiptera	...	...	...
Coleoptera	...	...	...
Trichoptera	...	1.1	0.7
Diptera	20.0	20.7	0.5
Hydracarina	...	...	trace
Orthoptera	...	...	6.6
Hemiptera	...	1.9	...
Homoptera	...	20.0	...
Coleoptera	...	2.2	0.2
Diptera	...	0.3	...
Hymenoptera	...	0.6	...
Araneae	...	...	...
Fish	...	...	...
Psocoptera	...	0.9	...
Plant Material	...	2.8	0.4
Animal Debris	...	...	2.6

TABLE 3. STOMACH CONTENTS OF FORD LAKE GRAYLING. BASED ON A SERIES OF 5 MALES AND 4 FEMALES COLLECTED APRIL 21, 1938. SEE TEXT FOR DETAILS.

Organism	Number of species	Number of individuals	Number of stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Average number of organisms in stomachs containing them	Percent of total volume, less debris
ENTOMOSTRACA							trace
Diaptomus sp.	1	12	1	12	12	12	trace
MALACOSTRACA							9.7
Hyalella nickerbockerii	1	42	4	27	2	10.5	9.7
EPHEMEROPTERA							6.5
Ephemera simulans N	1	4	2	2	2	2.0	3.2
Blasturus sp. N	1	9	3	5	1	3.0	3.3
ODONATA							38.7
Enallagma spp. N	2	16	7	5	1	2.2	22.6
Tetragoneuria sp. N	1	2	1	1	1	1.0	16.1
HEMIPTERA							3.2
Corixidae A	1	6	5	2	1	1.2	3.2
COLEOPTERA							16.1
Dytiscidae A	2	3	2	2	1	1.5	trace
Dytiscidae L	1	25	1	25	25	25.0	12.9
Gyrinidae A	1	4	4	1	1	1.0	3.2
Scarabaeidae A*	1	2	2	1	1	1.0	trace
Elateridae A*	1	1	1	1	1	1.0	trace
DIPTERA							19.3
Tanypodinae L	1	2	2	1	1	1.0	trace
Chironominae A	2	106	6	31	6	17.6	12.8
Chironominae P	1	2	2	1	1	1.0	trace
Chironominae L	2	4	4	1	1	1.0	3.2
Ceratopogonidae L	1	11	5	6	1	2.2	trace
Stratiomyiidae L	1	11	2	8	3	5.5	3.3
HYMENOPTERA							6.5
Tenthredinidae*	1	3	3	1	1	1.0	6.5
ARANEAE							trace
Thomisidae*	1	1	1	1	1	1.0	trace

*Terrestrial organisms.

TABLE 4. STOMACH CONTENTS OF FORD LAKE GRAYLING. BASED ON A SERIES OF 11 MALES AND 7 FEMALES COLLECTED MAY 8, 1938. SEE TEXT FOR DETAILS.

Organism	Number of species	Number of individuals	Number of stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Average number of organisms in stomachs containing them	Percent of total volume, less debris
ENTOMOSTRACA							
Bosmina	1	1	1	1	1	1.0	trace
Diaptomus	1	24	5	10	1	5.0	trace
MALACOSTRACA							
Hyalella	1	21	10	4	1	2.1	trace
EPHEMEROPTERA							2.0
Ephemera simulans N	1	1	1	1	1	1.0	trace
Blasturus cupidus N	1	1	1	1	1	1.0	trace
Baetis sp. N	1	15	8	3	1	1.9	2.0
ODONATA							19.4
Enallagma hageni N	1	49	15	8	1	3.3	19.4
Tetragoneuria sp. N	1	1	1	1	1	1.0	trace
HEMIPTERA							12.0
Corixidae A	1	18	11	5	1	1.6	4.0
Notonectidae A	1	8	7	2	1	1.1	8.0
Gerridae A	1	1	1	1	1	1.0	trace
COLEOPTERA							13.9
Haliplus sp. A	1	1	1	1	1	1.0	trace
Coptotomus sp. A	1	5	5	1	1	1.0	5.3
Bidessus sp. A	1	35	7	17	1	5.0	0.6
Dytiscidae, sp. L	1	2	2	1	1	1.0	trace
Dytiscidae, sp. A	1	2	2	1	1	1.0	4.0
Gyrinidae A	2	11	9	2	1	1.1	4.0
TRICHOPTERA							0.6
Sericostomatidae L	1	1	1	1	1	1.0	0.6
DIPTERA							20.4
Tanypodinae P	1	18	13	5	1	1.3	0.3
Chironominae L	2	56	12	12	1	4.7	1.3
Chironominae P	1	53	13	12	1	4.0	3.2
Chironominae A	1	11	4	8	1	2.7	trace
Ceratopogonidae L	1	12	9	4	1	1.3	0.3
Chaoborus punctipennis L	1	15	4	9	1	3.7	0.9
Empididae A	1	69	10	20	1	6.9	13.8
Stratiomyiidae L	1	3	2	2	1	1.5	0.6

(continued)

TABLE 4. (Continued)

Organism	Number of species	Number of individuals	Number of stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Average number of organisms in stomachs containing them	Percent of total volume, less debris
HYDRACARINA	1	9	6	4	1	1.5	trace
HEMIPTERA*							0.6
Enicocephalidae	1	1	1	1	1	1.0	0.6
COLEOPTERA*							3.9
Family?	3	3	1	1	1	1.0	0.6
Chrysomelidae	1	5	3	2	1	1.7	3.3
Aphodius sp.	1	2	2	1	1	1.0	trace
DIPTERA*							trace
Dolichopodidae	1	1	1	1	1	1.0	trace
HYMENOPTERA*							27.2
Formicidae	1	29	5	8	1	5.8	26.6
Family?	1	9	5	4	1	1.8	0.6
							100.0%

*Terrestrial organisms.

TABLE 5. STOMACH CONTENTS OF FORD LAKE GRAYLING. BASED ON A SERIES OF 17 MALES AND 11 FEMALES COLLECTED JULY 5 AND 6, 1938. SEE TEXT FOR DETAILS.

Organism	Number of species	Number of individuals	Number of stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Average number of organisms in stomachs containing them	Percent of total volume less debris
MOLLUSCA							trace
Physa sp.	1	2	2	1	1	1.0	trace
Pisidium sp.	1	1	1	1	1	1.0	trace
ENTOMOSTRACA							4.3
Bosmina sp.	1	+7,500	3	+6,000	1	+3,000	4.3
Diaptomus sp.	1	6	2	5	1	3.0	trace
MALACOSTRACA							2.4
Hyalella sp.	1	67	15	14	1	4.4	2.4
EPHEMEROPTERA							2.2
Baetidae	1	8	6	3	1	1.3	0.2
Ephemerella bicolor N	1	1	1	1	1	1.0	trace
Caenis simulans N	1	131	9	46	1	14.5	2.0
Tricorythodes allectus N	1	1	1	1	1	1.0	trace
ODONATA							13.2
Enallagma hageni	1	7	5	2	1	1.4	0.3
Anax junius	1	78	18	14	1	4.3	10.8
Libellulidae	2	8	5	3	1	1.6	0.4
Tetragoneuria sp.	1	3	1	3	3	3.0	1.7
HEMIPTERA							3.2
Corixidae A	1	38	12	9	1	3.1	3.0
Notonectidae A	1	5	4	2	1	1.2	0.2
COLEOPTERA							2.4
Haliplus sp. L	1	1	1	1	1	1.0	trace
Haliplus sp. A	1	1	1	1	1	1.0	trace
Gyrinidae A	1	14	7	3	1	2.0	1.9
Dytiscidae L	2	3	2	2	1	1.5	0.3
Dytiscidae A	1	2	2	1	1	1.0	0.2
TRICHOPTERA							12.8
Polycentropidae L	1	1	1	1	1	1.0	0.2
Oecetis inconspicua P	1	371	6	86	1	61.8	12.4
Sericostomatidae P	1	1	1	1	1	1.0	0.2
Family? A	1	1	1	1	1	1.0	trace

(continued)

TABLE 5. (Continued)

Organism	Number of Species	Number of individuals	Number of stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Average number of organisms in stomachs containing them	Percent of total volume less debris
DIPTERA							57.9
Chironominae L	2	4836	27	710	3	179.0	29.7
Chironominae P	2	2084	27	250	2	77.1	27.6
Ceratopogonidae L	1	12	2	8	4	6.0	trace
Ceratopogonidae P	1	34	16	7	1	2.1	0.2
Chaoborus punctipennis L	1	10	5	4	1	2.0	trace
Stratiomyiidae L	1	1	1	1	1	1.0	0.2
Chrysops sp. L	1	1	1	1	1	1.0	0.2
ORTHOPTERA							1.2
Ceuthophilus maculatus	1	1	1	1	1	1.0	1.2
COLEOPTERA*							0.2
Scarabaeidae	1	1	1	1	1	1.0	0.2
Family?	1	1	1	1	1	1.0	trace
HYMENOPTERA							0.2
Camponotus pennsylvanicus	1	1	1	1	1	1.0	0.2
							100.0%

*Terrestrial organisms.

TABLE 6. STOMACH CONTENTS OF FORD LAKE GRAYLING. BASED ON A SERIES OF 9 MALES AND 7 FEMALES COLLECTED OCT. 29-30, 1939. SEE TEXT FOR DETAILS.

Organism		Number of species	Number of individuals	Number of stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Average number of organisms in stomachs containing them	Percent of total volume less debris
AMPHIPODA								
Hyalella sp.		1	4	3	2	1	1.3	trace
EPHEMEROPTERA								0.1
Ephemera simulans		1	1	1	1	1	1.0	0.1
Ellasturus cupidus		1	1	1	1	1	1.0	trace
ODONATA								18.0
Gomphus exilis	N	1	4	3	2	1	1.3	3.8
Anax junius	N	1	18	7	4	1	2.6	12.2
Anax junius	A	1	2	1	2	2	2.0	0.1
Libellulidae	N	1	7	5	3	1	1.4	1.2
Libellulidae	A	1	2	2	1	1	1.0	0.7
HEMIPTERA								2.8
Corixidae	A	2	26	12	5	1	2.1	2.1
Notonecta undulata	A	1	2	1	2	2	2.0	0.7
COLEOPTERA								53.8
Dytiscidae	A	2	32	14	4	1	2.3	24.0
Gyrinidae	A	2	68	13	19	1	5.2	29.1
Hydrophilidae	A	1	4	3	2	1	1.3	0.7
TRICHIPTERA								0.1
Sericostomatidae	L	1	2	2	1	1	1.0	0.1
DIPTERA								
Chironomidae		1	4[1]	4	1	1	1.0	trace
ORTHOPTERA								3.9
Ceuthophilus maculatus		1	1	1	1	1	1.0	0.1
Lacustidae		1	2	1	2	2	2.0	3.8
HEMIPTERA*								0.7
Miridae		2	21	9	5	1	2.3	0.6
Lygoeidae		2	4	2	3	1	2.0	trace
Pentatomidae		1	1	1	1	1	1.0	0.1

*Terrestrial organisms.

[1] 1 larva, 3 pupae

(continued)

TABLE 6. (Continued)

Organism	Number of species	Number of individuals	Number of stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Average number of organisms in stomachs containing them	Percent of total volume less debris
HOMOPTERA							0.3
Cercopidae	2	3	2	2	1	1.3	0.2
Aphididae	1	21	6	9	2	3.5	0.1
COLEOPTERA*							11.7
Staphylinidae	1	2	2	1	1	1.0	trace
Buprestidae	1	1	1	1	1	1.0	0.1
Tenebrionidae	1	1	1	1	1	1.0	trace
Scarabaeidae (Aphodius sp.)	2	176	15	29	1	11.7	11.2
Chrysomelidae	2	4	4	1	1	1.0	0.1
Curculionidae	1	4	2	2	2	2.0	0.3
DIPTERA*							1.0
Bibionidae	1	2	2	1	1	1.0	0.3
Tachinidae	2	2	1	2	2	2.0	0.7
HYMENOPTERA							4.1
Ichneumonidae	2	3	3	1	1	1.0	0.8
Braconidae	1	1	1	1	1	1.0	trace
Formicidae	1	1	1	1	1	1.0	trace
Vespidae (*V. maculata*)	1	7	7	1	1	1.0	3.3
FISH							3.5
Bluegill (*L. macrochira*)	1	9	5	3	1	1.8	3.5
							100.0%

*Terrestrial organisms.

TABLE 7. STOMACH CONTENTS OF FORD LAKE CRAYLING. BASED ON A SERIES OF 4 MALES AND 6 FEMALES COLLECTED MARCH 1-2, 1939. SEE TEXT FOR DETAILS

Organism	Number of species	Number of individuals	Number of stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Average number of organisms in stomachs containing them	Percent of total volume, less debris
MOLLUSCA							11.0
Physa sp.	1	11	2	6	5	5.5	11.0
Helisoma sp.	1	1	1	1	1	1.0	trace
EPHEMEROPTERA							6.5
Ephemora simulans N	1	6	2	4	2	3.0	1.3
Hexagenia occulta N	1	2	2	1	1	1.0	3.0
Stenonema tripunctatum N	1	2	2	1	1	1.0	1.3
Blasturus cupidus N	1	23	4	20	1	5.7	0.9
ODONATA							17.2
Enallagma spp.	2	58	2	57	1	8.8	1.8
Aeshna sp.	1	1	1	1	1	1.0	0.9
Anax junius	1	8	4	4	1	2.0	11.6
Libellulidae	2	4	3	2	1	1.3	2.9
HEMIPTERA							2.7
Corixidae A	1	9	5	2	1	1.8	2.7
COLEOPTERA							28.0
Dytiscidae A	1	14	8	5	1	2.8	9.3
Gyrinidae A	1	49	8	17	2	6.1	18.7
TRICHOPTERA							0.3
Sericostomatidae P	1	1	1	1	1	1.0	0.3
DIPTERA							0.3
Chironominae L	1	49	8	14	1	6.1	0.3
FISH							34.0
Bluegill (*L. macrochira*)	1	40	10	8	1	5.0	34.0
							100.0%

TABLE 8. STOMACH CONTENTS OF BLUEGILLS FROM FORD LAKE, MICHIGAN. BASED ON A SERIES OF 9 SPECIMENS COLLECTED OCT. 28-29, 1939. SIZE RANGES: S.L., 15-26 mm., ave. 21.8 mm.; T.L., 18.33 mm., ave 27.4 mm.

Organism	Number of species	Number of individuals	Number of stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Average number of organisms in stomachs containing them	Percent of total volume less debris
ENTOMOSTRACA							
Bosmina sp.	1	147	8	50	3	18.4	51.7
MALACOSTRACA							
Hyalella knickerbockerii	1	2	1	2	2	2.0	6.6
EPHEMEROPTERA							
Paraleptophlebia sp.	1	3	3	1	1	1.0	21.7
DIPTERA							
Chironomus spp.	2	15	4	8	1	1.9	20.0
							100.0%

TABLE 9. STOMACH CONTENTS OF BLUEGILL FINGERLINGS FROM FORD LAKE, MICHIGAN. BASED ON A SERIES OF 15 SPECIMENS COLLECTED OCT. 28-29, 1938. SIZE RANGE: S.L., 33-50 mm., ave. 40.4 mm.; T.L., 42-63 mm., ave. 50.9 mm.

Organism	Number of species	Number of individuals	Number of stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Average number of organisms in stomachs containing them	Percent of total volume less debris
MOLLUSCA							1.9
Helisoma sp.	1	2	1	2	2	2.0	1.9
ENTOMOSTRACA							20.9
Bosmina sp.	1	38	3	20	3	16.0	8.7
Diaptomus sp.	1	51	6	20	4	8.5	12.2
MALACOSTRACA							4.7
Hyalella knickerbockerii	1	14	5	6	1	2.8	4.7
EPHEMEROPTERA							8.5
Ephemera simulans	1	1	1	1	1	1.0	2.2
Paraleptophlebia sp.	1	5	3	3	1	1.6	3.8
Baetis sp.	1	1	1	1	1	1.0	2.5
ODONATA							13.5
Enallagma sp.	1	4	1	1	1	1.0	13.5
TRICHOPTERA							1.1
Sericostomatidae	1	3	1	1	1	1.0	1.1
DIPTERA							20.7
Chironominae	2	111	11	30	1	10.9	20.7
PSOCOPTERA							0.9
Psocidae	1	2	1	1	1	1.0	0.9
HEMIPTERA*							1.9
Miridae	1	1	1	1	1	1.0	1.9
HOMOPTERA							20.0
Cicadellidae	1	1	1	1	1	1.0	0.3
Aphididae	1	33	7	9	3	4.7	19.7
COLEOPTERA*							3.2
Staphylinidae	1	1	1	1	1	1.0	0.3
Scarabacidae	1	1	1	1	1	1.0	1.6
Family ?	1	1	1	1	1	1.0	0.3
DIPTERA*							0.3
Family?	1	1	1	1	1	1.0	0.3
HYMENOPTERA							0.6
Ichneumonidae	1	1	1	1	1	1.0	0.6
Cynipidae	1	1	1	1	1	1.0	trace
ALGAE	2	...	4	...	...	...	2.8
							100.0%

*Terrestrial organisms.

TABLE 10. STOMACH CONTENTS OF BLUEGILLS FROM FORD LAKE, MICHIGAN. BASED ON A SERIES OF 18 SPECIMENS COLLECTED OCT. 28-29, 1938. SIZE RANGE: S.L., 105-130 mm., ave. 117.8 mm.; T.L., 132-160 mm., ave. 146.8 mm.

Organism	Number of species	Number of individuals	Number of stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Average number of organisms in stomachs containing them	Percent of total volume
ANNELIDA							4.0
Lumbricidae	1	1	1	1	1	1.0	4.0
MOLLUSCA							2.6
Helisoma sp.	1	4	4	1	1	1.0	2.2
Musculium sp.	1	1	1	1	1	1.0	0.4
MALACOSTRACA							trace
Hyalella knickerbockerii	1	1	1	1	1	1.0	trace
ODONATA							82.4
Gomphus exilis N	1	4	3	2	1	1.3	15.1
Anax junius N	1	3	3	1	1	1.0	10.6
Tetragoneuria cynosura simulans N	1	6	2	3	3	3.0	16.6
Ladona julia N	1	16	7	6	1	2.3	35.4
Celithemis elisa N	1	2	2	1	1	1.0	4.7
TRICHOPTERA							0.7
Phryganeidae L	1	1	1	1	1	1.0	0.7
DIPTERA							0.5
Chironomidae	2	14	4	7	1	3.5	0.5
Ceratopogonidae	1	7	2	4	3	3.5	trace
HYDRACARINA							trace
Hydrachnidae	1	1	1	1	1	1.0	trace
ORTHOPTERA							6.6
Ceuthophilus meridionalis	1	1	1	1	1	1.0	6.6
COLEOPTERA*							0.2
Carabidae	1	1	1	1	1	1.0	0.2
ANIMAL DEBRIS	...	...	1	...	...	...	2.6
PLANT DEBRIS	...	...	2	...	...	...	0.4
							100.0%

*Terrestrial organisms.