Original: Fish Division
cc: Dr. Leonard
Education-Game

INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

ALBERT S. HAZZARD, PH.D.
DIRECTOR

ADDRESS
UNIVERSITY MUSEUMS ANNEX
ANN ARBOR, MICHIGAN

March 20, 1941

REPORT NO. 659

THE FEEDING HABITS OF LEGAL BROOK TROUT IN HUNT CREEK DURING THE 1940 FISHING SEASON

by

Justin W. Leonard

INTRODUCTION

When the intensive creel census of the experimental sections of Hunt Creek (T. 29 N., R. 2 E., Sec. 35) was undertaken at the opening of the 1939 trout season, the census clerks were instructed to offer to clean the catch of anglers contacted, in order to make available for examination a large series of trout stomachs from the stream area about to receive prolonged and detailed ecological study. The practice was continued in 1940; and it is the collection of that year which is here considered.

Studies of bottom fauna production have also been under way since August, 1939, and a report on this work is in progress. Other similar investigations, on which progress reports are now being prepared, cover trout feeding habits in East Fish Lake, the large beaver pond near the upper end of Fuller Creek (where the trout show the largest size and best condition of any found in the system) and minor tributaries of Hunt Creek, as well as

collections from Hunt Creek during the 1939 trout season.

From such investigations it is expected that conclusions may be reached regarding the importance in the diet of the trout of aquatic and terrestrial food organisms, the relation between these and the character of the immediate environs of the stream, and the relation of food available to food actually eaten by trout.

MATERIALS AND METHODS

Stomachs collected by census clerks were wrapped in cheese cloth and preserved in formalin. Individual measurements were recorded only in the case of solitary specimens. When a series of stomachs was taken, the ranges of total length and weight were recorded on a lable inserted in the package, as well as the section of the stream where taken, the approximate time of day, and the type of lure employed. Collectors were warned to be especially careful to remove the entire gullet with the stomach, a necessary precaution because a trout taken by angling may regurgitate the contents of its stomach during its struggles to escape.

The stomachs were opened in the laboratory, after the formalin had been washed away, and their contents removed to alcohol-filled watch glasses for sorting. Food organisms were identified under the microscope, then their volume was measured by displacement of fluid in a centrifuge tube. With this tube, volumes may be measured exactly to 0.10 cubic centimeters, and estimated to 0.025 cubic centimeters with reasonable accuracy. Any item of food bulking less than 0.025 cubic centimeters was recorded as a "trace." The various food organisms encountered were recorded on the standard stomach analysis card, Form 5473.

From the five sections designated A, B, C, D and E, and the undesignated section lying immediately below Section A, 136 stomachs were obtained during the 1940 trout season. Of these, 5 were empty; only the 131 containing food are considered here. Of the 131 stomachs containing food, 10 are known to have been collected below Section A, and 12 more were taken by two anglers who fished both in and below Section A. Therefore, at least 110 stomachs were secured from the designated sections, which in 1940 yielded 406 legal trout; and at least 13 came from below A, from which 197 trout were recorded. The census below A, however, certainly did not cover all persons angling there, and the extent of water area involved was uncertain.

In the tables appended to this report, an attempt has been made to show the feeding habits of the trout by days and by sections (Tables 2 and 4-11) as well as to summarize the diet for the census area as a whole for the entire season. Figures for comparison of diet with bottom-inhabiting food organisms are provided in Table 3.

In Tables 4-7, determinations of food organisms were carried as far as was possible with the information at hand. Although some progress has been made, at the experiment station, in rearing through aquatic insects to connect their immature and adult stages and so render identifications reasonably certain, many remain to receive this attention. In these tables the growth stage of the various organisms when eaten has been indicated by letters: L = larva; N = nymph; A = adult; P = pupa; and S = subimago, a term referring to mayflies which have just emerged as adults but which have yet to undergo a second moult before becoming fully mature.

Inasmuch as the habitat requirements of the various growth stages differ, and since these differences undoubtedly affect their availability to trout, a brief comment on some of them may be in order. Larvae are, in general,

worm-like, soft-bodied oreatures which are the first growth stage of insects displaying complete metamorphosis (i.e., that type which includes a pupal, or resting, stage in its life-cycle). Among the common stream-inhabiting forms of this group are the beetles, the caddisflies, and the true flies (craneflies, midges, blackflies, deer flies, snipe flies, etc.). These larvae variously burrow in the bottom, cling to stones, or tunnel through marl concretions. A few, like some beetles, are free-swimming in quiet water, and a few may creep over submerged plants and debris. Some true fly larvae may adhere to stones in fast, shallow riffles by means of silken threads (black-flies) or spin for themselves delicate, semi-transparent tubes or cases on stones (some craneflies and some midges). Caddisfly larvae are famous for their protective cases, made of silk covered with sand, sticks or debris; but some of the most abundant stream species dispense with the larval case altogether (Rhyacophila, Chimarrha, Hydropsyche, Parapsyche), at most spinning a network of silken threads over the substratum as an anchor for their claws, or building a sort of fine gravel stockade fronted by a silk net to entrap minute floating food organisms. When a larva has completed its growth, it undergoes considerable change, and enters the so-called pupal stage. Most pupae are relatively quiescent, for in this stage the bodily structure of muscles and internal organs is radically altered. Some pupae are rendered wholly sessile by occupying cases cemented to the substratum. Such forms are helpless if exposed by a sudden lowering of the water level. Others, notably midge pupae, are quite active. From the pupae the adult insects emerge, or "hatch."

Nymphs are the immature stages of insects characterized by gradual or incomplete metamorphosis. Here belong the mayflies, dragonflies, stoneflies and water bugs. The pupa, or resting stage, is dispensed with, and the adult

emerges from the fully-grown nymph a perfect insect, save among the mayflies where the first winged stage, the subimagos ("duns" of the trout fisherman) undergo a moult before becoming sexually mature mayflies ("spinners" in anglers' parlance). Nymphs of most species of mayflies inhabiting the experimental area of Hunt Creek either clamber over the stones of the bottom (Ephemerella, Stenonema), or inhabit chinks between gravel and coarse pieces of sand in the bottom (Baetis). Nymphs of Paraleptophlebia are often found on submerged wood fragments and sometimes, with some species of Baetis, on aquatic plants. Burrowing nymphs of Ephemera and Hexagenia ("wigglers" of the ice fisherman) are rare in Hunt Creek, for their favored habitat, silty, quiet backwaters, is infrequent in the area. Nymphs of the dragonflies Ophiogomphus and Cordulegaster, being large and strong-bodied, are able to occupy swift-water areas where they cling to roughened stones or even burrow in coarse sand. Nymphs of Boyeria, another common trout stream dragonfly, generally occur in the tangle of exposed roots and debris in the shelter of undercut banks. Nymphs of stoneflies are strongly flattened and, in most instances (Capnia, Allocapnia, Leuctra, Isogenus), cling to the under side of stones in swift water. The protective value of this habitat is undoubtedly great, as trout would have to turn stones over to reach them. A few stonefly nymphs (Nemoura and some species of Isoperla) may be found associated with the mayfly Paraleptophlebia in quieter areas on submerged wood and debris.

True water bugs occur here and there in the stream, chiefly in quieter sections. In their development, which is also of the gradual metamorphosis type, there is little difference in appearance, aside from size, between young and fully grown specimens. The commoner water bugs of Hunt Creek are

water boatmen (Corixidae), backswimmers (Notonectidae) and various Belostomatidae (Belostoma and Lethocerus). Water boatmen are the most important of the aquatic Hemiptera in the trout diet. They occur commonly in backwater areas over flocculent silt deposits. When alarmed they either dart into the stream or burrow in the silt. Because of their wariness and agility they are not often taken in bottom samples in truly representative numbers.

In Tables 4-11 the listing shows the number of individual organisms consumed, and their percentage of the total volume, for each day of collection and, where possible, for each designated section. This has been done to show more plainly the wide acceptability and availability to trout of a great majority of the bottom-inhabiting organisms, and to facilitate close comparison of feeding habits with total bottom fauna, the latter being the subject of a report soon to be submitted.

It will be seen that, while numbers of individual organisms utilized are listed, the dietary importance of each form is computed, not on the basis of numbers, but on that of percentage of total of food volume consumed. Some workers have elected to assign importance on the basis of numbers. Needham (p. 114)* wrote: "Recording food organisms by number does show the selectivity [sic] of the fish, since it is probable that each organism swallowed must first be secured by a definite selecting effort on the part of the fish. In bulk, one good sized minnow or crayfish will equal perhaps fifty midge larvae or mayfly nymphs or twenty to twenty-five caddicefly larvae...However these [larger] animals are not abundant, and while they may offer a feast to trout occasionally, their 'daily bread' comes from the smaller but more abundant forms." Certain portions of this statement obviously are true, but others are

*Needham, P. R. Trout Streams. Comstock Publishing Co., Ithaca, N. Y., 1938.

open to argument. For, while it is true that one minnow or crayfish will many times outbulk a small form such as a midge or caddis larva (if anything, Needham's estimates are too low), it is also true that one or two feeding fish taken for stomach samples may have run into a swarm of some small species and gorged themselves thereon, while other fish of the same sample, not having chanced upon the swarm, will not contain this species. Such a situation leads to an erroneous conclusion as to importance just as surely as does one involving the occasional appearance of a single bulky food item such as a minnow or crayfish. For example, in Table 1 we see that 169 mayflies and 133 aquatic Hemiptera were found in the stomachs; yet, on a volumetric basis, the mayflies accounted for 5.0 per cent of the total volume while the aquatic Hemiptera made up only 1.5 per cent. We see further that mayflies were found in 52 stomachs while aquatic Hemiptera occurred in only 24. On the basis of numbers alone, aquatic Hemiptera should rank next to mayflies in importance, where by volume they rank fifth, which is almost certainly nearer their true value. Caddisflies, too, were found in 113 stomachs, numbered altogether 860 specimens, and accounted for 18.1 per cent of the total volume. Aquatic Diptera (midges, blackflies, deer flies, snipe flies, etc.), although numbering 1,332, much more than any other form, occurred in only 85 stomachs and accounted for only 9.9 per cent of the total volume.

It appears to the writer that the least misleading method of tabulation is that used by Clemens (1928)*, whereby percentages of dietary composition are assigned on a volumetric basis, but with the listing of total numbers of individuals and frequency of occurrence of forms also supplied. In this way, a very complete picture of feeding habits is supplied for instant reference.

---

*Clemens, W. A. 1928. Food of trout -- Oneida County. Trans. Am. Fish. Soc. 1928, pp. 183-197.

Another method of tabulation sometimes employed, most recently by Morofsky*, seems to the author to be even less useful in the analysis of fish feeding habits and in the application of this information to the practice of fisheries management. This method entails the inclusion of adult aquatic insects with terrestrial insects. While this may throw some light on the proportion of feeding done at the surface, it is confusing to the worker whose aim is to determine the value of the stream fauna in supporting its resident trout population. Aquatic insects are products of the stream, just as much when adult as when immature. The terrestrial environment provides the adults with almost no nutritional support except in the case of the dragonflies and a few flies, all unimportant to trout both in numbers and volume. The adults of mayflies and caddisflies almost never possess functional mouthparts, and adult stoneflies feed but little. In Tables 4-11, symbols are employed to indicate the growth stage of the organisms consumed. This serves to reveal the proportion of feeding carried on at or near the surface or at the bottom, and at the same time permits consideration of stream-produced food organisms as a unit for comparison with forms of strictly terrestrial origin.

Vertebrates consumed -- fish and frogs -- have been listed separately. Neither has proved to be important in Hunt Creek thus far, either in number or volume. The fish, of course, must be considered as a part of the stream's contribution toward the support of its trout population. For the frogs, such a distinction cannot be made easily. Frogs are, of course, strictly aquatic in their immature or tadpole stage, and even after metamorphosis frequent water. The immature stages, however, generally develop in ponded water. Thus, in both

---

*Morofsky, W. F. A comparative study of the insect food of trout. Jour. Econ. Ent. 33 (3):544-546, July 20, 1940.

stages, their indebtedness to the stream for nutritional support cannot be accurately estimated, and without knowing more of their habits it would be unsafe to assign to them a definite rank of importance in Hunt Creek.

DISCUSSION OF FEEDING HABITS BY SECTIONS

Below Section A.- As has been mentioned previously, the exact places where trout were taken below Section A cannot be accurately placed; they may have been caught almost anywhere in a half-mile or more of stream. Ten stomachs containing food were examined, however, and the findings listed in Table 4. It is probable that differences in diet of fish from below A as compared with those taken further upstream are to be accounted for chiefly by physical differences in the stream and its environs, with corresponding differences in bottom fauna and accidental terrestrial insects. For example, Table 4 shows the occurrence of crayfish (Cambarus sp.) in two stomachs. No crayfish were found in trout collected in the other sections. Among the mayflies were nymphs of Stenonema rivulicolum and of four species of Ephemerella. None of these were found in stomachs from Sections B, C, D or E. In these sections bottom samples have shown them to be of rare occurrence, and where present, only Ephemerella invaria has been found thus far. Ephemerella subvaria, needhami, lata and bicolor apparently possess requirements met by larger stream size than the designated sections provide. Although caddisflies and true flies were well represented in the stomachs, no one species was significantly more numerous than another. There is no indication of specific selectivity on the part of the trout as regards Diptera.

It is rather surprising that terrestrial forms were not of more importance

in the diet of the trout below A. In only two of the five collections did terrestrial insects outbulk forms of aquatic origin, despite the fact that, for the most part, this portion of the stream is relatively open, flowing through what would appear to be a favorable habitat for grasshoppers, land beetles and flies.

Section A.- This section of stream flows through a broad, marshy meadow. The stream itself is wide and often rather shallow, flowing over a bottom composed almost entirely of sand, the edges lined with silt bars of varying extent. Gravel appears but seldom in the bottom. The meadow is thickly grown with sedges, but streamside trees or shrubs are very infrequent. Occasional beds of aquatic plants -- fine-leaved Potamogetons and Veronica -- occur, but rather sparingly.

Natural food production in Section A, as revealed from such bottom samples as have been taken there to date, is apparently rather low. Burrowing mayfly nymphs (Ephemera and Hexagenia), freshwater shrimp (Hyalella and Gammarus), and various annelid worms are fairly plentiful in the weed beds and marginal silt bars, but apparently are not very readily available to trout. The mayflies, caddis and midges whose immature stages abound in the gravel-bottom sections upstream appear to be of very infrequent occurrence. For this reason, it is rather strange to find so many caddis and midge larvae in the stomachs of trout from Section A. Repeated seinings of marked fish in Hunt Creek have not as yet revealed any marked tendency toward extensive movement of the trout population between sections. It therefore seems likely that a good share of the normally gravel-inhabiting forms found in the Section A stomachs had been dislodged and were taken as floating drift.

In Section A, as below A, one might have expected to find a considerable

proportion of the diet composed of terrestrial forms; but in each collection, species of aquatic origin were responsible for more than half of the stomach contents.

One of the trout from this section contained a brook trout fingerling -- the only one of the 131 stomachs showing evidence of cannibalism. It should be borne in mind, too, that fish other than trout are not abundant in Hunt Creek in the experimental area. When Diversion Section II-A was drained down for the first time, the ratio of muddlers to trout was approximately 1 : 10. Blunt-nosed minnows and common shiners have been found, but very infrequently. It is possible that cannibalism may reach larger proportions during the colder parts of the year. Several isolated instances of this sort have been noticed during monthly seinings, and in the case of trout passing through the weirs.

Section A and below.- A series of 12 trout were taken by two anglers on June 21 from both Section A and the stream for some distance below. The fish in this catch could not be separated according to section of origin, and so are considered together. The stomach contents are summarized in Table 6.

Larvae of the log-cabin caddis, Brachycentrus americanus, were taken rather freely by these trout. This caddis is not common in the gravel sections, but has been encountered frequently in Section A, where the larvae cling to submerged drift, aquatic plants, and especially to leaves of sedges which overhang the banks and trail in the water. Because of the openness of Section A , trout inhabiting it are very wary. As overhanging banks afford the principal shelter, it is apparent that trout feeding on Brachycentrus larvae from overhanging sedges may do so with relative impunity, only a few inches from cover.

This lot of stomachs further illustrates the reasons mentioned on pages 6 to 8 for not listing food organisms solely according to numbers consumed.

Of the twelve stomachs, three contained a total of 294 adult dance flies (Empidae). But, of the three stomachs, one contained 252, another 40, and the last, two. Actually, more empids were taken than all other organisms combined from the twelve stomachs; yet, on a volumetric basis they made up only 6.3 per cent of the total contents, and occurred in only 25 per cent of the stomachs.

Section B.- This portion of the stream flows, for the most part, through a spruce-cedar-tamarack swamp, with occasional clumps of tag alder along the bank. The bottom, however, is not typical of swamp streams. Gravel is the predominant material, but there are extensive silt bars in many places, where grow thick beds of water speedwell, Veronica connata.

As would be expected in a gravel-bottom section, caddis larvae and pupae were well represented in the 11 stomachs available from Section B. However, in each of the four collections, terrestrial insects were responsible for a majority of the stomach contents. Grasshoppers, leafhoppers, beetles and ants were taken frequently, and the presence of tamaracks along the bank is reflected by the presence of larvae of the larch sawfly, Lygaeonematus erichsonii. It is the instinct of these larvae, when their growth is complete, to drop to the ground for pupation. At times there is a veritable rain of mature larvae; and those which feed on branches overhanging the stream naturally drop into the water.

The large amount of grasshoppers, beetles, etc., in the diet of the Section B fish seems surprising at first glance. A possible explanation is that almost the only openings in the thick swamp occur in the zone immediately adjacent to the stream bank, and sun-loving terrestrial insects probably congregate in this restricted region, with the result that many fall or jump into the stream.

One of the trout taken from Section B was 12½ inches long (the largest brook trout caught during 1940 from the experimental sections of Hunt Creek), but contained no fish, trout or other species.

Section C.- Throughout this section the current is swift (1.5-2.5 feet per second) and flows over a bottom in which fine to medium gravel predominates. Although the immediate environs of the stream bank are often of swampy character, the upper two-thirds of the section flows between high, sandy banks which support an open growth of aspen, birch and balm-of-Gilead. Clumps of alder frequently overhang the water. In the main, cover from streamside trees and shrubs is so extensive as to make fly-fishing difficult.

In this section, as in Section B, terrestrial food organisms outweighed those of aquatic origin. Aquatic Diptera, especially midge larvae which so often constitute the "bread-and-butter" of trout diet, here fell to a position of negligible importance. Only 12 midge larvae were encountered in the 23 stomachs examined! A wide variety of caddis immatures were found, but only Chimarrha and a small, sand-case limnophilid in large numbers. Ten robber flies (Asilidae) were consumed, a rather large amount for a terrestrial form never noticeably abundant. These flies are predatory and may have been attracted to the stream by "hatches" of aquatic insects.

Section D.- This section, which extends from the road bridge at the upper end of Section C to the edge of the big swamp in which Hunt Creek originates, actually presents three different ecological situations. The lower of these, extending up from the bridge for about 75 yards, is similar in character to Section C. Then one encounters a stretch about 50 yards in length where steep banks narrow down and deepen and accelerate the flow over a bottom where hard clay ledges, similar to those in the Pine River, Lake County, occur. Then the

first of two old beaver dams is reached. From them to the edge of the swamp the stream is open, rather sluggish, and flows over a soft bottom of silt, sand, and the muck generally deposited in beaver ponds. As Shetter has mentioned (Report No. 644), these dams are in poor repair, and hold up only about one-third as much water as when first seen by Institute workers in January, 1939.

It is likely that most of the fish taken from Section D during 1940 came either from the lower end, where conditions resemble those of Section C, or from the beaver ponds. The fast, clay-ledge run is so densely overhung with brush as to render angling very difficult.

Much the same variety of food organisms was found in the Section D stomachs as in those from Section C. There is little to suggest that the beaver ponds made any significant contribution to trout diet. Trout stomachs taken from ponds held up by beaver dams of fairly recent origin and in good repair generally include a considerable quantity of food species typical of this situation -- freshwater shrimp, crayfish, minnows, especially mud minnows (Umbra limi) and sticklebacks (Eucalia inconstans), burrowing mayfly nymphs (Hexagenia and Ephemera spp.) and various aquatic Hemiptera, especially water boatmen or corixids. The Section D stomachs either contained none of these organisms or displayed them in insignificant numbers. The 21 stomachs contained but four shrimp, no crayfish, only one minnow, no burrowing mayflies, and significant numbers of aquatic Hemiptera only in the July 2 collection. These findings support Shetter's view (Report No. 644) that partial failure of the dams with consequent lowering of ponded water has greatly decreased the value of these ponds as trout habitat.

Sections C and D combined.- Twenty-four trout taken by anglers fishing in both C and D could not be separated as to section of origin. The series was

divided among four collections, in each of which foods of terrestrial origin were in the majority. Blackflies (Simulium sp.) were well represented, as were two groups of caddis (Chimarrha and limnophilids). The occurrence of haliplid and omophronid beetles indicates feeding by trout in ponded areas, but the other food organisms are characteristic of general stream feeding. A notably large number of grasshoppers -- 15 -- was taken.

Sections C and E combined.- As has been mentioned, Section E designates the stream in the headwater swamp. The cedar and spruce growth is very dense, shading the stream almost completely at all times. Extensive additional cover in the form of fallen logs overgrown with moss also exists. The bottom is predominantly sandy, and supports very few organisms.

It is not known what part of the four fish listed under this heading were taken in Section E; but it is a fairly safe speculation that few bottom organisms were consumed there. Most of the terrestrial forms taken, however, would not be out of place in a swamp association.

GENERAL CONSIDERATIONS

It is of interest to compare Tables 1 and 3. The first summarizes, by Orders, the food of all the trout whose stomachs were examined. The other lists in similar fashion findings derived from 13 square-foot bottom samples taken from Sections B and C during the summer and early fall months.

In preparing the tables dealing with stomach analyses, numbers and per cent of volume of organisms consumed have been listed on the basis of unidentifiable organisms. Plant and animal debris were ignored in determining these values, for there is little reason to doubt that similar ratios exist in the finely comminuted debris. The animal debris comprised fragments of

food organisms. The plant debris, almost without exception, was composed of remains of caddis cases.

The average volume of the 13 bottom samples was 0.850 cubic centimeters. That of stomach contents for individual fish was found to average 0.638 cubic centimeters. Disregarding the plant debris, this latter figure drops to 0.565 cubic centimeters, the figure which should be used when comparing average stomach contents with average bottom samples, as caddis cases were not measured in the bottom sampling operations.

We do not yet know, unfortunately, how much natural food a legal trout consumes in a 24-hour period. The amount undoubtedly varies due to many factors, -- metabolic rate, size of fish, water and air temperatures, cloudy or fair weather, possibly barometric pressure, amount and accessibility of food present, and extent of competition. But if the average volume of stomach contents be considered as an average meal, it will be seen that, on the basis of bottom sampling averages, it would require all of the bottom fauna from two square feet to make an average meal for three legal trout if only bottom foods were taken. During the season covered, slightly more than half of the diet was of aquatic origin. Still using our averages, that would mean that all the bottom fauna of two square feet would supply the aquatic portion of one meal for six trout feeding equally on aquatic and terrestrial foods.

It is obvious, of course, that no one fish would be likely to capture all the organisms from a given square foot of bottom; but the foregoing comparative figures convey some idea of the feeding pressure which must be continually exerted against the bottom fauna. Just how much the bottom fauna would increase if relieved from this pressure is a problem which is being attacked by an experiment set up for Section II-A in the new diversions at the

Hunt Creek Experiment Station (see Report No. 645). This experiment entails shutting off fish entirely from one 282-foot section of the original stream channel, with bottom sampling at frequent intervals to check on the increase due to lack of predation.

It is eminently necessary that we learn more of the daily natural food requirements of trout of all sizes under various seasonal conditions. This will require carefully conducted physiological experiments; but in the meantime, empirical knowledge of practical management value may be obtained by an analysis of figures obtained from bottom sampling and stomach examinations, stream bottom surveys and trout population counts, and from a consideration of figures so derived in connection with results of trout condition, growth rate and yield investigations.

In comparing Tables 1 and 3 it is of interest to note that aquatic food organisms by no means occur in the same ratios in bottom samples and stomachs. Caddisflies lead in each case, but in the bottom samples stoneflies rank second, and in the stomachs last. Mayflies and Diptera (midges, blackflies, etc.) occur in reversed order, ranking second in the stomachs and third in the bottom samples, on a volumetric basis. Aquatic beetles, which were fourth in importance in the stomachs, occupied last place in the bottom sample.

The value of stoneflies to the trout population is questionable, for not only did they occupy an insignificant position in the trout diet, but also the bulkiest and one of the most numerous species, Isogenus frontalis, is itself carnivorous, feeding on other aquatic insects, especially mayfly nymphs and midge larvae.

The scarcity of freshwater shrimp (Gammarus and Hyalella) in the stream is doubtless due to the small extent of suitable habitat available. Shrimp

seem to be most abundant in dense beds of aquatic plants growing on bars composed of silt and fine organic debris -- watercress, Chara, white water buttercup -- and such plant beds and silt bars are infrequent and small in the stream area here considered. Shrimp are conceded to be one of the most desirable of natural trout foods, and it is noteworthy that anglers who have known Hunt Creek for many years agree that when the stream afforded excellent angling and large fish, Chara beds of great density and extent practically filled the stream, open water existing only in a network of narrow, anastomosing channels. At that time, it is said, the water and accumulated silt were so deep as to make wading difficult. About 1930, however (reports differ as to the exact time), it is claimed that a period of low water during the winter, coupled with heavy ice formation, followed by heavy spring floods, resulted in almost complete destruction of these Chara beds. However, some of the "old-timers" claim that the loss of plants was much hastened by increasing numbers of anglers wading through them, and by short-sighted bait seekers who, in their search for muddlers, raked out onto the banks large quantities of plants, much as bluegill bait hunters stripped some of the spring brooks in Kalamazoo County in the winter of 1934-35. Whatever the reason for their destruction, the disappearance of weed beds is generally agreed to have coincided with the reported decline of the fishery.

Although a total of 860 caddis were consumed, only 26 of these were Mystrophora americana, the species which, in natural occurrence, far outnumbers all other caddis species combined in Sections B and C. This species, both as larva and pupa, occupies small, dome-shaped cases of coarse sand cemented to the tops and sides of stones. As these forms are in plain sight and apparently easy of

access, it is surprising that so few were eaten. It is unlikely that the case presents any hindrance to feeding trout, for large numbers of sand-case limnophilids were found in the stomachs.

Five rose beetles (Macrodactylus subspinosus) were found in the stomachs. In this connection, reference is made to Report No. 610 and Memorandum No. 90 by Leonard Allison, in which is discussed the possible poisonous effect of these beetles in view of their recorded toxicity to chickens. It is planned to set up an experiment, when the rose beetles appear next summer, for the purpose of feeding them to brook, brown and rainbow trout to determine definitely whether or not they are dangerous to trout.

THE FEEDING HABITS OF LEGAL BROOK TROUT IN HUNT CREEK DURING THE 1940 FISHING SEASON

Justin W. Leonard

ABSTRACT

This report deals with brook trout feeding habits in the experimental area of Hunt Creek as revealed by analyses of stomachs secured from anglers by creel census clerks during the 1940 trout season.

A total of 131 stomachs containing food were examined. In these, foods of aquatic origin and foods of terrestrial origin were almost of equal bulk, but the former were more than four times as numerous as the latter. Caddisflies, true flies (including midges) and mayflies, immature and adult, were most important among aquatic foods. Grasshoppers, beetles and ants dominated the terrestrial share of the diet. Backboned animals, represented by fish and frogs, accounted for approximately 10 per cent of the diet on a volumetric basis, but were unimportant from the standpoint of numbers or frequency of occurrence.

Included in this report, for comparative purposes, are averages obtained from 13 bottom samples taken from the experimental area during the 1940 fishing season. It is shown that the average volume of contents of an individual legal-length brook trout stomach is approximately two-thirds that of the total fauna of an average square foot of bottom. It is pointed out that while little is yet known regarding the amount of natural food ordinarily eaten by a trout in a given length of time, the stomach contents at time of analysis may be arbitrarily designated as a meal. If this is done, calculation reveals that it would require all of the bottom fauna from two square feet to supply the aquatic portion of one meal for six legal-length trout feeding equally on aquatic and terrestrial foods.

INSTITUTE FOR FISHERIES RESEARCH
By Justin W. Leonard

Report approved by: A. S. Hazzard
Report typed by: Alma Hartrick

Table 1

FEEDING HABITS OF 131 LEGAL BROOK TROUT FROM HUNT CREEK,
ALL SECTIONS COMBINED, 1940 FISHING SEASON

Organism	No. of stomachs containing organism	Total no. of organisms	Per cent of total volume
(AQUATIC INVERTEBRATES)			
Trichoptera (Caddisflies)	113	860	18.1
Diptera (Flies, midges, etc.)	85	1,332	9.9
Ephemeroptera (Mayflies)	52	169	5.0
Coleoptera (Diving beetles, etc.)	22	29	2.5
Malacostraca (Shrimp and crayfish)	14	26	2.4
Odonata (Dragonflies)	8	8	2.1
Annelida (Aquatic earthworms)[1]	5	5	1.9
Hemiptera (Water boatmen, etc.)	24	133	1.5
Mollusca (Snails)	17	32	0.9
Plecoptera (Stoneflies)	18	26	0.8
Total, aquatic invertebrates:		2,620	45.1
(TERRESTRIAL INVERTEBRATES)			
Orthoptera (Grasshoppers, crickets)	35	37	12.9
Coleoptera (Beetles)	56	124	10.8
Hymenoptera (Ants, bees and wasps)	63	248	6.0
Lepidoptera (Moths)	19	27	4.7
Diptera (True flies)	24	40	4.3
Hemiptera (True bugs)	15	18	1.7
Diplopoda (Millipedes)	10	10	1.4
Homoptera (Leafhoppers, aphids, etc.)	26	65	1.0
Araneae (Spiders)	14	22	0.5
Gordiacea (Hairworms)[2]	7	12	0.5
Psocoptera (Psocids)	3	30	0.4
Total, terrestrial invertebrates:		633	44.2
(VERTEBRATES)			
Pisces (Fish)[3]	9	9	6.9
Amphibia (Adult frogs)	2	2	3.8
Total food consumed:	131	3,264	100.0

[1] It was not feasible to determine with certainty whether the annelids were aquatic, or terrestrial worms used as bait.

[2] Specimens of Gordius probably were ingested with grasshoppers and beetles, which they parasitize.

[3] One $4\frac{1}{2}$-inch trout, remainder muddlers and minnows.

Table 2

FEEDING HABITS OF 131 LEGAL BROOK TROUT FROM HUNT CREEK, 1940 FISHING SEASON, ACCORDING TO DATE AND SECTION OF COLLECTION; ORGANISMS GROUPED AS TO VERTEBRATE OR INVERTEBRATE, TERRESTRIAL OR AQUATIC ORIGIN

Date	No. of fish	% diet of aquatic invertebrates	% diet of terrestrial invertebrates	% diet of fish	% diet of frogs
BELOW SECTION A					
June 27	2	62.5	37.5	0.0	0.0
July 4	2	89.7	10.3	0.0	0.0
July 9	1	62.8	37.2	0.0	0.0
July 21	3	39.8	60.2	0.0	0.0
Aug. 29	2	44.4	55.6	0.0	0.0
SECTION A					
June 27	1	57.2	42.8	0.0	0.0
June 30	5	54.1	45.9	0.0	0.0
July 2	1	33.3	27.1	39.6	0.0
July 8	6	63.9	34.4	1.7	0.0
Aug. 2	8	85.1	14.9	0.0	0.0
Aug. 3	5	4.6	4.2	91.2	0.0
Aug. 23	1	100.0	0.0	0.0	0.0
SECTION A AND BELOW A COMBINED					
June 21	12	85.0	15.0	0.0	0.0
SECTION B					
Aug. 3	4	15.4	84.6	0.0	0.0
Aug. 11	2	5.0	95.0	0.0	0.0
Aug. 14	3	44.7	55.3	0.0	0.0
Aug. 29	2	8.7	91.3	0.0	0.0
SECTION C					
July 5	3	48.7	51.3	0.0	0.0
July 26	4	8.0	50.8	41.2	0.0
July 27	2	12.7	66.2	21.1	0.0
July 29	1	36.0	64.0	0.0	0.0
Aug. 8	1	3.8	96.2	0.0	0.0
Aug. 11	3	3.4	96.6	0.0	0.0
Aug. 17	5	11.1	88.9	0.0	0.0
Aug. 19	3	47.2	52.8	0.0	0.0
Aug. 20	1	13.4	86.6	0.0	0.0
SECTION D					
July 2	5	45.7	12.9	0.0	41.4
July 5	1	0.0	100.0	0.0	0.0
July 31	1	16.4	44.6	39.0	0.0
Aug. 3	1	69.7	30.3	0.0	0.0
Aug. 11	6	46.1	53.9	0.0	0.0
Aug. 15	1	87.5	12.5	0.0	0.0
Aug. 19	2	100.0	0.0	0.0	0.0
Aug. 21	2	33.2	66.8	0.0	0.0
Aug. 23	2	100.0	0,0	0.0	0.0
SECTIONS C AND D COMBINED					
July 4	14	32.3	59.8	5.3	2.6
July 9	3	44.0	56.0	0.0	0.0
July 10	1	9.7	90.3	0.0	0.0
Aug. 13	6	22.4	77.6	0.0	0.0
SECTIONS C AND E COMBINED					
Aug. 10	4	11.9	88.1	0.0	0.0

Table 3

AVERAGE BOTTOM FAUNA PRODUCTION PER SQUARE FOOT IN HUNT CREEK, SECTIONS B AND C. BASED ON THIRTEEN SQUARE FOOT SAMPLES TAKEN DURING THE SUMMER OF 1940

Organism	Average number per square foot	Average per cent of total volume
TRICHOPTERA (Caddisflies)	146	56.4
PLECOPTERA (Stoneflies)	19	17.6
DIPTERA (Flies and midges)	235	12.4
EPHEMEROPTERA (Mayflies)	52	6.3
ANNELIDA (Earthworms)	3	2.5
ODONATA (Dragonflies)	0.1	1.8
MALACOSTRACA (Shrimp)	4	1.4
MOLLUSCA (Snails)	0.6	1.1
HYDRACARINA (Water mites)	17	0.5
COLEOPTERA (Water beetles)	2	trace
TOTAL, AVERAGE SQ. FOOT:	478.7	100.0

Note: All average numbers of organisms are listed to the nearest whole number except for those forms which averaged less than one individual per square foot.

Table 4

TROUT STOMACH CONTENTS

Montmorency County, Michigan
Hunt Creek, below Section A bridge
Range: Total length, 174-243 mm.
Weight, 50-137 g.

In column headings, "No." indicates number of organisms present; "%" shows the per cent of total volume made up by each organism consumed.

Organism	Date taken:	June 27		July 4		July 9		July 21		Aug. 29	
	No.of trout:	2		2		1		3		2	
		No.	%	No.	%	No.	%	No.	%	No.	%
(AQUATIC ORIGIN):											
ANNELIDA		...		1	20.5	...		...		...	
MOLLUSCA - Physa sp.		...		...		...		1	1.5	...	
MALACOSTRACA * Hyalella sp.		...		...		...		1	trace	...	
Cambarus sp.		1	18.7	1	51.2	...		...		...	
EPHEMEROPTERA (Mayflies)											
Hexagenia occulta - N		...		...		...		...		1	16.6
Stenonema rivulicolum - N		...		...		1	11.4	...		...	
Ephemerella invaria - N		18	25.0	3	trace	...		...		...	
Ephemerella needhami - N		...		1	2.6	...		...		...	
Ephemerella lata - N		...		...		...		1	trace	...	
Ephemerella bicolor - N		...		...		...		8	1.5	...	
Baetis vagans - N		4	6.3	2	trace	1	2.8	2	trace	1	trace
ODONATA (Dragonflies)											
Ophiogomphus sp.		...		...		...		1	23.5	...	
PLECOPTERA (Stoneflies)											
Nemoura sp.		...		...		...		...		1	trace
COLEOPTERA (Water beetles)											
Dytiscidae		...		1	trace	...		...		1	22.2
Hydrophilidae		2	6.3	...		...		...		...	
Gyrinidae		...		...		...		1	5.8	...	
HEMIPTERA (Water bugs)											
Corixidae		...		6	2.6	...		?	trace	...	
Gerridae		...		...		...		1	1.5	...	
TRICHOPTERA (Caddisflies)											
Hydroptilidae - A		5	trace	...		...		...		...	
Hydroptilidae - L		1	trace	2	trace	...		...		...	
Hydropsyche sparna - L		...		1		...		...		...	
Parapsyche cardis - L		3	trace	1		2	11.4	...		...	
Chimarrha aterrima - A		1	trace	...		1	8.6	1	trace	...	
Molannidae - L		1	trace	5.1		...		...		...	
Leptoceridae - L		...		1	trace	...		...		...	
Limnophilidae - L		...		2		...		...		...	
Sericostomatidae - L		1	3.1	...		2	8.6	...		...	
Brachydentrus americana - L		...		2	2.6	...		...		...	
Family (?) - A		...		...		1	11.4	...		...	
Family (?) - L		...		...		...		1	trace	...	
DIPTERA (Flies and midges)											
Tipulidae - L		...		...		...		1	4.5	...	
Chironomidae - A		...		...		...		4	trace	...	
Chironomidae - P		...		...		...		3	trace	2	trace
Chironomidae - L		...		1	trace	...		10	trace	...	

Table 4

(Continued)

Organism	Date taken:	June 27		July 4		July 9		July 21		Aug. 29	
	No. of trout:	2		2		1		3		2	
		No.	%	No.	%	No.	%	No.	%	No.	%
(Diptera, continued):											
Ceratopogonidae - L		...		...		...		1	trace	...	
Simulium sp. - L		...		...		...		4	trace	1	trace
Atherix variegata - L		...		4	5.1	1	8.6	...		...	
Chrysops sp. - L		2	3.1	...		...		1	1.5	1	5.6
Hemerodromia sp. - P		...		...		...		...		1	trace
Hemerodromia sp. - L		...		...		...		1	trace	...	
Empidae - A		1	trace	1	trace	...		...		...	
Euparyphus sp. - L		...		...		...		1	trace	...	
(TERRESTRIAL ORIGIN):											
ORTHOPTERA (Grasshoppers)											
Locustidae		...		1	10.3	1	31.6	2	17.6	...	
HEMIPTERA (True bugs)											
Miridae		3	9.4	...		...		...		...	
HOMOPTERA (Leafhoppers and aphids)											
Cicadellidae		...		...		1	2.8	4	1.5	...	
Aphididae		...		...		...		10	trace	...	
COLEOPTERA (Beetles)											
Carabidae		1	6.3	...		...		...		1	27.8
Buprestidae		2	3.1	...		...		...		...	
Elateridae		1	trace	...		...		...		1	5.6
Macrodactylus subspinosus		...		...		...		1	2.9	...	
Anthicidae		1	trace	...		...		...		...	
Others		5	3.1	...		...		1	trace	...	
LEPIDOPTERA (Moths)											
Family ?		...		...		...		2	11.7	...	
DIPTERA (True flies)											
Asilidae		...		...		...		1	11.7	...	
Tachinidae		1	12.5	...		...		2	4.5	...	
HYMENOPTERA (Ants, bees and wasps)											
Tenthredinidae		...		...		...		1	trace	...	
Ichneumonidae		...		...		...		1	trace	...	
Braconidae		13	3.1	...		...		...		...	
Formicidae		...		...		...		23	5.8	1	trace
Andrenidae		...		...		...		1	4.5	...	
Others		1	trace	...		...		...		...	
ARANEAE (Spiders)		...		...		1	2.8	2	trace	3	5.6
GORDIACEA (Hair worms)		...		...		...		...		1	16.6

Table 5

TROUT STOMACH CONTENTS

Montmorency County, Michigan
Hunt Creek, Section A
Range: Total length, 174-260 mm.
Weight, 40-170 g.

In column headings "No." indicates number of organisms present; "%" shows percentage of total volume made up by each of the organisms consumed.

Organism	Date taken:	June 27		June 30		July 2		July 8		Aug. 2		Aug. 3		Aug.23	
	No.of stomachs:	1		5		1		6		8		5		1	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
(AQUATIC ORIGIN):															
MOLLUSCA (Snails)															
Physa sp.		...		...		...		2	1.7	1	1.7	...		...	
MALACOSTRACA (Shrimp, crayfish)															
Hyalella sp.		...		...		...		10	1.7	1	trace	...		...	
Gammarus sp.		...		...		...		2	trace	...		...		...	
EPHEMEROPTERA (Mayflies)															
Hexagenia occulta - N		...		...		...		1	5.1	6	10.0	1	trace	...	
Ephemerella invaria - N		2	28.6	1	trace	...		...		1	trace	...		...	
Ephemerella subvaria - N		1	14.3	...		...		...		...		...		...	
Baetis sp. - N		...		...		6	2.1	...		...		...		...	
Baetis vagans - N		...		...		...		3	trace	1	trace	1	trace	...	
Unidentified remains - N		...		1	trace	...		...		1	trace	...		...	
ODONATA (Dragonflies)															
Boyeria vinosa - N		...		1	3.3	...		...		...		...		...	
Libellulidae (fragments) - A		...		...		...		1	20.6	1	1.7	...		...	
PLECOPTERA (Stoneflies)															
Nemoura sp. - N		...		...		...		1	trace	...		...		...	
Unidentified remains - A		...		1	3.3	...		1	1.7	...		...		...	
HEMIPTERA (Water bugs)															
Corixidae - A		...		...		...		...		...		1	trace	...	
Nepa apiculata - A		...		...		...		1	8.6	...		...		...	
COLEOPTERA (Beetles)															
Dytiscidae - L		...		1	trace	...		1	1.7	...		...		...	
TRICHOPTERA (Caddisflies)															
Rhyacophila sp. - L		...		1		...		...		...		...		...	
Mystrophora sp. - L		...		..		...		17	5.1	...		...		...	
Chimarrha aterrima - L		...		5		...		...		1	trace	...		...	
Hydropsyche sparna - L		...		1		...		...		...		...		...	
Hydropsyche sparna - P		...		1	5.0	15	14.6	...		...		...		...	
Parapsyche cardis - L		3	14.3	4		1	trace	1	trace	2	trace	...		...	
Molanna sp. - L		...		..		...		1	trace	1	trace	1	trace	...	
Limnophilidae - L		...		..		...		34	12.6	63	66.6	15	3.6	1	100.0
Limnophilidae - P		...		..		1	trace	...		...		...		...	
Sericostomatidae - L		...		..		...		...		...		1	trace	...	
Brachycentrus sp. - L		...		1		...		5	1.7	3	1.7	2	0.6	...	
Unidentified remains - A		1	trace	...		...		...		...		...		...	
Unidentified remains - P		...		...		...		4	1.7	3	1.7	...		....	

Table 5

(Continued)

Organism	Date taken:	June 27		June 30		July 2		July 8		Aug. 2		Aug. 3		Aug.23	
	No.of stomachs:	1		5		1		6		8		5		1	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
DIPTERA (Flies and midges)															
Tipulidae - L		...		1	32.8	...		1	trace	...		...		...	
Tipulidae - A		...		...		1	trace	...		...		...		...	
Chironomidae - L		...		...		1	trace	5	trace	234	1.7	1	trace	...	
Chironomidae - P		...		1	trace	5	trace	5	trace	4	trace	...		...	
Chironomidae - A		...		2	trace	...		1	trace	...		...		...	
Ceratopogonidae - L		...		...		...		1	trace	2	trace	1	trace	...	
Simulium sp. - L		...		...		...		3	trace	4	trace	...		...	
Chrysops sp. - L		1	trace	1	1.6	...		...		...		2	0.4	...	
Hemerodromia sp. - L		...		...		...		...		1	trace	...		...	
Atherix variegata - L		...		2	1.6	...		...		1	trace	...		...	
Empidae - A		...		38	6.5	113	16.6	7	1.7	...		...		...	
HYDRACARINA (Water mites)		...		...		...		1	trace	...		...		...	
(TERRESTRIAL ORIGIN)															
ORTHOPTERA (Crickets, etc.)		...		2	36.0	1	25.0	...		...		1	0.4	...	
Nemobius sp.															
HOMOPTERA (Leafhoppers, etc.)															
Membracidae		...		...		...		...		1	1.7	...		...	
Cicadellidae		...		1	trace	...		3	trace	...		...		...	
HEMIPTERA (True bugs)															
Miridae		...		...		...		1	trace	...		...		...	
COLEOPTERA (Beetles)															
Carabidae		...		...		...		2	17.2	...		1	1.3	...	
Donacia sp. - L		...		1	1.6	...		...		...		...		...	
Donacia sp. - A		...		2	5.0	...		1	1.7	...		...		...	
Chrysomelidae		...		...		...		...		...		1	0.4	...	
Scarabaeidae		...		...		...		...		...		1	1.3	...	
Cerambycidae		...		...		1	2.1	1	13.8	...		...		...	
Unidentified remains		...		...		1	trace	1	1.7	...		...		...	
LEPIDOPTERA (Moths)															
Unidentified microjugate		...		3	trace	...		...		...		...		...	
DIPTERA (True flies)															
Asilidae		...		...		...		...		2	8.2	...		...	
HYMENOPTERA (Ants, bees, wasps)															
Ichneumonidae		...		...		...		...		...		1	trace	...	
Formicidae		1	28.5	4	3.3	...		2	trace	2	trace	7	0.4	...	
Vespidae		...		...		...		...		1	5.0	...		...	
ARANEAE (Spiders)		...		...		...		...		...		2	0.4	...	
GORDEACEA (Hair worms)		1	14.3	...		...		...		...		...		...	
PISCES (Fish)															
Salvelinus fontinalis		...		...		...		...		...		1	90.6	...	
Unidentified minnow		...		...		1	39.6	1	1.7	...		1	0.6	...	

Table 6

TROUT STOMACH CONTENTS
Michigan, Montmorency County
Hunt Creek, Section A and below A
Twelve trout all taken June 21, 1940
Size and weight range not available as fish were cleaned before checking in.

Organism	No. of species	No. of individuals	No. stomachs containing organisms	Most organisms in any stomach	Least organisms in any stomach	Av. organisms in stomachs containing them	% volume less debris
(AQUATIC ORIGIN)							
MOLLUSCA - Physa sp.	1	1	1	1	1	1	trace
MALACOSTRACA-Gammarus sp.	1	2	2	1	1	1	5.2
EPHEMEROPTERA							
Ephemerella invaria - N	1	58+	12	24	2	5	21.8
ODONATA							
Libellula quadrimaculata-A	1	1	1	1	1	1	2.1
PLECOPTERA-Acroneuria sp.-A	1	1	1	1	1	1	3.1
Genus and species ? - A	1	1	1	1	1	1	trace
TRICHOPTERA-Hydroptilidae-L	1	5	2	4	1	2.5	trace
Hydropsyche sparna - L	1	27	7	6	1	4	21.6
Parapsyche cardis - L	1	23	5	11	1	2.6	2.9
Parapsyche cardis - P	1	8	2	6	2	4	1.3
Sericostomatidae - L	1	1	1	1	1	1	trace
Brachycentrus americana-L	1	41	8	14	1	5.1	12.3
Family ? - A (fragments)	2	2	2	1	1	1	trace
Family ? - P (fragments)	2	5	3	2	1	1.6	1.6
DIPTERA - Tipulidae - A	3	7	3	4	1	2.3	3.4
Antocha sp. - L	1	2	1	2	2	2	0.3
Chironomidae - L	3	30	2	27	3	15	trace
Ceratopogonidae - L	1	1	1	1	1	1	trace
Simulium sp. - L	1	1	1	1	1	1	trace
Simulium sp. - P	1	1	1	1	1	1	trace
Atherix variegata	1	13	3	8	1	4.3	3.1
Chrysops sp. - L	1	2	2	1	1	1	trace
Chrysops sp. - A	1	1	1	1	1	1	trace
Empidae - A	1	294	3	252	2	98	6.3
(TERRESTRIAL ORIGIN)							
ORTHOPTERA - Nemobius sp.	1	1	1	1	1	1	2.1
HOMOPTERA - Cicadellidae	1	2	2	1	1	1	trace
HEMIPTERA - Pentatomidae	2	2	1	2	2	2	1.6
Lygaeidae	1	1	1	1	1	1	trace
Family ? (fragments)	1	1	1	1	1	1	trace
COLEOPTERA - Staphylinidae	1	1	1	1	1	1	trace
Lagriidae	1	8	3	4	1	2.6	1.6
Buprestidae	1	1	1	1	1	1	0.3
Macrodactylus subspinosus	1	2	1	2	2	2	1.6
Family ? (fragments)	4	9	3	5	1	3	1.0
LEPIDOPTERA-Family(fragments)	1	1	1	1	1	1	2.9
DIPTERA - Bibionidae	1	4	1	4	4	4	trace
Syrphidae	1	1	1	1	1	1	1.0
Rhagionidae	1	3	1	3	3	3	1.3
Family ? (fragments)	1	1	1	1	1	1	trace
HYMENOPTERA-Ichneumonidae	3	4	3	2	1	1.3	0.5
Formicidae	3	10	3	4	3	3.3	0.8
Chalcididae	1	1	1	1	1	1	trace
Family ? (fragments)	1	1	1	1	1	1	0.3
ARANEAE (Spiders)	3	3	2	2	1	1.5	trace
							100.0

Table 7

TROUT STOMACH CONTENTS

Montmorency County, Michigan

Hunt Creek, Section B

Range: Total length, 178-319 mm.

Weight, 47-321 g.

In column headings "No." indicates number of organisms present; "%" shows the percentage of the total volume, less debris, made up by each of the organisms consumed.

Organism	Date taken:	Aug. 3		Aug. 11		Aug. 14		Aug. 29	
	No. of stomachs:	4		2		3		2	
		No.	%	No.	%	No.	%	No.	%
(AQUATIC ORIGIN)									
ANNELIDA (Earthworms)		...		...		1	30.3	...	
MALACOSTRACA (Scuds, pillbugs)		1	trace	...		...		...	
Isopoda									
EPHEMEROPTERA (Mayflies)									
Unidentifiable debris - N		...		...		1	trace	...	
PLECOPTERA (Stoneflies)									
Nemoura sp. - N		...		...		...		5	4.3
COLEOPTERA (Beetles)									
Hydrophilidae - A		...		...		2	7.2	...	
TRICHOPTERA (Caddisflies)									
Mystrophora americana - L		...		...		2	trace	...	
Chimarrha aterrima - L		5	trace	...		1	trace	6	2.2
Hydropsyche sparna - L		...		...		2	1.8	1	trace
Hydropsyche sparna - P		...		...		3	3.6	1	2.2
Parapsyche cardis - L		...		...		...		1	trace
Limnophilidae - L		2	15.4	...		1	trace	...	
Brachycentrus americanus - L		...		2	5.0	...		...	
Undetermined pupae		...		1	trace	1	trace	1	trace
DIPTERA (Flies and midges)									
Chironomidae - L		3	trace	1	trace	11	1.8	...	
Ceratopogonidae - L		...		2	trace	...		...	
Simulium sp. - L		...		2	trace	...		...	
(TERRESTRIAL ORIGIN)									
DIPLOPODA (Millipedes)		...		...		1	5.3	2	4.3
ORTHOPTERA (Grasshoppers)									
Locustidae		...		2	45.0	2	10.7	1	32.6
Tettigoniidae		...		...		...		1	52.2
PSOCOPTERA (Booklice and allies)									
Psocidae		...		...		29	17.8	...	
HOMOPTERA (Leafhoppers)									
Cicadellidae		1	trace	2	10.0	1	7.2	...	
COLEOPTERA (Beetles)									
Carabidae		...		...		...		1	2.2
Lema trilineata		...		1	5.0	...		...	
Undetermined fragments		1	trace	...		...		...	
LEPIDOPTERA (Moths)									
Noctuidae ?		1	15.4	...		...		...	
HYMENOPTERA (Ants, bees and wasps)									
Lygaeonematus erichsonii - L		4	69.2	...		2	10.7	...	
Ichneumonidae		...		2	20.0	...		...	
Braconidae		...		...		1	trace	...	
Formicidae		...		6	10.0	5	3.6	...	
ARANEAE (Spiders)		...		2	5.0	...		...	

Table 8

TROUT STOMACH CONTENTS

Montmorency County, Michigan
Hunt Creek, Section C
Range: Total length, 177-273 mm.
Weight: 46-199 g.

In column headings "No." indicates number of organisms present; "%" shows the per cent of total volume made up by each of the organisms consumed.

Organism	Date: July 5		July 26		July 27		July 29		Aug. 8		Aug. 11		Aug. 17		Aug. 19		Aug. 20	
	No. trout: 3		4		2		1		1		3		5		3		1	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
(AQUATIC ORIGIN)																		
ANNELIDA (Earthworms)	...		...		1	9.4	....		...		...		...		1	3.0	...	
MOLLUSCA (Snails)																		
Physa sp.	...		1	0.7	...		1	8.0	...		...		...		...		...	
MALACOSTRACA (Shrimp)																		
Gammarus sp.	2	7.7	1	0.7	...		...		...		...		...		...		...	
EPHEMEROPTERA (Mayflies)																		
Hexagenia occulta-N	...		...		...		...		...		...		1	3.7	...		...	
Baetis vagans-N	1	trace	...		...		...		...		...		...		...		...	
ODONATA (DRAGONFLIES)																		
Libellulidae-N	...		...		...		...		...		1	trace	...		...		...	
PLECOPTERA (Stoneflies)																		
Nemoura sp. -N	...		...		...		...		...		...		...		4	3.0	...	
HEMIPTERA (Water bugs)																		
Corixidae - A	...		...		...		...		...		...		1	trace	...		...	
COLEOPTERA (Water beetles)																		
Dytiscidae - A	...		2	1.3	...		1	24.0	...		1	trace	...		...		...	
Hydrophilidae-A	...		...		...		...		...		...		...		1	6.0	...	
TRICHOPTERA (Caddis)																		
Rhyacophila sp.-L	...		...		1	trace	...		1	3.8	...		...		1		...	
Rhyacophila sp.-P	...		...		...		...		...		...		...		1	3.0	...	
Mystrophora sp.-L	2	trace	...		1	trace	1	trace	...		...		...		1		...	
Chimarrha sp. -L	15	10.2	2	0.7	...		...		...		...		2	trace	22	17.5	...	
Hydropsyche sp.-L	...		...		1	2.2	...		...		...		1	3.7	3		...	
Hydropsyche sp.-P	...		1	0.7	...		...		...		...		...		..		...	
Parapsyche sp.-L	2	2.6	3	1.3	...		...		...		...		...		2	11.7	...	
Limnophilidae-L	35	28.2	5	1.3	5	1.1	1	trace	...		7	3.4	1	trace	1		2	3.4
Limnophilidae-P	...		1	1.3	...		...		...		...		...		1		...	
Genus ? - P	...		...		...		...		...		1	trace	8	3.7	4	3.0	2	10.0
DIPTERA (Midges, etc.)																		
Chironomidae - L	2	trace	...		...		...		...		...		3	trace	6	trace	...	
Ceratopogonidae-L	...		...		...		...		...		...		...		1	trace	...	
Atherix sp. - L	...		...		...		...		...		...		...		2	trace	...	
Chrysops sp. - L	...		...		...		1	4.0	...		...		...		...		...	
Empidae - A	1	trace	...		...		...		...		...		...		2	trace	...	
Family ? - P	...		...		...		...		...		...		...		1	trace	...	
(TERRESTRIAL ORIGIN)																		
ORTHOPTERA (Grasshoppers)																		
Locustidae	...		1	trace	2	17.9	...		...		1	trace	...		1	3.0	2	66.6
Tettigoniidae	...		...		...		...		...		1	62.0	...		...		...	

Table 8

(Continued)

Organism	Date:	July 5		July 26		July 27		July 29		Aug. 8		Aug. 11		Aug. 17		Aug. 19		Aug. 20	
	No. trout:	3		4		2		1		1		3		5		3		1	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
HOMOPTERA (Leafhoppers)																			
Membracidae		...		...		...		1	trace	...		...		...		...		1	3.4
Cercopidae		...		1	0.7	2	trace	...		...		...		...		...		...	
Cicadellidae		...		...		...		...		...		...		...		11	11.7	...	
HEMIPTERA (True bugs)																			
Pentatomidae		...		...		...		1	16.0	...		1	trace	...		...		...	
COLEOPTERA (Beetles)																			
Carabidae		...		7	35.0	1	trace	...		...		...		...		1	trace	...	
Elateridae		1	2.6	1	2.7	...		...		...		...		...		...		1	trace
Silphidae		...		...		...		...		...		...		...		2	6.0	...	
Staphylinidae		...		...		...		...		...		...		...		1	trace	...	
Lampyridae		...		...		1	1.1	...		...		...		...		...		...	
Scarabaeidae		2	7.7	...		1	1.1	1	24.0	...		...		...		...		...	
Tenebrionidae		...		...		...		...		...		2	17.2	...		...		...	
Scolytidae		...		...		...		...		...		...		...		1	trace	...	
Cerambycidae		...		1	0.7	...		...		...		...		...		...		...	
Family ?		...		...		...		...		...		...		...		5	3.0	1	6.6
LEPIDOPTERA (Moths)																			
Family ?		...		...		2	8.5	...		...		...		1	59.2	2	3.0	...	
DIPTERA (Flies)																			
Asilidae		2	23.0	1	0.7	5	31.2	...		1	29.6	...		1	11.2	...		...	
Syrphidae		1	trace	...		...		...		...		...		...		....		...	
Anthomyiidae		...		...		...		...		...		1	3.4	...		...		...	
HYMENOPTERA (Ants, etc.)																			
Tenthredinidae - L		1	2.6	...		...		...		...		1	7.0	...		...		...	
Lygaeonematus sp.-L		2	2.6	6	11.0	1	3.2	...		...		2	trace	1	14.8	10	8.4	1	3.4
Braconidae		...		...		...		...		...		...		...		1	trace	...	
Formicidae		1	2.6	1	trace	5	3.2	4	trace	...		...		1	3.7	14	6.0	2	6.6
Chalcidae		...		...		...		...		...		...		...		3	trace	...	
Cynipidae		...		...		...		...		...		...		...		3	trace	...	
Vespa sp.		...		...		...		...		2	66.6	1	7.0	...		1	11.7	...	
ARANEAE (Spiders)		...		...		1	trace	1	8.0	...		...		...		...		...	
DIPLOPODA (Millipedes)		1	10.2	...		...		1	16.0	...		...		...		1	trace	...	
GORDIACEA (Hair worms)		...		...		...		...		...		1	trace	...		...		...	
PISCES (Fish)																			
Cyprinidae		...		1	11.0	...		...		...		...		...		...		...	
Cottus sp.		...		1	30.2	1	21.1	...		...		...		...		...		...	

Table 9

TROUT STOMACH CONTENTS

Montmorency County, Michigan
Hunt Creek, Section D
Size Range: Total length, 154-242 mm.
Weight, 50-135 g.

In the column headings "No." indicates number of organisms; "%" shows the percentage of total volume of organisms eaten.

Organism	Date	July 2		July 5		July 31		Aug. 3		Aug. 11		Aug. 15		Aug. 19		Aug. 21		Aug. 23	
	No. trout:	5		1		1		1		6		1		2		2		2	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
(AQUATIC ORIGIN)																			
MOLLUSCA (Snails)																			
Physa sp.		...		...		...		...		...		2	12.5	...		...		...	
MALACOSTRACA (Shrimp)																			
Gammarus sp.		...		...		...		...		3	4.0	...		...		1	trace	...	
EPHEMEROPTERA(Mayflies)																			
Baetidae - N	9	trace	1	trace	...		...		1	trace	...		1	trace	...		1	trace	
ODONATA(Dragonflies)																			
Cordulegaster sp.-N	...		...		...		...		1	trace	...		...		...		1	100.0	
PLECOPTERA(Stoneflies)																			
Nemoura sp.-N	...		...		2	trace	...		...		...		1	trace	...		...		
HEMIPTERA(Water bugs)																			
Corixidae - A	95	9.2	...		1	trace	...		2	1.3	2	12.5	...		...		1	trace	
Notonectidae - A	...		...		...		1	12.2	...		...		...		...		...		
COLEOPTERA(Beetles)																			
Dytiscidae - A	...		...		1	5.4	...		1	2.8	...		...		...		...		
TRICHOPTERA (Caddis)																			
Rhyacophila sp.-P	2	0.5	...		...		...		1	2.8	...		...		...		...		
Rhyacophila sp.-A	...		...		...		...		...		1	trace	...		...		...		
Mystrophora sp.-L	...		...		...		...		1	trace	...		...		...		...		
Chimarrha sp. - L	1	trace	...		20	3.7	...		2	trace	...		...		...		...		
Chimarrha sp. - P	1	trace	...		...		...		...		...		27	20.0	...		...		
Hydropsyche sp.-P	...		...		14	7.3	...		1	1.3	...		1	trace	...		...		
Limnophilidae - L	3	0.5	...		...		32	39.2	43	31.1	9	62.5	...		3	16.6	...		
Limnophilidae - P	2	2.2	...		...		6	15.2	...		...		...		...		...		
Sericostomatidae-L	1	trace	...		...		...		...		...		...		...		...		
Family ? - P	...		...		...		...		...		...		2	trace	4	16.6	...		
DIPTERA (Midges,etc.)																			
Tipula sp. - L	2	27.3	...		...		...		...		...		1	80.0	...		...		
Chironomidae-L	36	0.5	4	trace	1	trace	...		4	trace	3	trace	2	trace	...		...		
Chironomidae-P	1	trace	...		...		...		1	trace	...		...		1	trace	...		
Chironomidae-A	1	trace	...		...		...		...		...		...		...		...		
Ceratopogonidae-L	2	trace	...		...		...		...		...		...		...		...		
Simulium sp. - L	1	trace	...		...		...		...		...		...		...		...		
Simulium sp. - A	1	trace	...		...		...		...		...		...		...		...		
Empidae - A	126	5.5	1	trace	...		...		12	2.8	...		...		3	trace	...		
Chrysops sp. - L	...		...		...		3	3.1	...		...		...		...		...		

Table 9

(Continued)

Organism	Date	July 2		July 5		July 31		Aug. 3		Aug. 11		Aug. 15		Aug. 19		Aug. 21		Aug. 23	
	No. trout:	5		1		1		1		6		1		2		2		2	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
(TERRESTRIAL ORIGIN)																			
ORTHOPTERA(Roaches,etc.)																			
Blattidae		2	6.0	...		...		...		...		...		...		...		...	
Locustidae		...		...		1	7.3	...		...		...		...		...		...	
HOMOPTERA(Leafhoppers,etc.)																			
Cercopidae		...		...		1	trace	...		...		...		...		...		...	
Membracidae		...		...		...		...		8	4.0	...		...		1	8.4	...	
Cicadellidae		3	trace	...		...		...		...		...		...		1		...	
Aphididae		3	trace	...		...		1	trace	...		...		...		...		...	
HEMIPTERA(True bugs)																			
Miridae		1	0.5	...		...		...		...		...		...		...		...	
Pentatomidae		...		1	100.0	...		...		1	5.4	...		...		1	58.4	...	
COLEOPTERA(Beetles)																			
Carabidae		...		...		2	30.0	...		1	10.9	...		...		...		...	
Elateridae		1	trace	...		...		...		1	1.3	...		...		...		...	
Coccinellidae		1	0.5	...		...		...		1	1.3	...		...		...		...	
Buprestidae		1	trace	...		...		...		...		...		...		...		...	
Staphylinidae		1	trace	...		...		...		...		...		...		...		...	
Tenebrionidae		...		...		...		1	27.2	...		...		...		...		...	
Family ?		2	0.5	...		...		...		5	23.0	...		...		...		...	
DIPTERA(True flies)																			
Asilidae		...		...		...		...		2	5.4	...		...		...		...	
Dolichopidae		1	trace	...		...		...		...		...		...		...		...	
Tachinidae		1	trace	...		...		...		...		...		...		...		...	
Family ?		2	0.5	...		...		...		...		...		...		...		...	
HYMENOPTERA(Ants,etc.)																			
Lygaeonematus sp.L		...		...		2	1.8	...		2	trace	...		...		1	trace	...	
Ichneumonidae		...		...		...		1	3.1	1	trace	...		...		...		...	
Cynipidae		1	trace	...		...		...		...		...		...		...		...	
Formicidae		24	2.2	...		...		...		9	1.3	7	12.5	...		...		...	
Andrenidae		1	trace	...		...		...		...		...		...		...		...	
ARANEAE (Spiders)		3	2.7	...		2	3.7	...		2	1.3	...		...		...		...	
DIPLOPODA(Millipedes)		...		...		...		1	trace	...		...		...		...		...	
GORDIACEA(Hair worms)		...		...		1	1.8	...		...		...		...		...		...	
PISCES (Fish)		...		...		1	39.0	...		...		...		...		...		...	
AMPHIBIA (Frogs)		1	41.4	...		...		...		...		...		...		...		...	

Table 10

TROUT STOMACH CONTENTS

Montmorency County, Michigan
Hunt Creek, Sections C and D combined
Range: Total length, 177-226 mm.
Weight, 47-113 g.

In the column headings "No." indicates number of organisms; "%" shows the percentage of total volume made up by each organism consumed.

Organism	Date:	July 4		July 9		July 10		Aug. 13	
	No. of stomachs:	14		3		1		6	
		No.	%	No.	%	No.	%	No.	%
(AQUATIC ORIGIN)									
ANNELIDA (Earthworms)		1	2.6	...		...		...	
MOLLUSCA (Snails)									
Gastropoda		19	2.0	...		...		...	
Physa sp.		2	1.6	1	trace	...		1	4.0
EPHEMEROPTERA (Mayflies)									
Baetidae (transforming)		24	0.7	2	trace	...		...	
ODONATA (Dragonflies)									
Boyeria vinosa - N		1	trace	...		...		...	
PLECOPTERA (Stoneflies)									
Nemoura sp. - A		2	trace	...		...		2	trace
Isoperla sp. - A		2	0.7	...		...		...	
HEMIPTERA (Water bugs)									
Corixidae - A		18	1.0	2	trace	...		...	
COLEOPTERA (Water beetles)									
Dytiscidae - A		3	1.3	...		...		...	
Dytiscidae - L		2	trace	...		...		...	
Hydrophilidae - A		2	2.3	...		...		...	
Haliplidae - A		...		1	trace	...		...	
Elmidae - A		1	trace	3	2.0	...		...	
TRICHOPTERA (Caddisflies)									
Hydroptilidae - L		14	0.7	1	trace	...		1	trace
Rhyacophila sp. - L		4	trace	1	trace	...		...	
Rhyacophila sp. - A		1	trace	...		...		...	
Mystrophora americana - L		...		...		...		1	2.0
Chimarrha aterrima - L		48	3.3	11	2.0	...		4	2.0
Chimarrha aterrima - P		1	0.4	...		...		...	
Hydropsyche sparna - L		2	trace	...		...		...	
Parapsyche cardis - L		...		1	trace	...		...	
Limnophilidae - L		65	5.6	9	4.0	3	3.2	5	8.2
Sericostomatidae - L		6	trace	...		...		...	
Family ? - P		3	0.4	...		...		8	6.2
DIPTERA (Flies and midges)									
Tipulidae - L		3	1.3	1	34.0	...		...	
Chironomidae - L		68	1.0	21	2.0	1	trace	...	
Chironomidae - P		11	0.7	...		...		...	
Ceratopogonidae - L		1	trace	...		...		...	
Dixiidae - L		1	trace	...		...		...	
Simulium sp. - L		72	1.3	...		...		...	
Simulium sp. - P		28	0.7	1	trace	...		...	
Simulium sp. - A		14	0.4	1	trace	...		...	

Table 10

(Continued)

Organism	Date:	July 4		July 9		July 10		Aug. 13	
	No. of stomachs:	14		3		1		6	
		No.	%	No.	%	No.	%	No.	%
(DIPTERA - continued)									
Empidae - L		1	trace	...		...		...	
Odontomyia sp. - L		7	4.3	...		...		...	
Chrysops sp. - L		...		1	trace	...		...	
Atherix variegata - L		...		...		1	6.5	...	
(TERRESTRIAL ORIGIN)									
ORTHOPTERA (Grasshoppers, etc.)									
Locustidae		7	23.7	3	26.0	1	32.3	3	22.4
Tettigoniidae		1	0.7	...		...		...	
HOMOPTERA (Leafhoppers, etc.)									
Membracidae		...		...		...		3	6.2
Cicadellidae		3	trace	2	trace	1	trace	2	trace
Fulgoridae		1	trace	...		...		...	
Aphididae		2	trace	1	trace	...		...	
HEMIPTERA (True bugs)									
Pentatomidae		2	3.0	1	2.0	...		...	
COLEOPTERA (Water beetles)									
Carabidae		2	0.4	1	4.0	1	trace	...	
Staphylinidae		1	0.4	...		...		...	
Elateridae		1		...		...		2	6.2
Chrysomelidae		3	0.7	...		...		...	
Lagriidae		1	1.0	...		...		...	
Scarabaeidae		4	3.0	...		1	19.4	...	
Macrodactylus subspinosus		1	1.0	1	4.0	...		...	
Cantharidae		...		...		1	trace	...	
Omophronidae		...		1	4.0	...		...	
Family ?		1	0.4	...		...		4	6.2
Rhynchophora		1	0.7	...		...		...	
LEPIDOPTERA (Moths)									
Family ?		12	17.1	...		3	35.4	...	
DIPTERA (True flies)									
Anthomyiidae		3	trace	....		1	3.2	...	
Tachinidae		3	3.3	...		...		...	
HYMENOPTERA (Ants, wasps, etc.)									
Tenthredinidae		3	0.4	...		...		1	4.0
Ichneumonidae		2	0.7	...		...		1	trace
Formicidae		9	trace	1	2.0	...		15	14.2
Vespidae		...		...		...		1	8.2
DIPLOPODA (Millipedes)		2	3.3	1	12.0	...		...	
GORDIACEA (Hair worms)		1	trace	2	2.0	...		5	10.2
PISCES (Fish)		1	5.3	...		...		...	
AMPHIBIA (Frogs)		1	2.6	...		...		...	

Table 11

TROUT STOMACH CONTENTS

Montmorency County, Michigan
Hunt Creek, Sections C and E combined
Size range: Total length, 190-246 mm.
Weight, 70-156 g.
Four trout, all taken August 10, 1940

In column headings "Number" indicates number of organisms; "%" shows percentage of each organism in total volume.

Organism	Number	%
(AQUATIC ORIGIN)		
MALACOSTRACA (Shrimp, etc.)		
Isopoda	1	3.1
PLECOPTERA (Stoneflies)		
Nemoura sp. - N	2	trace
COLEOPTERA (Water beetles)		
Dytiscidae - L	1	1.9
TRICHOPTERA (Caddisflies)		
Chimarrha aterrima - L	4	1.9
Parapsyche cardis - L	1	3.1
Limnophilidae - L	2	trace
Limnophilidae - P	6	1.9
Family ? - P	2	trace
DIPTERA (Midges, etc.)		
Chironomidae - L	5	trace
(TERRESTRIAL ORIGIN)		
ORTHOPTERA (Grasshoppers, etc.)		
Locustidae	2	23.0
PSOCOPTERA (Psocids)		
Psocidae	1	trace
HOMOPTERA (Leafhoppers, etc.)		
Cercopidae	2	19.0
Membracidae	1	trace
Cicadellidae	1	trace
HEMIPTERA (True bugs)		
Reduviidae	1	trace
COLEOPTERA (Beetles)		
Carabidae	1	47.5
HYMENOPTERA (Ants, wasps, etc.)		
Lygaeonematus erichsonii - L	1	trace
Camponotus pennsylvanicus	1	trace
Vespa diabolica	1	1.9
Polistes pallipes	1	6.9
Family ?	1	6.9