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STUDIES OF SPECKLED TROUT (*SALVELINUS FONTINALIS*) IN ONTARIO

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CONTENTS

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Abstract

The distribution of speckled trout in Ontario is general, except in the extreme west, the extreme south-east, and smaller portions of south-western Ontario. Its occurrence is limited by the absence of permanently cold waters.

Measurements of thirty-three specimens from Ontario and Quebec lakes reveal no peculiarities which would serve as a basis for racial distinction. Material from five habitats indicates that, in their growth, speckled trout depart very little from the cube law relating weight and length.

Rate of growth, as determined by scale reading and catch analyses, appears to be the same in three habitats, being approximately three inches per year for trout of legal size.

The stomach contents of speckled trout are more varied than those of most fresh-water fishes, owing to the great variety of waters which they inhabit. A list of items, based upon the analyses of 1,200 stomachs, includes both plant and animal foods, as well as many indigestibe items.

Parasites are of general occurrence, being commonest in fish from the larger and warmer bodies of water, less common in those from smaller and colder ones. The more abundant forms belong to the divisions Nematoda, Cestoda, and Acanthocephala.

Reproduction of speckled trout has been observed in several Ontario streams and ponds. Spawning occurs from October to December, being marked by distinctive behaviour on the part of both sexes.

Introduction

Scientific enquiry into the habits and life-histories of the food and game fishes of Ontario has been prosecuted for the past decade by the Ontario Fisheries Research Laboratory. Work upon the speckled trout was begun in 1928 and has continued into 1931. Descriptions of the habitats visited during this time are to be found in an accompanying and a forthcoming paper. Information relating more directly to the trout themselves is set forth below.

DISTRIBUTION

Jordan, in his recent check-list (1929), gives the distribution of *Salvelinus fontinalis* as "from Maine to the Dakotas and north to the Arctic circle; south in the mountains to north Georgia; introduced into California and Colorado". In the area thus described is included the whole of the Province of Ontario. It is, therefore, to be expected that irregularity of distribution within the province will be the result of ecological rather than geographical barriers to dispersal.

Figure 1 shows the present distribution of specked trout in Ontario, as compiled from the records of the Ontario Department of Game and Fisheries,[1] from information given by anglers, and from the author's personal observations.

The basal rock formations of Ontario are to be divided into two classes. The Pre-Cambrian shield covers most of the province, and consists chiefly of Laurentian granites and gneisses. Palaeozoic sediments of Cambrian to Devonian age overlap this axis in three places: south-eastern Ontario, south-western Ontario (including "central" Ontario), and on the Hudson Bay slope.

In the rivers and lakes of the explored portion of the Laurentian country, speckled trout are usually abundant. They occur also in the smaller streams of the northern coastal plain, about James Bay, and in the tidewaters of Hudson and James Bays. Over most of the southern Ontario sedimentary region they occur sparingly, being common only in those counties where springs are abundant.

Speckled trout are not found in the extreme western part of the province, from west of the Lake Nipigon drainage to the Manitoba border. Similarly, no reports of their occurrence, in recent years at least, have come from the extreme eastern and western parts of southern Ontario. Concerning the most northern part of the province—the region included in the District of Patricia—no information is at hand.

In southern Ontario the occurrence of trout is largely

[1]The author is indebted to Mr. H. H. MacKay for permission to use these data.

FIGURE 1. Map of Ontario, showing distribution of speckled trout

dependent on the presence of springs. Springs are commonest in parts of the province where stratified rocks come close to the surface, or where extensive beds of sand and gravel occur. They are not frequent in heavy clay soil, nor near outcrops of igneous rocks. Springs of the first type, rock springs, occur in abundance along the Niagara cuesta and in the highlands to the west of it, and are partly responsible for the many fine trout streams of Bruce, Grey, and Dufferin Counties. Gravel springs are commonest among the hummocky hills of the glacial moraines. They give rise to many cool streams in Ontario, Durham, and Northumberland Counties along Lake Ontario, in Elgin and Norfolk

Counties along Lake Erie, and are not uncommon in some of the interior counties.

Even spring water will quickly warm up if it runs in an open channel; hence large trout streams are to be looked for only in places where considerable part of the forest has been left standing. If this forest be low and swampy, so much the better, for it will retain the spring flood waters at a low temperature, and allow them to seep slowly into the streams throughout the summer.

Grey County is particularly fortunate in all these respects: it possesses a large number of springs, which flow either from its numerous moraine hills or from the massive dolomite beneath, and much of its surface is still wooded, particularly in the south, where many thousands of acres of swamp land remain uncleared.

Most of the Pre-Cambrian area of Ontario is wooded, and beset with numerous swamps and bogs. Hence, even though springs are rare, its streams remain cool to a much larger size than do those of south-western Ontario, and trout are consequently commoner. The same region possesses innumerable small lakes, whose deeper waters never warm up, and many of which contain speckled trout.

Briefly, the distribution of speckled trout in Ontario is dependent upon the presence of waters of comparatively low temperature. Cold water is retained by forests and swamps, in lake basins, and by underground storage with subsequent outflow in rock or gravel springs.

APPEARANCE, SIZE, AND PROPORTIONS

The speckled trout occurring in Ontario have not been divided into subspecies, but trout from different waters are neither identical in appearance nor exactly similar in shape.

Differences in colour can usually be directly correlated with the type of water in which the trout are found. In streams and ponds of southern Ontario, trout are brightly coloured, with clearly defined spots on the side and a definite pattern above. In the soft waters of the north, the sides have a dusky cast and the back is much more nearly black, a condition which reaches its fullest development in the tea-brown waters of bog streams. In lakes, the back is often greenish, with well-defined vermiculations, the sides and belly are bright silver with pale spots, and fins not a particularly bright red. In the sea this condition is intensified, and the spots are sometimes almost or completely obscured.

Colour of flesh is also variable, ranging from white to a bright pink or salmon. In general, lake or pond fish are more likely to have coloured flesh than stream fish, and large trout are more often coloured than smaller ones. But all gradations of colour may be found in fish taken at the same time from the same pond or stream. Prince (1917) has discussed the occurrence of this red colour in salmonoid fishes. He says it is due to the presence of globules of a lipoid, possibly lecithin, and that an identical substance is found in the flesh of shrimps, prawns, *etc.* Nevertheless, he is convinced that it is a hereditary condition, uninfluenced by the amount or kind of food which the fish takes, or by its sex or sexual condition. Its origin and the reason, if any, for its irregular occurrence are unknown. Eggs of speckled trout also vary in colour from a pale lemon yellow to a bright orange.

The maximum size to which a speckled trout attains is apparently to be correlated with the size of the body of water in which it lives, and more closely, perhaps, with the presence of suitable large foods; *i.e.*, fish or crayfish. In small brooks a half-pound trout is unusual. In the *Chara* ponds and small lakes of old Ontario, a weight of one pound is only rarely attained. In southern rivers of moderate size they occasionally grow to three pounds, and one specimen weighing over five pounds is on record. In Laurentian lakes and rivers, large trout are more commonly met with, specimens of four or five pounds being not infrequently reported. The largest trout in the province, and in America, seem to come from the Nipigon River, where six- or seven-pound specimens are captured quite regularly, and one fourteen and a half pounds in weight—the largest on record—was taken in 1915. For a list of some of the large specimens caught by anglers in the province, see Sladen (1929) and Dymond (1927, p. 70).

The body proportions of fishes are commonly expressed by means of measurements, the length of each part being divided by the standard length (snout to end of vertebral column), so that fish of varying size may be compared. Kendall (1914, p. 99) has measured twenty-three specimens of speckled trout from New England lakes, Dymond (1927, p. 69) a number of Lake Nipigon specimens.

In connection with the present study thirty-three specimens of speckled trout were measured in detail but the differences found were not of such a nature as would serve as the basis of racial distinctions.

Keys (1928), in an analysis of the weight-length relation in fishes, has shown that the cube law, $W=aL^3$, is not an exact expression of this relationship in three species of fish, *i.e.*, that these fish do not grow absolutely symmetrically. He finds that the equation $W=aL^n$ gives a more correct picture, where both a and n are constant for each species. The value of n was for *Sardinia coerulea*, 3.1, for *Clupea harengus*, 3.5, for *Fundulus parvipinnis*, 3.8. The author has endeavoured to find to what extent speckled trout deviate from the cube law, by plotting the logarithm of weight against the logarithm of total length of trout from five different habitats, and taking the slope of the resulting line (table 1). The various groups, particularly those which include a large number of specimens, show only slight deviations from the power 3; 3.16 was the greatest slope measured, 2.95 the least. The Mad River trout, for which measurements of a great range of size are available, conform almost exactly ($n=3.01$).

This close agreement to the cube law justifies, in the case of these speckled trout, the use of the "condition number" as an indication of relative proportions. The condition number of a fish is defined as its (weight in pounds) ÷ (length in inches)^3 × 1,000,000, length being measured to the fork of the caudal fin. It gives a measure of the plumpness of a fish, or "how heavy it is for its length". The greater the number, the heavier is the fish, and presumably the better its condi-

TABLE 1. Mathematical expression of growth and proportions of speckled trout from various waters

Body of water	Number of specimens	Range of length inches	Average condition number	Best growth equation (W = Weight in lbs. L = Total length in inches)
Wolf Lake	16	9.5-14.4	33	$W=0.000224\ L^{3.25}$ or $\log W-3.16 \log L+3.65=0$
Lac Cassette	16	7.4-13.0	39	$W=0.000295\ L^{3.12}$ or $\log W-3.12 \log L+3.53=0$
Glen Major Ponds	106	4.6-11.0	40	$W=0.000343\ L^{3.09}$ or $\log W-3.09 \log L+3.46=0$
Mad River	109	0.9-22.6	39	$W=0.000381\ L^{3.01}$ or $\log W-3.01 \log L+3.42=0$
Little Wonder Pond	111	4.0-14.4	41	$W=0.000434\ L^{2.95}$ or $\log W-2.95 \log L+3.34=0$

TABLE 2. Condition number of Mad River trout

No. of specimens	Date taken	Av. length in inches	Limits of length	Limits of condition number	Average condition number	Sex	Remarks
15	May 22	1.11	0.91–1.30	29–41	36		Immature
9	July 8–Sept. 6	2.06	1.50–2.56	39–45	43		Immature
8	Aug. 4–14	4.8	4.2–5.4	33–46	38	♂♀	
31	May 16–21	7.1	5.9–7.9	31–52	38	♂♀	
22	May 16–21	8.6	8.0–9.9	34–43	39	♂♀	
5	May 16–21	10.2	10.1–11.0	35–41	38	♂♀	
1	?	22.6			44		
4	June 8	11.1	9.1–12.8	46–50	48	♂♀	Stomachs gorged
7	Sept. 5	7.5	7.2–8.2	37–43	39	♂♀	
4	Oct. 23–Nov. 18	8.4	7.6–9.8	39–56	47	♀	Ripe or nearly so
2	Nov. 18	9.6	8.0–11.1	29–34	32	♀	Spent
10	Oct. 23–Nov. 18	8.0	5.6–10.0	34–46	38	♂	Breeding

tion. Condition numbers for various groups of speckled trout are included in tables 1, and 2.

Several factors cause variations in the W/L^3 ratio (table 2). The most obvious is variation in weight of stomach contents. For example, during a great rise of mayflies on the Mad River in June, the ratio for large trout rose to forty-eight, from a mean of thirty-nine, owing to the great weight of mayflies in their stomachs. Females tend to become more obese as spawning season approaches, because of the increasing weight of their eggs, and this, too, is more noticeable in the case of large fish. Immediately after spawning they are unusually thin; the condition number drops to thirty-two. The "condition" of the males does not change noticeably with the advent of the breeding season; the weight of their testes is small compared to that of the ovaries of the female.

Of the five waters in table 1, Wolf Lake appears to harbour trout which are very noticeably slimmer than those occurring in the other four. Although taken not long before the breeding season, these fish have an average condition number of only thirty-three, compared with thirty-nine to forty-one in other places. This may be a racial peculiarity, or merely the result of poor nutrition, possibly owing to excessive parasitic infection. Wolf Lake fish were rather heavily infested with cestodes, but fish from Lac Cassette were at home to equally large numbers of acanthocephalons, and were as plump as most.

RATE OF GROWTH

Because of their minute size, the scales of speckled trout have been very little used for age determination. The only work which has come to the author's notice is that of Kendall and Dence (1927, p. 445), who determined the age of trout from various streams in Allegany State Park, N.Y. They found that, in August, trout in their first year of life averaged 2.22 inches long, in the second year 3.64 inches, and in the third year 6.1 inches.

In working with trout scales, the author is of the opinion that no great reliability can be attached to readings of ages over three years; annuli are very indistinct, and there is much variation between different scales from the same fish. It is necessary to assume that the greatest age read is the correct one, since scales can usually be found which give a variety of lower readings. Readings of one or two years are probably accurate in all cases. The author is indebted to Dr. W. C. Kendall for assistance in the method of scale reading. An attempt was made to use the otoliths for age determination but they were found to be less useful than the scales.

Supplementary to scale readings is a study of the sizes of fish caught. In figure 2 are plotted frequency polygons showing the distribution of the catch by length in the Mad River in 1930. Most of the fish were caught by anglers, for whom there is a minimum size limit of seven inches. This fact accounts for the absence of fish in their second year from the polygons for May and June, and perhaps for the abrupt lower limit of the third-year group. All fish in the first year were taken by the author in a dip net. The numbers on the

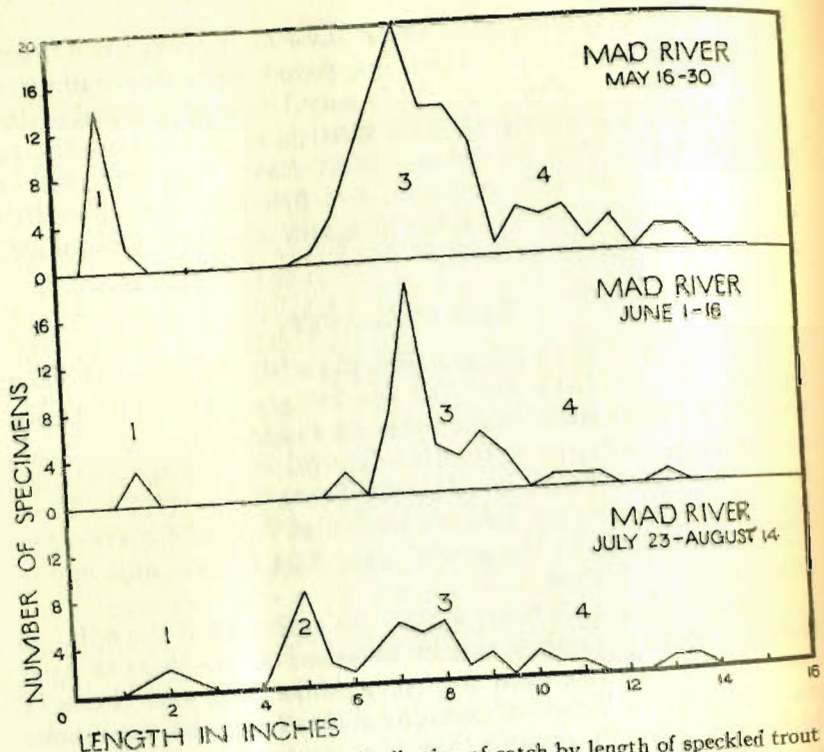

FIGURE 2. Graph showing the distribution of catch by length of speckled trout in the Mad River, 1930.

graphs represent a possible estimate of the age of the fish; this information may be summarized as follows:

	May 16-30	June 1-16	July 23-Aug. 14
	Average length in inches	Average length in inches	Average length in inches
Trout in their 1st year.....	1.1	1.5	2.0
" " " 2nd "			4.9
" " " 3rd "	7.6	7.8	7.6
" " " 4th "	10.5	11.0	10.4

Another construction might be put on the evidence of the

polygons, *viz.*, that fish included in group 3 really represent two age classes, with modes (in June) of 7.5 and 9.0 inches respectively. Such evidence as is available from scale reading is contrary to this conclusion, and in support of the above schedule.

In figure 3 the catch from Little Wonder Pond is treated in the same way. The same question arises, as to whether or not peaks (*a*) and (*b*) represent two separate age groups, and again the scales support the view that they do not; all fish up to about 9.5 inches long are in their third year. Four fourth-year fish averaged 10.6 inches in length, and the two fourteen-inch specimens were read as in their fifth year.

A possible explanation of the two peaks, (*a*) and (*b*) is

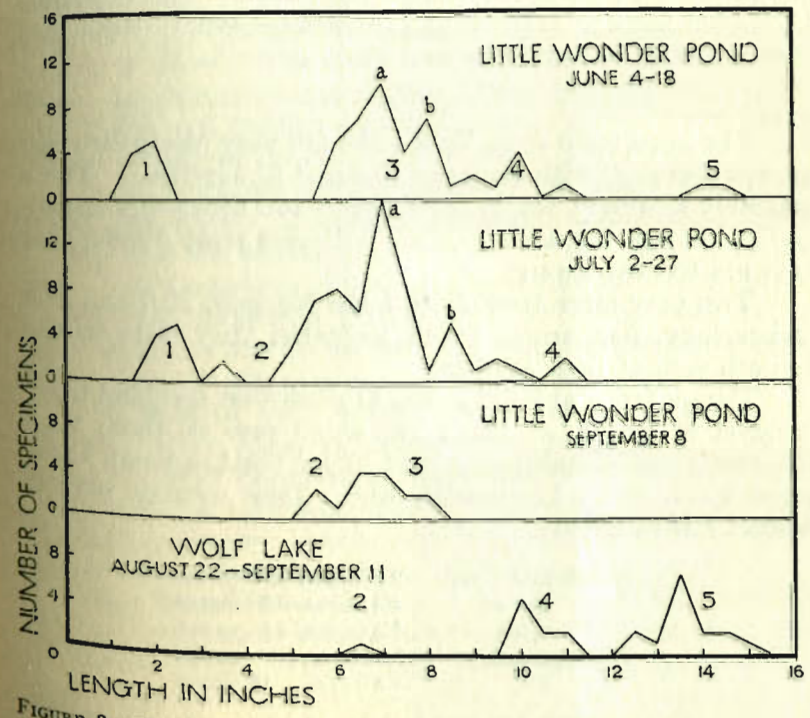

FIGURE 3. Graph showing the distribution of catch by length of speckled trout in Little Wonder Pond and Wolf Lake

that they represent fingerlings from the tributaries and from the pond itself, respectively. In the latter situation they will grow more rapidly than in the cold creeks, although their chance of survival is less.

A schedule for these fish, based on polygons and scale readings, is as follows:

	June 4-18	July 2-27	Sept. 8
	Average length in inches	Average length in inches	Average length in inches
Trout in their 1st year.....	1.8	2.3	
" " " 2nd "		4.8 ?	5.5
" " " 3rd "	7.1	7.1	7.1
" " " 4th "	10.2	10.6	
" " " 5th "	14.2		

The large trout from Wolf Lake fall very nicely into two groups (figure 3) with modes at 10.0 and 13.5 inches. These probably represent fish in their fourth and fifth years respectively, though the scale reading indicates some overlapping between the two groups.

Two very large trout from Lake Nipigon, 22.0 and 22.2 inches long, had scales which indicated they were in the seventh year of their growth.

The evidence at hand seems to show that speckled trout increase in length at about the same rate in three very different types of habitat: a cold *Chara* pond, a warm hard-water river, and a Laurentian lake. Their average size on August 1 is as follows:

Trout in their first	year :	2.0 inches,	0.05 ounces
" " " second	" :	4.8 inches,	0.7 ounces
" " " third	" :	7.5 inches,	2.5 ounces
" " " fourth	" :	10.5 inches,	7 ounces
" " " fifth	" :	13.5 inches,	15 ounces

The actual size of individual fish within each age group varies between wide limits, so that there is considerable overlapping between adjacent groups in every case, except, probably, between the first two. This rate of growth is rather greater than that of speckled trout in the small streams of Allegany State Park.

FOOD

A number of authors have interested themselves in the natural food of speckled trout in American streams and lakes, *i.e.*, Clemens *et al* (1924), Clemens (1928), Embody and Gordon (1924), Greely (1926, 1927), Harkness and Ricker (1929), Hildebrand and Towers (1927), Juday (1907), Kendall and Dence (1927), Leonard (1927), Metzelaar (1929), J. G. Needham (1903), P. R. Needham (1928, 1930), Pearse (1918), Ricker (1930), Rimsky-Korsakoff (1930), Smallwood (1918), and White (1930). Clemens, in his paper of 1928, includes a review of those works which had appeared previous to that time. Of the remainder, Greely (1927) and Rimsky-Korsakoff (1930) deal with only a small number of specimens, taken during a study of the entire fish fauna of a watershed.

P. R. Needham (1928) compares the insect food of 147 trout, principally *Salvelinus fontinalis*, taken in a small stream with the insects caught in a drift net set in the same place. The numbers of individuals of the various orders of aquatic and terrestrial insects were much the same in the trout stomachs and in the net, the principal exception being in the case of Trichoptera. This fact suggests that trout capture most of their insects when they are adrift in the current, either upon or below the surface of the water. Leonard (1927) examined the stomachs of ten large speckled trout from Lac La Pêche, Quebec, and found that their food, principally aquatic insects, was very similar to that of the horned dace (*Semotilus atromaculatus*), and shiner (*Notropis cornutus*) from the same place. Metzelaar (1929) lists the stomach contents of 411 speckled trout, 191 brown trout, and 47 rainbow trout, all more than seven inches long. He finds that brown and rainbow trout turn from an insect to a fish diet when they reach nine inches of length, but that this change is not so pronounced in the case of speckled trout,

which are more apt to take crayfish as they grow larger. P. R. Needham (1930) tabulates the foods of speckled trout in streams near Ithaca, N.Y., during every month of the year. He finds that terrestrial foods (including imaginal aquatic insects) exceed aquatic species in numbers during late summer and early autumn, but are quite scarce during the winter months. Finally, White (1930) has reported upon the contents of the food canals of thirty-one fry taken soon after they rose from the spawning beds, and before many of them had absorbed the yolk-sac. Two-thirds of the food of these minute fish consisted of chironomid larvae; copepods were next in importance.

The analyses tabulated by Harkness and Ricker (1929) and Ricker (1930) have been incorporated into the present series of papers. In all, about thirteen hundred stomachs have been examined by the author. These records are for the most part set forth in tables in the two accompanying papers, along with a description of the body of water from which each group was taken and, in some cases, the food of associated fishes. Discussions are there to be found of the change of diet associated with increase in size, and with the change of seasons, in several types of habitats.

LIST OF TROUT FOODS

The following is a complete list of materials (exclusive of parasites) found by the author in stomachs of speckled trout. In many cases, well-preserved specimens have been submitted to specialists for determination. Those who have co-operated in this manner are: Seeds—W. H. Wright, M.A., Seed Branch, Department of Agriculture, Ottawa; Entomostraca —Dr. D. S. Rawson, University of Saskatchewan; Ephemeroptera and other insects—F. P. Ide, M.A., University of Toronto; Odonata—Dr. E. M. Walker, University of Toronto; Heteroptera—G. Stuart Walley, M.A., Department of Agriculture, Ottawa; Pisces—Professor J. R. Dymond, University of Toronto. Terrestrial insects have not been identified beyond family. The author also wishes to acknowledge the assistance of Mrs. E. Spaulding Skelton, B.A., and other members of the Ontario Fisheries Research Laboratory.

Short notes on frequency of occurrence follow most of the organisms listed. Species are classified as abundant, frequent, occasional, or rare, in order of decreasing importance. If no qualifying statement follows an item, it is rare.

TRASH

Pebbles and limy concretions. Occasionally attaining a weight of one gram.

Sand

Bits of dead wood and bark

The foregoing materials often form part of caddis larval cases; in this condition they frequently occur in stomachs.

Willow cone galls

Cone scale of a gymnosperm

Fish-hooks. Five were found altogether. The occurrence of one of these might be of interest to physiologists as illustrating the relative acidity of different parts of the stomach. It had evidently been in the stomach a long time, probably a year, and was lodged with the hook in line with the curve of the stomach. The upper portion of the hook was partly corroded away, the central part of the shank was almost eaten through, the point and barb were not diminished in thickness. It may also interest anglers to know that when a fish escapes with the hook, it does not necessarily die at once. Hurst (1931) records a similar occurrence in the case of the brown trout (*Salmo fario*).

VEGETABLE MATTER

Algae

Nostoc colonies

Spirogyra. Occasional, usually in ponds.

Zygnema. Rarely with the preceding.

Mougeotia

Diatoms

Chara. Fresh sprigs are occasionally eaten, frequent as a component of caddis cases.

Leaves of vascular plants

Potamogeton. Occasionally forms part of caddis cases; otherwise rare.
Radicula Nasturtium-aquaticum
Carex and grasses. Leaves and stems rare.
Thuja occidentalis. Occasional.
Tsuga canadensis
Larix americana
Picea alba

Fresh twigs of cedar or deciduous trees. Occur rarely.

Stamens of Angiosperms

Seeds

Thuja occidentalis
Carex. Occasional; usually covered by perigynium.
Glyceria nervata?
Ulmus americana
Compositae
Nymphaea advena. Frequent in Mad River trout; found only once elsewhere. In midsummer the fruit of the waterlily breaks up, freeing the seeds which float at the surface of the water. These are roughly ovoid, about 4×3×3 mm., and pointed at the micropylar end, to which is attached a soft, pulpy mass. In late July and early August these were present in trout of all sizes over four inches in the Mad River. Although the pulp may be digestible, the seeds are protected by a hard, shining integument and invariably pass through the alimentary canal uninjured.

ANIMAL MATTER

Polyzoa

Plumatella. Statoblasts; rare.

Oligochaeta

Lumbriculidae
Tubificidae
Earthworms used as bait frequently occur.

Nematoda. The author has been unable to distinguish free-living nematodes, which would be classed as food organisms, from the abundant parasites.

Gordiacea. The one specimen certainly identified was apparently within a cricket's body when ingested. Parasites of aquatic larvae such as *Simulium* and *Chironomus* may also belong here.

Hirudinea

Haemopis plumbeus. Occasional in Mad River trout; not found elsewhere.
Unidentified leeches found occasionally.

Crustacea

Cladocera
Daphnia. Occasional in trout from Laurentian lakes; rare in *Chara* ponds. The only species identified was *D. longispina*.
Simocephalus. Occasional in some *Chara* ponds.
Chydorus. Occasional in fingerlings.
Leptodora. Abundant from deep water of Laurentian lakes.
Copepoda
Cyclops. Frequent in small fingerlings.
Canthocamptus. Frequent in small fingerlings.
Ostracoda. Frequent in small fingerlings.
Isopoda
Mancasellus tenax. Rare.
Asellus communis. Rare.
Amphipoda
Gammarus limnaeus. Occasional from one *Chara* lake. Not found elsewhere.
Hyalella knickerbockeri. Taken occasionally from almost all waters; abundant in one *Chara* lake.
Decapoda
Crago septemspinosus(?) Determined by Dr. A. Berkeley Needler. From north shore of Gulf of St. Lawrence.
Cambarus bartonii robustus. Frequently from stony streams.

Cambarus propinquus. Frequently from slow streams.

Diplopoda (millipedes). Rare.

Chilopoda (centipedes). Rare.

Aquatic Insects. Unless otherwise stated, all records refer to immature specimens (larvae or nymphs).

Collembola

Poduridae. Adults; rare in small fingerlings.

Ephemeroptera

Ephemeridae

Hexagenia. Occasional, chiefly from lakes, although two species, *H. viridescens* and *H. recurvata*, were taken from slow streams.

Ephemera cf. *simulans*. Nymphs and sub-imagos abundant in a slow river; imagos rare.

Ephemera guttulata. Rare.

Baetidae

Leptophlebia. Rare.

Blasturus nebulosus. Imagos, especially females, frequent from some slow streams.

Blasturus cupidus. Frequent, like the last.

Ephemerella. Frequent from some stony streams. The only species determined was *E. subvaria*. Imagos rare.

Caenis. Occasional; slow stream.

Callibaetis. Frequent from some *Chara* ponds; also Lac Cassette; imagos and sub-imagos rare.

Baetis. Occasional or frequent in stony streams.

Baetisca. Rare.

Heptagenidae

Siphlonurus. Occasional; slow streams and lakes.

Ecdyonurus tripunctata. Nymphs; sub-imagos and imagos rare.

Ecdyonurus canadensis. Rare.

Ecdyonorus sp. (*fusca* group). Rare.

Epeorus humeralis. Rare.

Odonata

Zygoptera. Imagos rare; nymphs occasional, including *Agrion aequabile*.

Anisoptera

Imagos

Sympetrum obtrusum. Rare.

Aeshna sp. Rare.

Nymphs

Aeshna umbrosa. Occasional.

Gomphus exilis. Rare.

Libellula? Rare.

Plecoptera

Perla. Nymphs and imagos rare.

Alloperla? Rare.

Isoperla. Rare.

Nemoura. Imagos; rare.

Leuctra. Nymphs and imagos rare.

Neuroptera

Sialis. Rare.

Chauliodes. Rare.

Trichoptera

Hydroptilidae. Rare.

Rhyacophilidae

Mystrophora americana. Rare.

Rhyacophila fuscula. Occasional.

Hydropsychidae. Frequent from stony streams.

Philopotamidae

Philopotamus. Rare.

Chimarrha. Rare.

Polycentropidae

Sericostomatidae

Lepidostoma. Rare.

Micrasema(?) Rare.

Helicopsyche. Occasional.

Molannidae

Molanna

Leptoceridae

Oecetis

Mystacides sepulchralis. Frequent from Mad River.

Setodes? From Lac Cassette.

Phryganeidae
Phryganea. Larvae generally distributed, but not common; pupae and imagos rare.
Neuronia

Limnephilidae. Undetermined larvae, pupae and adults, frequent.
Limnephilus. Abundant from *Chara* ponds. Imagos of *Limnephilus* (sp. 34 of Dr. Betten's manuscript)—abundant from Mulmur Lake.
Stenophylax scabripennis
Halesus guttifer. Occasional.
Hesperophylax designatus. Cold streams.
Neophylax. Occasional; stony streams.

Heteroptera
Corixidae. Adults and nymphs frequent, especially from *Chara* ponds. Include the following species:
Palmacorixa nana. Frequent from Mad River.
Arctocorixa modesta. Frequent.
Arctocorixa atopodonta. Rare.

Belostomatidae
Belostoma. Adult rare.

Notonectidae
Notonecta. Adults occasional.

Veliidae
Rhagovelia. Rare.

Gerridae. Occasional.

Diptera
Tipulidae. Larvae occasional, imagos rare, including
Antocha. Occasional from swift streams.
Tipula. Rare.

Psychodidae. Pupae rare.

Culicidae. Larvae and imagos rare.

Corethridae
Corethra. Occasionally from Laurentian lakes.

Ceratopogonidae
Culicoides. Occasional in small trout.

Chironomidae. Abundant from practically all types of waters. Most often taken in the pupal state, but quite commonly in the larval, and occasionally in the imaginal condition. Chironominae are commoner than Tanypinae.

Simuliidae
Simulium. Larvae and pupae abundant from swift, soft waters; occasional from hard waters; imagos not uncommon.

Stratiomyidae
Odontomyia. Rare.

Leptidae
Atherix. Frequent from Credit River.

Empidae
Rhamphomyia? Occasional.

Syrphidae. One larva found, resembling *Eristalis*.

Coleoptera
Haliplidae
Haliplus. Adults and larvae occasional from ponds.
Berosus. Rare.

Dytiscidae. In addition to those listed below, large adults of several species were taken.
Hydroporus. Larvae abundant, adults occasional, from some ponds.
Tropisternus. Rare.
Dytiscus. Rare.

Gyrinidae
Gyrinus. Rare.
Dineutes. Rare.

Hydrophilidae. Rare.

Helmidae
Helmis. Adults and larvae rare.

Psephenidae
Psephenus. Rare.

Chrysomelidae
Donacia. Adults rare.

Terrestrial Insects. Unless otherwise stated all records refer to adult specimens.

Orthoptera
- Acrididae. Occasional.
- Tettigoniidae. Rare.
- Gryllidae. Rare.

Thysanoptera. Occasional in small fingerlings.

Homoptera
- Membracidae. Occasional.
- Cercopidae. Frequent.
- Cicadellidae. Frequent.
- Aphidae. Occasional.

Heteroptera
- Miridae. Rare.
- Nabidae. Rare.
- Pentatomidae. Frequent.
- Corimelaenidae. Rare.

Lepidoptera
- Geometridae. Larvae occasional.
- Other families are doubtless represented.

Diptera
- Cecidomyidae. Occasional.
- Bibionidae. Abundant in stomachs from several localities taken in September, 1928; occasional at other times.
- Asilidae. Rare.
- Dolichopodidae. Rare.
- Syrphidae. Rare.
- Muscidae. Occasional.
- Scatophagidae. Rare.

Coleoptera
- Carabidae. Occasional.
- Staphylinidae. Frequent.
- Coccinellidae. Rare.
- Elateridae. Occasional.
- Lampyridae. Rare.
- Scarabeidae
  - *Aphodius fimetarius*. Occasional.

  - *Aphodius* spp. Frequent.
  - *Diplotaxis*. Rare.
- Cerambycidae. Of the tribe Lepturini; rare.
- Chrysomelidae. Occasional, including *Leptinotarsa decemlineata*.
- Curculionidae. Frequent.

Hymenoptera
- Tenthredinidae. Rare.
- Ichneumonidae. Occasional.
- Chalcidoidea. Rare.
- Formicidae. Frequent, often abundant; winged and wingless forms are about equally common.
- Vespoidea. Rare.
- Sphecoidea. Rare.
- Andrenidae. Occasional in one group of stomachs.
- Bombidae. Rare.

Arachnida. Two major divisions of this class were represented.

Araneida. Spiders were occasional, from a great variety of localities.

Hydracarina. Occasional, usually from static waters. They commonly occur as adults, but nymphs have been found. The following species taken from these trout stomachs have been determined and recorded by Marshall (1929):
- *Lebertia porosa*
- *Limnesia histrionica wolcotti*
- *Hygrobates longipalpis*
- *Hygrobates neoöctoporus*
- *Piona interrupta*
- *Pionopsis latilamellis*

Mollusca

Pelecypoda
- Sphaeriidae
  - *Pisidium*. Occasional. Abundant in a few specimens.
  - *Musculium*. Rare; Glen Major only.
  - *Sphaerium*. Rare.

Gastropoda
Lymnaeidae
Lymnaea stagnalis. Rare.
Stagnicola? Occasional.
Planorbidae
Helisoma antrosus. Rare.
Gyraulus sp. cf. *parvus.* Occasional; in ponds sometimes abundant.
Physidae
Physella gyrina. Abundantly or frequently from most *Chara* ponds.
Physella sp. Rarely from streams; some of the pond specimens may not belong to *P. gyrina.*
Valvatidae
Valvata tricarinata. Rare.

Pisces. (See also the list to follow.)
Salmonidae (Trout, *etc.*)
Salvelinus fontinalis. Only three instances of cannibalism have come to the author's notice. It is doubtless much commoner when the trout are crowded, as in some hatchery ponds.
Catostomidae (Suckers)
Catostomus commersonii. Two specimens.
Cyprinidae (Minnows)
Semotilus atromaculatus. Occasionally from Laurentian lakes or the larger rivers.
Notropis cornutus. One specimen.
Notropis rubellus(?) One specimen.
Ameiuridae (Cat-fish)
Ameiurus. One specimen.
Percopsidae (Trout-perch)
Percopsis omisco-maycus. Three specimens from one stomach.
Gasterosteidae (Sticklebacks)
Eucalia inconstans. Occasionally from hard-water streams and ponds.

Percidae (Perch)
Perca flavescens. Occasionally from Laurentian lakes.
Cottidae (Sculpins, muddlers, or miller's thumbs)
These fish were taken more frequently than all the rest together.
Cottus bairdii. Frequently from hard-water streams.
Cottus cognatus. Unidentifiable specimens of *Cottus* were occasionally taken from waters where this species, rather than the last, is known to occur.

Fish Eggs
Eggs of *Salvelinus fontinalis.* Eaten in large numbers, during the spawning season.
Eggs of *Eucalia inconstans.* Two eggs were taken along with a fish of this species.
Eggs of *Cottus bairdii.* Two trout from the Mad River had eaten masses of eyed eggs identical in appearance with those of this abundant species.

Amphibia
Plethodon cinereus. Reported by a reliable observer.
Rana. One adult specimen was found in a large trout.
Rana clamitans? Tadpoles doubtfully recorded from two stomachs.

Reptilia
Colubridae. A snake was found in a trout seven inches long, taken from a small stream near Bonfield, Ontario.

VERTEBRATE FOODS

Popular interest in the vertebrate food of trout, and of fish in general, has always been strong. The following list has, therefore, been compiled, to include all species of vertebrates which have been found in speckled trout stomachs. Where no authority is quoted, the observation is the author's

VERTEBRATES RECORDED FROM TROUT STOMACHS

Species	Locality	Authority
Fish		
Labidesthes sicculus (silversides)	Lac la Pêche, P.Q.	Leonard (1927)
Eupomotus gibbosus (sunfish)	Clear Lake, N.Y.	Smallwood (1918)
	Northern New York	Sibley and Rimsky-Korsakoff (1931)
Percina caprodes (log-perch)	Michigan	Metzelaar (1929)
Hadropterus maculatus (black-sided darter)	Michigan	Metzelaar (1929)
Perca flavescens (perch)	Michigan	Metzelaar (1929)
	Algonquin Park, Ont.	
	Northern New York	Sibley and Rimsky-Korsakoff (1931)
Cottus bairdii (sculpin)	Near Ithaca, N.Y.	P. R. Needham (1930)
	Michigan	Metzelaar (1929)
	Grey Co., Ont.	
Cottus cognatus (sculpin)	Lake Nipigon, Ont.	Clemens *et al* (1924)
	Michigan	Metzelaar (1929)
	Dufferin Co., Ont.	
Fish Eggs		
Salvelinus fontinalis	Fish Lake, Utah[1]	Hildebrand and Towers (1927)
	Forbes Brook, P.E.I.	White (1930)
	Near Ithaca, N.Y.	P. R. Needham (1930)
	Grey Co., Ont.	
Cottus bairdii	Grey Co., Ont.	
Eucalia inconstans	Dufferin Co., Ont.	
Amphibians		
Ambystoma jeffersonianum (Jefferson's salamander)	Near Ithaca, N.Y.	P. R. Needham (1930)
Plethodon cinereus (red-backed salamander)	Dufferin Co., Ont.	Reported
Eurycea bislineata (two-lined salamander)	Near Ithaca, N.Y.	P. R. Needham (1930)
Rana sp. (frog)	Algonquin Park, Ont.	
Reptiles		
Colubridae (snake)	Dist. of Nipissing, Ont.	

[1]Since they were taken late in autumn, the fish eggs listed by Hildebrand and Towers are undoubtedly those of the specked trout themselves.

VERTEBRATES RECORDED FROM TROUT STOMACHS

Species	Locality	Authority
Fish		
Leucichthys sp. (cisco or lake herring)	Lake Nipigon, Ont.	Clemens *et al* (1924)
Salvelinus fontinalis (speckled trout)	Dufferin Co., Ont.	Harkness and Ricker (1929)
	Muskoka and Ontario Co.	
Salvelinus oquassa (blueback trout)	Rangeley Lakes, Maine	Whitney (1900)
Osmerus mordax (smelt)	Rangeley Lakes, Maine	Whitney (1900)
Catostomus commersonii (sucker)	Michigan	Metzelaar (1929)
	Oneida Co., N.Y.	Clemens (1928)
	Algonquin Park, Ont.	
Chrosomus erythrogaster (red-bellied dace)	Northern New York	Sibley and Rimsky-Korsakoff (1931)
Margariscus margarita (*Leuciscus carletoni*)	Northern New York	Sibley and Rimsky-Korsakoff (1931)
	Clear Lake, N.Y.	Smallwood (1918)
Semotilus atromaculatus (horned dace)	Northern New York	Sibley and Rimsky-Korsakoff (1931)
	Michigan	Metzelaar (1929)
	Oneida Co., N.Y.	Clemens (1928)
	Algonquin Park and Dufferin Co., Ont.	
Rhinichthys atronasus (black-nosed dace)	Michigan	Metzelaar (1929)
	Oneida Co., N.Y.	Clemens (1928)
Rhinichthys cataractae (long-nosed dace)	Michigan	Metzelaar (1929)
Notropis cornutus (shiner)	Michigan	Metzelaar (1929)
	Northern New York	Sibley and Rimsky-Korsakoff (1931)
Notropis rubellus? (rosy-faced minnow)	Algonquin Park, Ont.	
Hybognathus hankinsoni (Hankinson's minnow)	Northern New York	Sibley and Rimsky-Korsakoff (1931)
Ameiurus sp. probably *nebulosus* (catfish)	Algonquin Park, Ont.	
Percopsis omisco-maycus (trout-perch)	Lake Nipigon, Ont.	Clemens *et al* (1924)
	Muskoka, Ont.	
Pungitius pungitius (nine-spined stickleback)	Lake Nipigon, Ont.	Clemens *et al* (1924)
Eucalia inconstans (five-spined stickleback)	Grey and Dufferin Counties, Ont.	

own. Dr. Carl L. Hubbs has kindly supplied a list of specific determinations of the fishes mentioned in Dr. Metzelaar's paper of 1929.

PARASITES

In connection with the food studies, records have been kept of the parasites found in the digestive tracts of almost all the fish examined. Unfortunately, the specimens have not been examined by specialists, so that only a gross classification is possible. External parasites do occur, but most of the parasites noted by the author have been in the food canal or its diverticula. Out of the many hundred fish which have been eviscerated, not one contained Nematoda in the body cavity—a condition which frequently occurs, for example, in the whitefish (*Coregonus clupeaformis*).

TREMATODA

Small distomes, about two millimetres in length, were obtained from the intestines of six specimens of trout about six inches in length, taken in midwinter from a large hard-water spring. In number they averaged eight parasites per fish and were in some cases associated with a few nematodes. They have not been found in other trout but might easily have been overlooked. A stickleback taken in July from the creek below the spring had parasites of similar appearance in its stomach.

P. R. Needham (1930) found many flatworms in the stomachs of stream trout taken in October and December. They belonged to the species *Crepidostonum cornutum* and *Allocreadium lobatum*.

CESTODA

Tapeworms are frequently found in the pyloric caeca, duodenum, and upper intestine of large trout taken in large streams or lakes of the Laurentian country. Typical localities are the Oxtongue River, Petawawa River, and Wolf Lake, all in Algonquin Park; Lake Nipigon, and the Blanc Sablon River, P.Q., along the north shore of the Gulf of St. Lawrence. The worm is usually anchored at the tip of a caecum, while its body grows down it and into the lumen of the intestine. In some cases they are so numerous that the duodenum would seem to be completely blocked; yet these fish show no signs of noxious effects externally. More often they are present in more moderate numbers; fifteen per fish would perhaps be an average number for all fish found to contain them.

Typical tapeworms were not found in trout from the hard-water lakes and rivers of southern Ontario. However, one large specimen from the Beaver River had in its stomach a Cestode 3.4 centimetres long, which resembled *Ligula* in appearance. It may have been the parasite of a small fish which was found with it, though the two were not in any way connected when the stomach was first examined.

NEMATODA

Roundworms are easily the commonest parasites of speckled trout, being found in specimens from every type of habitat. Individual streams and lakes vary greatly in the extent of the infestation of their fish, and it does not seem possible at present to correlate this with any particular environmental characteristics. They are, however, much less frequent in the Laurentian lakes than in hard waters, and of the latter, those of higher temperature and far from the stream sources contain the most heavily infected trout. Each of the tables of stomach contents in the two accompanying papers contains a record of gastric nematodes.

Most of the nematodes found are very slender, from two to forty millimetres long and not more than 0.4 mm. in diameter. When preserved, they are found to be variously twisted, or often, as Kendall and Dence have noted (1927), tightly coiled like a watchspring. They are usually found in the stomach; when occasionally they are in the intestine, it is always near the pyloric end. Infestation may begin early in the life of the fish; specimens only two inches long and not more than six months old have been found to contain a few of these parasites. Older fish are sometimes very heavily

attacked; several stomachs contained over five hundred medium to large-sized specimens.

Another type of nematode parasite is much larger in size: usually about thirty millimetres long by 1.0 mm. broad. It occurs most commonly in the upper part of the intestine, rarely in the caeca or stomach. Not more than six specimens have been seen in a single host. It was found in trout from the Beaver and Noisy Rivers—both hard-water streams, and rarely from Wolf Lake.

One trout examined was host to several hundred parasites, probably metacercarial roundworms of the family Strigeidae. They appeared as black dots on the skin. (See Hunter and Hunter (1931).)

ACANTHOCEPHALA

In speckled trout, Acanthocephala appear to be exclusively intestinal parasites. Like cestodes, they are commonest in soft-water lakes and rivers, *e.g.*, Wolf Lake, and the Petawawa River in Algonquin Park, Lac Cassette and the Blanc Sablon in Quebec, but they have been found in one limy southern stream, the Noisy River. In waters where both cestodes and Acanthocephala are found, they sometimes occur together in the same host; more often they do not. In the former case, the tapeworms occupy the pyloric region, the Acanthocephala the lower region of the intestine, though left to themselves, the thorn-heads seem to prefer a more anterior situation. In Lac Cassette they were particularly common, over a hundred specimens having been taken from a single fish. In size they average about thirty millimetres long and 1.4 mm. in diameter. Only a few of the specimens examined had their probosces extruded.

HIRUDINEA

During October and November, trout taken in the spawning run from certain hard-water ponds have small leeches attached to them. These are often squeezed loose if the fish is stripped, and transferred on eggs to the hatchery troughs, where they live sometimes for several weeks until

removed by the man in charge. Alcoholic specimens submitted to Dr. J. Percy Moore were identified as "*Piscicola punctata* (Verrill) (?Young)". On November 3, 1928, some of the fish running up from a certain lake bore as many as four of these parasites; others had none; the average for all fish was 1.4. One preceding season the fish were said to have been "just plastered" with leeches.

CRUSTACEA

A parasitic copepod, *Salmincola edwardsii* in all probability, was not infrequently found on trout from northern lakes. It occurred on the dorsal, anal, pectoral, or pelvic fins, but was commonest on the gill filaments, in which situation over a hundred specimens were found on one Lake Nipigon fish. The average number on sixteen trout from Lac Cassette, P.Q., was 2.6; Wolf Lake fish were even more lightly attacked.

REPRODUCTION

The following notes upon the spawning behaviour of speckled trout are compiled chiefly from observations made at the Mad River and the ponds of the Waylington Hatchery.

Information about the spawning of trout in Lake Nipigon has been furnished by Messrs. A. W. McLeod and William Kennefick, of the Ontario Department of Game and Fisheries.

TIME

In southern Ontario, speckled trout spawn in the fall of the year, from about October 15 to December 15. At the Mad River, spawning was well under way on October 20, 1930, and from November 11 to 20 it was in full swing. At this time some of the females taken were completely spent, others were not yet ripe. All the males examined at this time extruded ripe milt on pressure, a fact which suggests that they are sexually active over a much longer period than their mates. Even in early January, one of five males taken had considerable milt left. Farther north spawning occurs

somewhat earlier in the year: from October 10 to November 15 in Lake Nipigon, and beginning at least as early as September 25 at Kowkash (Mr. Harry Overholt).

PLACE

For spawning purposes the trout congregate on redds, or spawning beds, which are often situated in places where few or no trout are found during summer. In streams they are in spring pools, in river-bed springs, or more rarely in parts of the river which lack springs. Most of the southern pond fish ascend tributary streams, but a few spawn in shallow water in the pond itself. Many Laurentian lakes have no such suitable tributaries, so that their trout must all remain in the lake. In Lake Nipigon the large trout do not enter the rivers, but spawn on gravel beds, close to shore, and in water about two feet deep.

A typical spring pool near the Mad River was twelve by eight feet in extent and five feet deep in the middle, with water welling up at a rate not greater than 0.1 cubic feet per second. The sides were of mud and the bottom of mud and vegetable debris. A few trout were spawning in this spring on October 20; on November 18 it contained about seventy-five trout of all sizes; its normal summer population is not more than ten small trout. River-bed springs more often have coarse marl or gravel bottoms. In them spawning takes place at depths of fifteen inches to five feet. The marl is swept bare and white by the trout hovering above it.

River spawning occurs in riffles with gravel or stony bottom. A few nests have been found just above a suitable spring, but they are commoner where springs are not available, as at the foot of insuperable barriers such as dams or falls.

In order to reach suitable spawning grounds speckled trout will undertake very considerable migrations. Sometimes they travel for several miles up small brooks to the springs at their source. The spring pool mentioned above had an outlet only a foot wide, an inch or less in depth, and twenty feet long, yet through it passed a great number of

spawning trout. At Waylington the author has observed trout at the foot of a fall jump repeatedly as high as sixteen inches in an effort to surmount the barrier.

SIZE

The smallest trout to engage in breeding activities are between five and six inches long—a male 5.6 inches long was the smallest captured. This means that most trout do not spawn until the third year of their life. There is no known upper limit of length or age at which sexual activity ceases. In the Mad River, the males seemed to average about an inch shorter than the females on the same redd.

In southern streams and ponds all speckled trout more than seven and one-half inches long at the spawning season were found to be sexually mature. In the Laurentian lakes they appear to mature at a rather larger size. In Lac Cassette the average size at the time of first sexual activity is nine inches. Wolf Lake fish are more puzzling. Two male trout more than thirteen inches long, taken in August, were obviously not ready to breed in the approaching autumn, while two others barely ten inches long had well-developed testes. Of thirty-two fish taken there, 9.4-14.4 inches long, twenty were ready for reproduction, eight unready, two doubtful, and two had diseased ovaries. These facts account for the belief which prevails among some guides, that the trout in such lakes spawn only every other year.

APPEARANCE

Trout from streams and ponds have all the colours of the body brighter and more intense at spawning time. In males the sides become a brilliant red, almost scarlet, the belly is dusky, spots are bright and distinct, and the fins have a clear white sub-marginal ray—anteriorly on the pectorals, ventrals, and anal, ventrally on the caudal, and anteriorly on the outer half of the dorsal. Along the back on either side is a broad yellowish or light grey line, while between these and the red band of the sides, the shoulders are quite dark,

with vermiculations obscured. Females are not so distinctively marked but are more brilliant than usual.

Another sexual peculiarity is observed in the larger males. The point of the lower jaw becomes narrowed and turned up while its more anterior teeth project prominently. This change is, however, not nearly so conspicuous as it is in the salmon.

THE WATER

The time spawning takes place is probably dependent to some extent upon water temperature, though direct experimental evidence of this is lacking. In the Mad River region the temperature in spring pools was found to be 7°-8°C., in the stream 2°-9°C., and about the river bed springs all intermediates should occur. The hydrogen-ion concentration in the springs was pH 7.2, as compared with 7.8 in the river. The importance of an adequate oxygen supply is illustrated by a comparison of two springs which flow into Dogwood Creek, a tributary of the Mad River. These two are situated within fifty yards of each other and are almost identical as regards surroundings, diameter, depth, nature of bottom, temperature, hydrogen-ion concentration, volume of flow, and accessibility. The first, with an oxygen content of 5.9 parts per million, contained about seventy-five spawning trout; the second with 4.7 parts per million was devoid of fish life. This difference, 1.2 parts per million, is not very great, but it should be noted that the respiratory activity of the large population of trout had reduced the figure in the case of spring number one.

OVIPOSITION

The following observations were made on the Mad River: males outnumber females on the redds by about three to one, owing doubtless to their longer period of sexual activity, but during oviposition only two fish are together. Spawning takes place throughout the day, from early morning to sundown. At any given time only a few fish on a bed will be actually breeding. When in the mood a male will take possession of a limited area and drive away all other males smaller, and even some larger, than himself. If a really big one appears, he hovers near by. This pugnacity is accentuated if a female comes to lay eggs, and for this reason he is sometimes absent from the redd while the eggs are being extruded. Females are usually smaller than the males with which they mate.

In ovipositing, the females turn quickly on either side, give two to four flips of the tail, and the eggs are shot out. The male, if not chasing other fish, stays close above her. It is not certain just when the milt is usually extruded; on the only occasion it was seen, it was fifteen seconds after an oviposition and about eight inches downstream from the female. One pair will remain in one spot for at least half an hour, probably much longer, the female depositing eggs at intervals of three seconds to five minutes. Usually several extrusions, fifteen seconds apart, are followed by a rest of several minutes. All the time they are on the bed both male and female are very restless, and their constant turning cleans all silt and debris from off the gravel. The eggs fall to the bottom when the female has laid them, and the author did not observe that the spawning pair took any further notice of them. White (1930) has described the motions of the female trout in covering eggs with gravel; they resemble closely her actions at the time of oviposition, as seen in Ontario streams. All the eggs recovered from the Mad River seemed to be buried a short distance in gravel or vegetable debris.

EGGS

The number of eggs deposited by a female varies, of course, with her size. The total number of eggs of fish from various localities was found by counting the number in a small part of an ovary, then comparing its weight with the total weight of the ovaries. All counts were made of fish taken later in the year than August 1. The smallest number of eggs found was eighty, in a fish 5.1 inches long; the largest was 5,630, in a twenty-two inch trout taken from Lake

Nipigon. The number of eggs in a fish of any particular size varies greatly, the upper limit being about twice the lower.

Titcomb (1897) has counted the number of eggs in twenty-nine trout from a Vermont lake, taken November 26, 1896. This information has been combined with that from Ontario in the construction of the graph in figure 4. Titcomb notes that "some of these trout had apparently dropped part of their eggs before being captured".

The size of the eggs when spawned also varies consider-

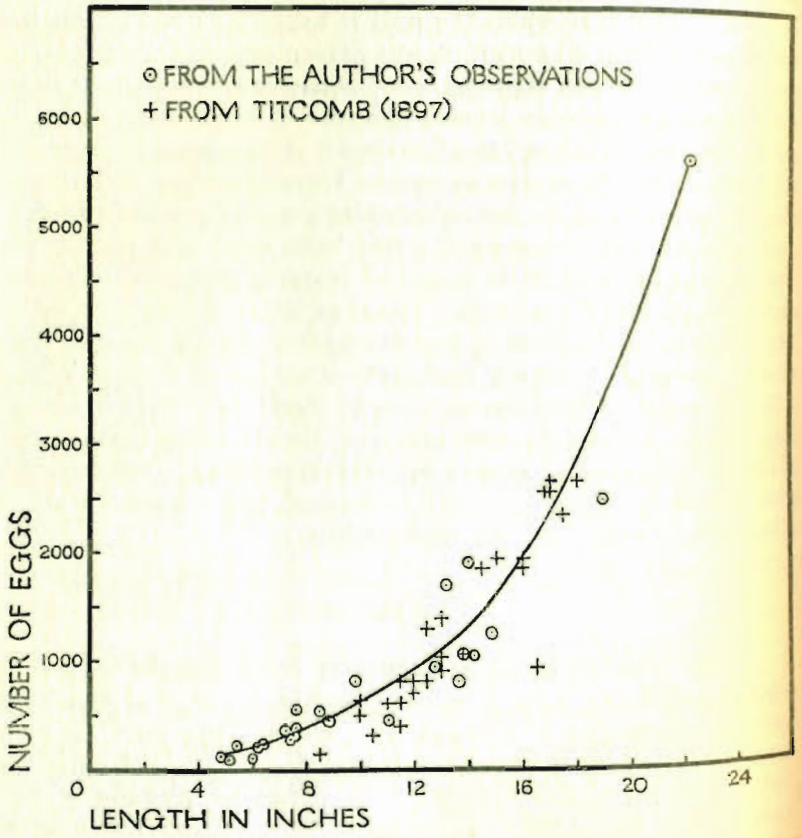

FIGURE 4. Graph showing relation between number of eggs and size of speckled trout

ably, from 3.5 to 5.0 mm. in diameter, the larger eggs coming from the larger trout. As soon as they are laid they swell so that the diameter increases by about one-fourth.

The author has not observed any other fish eating trout eggs, nor, indeed, were any other fish seen near the redds; but, as several writers have noted, trout eggs are eaten by the trout themselves. Around each spawning pair hover four or five males, apparently waiting to get the eggs when they are extruded. Sometimes a male will momentarily seize the spawner in the anal region. Doubtless the destruction of eggs would be far greater were it not for the activity of the breeding male in warding off these cannibals. Of eight males captured on a spawning bed, four had eaten eggs, to the number of one, six, eleven, and twenty-five respectively. It is possible that spent females may aid in the depredations since they remain on the redds for some time after their eggs have been laid.

FRY AND FINGERLINGS[1]

Three eyed-eggs were recovered from a Mad River tributary on January 17, 1931; on March 20 about forty young trout and no eggs were taken from the same spring. Some of these had a large yolk-sac still attached; others had completely absorbed it. It is probable that the eggs hatch over a period of three weeks or more in February and perhaps early in March. At Waylington, eggs taken on November 17 hatched during the last week of January, but they were held at uniformly high temperature of about 7°C.

None of the fry and fingerlings taken on March 20 had risen out of the muddy debris into which the eggs had been laid the preceding autumn; they were still buried from two to five inches deep. By May 22 all the fish had left this redd and were to be found in the shallow mud-bottomed borders of the creek below, in water up to six inches deep. At this time they

[1]The terms "fry" and "fingerlings" are variously used. Often all trout in their first year are called fry. A more correct usage, perhaps, and the one followed here, is to apply the term fry to the stage between hatching and the final absorption of the yolk-sac, the term fingerlings from that time to the end of the first year, and yearling or year-old to trout in the second year of life.

could rather readily be taken in a dip net. On June 14 it was noticed that many of the fingerlings had moved out to midstream where they skulked among leaves of *Sparganium*, *Ranunculus*, or *Potamogeton amplifolius*. They were much more wary too, and only with difficulty were a few specimens obtained. By July 12 the seine was the only practical means of capturing them. In his description of the habits of trout fry, White (1924) says that when young they will lie motionless on the bottom of a stream at night, and at such times are most exposed to attack from other fish. Where small cold-spring creeks flow into a larger river or lake, many of the trout ascend these to spawn. For the first three months of their life, most of the fingerlings remain in these small streams; later they are supposed to move down to the larger body of water. Fry which are hatched in ponds or rivers do not fare so well; they seek the shelter of the shallow borders in water four inches or less in depth, but even so the mortality appears to be much heavier among them than among those in the small creeks.

The causes of mortality among trout fry in Ontario have been investigated by White (1924). He found that of 5,000 fry (fingerlings) planted on June 15 in a small creek, only 181, or four per cent., survived to the end of August. Their enemies were found to be rock bass (*Ambloplites rupestris*), larger trout, and, in one case, a giant water bug (*Belostoma americana*). Later experiments in Prince Edward Island (White, 1927, 1930) show that cannibalism among the fry themselves may account for large losses, and that the presence of large trout is a greater menace to their safety than are fish-eating birds; these in turn are more destructive than sticklebacks (*Gasterosteus aculeatus*).

SOME HABITS OF ADULT TROUT

In nature a speckled trout is most often seen lying near the bottom of a stream, head against the current, maintaining its position by a gentle swaying of the tail and alternate movements of the pectoral fins. Occasionally it will dart off several rods or rise to take an insect at the surface, but, unless

disturbed, it usually soon returns to its former position. In ponds they may be seen hovering quietly near shore, either singly or in small groups, only rarely changing position or stooping to seize a *Limnephilus* larva and shake it free of its case. Except in the spawning season they do not seem to undertake long journeys either up or down stream. White (1930) records several cases of adult trout being found in the same pool over a period of two or three years.

The habits and preferences of trout are, of course, of the greatest interest to anglers, especially to fly fishermen. Many of these make careful observations of their antagonists' idiosyncrasies, and much valuable information might be obtained if some method could be devised for sifting authoritative articles from the great mass of irrelevant and often inaccurate detail found in sportsmen's magazines.

SUMMARY

The speckled trout (*Salvelinus fontinalis*) is distributed abundantly over the Province of Ontario, except in the extreme west, and in some southern sections where the scarcity of springs, extensive clearing of the land, and absence of small, deep lakes preclude the possibility of its finding suitable cool waters.

It reaches a maximum size of from half a pound to fifteen pounds, according to the size of the body of water which it inhabits, or the size and quantity of food which is available. Its body proportions, as represented by the weight/length^3 ratio, change slightly or not at all with increasing size, but there are great differences between individual fish in this respect. Trout from one Laurentian lake were much slimmer than the others measured.

Some evidence is at hand to show that speckled trout commonly grow to about two and a half inches in length during their first summer, and about three inches per year thereafter. The rate of increase in length is about the same in Laurentian lakes as in hard-water streams and ponds.

Speckled trout ingest a varied assortment of animate and

inanimate objects, of animal, vegetable, or mineral origin. Their principal foods are aquatic insects when young, and fish and crayfish when older.

Internally, speckled trout are often infested with parasitic Nematoda, Cestoda, or Acanthocephala; externally by the leech *Piscicola* or the copepod *Salmincola*. Moderate parasitic infection does not appear to affect the health of the fish in any way.

Speckled trout spawn in spring-beds and riffles of streams and on shoals of lakes, during the last three months of the year. Most of the fry hatch in February, but do not rise out of the beds until the yolk-sac is absorbed. A great reduction in the numbers of fingerlings occurs during the first year of their life, apparently the result of destruction by other trout, various other fish, and piscivorous birds.

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