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THE RATE OF GROWTH AND THE FOOD OF THE HORNED DACE (*SEMOTILUS ATROMACULATUS*) IN QUEBEC, WITH SOME DATA ON THE FOOD OF THE COMMON SHINER (*NOTROPIS CORNUTUS*) AND OF THE BROOK TROUT (*SALVELINUS FONTINALIS*) FROM THE SAME REGION

BY

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THE RATE OF GROWTH AND THE FOOD OF THE HORNED DACE (*SEMOTILUS ATROMACULATUS*) IN QUEBEC, WITH SOME DATA ON THE FOOD OF THE COMMON SHINER (*NOTROPIS CORNUTUS*) AND OF THE BROOK TROUT (*SALVELINUS FONTINALIS*) FROM THE SAME REGION

The material upon which this report is based was sent to the Department of Biology, University of Toronto, by Mr. Alex. Andrew, Laurentian Club, Lac La Pêche, Quebec. In the region from which the material came there had been a considerable falling off in the numbers of trout and an apparent increase in numbers of other fish, particularly of horned dace. It was feared that the dace had invaded the region and were destroying or supplanting the trout. Obviously the solution of the problem could only be obtained by a comprehensive field study, but it was thought that an examination of stomach contents might supply some preliminary data. An examination of the scales of the dace has been made for the purpose of adding some additional information.

The study has been carried out under the direction of Dr. W. A. Clemens, now Director of the Pacific Biological Station, Nanaimo, B.C., whose kind assistance the writer wishes to acknowledge.

Rate of Growth of Horned Dace

A total of 76 specimens of dace were examined. The length and weight of each fish were determined, and the scales removed.

The length in centimeters is the distance from the tip of

the snout to the end of the vertebral column, while that in inches is from the tip of the snout to the fork of the caudal fin. Scales were taken from the mid-lateral region, cleaned and examined dry under a monocular compound microscope. Examination of the scales shows alternate areas of closely placed and relatively widely placed lines. The former is considered as representing a winter period of growth, and the latter a summer period. The data for each fish are given in the following table:

TABLE 1, giving the length, weight, sex, age, locality and date taken of seventy-six specimens of Horned Dace

No.	Length in centimeters	Length in inches	Weight in ounces	Sex	Age in years	Locality, Prov. of Quebec	Date, 1923
851	11.2	5.3	1.3	♂	2	Lake Edward	June 29
852	14.5	6.5	2.3	♂	3	Trout lake	July 6
853	13.7	6.1	1.8	♂	2	" "	"
854	10.6	4.8	0.8	♀	2	" "	"
855	10.2	4.5	0.7	♀	2	" "	"
856	12.4	5.4	1.0	♀	2	" "	"
857	11.1	5.2	1.2	♂?	2	" "	"
858	11.0	5.0	—	♂	2	" "	"
859	11.2	5.0	1.2	♂	2	" "	"
860	15.3	6.9	2.3	♂	3	" "	Sept. 22
861	17.7	8.4	3.7	♂	4	" "	"
862	15.8	7.1	2.4	♀	3	" "	"
863	10.7	4.9	0.9	♂	2	" "	Aug. 19
864	16.5	7.4	2.6	♂	3	" "	"
865	16.4	7.3	2.8	♂	3	" "	"
866	10.7	4.8	0.8	♂	2	Lake Edward	June 29
867	10.5	4.6	0.8	♂	2	" "	"
868	13.9	6.1	1.8	♀	3	Trout lake	June 26
869	8.4	3.7	0.5	♀	1	Lake Edward	" 29
870	12.3	5.5	1.2	♂	2	Lac la Pêche	" 27
871	11.3	5.1	1.2	♂	2	Lake Edward	" 29
872	6.8	3.1	0.3	♂	1	" "	June 29
873	11.8	5.3	1.2	♂	2	Trout lake	Sept. 22
874	12.4	5.8	1.3	♂	3	" "	"
875	8.4	3.8	0.5	♀	2	" "	"
876	10.6	4.9	0.9	♀	2	" "	"
877	11.2	5.1	1.0	♀	2	" "	July 9
878	13.1	6.0	1.7	♂	2	" "	"

No.	Length in centimeters	Length in inches	Weight in ounces	Sex	Age in years	Locality, Prov. of Quebec	Date, 1923
879	10.5	4.5	0.7	♀	2	Trout lake	July 9
880	12.2	5.4	1.3	♀	2	" "	Sept. 22
881	10.5	4.7	0.8	♀	2	" "	"
882	11.7	5.3	1.0	♀	3	" "	"
883	11.2	5.0	1.0	♂	2	" "	"
884	11.1	5.0	1.1	♂	2	" "	"
958	13.2	6.0	1.8	♀	3	" "	"
959	13.0	5.6	1.5	♂	2	" "	"
960	12.2	5.5	1.7	♂	2	" "	"
961	14.0	6.3	1.6	♂	2	" "	"
962	15.7	6.9	2.0	♂	3	" "	"
963	16.0	7.0	2.3	♂	3	" "	"
964	14.4	6.4	1.6	♂?	3	" "	"
965	16.0	7.0	2.5	♂	3	" "	"
966	15.4	6.8	2.4	♂	3	" "	"
967	14.5	6.4	1.8	♂	3	" "	"
968	11.9	5.4	—	♂	2	Hay lake	July 18
969	16.3	7.4	2.7	♂	3	" "	"
970	9.4	4.2	0.7	♂	2	" "	"
971	14.8	6.5	1.7	♂	3	Trout lake	Aug. 19
972	13.2	5.9	1.5	♂	3	" "	"
973	14.3	6.3	2.0	♂	3	" "	"
974	16.9	7.5	3.4	♂	3	" "	July 9
975	13.6	6.0	1.8	♂	3	" "	Aug. 19
977	14.5	6.4	2.0	♂	2	" "	"
978	14.8	6.5	2.1	♂	3	" "	"
979	14.7	6.6	2.2	♂	3	" "	"
980	15.1	6.8	2.1	♀	3	" "	"
981	15.6	7.0	2.3	♂	3	" "	"
982	15.8	7.1	2.6	♂	3	" "	"
983	14.6	6.5	2.2	♂	3	" "	"
984	14.1	6.3	1.8	♂	3	" "	"
985	13.2	5.9	1.6	♂	3	" "	"
986	12.2	5.6	1.4	♂	2	" "	July 9
987	13.2	6.0	1.5	♀	–	" "	"
988	13.0	5.8	1.6	♂	3	" "	"
989	12.9	5.8	1.8	♂	2	" "	July 6
990	12.2	5.5	1.3	♀	2	" "	"
991	15.7	7.1	2.3	♂	3	" "	"
992	14.8	6.6	2.2	♂	3	" "	Aug. 19
993	16.0	7.3	2.8	♂	3	" "	"
994	14.8	6.6	1.8	♂	3	" "	"
							Sept. 22

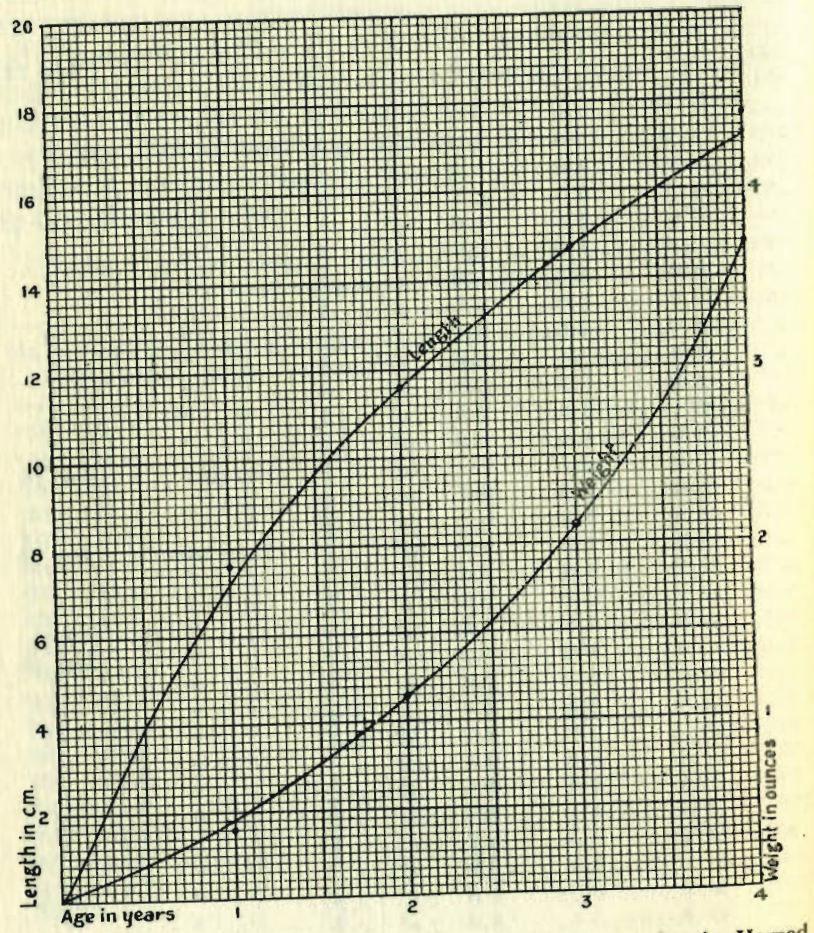

Fig. 1.—Curves showing relation of length and weight to age for the Horned Dace in Quebec

No.	Length in centimeters	Length in inches	Weight in ounces	Sex	Age in years	Locality, Prov. of Quebec	Date, 1923
995	13.7	6.1	1.5	♂	3	Trout lake	Sept. 22
996	15.6	7.0	2.2	♂	3	" "	"
997	14.6	6.5	2.1	♂	3	" "	Aug. 19
998	14.3	6.4	1.7	♀	3	" "	"
999	14.8	6.6	2.2	♂	3	" "	"
1000	13.6	6.0	1.7	♂	3	" "	"

From these data the average lengths and weights of the fish in each of the one-, two-, three-, and four-year classes have been found and used in the graphs (Fig. 1). Only two fish showed one winter area and only one individual showed four. The great majority thus came in the two- and three-year classes. From the graph it is seen that the most rapid growth is made during the first year and that the rate decreases considerably thereafter. The curve illustrating the relation between age and weight indicates that there is a uniform increase in weight during the first three years. The following table gives a summary of the results obtained:

TABLE 2. Average length and weight and average increase in length and weight of Horned Dace

Age	No. examined	Average length in cm.	Range in length in cm.	Increase	No. exam. ined	Average weight in oz.	Range in weight in oz.	Increase
1	2	7.2	6.8- 8.4	7.2	2	0.45	0.3-0.5	0.45
2	32	11.6	8.4-14.5	3.6	30	1.15	0.5-2.0	0.70
3	40	14.7	11.7-16.9	3.1	40	2.1	1.0-3.4	0.95
4	1	17.2	.....	2.5	1	3.7	.....	1.60

FOOD OF HORNED DACE

Food materials were present in the alimentary tracts of 53 individuals. The following are the results of the examinations:

No. 851—2 caddis larvae.
855—2 burrowing mayfly nymphs; caddis adult.
858—statoblast of *Cristatella*; 3 dragonfly nymphs.

No. 862—dragonfly nymph; 2 *Sialis* larvae.
863—dragonfly nymph; caterpillar.
864—2 dragonfly nymphs.
867—mayfly nymph; caddis larva; plant remains.
868—hydrachnid; mayfly nymph; insect fragments.
869—3 mayfly nymphs; plant debris.
870—2 beetles; cranefly larva; dipterous larva; bee.
871—2 caddis larvae.
876—dragonfly nymph.
877—dragonfly nymph; plant remains.
879—fragments of chitin; plant debris.
880—dragonfly nymph; caddis larva.
883—fragments of crayfish; mayfly nymph; plant debris.
884—2 hydrachnids; 2 bugs; 24 dipterous pupae (probably Chironomidae); small Hymenoptera (Ichneumonidae).
958—5 dragonfly nymphs.
961—burrowing mayfly nymph; dragonfly nymph.
963—3 *Sialis* larvae; chironomid larva; plant debris.
965—crayfish.
967—crayfish; plant fragments.
968—4 caddis larvae.
971—crayfish; caddis larva.
972—2 dragonfly nymphs.
973—crayfish chela; insect fragments.
974—insect fragments.
975—mayfly adult (?); insect fragment; plant remains.
978—3 dragonfly nymphs.
979—12 dragonfly nymphs; caddis larva.
980—2 dragonfly nymphs; plant remains.
981—2 dragonfly nymphs; moss.
984—snail; 3 bugs (terrestrial); caddis larva; plant remains.
985—dragonfly nymph.
986—3 small spiders; damselfly nymph; 1 bee leg.
987—spider; burrowing mayfly nymph; *Sialis* larva.
988—lepidopteran wing fragments; fragments of chitin; plant remains.

990—2 bugs (aphid, pentatomid); caddis pupa.
991—dragonfly nymph.
992—dragonfly nymph; plant debris.
993—crayfish.
995—crayfish leg; 2 dragonfly nymphs.
996—burrowing mayfly nymph.
997—statoblast of *Cristatella*; 2 dragonfly nymphs.
998—3 dragonfly nymphs.
999—1 dragonfly nymph.

7 stomachs contained small amounts of plant tissues.
23 stomachs were empty.

The following list shows the frequency of the various materials, the numbers indicating the numbers of digestive tracts in which each group was found: Odonata 22; plant remains 13; Trichoptera 10; Ephemeridae 9; crayfish 7; Arachnida 4; *Sialis* 3; Hemiptera 3; Diptera 3; Hymenoptera 3; Lepidoptera 2.

The food of the dace thus consisted largely of insects, with considerable amounts of crayfish and plant tissue. In many cases the plant material would not be of any food value, some possibly being fragments of caddis larvae cases.

FOOD OF SHINERS

In addition to the dace stomachs, the contents of the stomachs of six shiners were examined. These were taken in Lake Edward on June 29, 1923. Mr. N. K. Bigelow kindly identified the smaller organisms. The results were as follows:

No. 10—small Cladocera, 1 small *Hydracarina*, 2 psocids, filamentous algae and higher plant tissue.
11—*Centropyxis*, *Difflugia acuminata*, oligochaete podal spines, *Bosmina longirostris*, *Chydorus sphaericus*, *Anchistropus minor*, hydrachnid nymphs and adults, chironomid larvae and pupae, *Tabellaria*, *Cocconema*, *Cosmarium*, *Triploceras*, *Docidium crenulatum*, *Ulothrix*, *Oedogonium*, *Spirogyra*, *Chara*.

12—*Monostyla lunaris*, *Conochilus* sp., *Keratella cochlearis*, *Bosmina longirostris*, *Chydorus sphaericus*, *Acantholeberis*, fragments of a spider, lepidopterous scales, chironomid larva, pupa and adult, *Tabellaria fenestrata*, *Synedra*, *Navicula*, *Diatoma* (?), *Pinnularia*, *Eusatrum*, *Closterium*, *Ulothrix*, *Tribonema*, *Bulbochaeta*.

13—2 mayfly nymphs (*Ephemerella*), 7 aphids, 1 psocid, 1 chironomid pupa, 2 larvae (unidentified).

14—*Acantholeberis curvirostris*, mayfly nymphs, corixid eggs, 2 caddis pupa, *Corethra* pupa.

16—Cladocera, aphid, beetle, chironomid larva and pupa, filamentous algae.

The relative frequency of the chief materials in the food of the shiners is as follows: Cladocera 5; Algae and higher plant tissue 4; Chironomidae 4; Arachnida 3; Ephemeridae 2; Aphidae 2; Psocidae 2.

It is evident that insects form the most important item in the food of these fish.

FOOD OF TROUT

In order to obtain data as to the food of the trout examination was made of ten stomachs of fish taken in Trout Lake. The following table contains the available information as to length, weight, etc.:

TABLE 3, giving the length, weight and date taken of six specimens of Brook Trout

No.	Length in inches	Weight in pounds	Date, 1923
3	13	1	(?)
21(*a*)	10	¾	July 6
21(*b*)	(?)	(?)	"
26	10	½	July 15
44	17	2	Sept. 17
45	15	1½	"

The identification of the materials in the stomachs is as follows:

No. 3—5 caddis pupae; 2 chironomid pupae, 4 fish (too far digested to be identified).

21(*a*)—caddis larva; seed.

21(*b*)—2 burrowing mayfly nymphs; 2 fish (one a brook silversides—*Labidesthes sicculus*).

26 —24 *Hyalella knickerbockeri*; 7 mayfly nymphs; 2 bugs (Pentatomidae); 2 caddis larvae; 1 chironomid larva.

36(*a*)—13 *Hyalella knickerbockeri*; 8 mayfly nymphs (burrowing and others); 2 bugs (terrestrial); caddis larva.

36(*b*)—Caddis pupa; *Corethra* larvae and pupae (very abundant); plant remains.

36(*c*)—Hydrachnids; burrowing mayfly nymph; caddis larva; *Corethra* larvae and pupae (numerous); chironomid larvae and pupae.

36(*d*)—3 dragon-fly nymphs; chironomid pupa; higher plant tissue.

44—empty.

45—Mayfly nymph (*Hexagenia bilineata*); dragon-fly nymph; 5 chironomid pupae.

The frequency of the occurrence of the important constituents is as follows: Trichoptera 6; Ephemeridae 5; Chironomidae 5; *Hyalella* 2; Odonata 2; Hemiptera 2; *Corethra* 2; fish 2.

SUMMARY AND CONCLUSIONS

It is evident from these studies that all three species of fish—dace, shiner, and trout—are largely insectivorous in their feeding. Thus the dace and the shiners are direct competitors of the trout for food and large numbers of them in a lake might bring about a reduction in numbers of the trout. There is no evidence here to show that dace are piscivorous, but a more extended study carried out throughout the year would be necessary to settle this point.

It is a more or less common observation that dace and trout occur together in many streams in areas where the surrounding land has been cleared or partly so. This, no doubt, means that the ranges in environmental factors of the two species overlap. The situation in the lakes in Quebec can only be a matter of supposition at the present time, but it is not improbable that deforestation has brought about a change in conditions, probably chiefly in temperature, so that environmental factors have become more favourable for dace and less so for trout, with resulting increase in numbers of the former and decrease of the latter. Food competition may be a secondary factor.

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A DESCRIPTION OF *LEUCICHTHYS TULLIBEE* (RICHARDSON) BASED ON SIX SPECIMENS FROM THE TYPE LOCALITY

BY

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