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THE FOOD OF THE YELLOW PERCH, PERCA FLAVESCENS (MITCHILL) OF
LAKE CHAMPLAIN.

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THE FOOD OF THE YELLOW PERCH, PERCA FLAVESCENS (MITCHILL),
OF LAKE CHAMPLAIN.

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INTRODUCTION.

During the winter and spring of 1930, the International Fact-finding Fisheries Commission for Lake Champlain secured about thirteen hundred yellow perch (*Perca flavescens*, Mitchill). This collection was supplemented in the autumn of 1931 by over one hundred additional individuals, so that somewhat more than fourteen hundred (1,418) specimens of yellow perch have been used in this analysis.

Of the stomachs taken, only 877 contained food substances. The various constituents of the diet were determined as precisely as possible, both as to identity and quantity. The quantity used in this analysis is volume (in cubic centimetres), and was determined by the method of fluid displacement in alcohol, in small graduated cylinders.

Sampling of the yellow perch population was carried out in five major districts: two at the southern end of the lake; two in the central portion; and one in the northern end. Of these districts, one of the central portions and also the northern area have been subdivided into three. These districts and their respective subdivisions, together with the dates on which collections were made, are as follows:

Southern lake Champlain:

Fort Ticonderoga (and Crown point) February 1930.
Larabee's Landing November 1931.

Central lake Champlain:

Burlington	)	February 1930.
Sand-bar bridge: Cowbanks)	
Pike reef	)	February 1930.
Milton shore)	

Northern lake Champlain:

Missisquoi bay: western)	
eastern	)	April-May 1930.
Sandy point)	

The data collected during the winter fishery (February 1930) included the determinations of sex, length and weight of each specimen. Weights were taken with a spring-balance, to the nearest quarter-ounce; total lengths were measured with a metal tape, in millimetres. The stomachs were removed, and segregated according to the size of fish - less than 6 inches; 6 to 7 inches; 7 to 8 inches; and so on. In the group from Larabee's Landing (November 1931), 71 specimens were preserved whole, from which lengths, weights and scale samples were taken subsequently, together with the stomachs. The balance of the material from this locality consisted of stomachs only. From the Missisquoi bay group, taken in April and May, 1930, no lengths or weights were secured - only the stomachs were removed from a maximum (usually) of 50 specimens taken in each sample.

VARIATION IN THE FOOD OF PERCH ACCORDING TO SEASON AND LOCALITY.

Although identifications of food organisms were made as detailed as possible for all groups - to genera whenever possible - yet in tabulating the results of the stomach analysis, chiefly the larger groups (phyla) have been used, though fish are listed by species, and insects by orders. For each region and subdivision thereof, a table has been prepared, listing the food organisms found in that region (Tables 1 to 11, inclusive). The quantities

of the various items consumed are indicated by the fourth columns of these tables, and the "fishing effort" on the part of the perch, by the first and second columns. Two summary tables (A and B) have been prepared to facilitate the comparison of all the parts of the lake studied, with respect to the constitution of the diet of the yellow perch. In both these tables, the first four columns are for the four main divisions (Burlington being omitted since only five full fish-stomachs were secured there). The succeeding columns in each table give data for certain of the subdivisions depending in each table upon the available space and on the relative importance of the data for the different districts. In Table A, the orders of the food items in the different groupings is such that the dominant organism leads in each group.

In interpreting these data, it must be remembered that apart from the purely geographical nature of differences revealed in this table, there are certain seasonal differences as well, as exemplified by the large amount of fish-eggs consumed in western Missisquoi bay. This seasonal effect is also clearly illustrated by Table C below (average amounts per stomach).

Table C provides a comparison between various parts of the lake with respect to: the total number of stomachs collected; the number with food; the percentage of the full stomachs of the total collected; the total amount of food in these stomachs; and the average amount of food per stomach for each region. The seasonal differences to which reference has been made previously, are well shewn in this table, for the regions in which the perch had the least average contents are those in which the winter fishery was investigated - Fort Ticonderoga, Burlington and Sand-bar bridge.

Table A. Summary of the principal items (per cent) in the stomachs of the lake Champlain yellow perch, together with the percentage of perch taking each principal item, and also principal fish and insects consumed.

Item.	Ft.Tic- onderoga	Larabee Landing	Sand-bar bridge	Missis- quoi bay	Burl- ing ton	Cow banks	Pike reef	Milton shore	West Miss- 'oi bay	East Miss- 'oi bay	Lake- wood hatch- ery
	Feb. 1930	Nov. 1931	Feb. 1930	Apr.-My 1930	Feb. 1930	Feb. 1930	Feb. 1930	Feb. 1930	Apr.- My' 30	Apr.- My' 30	Apr.- My' 30
	(356 perch)	(88 perch)	(77 perch)	(351 perch)	(5 perch)	(3 perch)	(34 prch.)	(40 pch.)	(234 pch)	(27 pch)	(110 pch.)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

Percentage of perch that consumed the principal foods in the diet.

Insects	87	61	69	44	80	100	35	95	41	70	41
Fish	40	33	34	19	20	--	38	33	20	41	10
Crustacea	23	2	22	8	60	--	35	13	8	30	3
Molluscs	2	10	1	30	--	--	--	3	36	30	16
Fish eggs	--	--	--	53	--	--	--	--	42	15	86

Percentage (by volume) of the principal items in the diet.

Fish	62	75	73	26	15	--	79	68	42	29	4	4
Insects	30	20	17	13	20	100	6	25	11	41	8	4
Crustacea	7	1	9	3	65	--	14	5	5	7	0*	1
Mollusc	1	4	1	5	--	--	--	1	6	5	2	
Fish eggs	--	--	--	47	--	--	--	--	33	3	79	

Percentage (by volume) of the principal fish consumed and identified.

Tesselated darter	2	6	18	2	15	--	26	11	2	1	1
Smelt	1	--	19	--	--	--	16	21	--	--	--
Trout-perch	--	42	--	16	--	--	--	--	31	5	--
Silvery minnow	27	--	--	1	--	--	--	--	--	--	2*
Spot-tail minnow	--	1	--	1	--	--	--	--	2	--	0*

Percentage (by volume) of the principal insects consumed and identified.

May-flies	20	11	15	5	6	100	5	22	3	5	6
Alder-flies	6	1	1	0*	3	--	--	1	0*	1	0*
Dragon-flies	0*	1	--	6	--	--	--	--	5	28	1
Caddis-flies	3	1	1	2	--	--	1	1	2	5	1
True flies	0*	--	--	0*	3	--	--	--	0*	0*	0*

* Value less than 0.5 per cent.

Table B: Summary of the stomach contents (food organisms only) of perch from various regions of Lake Champlain investigated.

(For each locality, column one gives the percentage of total number of stomachs, the second the percentage total food consumed in that locality).

Food. (Non-food is not included in this table, for reasons of space)	Fort Ticonderoga		Larabee's Landing		Sand-bar bridge		Missisquoi bay (whole)		Pike reef		Missisquoi bay-west		Missisquoi bay-east		Missisquoi bay-Sandy Pt	
	(Feb., 1930)		(Nov., 1931)		(Feb., 1930)		(April-May, 1930)		(Feb., 1930)		(April-May, 1930)		(April-May, 1930)		(Apr.-My., 1930)	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Flatworms (Planaria)	....	....	....	....	....	....	0.3	0.0*	....	....	0.4	0.0*	....	....	....	....
Annelids (leeches, earthworms, etc.)	0.3	0.1	....	....	1.3	0.3	0.3	0.1	....	....	....	....	3.7	0.6	....	....
Crustacea (crayfish, etc.)	23.3	6.8	2.2	0.7	22.1	9.0	8.1	3.3	35.3	13.8	8.1	5.0	29.6	6.9	2.7	0.0*
Insects	86.8	30.3	61.4	20.3	68.8	16.8	44.0	13.3	35.3	5.8	41.4	10.6	70.4	41.1	40.9	8.4
Neuroptera (aldef-flies)	47.8	5.9	10.2	0.6	7.8	0.7	3.8	0.3	....	....	3.0	0.3	11.1	0.8	3.6	0.1
Ephemera (may-flies)	70.8	20.4	43.2	10.8	63.6	14.9	28.4	4.5	26.5	4.8	28.6	3.2	48.1	4.8	22.7	6.2
Odonata (dragon-flies)	1.4	0.3	3.4	1.1	....	....	5.7	6.0	....	....	5.1	4.7	26.0	28.4	1.8	0.7
Hemiptera (bugs)	0.3	0.0*	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Coleoptera (beetles)	....	....	....	....	....	....	0.8	0.2	....	....	....	....	3.7	1.1	1.8	0.1
Trichoptera (caddis-flies)	3.4	3.1	5.7	1.4	3.9	1.1	12.9	2.1	2.9	0.7	10.7	2.1	11.1	5.3	18.2	1.2
Diptera (midgets, mosquitoes, etc.)	0.3	0.0*	....	....	....	....	4.6	0.1	....	....	5.1	0.1	14.8	0.1	0.9	0.0*
Insect remains	3.1	0.6	25.0	6.5	9.1	0.1	3.5	0.1	5.9	0.2	3.0	0.1	11.1	0.5	2.7	0.0*
Molluscs (clams, snails, etc.)	2.2	0.8	10.0	3.7	1.3	0.6	30.0	4.7	....	....	36.3	6.3	29.6	5.4	16.4	2.1
Fish eggs	....	....	....	....	....	....	53.4	46.8	....	....	42.3	32.8	14.8	3.1	86.3	78.5
Fish	39.6	61.5	33.4	75.2	33.8	72.6	18.6	25.8	38.2	79.0	20.1	41.7	40.8	28.5	10.0	3.8
Osmerus mordax (smelt)	1.7	0.7	....	....	6.5	18.5	....	....	5.9	15.9	....	....	....	....	....	....
Notropis hudsonius (spot-tail minnow)	....	....	1.1	0.6	....	....	0.5	1.0	....	....	0.4	1.8	....	....	0.9	0.3
Notropis atherinoides (lake shiner)	0.3	1.0	1.1	4.7	....	....	....	....	....	....	....	....	....	....	....	....
Notropis cornutus (common shiner)	0.3	0.9	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Notropis volucellus (mimic shiner)	....	....	5.7	2.2	....	....	....	....	....	....	....	....	....	....	....	....
Hybognathus reginus (silvery minnow)	13.5	27.0	....	....	....	....	0.8	0.8	....	....	....	....	....	....	2.7	2.1
Hyborhynchus notatus (blunt-nose m'w)	....	....	2.2	6.2	....	....	....	....	....	....	....	....	....	....	....	....
Percopsis omiscomaycus (trout-perch)	....	....	10.2	42.2	....	....	5.7	16.3	....	....	8.1	31.4	7.4	4.9	....	....
Perca flavescens (yellow perch)	1.4	1.1	1.1	1.5	....	....	....	....	....	....	....	....	....	....	....	....
Percina caprodes (log perch)	....	....	2.2	4.1	....	....	....	....	....	....	....	....	....	....	....	....
Cottogaster copelandi (Copeland's d'r.)	....	....	1.1	0.3	....	....	....	....	....	....	....	....	....	....	....	....
Boleosoma nigrum (tesselated darter)	3.7	2.3	10.2	6.4	9.1	17.6	3.0	1.6	11.8	25.9	3.0	2.2	3.7	0.7	2.7	0.8
Lepomis gibbosus (sunfish)	2.0	1.6	1.1	0.8	....	....	....	....	....	....	....	....	....	....	....	....
Centrarchid remains	1.7	2.6	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cottid (sculpin)	....	....	....	....	2.6	3.4	....	....	5.9	7.6	....	....	....	....	....	....
Fish remains	21.3	24.4	7.9	6.3	19.5	33.0	8.9	5.9	20.6	29.7	8.1	6.3	33.4	23.0	4.6	0.2
Amphibia (frogs)	0.6	0.4	....	....	9.1	0.7	1.1	0.8	5.9	1.5	0.9	0.4	3.7	3.5	0.9	0.4
Algae	....	....	....	....	1.3	0.1	11.6	4.1	2.9	0.1	7.3	2.3	22.2	3.4	18.2	6.7
Food remains (unidentifiable)	0.8	0.2	....	....	....	....	3.5	1.1	....	....	3.4	0.8	18.6	7.7	....	....

* Value is less than 0.05 per cent.

Table C.

Region	Number of stomachs with food		Total amount of food (cubic centimetres)	Average amount of food - per stomach; (cubic centimetres)	
	Total number	per cent of total			
Fort Ticonderoga	456	356	78	268.7	0.75
Larabee's Landing	113	88	78	89.1	1.00
Burlington	14	5	36	0.7	0.13
Sand-bar bridge	264	77	29	32.1	0.42
Missisquoi bay	571	351	62	618.3	1.67
Total or average	1,418	877	62	1,008.9	1.15

Food of Perch in late Fall and Winter (November and February)

Fort Ticonderoga: This was the most southern of the areas investigated. A total of 456 stomachs was secured, of which 100 were empty. The detailed analysis of the results for perch of this region is given in Table 1. Fish formed the great bulk of the food (62 per cent); insects were next (30 per cent); and Crustacea (seven per cent) were third. Of the identifiable fish, the silvery minnow (Hybognathus regius) formed the major portion. Of the insects, may-flies (Hexagenia) and alder-flies (Sialis) were the most important. Insects, however, occurred more frequently in the diet than fish; appearing in 87 per cent of the stomachs, whereas only 40 per cent contained fish.

In the Fort Ticonderoga region, the average content of food was 0.75 cubic centimetres, per stomach. As indicated in Table C this area was the best (judged by the average content of the stomachs) of the three studied in the winter fishery. Only areas sampled in the spring (Missisquoi bay) and autumn (Larabee's Landing) contained more food per stomach.

An interesting difference was discovered between the samples taken on the New York side and a small sample taken from the Vermont side. In this latter sample, the percentage of Crustacea was as large as, or larger than any other component of the diet. This predominance was due entirely to the abundance of a single form, namely the aquatic sow-bug (Asellus). In the later samples from the New York side this animal had been appearing in increasing numbers, so that it may be significant that the sample from the Vermont side was the last from this region of the winter investigation. Welch (1935, p.341) reported Asellus as "numerically

Table 1. Summary of stomach contents of 356 perch taken between February 19 and 26, 1930, near Fort Ticonderoga, New York. (100 stomachs of the 456 examined were empty; total amount of food consumed was 268.7 cubic centimetres; average amount per stomach was 0.75 cubic centimetres.)

Item	Number of stomachs with each class of food.	Percentage of total number (356) of stomachs.	Percentage of total amount (268.7 cubic centimetres) of food, or other items consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
Food..				
Annelids (leeches, earthworms, etc.)	1	0.3	0.1	0.02
Crustacea (crayfish, etc.)	63	23.3	6.8	0.22
Insects	309	86.8	30.3	0.26
Neuroptera (alder-flies)	170	47.8	5.9	0.09
Ephemera (may-flies)	252	70.8	20.4	0.21
Odonata (dragon-flies)	5	1.4	0.3	0.13
Hemiptera (bugs)	1	0.3	0.0*	0.05
Trichoptera (caddis-flies)	12	3.4	3.1	0.70
Diptera (midges, mosquitoes, etc.)	1	0.3	0.0*	0.02
Insect remains	11	3.1	0.6	0.15
Molluscs (clams, snails, etc.)	8	2.2	0.8	0.22
Fish	141	39.6	61.5	1.17
<i>Osmerus mordax</i> (smelt)	6	1.7	0.7	0.31
<i>Notropis atherinoides</i> (lake shiner)	1	0.3	1.0	2.30
<i>Notropis cornutus</i> (common shiner)	1	0.3	0.9	2.80
<i>Hybognathus regius</i> (silvery minnow)	48	13.5	27.0	1.51
<i>Perca flavescens</i> (yellow perch)	5	1.4	1.1	0.61
<i>Boleosoma nigrum</i> (tesselated darter)	13	3.7	2.3	0.48
<i>Lepomis gibbosus</i> (sunfish)	7	2.0	1.6	0.60
Centrarchid remains	6	1.7	2.6	1.16
Fish remains	76	21.3	24.4	0.86
Amphibia (frog)	2	0.6	0.4	0.57
Food remains	3	0.8	0.2	0.15
Non-food.				
(not included in above calculations-total 1.96 cubic centimetres)				
Parasites (tapeworms, etc.)	8	2.2	19.4	0.06
Debris (stones, sticks, etc.)	17	4.8	80.6	0.09

* Less than 0.1 per cent.

dominant at two times during the year, viz., in the spring and in the autumn." At the time when this particular sample was taken, the weather had become very mild, and very rapid melting of the ice was taking place.

Larabee's Landing: This point is in the Fort Ticonderoga and Crown point district, and so might have been included in that region. However, the difference in the season of the year when the sample was taken, made it desirable to give the data for the perch from Larabee's Landing separate treatment. The sample consisted of 113 stomachs, of which 25 were empty. There was an even greater proportion of fish than at Ticonderoga - in fact the percentage was one of the highest found. Fish made up 75 per cent of the diet; insects 20 per cent; Crustacea 1 per cent; molluscs, chiefly Sphaeridae, 4 per cent. Insects were found in 61 per cent of the stomachs; fish in 33 per cent, and molluscs in 10 per cent.

The variety of fish in the diet was also greater than at any other point, since 10 different species were identified. Of these, the trout-perch (Percopsis omiscomaycus) was the most abundant. Only in Missisquoi bay was this species found in perch stomachs, other than at Larabee's Landing.

The average stomach content was 1.00 cubic centimetre, which value was more than that for any other locality except Missisquoi bay. This large average stomach content is likely due to the seasonal differences (although see notes on Burlington area below), since the samples were taken at the beginning of November, when the waters were still fairly warm.

Burlington: Only 14 specimens were secured from this region, of which only five contained food. The average stomach content of these

Table 2. Summary of stomach contents of 88 perch taken between October 30 and November 9, 1931, near Larabee's Landing, Vt., and Crown point, N.Y. (25 stomachs of the 113 examined were empty; total amount of food consumed was 89.1 cubic centimetres; average amount per stomach was 1.00 cubic centimetres).

Item.	Number of stomachs with each class of food.	Percentage of total number (88) of stomachs.	Percentage of total amount (89.1 cubic centimetres) of food or other items consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
Food.				
Crustacea (crayfish, etc.)	2	2.2	0.7	0.33
Insects	61	61.4	20.3	0.30
Neuroptera (alder-flies)	9	10.2	0.6	0.05
Ephemera (may-flies)	38	43.2	10.8	0.25
Odonata (dragon-flies)	3	3.4	1.1	0.32
Trichoptera (caddis-flies)	5	5.7	1.4	0.40
Insect remains	22	25.0	6.5	0.26
Molluscs (clams, snails, etc.)	10	10.0	3.7	0.33
Fish	33	33.4	75.2	2.00
<i>Notropis hudsonius</i> (spot-tail minnow)	1	1.1	0.6	0.50
<i>Notropis atherinoides</i> (lake shiner)	1	1.1	4.7	4.20
<i>Notropis volucellus</i> (mimic shiner)	5	5.7	2.2	0.41
<i>Hyborhynchus notatus</i> (blunt-nosed minn)	2	2.2	6.2	2.75
<i>Percopsis omiscomaycus</i> (trout-perch)	9	10.2	42.2	4.17
<i>Perca flavescens</i> (yellow perch)	1	1.1	1.5	1.30
<i>Percina caprodes</i> (log-perch)	2	2.2	4.1	1.80
<i>Cottogaster copelandi</i> (Copeland's darter)	1	1.1	0.3	0.28
<i>Boleosoma nigrum</i> (tesselated darter)	9	10.2	6.4	0.52
<i>Lepomis gibbosus</i> (sunfish)	1	1.1	0.8	0.68
Fish remains	7	7.9	6.3	0.80
Non - food.				
(not included in above calculations-total 1.28 cubic centimetres)				
Debris (stones, sticks, etc.)	16	18.2	100.0	0.08

five (0.13 cubic centimetres) was also the least, excepting only the Cowbanks area.

In both the Burlington and the Cowbanks areas, the 100-foot contour is close to shore. In the Ticonderoga-Crown point area, and in Missisquoi bay no depth as great as 50 feet occurred, and most of the deepest water is about 25 feet. This lack of shallow water possibly may be a contributory factor to the small yield of perch - and also possibly to the apparently small amount of food in the stomachs.

Another factor of some importance is the manner of capture. In both Missisquoi bay, and at Larabee's Landing, in which regions the greater amounts of food per stomach (average) were found, the method of capture was by seine. In the winter fishery, angling was the only method available. At Cowbanks some perch were observed to regurgitate the stomach contents partially or completely, and many stomachs were found everted when examined for analysis.

The small proportion of fish (15 per cent) in the stomach contents is noteworthy. The stomachs from only one other area had less, namely the Lakewood hatchery region, where fish eggs made up 79 per cent of the stomach contents. At Burlington, the most important organisms were Crustacea, which formed 65 per cent. The fresh-water shrimp (Mysis relicta), a form found nowhere else in perch stomachs of lake Champlain was dominant. Insects formed 20 per cent of the content - a value about the same as that for most other localities.

Sand-bar bridge: The area selected for investigation was at Cowbanks, just north of the western end of the Sand-bar, which was the location of an important winter fishery for smelt. The catch of yellow perch at Cowbanks, which was incidental to the smelt fishery,

Table 3. Summary of stomach contents of five perch taken February 19, 1930, off Rocky point, near Burlington, Vt. (10 stomachs of the 14 examined were empty; total amount of food consumed was 0.65 cubic centimetres; average amount per stomach was 0.13 cubic centimetres).

Item	Number of stomachs with each class of food.	Percentage of total number of stomachs (5).	Percentage of total amount (0.65 cubic centimetres) of food or other items consumed.	Average amount in cubic centimetres of food, per stomach.
Crustacea (crayfish, etc.)	3	60.0	64.6	0.14
Insects	4	80.0	20.0	0.03
Neuroptera (alder-flies)	1	20.0	3.1	0.02
Ephemera (may-flies)	2	40.0	6.2	0.02
Diptera (midgits, mosquitoes, etc.)	1	20.0	3.1	0.02
Insect remains	1	20.0	7.7	0.05
Fish (<u>Boleosoma nigrum</u> : tessellated darter)	1	20.0	15.4	0.10

had been so unsatisfactory - only 21 specimens in five days (of. supra - Burlington) that visits to two neighbouring fishing grounds were made, where perch fishing was reputed to be better. At Pike reef, 4 miles northward, a sample of 145 yellow perch was secured, and the day following, on the Milton shore, $2\frac{1}{4}$ miles to the eastward, 96 perch were obtained.

Separate tables have been prepared illustrating the differences between the three grounds, which seem great when one considers how close together the three localities are situated. A composite table for the whole region has also been prepared. Thus there are four tables for the Sand-bar bridge area. Insofar as the amounts and frequency of occurrence of food are concerned, the comparison may be made most easily by means of Table A (page 4) columns 6, 7 and 8. At Cowbanks, only insects were found in the stomachs. At the other two points, fish formed more than half of the contents. On the Milton shore fish comprised 68 per cent; insects 25 per cent; and Crustacea 5 per cent. At Pike reef, fish formed an even greater proportion (79 per cent), but Crustacea were second at 14 per cent. The crayfish (Cambarus) was the dominant crustacean. Insects were reduced to the comparatively low value of 6 per cent. Of the fish found in the stomachs from this region, the tessellated darter (Boleosoma nigrum) and the smelt (Osmerus mordax) were found in about equal proportions from both Pike reef and the Milton shore. A sculpin (Cottid) found in two stomachs from Pike reef, was found nowhere else in the present investigation. At the Milton shore, there was also a fishery for whitefish (ciscoes - Leucichthys artedi).

The average amount of food per stomach for the entire region was 0.42 cubic centimetres; the least of the three was 0.08 cubic centimetres, at Cowbanks; and both Pike reef and Milton shore were

Table 4. Summary of stomach contents of 77 perch taken between February 15 and 22, 1930, near the Sand-bar bridge, South Hero, Vt. (187 stomachs of the 264 examined were empty; total amount of food consumed was 32.1 cubic centimetres; average amount of food per stomach was 0.42 cubic centimetres).

Item	Number of stomachs with each class of food.	Percentage of total number (77) of stomachs.	Percentage of total amount (32.1 cubic centimetres) of food or other items consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
Food.				
Annelids (leeches, earthworms, etc.)	1	1.3	0.3	0.10
Crustacea (crayfish, etc.)	17	22.1	9.0	0.17
Insects	53	68.8	16.8	0.10
Neuroptera (alder-flies)	6	7.8	0.7	0.04
Ephemera (may-flies)	49	63.6	14.9	0.10
Trichoptera (caddis-flies)	3	3.9	1.1	0.12
Insect remains	2	2.6	0.1	0.07
Molluscs (clams, snails, etc.)	1	1.3	0.6	0.20
Fish	26	33.8	72.6	0.90
<i>Osmerus mordax</i> (smelt)	5	6.5	18.5	1.19
<i>Boleosoma nigrum</i> (tesselated darter)	7	9.1	17.6	0.81
Cottid (sculpin)	2	2.6	3.4	0.55
Fish remains	15	19.5	33.0	0.71
Amphibia (frogs)	2	2.6	0.7	0.11
Algae	1	1.3	0.1	0.02

Non - food.

(not included in above calculations-total 0.22 cubic centimetres)

Parasites (tapeworms, etc.)	2	2.6	100.0	0.11
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Table 5. Summary of stomach contents of 3 perch taken between February 15 and 18, 1930, at Cowbanks, South Hero, Vt. (18 stomachs of the 21 examined were empty; total amount of food consumed was 0.19 cubic centimetres; average amount of food per stomach was 0.08 cubic centimetres).

Item	Number of stomachs with each class of food.	Percentage of total number (3) of stomachs.	Percentage of total amount (0.19 cubic centimetres) of food or other items consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
Insects (food) Ephemera (may-flies)	3	100.0	100.0	0.06
Parasites (non-food) tapeworms, etc.	1	33.3	100.0	0.02

Table 6. Summary of stomach contents of 34 perch, taken on February 21, 1930, from Pike reef, Grand Isle, Vt. (111 stomachs of the 145 examined were empty; total amount of food consumed was 14.5 cubic centimetres; average amount of food per stomach was 0.43 cubic centimetres).

Item.	Number of stomachs with each class of food.	Percentage of total number (34) of stomachs.	Percentage of total amount (14.5 cubic centimetres) of food or other items consumed.	Average amount in cubic centimetres of food per stomach.
Crustacea (crayfish, etc.)	12	35.3	13.8	0.17
Insects	12	35.3	5.8	0.07
Ephemera (may-flies)	9	26.5	4.8	0.06
Trichoptera (caddis-flies)	1	2.9	0.7	0.10
Insect remains	2	5.9	0.2	0.02
Fish	13	38.2	79.0	0.88
<u>Osmerus mordax</u> (smelt)	2	5.9	15.9	1.15
<u>Boleosoma nigrum</u> (tesselated darter)	4	11.8	25.9	0.94
Cottid (sculpin)	2	5.9	7.6	0.55
Fish remains	7	20.6	29.7	0.61
Amphibia (frogs)	2	5.9	1.5	0.11
Algae	1	2.9	0.1	0.02

Table 7. Summary of stomach contents of 40 perch taken on February 22, 1930, near Milton (Sand-bar bridge), Vt. (58 stomachs of the 98 examined were empty; total amount of food consumed was 17.4 cubic centimetres; average amount of food per stomach was 0.43 cubic centimetres).

Item	Number of stomachs with each class of food.	Percentage of total number (40) of stomachs.	Percentage of total amount (17.4 cubic centimetres) of food or other items consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
Food.				
Annelids (leeches, earthworms, etc.)	1	2.5	0.6	0.10
Crustacea (crayfish, etc.)	5	12.5	5.3	0.18
Insects	38	95.0	25.0	0.11
Neuroptera (alder-flies)	6	15.0	1.2	0.04
Ephemera (may-flies)	37	92.5	22.3	0.11
Trichoptera (caddis-flies)	2	5.0	1.4	0.12
Molluscs (clams, snails, etc.)	1	2.5	1.2	0.20
Fish	13	32.5	68.1	0.91
<i>Osmerus mordax</i> (smelt)	3	7.5	21.0	1.22
<i>Boleosoma nigrum</i> (tesselated darter)	3	7.5	10.9	0.63
Fish remains	8	20.0	36.2	0.79
Non - food.				
(not included in above calculations - total 0.20 cubic centimetres)				
Parasites (tapeworms, etc.)	1	2.5	100.0	0.20

the same, with 0.43 cubic centimetres. The very high proportion of empty stomachs (Table C), many of which were completely everted, as mentioned above, is probably of considerable significance, and seemed to be due entirely to the method of capture.

As mentioned previously, an explanation at least in part for the poor fishery at Cowbanks might be the rapid deepening of the water, for the 100-foot contour comes in close to the shore at this locality. At Pike reef, shoal water (less than 50 feet) extends for considerable distances in all directions, except southwards. While the 100-foot contour also comes quite close to the Milton shore, it seems possible that this district may be influenced by the extensive shallows on the north side of the Sand-bar bridge, through the prevailing winds. Analysis of weather records (Monthly Weather Review, Climatological data) for the eight years 1932 to 1939 inclusive reveal that the prevailing direction of the wind at Burlington has been southerly for 82 per cent of the months. It was north-west for 12 per cent. So far as known, all of the best samples (in numbers and stomach contents) were taken in shallow waters.

Summary of fall and winter observations: A considerable variation in the food of the perch may be noticed among the regions investigated during the winter fishery (see Table B). The may-fly Hexagenia was ubiquitous and the only form common to all regions. The predominant fish in the districts at the south end were, in February the silvery minnow (Hybognathus regius) and in November the trout-perch (Percopsis omiscomaycus). In the Sand-bar bridge area, the tessellated darter (Boleosoma nigrum) was the most important with the smelt (Osmerus mordax) next. The aquatic sow-bug (Asellus) occurred at the south end, and in the Sand-bar bridge area, as did also the crayfish (Cambarus), but Asellus was important in the south, Cambarus at the

Table 8. Summary of stomach contents of 371 perch, taken between April 25 and May 20, 1930, in Missisquoi bay, Quebec, and Lakewood, Vt. (220 stomachs of the 571 examined were empty; total amount of food consumed was 618.3 cubic centimetres; average amount of food per stomach was 1.67 cubic centimetres.

Item	Number of stomachs with each class of food.	Percentage of total number (371) of stomachs.	Percentage of total amount (618.3 cubic centimetres) of food of other items consumed.	Average amount of cubic centimetres of food, or other items, per stomach.
Food.				
Flatworms (Planaria)	1	0.3	0.0*	0.02
Annelids (leeches, etc.)	1	0.3	0.1	0.40
Crustacea (crayfish, etc.)	30	8.1	3.3	0.68
Insects	163	44.0	13.3	0.51
Neuroptera (alder-flies)	14	3.8	0.3	0.12
Ephemera (may-flies)	105	28.4	4.5	0.27
Odonata (dragon-flies)	21	5.7	6.0	1.77
Coleoptera (beetles)	3	0.8	0.2	0.37
Trichoptera (caddis-flies)	48	12.9	2.1	0.27
Diptera (midges, mosquitoes, etc.)	17	4.6	0.1	0.03
Insect remains	13	3.5	0.1	0.05
Molluscs (clams, snails, etc.)	111	30.0	4.7	0.26
Fish eggs (chiefly pike-perch)	196	53.4	46.8	1.46
Fish	69	18.6	25.8	2.29
<i>Notropis hudsonius</i> (spot-tail minnow)	2	0.5	1.0	3.15
<i>Hybognathus regius</i> (silvery minnow)	3	0.8	0.8	1.62
<i>Percopsis omiscomaycus</i> (trout-perch)	21	5.7	16.3	5.00
<i>Boleosoma nigrum</i> (tesselated darter)	11	3.0	1.6	0.92
Fish remains	33	8.9	5.9	1.10
Amphibia (frogs)	4	1.1	0.8	1.21
Algae	43	11.6	4.1	0.59
Food remains	13	3.5	1.1	0.62
Non - food.				
(not included in above calculations-total 45.3 cubic centimetres)				
Debris (sticks, stones, etc.)	136	38.8	100.0	0.33

* Value is less than 0.05 per cent.

Table 9. Summary of stomach contents of 234 perch, taken between April 28, and May 20, 1930; on the western shore of Missisquoi bay, Quebec. (157 stomachs of the 391 examined were empty; total amount of food consumed was 309.5 cubic centimetres; average amount of food per stomach was 1.32 cubic centimetres.

Item	Number of stomachs with each class of food.	Percentage of total number (234) of stomachs.	Percentage of total amount (309.5 cubic centimetres) of food or other items consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
Food.				
Flatworms (<u>Planaria</u>)	1	0.4	0.0*	0.02
Crustacea (crayfish, etc.)	19	8.1	5.0	0.81
Insects	97	41.4	10.6	0.34
Neuroptera (alder-flies)	7	3.0	0.3	0.13
Ephemera (may-flies)	67	28.6	3.2	0.01
Odonata (dragon-flies)	12	5.1	4.7	1.25
Trichoptera (caddis-flies)	25	10.7	2.1	0.12
Diptera (midges, mosquitoes, etc.)	12	5.1	0.1	0.03
Insect remains	7	3.0	0.1	0.03
Molluscs (clams, snails, etc.)	85	36.3	6.3	0.23
Fish eggs (chiefly pike-perch)	99	42.3	32.8	1.02
Fish	47	20.1	41.7	2.74
<u>Notropis hudsonius</u> (spot-tail minnow)	1	0.4	1.8	5.50
<u>Percopsis omiscomaycus</u> (trout-perch)	19	8.1	31.4	5.11
<u>Boleosoma migrum</u> (tesselated darter)	7	3.0	2.2	0.97
Fish remains	19	8.1	6.3	1.02
Amphibia (frogs)	2	0.9	0.4	0.68
Algae	17	7.3	2.3	0.42
Food remains	8	3.4	0.8	0.32
Non - food.				
(not included in above calculations-total 18.7 cubic centimetres)				
Debris (sticks, stones, etc.)	92	39.3	100.0	0.20

* Value is less than 0.05 per cent.

Table 10. Summary of stomach contents of 27 perch, taken between April 25 and May 17, 1930; on the eastern shore of Missisquoi bay, Quebec. (20 stomachs of the 47 examined were empty; total amount of food consumed was 72.0 cubic centimetres; average amount of food per stomach was 2.7 cubic centimetres.

Item	Number of stomachs with each class of food.	Percentage of total number (27) of stomachs.	Percentage of total amount (72.0 cubic centimetres) of food, or other items consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
F o o d .				
Annelids (leeches, earthworms, etc.)	1	3.7	0.6	0.40
Crustacea (crayfish, etc.)	8	29.6	6.9	0.62
Insects	19	70.4	41.1	1.55
Neuroptera (alder-flies)	3	11.1	0.8	0.19
Ephemera (may-flies)	13	48.1	4.8	0.27
Odonata (dragon-flies)	7	26.0	28.4	2.92
Coleoptera (beetles)	1	3.7	1.1	0.80
Trichoptera (caddis-flies)	3	11.1	5.3	1.28
Diptera (midges, mosquitoes, etc.)	4	14.8	0.1	0.02
Insect remains	3	11.1	0.5	0.12
Molluscs (clams, snails, etc.)	8	29.6	5.4	0.60
Fish eggs (chiefly yellow perch)	4	14.8	3.1	0.56
Fish	11	40.8	28.5	1.87
<u>Percopsis omiscomaycus</u> (trout-perch)	2	7.4	4.9	1.75
<u>Bolcosoma nigrum</u> (tesselated darter)	1	3.7	0.7	0.50
Fish remains	9	33.4	23.0	1.83
Amphibia (frogs)	1	3.7	3.5	2.50
Algae	6	22.2	3.4	0.40
Food remains	5	18.6	7.7	1.11

N o n - f o o d .

(not included in above calculations - total 3.96 cubic centimetres)

Debris (sticks, stones, etc.)	3	11.1	100.0	1.32
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Table 11. Summary of stomach contents of 110 perch, taken between April 30 and May 11, 1930, at Sandy point (Lakewood hatchery), West Swanton, Vt. (43 stomachs of the 153 examined were empty; total amount of food consumed was 236.7 cubic centimetres; average amount of food per stomach was 2.00 cubic centimetres)

Item	Number of stomachs with each class of food.	Percentage of total number (110) of stomachs.	Percentage of total amount (236.7 cubic centimetres) of food, or other items consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
F o o d .				
Crustacea (crayfish, etc.)	3	2.7	0.0*	0.02
Insects	45	40.9	8.4	0.44
Neuroptera (alder-flies)	4	3.6	0.1	0.06
Ephemera (may-flies)	25	22.7	6.2	0.58
Odonata (dragon-flies)	2	1.8	0.7	0.85
Coleoptera (beetles)	2	1.8	0.1	0.16
Trichoptera (caddis-flies)	20	18.2	1.2	1.42
Diptera (midges, mosquitoes, etc.)	1	0.9	0.0*	0.04
Insect remains	3	2.7	0.0*	0.11
Molluscs (clams, snails, etc.)	18	16.4	2.1	0.27
Fish eggs (chiefly pike-perch)	95	86.3	78.5	1.96
Fish	11	10.0	3.8	0.82
Notropis hudsonius (spot-tail minnow)	1	0.9	0.3	0.80
Hybognathus regius (silvery minnow)	3	2.7	2.1	1.63
Boleosoma nigrum (tesselated darter)	3	2.7	1.2	1.42
Fish remains	5	4.6	0.2	0.09
Amphibia (frogs)	1	0.9	0.4	1.00
Algae	20	18.2	6.7	0.79

N o n - f o o d .

(not included in above calculations-total 22.6 cubic centimetres)

Debris (sticks, stones, etc.)	41	37.3	100.0	0.55
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* Value less than 0.05 per cent.

Sand-bar bridge. The fresh-water shrimp (*Mysis relicta*) formed nearly 100 per cent of the stomach contents at Burlington.

Food of Perch in the Spring (April and May)

Missisquoi bay: The Missisquoi bay region has been subdivided into three areas, in which the stomach contents of perch differ strikingly. These subdivisions are: (i) the western, (ii) eastern shores of the bay proper, and (iii) Sandy point (Lakewood hatchery) at the entrance to the bay. All stomachs for the study of the food of perch in the spring were collected in the Missisquoi bay region by a 40-rod seine, requiring a windlass and a horse for hauling (except in the Pike river, included with the eastern shore grounds, where a smaller seine had to be used. In any haul, if the perch were less than 50 in number, the whole lot was taken, but usually not more than 50 were taken, no matter how large the haul. On the western shore, samples were obtained from the seining grounds of Desranleau, Miller and Bullock (though no perch was taken at this latter ground). On the eastern shore, hauls were made in the Pike river, at the seining grounds of Jones, and Lariviere, and by night-line set off Phillipsburg. At Sandy point, hauls were made about the hatchery and also across on the East Alburg shore.

The chief source of perch from the western shore was Desranleau's grounds, where eight hauls were made; two more hauls were made from the near-by grounds of Miller. The most important difference in the diet of the yellow perch in Missisquoi bay as compared to other localities is shown by these samples, particularly the earlier ones from Desranleau's (April 28 to May 1 inclusive), and those taken at Sandy point. This peculiar feature is the high content of fish eggs, undoubtedly the eggs of the dore or pike-perch (*Stizostedion vitreum*).

In some samples, this content was as high as 80 per cent, with an average of 33 per cent for all samples taken on this shore (Table 9). By May 7, the amount of eggs had fallen to about 2 per cent, and by mid-May, no more eggs were found.

This high proportion of eggs naturally replaced other more staple components of the diet. Thus, fish comprised 42 per cent, and insects 11 per cent, both of which figures are lower than the general average for the lake. The high proportion of molluscs (chiefly gastropods - snails) and of non-food (bits of straw, etc.) is of considerable interest, because the pike-perch eggs are adhesive when first shed. Possibly, for a similar reason, algae formed an exceedingly high proportion of the stomach contents, although Pearce and Achtenberg (1920) showed a definite increase in algal food for the yellow perch of Lake Mendota and Lake Wingra about the end of April (see also Welch, 1935, page 302). Algae might be included as non-food in this analysis, since their abundance in the stomach contents increased at the same time as items listed as "debris", and this coincided with the great increase in egg consumption. Furthermore, only in the Burlington and Sand-bar bridge areas was there no debris (Tables 3-7, incl.), and those regions with the highest egg content had the highest debris (Tables 8, 9, and 11). Other localities had intermediate quantities (Tables 1, 2, and 10). However, algae appeared in the stomach contents of the Sand-bar bridge region, and were present in a higher percentage of the stomachs from the eastern shore of Missisquoi bay (Table 10) than of those from the western shore. In a letter to the writer, Dr. J. Van Oosten suggested that even if so taken (as debris), the algae may have food value. Pearce and Achtenberg (1920) had included algae as food, so for these several reasons, it seemed best to include these organisms as food, in this analysis.

The average content of the stomachs of perch from this shore was 1.32 cubic centimetres. The list of fish in the diet is interesting because the trout-perch (Percopsis omiscomaycus), as at Larabee's Landing, was the most important food species. Other organisms of importance, especially after the fish-eggs had disappeared were the crayfish (Cambarus) the may-fly (Hexagenia), the snail (Physa), and the tessellated darter (Boleosoma nigrum).

Because it was conveniently located for operations from the base at Phillipsburg, we attempted to follow any changes in the fishery by daily seine hauls at Jone's grounds, on the eastern shore, north of Phillipsburg. No large number of fish was ever secured by this means (total of 13 yellow perch), so for this reason the ground was abandoned. A night-line at Phillipsburg yielded several fish, and one haul south of Phillipsburg gave one. In all, 47 perch (20 of the stomachs were empty) make up the total for this shore, compared with 371 for the western shore, and 153 for Lakewood.

The relatively high insect content of the stomachs (41 per cent) is of interest. Fish-eggs were a minor item in these stomachs (3 per cent), and was made up entirely of yellow perch eggs. Fish comprised only 29 per cent, of which the trout-perch (Percopsis omiscomaycus) made up the greater part. Both Crustacea and molluscs (5 per cent each) were present in unusually high proportions. The average stomach content of 2.67 cubic centimetres was the greatest for any of the regions or subdivisions investigated in lake Champlain.

Four groups of yellow perch were secured about Sandy point - a total of 153 perch being taken. A comparison of the stomach contents of these fish with other Missisquoi bay groups is most interesting. One group (taken on May 11) is of particular interest, for on that day large quantities of dead pike-perch eggs were being siphoned

Table D. Summary showing the percentage of perch consuming principal foods; percentage of principal items of diet; and the percentage of principal fish and insects of the diet.

Size class (inches)	Less than 6	6.0-6.75	7.0-7.75	8.0-8.75	9.0-9.75	More than 10
Total number of stomachs	19	109	213	131	59	4
Average content per stomach-cubic cent'rs	0.19	0.40	0.62	0.62	1.6	1.3

Item	Percentage of perch that consumed the principal foods in the diet.					
Insects	74	87	81	67	61	50
Fish	16	22	32	47	64	25
Crustacea	11	11	15	32	29	50
Molluscs	11	5	3	1	5	..

	Percentage (by volume) of the principal items in the diet.					
Fish	14	63	59	72	70	34
Insects	71	35	30	17	26	30
Crustacea	3	1	8	8	3	36
Molluscs	8	1	3	0*	0*	..

	Percentage (by volume) of the principal fish in the diet.					
Tessellated darter	4	6	6	7	1	..
Smelt	..	..	4	2	1	..
Trout-perch	..	11	17	..	3	..
Silvery minnow	..	14	15	19	33	..
Notropis spp. (shiner)	7	2	4	..	..	..

	Percentage (by volume) of the principal insects in the diet.					
May-flies	22	20	20	14	17	4
Alder-flies	22	8	7	2	1	..
Dragon-flies	..	1	1	0*	0*	..
Caddis-flies	9	1	1	0*	7	26

* Value less than 0.5 per cent.

Table E. Summary of the stomach contents (food organisms only) for various length-groups of perch faken in the lake Champlain investigation. (For each length-group the first column (1) gives the percentage of the total number of stomachs with each class of food; the second column (2) gives the percentage of the total amount of food (by volumn)

Size class (inches)	Less										More than	
	than 6	6.0-6.75	7.0-7.75	8.0-8.75	9.0-9.75	10						
Total number of stomachs	19	109	213	131	59	4						
Average content per stomach (cu.cent're)	0.19	0.40	0.62	0.62	1.6	1.3						
Item	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Annelids (leeches,earthworms,etc.)	5.3	2.8	.....	.....	.....	.....	0.8	0.0*	.....	.....	.....	.....
Crustacea (crayfish, etc.)	10.5	3.4	11.0	1.4	14.8	8.0	32.1	8.3	28.8	2.8	50.0	36.2
Insects	73.6	71.1	87.0	34.9	80.8	29.6	67.1	17.4	61.0	26.0	50.0	30.2
Neuroptera (alder-flies)	21.1	22.0	46.8	8.1	39.4	7.1	17.6	2.1	30.5	1.1	.....	.....
Ephemera (may-flies)	58.0	22.4	67.9	19.7	64.4	20.4	55.6	14.2	49.1	16.9	50.0	3.8
Odonata (dragon-flies)	.....	.....	1.8	0.5	1.0	0.6*	1.5	0.3	1.7	0.3	.....	.....
Hemiptera (bugs)	.....	.....	.....	.....	0.5	0.0*	.....	.....	.....	.....	.....	.....
Trichoptera (caddis-flies)	5.3	8.9	3.7	0.8	2.0	0.7	2.8	0.4	10.0	7.0	25.0	26.4
Diptera (midges,mosquitoes,etc.)	.....	.....	.....	.....	0.5	0.0*	.....	.....	.....	.....	.....	.....
Insect remains	10.5	17.8	9.2	5.9	3.4	0.7	3.1	0.5	5.1	0.8	.....	.....
Molluscs (clams,snails,etc.)	10.5	8.4	4.6	1.1	3.4	3.0	0.8	0.3	5.1	0.4	.....	.....
Fish	15.8	14.2	22.0	62.6	32.0	59.1	46.5	72.4	64.4	70.3	25.0	34.0
Osmerus mordax (smelt)	.....	.....	.....	.....	3.4	4.2	1.5	2.0	3.4	0.9	.....	.....
Notropis atherinoides (lake shiner)	.....	.....	.....	.....	0.5	1.8	.....	.....	.....	.....	.....	.....
Notropis cornutus (common shiner)	.....	.....	.....	.....	0.5	2.2	.....	.....	.....	.....	.....	.....
Notropis volucellus (mimic shiner)	5.3	7.3	1.8	1.9	0.5	0.3	.....	.....	.....	.....	.....	.....
Hybognsthus regius (silvery minnow)	.....	.....	6.4	14.2	8.4	15.3	8.4	18.7	37.3	3.4	.....	.....
Percopsis omiscomaycus (trout-perch)	.....	.....	1.8	11.1	2.5	16.7	.....	.....	1.7	2.8	.....	.....
Perca flavescens (yellow perch)	.....	.....	.....	.....	1.0	0.7	1.5	0.9	1.7	1.6	.....	.....
Percina caprodes (log-perch)	.....	.....	0.9	6.0	0.5	0.8	.....	.....	.....	.....	.....	.....
Cottogaster copelandi (Copeland's d'r)	.....	.....	0.9	0.6	.....	.....	.....	.....	.....	.....	.....	.....
Boleosoma nigrum (tesselated darter)	5.3	4.2	4.6	6.0	6.4	5.7	5.3	7.2	5.1	1.4	.....	.....
Lepomis gibbosus (sunfish)	.....	.....	0.9	1.6	.....	.....	3.1	3.8	3.4	0.4	.....	.....
Centrarchid remains	.....	.....	.....	.....	1.0	1.2	.....	.....	6.8	5.6	.....	.....
Cottid (sculpin)	.....	.....	.....	.....	.....	.....	1.5	1.4	.....	.....	.....	.....
Fish remains	5.3	2.8	10.0	21.3	12.8	10.2	26.0	38.4	37.3	24.4	25.0	34.0
Amphibia (frogs)	.....	.....	.....	.....	1.0	0.2	0.8	0.9*	1.7	0.5	.....	.....
Algae	.....	.....	.....	.....	.....	.....	0.8	0.0*	.....	.....	.....	.....
Food remains	.....	.....	.....	.....	.....	.....	2.8	0.6	.....	.....	.....	.....

* Values less than 0.05 per cent.

Table 12. Summary of stomach contents of 19 perch, less than 6 inches long. (5 stomachs of the 24 examined were empty; total amount of food consumed was 3.6 cubic centimetres; average amount per stomach was 0.19 cubic centimetres).

Item	Number of stomachs with each class of food.	Percentage of total number (19) of stomachs.	Percentage of total amount (3.6 cubic centimetres) of food and other items consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
F o o d.				
Annelids (leeches, earthworms, etc.)	1	5.3	2.8	0.10
Crustacea (crayfish, etc.)	2	10.5	3.4	0.06
Insects	14	73.6	71.1	0.18
Neuroptera (alder-flies)	4	21.1	22.0	0.20
Ephemera (may-flies)	11	58.0	22.4	0.08
Trichoptera (caddis-flies)	1	5.3	8.9	0.32
Insect remains	2	10.5	17.8	0.32
Molluscs (clams, snails, etc.)	2	10.5	8.4	0.15
Fish	3	15.8	14.2	0.17
Notropis volucellus (mimic shiner)	1	5.3	7.3	0.26
Boleosoma nigrum (tesselated darter)	1	5.3	4.2	0.15
Fish remains	1	5.3	2.8	0.10

N o n - f o o d.

(not included in above calculations-total 0.11 cubic centimetres)

Debris (sticks, stones, etc.)	2	10.5	100.0	0.06
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Table 13. Summary of stomach contents of 109 perch, 6.0 to 6.75 inches long. (101 stomach of the 210 examined were empty; total amount of food consumed was 43.7 cubic centimetres; average amount per stomach was 0.40 cubic centimetres).

Item	Number of stomachs with each class of food.	Percentage of total number (109) of stomachs.	Percentage of total amount (43.7 cubic centimetres) of food, or other items, consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
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F o o d.

Crustacea (crayfish, etc.)	12	11.0	1.4	0.05
Insects	95	87.0	34.9	0.16
Neuroptera (alder-flies)	51	46.8	8.1	0.07
Ephemera (may-flies)	74	67.9	19.7	0.12
Odonata (dragon-flies)	2	1.8	0.5	0.11
Trichoptera (caddis-flies)	4	3.7	0.8	0.08
Insect remains	10	9.2	5.9	0.26
Molluscs (clams, snails, etc.)	5	4.6	1.1	0.10
Fish	24	22.0	62.6	1.16
Notropis volucellus (mimic shiner)	2	1.8	1.9	0.42
Hybognathus regius (silvery minnow)	7	6.4	14.2	0.90
Percopsis omiscomaycus (trout-perch)	2	1.8	11.1	2.45
Percina caprodes (log-perch)	1	0.9	6.0	0.28
Cottogaster copelandi (Copeland's darter)	1	0.9	0.6	0.28
Boleosoma nigrum (tesselated darter)	5	4.6	6.0	0.53
Lepomis gibbosus (sunfish)	1	0.9	1.6	0.70
Fish remains	11	10.0	21.3	0.86

N o n - f o o d.

(not included in above calculations-total 0.64 cubic centimetres)

Parasites (tapeworms, round-worms, etc.)	1	0.9	31.3	0.20
Debris (sticks, stones, etc.)	6	5.5	68.7	0.07

Table 14. Summary of stomach contents of 203 perch, 7.0 to 7.75 inches long. (125 stomachs of the 328 examined were empty; total amount of food consumed was 126.1 cubic centimetres; average amount per stomach was 0.62 cubic centimetres.

Item	Number of stomachs with each class of food.	Percentage of total number (203) of stomachs.	Percentage of total amount (126.1 cubic centimetres) of food, or other items, consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
F o o d .				
Crustacea (crayfish, etc.)	30	14.8	8.0	0.34
Insects	164	80.8	29.6	0.23
Neuroptera (alder-flies)	80	39.4	7.1	0.11
Ephemera (may-flies)	132	64.4	20.4	0.19
Odonata (dragon-flies)	2	1.0	0.6	0.38
Hemiptera (bugs)	1	0.5	0.0*	0.05
Trichoptera (caddis-flies)	4	2.0	0.7	0.23
Diptera (midges, mosquitoes, etc.)	1	0.5	0.0*	0.05
Insect remains	7	3.4	0.7	0.13
Molluscs (clams, snails, etc.)	7	3.4	3.0	0.55
Fish	65	32.0	59.1	1.15
Osmerus mordax (smelt)	7	3.4	4.2	0.77
Notropis atherinoides (lake shiner)	1	0.5	1.8	2.30
Notropis cornutus (common shiner)	1	0.5	2.2	2.80
Notropis volucellus (mimic shiner)	1	0.5	0.3	0.40
Hybognathus regius (silvery minnow)	17	8.4	15.3	1.13
Percopsis omiscomaycus (trout-perch)	5	2.5	16.7	4.20
Perca flavescens (yellow perch)	2	1.0	0.7	0.43
Percina caprodes (log-perch)	1	0.5	0.8	0.97
Boleosoma nigrum (tesselated darter)	13	6.4	5.7	0.56
Centrarchid remains	2	1.0	1.2	0.78
Fish remains	26	12.8	10.2	0.50
Amphibia (frogs)	2	1.0	0.2	0.11
N o n - F o o d .				
(not included in above calculations-total 1.16 cubic centimetres)				
Parasites (tapeworms, round-worms, etc.)	4	2.0	9.5	0.04
Debris (sticks, stones, etc.)	12	5.9	90.5	0.09

* Value less than 0.05 per cent.

Table 15. Summary of stomach contents of 131 perch, 8.0 to 8.75 inches long. (61 of the 192 stomachs examined were empty; total amount of food consumed was 81.8 cubic centimetres; average amount per stomach was 0.62 cubic centimetres.)

Item	Number of stomachs with each class of food.	Percentage of total number (131) of stomachs.	Percentage of total amount (81.8 cubic centimetres) of food, or other items consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
F o o d .				
Annelids (leeches, earthworms, etc.)	1	0.8	0.0*	0.02
Crustacea (crayfish, etc.)	42	32.1	8.3	0.16
Insects	88	67.1	17.4	0.16
Neuroptera (alder-flies)	23	17.6	2.1	0.08
Ephemera (may-flies)	73	55.6	14.2	0.16
Odonata (dragon-flies)	2	1.5	0.3	0.14
Trichoptera (caddis-flies)	3	2.8	0.4	0.10
Insect remains	4	3.1	0.5	0.11
Molluscs (clams, snails, etc.)	1	0.8	0.3	0.25
Fish	61	46.5	72.4	0.96
<u>Osmerus mordax</u> (smelt)	2	1.5	2.0	0.80
<u>Hybognathus regius</u> (silvery minnow)	11	8.4	18.7	1.29
<u>Perca flavescens</u> (yellow perch)	2	1.5	0.9	0.35
<u>Boleosoma nigrum</u> (tesselated darter)	7	5.3	7.2	0.83
<u>Lepomis gibbosus</u> (sunfish)	4	3.1	3.8	0.77
Cottid (sculpin)	2	1.5	1.4	0.55
Fish remains	34	26.0	38.4	0.91
Amphibia (frogs)	1	0.8	0.9*	0.70
Algae	1	0.8	0.0*	0.02
Food remains	3	2.8	0.6	0.45
N o n - f o o d l				
(not included in above calculations-total 1.14 cubic centimetres)				
Parasites (tapeworms, round-worms, etc.)	2	1.5	10.5	0.06
Debris (sticks, stones, etc.)	18	6.1	89.5	0.13

* Value less than 0.05 per cent.

Table 16. Summary of stomach contents of 59 perch, 9.0 to 9.75 inches long. (6 stomachs of the 65 examined were empty; Total amount of food consumed was 95.8 cubic centimetres; average amount of food per stomach was 1.6 cubic centimetres.

Item	Number of stomachs with each class of food.	Percentage of total number (59) of stomachs.	Percentage of total amount (95.8) cubic centimetres) of food, or other items, consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
F o o d .				
Crustacea (crayfish, etc.)	17	28.8	2.8	0.16
Insects	36	61.0	26.0	0.69
Neuroptera (alder-flies)	18	30.5	1.1	0.06
Ephemera (may-flies)	29	49.1	16.9	0.56
Odonata (dragonflies)	1	1.7	0.3	0.25
Trichoptera (caddis-flies)	6	10.0	7.0	1.12
Insect remains	3	5.1	0.8	0.27
Molluscs	3	5.1	0.4	0.12
Fish	38	64.4	70.3	1.77
<u>Osmerus mordax</u> (smelt)	2	3.4	0.9	0.43
<u>Hybognathus regius</u> (silvery minnow)	22	37.3	33.4	1.45
<u>Percopsis omiscomaycus</u> (trout-perch)	1	1.7	2.8	2.65
<u>Perca flavescens</u> (yellow perch)	1	1.7	1.6	1.50
<u>Boleosoma nigrum</u> (tesselated darter)	3	5.1	1.4	0.43
<u>Lepomis gibbosus</u> (sunfish)	2	3.4	0.4	0.20
Centrarchid remains	4	6.8	5.6	1.35
Fish remains	22	37.3	24.4	1.06
Amphibia (frogs)	1	1.7	0.5	0.45
N o n - f o o d .				
(not included in above calculations-total 0.31 cubic centimetres)				
Parasites (tapeworms, round-worms, etc.)	3	5.1	45.0	0.05
Debris (sticks, stones, etc.)	5	8.5	55.0	0.03

Table 17. Summary of stomach contents of 4 perch, more than 10 inches long. (5 stomachs of the 9 examined were empty; total amount of food consumed was 5.3 cubic centimetres; average amount of food per stomach was 1.3 cubic centimetres).

Item	Number of stomachs with each class of food.	Percentage of total number (4) of stomachs.	Percentage of total amount (5.3 cubic centimetres) of food, or other items, consumed.	Average amount in cubic centimetres of food, or other items, per stomach.
F o o d .				
Crustacea (crayfish, etc.)	2	50.0	36.2	0.86
Insects	2	50.0	30.2	0.80
Ephemera (may-flies)	2	50.0	3.8	0.10
Trichoptera (caddis-flies)	1	25.0	26.4	0.70
Fish (remains only)	1	25.0	34.0	0.90
Non - food.				
(not included in above calculations-total 0.10 cubic centimetres)				
Debris (sticks, stones, etc.)	1	25.0	100.0	0.10

out of the hatchery, and in this way there has been provided a very definite demonstration that these are the eggs taken so readily by the yellow perch (when available). In addition, they provide a ready means of comparison with eggs of unknown origin which had been found in other parts of the bay.

Fish-eggs formed so great a proportion of the stomach contents (79 per cent) that other food organisms of necessity were very much reduced - insects 8 per cent, and fish 4 per cent. The average stomach content was 2.00 cubic centimetres. As at Desranleau's, the quantity of non-food was very high, probably for the same reason (page 23) The silvery minnow (Hybognathus regius), with the tessellated darter (Boleosoma nigrum), next, was the most important of the fish species in the stomach contents. May-flies (Hexagenia), dragon-flies (Gomphus), and snails (Limnea) were other important food organisms (see Table A and Table B).

VARIATION IN THE FOOD OF THE PERCH ACCORDING TO SIZE.

Data on the variation in the food of the perch of different size may be found in Tables D and E, and Tables 12 to 17 inclusive. The arrangement of the various food items in Tables D and E is the same as that employed for Tables A and B. However, in Tables D and E, it is to be noted that the dominant organism may not be at the head of its group. In the other tables, the general arrangement is identical with the similar tables for the various regions studied. As already mentioned (page 2) the size-groups employed began at less than 6 inches, and proceed by ranges of 1 inch to a size-class of more than 10 inches. The number of stomachs included in each size-class is shown in Table D. The number of individuals forming the extreme size-classes was small, especially in the larger sizes. It is quite evident nevertheless that there is a very definite change in diet with

increase in age. This change can perhaps be seen most clearly in Table D, "percentage of perch that consumed the principal foods in the diet".

It may be seen that the number of perch taking insects decreased from about 80 per cent to 50 per cent; fish-eaters increased from 20 per cent to about 50. There appears also to have been a decrease in molluscs, and an increase in the proportion of Crustacea. There is also a change in the kinds taken, from within a "group" of food organisms. Among the fish species consumed, the percentage of the silvery minnow (*Hybognathus regius*) rose steadily whereas that of the shiners (*Notropis* spp.) fell, in spite of a rise in the total amount of fish consumed. It would appear that the consumption of the smelt (*Osmerus mordax*) also declined, with increase in the size of the perch. Among the insect orders, the Neuroptera (alder-flies or Sialis) shewed a definite decrease from about 20 per cent to none, and the may-flies had a moderate decrease from about the same level to about 10 per cent or less.

As might be expected, as the stomach increases in capacity, with increased size, there was an increase in the average stomach content. This fact is shewn in Table D, at the head of each column.

SUMMARY.

1. The amount of food taken by perch in lake Champlain was found to vary from place to place, but was greatest in the shallower regions, such as the Fort Ticonderoga, and the Missisquoi bay areas, although some seasonal differences complicate the interpretation of the data.

2. The amount of food per stomach was found to vary according to season. This variation between seasons was greater apparently than the geographical, variation within a single season (winter).

3. A greater variety of organisms was found in the diet in the autumn sample than at other times.

4. The most marked seasonal change of food was the great increase of fish eggs at the end of April and early in May.

5. The increase of Asellus at the end of February and of algae at the end of April are probably seasonal variations.

6. While a considerable diversity of food organisms was observed, fish and insects formed by far the greater part of the diets.

7. A definite variation of diet was found in the various length-groups (ages). The smaller (younger) fish had a higher proportion of insects: the larger (older) had a higher proportion of fish.

8. The manner of capture should be considered in any study of yellow perch diets, Fish taken on the hook frequently have everted stomachs.

9. It would appear that yellow perch do not migrate rapidly. Perch of the three areas in the Sand-bar bridge region, and also those from the three parts of Missisquoi bay, although captured in geographically contiguous areas, yet have very different diets.

LITERATURE CITED.

Welch, Paul S.

1935. Limnology. 471 pp. 46 text figures. McGraw-Hill Book Co. Inc. New York and London.

Weather Bureau, U.S. Dept. Agriculture.

1932-1939 (incl.) Monthly Climatological data for Burlington, Vt., Monthly Weather Review Vol's. LX-LXXVII (1-12) incl.: Washington, D.C.

Pearse, A. S. and Henrietta Achtenberg.

1920. Habits of Yellow Perch in Wisconsin Lakes. Bull. U.S. Bur. Fish. XXXVI, 295-366.