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THE RATE OF GROWTH OF THE WHITE FISH (*COREGONUS ALBUS*) IN LAKE ERIE

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The purpose of this investigation has been to obtain some definite information concerning the rate of growth of whitefish in Lake Erie. The study was undertaken at the suggestion of Dr. W. A. Clemens to whom the writer desires to express his appreciation of the kind assistance given.

The specimens were procured from points along the north shore of Lake Erie (Kingsville, Merlin, Ridgetown and Nanticoke) through the kindness of Messrs. B. Wescott, A. E. Crewe, W. D. Bates and A. B. Hoover. For purposes of comparison eight specimens of whitefish were obtained from Port Credit on Lake Ontario and two from Hudson Bay. The latter were collected by Rev. W. G. Walton on July 22, 1919, at Great Whale river.

Identification

The fish from Lake Erie are here referred to the species *C. albus* Le Sueur, while those from Lake Ontario to *C. clupeaformis* (Mitchell) following Jordan and Evermann (1911). By way of comparison detailed measurements were taken of three specimens from Lake Erie, numbers 101, 102 and 105; three from Lake Ontario, numbers 66, 67 and 68; and the two from Hudson Bay, numbers 131 and 132. All the specimens had been preserved in formalin and alcohol some time previous to the time the measurements were made. The results are shown in the following table:

	LAKE ERIE				LAKE ONTARIO				HUDSON BAY		
Specimen No.	102	103	105	Av.	66	67	68	Av.	131	132	Av.
Body length (mm.)	558	428	382		462	350	418		302	234	
Dorsal rays	13	11	12		13	11	11		14	13	
Anal rays	13	14	13		11	12	13		13	13	
Scales	85	81	85		84	87	84		78	79	
Gill rakers	22	25	28		25	26	25		26	25	
*Head	.20	.21	.19	.20	.21	.22	.21	.21	.235	.22	.23
Body depth	.29	.34	.29	.31	.28	.24	.23	.25	.275	.27	.27
C.P. length	.07	.09	.08	.08	.11	.09	.10	.10	.11	.11	.11
C.P. depth	.09	.10	.08	.09	.08	.08	.07	.08	.09	.09	.09
Eye	.03	.04	.03	.03	.035	.04	.04	.04	.05	.05	.05
Maxilla	.05	.05	.05	.05	.05	.05	.055	.05	.07	.07	.07
Pectoral length	.16	.17	.16	.16	.18	.17	.17	.17	.19	.17	.18
Pelvic length	.15	.15	.14	.15	.17	.16	.165	.165	.17	.18	.175
Dorsal height	.16	.17	.17	.17	.18	.18	.18	.18	.19	.21	.20
Anal length	.13	.13	.105	.12	.13	.14	.13	.13	.13	.11	.12

*Measurements given as decimal fractions of body length.

The results for the Lake Erie and Lake Ontario fish agree closely with those given by Jordan and Evermann (*loc. cit.*) and Bensley (1915). For the Hudson Bay fish several slight though interesting variations appear. The caudal peduncle appears to be longer; the diameter of the eye greater; the length of the maxilla greater; the height of the dorsal greater; the lengths of the pectoral and pelvic fins greater, and the scales on the lateral line fewer. In spite of these differences there is a close resemblance to the Lake Ontario whitefish and it seems advisable for the present to refer these two fish to the species *C. clupeaformis*.

Rates of Growth

The rate of growth was determined by plotting curves between the age ascertained from the scales and the length and weight determined by direct measurement. The scales for determining the age were taken from the side of the fish, some from just below the anterior part of the dorsal fin, some near and including the lateral line, and some from just before the pelvic fin where the scales are large. The round even scales from the dorso-lateral region were found to be more satisfactory than those from the ventro-lateral region. The latter were larger but had radiate markings and ridges on them and the summer and winter areas were not so well defined. The vertebrae and otoliths of some specimens were preserved as a secondary means of determining the age but they were found to be much less reliable beyond three years of age. The method of determining the age from the scales is illustrated in figure 1. It is assumed that the areas with widely separated lines represent spring and summer periods when growth conditions are at their best. Conversely the closely spaced areas represent the winter months. In Fig. 1 the upper two scales (A and B) are from whitefish from Lake Erie aged two and five years respectively. The lower two (C and D) are from the whitefish from Hudson Bay, aged five and ten years respectively. All scales are enlarged to the same degree, i.e. fifteen diameters. The scales and likewise the fish themselves from Hudson Bay

are smaller than those from Lake Erie, although the former are much older. This apparently furnishes a striking illustration of the effect of cold water on the growth of these fish.

The rates of growth of the fish examined are shown in Fig. 2. The results indicate that during the first two or

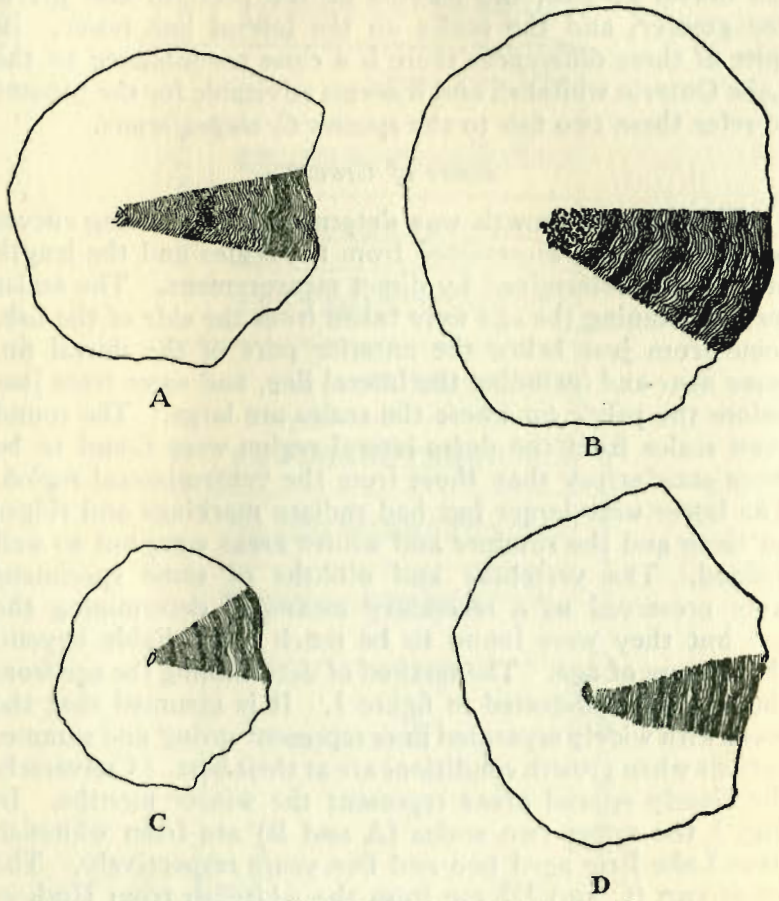

Fig. 1. Scales from whitefish from Lake Erie and Hudson Bay.
A and B from Lake Erie, third and sixth summers respectively.
C and D from Hudson Bay, sixth and eleventh summers respectively.

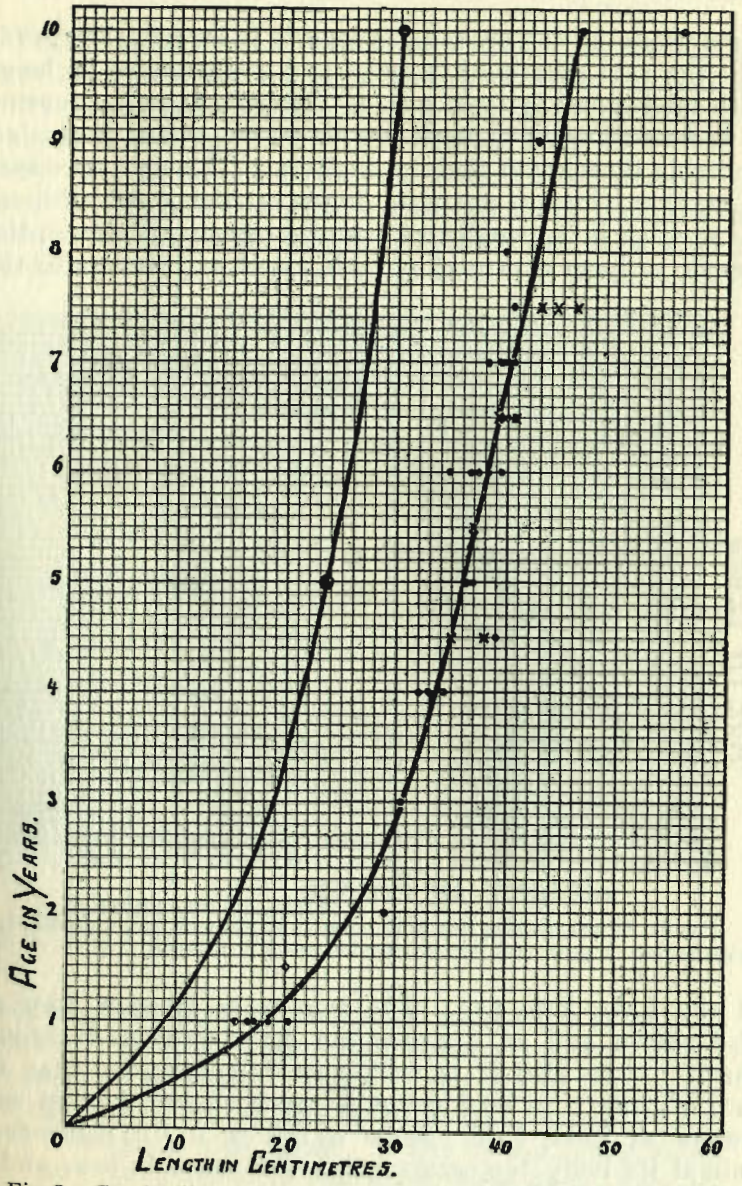

Fig. 2. Graphs illustrating rates of growth of whitefish from Lake Erie and Hudson Bay.

O, whitefish from Hudson Bay.
o, " " Lake Erie.
X, " " Lake Ontario.

three years the fish grow quite rapidly in length, then gradually the rate of growth lessens and the increase in length with age is much less noticeable. They do however, continue to increase in length until ten or twelve years of age and probably throughout their entire lives. The eight specimens from Lake Ontario are also shown on the graph although the number is too small to warrant a curve. However, they appear to have a rate of growth somewhat similar to that

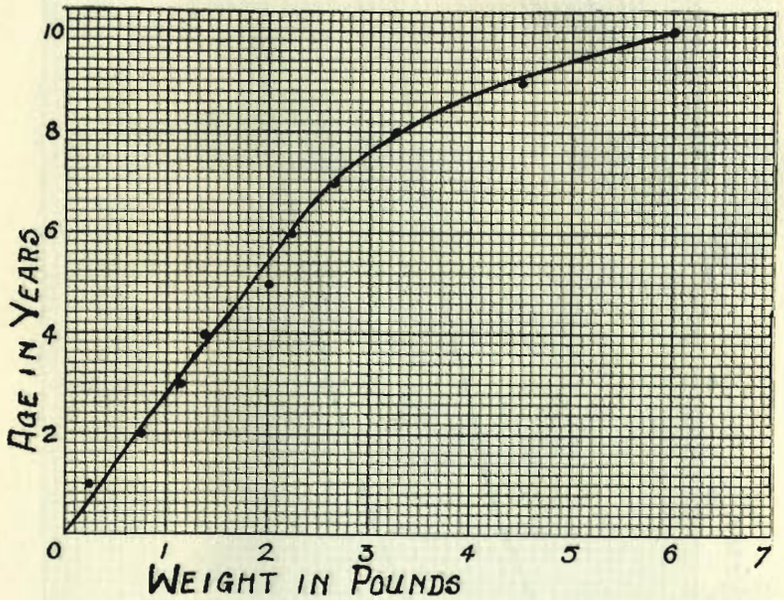

Fig. 3. Graph showing rate of increase in weight with age, whitefish, Lake Erie.

of the Lake Erie fish. The two from Husdon Bay are also shown and an approximate curve projected through them. Here also it is strikingly demonstrated that the rate of growth in cold water is much slower than in such waters as Lake Erie. Since a fish is a "cold-blooded" animal its body temperature in cold water is low, and it follows directly that its metabolic reactions are all depressed and hence that growth is retarded.

The fish were weighed at the same time that the scales were removed and the lengths determined. It is interesting to compare the rate of increase of length with age (Fig. 2) and the rate of increase of weight with age (Fig. 3).

Since the conditions of the fish, such as the amount of fat and the development of the gonads, result in considerable differences in weight, the average of all the fish in each year was taken and this is used in this curve. It indicates that

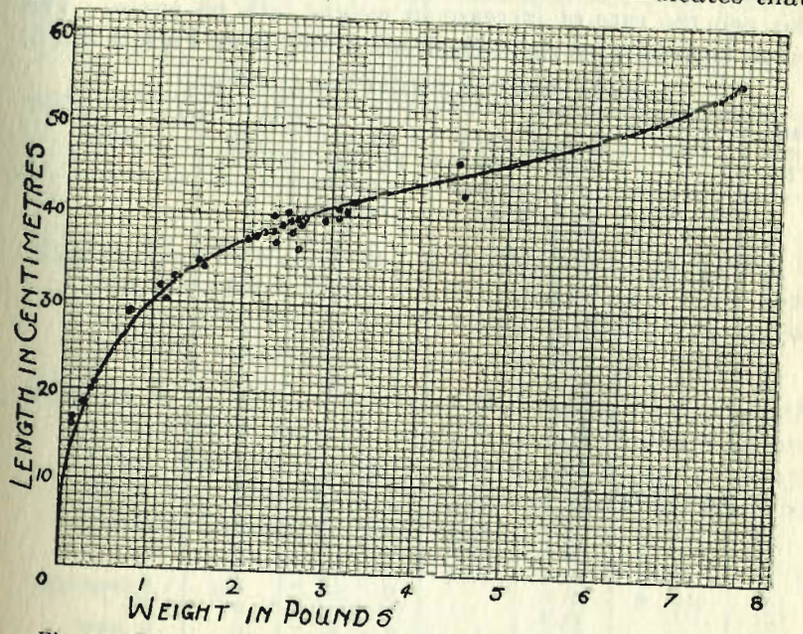

Fig. 4. Graph showing relation between length and weight, whitefish, Lake Erie.

the fish increase quite uniformly in weight up to four or six years of age, after which they increase rapidly relative to age and also to length. This is of the utmost importance from a commercial standpoint as the weight obviously bears a direct relation to food value. If left to the age of seven to ten years (40-50 cm.) the fish would have passed through that period when there is the greatest relative increase in weight. The wisdom of such a course is obvious. Another

phase of this matter has been illustrated in Fig. 4 where weight and length have been plotted. In this graph each individual fish was recorded. It shows that at first the fish develops rapidly in length for a small increase in weight. Then at about 35 cms. the rate of growth in length decreases and the fish begins to increase in weight. This rapid increase in weight and comparatively slow increase in length continues at least up to ten years of age though probably soon after this age the rate of increase in weight falls off again. The curve corroborates the deductions drawn from Figs. 2 and 3.

DATA—*COREGONUS ALBUS*—LAKE ERIE

Specimen No.	Date	Length cm.	Girth cm.	Weight lb. oz.	Age Years	Sex
1	May 1919	32.0		1 lb. 1 oz.	4	
2	"	29.0		0 " 12 "	2	
3	"	20.0		0 " 5 "	1½	
25	June 6	37.0		2 " 6 "	5	♀ very fat
26	"	46.5		4 " 7 "	10+	♀ fat
27	"	33.0		1 " 4 "	4	♀
28	"	34.3		1 " 9 "	4	♂ fat
29	"	30.3		1 " 2 "	3	♂
30	"	34.8		1 " 8 "	6	♂
31	"	18.5	10.1		1	
32	"	17.1	9.5		1	
33	"	15.7	8.8		1	
34	"	15.6	8.8		1	
50	June 25/20	16.8	10.1	0 " 2 "	1	
51	"	18.5	12.6	0 " 4 "	1	
52	July 5	20.3	14.5	0 " 5 "	1	
53	" 6	16.1	11.0	0 " 2 "	1	
54	" 13	36.5	39.8	2 " 10 "	5	
100	Dec. 6	39.6		2 " 15 "	6½	♀ large eggs
101	"	42.8		4 " 8 "	9	♀ " "
102	"	55.8		7 " 10 "	10	♀ spent
103	"	40.0		3 " 2 "	6½	♀ large eggs
104	"	40.5		2 " 8 "	7	♀ spent
105	"	38.2		2 " 5 "	6	♀ large eggs
106	"	39.3		2 " 7 "	7	♂ large testes
107	"	40.6		3 " 2 "	7	♂ partly spent
108	"	39.6		2 " 9 "	6	♂ " "
109	"	37.3		2 " 1 "	6	♂ " "
110	"	40.5		3 " 3 "	7½	♀ large eggs
111	"	38.1		2 " 9 "	7	♂ fat
112	"	39.9		2 " 11 "	8	♂ partly spent
113	"	41.8		3 " 4 "	6½	♀ large eggs
114	"	37.8		2 " 2 "	6	♀ partly spent
115	"	39.0		2 " 10 "	4½	♀ " "
116	"	39.7		2 " 10 "	7	♀ entirely "
117	"	40.3		2 " 8 "	7	♀ " "
118	"	38.1		2 " 4 "	6	♂ partly spent
119	"	39.4		2 " 11 "	6	♀ large eggs
120	"	40.0		2 " 5 "	7	♀ spent

DATA—*COREGONUS CLUPEAFORMIS*—LAKE ONTARIO

No.	Date	Length cm.	Weight	Age Years
61	Dec. 2, 1920	44.5	2¾ lb.	7½
62	"	38.0	1¾ "	4½
63	"	39.3	2¼ "	6½
64	"	37.0	1⅝ "	5½
65	"	43.0	2¾ "	7½
66	"	46.2	3 lb. 13 oz.	7½
67	"	35.0	1 " 6 "	4½
68	"	41.8	2 " 7 "	6½

DATA—*COREGONUS CLUPEAFORMIS*—HUDSON BAY

No.	Date	Length cm.	Age Years	
131	July 22 1919	30.2	10	Great Whale River
132	"	23.4	5	" " "

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