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A STUDY OF THE CISCOES OF LAKE ERIE

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## A STUDY OF THE CISCOES\* OF LAKE ERIE

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This study was carried out under the auspices of the Biological Board of Canada in response to a request from the Lake Erie Fishermen's Association for an investigation of some of the problems in connection with the cisco fishing industry. In the request it was desired particularly that some information be obtained as to why smaller ciscoes in general are taken in the eastern end of the lake than in the western part.

The major portion of the work having to do with the measurements of the fish and the taking of scales was carried out at various points on Lake Erie during the summer and fall of 1920, but shipments from various points were examined in Toronto during the years of 1919 and 1920.

The author desires to express his appreciation of the assistance given by many fishermen, in particular by Mr. A. E. Crewe, who kindly provided accommodation for the carrying out of the work during the summer of 1920, freely placed all the material of his catches for examination, and gave assistance in many ways. Other gentlemen who facilitated the work in supplying material and in other ways were: Messrs. Charles Ross, Roy Ross, Wilson S. McKillop, A. B. Hoover, C. W. Barwell, R. Kolbe, and W. D. Bates.

### IDENTIFICATION OF SPECIES

For the separation of the species of shallow water ciscoes (subgenus *Thrisomimus*) as described by Jordan and Evermann† (1911) it appears that three proportional measurements are more or less critical, namely, head in length, depth in length, and depth of caudal peduncle in head. Jordan and Evermann give the following proportions:

\*The word cisco is here used instead of herring for all members of the genus *Leucichthys* except for the tullibees, in accordance with the list of standardized names of North American fish as agreed upon by the U.S. Bureau of Fisheries, the Biological Board of Canada and the Canadian Fisheries Association.

†Jordan, D. S., and Evermann, B. W. 1911. A Review of the Salmonoid Fishes of the Great Lakes with notes on the Whitefishes of other Regions. *Bull. U.S. Bureau Fish.*, Vol. xxix (1909). Document No. 737 (1911).



Species	Head in length	Depth in length	Depth of caudal peduncle in head
<i>L. harengus</i> .....	4.33	4.3-4.6	3.0
<i>L. sisco huronius</i> .....	4.66	4.2-4.5	2.9
<i>L. ontariensis</i> .....	4.5	3.7-4.2	2.66
<i>L. artedi</i> .....	4.4	3.5-4.0	2.0-2.5
<i>L. eriensis</i> .....	4.4	3.3-3.5	2.2

Accordingly for each fish examined the necessary measurements were made for the calculation of the above proportions. In addition the girth and the weight were determined and scales removed for age estimation. From June 14 to August 24, 1920, the ciscoes taken in twenty pound nets at the Crewe Bros. Fishery near Merlin were examined daily. In August and November the fish taken at Port Dover, Nanticoke, McKillop's Fishery (near Port Maitland) and Dunnville were examined. The following species have been identified:

(1) *Leucichthys sisco huronius* (J. & E.), Lake Huron cisco.

This species was readily distinguished by the long spindle-shaped body. The average proportions for 60 individuals were as follows: head in length 4.6, depth in length 4.3, depth of caudal peduncle in head 2.95. These figures are practically identical with those given by Jordan and Evermann for Lake Huron. This species is taken rather abundantly in the pound nets at Merlin but very few specimens were seen east of Long Point.

(2) *L. eriensis* (J. & E.). Jumbo cisco.

This is the most abundant species taken in pound nets from Rondeau to Point Pelee. It also occurs in large numbers eastward to Long Point but appears to become very much less abundant beyond. It is noted for the large size attained as compared with the other species of the genus *Leucichthys*. The outstanding characters are (1) the deep body, (2) the more or less pronounced hump at the nape, (3) the deep caudal peduncle, (4) the relatively large scales. The average proportions for 150 individuals were: 4.41, 3.42 and 2.44.

(3) *L. artedi* (Le Sueur). Lake Erie cisco or grayback.

This species occurred in numbers at Merlin next in abundance to *L. eriensis* and appears to occur abundantly throughout the lake. It has been distinguished from the jumbo cisco by (1) the somewhat narrower peduncle, (2) the narrower body with usually little or no hump at the nape, (3) the smaller scales with less of the shiny appearance, (4) the much slower rate of growth as shown in the following table and also later in the discussion of the results of the scale examinations.

<i>L. artedi</i>					<i>L. eriensis</i>				
No.	Date	Length cm.	Weight oz.	Age Years	No.	Date	Length c.m.	Weight oz.	Age Years
600	July 8	20.7	6	4	234	July 8	20.8	6	3
601		21.8	6	5	235		21.9	7	3
602		21.0	6	5	237		21.1	7	3
603		21.5	6	5	238		22.2	8	3
604		21.0	6	5	239		22.6	8	3
605		22.2	6	6	240		22.8	9	2
606		21.8	6	5	241	July 9	23.7	9	3
607	July 9	22.8	7	6	242		26.5	12	4
609		22.9	7	5	243		21.5	7	3
610		23.4	7	5	244		24.1	10	3

Figure 1 shows a drawing of a scale from specimen No. 606, *L. artedi* and a drawing of a scale from specimen No. 235, *L. eriensis*.

The average proportions for 50 individuals as they occurred at Merlin were 4.26, 3.7 and 2.86. These figures are somewhat different from those given by Jordan and Evermann and may be due in part to the fact that the young of *L. eriensis* are somewhat difficult to separate from this species, and in the selection of the above 50 individuals rather extreme forms were chosen. There is an indication, however, that *L. artedi* is more closely related to the species of the other lakes than perhaps the figures of Jordan and Evermann show.

(4) *L. prognathus* (Smith). Lake Ontario deep water cisco or longjaw.

In both the pound nets and gill nets from Port Dover to Port Maitland a cisco occurs very abundantly whose exact identity and relationships have not been determined as yet. Dr. B. W. Evermann, to whom ten specimens were submitted for identification, refers them provisionally to the species *prognathus* pending further examination of these and additional specimens. The outstanding features of this form are the following: (1) the long mandible which usually projects beyond the upper jaw and in extreme cases almost hooks over it, (2) the relatively long bony snout, (3) the narrow caudal peduncle, (4) the shiny appearance of the scales, (5) the rather deeply forked caudal fin. In a great many individuals the above characters are extreme as well as other features, as indicated by the following proportions, 4.0, 4.2, and 3.2. In other specimens the proportions are about as follows: 4.3, 3.75, and 2.85. The average for 148 individuals is 4.22, 3.88, and 2.85. However, Dr. Evermann states that *L. prognathus* varies greatly. Only a single longjaw was taken at Merlin during



the summer of 1920 on August 24, and it had the proportions 4.1, 3.3, and 2.8. A fisherman at Point Pelee has stated that he recalled having seen during one spring rather large numbers of small longjaws taken in the pound nets in that region. This would indicate a migration occurring during the winter or spring months when temperature conditions would be rather uniform throughout the lake.

The longjaws examined at Dunnville and Port Dover early in November, 1920, were almost ready to spawn. Typically, members of the subgenus *Cisco* (Jordan and Evermann) are said to spawn in late summer but it would not be surprising to find the deep water forms in the shallower, warmer waters of Lake Erie spawning later than those in the other Great Lakes, especially in a mild fall such as occurred in 1920. Two females of *L. johanna* received from Wiarton, Georgian Bay, November 24, 1920, were found not to have spawned.

The following table shows comparative measurements of certain characters of the longjaws in Lake Erie. Measurements are given in decimal fractions of body length.

	PORT MAITLAND						PORT DOVER		
	1032	1042	1037				919	907	918
Head.....	.26	.25	.25	.245	.25	.24	.23	.23	.24
Depth.....	.24	.21	.22				.24	.26	.30
C.P. depth.....	.087	.078	.081	.082	.082	.089	.084	.079	.082
Eye.....	.054	.058	.060	.06	.06	.055	.066	.055	.065
Snout.....	.063	.063	.064	.063	.063	.057	.058	.053	.058
Maxillary.....	.085	.083	.09	.08	.087	.085	.079	.08	.089
Snout to occiput.....	.17	.17	.17	.17	.17	.16	.166	.15	.173
Gill rakers.....	45	46	45	41	41	45	45	45	41
Head in length.....	4.0	4.0	4.0	4.0	4.0	4.1	4.3	4.3	4.1
Depth in length.....	4.2	4.7	4.6				4.1	3.9	3.3
C.P. depth in head.....	3.2	3.2	3.2	3.0	3.0	2.7	2.8	3.0	2.9

(5) *L. harengus* (Richardson). Georgian Bay cisco.

A few individuals were taken which agreed in measurements and description with the Georgian Bay cisco. Jordan and Evermann report this species in Lake Erie and no doubt it occurs in small numbers.

For purposes of comparison and for confirmation of the value of proportional measurements, specimens of *L. ontariensis* were obtained from Port Credit on Lake Ontario, and specimens of *L. harengus* from Wiarton and Midland on

Georgian Bay. The average proportions of 20 individuals of *L. ontariensis* were 4.5, 3.8, and 2.6. The average for 25 individuals of *L. harengus* were 2, 4.3, and 3.1.

The following table shows the measurements of typical individuals of the various species examined. Measurements are given in decimal fractions of body length.

	<sup>1</sup> <i>L. harengus</i>	<i>L. sisco</i> <i>huronius</i>	<sup>2</sup> <i>L. ontari-</i> <i>ensis</i>	<i>L. artedi</i>	<i>L. eriensis</i>	<i>L. prognathus</i>
	21	328	3	666	1026	1038
Head.....	.24	.22	.21	.23	.23	.25
Depth.....	.21	.22	.26	.26	.33	.24
Caudal peduncle length..	.11	.12	.11	.11	.10	.11
Caudal peduncle depth...	.073	.074	.084	.085	.095	.081
Eye.....	.062	.051	.054	.057	.057	.065
Snout.....	.057	.053	.051	.055	.050	.056
Interorbital space.....	.068	.064	.062	.068	.067	.065
Maxillary.....	.079	.074	.066	.081	.073	.086
Snout to occiput.....	.16	.14	.15	.16	.15	.17
Ventral to pectoral.....	.31	.36	.35	.36	.36	.33
Pectoral to P-V distance..	2.25	2.2	2.4	2.2	2.3	1.9
Pectoral length.....	.14	.14	.14	.16	.16	.17
Ventral length.....	.13	.12	.14	.15	.16	.17
Dorsal height.....	.14	.13	.15	.16	.17	.18
Adipose length.....	.053	.06	.062	.064	.073	.053
Anal height.....	.88	.88	.94	.11	.11	.13
Gill rakers.....	49	47	48	43	46	45
Scales.....	9-85-8	9-82-8	9-78-8	8-70-7	8-75-7	8-75-7
Head in length.....	4.2	4.6	4.6	4.3	4.4	4.1
Depth in length.....	4.7	4.5	3.8	3.5	3.1	4.2
C.P. depth in head.....	3.2	3.0	2.7	2.8	2.4	3.0

<sup>1</sup>From Georgian Bay.

<sup>2</sup>From Lake Ontario.



The following table shows proportions as given by Jordan and Evermann and those obtained for the ciscoes in Lake Erie with the exception of *L. harengus* and *L. ontariensis*.

Species	Jordan and Evermann			Lake Erie		
	Head in length	Depth in length	Depth C.P. in length	Head in length	Depth in length	Depth C.P. in length
<i>L. harengus</i> .....	4.33	4.3-4.6	3.0	<sup>1</sup> 4.2	4.3	3.1
<i>L. sisco huronius</i> .....	4.66	4.2-4.5	2.9	4.6	4.3	2.95
<i>L. ontariensis</i> .....	4.5	3.7-4.2	2.66	<sup>2</sup> 4.5	3.8	2.6
<i>L. artedi</i> .....	4.4	3.5-4.0	2.0-2.5	4.26	3.70	2.86
<i>L. eriensis</i> .....	4.4	3.3-3.5	2.2	4.41	3.42	2.44
<i>L. prognathus</i> .....	4.0	3.5	3.5	4.22	3.88	2.87

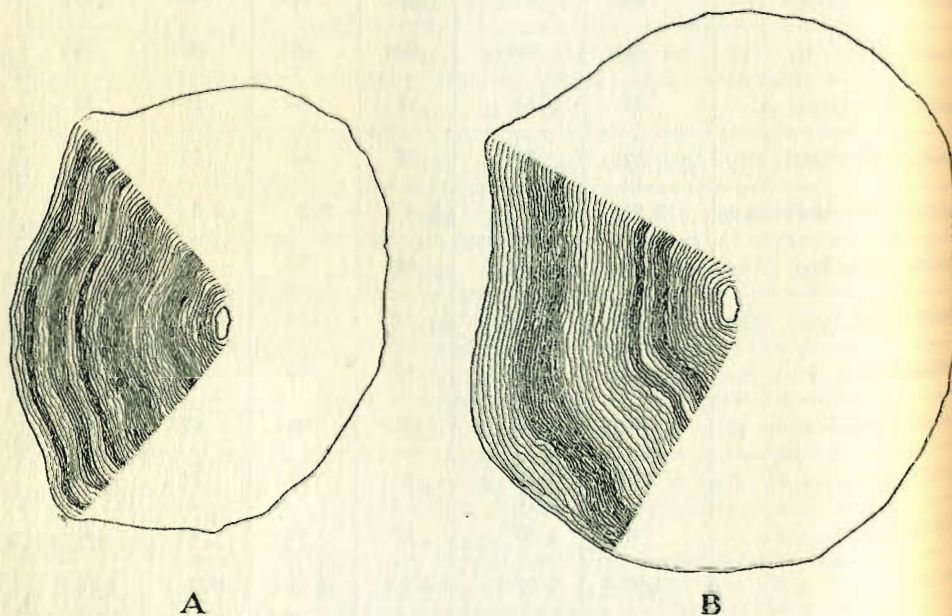


Fig. 1.—Drawings of scales of ciscoes.

A, from specimen No. 696, *L. artedi*, showing 5 winter bands, the fish therefore being in its sixth summer. B, from specimen No. 235, *L. eriensis*, showing three winter bands, the fish therefore being in its fourth summer.

<sup>1</sup>From Georgian Bay.

<sup>2</sup>From Lake Ontario.

The scales were used in determining the rates of growth of the various species of ciscoes. The growth areas are usually well marked. Scales from approximately the following number of fish of each species were examined: *L. eriensis*

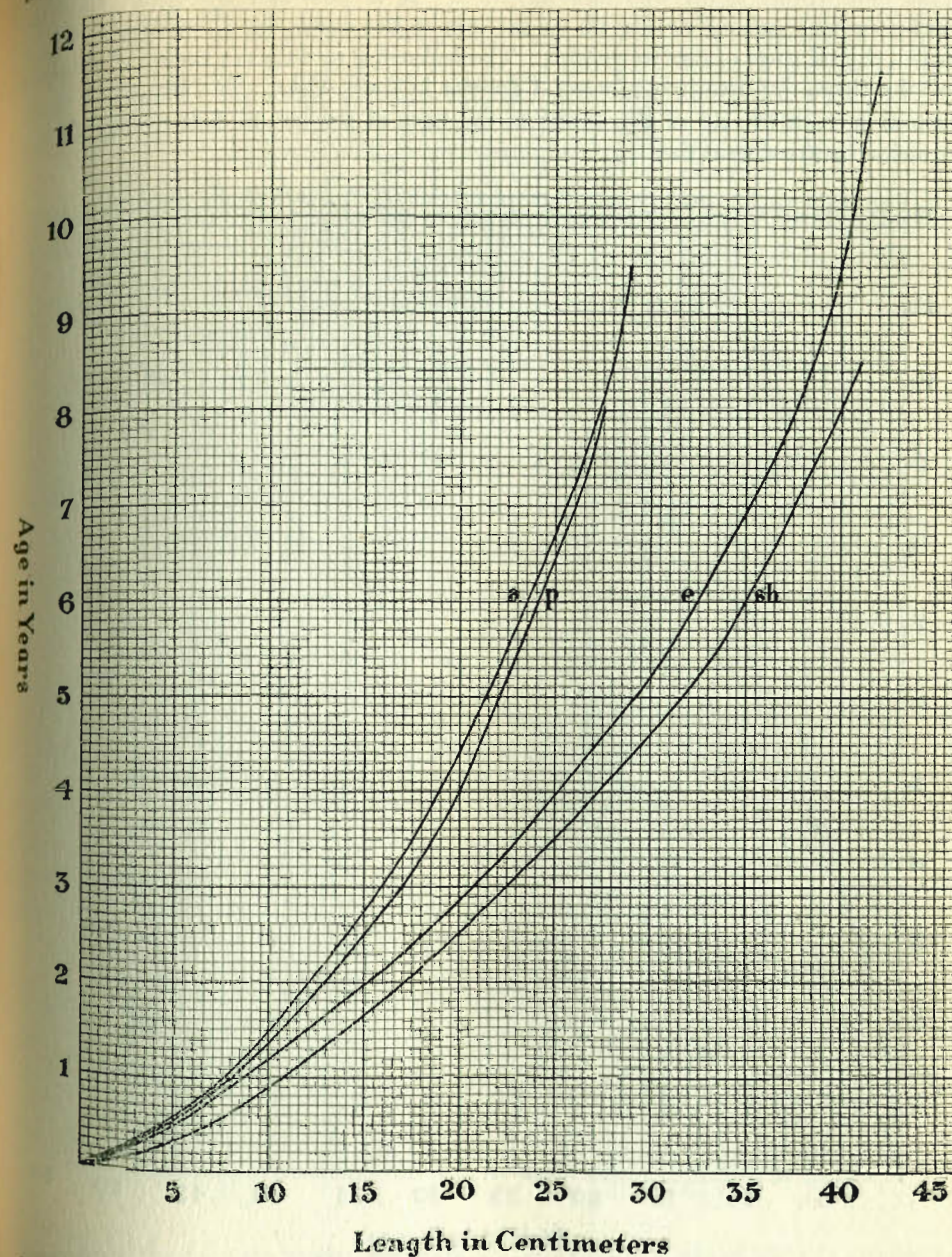


Fig. 2.—Graph illustrating rates of growth of ciscoes in Lake Erie a = *L. artedi*, p = *L. prognathus*, e = *L. eriensis*, sh = *L. sisco huronius*.



140; *L. artedi* 55; *L. sisco huronius* 55; *L. prognathus* 150. The results are shown in Fig. 2. Considerable difficulty was experienced in estimating the rate of growth of *L. sisco huronius*. In the majority of scales some of the winter bands were difficult to distinguish and there was evidence that in some cases at least one winter band was not recorded. It is possible, therefore, that the curve for this species should lie to the left of the curve for *L. eriensis*. Fig. 3 shows the relation of age to weight. The following table gives the data obtained for the three important commercial species in Lake Erie. The length in centimeters is from the tip of the snout to the base of the caudal fin; the girth just anterior to the dorsal fin.

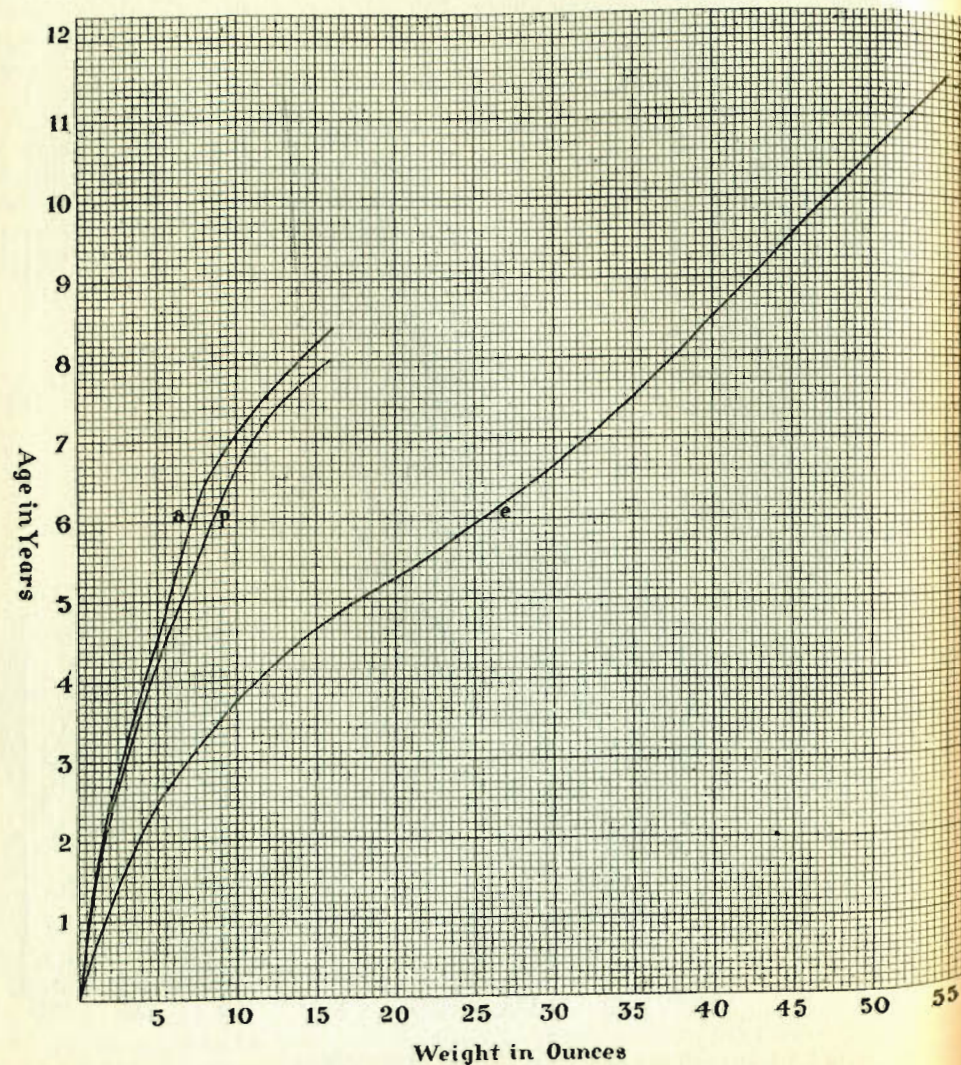


Fig. 3.—Graph illustrating relation of weight to age of ciscoes in Lake Erie. a = *L. artedi*, p = *L. prognathus*, e = *L. eriensis*.

Age	<i>L. eriensis</i>				<i>L. artedi</i>				<i>L. prognathus</i>			
	Length c.m.	Length in.	Weight oz.	Girth in.	Length cm.	Length in.	Weight oz.	Girth in.	Length cm.	Length in.	Weight oz.	Girth in.
1	8.5	4.0	1.5	...	7.5	3.0	...	...	8.0	3.0	...	...
2	15.0	6.6	3.5	...	12.5	5.2	...	...	13.0	5.2	...	...
3	20.5	9.1	7.0	6.1	16.0	7.0	3.0	4.5	17.0	7.0	3.0	4.5
4	25	11.4	11.5	7.4	19.0	8.5	4.5	5.2	20.0	8.5	4.5	5.2
5	29	13.3	17.5	8.5	21.5	9.6	5.5	5.8	22	9.8	6.5	5.7
6	32.5	14.8	25.5	9.4	23.5	10.3	7.5	6.3	24	10.7	8.5	6.3
7	35.5	16.0	32.0	10.1	25.5	10.7	9.5	6.7	26	11.4	11.0	...
8	37.5	17.0	37.5	10.8	27.5	11.8	12.5	...	...	...	...	...
9	39.5	17.6	42.5	11.3	28.5	...	...	...	...	...	...	...
10	40.5	18	47.5	11.8	...	...	...	...	...	...	...	...
11	41.5	18.5	52.5	...	...	...	...	...	...	...	...	...

The difference in weight between *L. artedi* and *L. prognathus* is partly due to the fact that the specimens of the latter species were examined chiefly in November and the females were then heavy with spawn.



## SUMMARY

1. Three species form the bulk of the cisco catch in the Canadian waters of Lake Erie, namely, *L. eriensis*, *L. artedi* and *L. prognathus*.

2. *L. eriensis* is the dominant form westward from Long Point, and *L. prognathus* eastward from Long Point. This statement holds in general, for the former appears to prefer the shallower water while the latter is apparently a deep water form. However their ranges tend to overlap and their migrations at times take them into one another's territory. For example, fishermen have reported occasional schools of longjaws as far west as Point Pelee, and, on the other hand, the jumbo is reported as abundant, at times, off Port Maitland. *L. artedi* occurs abundantly throughout the lake, but probably in greatest numbers west of Long Point.

3. *L. artedi* and *L. prognathus* have rates of growth and increases in weight which are practically identical, while *L. eriensis* increases about 1 1/3 times faster in length and two to three times faster in weight.

4. Examinations of the graphs and tables for rates of growth and increases in weight show that the optimum size for the taking of the jumbo cisco is from the fifth summer upward when they are at least 12 inches in length and 1 pound in weight. Whether the food supply would permit of this as the minimum size it is impossible to say. In regard to *L. artedi* and *L. prognathus* a minimum length of about 10 inches and a weight of about 6 or 7 ounces, when the fish are in their sixth summer, would appear to be quite satisfactory.

5. Concerning the occurrence of smaller ciscoes in the eastern end of the lake, this much can be safely said: that in respect to gill net catches the fishermen in the western portion of the lake secure a larger percentage of jumbo ciscoes and, therefore, get large fish, while the fishermen in the eastern end, particularly off Port Maitland, secure chiefly the smaller species, *L. artedi* and *L. prognathus*. The same facts apply to the pound net catches, with the addition that, since the young inhabit the shallow waters and the shallow water area east of Long Point is more limited, there appears to be a concentration of young ciscoes along the shore, particularly in Long Point Bay, and hence the young are apt to be impounded in large numbers in the pound nets.

6. No data were obtained as to the age when the various species spawn for the first time. Spawning is probably at the end of the third summer, and, if so, the six-ounce regulation protects the two species, *L. artedi* and *L. prognathus* in respect to being allowed to spawn once, but does not protect *L. eriensis* since it attains a weight of six ounces in its third summer.

7. The girth measurements were taken around the body just anterior to the dorsal fin, that is where the greatest girth occurs. The results show that the three inch gill net regulation is quite satisfactory for the species *L. artedi* and *L. prognathus* since they do not attain a girth of six inches until the sixth summer, but barely protects *L. eriensis* since this species attains a girth of six inches in three years.

8. In any undertaking for the artificial propagation of ciscoes in Lake Erie, at least for the region west of Long Point, particular attention should be given to *L. eriensis*, because of its rapid growth and its excellent qualities as a food fish.

## CONCLUSION

This study has proved to be merely preliminary. The ciscoes of Lake Erie form a complex association and it has been impossible in this investigation to determine their inter-relations or to study the physical factors in relation to the various forms. Solution of the many difficult problems must await a thorough study of the physical conditions of existence in the various parts of the lake, such as distribution of temperatures, oxygen, carbon dioxide, currents, etc., and the relation of these factors to spawning, growth, movements of the fish, as well as to the production and distribution of their food organisms.