

**FISHERIES RESEARCH BOARD
OF CANADA**

MANUSCRIPT REPORTS OF THE BIOLOGICAL STATIONS

No.

446

Title

Investigation of Heming Lake ciscoes, (Leucichthys) 1950

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INTRODUCTION

The presence in whitefish, Coregonus clupeaformis, of intermediate stages of the tapeworm Triaenophorus crassus continues to be a problem of great importance in Central Canada. Quantities of these parasites in the whitefish impair commercial values, particularly in shipments destined for the United States.

Where whitefish, C. clupeaformis and ciscoes or herring, Leucichthys sp. occur together in infected lakes the latter are more heavily parasitized. Ciscoes are regarded as the principal second intermediate host of Triaenophorus and their reduction has been advocated, (Miller, 1948). Keleher (1950) has shown that the species of Lake Winnipeg ciscoes differ not only in their incidence of infection with Triaenophorus but also in the relationship of infection to age of host.

Because of the important role of the cisco in the life history of Triaenophorus it was felt that objectives of the Triaenophorus study begun at Heming Lake, Manitoba should include determination of the species of Leucichthys present and the relationship to infection by Triaenophorus plerocercoids.

DESCRIPTION OF HEMING LAKE

Heming Lake is situated in the Province of Manitoba at approximately 54° 53' N. Lat. and 101° 7' W. Long. It is 18 miles south of the town of Sherridon, is 3 miles in length and from one-quarter to one-half mile in width, 588 acres in area, and lies in the headwaters of the Grass River, a tributary of Nelson River which flows into Hudson Bay. There are 8 main bays with muskeg shores and muck bottom, depths of water up to 6 feet, and with a fringe of emergent and considerable submerged vegetation.

The remainder of the lake has little vegetation, has shores of igneous rock and sand, and a bottom of inorganic silt covered with decayed organic matter. Depths do not exceed 16 feet, the water is acid and brownish, and visibility is about 6 feet. There are two main tributary streams.

COLLECTION AND TREATMENT OF DATA

Data were collected from 150 ciscoes captured in various mesh size gill-nets ranging from $1\frac{1}{4}$ " to $4\frac{1}{2}$ ". The sampling was carried out regularly at several areas of the lake between May 24 and October 10. During July and August gill-nets of $1\frac{1}{4}$ " to $1\frac{1}{2}$ " stretched mesh were fished at least twice weekly to obtain as many yearling whitefish and ciscoes as possible. Camp broke up on September 3 and there was no fishing between this time and October 10 when the writer and Dr. K. H. Doan visited Heming Lake for the purpose of taking a sample of whitefish for the annual fall infection check. At this time 25 ciscoes were captured bringing the year's total to 150.

Scale samples and morphometrical data (13 measurements and 1 count) were recorded for all ciscoes examined. Standard length, sex, weight and the numbers of cysts of Trisacnophorus crassus for each fish were recorded on scale envelopes and later transferred to permanent record books. Except for the 25 ciscoes taken in October and preserved in 8 per cent formalin, all ciscoes were examined in a fresh state.

Scales collected from the left side of the fish below the dorsal fin and above the lateral line were stored in envelopes and later mounted "wet" between glass slides and were magnified on a Bausch and Lomb micro-projector. Ages were recorded as the number of completed annuli.

INFECTION OF HEMING LAKE CISCOES

Incidence

The ciscoes were examined by the method developed by the whitefish inspection service of the Department of Fisheries and the number of parasites per right and left fillet was recorded. The ciscoes taken in October and preserved in formalin were not as easy to slice as those in the fresh state, however, the writer feels that just as accurate a count of the parasites was made on these fish.

The frequency polygon, Fig. 1, shows that the number of cysts per fish follows a poisson-type distribution. Keleher (1950) found the same type of distribution for L. zenithicus and L. nigripinnis as did Newton (1932) for three Lake Winnipeg coregonines. The high percentage non-infected is the result of a very large sample of one-year-old fish where the infection rate was extremely low.

Examination of one-year-old ciscoes throughout the summer revealed the fact that no encystment had taken place up to the end of August. The worms were naked in the flesh and extended across several myomeres, often forming a lace-like pattern.

Miller (1945) and Newton (1932) found a consistently greater number of cysts in the right side of the fish than on the left. Examination of 142 ciscoes showed 184 cysts on the right side and 155 on the left. Application of the X^2 test showed the difference between the number of cysts per side was not significant.

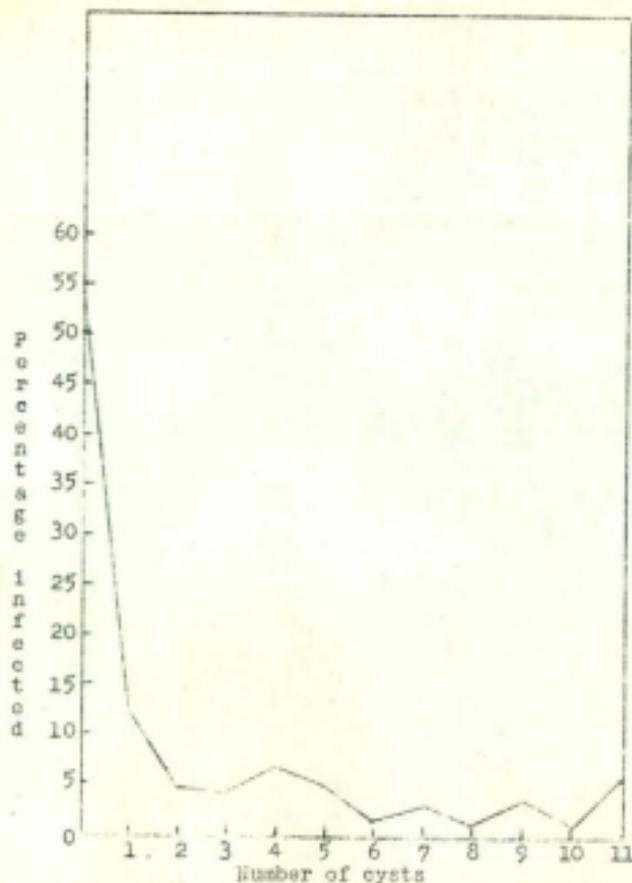


Figure 1. Percentage frequency distribution of *Trisenocephalus crassus* infection in Heming Lake ciscoes.

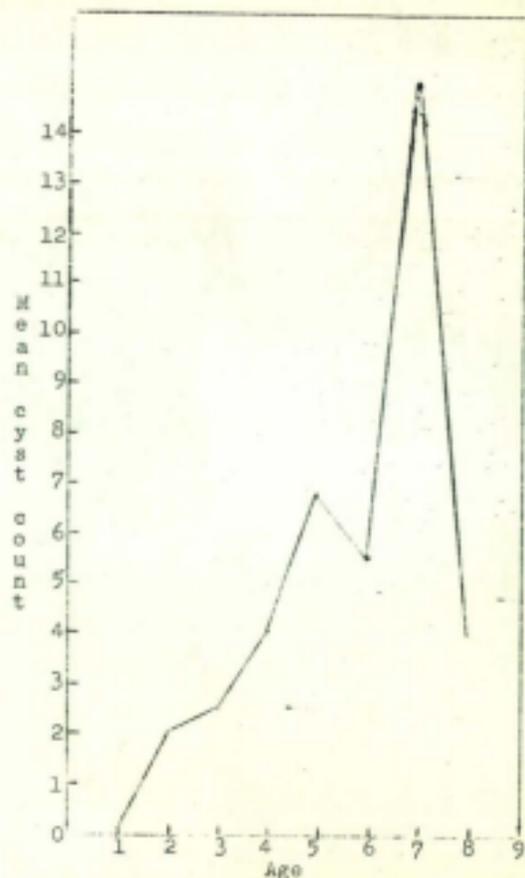


Figure 2. Relationship of age to mean cyst count in Heming Lake ciscoes.

A comparison of Trisphenophorus infection of Leucichthys in Lake Winnipeg and Heming Lake is shown in Table I. In this comparison, age, sex, locality and time of capture are disregarded and the data are combined.

Table I. Trisphenophorus infection of Leucichthys collected from Lake Winnipeg, 1947-1949 (Keleher 1950) and Heming Lake, 1950.

	Lake Winnipeg		Heming Lake	
	<u>zenithicus</u>	<u>nigripinnis</u>	<u>nipigon</u>	ciscoes
No. of specimens	501	164	176	150
No. infected	309	105	167	66
Percentage infected	62	61	96	44
No. of cysts	778	399	1253	386
No. of cysts per fish	1.5	2.4	7.1	2.57
No. of cysts per fish infected	2.5	3.8	7.5	5.8

The percentage of Heming Lake ciscoes infected is much lower than that for any of the three Lake Winnipeg species. This difference is no doubt the result of the large number of lowly infected yearling fish examined. No fish under three years of age were examined on Lake Winnipeg. The number of cysts per fish (2.57) shown in line 5 is very close to that of L. nigripinnis (2.4) in Lake Winnipeg. The number of cysts per infected fish (5.8), line 6, lies between L. nigripinnis and L. nipigon.

Relation between number of cysts and age of host

Miller (1945) showed a correlation between the number of cysts in the flesh and the age of the fish. The infection of year classes as they increase in age should be calculated to understand the true relationship between the incidence of

infection and the age of the host. This may be possible at Heming Lake during the next few years because of the exceptionally good catch of yearling ciscoes in 1950, however at the present time it is only possible to use the mean cyst count for each age group. These data are presented in Table II and Fig. 2.

Table II. Trinenophorus infection and age of Heming Lake Leucichthys 1950. Figures in parentheses are number of specimens.

	Age in completed years							
	1	2	3	4	5	6	7	8
Mean number of cysts.....	.13 (85)	2 (3)	2.5 (2)	4.05 (17)	6.9 (27)	5.5 (4)	15 (3)	4 (1)
Percentage ciscoes infected..	12.9	66.6	100	94.1	96.3	100	100	100
Number of cysts per 100 pounds ..	120 (78)	377 (2)	-	545 (7)	862 (17)	478 (4)	1306 (2)	-
Number of cysts per 100 fish	12.9 (85)	200 (3)	250 (2)	405 (17)	692 (27)	550 (4)	1533 (3)	400 (1)

Table II shows that in the 1950 sample from Heming Lake there is a correlation between infection and age. The mean number of cysts ranged from .13 in the one-year-old fish to 6.8 in the five-year-old fish. The mean number of cysts in seven-year-old fish was 15, but as only three fish were examined in this age group this figure is possibly not representative of the age group.

The gill-nets employed in the sampling did not capture two- or 3-year-old fish in any significant numbers and the percent infection shown in Table II is probably not the true percentage of the age group.

The number of cysts per 100 pounds increased from 120 for one-year-old fish to 1306 for seven-year-old fish. The one-

year-old fish would be better contrasted with the five-year-old fish on the basis of the larger sample.

GROWTH

The variates used for the growth curve presented in this study are the completed ages of the fish and their actual standard length at the time of capture. Table III showing the actual lengths of one-year-old fish at regular intervals throughout the summer clearly demonstrates that actual lengths do not represent the size of the fish at a discrete age. The one-year-old fish captured early in July are definitely smaller than the one-year-old fish in late August.

Table III. Lengths of one-year-old ciscoes in Heming Lake during summer of 1950 showing spread in growth.

Length in mms.	Frequency			
	July 7-21	July 22-Aug.5	Aug.6-20	Aug. 21-Sept.4
116	1	-	-	-
117	1	-	-	-
118	2	-	-	-
119	4	-	-	-
120	5	1	-	-
121	-	2	-	-
124	2	-	-	-
125	-	4	2	-
126	1	4	2	-
127	1	2	1	-
128	1	-	2	2
129	-	1	3	-
130	-	1	1	2
131	-	3	2	1
132	-	1	1	2
133	-	-	-	2
134	-	1	2	1
135	-	-	1	4
136	-	-	1	1
137	-	-	-	2
138	-	-	-	5
139	-	-	-	2
142	-	-	-	1
146	-	-	-	1
Mean length	121	127	130	135

Because of the paucity of specimens among the fish older than one year and because the one-year-old ciscoes were not mature, no determinations were made to see whether any growth differences existed between males and females of the same age group. All data were combined.

The mean lengths were determined for each age group and the curve is shown in Fig. 3. The histograms indicated roughly the number of fish in the sample and the variation in length within an age group. The mean length for two- or three-year-old fish are not substantiated by adequate data.

The mean lengths at different ages for three species of Lake Winnipeg ciscoes (Keleher, 1950) are compared with the mean lengths of Heming Lake ciscoes in Table IV. Although the fish compared were taken in different calendar years and were thus subject to different environmental conditions the differences in growth are evident. The Heming Lake ciscoes were longer at all ages than the three species of Lake Winnipeg ciscoes. The mean lengths of Heming Lake ciscoes are closer to L. nipigon at four, five, and six years of age than to L. nigripinnis.

Table IV. A comparison of the mean lengths of three Lake Winnipeg ciscoes and Heming Lake ciscoes at each known age. Numbers of specimens in parentheses.

	1	2	3	Age 4	5	6	7	8
Heming Lake	129 (85)	175 (3)	237 (2)	263 (17)	273 (27)	299 (4)	310 (3)	325 (2)
Lake Winnipeg								
<u>L. nigripinnis</u>	-	-	138 (14)	183 (30)	225 (41)	256 (32)	287 (16)	313 (16)
<u>L. nipigon</u>	-	-	-	230 (12)	252 (62)	262 (57)	267 (42)	-
<u>L. zenithicus</u>	-	138 (12)	135 (40)	182 (56)	221 (41)	240 (45)	250 (86)	258 (18)

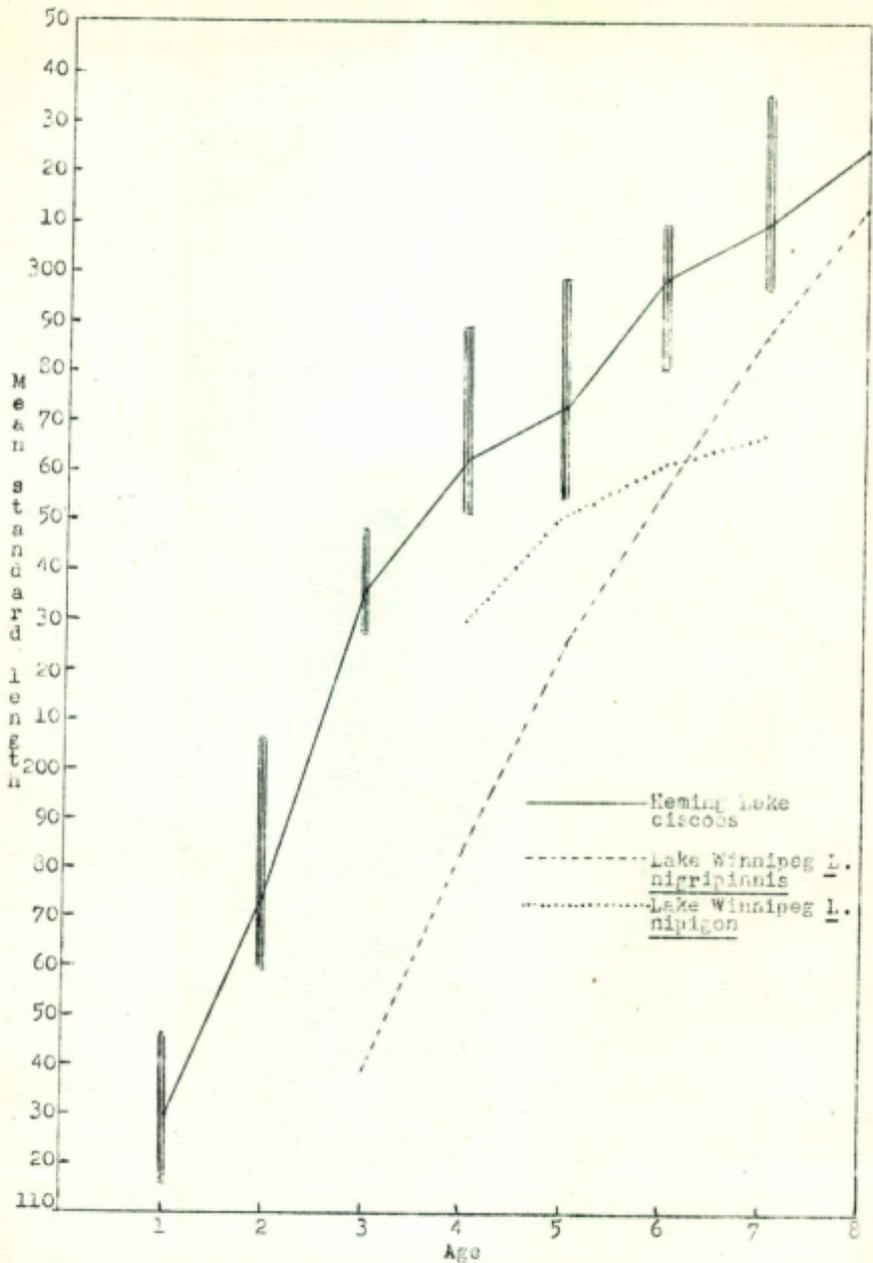


Figure 3. Age-length relationship of ciscoes.

MORPHOMETRY OF HEMING LAKE CISCOES

Throughout the summer while sampling the fish populations of Heming Lake the author observed that the ciscoe population formed one natural group. In an attempt to test this homogeneity various morphometrical data were collected. Of the morphometrical data gathered the following counts and measurements were used because they appear to be the best taxonomic character in discussion of the highly variable member of the genus Leucichthys.

Gill-rakers

In the discussion of Heming Lake ciscoes which appeared in the 1950 Annual Report of the Central Fisheries Research Station, the data indicated there was no significant difference between gill-raker means of one-year-old fish and fish of older age groups. This signified that the samples of fish were homogeneous with respect to gill-raker counts. Recent analysis shows that the mean gill-raker count for fish older than one year (46.6) approximates more closely the mean gill-raker count for yearling fish (46.5) than did the fall analysis. Although the difference of means was not calculated for the present data it would appear a stronger case has been presented for the homogeneity of the samples.

Table V shows the gill-raker frequency for 145 ciscoes of all ages of fish taken in 1950. The gill-rakers vary from 41-52 with the mean at 46.8. From Table V it is seen that the gill-rakers are unimodally distributed. If more than one species was present we would expect to find a bimodal distribution. There does not appear superficially to be any trend towards an increasing frequency of gill-rakers with age and size, (Tables V & VI). The conclusion, with respect to gill-rakers, is that only one species of ciscoes exists in Heming Lake.

Table V. Frequency of gill-raker count according to age of 145 Heming Lake *Leucichthys*, 1950.

Number of gill-rakers	Age of fish								Total
	1	2	3	4	5	6	7	8	
41	1	1	-	-	-	-	-	-	2
42	-	-	-	-	-	-	-	-	-
43	1	-	-	-	-	-	-	-	1
44	7	-	-	2	-	-	-	-	9
45	12	3	-	-	-	1	-	-	16
46	19	1	1	2	4	1	1	1	30
47	19	-	-	4	6	1	2	-	32
48	20	-	-	3	8	-	-	-	31
49	6	-	1	4	7	1	-	-	19
50	1	-	-	-	1	-	1	-	3
51	-	-	-	1	-	-	-	-	1
52	-	-	-	-	1	-	-	-	1

Table VI. Frequency of gill-raker count according to length of 143 Heming Lake ciscoes, 1950.

Length (Mm.)	Number of gill-rakers										
	41	42	43	44	45	46	47	48	49	50	51
109-129	1	-	1	4	8	13	8	10	4	-	-
130-149	-	-	-	3	4	6	11	10	2	1	-
150-169	-	-	-	-	1	1	-	-	-	-	-
170-189	1	-	-	-	1	-	-	-	-	-	-
210-229	-	-	-	-	-	1	-	-	-	-	-
230-249	-	-	-	-	-	-	-	-	1	-	-
250-269	-	-	-	2	-	2	4	2	4	-	1
270-289	-	-	-	-	-	3	5	8	6	1	-
290-309	-	-	-	-	1	2	3	1	1	1	-
310-329	-	-	-	-	-	2	-	-	1	-	-
330-349	-	-	-	-	-	-	1	-	-	-	-
Total	2	-	1	9	15	30	32	31	19	3	1

Lateral line scales

Lateral line scales are not too constant a taxonomic character because of their great variability in different environments. They are included in this study however as the number of scales exhibits a unimodal distribution and thus supports the hypothesis that only one species of ciscoes is present. The mean number of lateral line scales in the sample was 64.5, the actual numbers ranging from 59 to 70 (Table VII).

Table VII. Distribution of lateral line scales of 77 Heming Lake ciscoes (1950).

	Number of scales in lateral line											
	59	60	61	62	63	64	65	66	67	68	69	70
Frequency	1	-	5	7	9	11	24	8	7	3	-	2

Head length

Koelz has stated that the proportion of the head length to that of the whole fish is but slightly different for the forms of the Leucichthys group and has little systematic value. Fig. 4 shows a unimodal distribution of head length for the Heming Lake specimens. The change in head length with growth of the individual is clearly evident when the older fish are segregated from the yearling fish.

The writer concludes then that the unimodal distribution exhibited by the three taxonomic characters previously discussed substantiates the argument that only one species of Leucichthys is present in Heming Lake.

DISCUSSION

To identify and describe species of the genus

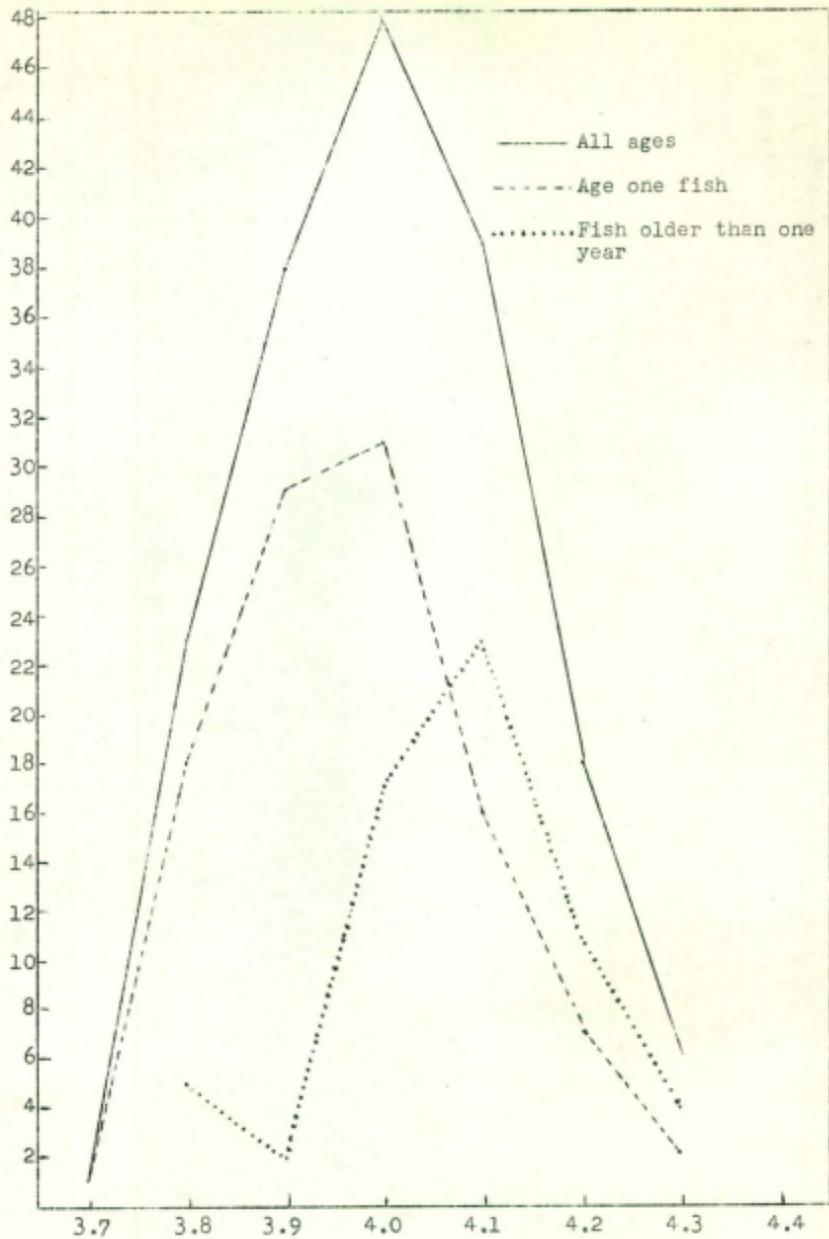


Figure 4. Frequency distribution of head lengths of Heming Lake ciscoes.

Leucichthys an investigator must exercise caution as there is still disagreement on the number of species that should be recognized.

To identify the ciscoes of Heming Lake keys given in Dymond and Pritchard (1930) and Dymond (1947) were used. The key outlined in the former paper is given here.

- A. Gill-rakers 55 or more on first branchial arch - L. nipigon.
- AA. Gill-rakers fewer than 43 on first branchial arch - L. zenithicus.
- AAA. Gill-rakers 43 to 54 on first branchial arch.
 - B. Head long, in specimens 10 inches and more in length 3.8-4.0 - L. nigripinnis.
 - BB. Head short, 4.1-4.4 - L. tullibee.

As the mean gill-raker count for the Heming Lake specimens was 46.5 and the range 41-52 it was concluded that neither L. nipigon or L. zenithicus were present in the sample. The above key is ambiguous with respect to the separation of L. nigripinnis and L. tullibee. Does the head length (4.1-4.4) given for L. tullibee refer only to specimens 10 inches and over? The key apparently gives no characters to identify specimens of L. nigripinnis under 10 inches.

The Heming Lake ciscoes were then compared using Dymond's 1947 key. The majority of the specimens were less than 300 millimeters in length. The key from Dymond (1947) is reduced and reproduced below.

- A. head long 3.8-4.4 in standard length.

B. Eye 14-16 in standard length.

C. Gill-rakers 46-51 - L. nigripinnis.

AA. Head shorter 4.2-5.4.

D. Head 4.2-4.5; gill-rakers 38-57; eye 16-22 in standard length. - L. artedi

The head lengths were plotted against standard length on arithmetic graph paper and appear as Fig. 5 in the text. Boundary lines representing ranges in head lengths taken from the keys were superimposed on the points. It can be seen that among the smaller ciscoes all head lengths lay above the 4.2 line and the majority of the larger fish also were above the 4.2 line. This character would identify the specimens as being L. nigripinnis.

The eye diameters were graphed in a similar manner, Fig. 6. Again all fish under 200 millimeters in length were found above the line representing eye diameters of 16, the dividing line for L. nigripinnis and L. artedi. Of the fish over 200 millimeters in length the points are scattered above and below the line with the majority falling below. In this case, if one sampled only small fish they would be identified as being L. nigripinnis on the basis of key identification. Fish over 200 millimeters would be placed in the doubtful category but the case is stronger for identifying them as L. artedi.

Fig. 2 from Dymond (1943) was graphed and the Heming Lake measurements were superimposed. These appear in the text as Fig. 7, 8, and 9. The line representing the relation between head length and body length lies closer to L. nigripinnis than to any of the other Leucichthys species, Fig. 9. 7.

Fig. 8 showing the relationship between eye diameter and body length does not help in naming the species as the eye diameter relation appears to be intermediate between L. artedi and L. nigripinnis. The dorsal height, usually much greater for L. nigripinnis than other Leucichthys species, is shown in Fig. 9. From this graph it is seen that the dorsal height is greater for Heming Lake ciscoes than that described for Lake Nipigon L. nigripinnis.

Dymond (1943) has shown that the Pine Island Lake ciscoes called L. tullibee morphometrically approximate more closely nigripinnis than artedi. When the Heming Lake measurements were compared (see Fig. 8) they too lay very close to nigripinnis. Ecologically nigripinnis are thought to be deep water fish, seldom taken at depths less than 30 fathoms. Heming Lake is only 18 feet deep and is smaller in size than Pine Island Lake where the original description of L. tullibee was made.

It appears, therefore, that the Heming Lake ciscoes are morphometrically similar to the Great Lakes nigripinnis but are ecologically different from them. Until further examinations are made of western Canadian shallow lakes it seems advisable to give the Heming Lake ciscoes the name L. tullibee.

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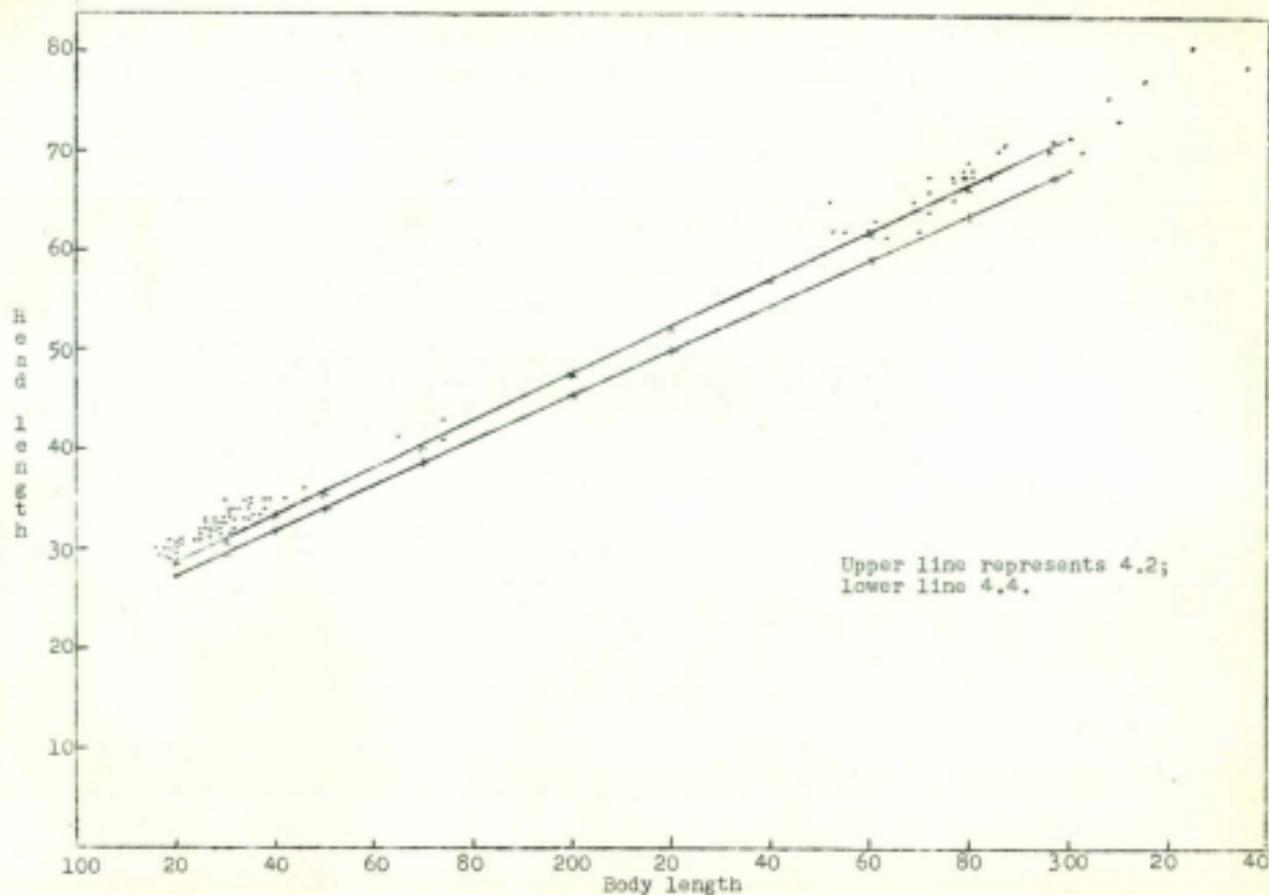


Figure 5. Relative growth in Hening Lake ciscoes.

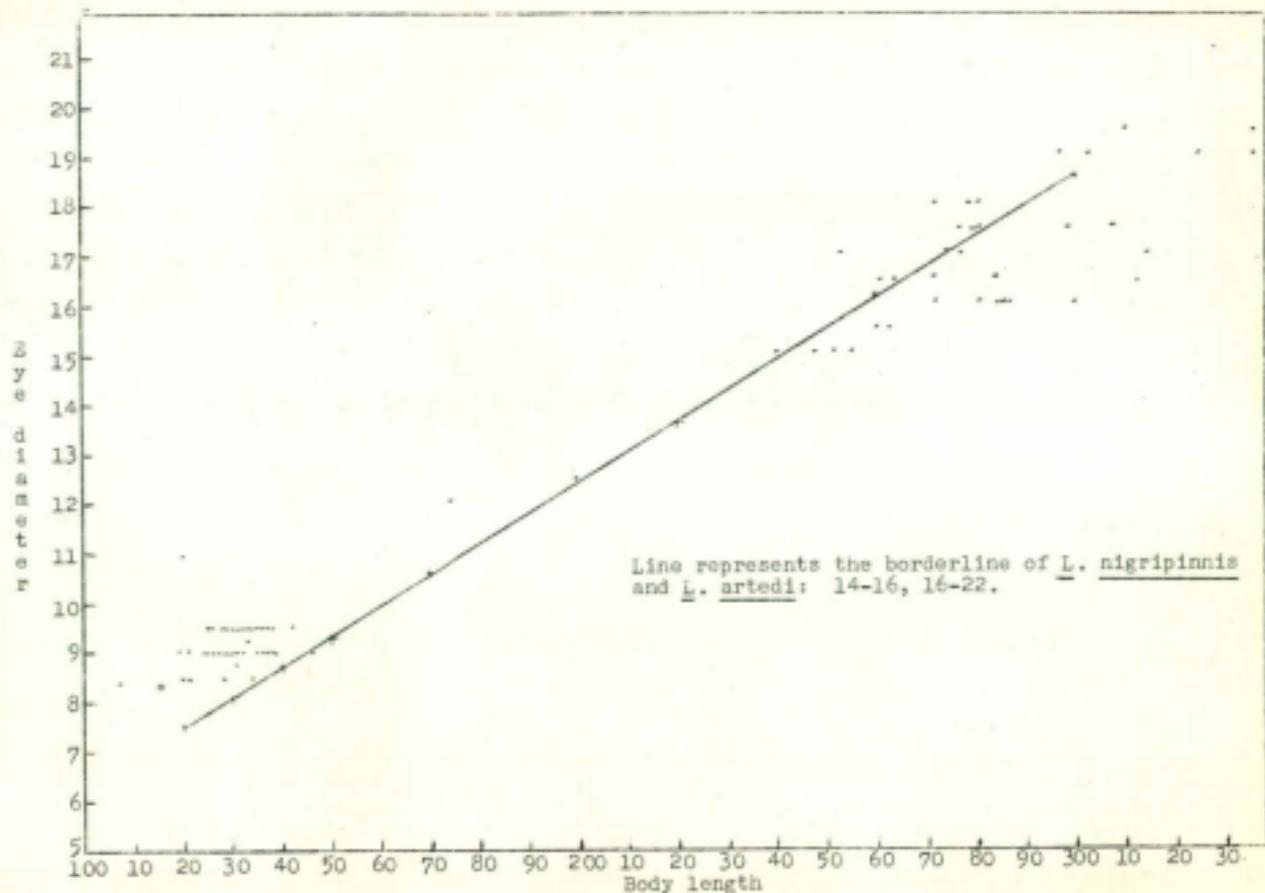


Figure 6. Relative growth in Hering Lake ciscoes.

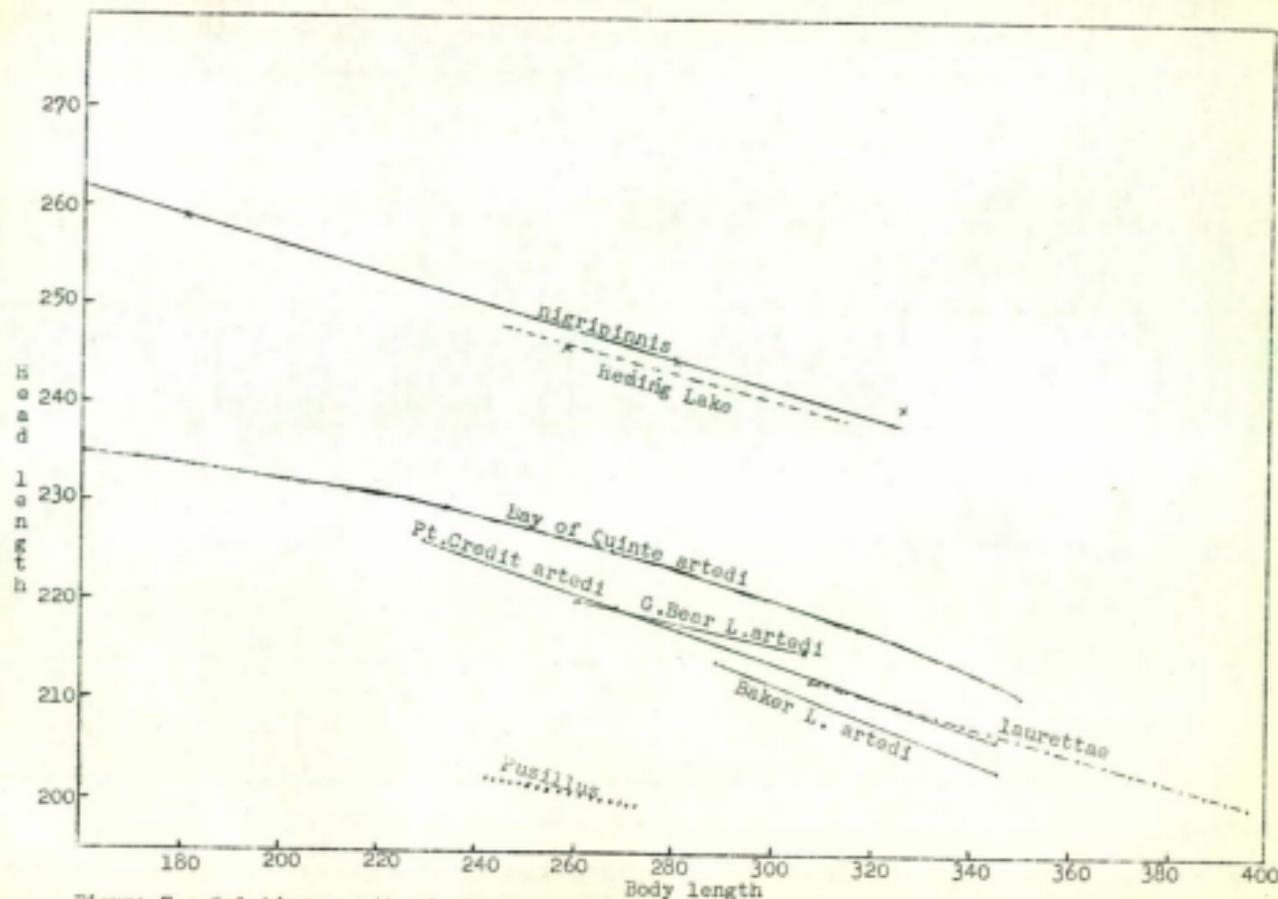


Figure 7. Relative growth of ciscoes.

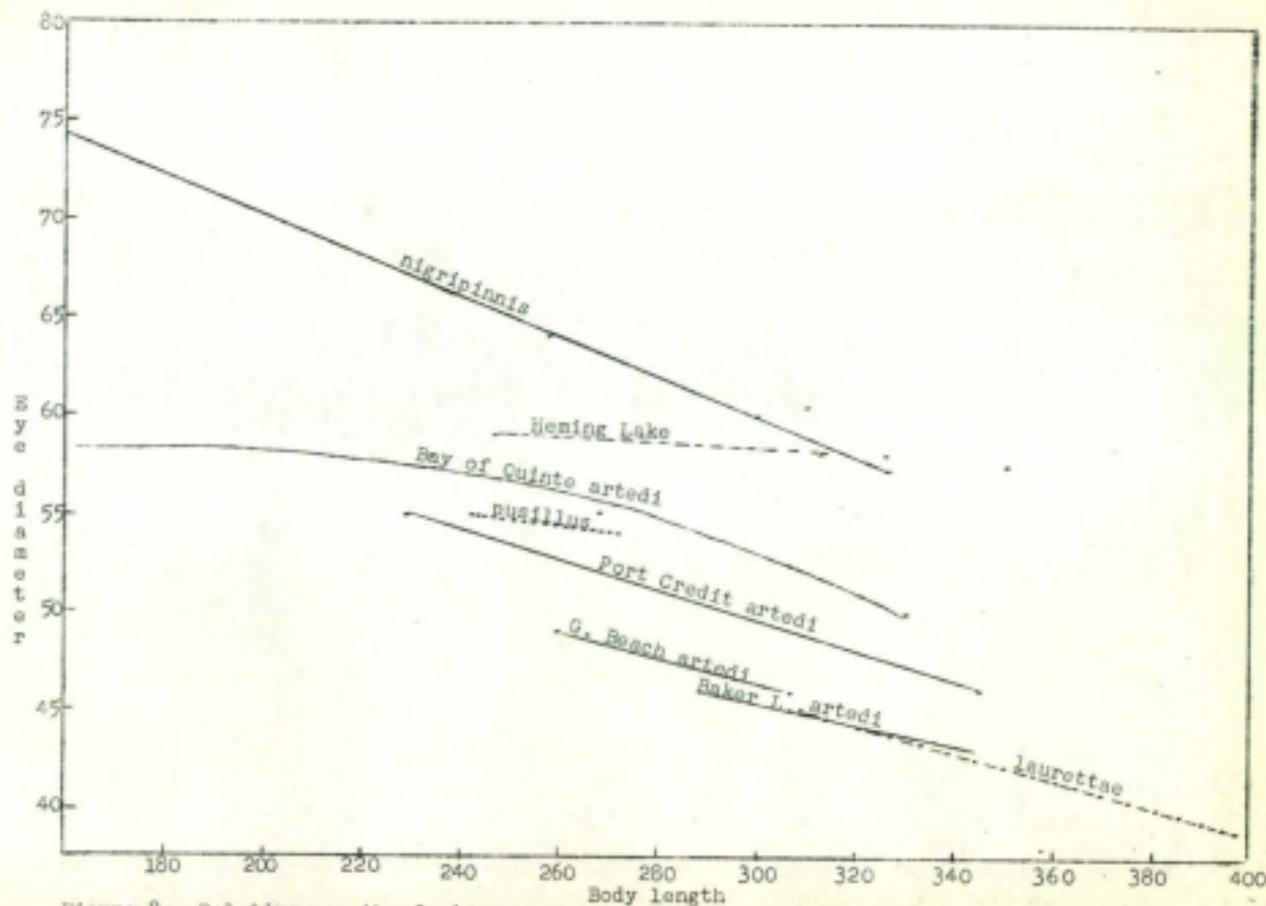


Figure 8. Relative growth of ciscoes.

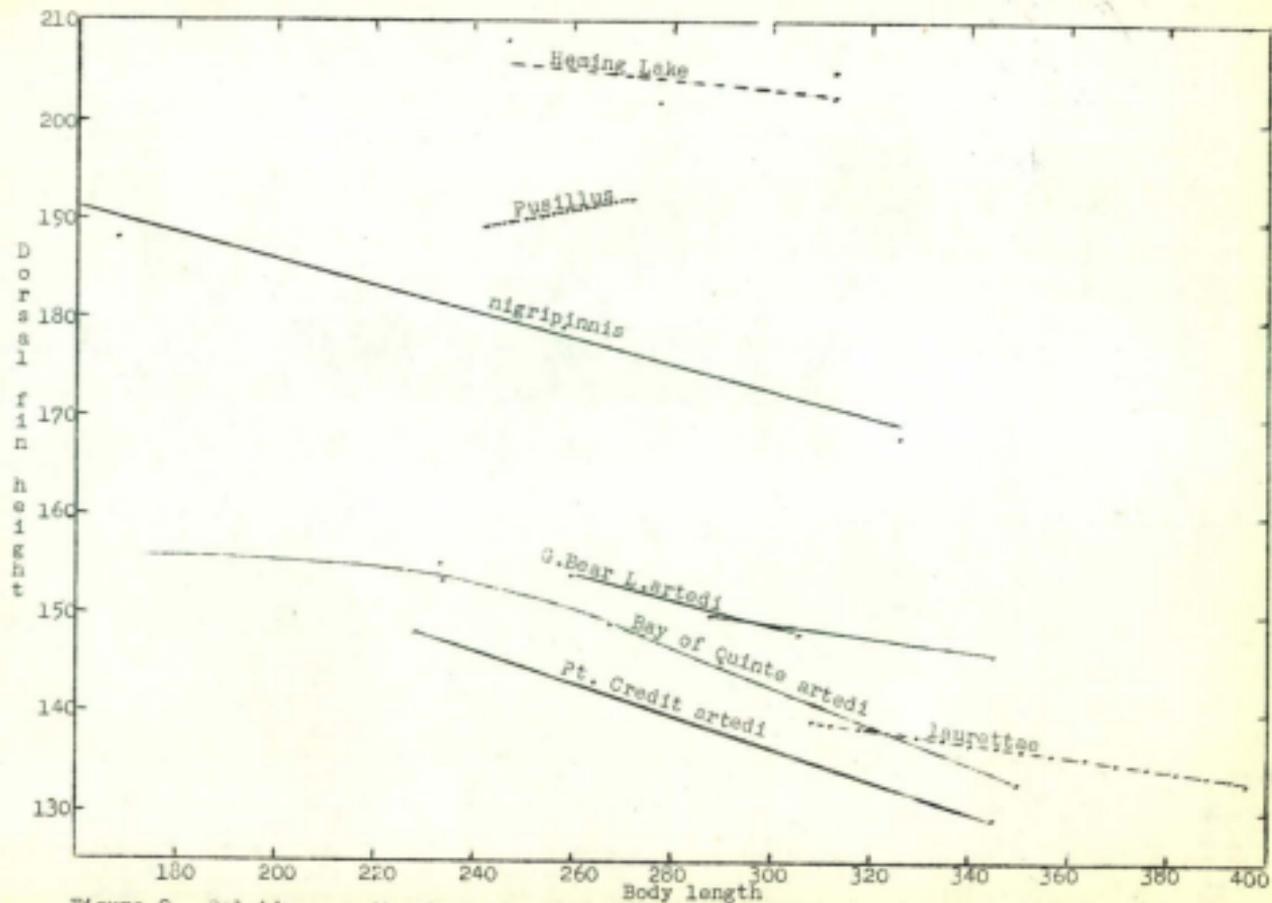


Figure 9. Relative growth of ciscoes.

