INSTITUTE FOR FISHERIES RESEARCH
UNIVERSITY MUSEUMS
UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

Report 278 April 2, 1935

STUDIES ON THE CISCO, *Leucichthys artedi* (Le Sueur) IN BLIND LAKE, WASHTENAW COUNTY, MICHIGAN

Blind Lake is situated in the southeast corner of Section 1 of Lyndon Township, Washtenaw County, Michigan. The lake is connected with Half Moon Lake by an artificially dredged channel about 200 yards long, 20 to 40 feet wide, and 2 to 4 feet deep. Half Moon Lake is also connected with Brewen Lake; these three lakes forming part of the headwaters of the Huron River. Prior to the recent dredging of the above mentioned channel, Blind Lake was connected with Half Moon Lake by a flooded marshy area. Local residents reported that the water in this marshy region was shallow but would permit fish to go from one lake to the other, at least at certain seasons.

Blind Lake has an area of approximately 50 acres. The long axis of the lake lies east and west. It is typically a marl lake having a shoal water area varying from 10 to 100 feet in width. *Chara* is the dominant vegetation type; *Nitella* and *Potamogeton* are present but less abundant. According to reports by local residents, a large portion of the lake has a depth of at least 60 feet. At the west end of the lake there is a well defined cove of about 5 acres in extent and a reported maximum depth of 25 feet. This cove is somewhat separated from the main part of the lake by a constriction of the shorelines, producing a broad channel-like connection which is about 30 feet wide and has a maximum depth of 10 feet. The dredged channel between Half Moon and Blind lakes enters Blind Lake at the distal end of this west bay. The collection of ciscoes, herein considered,was obtained entirely from this west bay.

The following information, of historical interest, was obtained from Mr. Howard F. Brooks of Chelsea, Michigan and Dr. Glenn R. Brooks of Rochester, Michigan. Both of these men have been well acquainted with the lake for many years. According to them, the lake has supported a large cisco population for at least the past 30 years. At present, night spearing for this fish by means of a boat and jack-light is popular among the local fishermen. The total catch by spear, of ciscoes from Blind Lake by local fishermen (few, if any, tourists engage) was estimated at about 400 fish yearly for the past 3 or 4 years. It has been the impression of these two men that the average size of ciscoes taken from Blind Lake has been increasing during recent years, and that the ciscoes taken from Half Moon and Brewen lakes are much larger than those from Blind Lake.

On December 1 and 2, 1934, the writers, together with Dr. G. R. Brooks, collected a series of ciscoes from the west bay of Blind Lake, employing both spears and gill nets. The gill nets were of an experimental type with various sizes of mesh. These nets were set continuously from 6 P.M. on December 1 to 8 P.M. on December 2. Specimens were taken by spear from 8 P.M. December 1 to 3 A.M. December 2, and from 6 to 8 P.M. December 2. A total of 152 ciscoes were obtained with the two types of gear. Spearing was found most productive from 7 to 10 P.M. in water 2 to 6 feet deep. Likewise the gill nets were most e ffective in shallow water and during the early part of the evening. That portion of the net, stretched across the shallow bar between the west bay and the main body of the lake, was very effective during the early part of the evening; the position of the fish in the net indicated that, at this time, the ciscoes were migrating in considerable numbers from the lake proper into the west bay.

Spearing for ciscoes is apparently very effective only when the fish are on or near the spawning grounds in shallow water. The spawning season in Blind Lake is said to extend over a period of 1 to 2 weeks. The vixit to Blind Lake on December 1 and 2 was not long after the beginning of the spawning season according to local reports. The concentration of the species in the shallow west bay was clearly related to spawning as was also the migration into the bay during the earlier part of the evening. What appeared to be the spawning act was observed several times between 8 and 11 P.M. on December 1.

A typical description of the behavior of a pair of fish in what we assumed to be the spawning act, is as follows. While looking downward into water of 15 feet or more in depth, we observed, about 5 feet below the water's surface, two fish, presumably a male and female, in the act of circling each other while swimming upward toward the water's surface. During this ascent the two fish, though constantly circling, remained more or less parallel with each other. Upon reaching the surface the two fish lay somewhat prostrate after which they independently descended. The depth at which these fish first began their upward swim was not determined because turbidity of the water made the visibility poor below a depth of 5 feet. If this was not the actual spawning act, it certainly must have been connected with the spawning behavior. However, Cahn (1927: 97), who observed the spawning of ciscoes in certain Wisconsin lakes, did not record these gyratory movements which we observed, for he states that "the female descends to within six or eight inches above the bottom as the eggs are deposited, the male following close behind and along side. .... The spawning fish does not cease swimming, with the result that the total egg complement is well scattered over a considerable area".

Of the 152 specimens collected by the two types of gear from Blind Lake, 130 were examined in the field immediately after their capture. The standard lengths (measured in a straight line from the snout to the base of the caudal peduncle) and total lengths (snout to tip of upper lobe of caudal fin) were measured to the nearest eighth of an inch. Scale samples were taken from the left side of the body, anterior to the dorsal fin. The sex, the general condition as to maturity, and the type of gear by which the specimen was taken, were recorded for each fish.

The remaining 22 specimens were immediately preserved in 10 per cent formalin, and after 4 days were transferred to alcohol. Measurements of total and standard lengths, sex and weight to the nearest gram, were determined for each fish about two months after their preservation; scale samples were also taken at this time. Both the standard and total lengths of the preserved specimens were corrected to allow for the shrinking effect of the preserving fluids, employing the corrective factor of 1.016 given by

Table I. Comparison of catch by two types of gear.

The average standard lengths in inches, based on the lengths of the fish when collected, are given for each age group of each sex for each type of gear.

Sex	Gear	Completed summers of life: I	II	III	IV	V	VI	VII	VIII	Average
Males	Spear	....	....	7.78	8.04	8.59	9.25	8.88	....	8.32
	No. of specimens	....	....	5	3	4	2	1	....	15
	Gillnet	....	7.00	7.87	8.14	8.54	8.90	9.47	10.54	8.37
	No. of specimens	....	1	10	44	25	5	7	1	93
Females	Spear	....	....	7.79	8.12	8.38	9.25	9.25	....	8.46
	No. of specimens	....	....	3	3	2	3	1	....	12
	Gillnet	5.21	6.93	7.78	8.14	8.36	....	11.0	....	8.05
	No. of specimens	1	2	5	16	7	....	1	....	32
Both sexes	Spear	....	....	7.78	8.08	8.52	9.25	9.06	....	8.38
	No. of specimens	....	....	8	6	6	5	2	....	27
	Gillnet	5.21	6.95	7.84	8.14	8.50	8.90	9.66	10.54	8.29
	No. of specimens	1	3	15	60	32	5	8	1	125

Van Oosten (1929: 273). No correction was made for the weights of the fish taken after preservation.

For age determination, scales from all fish were mounted in glycerine jelly and examined by means of a projecting machine. It was determined by projecting a stage micrometer with this machine, that no optical distortion was produced on the projecting field. The validity of the scale method for age determination of this species (L. artedi) was aptly demonstrated by Van Oosten (1929). Van Oosten also worked out, for this species, the most satisfactory known method of computing the size of the fish at the end of previous growing seasons, namely the following equation:

$$\frac{\text{Length of scale included in annulus of year X}}{\text{Total length of scale}} = \frac{\text{Length of fish at end of year X}}{\text{Length of fish at time of capture}}$$

The scale length was measured directly through the focus. In this formula the "length of fish at end of year X" is the unknown. The equation is repeated for each year of life for each fish. This method of length computation was employed in the present study.

It is assumed that the experimental gill nets took a random sample of the entire population of ciscoes present at that time in the west bay. If this is true then, as can be seen from Table I, the spear was not selective for any particular size limits within the spawning population; the average size of speared and netted males was practically the same; and the difference between the average size of speared and of netted females was probably not significant. However, this slight difference between the size of the netted and speared females, which suggests that the larger females can be speared more easily than the smaller, assumes more significance in view of the fact that 27 per cent of the females were collected by spearing while only 14 per cent of the males were taken by spear. Thus the data suggest that females are more easily speared than males and the larger females more readily speared than the smaller ones; one possible explanation for these differences is that spawn-laden or spent females are less agile than males, and the effects of either of these two conditions among the females would be more pronounced with increase in size. Disregarding the three small specimens (I and II group), the average size, and the distribution throughout the year classes, are about the same for all speared and all netted specimens

Table II. Length-weight relationship.

The table gives the individual weights for the 22 specimens (determined after being in the preserving fluid for two months). No corrective factor, for the change in weight due to the preservative fluids, has been used.

Standard length in inches	Total length in in.	Sex	Condition as to maturity	Completed summers of life	Weight in grams
5.21	6.22	female	immature	I	24
6.48	7.75	"	"	II	53
7.24	8.76	male	adult	III	84
7.37	9.02	"	"	IV	68
7.37	8.51	female	ripe	III	78
7.37	9.02	"	"	II	82
7.49	9.02	male	adult	III	79
7.62	9.14	"	"	IV	114
7.62	9.27	"	"	IV	91
7.62[1]	9.14	female	ripe	IV	89
7.75	9.27	"	"	IV	96
7.87	9.53	"	"	IV	104
8.00	9.40	male	adult	III	92
8.00	9.53	"	"	III	105
8.00	9.65	"	ripe	IV	90
8.13	9.65	female	"	III	200
8.76	10.67	male	"	VI	134
8.76	10.67	"	spent	V	150
9.02	10.67	"	"	V	164
9.02	11.05	"	adult	V	153
9.14	11.18	"	"	III	137
9.91	11.68	"	spent	VII	181

[1] This specimen contained 2,565 eggs (determined by actual count).

The conclusion seems appropriate (without placing undue emphasis on the slight size selectivity of the spear within the minority group of females) that spearing takes. A sample of the fish on the spawning grounds, which is fairly representative in size distribution, but which shows some preference for the female sex.

Since all but 5 of the 152 specimens were adult spawning fish, it appears that the immature fish do not mingle with the adults on the spawning beds.

The males in the collection far outnumbered the females—108 males and 44 females. This apparently aberrant sex ratio was most probably due to the collecting of these fish during the first part of the spawning season, at which time the males normally outnumber the females due to the earlier arrival of the males (see Van Oosten; and Cahn). Van Oosten (1929: 380) found a nearly equal ratio of the two sexes among 2,950 <u>L. artedi</u> from Lake Huron. Hile (in an unpublished report) notes a slightly higher percentage of females, than males for certain inland lakes of Wisconsin. Cahn (1927) however found a greater proportion of males in certain Wisconsin lakes (Cahn attributes this to a greater mortality of the females in late summer; his specimens may have been, in part, taken by sampling spawning populations where the males predominate).

The weights of the 22 preserved specimens are given in Table II and Figure 1. The great variation in the length-weight relationship is due to differences in sex, in stage of maturity, and in general body condition. The weight increases rapidly with increase in size.

The size frequency distribution of the sample is given in Table III; for this table the lengths were grouped for convenience into half-inch classes. However, all calculations on average lengths are based on the actual measurements, not on these frequency classes.

Since the entire collection was taken in December after the completion of the 1934 growing season, all average lengths can be considered in turns of completed growing seasons. The data on rate of growth, here presented, are composed of (1) the average empirical length for each age group, and (2) the average computed length. The average length, at the time the fish were collected of each age group of each sex is given as

Table III. Length distribution[1].

Only the actual body lengths of the fish at the time they were collected are used in this table. The measurements were taken to the nearest eightth of an inch. Those measurements which were taken after preservation were corrected by the shrinkage factor of +1.016.

Completed summers of life	Sex	Standard length frequencies													Total
		5.00 to 5.49	5.50 to 5.99	6.00 to 6.49	6.50 to 6.99	7.00 to 7.49	7.50 to 7.99	8.00 to 8.49	8.50 to 8.99	9.00 to 9.49	9.50 to 9.99	10.00 to 10.49	10.50 to 10.99	11.00 to 11.49	
I	Males	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Females	1	..	..	..	..	..	..	..	..	..	..	..	..	1
II	Males	..	..	..	..	1	..	..	..	..	..	..	..	..	1
	Females	..	..	1	..	1	..	..	..	..	..	..	..	..	2
III	Males	..	..	..	..	2	8	4	..	1	..	..	..	..	15
	Females	..	..	..	..	1	5	2	..	..	..	..	..	..	8
IV	Males	..	..	..	..	2	11	27	5	1	1	..	..	..	47
	Females	..	..	..	..	..	6	10	2	..	1	..	..	..	19
V	Males	..	..	..	..	..	..	12	12	4	..	1	..	..	29
	Females	..	..	..	..	..	..	6	3	..	..	..	..	..	9
VI	Males	..	..	..	..	..	..	1	4	..	2	..	..	..	7
	Females	..	..	..	..	..	..	1	..	1	..	1	..	..	3
VII	Males	..	..	..	..	..	..	..	3	1	3	1	..	..	8
	Females	..	..	..	..	..	..	..	..	1	..	..	..	1	2
VIII	Males	..	..	..	..	..	..	..	..	..	..	..	1	..	1
	Females	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Total	Males	..	..	..	..	5	19	44	24	7	6	2	1	..	108
	Females	1	..	1	..	2	11	19	5	2	1	1	..	1	44
	Both sexes	1	..	1	..	7	30	63	29	9	7	3	1	1	152

[1] Standard length in inches.

Table IV. Summary of the average standard body lengths in inches and the distribution of the two sexes, in each age group.

The averages for each age group are based only on the actual lengths of the fish when collected; no computed lengths for previous years are involved. The measurements were taken to the nearest eighth of an inch##; averages were figured to the nearest hundredth of an inch.

	Completed summers of life: I	II	III	IV	V	VI	VII	VIII	Averages and totals
Males	....	7.0	7.84	8.13	8.55	9.00	9.40	10.54	8.37
No. of specimens	....	1	15	47	29	7	8	1	108
Per cent of males in each year class	....	1	14	44	27	6	7	1	100
Females	5.21	6.93	7.78	8.14	8.36	9.25	10.13	....	8.16
No. of specimens	1	2	8	19	9	3	2	....	44
Per cent of females in each year class	2	5	18	43	20	7	5	....	100
Both sexes	5.21	6.95	7.82	8.13	8.51	9.08	9.54	10.54	8.31
No. of specimens	1	3	23	66	38	10	10	1	152
Per cent in each year class	1	2	15	43	25	7	7	1	101
Sex ratio: No. of males per female	....	0.5	1.9	2.5	3.2	2.3	4.0	....	2.45

Table VI. Rate of growth of the two sexes.

The average body length in inches of the two sexes of each year class at the conclusion of each growing season, arranged according to the respective growing seasons.(I, II, etc.). The final average for each sex of each year class is based on the actual length of the fish when collected. The grand averages give the average size of each sex at the end of the respective growing seasons; these averages are based on both computed lengths and actual lengths of the fish when collected.

Young of:	Sex	No. of specimens	Length at conclusion of growing season: I	II	III	IV	V	VI	VII	VIII
1934	Males	....	....	....	....	....	....	....	....	....
	Females	1	5.21	....	....	....	....	....	....	....
1933	Males	1	4.88	7.00	....	....	....	....	....	....
	Females	2	4.16	6.93	....	....	....	....	....	....
1932	Males	15	4.45	6.67	7.84	....	....	....	....	....
	Females	8	4.49	6.59	7.78	....	....	....	....	....
1931	Males	47	4.32	6.40	7.44	8.13	....	....	....	....
	Females	19	4.59	6.59	7.50	8.14	....	....	....	....
1930	Males	29	4.02	5.95	7.16	8.00	8.55	....	....	....
	Females	9	4.47	6.41	7.23	7.83	8.36	....	....	....
1929	Males	7	2.84	4.35	5.73	7.45	8.30	9.00	....	....
	Females	3	2.80	5.09	6.70	7.87	8.68	9.25	....	....
1928	Males	8	3.16	4.83	6.27	7.63	8.35	8.85	9.40	....
	Females	2	3.76	5.30	6.58	8.07	8.89	9.48	10.13	....
1927	Males	1	3.26	5.77	8.17	8.97	9.57	10.03	10.34	10.54
	Females	....	....	....	....	....	....	....	....	....

		I	II	III	IV	V	VI	VII	VIII
	Males	4.07	6.07	7.23	8.00	8.50	8.99	9.50	10.54
	No. of specimens	(108)	(108)	(107)	(92)	(45)	(16)	(9)	(1)
Grand	Females	4.38	6.41	7.39	8.03	8.51	9.34	10.13	....
	No. of specimens	(44)	(43)	(41)	(33)	(14)	(5)	(2)	....
Average	Both sexes	4.16	6.16	7.27	8.01	8.50	9.07	9.61	10.54
	No. of specimens	(152)	(151)	(148)	(125)	(59)	(21)	(11)	(1)

Table VII. Rate of growthin relation to the growing seasons.

The average body length of each year class at the conclusion of each growing season, arranged according to the respective growing seasons (I, II, etc.). The final average for each year class is based on the actual length of the fish when collected. The grand averages give the average size of all fish at the end of the respective growing seasons; these averages are based on both computed lengths and actual lengths of the fish when collected.

Young of:	No. of specimens	Length at conclusion of growing season: I	II	III	IV	V	VI	VII	VIII
1934	1 (♀)	5.21	....	....	....	....	....	....	....
1933	3	4.40	6.95	....	....	....	....	....	.....
1932	23	4.46	6.64	7.82	....	....	....	....	....
1931	66	4.40	6.45	7.46	8.13	....	....	....	....
1930	38	4.13	6.06	7.18	7.96	8.51	....	....	....
1929	10	2.83	4.57	6.02	7.58	8.41	9.08	....	....
1928	10	3.28	4.92	6.33	7.72	8.46	8.98	9.54	....
1927	1 (♂)	3.26	5.77	8.17	8.97	9.57	10.03	10.34	10.54
Grand Average		4.16	6.16	7.27	8.01	8.50	9.07	9.61	10.54
Number of specimens		(152)	(151)	(148)	(125)	(59)	(21)	(11)	(1)

Table VIII. Rate of growth in relation to the calendar years.

The average body length of each year class at the conclusion of each growing season arranged according to the year during which the growth was made.

Young of:	No. of specimens	Length at conclusion of growing season in the years:							
		1927	1928	1929	1930	1931	1932	1933	1934[1]
1934	1 (♀)	....	....	....	....	....	....	....	5.21
1933	3	....	....	....	....	....	....	4.40	6.95
1932	23	....	....	....	....	....	4.46	6.64	7.82
1931	66	....	....	....	....	4.40	6.45	7.46	8.13
1930	38	....	....	....	4.13	6.06	7.18	7.96	8.51
1929	10	....	....	2.83	4.57	6.02	7.58	8.41	9.08
1928	10	....	3.28	4.92	6.33	7.72	8.46	8.98	9.54
1927	1 (♂)	3.26	5.77	8.17	8.97	9.57	10.03	10.34	10.54

[1] The average lengths given for 1934 are based on the actual lengths of the fish when collected; lengths for all previous years were computed on the basis of scale diameters.

standard length in inches in Table IV, and as total length in inches in Table V. There is no apparent sex difference in rate of growth. The IV-, V- and II-groups were, respectively, the dominating year classes on the spawning grounds.

Table V. Summary of the average total lengths (length of body plus tail) in inches in each age group for each sex of the Blind Lake ciscoes

	Completed summers of life								Average for all specimens
	I	II	III	IV	V	VI	VII	VIII	
Males	....	8.00	9.32	9.67	10.12	10.85	11.18	12.63	9.94
Females	6.22	8.39	9.18	9.65	9.85	11.04	12.00	....	9.67

The computed and empirical lengths averaged together (Table VI) likewise give no indication of a consistently significant sex difference in growth rate. Thus the data for the two sexes are combined and given in Tables VII and VIII. The average length attained at the end of each growing season by each year class is given according to the growing season (I, II, etc.) in Table VII and Figure 2, and according to the year (1927, 1928, etc.) in Table VIII. It is evident from these tables that the rate of growth of certain year groups was much greater than others. The young of 1929[1] had a very poor growth during their first year, for which there was a gradual compensation during later years. Further, the tables indicate a gradual increase, among specimens hatched in succeeding years, in the growth attained during corresponding seasons, i.e., there is a general trend, from 1927 to 1934, toward an increase in size at the end of the first year, and this general trend is quite constant for subsequent growing seasons.

There are several possible explanations for this increase, within consecutive year classes, in average length at the end of the same growing season:

[1] According to Pritchard (1930 and 1931), the eggs of L. artedi hatch in the spring, in April or May, following the spawning season.

1. The fish may be actually growing faster each year due to better environmental conditions. Consistent spearing may have been one of the factors which sufficiently reduced the population to allow more rapid growth. This explanation of increased growth, seems to be the most valid one, and receives confirmation from the observations of the local fishermen as they state that the average size of the Blind Lake ciscoes have been increasing during the past few years.

2. A greater mortality among more rapidly growing fish would tend to leave only the more slowly growing fish of each of the older year classes. Although there is no evidence to support this explanation, it is worthy of consideration.

3. There is always, in collecting material, the possibility that the gear is selective. The general coincidence in size distribution of the speared and netted specimens, and the fact that various sizes of mesh were contained in the gill nets, considerably discredit this explanation.

4. An error may be involved by computing the size at the end of previous growing seasons by the direct proportion method, i.e., Lee's phenomenon--that, if the direct proportion method is used, lengths calculated for a given year from scales of young fish are greater than lengths calculated for the same year from scales of the same fish when older--may apply to this species. Van Oosten (1929) recognizes the possible errors involved in uncorrected computed lengths, but he found the direct proportion method to be the most reliable one until the body-scale ratio is determined more definitely.

A general trend of growth rate is perhaps best obtained by averaging, for all fish, the computed and actual lengths at the conclusion of corresponding (first, second, etc.) growing seasons (see bottom of Table VII). The summarized growth rate trend of the Blind Lake ciscoes is compared to published data on growth of <u>L. artedi</u> in Table IX. Data on lengths from the various localities, given in this table, are not exactly comparable, for the Blind Lake specimens were collected at the end of the growing season, while many of the specimens from other localities had an added portion of the growing season, during which they were collected, which is not included by the indicated age.

Table IX. Rate of growth of ciscoes (Leucichthys artedi)[1] from various localities.

In this table are summarized published data on rate of growth of this fish. The Blind Lake data is converted to millimeters for comparison

Age in years	Saginaw[2] Bay	Oconomowoc[3] Lake, Wiscon-sin	Pine Lake,[3] Wis-consin	Lake[4] Erie	Lake[5] Ont-	Indian[6] Village Lake, Indiana	Hudson[7] Bay	Blind[8] Lake
5 mos.	....	62	....	....	....	....	....	....
I year	127	....	....	75	129	....	....	106
II	185	135	125	125	196	260	184	156
III	218	174	162	160	226	301	214	185
IV	235	223	195	190	233	316	284	203
V	244	282	246	215	253	342	290	216
VI	258	315	283	235	270	336	308	230
VII	274	336	314	255	297	374	324	244
VIII	292	362	330	275	303	....	336	268
IX	....	374	338	285	358	....	....	....
X	....	386	345	....	345	....	....	....

[1] The various cisco populations compared in this table represent several subspecies of artedi. In most of the original reports from which these data were obtained, the authors were not definite in designating the specific subspecies, a circumstance which is undoubtedly the result of the present dilemma in coregonid systematics. Probably subspecific or racial potentialities are factors as potent as are variations in environmental conditions in affecting the great diversity in rate of growth within the species.

[2] Saginaw Bay, Lake Huron. Van Oosten (1929: 374, Table 43). Uncorrected computed averages and actual lengths combined, employing 2,315 specimens.

[3] Based on actual body lengths only, of 1,199 Oconomowoc Lake specimens and 537 Pine Lake specimens. From Cahn (1927: 102, Table 25).

[4] Based on actual body lengths of 55 specimens. From Clemens (1922: 35).

[5] Based on actual body lengths. From Pritchard (1931).

[6] These specimens were caught towards the end of, or after, their last growing season; thus they are nearly a year older than indicated. Data on three lakes combined. From Hile (1931), Tables XXXIV, XXXV, XLII, XLIII, and XLVII.

[7] Actual lengths of 61 specimens. Dymond (1933: 10).

[8] Averages of computed and actual lengths of all Blind Lake ciscoes.

Thus the average size of the age groups of the Blind Lake ciscoes should be somewhat greater if a fair comparison is to be made. These comparative data show that the rate of growth of the Blind Lake ciscoes is about average.

An examination of approximately 50 of the 152 Blind Lake ciscoes indicated a 100 per cent infestation of the larval form of the tape worm Triaenophorus robustus Olss in the flesh of these fish. These larval cysts are about 1/4 inch in length, and being about the same color as the flesh of the fish, are not easily seen. They, therefore, are probably not noticed by the fishermen. The adults of this worm are found in the pike (Esox lucius) which is a common species in Blind Lake. The pike becomes infested by eating the ciscoes. Local fishermen report that the stomachs of pike caught during the summer contain mostly small ciscoes. Man is not susceptible to infestations of this parasite, and, since not easily detected by the layman, the presence of the worm does not detract from the value of the fish. There is, however, the probability that this heavy infestation does inhibit, to some extent, the growth and general welfare of cisco.

Literature cited

Cahn, Alvin Robert. 1927. An Ecological Study of Southern Wisconsin Fishes. The Brook Silversides (Labidesthes sicculus) and the Cisco (Leucichthys artedi) in their relation to the Region. Ill. Biol. Monographs. Vol. XI, No. 1; 1-151, January, 1927.

Clemens, Wilbert A. 1922. A Study of the Ciscoes of Lake Erie. Univ. of Toronto Studies. Biol. Series, No. 20: Pub. of Ont. Fish Res. Lab., I-IX, No. 2: 25-37, 1922.

Dymond, J. R. 1933. Biological and Oceanographic Condition in Hudson Bay. 8. The Coregonine Fishes of Hudson and James Bays. Contr. Canad. Biol. and Fish., Vol. VIII, No. 1 (Series A, General, No. 28). Toronto.

Hile, Ralph. 1931. Investigations of Indiana Lakes. 2. The Rate of Growth of Fishes of Indiana. Dept. of Consv., State of Indiana. Pub. by Div. of Fish and Game. Pp. 7-55, 1931.

______ (in manuscript form) Age and Growth of the Cisco (Leucichthys artedi Le Sueur) in the lakes of Northeastern Highlands, Wisconsin.

Pritchard, Andrew L. 1930. Spawning Habits and Fry of the Cisco (Leucichthys artedi) in Lake Ontario. Contrib. to Canad. Biol. and Fish., being Studies from Biol. Sta. of Canad., N.S., Vol. VI, No. 9, 1930: 227-240.

Pritchard, Andrew L. 1931. Taxonomic and Life History Studies of the Ciscoes of Lake Ontario. Univ. Toronto Studies. Biol. Series. No. 35; Pub. Ont. Fish. Res. Lab., XLI, p. 1-78.

Van Oosten, John 1929. Life History of the Lake Herring (Leucichthys artedi Le Sueur) of Lake Huron as Revealed by its Scales, with a Critique of the Scale Method. Bull. U. S. Bur. Fish., Vol. XLIV, 1928. Doc. No. 1053.

INSTITUTE FOR FISHERIES RESEARCH

Gerald P. Cooper

Gerald P. Cooper and R. W. Eschmeyer

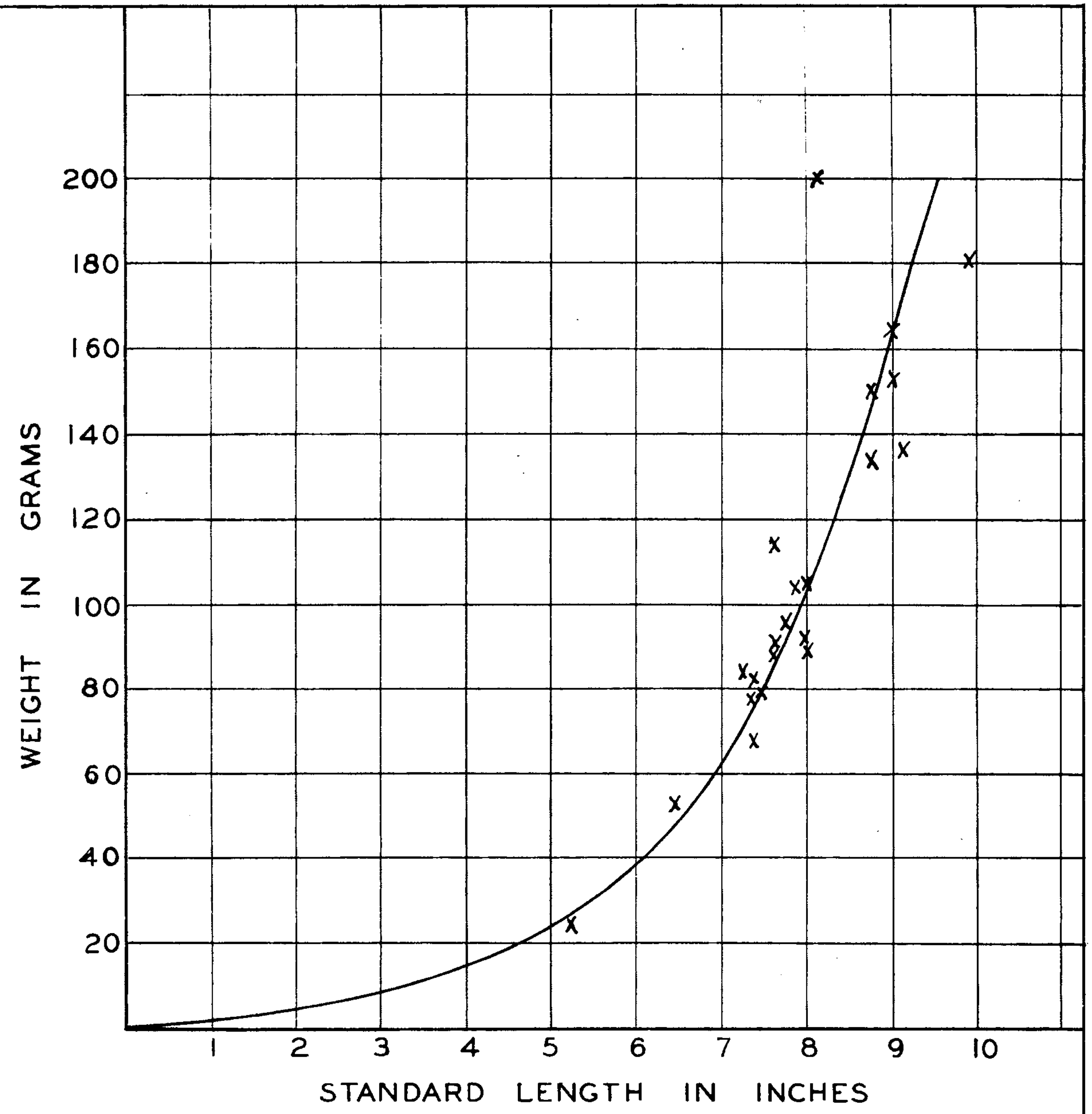

FIG. I. LENGTH-WEIGHT CURVE FOR BLIND LAKE CISCOES. DATA FROM TABLE II

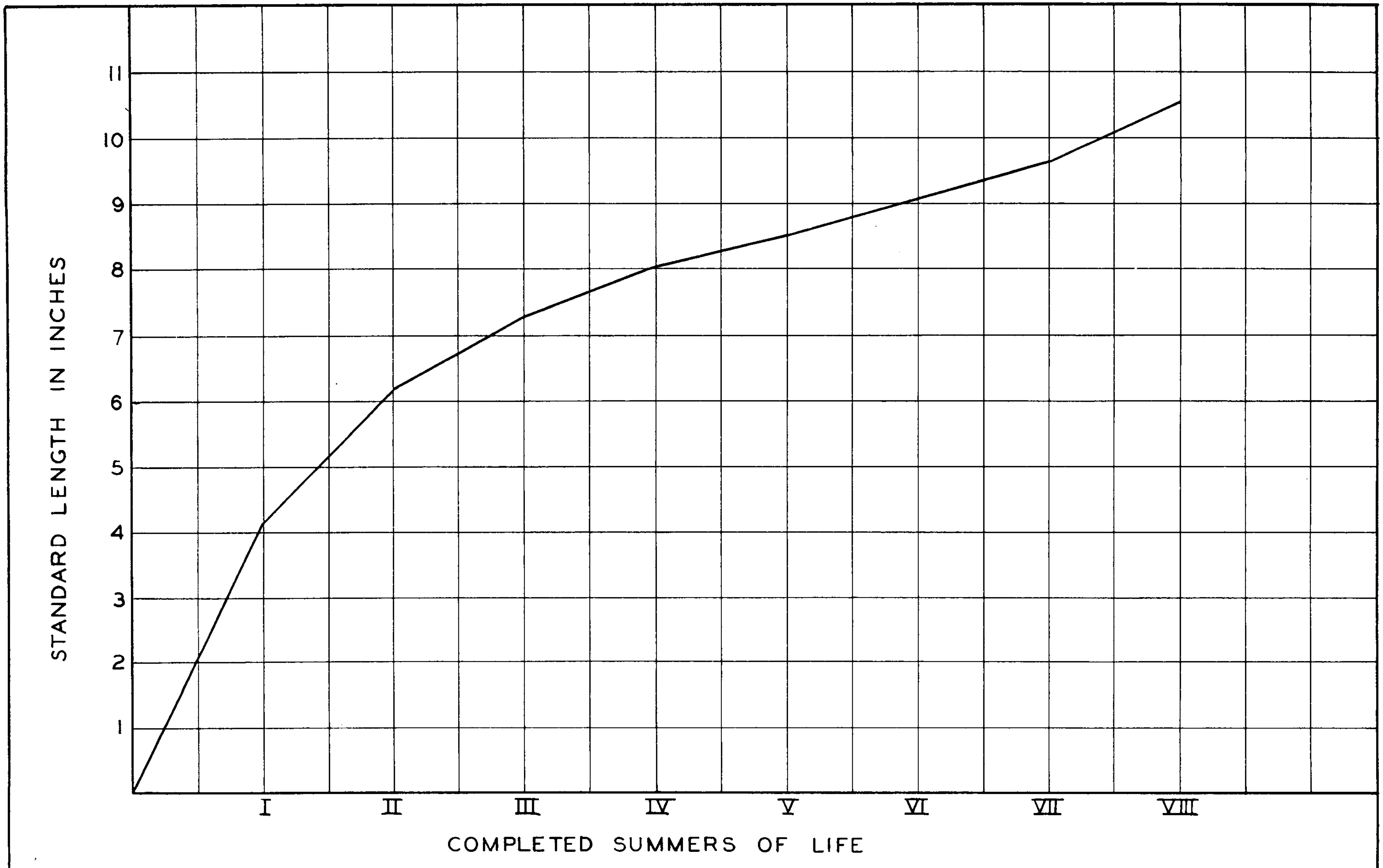

FIG. 2. GROWTH RATE OF BLIND LAKE CISCOES. DATA FROM TABLE VII