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A PRELIMINARY REPORT ON THE ECOLOGICAL REQUIREMENTS AND LENGTH OF LARVAL LIFE OF SEA LAMPREY AMMOCOETES

By

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The sea lamprey, Petromyzon marinus, may be responsive to control measures during three phases of its life history: (1) the spawning migration of sexually mature lampreys, (2) the downstream migration of recently transformed individuals, and (3) the non-parasitic larval stage (Applegate, 1950). Current control measures are designed to exploit the first; however, the inherent possibilities and advantages of a program which would be directed against the stream-dwelling ammocoetes made it appear that an intensive study of the larval stage might be profitable. Promising new discoveries in larvicide research have given added impetus to the search for more data concerning this stage of the sea lamprey's life history.

A survey was conducted during the summer and fall of 1955 to secure additional data on the larval stage of sea lampreys. A total of 111 stations on 16 river systems were studied from July 5 to November 5, 1955 (Table 1). The survey was made in an attempt to resolve the following problems: (1) extent of sea lamprey escapement from

Table 1.--Northern Michigan streams surveyed for sea lamprey ammocoetes, 1955

Stream system	Drainage	County	Number of stations surveyed	Type of weir	Dates of survey
Carp Lake River[1]	Lake Michigan	Emmet and Cheboygan	10	Mechanical	July 5-14
Chocolay River	Lake Superior	Marquette	8	Electrical	July 21-Aug. 26
Sucker River	Lake Superior	Alger	14	Electrical	July 25-Aug. 4
Hurricane River	Lake Superior	Alger	2	Electrical	do
Seven Mile Creek	Lake Superior	Alger	2	None	do
Rock River	Lake Superior	Alger	13	Electrical	Aug. 5-23
Bay Furnace	Lake Superior	Alger	6	Electrical	do
Miner's Creek	Lake Superior	Alger	2	Electrical	do
Hog Island Creek	Lake Michigan	Mackinac	4	None	Aug. 29-Sept. 16
Davenport Creek	Lake Michigan	Mackinac	4	None	do
Paquin Creek	Lake Michigan	Mackinac	6	None	do
Cut River	Lake Michigan	Mackinac	3	None	do
Huron River	Lake Superior	Baraga	15	Electrical	Oct. 4-12
Silver River	Lake Superior	Baraga	4	Electrical	do
Black River	Lake Michigan	Mackinac	10	Mechanical	Oct. 18-26
Two-Hearted River	Lake Superior	Luce	8	Electrical	Oct. 31-Nov. 5
Total	...	...	111	...	...

[1] Includes Mud Creek, Cheboygan County.

mechanical and electro-mechanical barriers, (2) length of the non-parasitic larval period, (3) effect of the barriers on reproduction of anadromous species of fish, especially rainbow trout, (4) optimum and marginal ecological requirements of sea lamprey ammocoetes, and (5) location of streams used by sea lampreys and a determination of their physical characteristics.

This paper is confined largely to a discussion of the length of larval life and ecological requirements of sea lamprey ammocoetes in the eastern part of the Upper Peninsula.[1]

Methods

Because one of the primary considerations of the field work was lamprey escapement through weirs, the majority of the stream systems for this survey are tributaries of Lake Superior in the central and eastern Upper Peninsula which support lamprey runs and on which control devices have been installed (Table 1). Stations on a specific stream system were selected to give a complete coverage within the limits imposed by accessibility. In general, the stations on any particular stream were located not less than two miles apart.

Thirty-one collections were made with an alternating-current shocker and 80 with a direct-current shocker on 16 streams, 6 of which are tributary to Lake Michigan and 10 of which are tributary to Lake Superior. The D. C. shocker generated 10.9 amperes at 230 volts; the A. C. shocker generated 4.5 amperes at 110 volts. A

[1] The Carp Lake River, located in the northern tip of the lower Peninsula, is included.

small plywood boat was used to transport the motor whenever there was a sufficient volume of water. On very small streams or at stations where conditions prohibited the floating of the boat, a 200-foot rubber-coated extension cord was used.

In general, standard stream survey techniques were employed in this survey (Hazzard, Brown, and Cooper, 1950).[2] At each station approximately one hour was spent collecting ammocoetes and fish. One crew composed of Martin J. Hansen, William Ward, and Albert Vincent surveyed 82 of the stations; the remaining stations were worked by Institute biologists and district fisheries supervisors. A crew consisted of three men; two operated the positive electrodes and captured stunned fish with scap nets, while the third towed the boat and tended the lines. Standard shocking procedures were used to capture fish and a special effort was made to capture lamprey ammocoetes. Occasionally the methods used to capture free-swimming fish sufficed for the collections of ammocoetes; however, in general the techniques used in collecting ammocoetes differed somewhat from those used in the capture of other fish. When searching for ammocoetes the functional ends of the electrodes, suspended several inches above the bottom, were moved very slowly over the stream bed. In some locations it was necessary to hold the electrodes motionless for several minutes before the ammocoetes would emerge from their burrows. Silt beds formed in eddies along the stream edges were especially productive of ammocoetes. As much as 30 minutes could sometimes be spent profitably in one location gathering larvae.

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[2] Hazzard, A. S., C. J. D. Brown, and G. P. Cooper, 1950. Institute for Fisheries Research Inventory Methods, Institute for Fisheries Research, 33 pp. (mimeographed).

Ammocoetes are agile swimmers, adept at escaping when the electric field is removed; consequently, the removal of the electrodes from the water was avoided while working a silt bed. Disturbance of the fine sediments comprising the larval habitat resulted in lowered visibility, often making it difficult to capture the ammocoetes. In order to reduce this turbidity to a minimum, it was customary to progress against the current. Fine-mesh (bobbinet) scap nets which retained lampreys down to a length of 1 inch, were most suitable for this type of collecting.

Field observations indicated that the D. C. shocker was superior to the A. C. shocker for collecting ammocoetes. The A. C. shocker appeared to exert a greater paralyzing effect, seeming to stun many of the larvae in their burrows, and thus lowering the percentage of recovery. On the other hand, it appeared that the ammocoetes were less apt to be rendered helpless by the D. C. current; the effect was essentially stimulating rather than paralyzing and therefore more likely to cause their emergence from the silt beds.

Physical data for all collection stations were recorded. Station lengths were measured with a 100-foot steel tape. At least one photograph was taken of a representative portion of each station. Ammocoetes and forage fish were preserved in 10 percent formalin. Scale samples and measurements were taken from the game fish collected.

In the laboratory the ammocoetes were identified, counted and measured to the nearest 0.1 inch. Transformed individuals (adults) were not included in the count. Specimens with eyes and whose mouth parts showed at least partial transformation were classified as adults. The separation of the genus Ichthyomyzon from the genera Petromyzon and Lampetra was not difficult; the larger ammocoetes with one continuous dorsal fin (Ichthyomyzon) could easily be distinguished from those with two distinct dorsal fins (Petromyzon and Lampetra). For larvae less than two inches long the distinction between these two groups was made by counting myomeres (Hubbs and Lagler, 1947, and Vladykov, 1950). The various species of Ichthyomyzon were not identified.

The techniques used for distinguishing American brook lamprey ammocoetes from sea lamprey ammocoetes were derived from Vladykov (op. cit.), as follows:

(1) On the sea lamprey the black pigmentation on the extreme end of the caudal fin extends from the trunk to the extremity of the caudal rays. The dark pigmentation on the American brook lamprey in the same region is typically more intense, covers a much smaller area, and does not extend to the end of the caudal rays.

(2) Sea lampreys possess a larger pigmented area in the head region than do the American brook lampreys. The chromatophores in the sea lamprey extend down almost to the lower edge of the upper lip, whereas the brook lamprey has a distinct, unpigmented area on the lower edge of the lip.

(3) The American brook lampreys have a rather sharp line of demarcation between the heavily pigmented side and the nearly unpigmented ventral surface; this character is less evident on the sea lamprey.

(4) In general, the over-all color pattern of sea lamprey ammocoetes makes them appear darker than American brook lampreys.

Of the characters listed above, the first and second proved to be the most useful in our identifications, although items (3) and (4) were utilized when identification was difficult. The characteristic pattern of pigmentation in the caudal region was especially evident in the larger ammocoetes, but not as evident in the smaller (1- to 3-inch) individuals. In the identification of small sea lampreys, where the tail pigmentation appeared to be less reliable as an identifying feature, more reliance was placed on the second and fourth characters. Our observations indicated that the third character was less valuable than the others as a criterion for the separation of the two species.

Admittedly, the gross characteristics of different species of larval lampreys, especially those under 2 inches in length, are similar enough to make identifications relatively difficult. However, it is believed that the combined taxonomic characters are completely reliable, and that a high degree of accuracy was achieved in our identifications.

Duration of Larval Life

Applegate (op. cit.) estimated that the length of the larval life of sea lampreys varied from 41 to 47 months, with the possibility that this might be followed by a 12-month rest period. He based his estimate on an analysis of length-frequency data. In an extensive collection of ammocoetes from the Ocqueoc River he was able to identify several different size classes which presumably indicated distinct age groups. He substantiated the identities of the younger age groups by later collections. The identity of age-group 0 was established by observing the growth of newly hatched larvae through their first growing season. Age-group I was clearly identified from a collection made in May of the following year before the new age-group 0 had appeared. A frequency polygon was constructed from data obtained from this collection which demonstrated a pronounced length group (23.0 to 43.0 millimeters), taken to be age-group I (age-group 0 of the preceding year). Age-groups II and III were tentatively identified, although the balance of the frequency distribution did not reveal definite modes which might represent older age groups.

Gage (1928) estimated that the length of the larval life was at least 4, and probably 5 years. He also based his estimate primarily on length-frequency distribution.

Stauffer[3] postulated that the duration of larval life possibly exceeds 4 years and that it may be as long as 8 or more years. His estimate was based on data collected during the operation of the Black River and Carp Lake River lamprey weirs and on the length frequencies of ammocoetes collected above both barriers. In July 1955 a special effort was made to determine the reason for the continued presence of sea lamprey ammocoetes in the Carp Lake River above the weir, after upstream-migrating adult sea lampreys presumably had been blocked for 6 consecutive years. Two possible explanations were proposed: (1) recruitment to the population, either over the weir or from a resident population of sea lampreys in Carp Lake, or (2) a longer larval life than previously estimated.

Although the data were conflicting in many respects and made analysis difficult, Stauffer stated that a longer larval life may be the explanation of the continued presence of sea lamprey ammocoetes in Carp Lake River. This belief was based on the following findings: (1) smaller size groups were absent (Fig. 1) from Carp Lake River collections (indicating that age groups present in the stream were older than age-group 0 and age-group I), (2) no evidence of spawning was observed in 1955 (this tended to support a statement by Applegate--personal communication--who had been in charge of the weir since its construction, that there has been no escapement since 1949), and (3) the similarity

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[3] Stauffer, Thomas M., 1955. An investigation of the continued capture of downstream-migrating recently transformed sea lampreys in the downstream trap of a weir on Carp Lake River, Emmet County, 1955. Institute for Fisheries Research Report No. 1474, (MS).

between length-frequency data collected at the Black River weir (an effective barrier since 1951, except for 1953 when there was a small escapement) and length-frequency data from the Carp Lake River. Length-frequency distributions from the Black River also demonstrated an absence of the smaller size groups.

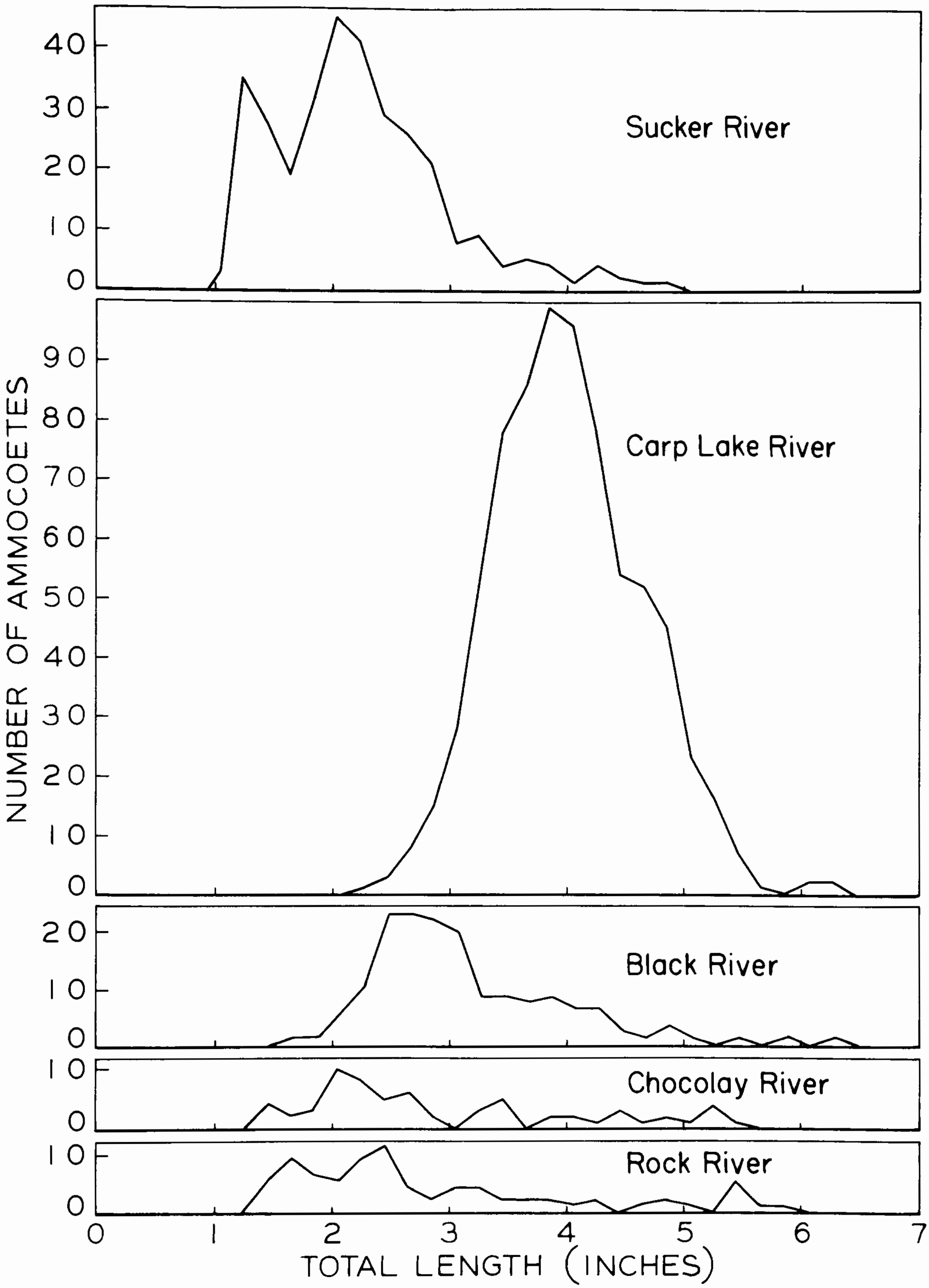
Data obtained during the present study which might prove useful for determining the duration of larval life consisted of length frequencies for larval sea lampreys in other streams (Table 2; Figs. 1 and 2). Only five watersheds produced enough sea lamprey ammocoetes to justify plotting (Fig. 1), and enough ammocoetes for an adequate sample were collected at only three individual stations (Fig. 2). The only collections in which year classes could be identified were from the Sucker River (both Station SR 12 and the Sucker River as a whole). Plotting of the length frequencies revealed a definite peak at 1.2-1.3 inches for both Station SR 12 and the Sucker River as a whole. The size group represented by this peak was assumed to be age-group I. The second peak for Station SR 12 was between 2.0 and 2.8 inches; for the Sucker River as a whole it occurred at 2.0-2.1 inches. The second peak was judged to represent age-group II. Beyond this age group, our length-frequency data show no distinct modes.

Failure of other writers and the authors to conclusively establish the duration of larval life of the sea lamprey by analysis of length-frequency data could perhaps be due to intermixing of ammocoete populations from different parts of the stream where growth rates may differ. A downstream migration of ammocoetes occurs in Carp Lake River (Applegate and Brynildson, 1952). Also, a movement of ammocoetes has been observed at night in the Chocolay River by Alberton McLain

Table 2.--Length-frequency distribution of sea lamprey ammocoetes from watersheds surveyed in 1955

Total length (inches)	Stream system											
	Carp Lake River	Chocolay River	Sucker River	Rock River	Miner's River	Hog Island Creek	Paquin Creek	Huron River	Silver River	Black River	Two Hearted River	Total
1.0-1.1	..	..	3	..	..	..	..	2	..	..	..	5
1.2-1.3	..	..	35	..	..	..	..	..	1	..	..	36
1.4-1.5	..	4	28	5	..	..	..	..	..	..	..	37
1.6-1.7	..	2	19	9	1	..	..	..	..	1	2	34
1.8-1.9	..	3	31	6	..	1	..	..	1	1	2	45
2.0-2.1	..	10	45	5	1	..	..	..	2	..	..	63
2.2-2.3	1	8	41	9	2	1	..	..	..	10	1	73
2.4-2.5	3	5	29	11	2	..	..	..	..	22	..	72
2.6-2.7	8	6	26	4	..	1	..	1	1	22	..	69
2.8-2.9	15	2	21	2	2	..	..	..	1	21	..	64
3.0-3.1	28	..	8	4	3	..	..	..	..	19	..	62
3.2-3.3	53	3	9	4	..	..	..	1	1	8	1	80
3.4-3.5	78	5	4	2	2	..	..	..	..	8	..	99
3.6-3.7	86	..	5	2	2	..	1	..	..	7	..	103
3.8-3.9	99	2	4	2	..	..	..	..	..	8	..	115
4.0-4.1	96	2	1	1	1	..	..	..	1	6	..	108
4.2-4.3	78	1	4	2	..	1	..	..	..	6	..	92
4.4-4.5	54	3	2	..	..	..	1	..	1	2	..	63
4.6-4.7	52	1	1	1	1	1	..	..	..	1	..	58
4.8-4.9	45	2	1	2	..	..	..	..	1	3	..	54
5.0-5.1	23	1	..	1	..	..	..	..	1	1	..	27
5.2-5.3	16	4	..	..	..	..	..	..	1	..	..	21
5.4-5.5	7	1	..	5	..	..	..	..	2	1	..	16
5.6-5.7	1	..	..	1	..	..	..	..	1	..	..	3
5.8-5.9	..	..	..	1	..	..	..	..	..	1	..	2
6.0-6.1	2	..	..	..	..	..	..	..	..	..	..	2
6.2-6.3	2	..	..	..	..	..	..	..	..	1	..	3
Total	747	65	317	79	17	5	2	4	15	149	6	1407

Figure 1.--Length-frequency distribution of sea lamprey ammocoetes from five watersheds surveyed in 1955 (all stations combined).



Sucker River
Carp Lake River
Black River
Chocolay River
Rock River
NUMBER OF AMMOCOETES
TOTAL LENGTH (INCHES)

Figure 2.--Length-frequency distributions of sea lamprey ammocoetes from the three largest individual collections made in 1955.

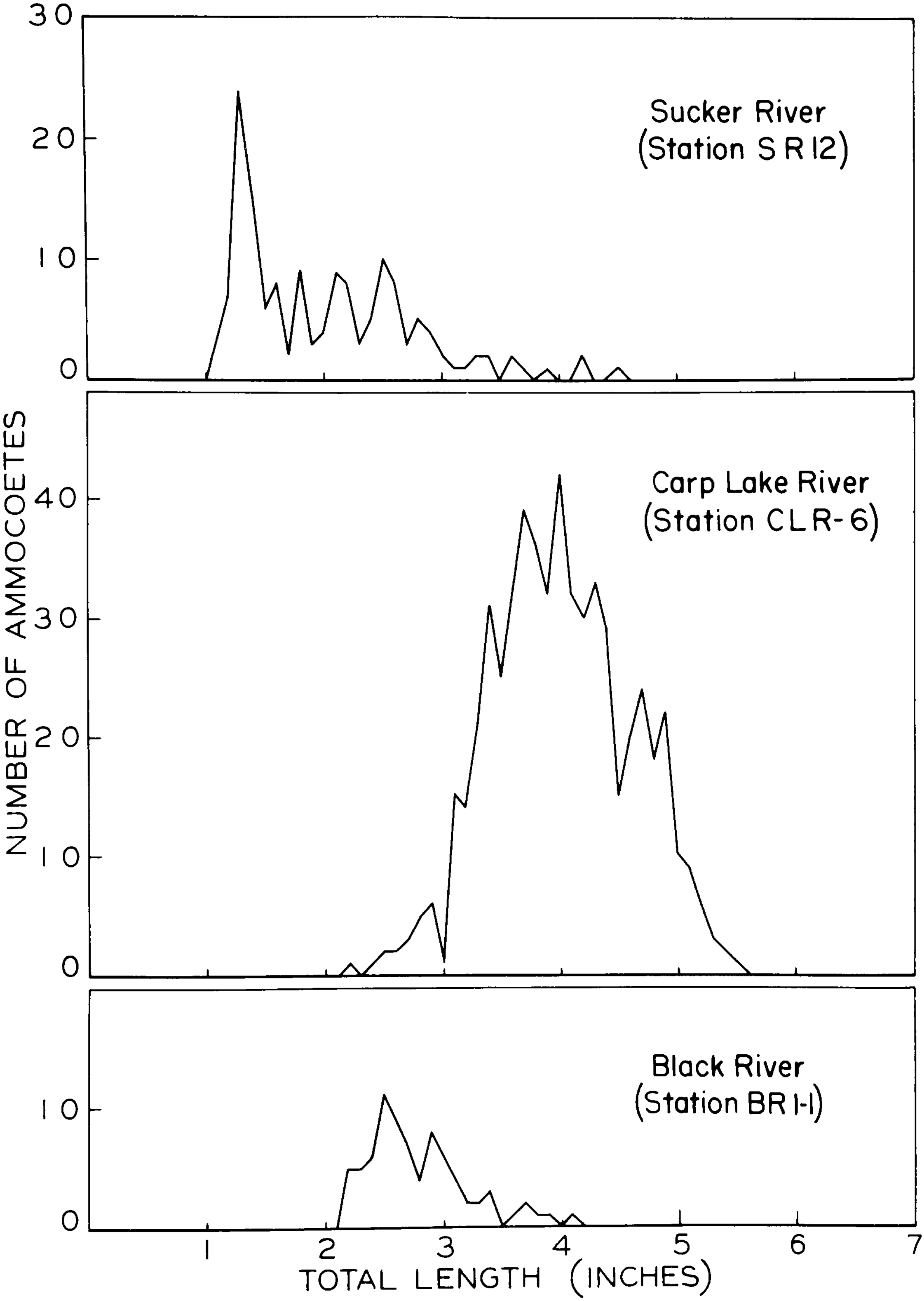

Sucker River
(Station S R 12)
Carp Lake River
(Station CLR-6)
Black River
(Station BR 1-1)
NUMBER OF AMMOCOETES
TOTAL LENGTH (INCHES)
0
10
20
30
40
1
2
3
4
5
6
7

Table 3.--The abundance and occurrence of sea lamprey ammocoetes, as related to stream depth, width, and volume (all collections, 1955)

Item	Stations where ammocoetes were: Absent		Present		Number of stations	Number of ammocoetes per hour per station
	Number	Percentage	Number	Percentage		
Average depth (inches)						
0-6	31	76	10	24	41	3.9
7-12	20	53	18	47	38	19.3
>12	13	41	19	59	32	4.3
Total stations	64	..	47	..	111	..
Average width (feet)						
0-9	26	87	4	13	30	4.5
10-30	28	47	31	53	59	15.6
>30	10	46	12	54	22	4.4
Total stations	64	..	47	..	111	..
Average volume (c.f.s.)						
0-9	43	73	16	27	59	9.2
10-30	17	50	17	50	34	6.1
>30	4	22	14	78	18	15.6
Total stations	64	..	47	..	111	..

Sea lamprey ammocoetes were most plentiful at average depths of 7 to 12 inches, average widths of 10 to 30 feet, and at stations with a flow of more than 30 c.f.s. Thus, in general, sea lamprey ammocoetes were most commonly found and were most abundant in the larger waters.

The population of sea lamprey ammocoetes was greater in main-stream than in tributary waters. Larvae were present in 56 percent of 68 collections from main-stream waters and were taken at the rate of 26.4 per hour per station. In tributary waters, they occurred at only 21 percent of the 43 stations and were collected at an average rate of only 2.9 per hour. Ammocoetes were found in tributary waters in only 2 (Black and Two Hearted rivers) of the 16 stream systems studied.

The following suggestions are offered as possible reasons for the greater abundance of sea lamprey ammocoetes in larger or main-stream waters: (1) the size of the stream reflects temperature (an analysis of temperatures and volumes showed that 46 percent of the stations having flow volumes up to 9 c.f.s. had temperatures greater or less than the optimum [see following section], whereas only 8 percent of the stations with a flow of 10 c.f.s. and over had temperatures outside the optimum range; thus, perhaps optimum temperatures are more likely to be found in the larger waters.); (2) the downstream-migrating tendency of ammocoetes in Carp Lake River as mentioned by Applegate (1950) may tend to concentrate them in the lower and consequently larger waters; and (3) adults may prefer the larger waters for spawning.

Water temperature.--Water temperatures recorded at all stations surveyed between July 1 and September 22, 1955, are summarized in Table 4. Discrepancies due to seasonal and diurnal variation in temperature are undoubtedly present, but it is believed that they do not appreciably affect the conclusions.

Table 4.--Abundance and occurrence of sea lamprey ammocoetes as related to water temperature, July 1-September 22, 1955

Temperature Range (°F.)	Stations where ammocoetes were: Absent		Present		Number of stations	Number of ammocoetes per hour per station
	Number	Percentage	Number	Percentage		
40-49	7	78	2	22	9	0.2
50-59	10	83	2	17	12	0.3
60-69	16	53	14	47	30	6.9
70-79	9	45	11	55	20	37.5
> 79	2	67	1	33	3	1.7
Total stations	44	...	30	...	74	...

Ammocoetes were most often found and their abundance was greatest at stations with water temperatures between 60° F. and 79° F. (Table 4). By far the greatest catch per hour was in streams with a temperature range of 70° F. to 79° F. The data suggest that water temperature is a factor of prime importance in distribution of sea lamprey ammocoetes. Applegate (verbal communication) noted that adult sea lampreys migrating to spawning grounds avoid the colder streams. Presumably this accounts for the marked reduction in number of ammocoetes at temperatures below 60° F.

Bottom types.--Applegate (1950) showed that sea lamprey ammocoetes are most commonly located in soft bottom types which contain a combination of silt and sand, with silt predominating. Our field observations confirm his findings. Species determination was not attempted at the time of collection, so species requirements could not be established accurately by direct field observation. However, since most ammocoetes were taken from soft bottoms, and since sea lamprey ammocoetes were identified from these collections, the sea lamprey's best habitat was judged to be a soft bottom comprised of a mixture of sand and silt in varying proportions.

When the data were analyzed to determine the relationship between various combinations of bottom types and sea lamprey ammocoete distribution, it was found that sea lamprey ammocoetes were more abundant at stations with a heterogeneous bottom (composed of soft and hard types, each an entity in itself) than at stations with homogeneous (either soft or hard) bottoms (Table 5). Sea lamprey ammocoetes were present at 47 percent of the stations with a combination soft and hard bottom and at 37 percent of the stations, with a soft bottom only, but were not present at stations with only hard bottom. Stations with a heterogeneous bottom (both hard and soft) produced 12.7 lampreys per hour as contrasted to 3.4 from stations containing soft bottom only.

Table 5.--Abundance and occurrence of sea lamprey ammocoetes as related to bottom type (all collections, 1955)

Bottom type	Stations where ammocoetes were: Absent		Stations where ammocoetes were: Present		Number of stations	Number of ammocoetes per hour per station
	Number	Percentage	Number	Percentage		
Soft (silt, silty sand, and sand)	22	63	13	37	35	3.4
Soft and hard, in combination	38	53	34	47	72	12.7
Hard (gravel and rubble)	4	100	0	0	4	0.0
Total number of stations	64	...	47	...	111	...

The size of the ammocoete population (which utilizes soft bottom) may be dependent on the size of the spawning run of mature sea lampreys which require hard bottom. Therefore, a direct relationship between the ammocoete population and the extent to which the stream bottom is varied might possibly be expected.

Velocity.--Measurements of velocity were averaged for each station, i.e., stations classified as sluggish may have had some rapid water, and conversely, those classified as rapid may have contained sluggish stretches. Consequently, flow velocity data (Table 6) indicated little difference in the frequency of occurrence of sea lamprey ammocoetes between stations with sluggish velocity (less than 0.5 foot per second) and those where the velocity was rapid (over 0.5 foot per second). Stations with torrential current were too few to warrant detailed consideration. The density of ammocoetes appeared to be somewhat greater at stations where the velocity was classified as sluggish. They were found commonly in slack water near the stream banks, in pools, or in eddies. Applegate (op. cit.) stated that typical larval habitat was usually "...situated in backwaters, eddies, sloughs, or along the inside of bends in the river where sluggish current or slack water existed."

Color.--The determination of water color was not as accurate as could be desired, since it was made visually and there was a high degree of variation in color determination by different crew leaders. The admittedly inadequate data tend to suggest, however, that sea lamprey ammocoetes were least abundant at stations with dark brown water (Table 6).

Aquatic vegetation.--Sea lamprey ammocoetes were more likely to occur and were most plentiful at stations where aquatic plants were

Table 6.--Abundance and occurrence of sea lamprey ammocoetes as related to velocity, color, aquatic vegetation, and pools (all collections, 1955)

Item	Stations where ammocoetes were:				Number of stations	Number of ammocoetes per hour per station
	Absent		Present			
	Number	Percentage	Number	Percentage		
Velocity of water						
sluggish	22	50	22	50	44	14.6
rapid	41	63	25	37	65	6.0
torrential	1	50	1	50	2	0.6
Total stations	64	...	47	...	111	...
Color of water						
colorless	28	56	22	44	50	8.1
light brown	19	56	15	44	34	17.4
dark brown	17	63	10	37	27	1.3
Total stations	64	...	47	...	111	...
Aquatic vegetation						
absent	31	62	19	38	50	4.4
rare	24	49	25	51	49	15.5
common	9	75	3	25	12	4.7
Total stations	64	...	47	...	111	...

rare (Table 6). However, ammocoetes were quite frequently collected from small clumps of Ranunculus spp. which held silt and silty sand from being washed away by the current.

Species Associated with Sea Lamprey Ammocoetes

Sea lamprey ammocoetes were most commonly found (as shown by percentage of occurrence) with Ichthyomyzon spp., American brook lampreys, white suckers, and longnose dace, in that order (Table 7). The density of sea lamprey ammocoetes was highest at stations where Ichthyomyzon spp., mudminnows, American brook lampreys, longnose dace, or blacknose dace were one of three dominant species. The two methods of analysis substantiate each other in that both show Ichthyomyzon spp. in the first position, and that, in both, American brook lampreys and longnose dace are in the group of four species most commonly associated with sea lamprey ammocoetes. Although sufficient stations containing American brook lamprey ammocoetes and longnose dace were sampled for a reasonably valid analysis, more samples are needed from stations where Ichthyomyzon spp. and mudminnows are present.

An inverse relationship is apparent between abundance of brook trout and slimy sculpins and abundance of sea lamprey ammocoetes. Sea lamprey ammocoetes were absent at 84 percent of the stations where brook trout were one of the three most abundant species, and at 71 percent of the stations where slimy sculpins were one of the three most abundant species. Among species for which an adequate sample was obtained, sea lamprey ammocoetes were least dense at stations where brook trout and/or slimy sculpins were abundant.

A similar table (not presented) compiled for only the Lake Superior drainage showed similar results.

Table 7.--Species of fish associated with sea lamprey ammocoetes, all stations, 1955

Species[1]	Occurrence of other species at stations where ammocoetes were:				Number of stations where species was one of three most abundant	Average number of ammocoetes collected per hour per station
	Absent		Present			
	Number	Percentage	Number	Percentage		
Ichthyomyzon spp.	0	0	7	100	7	60.8
American brook lamprey	17	33	35	67	52	18.6
White sucker	3	38	5	62	8	5.0
Longnose dace	8	44	10	56	18	17.4
Northern mottled sculpin	19	48	21	52	40	6.3
Western blacknose dace	16	53	14	47	30	13.6
Creek chub	6	54	5	46	11	3.1
Central mudminnow	6	60	4	40	10	50.5
Brook stickleback	6	60	4	40	10	1.9
Etheostoma spp.	3	60	2	40	5	1.2
Rainbow trout	30	62	18	38	48	1.4
Slimy sculpin	17	71	7	29	24	0.9
Yellow perch	5	71	2	29	7	7.3
Brook trout	31	81	7	19	38	0.7

[1] Brown bullheads, largemouth bass, northern redbelly dace, northern pearl dace, brown trout and rock bass were occasionally dominant at stations where sea lamprey ammocoetes were found, but the number of such occurrences were too few to warrant inclusion in this table.

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INSTITUTE FOR FISHERIES RESEARCH

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