LIFE HISTORY AND DISTRIBUTION OF THE ARCTIC LAMPREY (LENTHENTERON JAPONICUM (MARTENS)) OF GREAT SLAVE LAKE, N.W.T.

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LIFE HISTORY AND DISTRIBUTION OF THE ARCTIC LAMPREY (LETHENTERON JAPONICUM [MARTENS]) OF GREAT SLAVE LAKE, N.W.T.

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ABSTRACT

Of 26 rivers investigated which are tributary to Great Slave Lake, ammocoetes of the arctic lamprey were found only in the Mackenzie, Hay and Slave. The ammocoetes population of the Hay River was studied most thoroughly. Population estimates of ammocoetes were attempted, but are considered to be very low. Adult lampreys are concentrated in the west basin of Great Slave Lake. Spawning takes place chiefly in late June and early July. Mean egg count of 18 specimens was 21,415. Transformation of the ammocoetes begins in late summer and continues through the winter. Immature adults disperse into the lake in late spring and early summer. Sexual maturation is believed to take place in the lake during the following winter. Four year-classes, based on length-frequency distribution of ammocoetes were established. The adult is believed to live one year, thus giving a five-year life span to the arctic lamprey of Great Slave Lake. The lamprey preys on lake whitefish, cisco, inconnu, lake trout, and longnose sucker. Predators of the arctic lamprey include burbot, pike, and reportedly walleye and inconnu. Gulls are reported to eat lampreys caught in the Fort Smith water intake reservoir.

INTRODUCTION

Information about the biology of *Lethenteron japonicum* (Martens), the arctic lamprey, in Canada, is not abundant, being restricted to comments of early Arctic explorers, and more recent notes published by Rawson (1951), Walters (1953, 1955), Wilimovsky (1954), McPhail and Lindsey (1970). The arctic lamprey has been reported from the Mackenzie River, the Anderson River, the Yukon River, Great Slave Lake and Artillery Lake.

In 1966 a study of the arctic lamprey was initiated by the Fisheries Research Board of Canada at Great Slave Lake, N.W.T. Great Slave Lake lies between latitude 61° and 63°N and longitude 109° and 117°W in the District of Mackenzie, N.W.T. The east arm and north shore are in Precambrian rock while the west basin and much of the south shore are in the Mackenzie Lowlands. The total area of Great Slave Lake is 10,500 square miles and maximum depth in the east arm is 614 meters (2,015 feet). In the basin west of longitude 113°W the mean depth is 41 meters, whereas in Christie Bay of the east arm mean depth is 249 meters (Rawson, 1950). The distribution of arctic lamprey is affected by the different conditions of west basin and east arm of the lake.

METHODS

Both ammocoete larvae and adult lampreys were studied. During the summers of 1966 and 1967, 25 rivers entering Great Slave Lake and the Mackenzie River were examined for the presence of ammocoetes, by means of 110 volt AC electrofishing gear. The number of ammocoetes captured was 3,076. The rivers shown in Fig. 1 were those fished for ammocoetes.

The capture of adult lampreys is more difficult. All adults from Great Slave Lake were obtained from commercial fishermen. A reward was offered for every adult turned in, with information on time and place of capture. Adults were also obtained from an inlet reservoir at the water treatment plant in Fort Smith on the Slave River, N.W.T. (July 8, 1967). A total of 112 mature and 78 newly transformed lampreys were examined.

In addition, 15,502 fish from the commercial fishery, the FRBC experimental fishery, or caught by other means, were examined for lamprey

scars. The stomach contents of 1,283 piscivorous fish were examined for the presence of lampreys.

Trapnets were used in the Hay River from June 23 to August 9, 1967, to capture lampreys migrating to spawning grounds. This technique captured only two adults and 10 ammocoetes.

DISTRIBUTION IN GREAT SLAVE LAKE

a) Ammocoete distribution

Ammocoetes were found only in the Slave, Hay and Mackenzie rivers, all of which connect to the west basin of Great Slave Lake.

The rivers of the east arm are extremely clear with rocky bottoms. Many have waterfalls near their mouths. The lack of suitable ammocoete habitat, in the form of beds of silty mud in quiet backwaters, is probably the major reason for the failure of lampreys to exploit the rivers of the east arm region. It was not possible to confirm reports of lampreys spawning in the Artillery Lake region (Walters, 1955).

Many rivers entering the west basin are very shallow and probably freeze into the bottom during winter, which may inhibit their colonization by ammocoetes.

Few creeks suitable for spawning occur along the west shore of Great Slave Lake. The charts for this region are largely incomplete or inaccurate.

The Buffalo and Little Buffalo rivers of the south shore of the west basin appear to be suitable for ammocoetes, although none were found there. Perhaps unusually high sulphate concentrations (40 to >300 ppm) inhibit lamprey entry.

Ammocoetes were found in the Mackenzie River, the outlet of Great Slave Lake, both near Big Island at its origin, and downstream about 47 miles (ca. 75 Km) near Fort Providence. Although the Mackenzie appears to be used as a spawning stream, it is probable that not many ammocoetes make their way to Great Slave Lake, but most are distributed downstream. Ammocoetes which escaped capture and moved into the main current of any of the rivers were unable to make progress against the current; this is undoubtedly important in the distribution of the animal. It seems safe to conclude that the Hay and Slave rivers are the main sources of

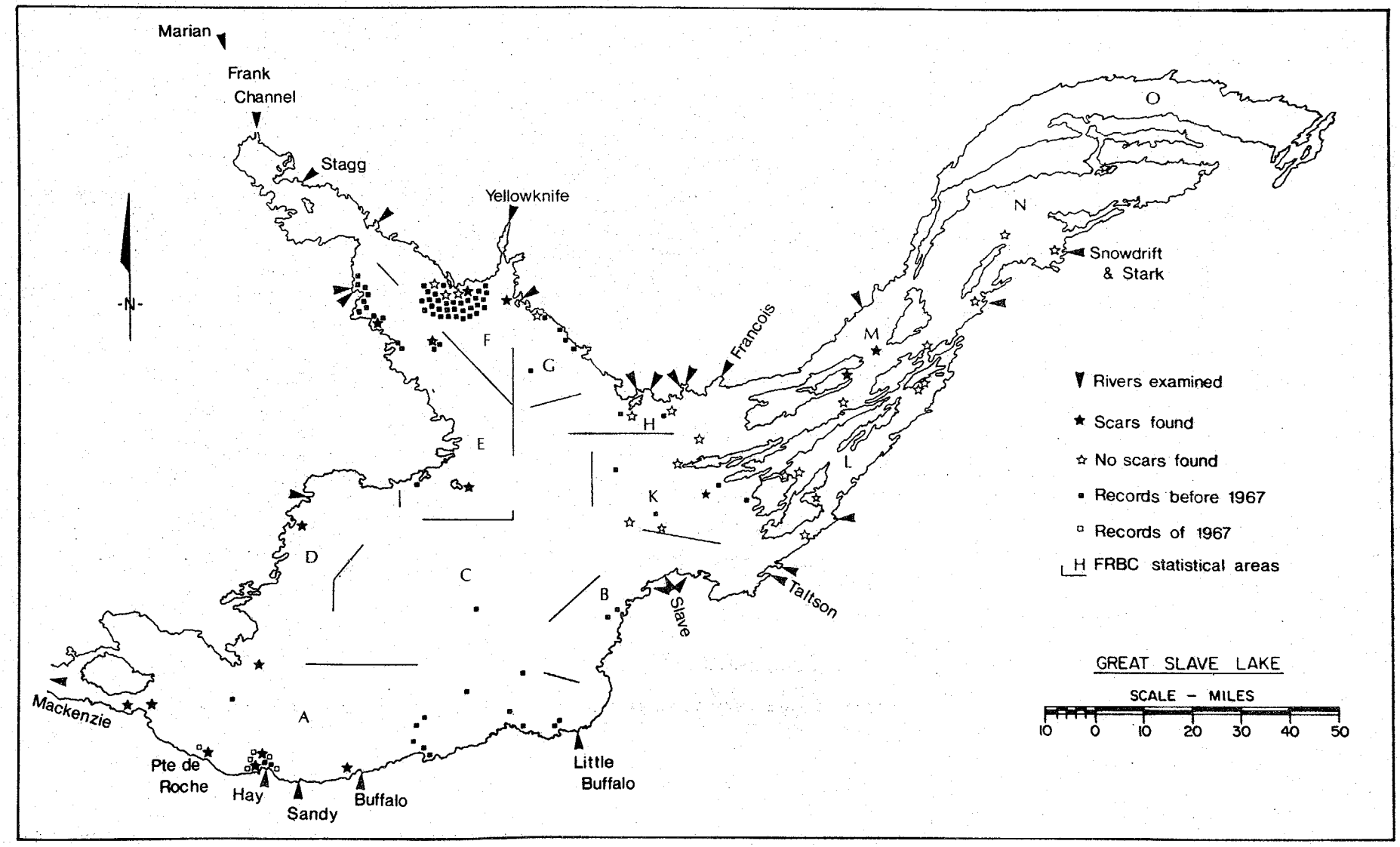

Fig. 1 Great Slave Lake, showing locations of rivers examined for ammocoetes, sites of adult lamprey captures in 1967, and in years previous, and sites of fish collections examined for lamprey scars.

recruitment to the lamprey population of Great Slave Lake. Ammocoetes were found as far upstream in the Slave River as Fort Smith.

A detailed study of ammocoete distribution in the Hay River was made during the summer of 1967. Fig. 2 shows the locations of ammocoete beds examined there.

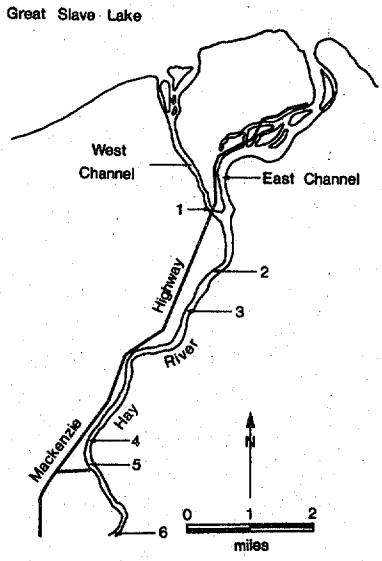

Fig. 2 The lower reaches of the Hay River, showing the locations of ammocoete beds 1-6.

It is our opinion that ammocoete beds are concentrated within the lower 20 miles (32 Km) of the Hay River. The Louise and Alexandra falls form an impassable barrier about 45 river miles (72 Km) upstream. Between the falls and Bed 7 (about river mile 18; Km 29) there is little suitable substrate for the larvae. The smallest ammocoetes obtained were captured at Bed 6, at about river mile 10 (ca. 16 Km) from the river mouth. As will be described below, ammocoetes tend to move downstream as they mature.

Another observation of interest is that ammocoete beds are frequently well-developed in silty areas downstream from man's activities, e.g., where silt accumulates as a result of upstream road or bridge-building.

b) Ammocoete numbers

An attempt was made in 1967 to estimate the ammocoete population in the Hay River. Specimens were marked with subcutaneous injections of cadmium sulphide, mercuric sulphide or lampblack, following the procedure of Hansen and Stauffer (1964). Position and color of the marker were used to code for location of capture. The technique was not difficult and the ammocoetes were released within a few hours of capture.

Specimens were marked on ammocoete beds 2, 3, 5, and 7 (Fig. 2). In each case marking was done within a five-day period. Recaptures were made throughout the summer.

Population estimates are based upon Bailey's formula (Ricker, 1958, p. 84, Eqn. 3.7):

$$N = M\,(C + 1)\,/R + 1$$

where M is the number of fish marked, R is the number recaptured, and C is the number of specimens in the sample from which the recaptured fish are taken. Table 1 shows the results obtained.

The 95% confidence limits were obtained as suggested by Ricker (1958) using the chart of Clopper and Pearson (1934). However, here the limits must be taken as being less reliable than suggested, for the returns were so small that the chart had to be read very close to its origin, where estimates become very rough owing to short distances between lines.

On August 26, 1967, an attempt to gain a further idea of ammocoete density on a bed was made, when water receded from Bed 7. A count was made of openings to ammocoete burrows over six square meters. The number of holes recorded per square meter were: 284, 188, 38, 111, 89 and 114, for an average value of 137. It is not possible to define the limits of a bed of ammocoetes clearly, nor is it possible to be certain that the entire bed is sampled in recapture tests.

An estimate of the area of exposed Bed 7 was made at the time ammocoete burrow openings were counted. It should be noted that observations in aquaria show that the number of burrow openings very closely reflects the number of ammocoetes present. The approximate area of Bed 7 was 48 m^2. Using 137 as the mean number of burrows per square meter, we have a calculated ammocoete population of 6,576. This is nearly 2.9 times the

Table 1. Population estimates from mark- and -recapture experiments with ammocoetes in the Hay River, 1967.

Bed No.	Date of Marking	No. Marked (M)	No. Sampled (C)	No. Recaptured (R)	Population Estimate (N)	95% Confidence Limits
2	May 24-28	83	85	0	7138	2099 - ∞
3	May 26-30	157	276	4	8698	4483 - 10607
5	July 3- 4	113	543	9	6147	2833 - 11384
7	June 21	110	187	8	2298	1388 - 5589
	Total	463	1091	21	22982 (calc)	18519 - 30829

population estimated for Bed 7 from mark- and -recapture tests and is, indeed, beyond the 95% confidence limits for that estimate.

Attempts to extend the population estimates further are fruitless, since the number of ammocoete beds is unknown. Certainly our total represents much less than half the ammocoetes of the Hay River.

c) Distribution of adult lampreys

Fig. 1 shows the distribution of adult lampreys captured in Great Slave Lake and distribution of fish bearing lamprey scars. It is clear that the lamprey population is concentrated in the west basin. Adults have been collected for several years from the commercial fishery. Not all areas of the lake have been fished with equal intensity. Certain areas are closed when catch quotas are filled. Areas near settlements are closed to commercial fishing, to allow a domestic fishery for food and dogfood. McLeod Bay is closed to allow a sport fishery there. The central part of the west basin is seldom fished commercially, and the western part of the west basin, north of the Mackenzie River, usually is not fished after early July.

The specimens recorded in the north arm were captured mainly during 1964, but fishermen comment that lampreys are commonly caught there in the late summer fishery each year. Attempts to locate spawning areas in the north arm were futile despite much effort; electrofishing in Stagg River, Yellowknife River and Frank Channel revealed no ammocoetes.

Dogrib Indians at Fort Rae reported adults from Marion Lake.

The southern limit of distribution found in this study was at Fort Smith, on the Slave River, as noted above. The 31 adult specimens captured there were all individuals in spawning condition.

LIFE HISTORY

Many studies have shown that most lampreys have similar life histories. All known species spawn in fresh water. Spawning usually takes place in shallow water over a gravel stream bottom, with the adults dying shortly after. The ammocoete larvae hatch in a few weeks and drift downstream to settle in eddies and backwaters. Here they burrow into mud to filter feed on aquatic microorganisms ie. desmids, diatoms. After a

number of years, the larvae undergo a metamorphosis (here called transformation) to emerge as adult lampreys. They then leave the ammocoete beds and move downstream into oceans or lakes, or else the adults remain in the stream.

At this time the life histories of parasitic and non-parasitic species diverge. Parasitic lampreys feed as adults. Eventually they mature, and return to streams to spawn.

Non-parasitic lampreys do not feed as adults. They mature rapidly and spawn. Usually sexual development is advanced at the time of transformation from ammocoete. In the European brook lamprey (*Lampetra zanandreai* Vladykov) metamorphosis and sexual maturity are coincident (Zanandrea, 1961).

Changes which can be noticed in maturing lampreys are:

1. The teeth become blunt and ineffective for feeding.
2. The intestine becomes small and non-functional.
3. The gonads fill the coelom.
4. The female develops a large anal fin.
5. A prominent genital papilla often appears in the male.

Although two mature specimens were captured in trapnets in the Hay River in June 1967, and 31 were captured in the Slave River at Fort Smith in the reservoir at the inlet of the water treatment plant in July 1967, at no time were lampreys found in the act of spawning, nor were spawning grounds identified.

One Hay River specimen, captured June 14, 1967, was a female which had spawned. It had blunt teeth, a well-developed anal fin and a few large eggs in the coelom. It was 168 mm long.

The second Hay River specimen, captured June 27, 1967, was a male with a well-developed gonad. The teeth were blunt. Its length was 226 mm.

The Slave River specimens, all apparently ready to spawn, were collected July 8, 1967. How long they had been trapped in the inlet reservoir is not known.

Fig. 3 shows the width of the intestine of adult lampreys captured at different times of the year. June-July specimens had much smaller guts.

The smallest ammocoetes captured were taken from Bed 6 in the Hay River (Fig. 2) on July 11, 1967. There were two specimens each 12 mm in

length. Comparison with data from Great Lakes *Petromyzon marinus* (Applegate, 1951; Lennon, 1955; McCauley, 1963) suggests that ammocoetes of this size may be from three to six weeks old.

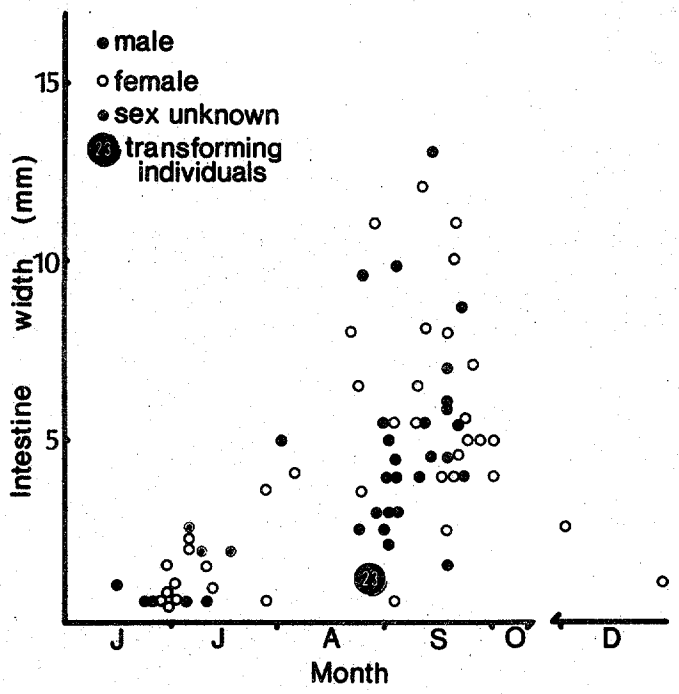

Fig. 3 The intestinal width of adult lampreys at different times of year. The large mark represents a group of 23 individuals undergoing transformation from ammocoetes to adults.

Heard (1966) reports spawning of the arctic lamprey in the Naknek River of Alaska between May 28-July 2. This river system is within a few degrees of the latitude of Great Slave Lake.

These data suggest that spawning of the Great Slave Lake arctic lamprey takes place chiefly in late June and early July. This conclusion is supported by examination of sexual development in adult lampreys.

In Great Slave Lake, the sex ratio of adult lampreys is close to 1:1 (Table 2).

Table 2. The sex ratio of adult lampreys in the Great Slave Lake region.

Location	No. examined	No. Male	No. Female	Ratio
Great Slave Lake	72	33	39	1:1.18
Hay River	6	3	3	1:1
Slave River	31	19	12	1:0.63
Total	109	55	54	1:0.98

Adult lampreys taken from the north arm of Great Slave Lake are found there only in late August and September, despite summer-long fishing pressure. These specimens are large, many exceeding 300 mm in length, have engorged guts, and sexually identifiable gonads which are small.

The winter fishery seldom provides lamprey specimens. Two specimens were taken near the Simpson islands in a December catch. Both show gonadal enlargement and intestinal degeneration. If these specimens are typical of adult arctic lamprey in the winter, the paucity of winter specimens may be partly explained by cessation of feeding, so that fewer are attached to fish and subject to capture by fishermen.

SEXUAL DEVELOPMENT

The sexual condition of all adults was recorded, using the method of Vladykov and Mukerji (1961), in which seven stages may be recognized, progressing from zero (when sex is not distinguishable) to six (postspawning). Fig. 4 relates the adult sexual condition to the time of capture. It is to be noted that most specimens at stage 5, ready for spawning, were captured in late June and early July, which is the postulated time of

spawning.

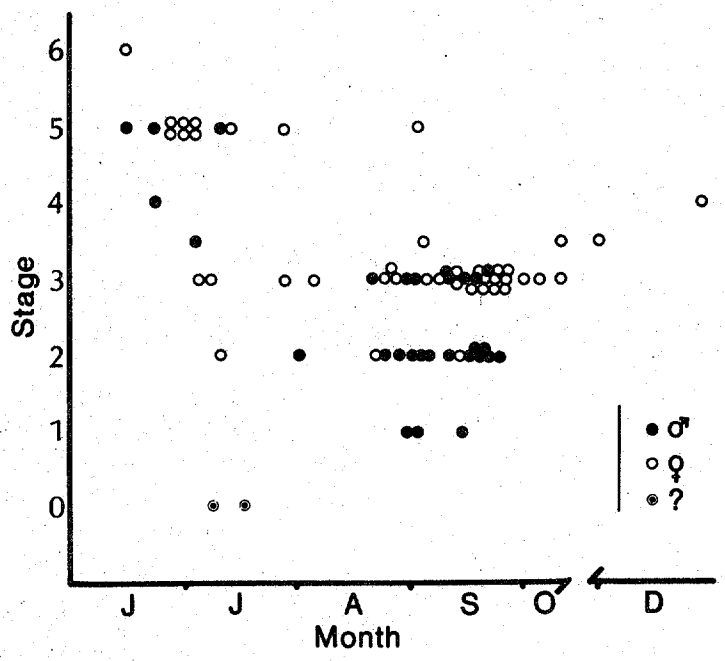

Fig. 4 The sexual condition of adult lampreys recorded at time of capture according to the method of Vladykov and Mukerji (1961). Stage 0: Immature condition; Stage 1 and 2: Early development of gonads; Stage 3: Mid-point of development of gonads; Stage 4: Pre-spawning; Stage 5: Spawning; Stage 6: Post-spawning.

Testis and ovary weights, taken as percentages of total body weight also show their largest values in June and July (Fig. 5).

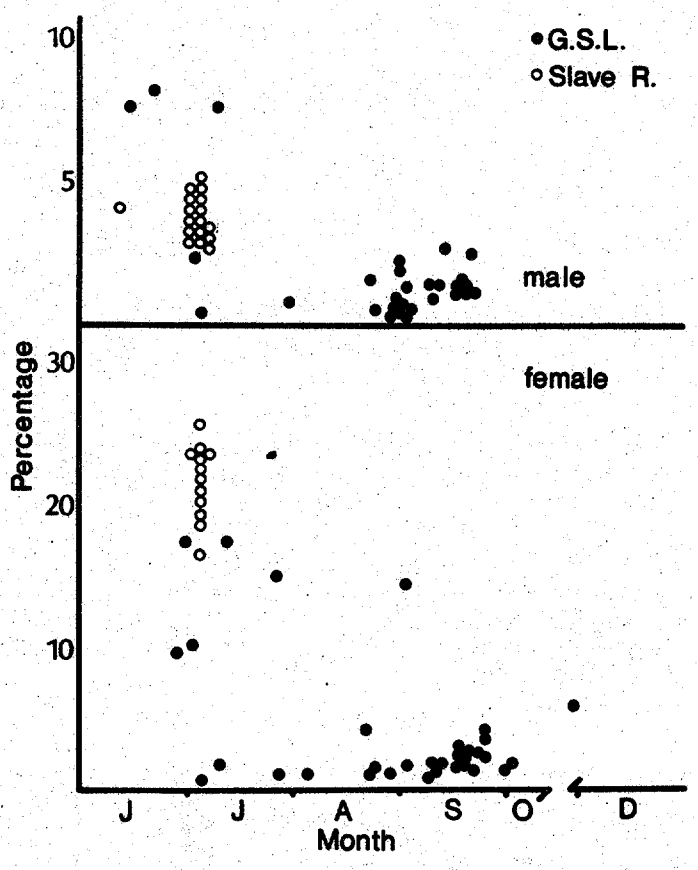

Fig. 5 Testis and ovary weights as a proportion of body weight at different times of the year.

Fecundity, in terms of egg production, is shown in Table 3. Counts were made using Vladykov's (1951) method. The range of numbers is 9,790 to 29,780, with a mean of 21,415, in 18 specimens examined. Berg (1931) stated that *Lampetra japonica septentrionalis* (=*Lethenteron japonicum*) produces about 25,000 eggs, and that *L. j. kessleri* has few, but gave no absolute values.

Table 3. Egg counts from 18 mature female lampreys.

Lamprey No.	Location	Total
1014	G.S.L.	22,732
1171	G.S.L.	19,168
1178	G.S.L.	14,823
1204	G.S.L.	19,374
1342	G.S.L.	9,790
1357	S.R.	17,043
1360	S.R.	19,876
1362	S.R.	22,230
1365	S.R.	27,302
1366	S.R.	26,670
1373	S.R.	22,797
1374	S.R.	24,365
1375	S.R.	26,430
1377	S.R.	29,780
1380	S.R.	14,747
1381	S.R.	27,920
1384	S.R.	20,999
1340	H.R.	19,428

Great Slave Lake mean	17,177	Range	9,790 to 22,732
Slave River mean	23,347	Range	14,747 to 29,780
Mean of all specimens	21,415		

G.S.L. = Great Slave Lake S.R. = Slave River H.R. = Hay River

BIOLOGY OF THE AMMOCOETES

a) Habitat

Ammocoetes are usually collected in small backwaters along the edge of a river, where current is slight and the bottom consists of mud. Large concentrations may occur if conditions are suitable. For example, on August 25, 1967, 383 specimens were captured from Bed 6 in the Hay River in a period of 137 minutes. Many specimens escaped, for they emerged from their burrows under the influence of the electric field more rapidly than they could be picked up.

The complete distribution of ammocoetes in the rivers examined was not determined, many reaches not being accessible to collecting. Collecting was particularly difficult in the Slave River, where the banks are generally steep.

b) Ammocoete movements

Movement of ammocoetes is generally considered to be with the river current. Ammocoetes which swam into the main current of the Hay River, during electrofishing, were not able to swim against it. Analysis of age distribution of ammocoetes in different beds in the Hay River suggests some migration downstream from bed to bed (see below). It is obvious that some free movement must occur, but it has not been possible to determine when or over what distances. Only 10 specimens were captured in trapnets in the Hay River during the period June 3 to August 9, 1967, in more than 5,000 hours of trapping.

In mark- and -recapture experiments, marked specimens were never recaptured anywhere but in their original location. Ammocoetes kept in aquaria during the summer of 1967 were never seen to leave the mud (except when aeration failed) although the openings to their burrows were obvious. However, two of these that transformed in aquaria were seen frequently to lie on the mud surface in the aquaria following transformation (after August 1, 1967).

c) Ammocoete growth

In this study 3,076 ammocoetes were examined to establish length-frequency distributions to determine ages.

A number of biases come into the estimates. Among these are:

a) electrofishing selects larger ammocoetes, as shown by the facts that small ammocoetes may be seen swimming without hindrance through the electrical field, and the collections are noticeably lacking in small larvae.

b) the population of an ammocoetes bed that is sampled several times is changed in number and composition at each sampling.

c) Hay River samples come from 7 beds which extend some 20 miles upstream, while Slave River samples come only from the delta, and may represent only one or two age-classes. This makes comparison between the populations of the two rivers difficult.

d) many individual ammocoetes escape capture despite being driven from the beds by electric current. The number and age proportions of the escapees are unknown.

Despite these factors, two things became evident. They are, first,

that four age-classes exist in the ammocoetes population of the Hay River, and, second, that there is a downstream migration of ammocoetes with increasing age.

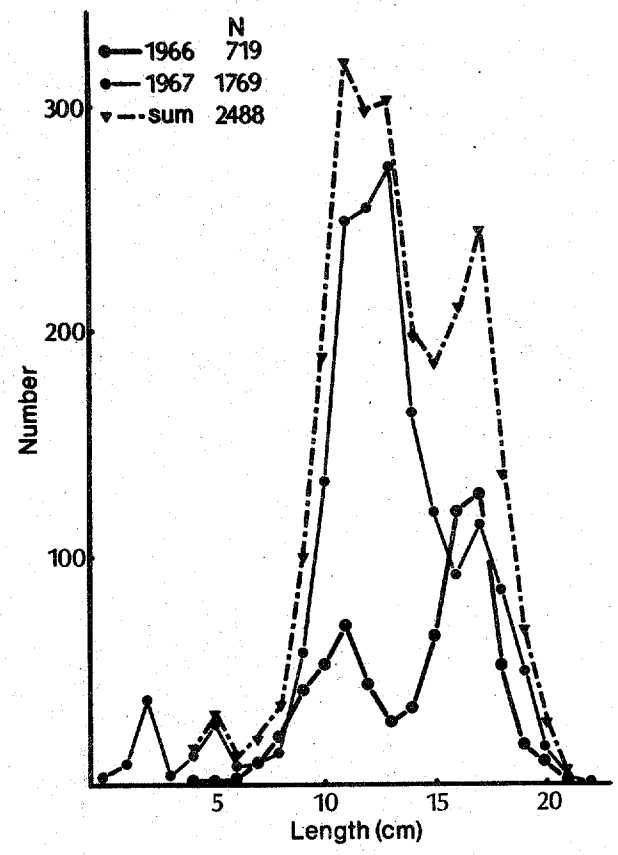

Fig. 6 The length-frequency distribution of ammocoetes in the Hay River during 1966 and 1967.

Fig. 6 shows the length-frequency distribution of ammocoetes in the Hay River during 1966 and 1967. The four peaks shown are taken to represent the four age-classes. The small height of the peaks for the two smallest classes reflect the difficulty in collecting small ammocoetes. We were particularly fortunate in capturing small ammocoetes during 1967. The length distributions of the age-classes are approximated as follows:

Year	Length
1	0- 35 mm
2	30- 65 mm
3	60-155 mm
4	150-220 mm

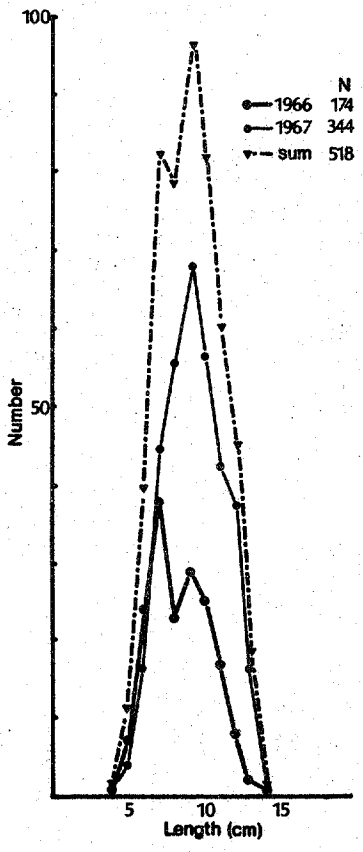

Fig. 7 The length-frequency distribution of ammocoetes in the Slave River during 1966-1967.

The Slave River length-frequency distribution (Fig. 7) is more difficult to interpret, probably because all collections were made in the delta region and may represent only the oldest one or two age-classes. What is apparent is that the ammocoetes from the Slave River are consistently smaller than those from the Hay. A transformation size of about 140 mm is

suggested for Slave River ammocoetes; the mean size at transformation of Hay River specimens is 184 mm.

Examination of individual ammocoete beds in the Hay River at different times during the summer revealed changes in length-frequency distributions. Fig. 8 illustrates conditions in selected beds at particular times. Refer to Fig. 2 for locations of the ammocoete beds.

Fig. 8A shows conditions in Bed 3 during the periods May 16-31, and June 1-15, 1967. It illustrates, in general the replicability of sampling at least at the major modes. Year-classes 2,3 and 4 are represented, the major mode showing Year 3. In the May sample there is a better capture of Year 4 specimens; there are two minor modes attributable to this group. This may be because of the vagaries of sampling, or it could indicate the possibility of stretching the last growth phase of the ammocoetes over two years, as suggested for *Lampetra fluviatilis* by Hardisty and Huggins (1970), although in that case the extension is into a fourth year from a third. There is little other evidence to suggest the extension of the terminal phase of the *Lethenteron japonicum* ammocoete over two years.

Fig. 8B compares the length-frequency distribution of ammocoetes in Bed 1 (about two miles from the mouth of the Hay River) with that in Bed 5 (more than eight miles from the river mouth), during the period July 1-15, 1967. Year-classes 2,3 and 4 are represented. Year 3 provides the major mode for Bed 5, Year 4 for Bed 1, i.e., mean and modal sizes are greater in Bed 1 than Bed 5 though the ranges are similar. This suggests a concentration of the oldest ammocoetes in the beds furthest downstream, i.e., a gradual movement downstream of ammocoetes during the years of the larval period.

The two peaks in Year-class 3 of the Bed 1 sample is most easily explained (as in Fig. 8A) as sampling variation. Less than 10 specimens are involved in each peak. It is also to be noted that the July mode for Year 3 in Bed 5 (Fig. 8B) is displaced to the right from the May and June modes for Year 3 in Bed 3 (Fig. 8A), which is taken to indicate growth of the ammocoetes during the period.

Fig. 8C shows changes in the composition of the ammocoete population in Bed 5 between the periods July 1-15 and August 16-31, 1967. The July population is predominantly of Year-classes 3 and 4. In August, most significantly, specimens of Year 1 are found, presumably progeny of that year's spawning.

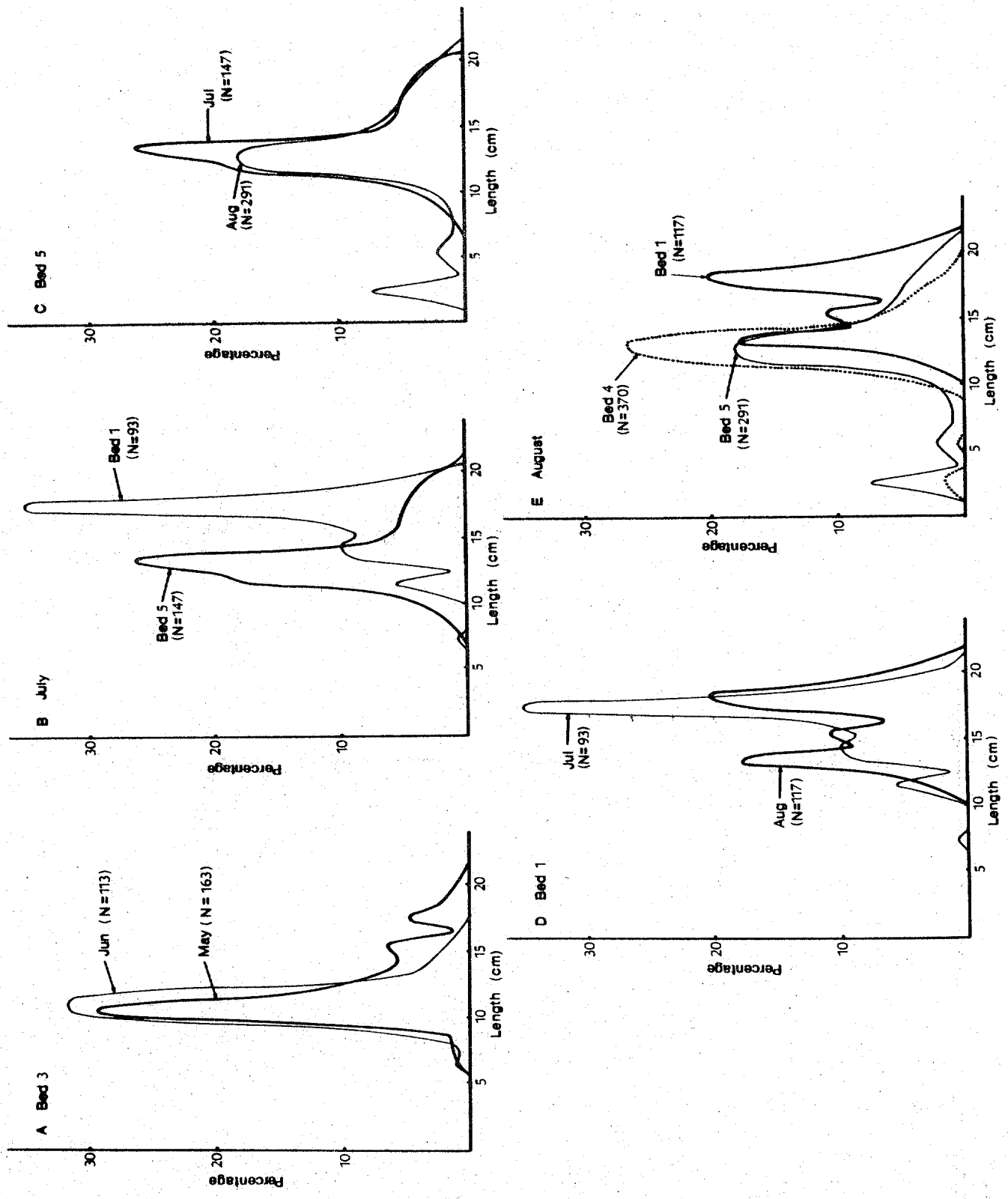

Fig. 8 Length-frequency distributions of ammocoetes in the Hay River at selected beds and selected times.

Fig. 8D shows changes in the composition of the ammocoete population in Bed 1 between the periods July 1-15 and August 16-31, 1967, i.e., the same time comparison as in Fig. 8C. In July Year-classes 2,3 and 4 are represented; in August 3 and 4 only. The shift to the right of the modal points reflects growth of the ammocoetes during the period covered. The persistent bimodal condition for Year 2 is unexplained except as sampling variability.

Fig. 8E combines the August data of C and D, and includes data from Bed 4, which lies within one-half mile of Bed 5. Bed 3 cannot be included in a late season comparison for it dried up after mid-June, 1967.

It appears that the beds nearest the mouth of the Hay River contain relatively more of the largest (oldest) ammocoetes. It is less clear, but the data suggest that the youngest ammocoetes are most abundant in upstream beds. In fact, the further upstream one goes, the more complicated becomes the distribution of age classes of ammocoetes in the beds examined, at least in the Hay River. We take these things to mean that the chief spawning grounds of the arctic lamprey are much further upstream than the mouths of the ammocoete rivers, and indeed are upstream of the major beds. During the period of larval life there is a slow but general migration downstream of ammocoetes. It is probably largely fortuitous, depending on individuals leaving their burrows and being carried away by river currents.

All our observations indicate that transformation of ammocoetes in the Hay River takes place in late August and September. This is about the same time as reported for *Lampetra zanandreai* in Italy (Zanandrea, 1961), later than that for *L. fluviatilis* and *L. planeri* in England (Hardisty, Potter and Sturge, 1970) and for *Petromyzon marinus* Lakes Superior and Michigan (Manion and Stauffer, 1970). According to Heard (1966) *Lethenteron japonicum* ammocoetes transform to adults in spring and early summer in the Naknek river system in southwest Alaska. In all instances it is reported that completion of transformation requires from several weeks to a few months. The arctic lamprey of Great Slave Lake would appear to transform slowly during the winter to be ready for active feeding on entry into the lake in May-June-July.

RELATIONSHIP OF LAMPREYS TO OTHER FISH IN GREAT SLAVE LAKE

There are 26 species of fish in Great Slave Lake (Keleher, 1964). Those of most importance in this study as lamprey prey or predators are: lake trout [*Salvelinus namaycush* (Walbaum)], lake whitefish [*Coregonus clupeaformis* (Mitchell)], northern pike [*Esox lucius* Linnaeus], walleye [*Stizostedion vitreum* (Mitchell)], cisco [*Coregonus* spp.], inconnu [*Stenodus leucichthys* (Guldenstadt)], longnose sucker [*Catastomus catostomus* (Forester)], and burbot [*Lota lota* (Linnaeus)].

Table 4 shows the number of fish examined for lamprey scars from commercial and experimental fishing samples during summer, 1966. The data are arranged according to the FRB statistical areas of Great Slave Lake. Scarring is expressed in percentage of specimens examined.

Table 5 shows the numbers of fish examined and the percentage of scarring for summer, 1967. In this case the locations of capture are different from those of Table 4, as they represent experimental fishing only.

The locations of catches examined for lamprey scars, and the incidence of scarring or lack of scarring are shown in Fig. 1.

In addition to lake fish, more than 1,000 specimens were examined in the course of river surveys.

Almost invariably prey fish were attacked by lampreys beneath the lateral line, and most commonly in the region anterior to the pelvic fins. In only four cases out of a total of 15,502 fish examined was there evidence of multiple scarring and they appeared to be the result of movement from one site to another by the original predator.

The distribution of scarred fish suggests a dispersion of adult lampreys from the Hay River in early summer. From the last half of June to the first half of August, 1967, the percentage of scarred lake whitefish dropped from 11.2 to 2.0 near the Hay River mouth.

In June, 1967, scarring was recorded as 6.3 per cent of the lake whitefish population at Point de Roche, some 13 miles west of the Hay River mouth.

By August, 1967, results from Sandy Creek and Buffalo River, east of the Hay River mouth show a slightly greater proportion of scarring than results from the Hay River region itself.

Table 4. Number of fish examined and percentage showing lamprey attacks in 1966 summer experimental and commercial fishing samples.

Area																						
Species	number	%	number	%	number	%	number	%	number	%	number	%	number	%	number	%	number	%	number	%	number	%
lake whitefish	841	1.1	607	1.8	931	2.4	851	1.3	200	1.5	87	0.0	553	0.4	2008	0.0	957	0.1	76	0.0	7111	0.8
cisco	919	8.8	489	5.7	80	1.3	0	0.0	0	0.0	21	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1509	7.3
inconnu	10	0.0	6	33.0	2	0.0	11	0.0	52	0.0	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	82	4.1
lake trout	41	2.4	22	4.5	8	0.0	10	0.0	62	1.6	0	0.0	0	0.0	220	0.0	154	1.9	288	0.0	805	0.7
longnose sucker	955	0.1	6	0.0	6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	967	0.1
pike	28	0.0	3	0.0	1	0.0	124	0.0	0	0.0	0	0.0	0	0.0	4	0.0	43	0.0	4	0.0	207	0.0
walleye	0	0.0	0	0.0	0	0.0	84	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	84	0.0
burbot	51	0.0	56	0.0	31	0.0	0	0.0	0	0.0	15	0.0	0	0.0	0	0.0	0	0.0	0	0.0	153	0.0
Total	2845	3.2	1189	3.5	1059	2.2	1080	1.0	314	1.3	124	0.0	553	0.4	2232	0.0	1154	0.4	368	0.0	10918	1.6

Table 5. Number of fish examined and percentage showing lamprey attacks in 1967 summer.

Location Time Period Species	N of Hay River June 16-30 number	 per cent	N of Hay River August 1-15 number	 per cent	Point de Roche June 16-30 number	 per cent	Sandy Creek August 1-15 number	 per cent	Buffalo River August 1-15 number	 per cent
lake whitefish	831	11.19	397	2.01	284	6.33	161	2.48	23	4.34
cisco	446	4.26	3	0.00	579	3.97	7	0.00	0	0.00
inconnu	3	0.00	2	0.00	2	0.00	8	0.00	19	0.00
lake trout	31	6.45	0	0.00	89	6.74	5	0.00	0	0.00
longnose sucker	71	0.00	71	0.00	153	0.00	98	0.00	13	0.0
burbot	74	1.35	3	0.00	111	0.90	6	0.00	1	0.00
Total	1456	7.90	476	1.68	1218	3.94	285	1.40	41	2.44

The 1966 data, which are not collated in time (Table 4), show a decrease in proportion of scarring which is closely related to the distance of the sampling site from the Hay River.

We conclude that there is a wide, fairly rapid and relatively even dispersal of adult lampreys out into the west basin of Great Slave Lake in early summer.

Lampreys and ammocoetes are themselves preyed upon to a limited extent by fish. During this study the stomach contents of 1,283 fish were examined, including 219 northern pike, 176 lake trout, 69 inconnu, 615 walleye and 204 burbot. Of these, four burbot taken near the Hay River were found to have eaten ammocoetes, one northern pike taken near an ammocoete bed in the Hay River had eaten several ammocoetes and one adult lamprey, and another northern pike taken from the main channel of the Hay River, had eaten a mature adult lamprey. Thus only 0.5 per cent of the fish examined had preyed upon lampreys.

F.G. Bishop (pers. comm.) examined 820 northern pike and 578 lake trout near the Mackenzie River outlet at the west end of the lake and at Stark River in the east arm. Lamprey adults were found in two pike from the Mackenzie River region; none was found in fish from Stark River. Fuller (1955) recorded no lampreys from 196 inconnu. Rawson (1951) examined 650 lake trout, 116 walleye and 87 burbot without recording a lamprey. He did report hearing about one in a burbot from Hay River and from an inconnu near Gros Cap. J.J. Keleher (pers. comm.) reported none found in 48 northern pike taken at Sandy Creek, nor from 500 lake trout taken at Taltheilei Narrows. E. Hagglund (pers. comm.) has reported catching walleye with ammocoetes in their stomachs, and on occasion fishermen have brought ammocoetes to the Fisheries Research Board Office in Hay River having removed them from walleye stomachs. Sometimes rumors are heard that northern pike have been caught which are gorged on ammocoetes. There is no confirmation of this. It should be noted that leeches (Hirudinea) are frequently mistaken for ammocoetes by people of the area.

Mr. Bert Edge, in charge of the water treatment plant at Fort Smith, has said that gulls eat lampreys when the water intake reservoir is emptied. Lampreys have been recorded previously in the stomachs of gulls (Merrell, 1959) and mergansers (Lindroth, 1955).

THE LIFE CYCLE OF THE ARCTIC LAMPREY IN GREAT SLAVE LAKE

Spawning of the arctic lamprey of Great Slave Lake takes place in June and July far up the Hay and Slave rivers primarily, after which the adults die. Ammocoete larvae live in the rivers for four years, migrating downstream gradually as they mature.

Transformation into adults begins in late August, September and possibly later, continuing through the winter.

Dispersion of adults seems not to take place until the following spring. There is a rapid dispersion into the west basin of the lake, and by late summer concentrations of large adults may be found in the north arm, although undoubtedly the adults are widely spread throughout the west basin of Great Slave Lake.

If adult life is but one year for the arctic lamprey, it is characterized by extremely rapid growth (from ca. 180 mm to > 300 mm). However, there is no evidence at present that adults live for more than one year.

During the winter the adults cease to feed and move back towards the spawning rivers. The gonads mature. In the spring the mature adults enter the spawning rivers and move to the spawning grounds.

The total life span of the arctic lamprey is probably five years, four years being spent as an ammocoete and one as an adult.

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