Fecundity of Quebec Lampreys[1]

by

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The published data on the fecundity of lampreys are very scanty. There are only the odd observations on *Petromyzon marinus* by Surface (1899) and Gage (1928), and on *Ichthyomyzon fossor* by Leach (1940). The purpose of the present paper is to fill the gaps in our knowledge of this subject.

As was mentioned in a previous paper (Vladykov, 1949), the following four species are found in Quebec waters:

1. American Brook Lamprey, *Entosphenus lamottenii* (Le Sueur) 1827,
2. Northern Brook Lamprey, *Ichthyomyzon fossor* Reighard & Cummins 1916,
3. Northern Lamprey, *Ichthyomyzon unicuspis* Hubbs & Trautman, 1937, and
4. Sea Lamprey, *Petromyzon marinus* Linnaeus 1758.

The first two species are non-parasitic lampreys, while the remaining two are dangerous predators preying on a number of different fish species. For the list of victims of landlocked *P. marinus*[2] see Surface (1899) and Gage (1928), while the information on the anadromus form is summarized by Vladykov (1949), and Bigelow & Schroeder (1948). Hubbs & Trautman (1937) listed some species on which *I. unicuspis* feeds.

For the present investigation 59 specimens, belonging to four species, have been studied. The great majority of lampreys came from Quebec (Table 1), while landlocked *P. marinus* were obtained from the Great Lakes. Mr. Matt Patterson kindly collected *P. marinus* from Hibbards Creek, a tributary of Lake Michigan, Wisconsin; while Mr. R. E. Whitfield obtained landlocked specimens from the Thessalon River, North Channel, Ontario. The author wishes to thank most cordially those persons for their help.

Method of Determining Fecundity

As eggs of lampreys are very small, the volumetric method[3] is not practical. The direct counting of the eggs is not very easy either on account of their size and high numbers. Therefore, the estimate of the eggs was made by weighing a sample of the ovary and then counting the eggs contained in it. The number thus obtained was multiplied by the weight of the whole ovary[4]. The procedure was as follows:

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(1) *Contribution No. 33 of the Department of Fisheries, Quebec.*

(2) *A resume of dangerous predation of landlocked* P. marinus *in the Great Lakes region during recent years is given by Vladykov (1949). Royce (1950) published an account on the number of scars made by* P. marinus *on Lake Trout* (Cristivomer namaycush) *in the Seneca Lake, New York.*

(3) *This method was employed with success for species with larger eggs, such as* Leucichthys artedi *(Stone, 1937),* Salvelinus fontinalis *(Vladykov & Legendre, 1940), etc.*

(4) *The same method was used already by Gage (1928, p. 169).*

Table 1

Details of material studied

Species	Number of specimens	Collecting data			
		Date	Locality	Method of fishing	Collector
E. lamottenii	4	May 5 '49	Veuillette R., Ste-Geneviève-de-Batiscan, P.Q.	dip net	V. D. Vladykov
E. lamottenii	6	May 28 '48	Noire R., Pont-Rouge, P.Q.	dip net	V. D. Vladykov
I. fossor	9	May 8 and 22 '48	Yamaska R., St-Césaire, P.Q.	dip net	V. D. Vladykov
I. unicuspis	10	1944–49	St. Lawrence R., various localities, P.Q.	fishing weir	V. D. Vladykov
P. marinus	10	May 20 '49	St. Lawrence R., St-Vallier, P.Q.	fishing weir	V. D. Vladykov
P. marinus	10[1]	June 2 '48	Little Thessalon R., Thessalon, Ontario	dip net	R. E. Whitfield
P. marinus	10[2]	June 9–July 7 '48	Hibbards Creek, Jacksonport, Wisconsin	lamprey trap	Matt Patterson

(1) These specimens were caught in the Thessalon River, at Little Rapids, North Channel, between Lakes Superior and Huron.
(2) These specimens were taken from traps set across Hibbards Creek, a tributary of Lake Michigan, about one mile north of Jacksonport, Door County, Wisconsin.

Table 2

Comparison of actual and estimated fecundities of *I. fossor*

No.	Number of eggs counted	Number of eggs evaluated	Difference per cent
1	1,317	1,324	+ 0·5
2	1,233	1,284	+ 4·1
3	1,115	1,128	+ 1·2
4	1,374	1,416	+ 2·3
5	1,336	1,278	− 4·3
6	1,824	1,820	− 0·2
7	1,979	1,960	− 1·0
8	1,824	1,740	− 4·6
9	1,711	1,626	− 5·0
Average	1,524	1,508	−1·07

1. A specimen, after being preserved in 4·5 per cent formalin for a period varying from a few weeks to six years, was measured to the nearest millimeter, from the anterior tip of the disc to the extremity of the caudal fin, and accurately weighed.

2. The female lamprey was pinned with its right side next to the cork board. The incision was made on the left side to expose the ovary.

3. The dimensions of the ovary in situ were taken and then the ovary was removed.(1)

4. The ovary, after being placed on cheese cloth to remove excess moisture, was weighed very accurately on a Torsion balance.

5. A portion of the ovary was removed and weighed. It is preferable to have a sample weighing exactly one gram.

6. The eggs contained in this sample were separated by means of two dissecting needles, one straight and the other hooked, and then counted in a glass dish placed over a black back-ground.(2)

7. The total number of eggs in the ovary was evaluated by multiplying the number of eggs in a one gram sample by the total weight of the ovary.

8. The diameter of 20 eggs was measured to the nearest 0.5 millimeter by placing the eggs in a row on a measuring board, made in a form of a trough with a triangular cross-section.

(1) *There is only a single ovary in lampreys.*

(2) *The determination of the number of eggs were made with great care by Michael T. H. Brodeur, summer assistant.*

Table 3

Comparison of actual and estimated fecundities of *E. lamottenii*

No.(1)	Number of eggs counted	Number of eggs evaluated	Difference per cent
2	3,648	3,484	− 4·5
3	2,907	2,920	+ 0·4
4	3,067	3,158	+ 3·0
5	1,085	1,052	− 3·0
6	1,568	1,600	+ 2·0
7	1,728	1,780	+ 3·0
8	2,191	2,234	+ 2·0
9	2,372	2,274	− 4·1
10	2,371	2,360	− 0·5
Average	2,326	2,318	− 0·36

(1) *Specimen No. 1 (see Table 4) was excluded from this table, as the number of evaluated eggs in its case differed by 19 per cent from the counted number of eggs, no doubt due to a faulty manipulation.*

The described method, although rather tedious as a gram of ovary contains at least 1,000 eggs, is sufficiently accurate to give a clear picture of the fecundity of lampreys. A comparison of actual and estimated fecundities in the case of two species is given in Tables 2 and 3. The maximum difference was not greater than 5 per cent.

It should be borne in mind that lampreys spawn only once in their life-span, hence all or at least the greatest majority of oocytes ("primary ova") are developing into mature eggs, all of which are of the same size. In other words, the weight of the ovary consists principally of the weight of the eggs, while the connective tissue and other ovarian elements account for a very negligible part.

Stages of Maturity

In the case of female lampreys the degree of maturity can be determined first of all by the dimensions of their unshed eggs, which during the spawning season in Quebec species vary from 0.8 millimeters (in *I. unicuspis*) to 1.2 millimeters (in *I. fossor*). However, there are several other characteristics interior and exterior which help to classify females according to their sexual development. These characters are as follows:

1. In mature females the anal fin-like fold is well-developed, and the tail turns typically upwards, while in breeding males it bends downwards.

2. The lumen of the intestinal tract(1) reduces progressively, becoming non-functional and closed in fully mature individuals of all lamprey species. Moreover,

(1) *In our Tables 4-9, the width of the intestine was measured immediately behind the posterior end of the liver.*

the liver acquires a green colour, due to probably the diffusion of the bile. Thus the smaller the width of the intestine, the more mature is the lamprey of either sex.

Table 4

Actual fecundities of *E. lamottenii*

No.	Lamprey		Ovary weight (g.)	Number of eggs	Diameter of 1 egg (mm.)	Width of intestine (mm.).	Maturity index
	Length (mm.)	Weight (g.)					
1	116	3·1	0·6	1,085	0·93	1·0	19·4
2	118	3·8	0·5	1,568	0·83	3·0	13·2
3	128	3·0	0·9	1,728	0·95	0·5	30·0
4	138	4·0	1·0	2,191	0·88	3·0	25·0
5	149	5·4	1·2	2,372	0·95	1·5	22·2
6	152	5·5	1·4	2,371	0·80	3·0	25·4
7	154	5·6	1·0	2,451	0·88	1·0	17·9
8	156	7·0	1·2	3,648	0·90	0·5	17·2
9	156	7·7	1·3	2,907	0·90	2·0	16·9
10	158	7·0	1·3	3,067	0·90	2·0	18·6
Average	142·5	5·2	1·04	2,339	0·89	1·75	20·0

Table 5

Actual fecundities of *I. fossor*

No.	Lamprey		Ovary weight (g.)	Number of eggs	Diameter of 1 egg (mm.)	Width of intestine (mm.)	Maturity index
	Length (mm.)	Weight (g.)					
1	128	3·8	1·2	1,317	0·95	0·1	31·6
2	131	3·0	1·4	1,233	1·10	0·2	46·6
3	133	3·6	1·0	1,115	0·98	0·1	27·7
4	133	4·1	1·2	1,374	1·20	0·1	29·2
5	134	4·2	1·5	1,336	1·05	0·2	35·7
6	139	4·6	1·7	1,824	1·05	0·2	37·0
7	144	5·5	1·7	1,979	1·20	0·2	30·9
8	146	4·7	1·4	1,824	0·98	0·1	29·8
9	150	5·2	1·8	1,711	1·05	0·2	34·6
Average	137·6	4·3	1·43	1,524	1·01	0·14	33·2

Table 6

Estimated fecundities of *I. unicuspis*

No.	Locality (Quebec)	Date	Lamprey		Ovary weight (g.)	Number of eggs	Diameter of 1 egg (mm.)	Width of intestine (mm.)	Maturity index
			Length (mm.)	Weight (g.)					
1	Neuville	April 21 '47	201	13·5	4·6	15,474	0·80	2·0	33·0
2	Neuville	Oct. 5 '45	204	21·9	1·2	17,848	0·45	5·5	5·5
3	Gentilly	Jan. 18 '49	217	41·9	4·6	15,134	0·70	13·0	11·0
4	Ste-Pétronille	April 24 '48	246	35·6	3·4	15,443	0·70	8·0	9·6
5	Montmorency	May 9 '48	251	37·5	5·3	14,310	0·85	4·0	14·1
6	Berthier-en-bas	Oct. 6 '46	262	54·6	3·4	18,795	0·60	7·5	6·2
7	Nicolet	Oct. 10 '45	270	46·5	6·0	12,006	0·80	7·0	12·9
8	St-Romuald	Nov. 10 '44	287	56·6	8·6	25,310	0·80	6·0	15·2
9	St-Vallier	Sept. 26 '44	300	75·0	4·3	29,412	0·60	9·5	5·7
10	Neuville	Sept. 16 '46	312	68·1	7·9	26,386	0·70	8·5	11·6
Average	St. Lawrence River	1944-49	255	45·1	4·93	19,012	0·70	7·10	10·9

3. From the time of reaching the peak of physical development, which in Quebec corresponds to the period November-January, to spawning in the spring the length and weight of adult lampreys of both sexes progressively diminish. Thus at spawning time sexually mature individuals are much smaller than they were a few months previous. In the extreme case of a spawning *I. unicuspis*, the shrinkage in length was up to 22 per cent and loss of weight to 57 per cent in comparison with the measurements made on the same specimen in November, that is six months before (Vladykov and Roy, 1948). On account of this shrinkage the extent of which varies with the individual, it is often very difficult to establish a correlation between the number of eggs and the size of a female.

4. To define the degree of maturity, the weight of the ovary in grams was expressed in percentage of the total weight in grams of a female, and is called "maturity index". Thus the higher the index, the higher is the degree of maturity. In all our species, during spawning this index is equal to at least 30, with a maximum of 47.

Fecundity in Different Species

In the case of *E. lamottenii* (Table 4) and *I. fossor* (Table 5) the number of eggs were actually counted, while in the remaining species (Tables 6-9) it was evaluated.

E. lamottenii.—The data on the absolute fecundity of ten specimens from Quebec are given in Table 4. The length of these females varied from 116 to 158 millimeters, with an average of 143 millimeters, and average weight of 5.2 grams. All these lampreys were taken at the spawning season, thus there was very little variation in the diameter of the eggs, the range being 0.80-0.95 millimeters and an average of 0.89 millimeters.

The number of eggs varied from 1,085 to 3,648, with an average of 2,339. There is a definite correlation between the size of the specimen and the number of eggs. In the case of the three smallest females (116-128 mm.) the number of eggs is less than 2,000. In a group of an intermediate size (138-154 mm.) the number of eggs was more than 2,000 but less than 2,500. In the three largest lampreys (156-158 mm.) the variation was from 2,900 to 3,650. Published records on the number of eggs in *E. lamottenii* are very limited: Gage (1928, p. 169) gave for a New York specimen 3,276 eggs; Dean & Sumner (1898) estimated from a gravid female taken at the spawning time that she contained 860 eggs. It seems almost certain that a part of her eggs had already been laid.

The maturity index in our specimens varied from 17 to 30, the average being 20. The individual (No. 3) with the highest index was a female in the most advanced stage of maturity: the diameter of the eggs was 0.95 millimeters, and the width of the intestine was only 0.5 millimeter.

I. fossor.—The data on the fecundity of nine Quebec specimens are given in Table 5. The lengths varied from 128 to 150 millimeters, with an average of 138 millimeters and an average weight of 4.3 grams. These specimens were collected during the spawning season, thus showed large eggs with the diameter varying from 0.95 to 1.05 millimeters, with an average of 1.01 millimeters.

Table 7

Estimated fecundities of landlocked *P. marinus* from Ontario

No.	Lamprey		Ovary weight (g.)	Number of eggs	Diameter of 1 egg (mm.)	Width of intestine (mm.)	Maturity index
	Length (mm.)	Weight (g.)					
1	330	81·1	16·7	28,891	0·90	3·0	20·6
2	353	100·4	19·2	39,490	0·80	2·5	19·2
3	359	109·2	22·7	52,437	0·85	2·0	20·8
4	368	112·0	24·0	53,520	0·85	3·0	21·4
5	377	129·7	26·5	62,924	0·83	2·5	20·5
6	390	130·6	28·8	65,280	0·85	4·0	22·0
7	396	143·6	30·2	50,343	0·95	3·0	20·9
8	409	153·7	27·6	74,023	0·80	3·5	18·0
9	418	175·3	40·6	66,709	0·90	2·0	23·2
10	435	221·0	34·3	65,513	0·85	4·0	15·6
Average	383·5	135·7	27·06	55,913	0·86	2·95	20·0

Table 8

Estimated fecundities of landlocked *P. marinus* from Wisconsin

No.	Lamprey		Ovary weight (g.)	Number of eggs	Diameter of 1 egg (mm.)	Width of intestine (mm.)	Maturity index
	Length (mm.)	Weight (g.)					
1	291	65·2	19·7	58,485	0·80	3·0	30·2
2	310	59·0	14·0	40,838	0·75	2·5	23·7
3	313	61·8	14·7	49,686	0·75	5·0	23·8
4	326	101·0	23·3	38,678	0·88	5·0	23·0
5	343	97·2	19·0	45,410	0·80	5·0	19·6
6	366	167·0	55·0	77,440	1·00	1·0	33·0
7	372	169·1	47·1	72,110	0·90	2·5	27·9
8	410	184·6	47·5	79,420	0·95	4·5	25·8
9	423	208·5	51·9	85,712	0·90	3·5	24·8
10	439	158·5	28·0	80,920	0·80	9·0	17·7
Average	359·3	127·2	32·01	62,870	0·85	4·1	25·1

The number of eggs ranged from 1,115 to 1,979, the average being 1,524. The correlation between the size and number of eggs is noticeable to a certain degree. In the case of lampreys ranging from 128 to 134 millimeters, the number of eggs was less than 1,500, while in larger females (139-150 mm.) this number was from 1,700 to nearly 2,000. Leach (1940, p. 32) counted the eggs in three *I. fossor* from Indiana. Specimens with lengths of 92, 113, and 122 millimeters showed the numbers of eggs to be 780, 1,050 and 1,340 respectively.

The maturity index in our material was very high, from 28 to 47, with an average of 33, as all females were collected on the spawning ground.

I. unicuspis.—Specimens were taken in the St. Lawrence River, Quebec, from eight different localities throughout the six-year period, 1944-49 (Table 6). These lampreys were caught in different months of the year from January to November.

The lengths ranged from 201 to 312 millimeters, with an average of 255 millimeters, and an average weight of 45 grams. The diameter of the eggs varied considerably from 0.45 to 0.85 millimeters, with an average of 0.73 millimeters.

The number of eggs was evaluated to be from 12,006 to 29,412, with an average of 19,012 eggs. The correlation between the size of lamprey and number of eggs is evident only in specimens arranged in large length-classes. In individuals from 201 to 270 millimeters the number of eggs was smaller than 20,000, while in larger females (287-312 mm.) this number varied from 25,000 to nearly 30,000.

As our specimens were collected in different months, their indices of maturity showed an unusually large range from about 6 to 33, with an average of 11. From Table 6 it is evident that only specimen No. 1 was ready to spawn, while the remaining were immature females.

Table 9

Estimated fecundities of anadromous *P. marinus* from Quebec

No.	Lamprey		Ovary weight (g.)	Number of eggs	Diameter of 1 egg (mm.)	Width of intestine (mm.)	Maturity index
	Length (mm.)	Weight (g.)					
1	666	560	73·8	142,139	0·90	10·0	13·1
2	688	600	78·9	123,873	0·90	6·0	13·2
3	722	680	92·6	136,122	0·95	6·0	13·6
4	742	925	122·6	202,413	0·95	7·0	13·2
5	750	870	127·9	187,757	0·95	7·0	14·7
6	750	905	107·9	166,245	0·90	13·0	11·9
7	751	875	110·3	137,875	0·95	10·0	12·6
8	753	1,000	116·4	258,874	0·90	12·0	11·6
9	766	860	102·0	128,724	1·05	5.0	11·8
10	841	1,145	146·2	231,873	0·95	12·0	12·8
Average	742·9	842·0	107·86	171,589	0·94	8·80	12·8

P. marinus.—In the Province of Quebec there is commonly found only the anadromous form of *P. marinus* (Vladykov, 1949). In order to complete our studies, we obtained samples of the landlocked form from North Channel, Ontario, and Lake Michigan, Wisconsin. Tables 7-9 summarize the data on fecundities of different forms of *P. marinus*.

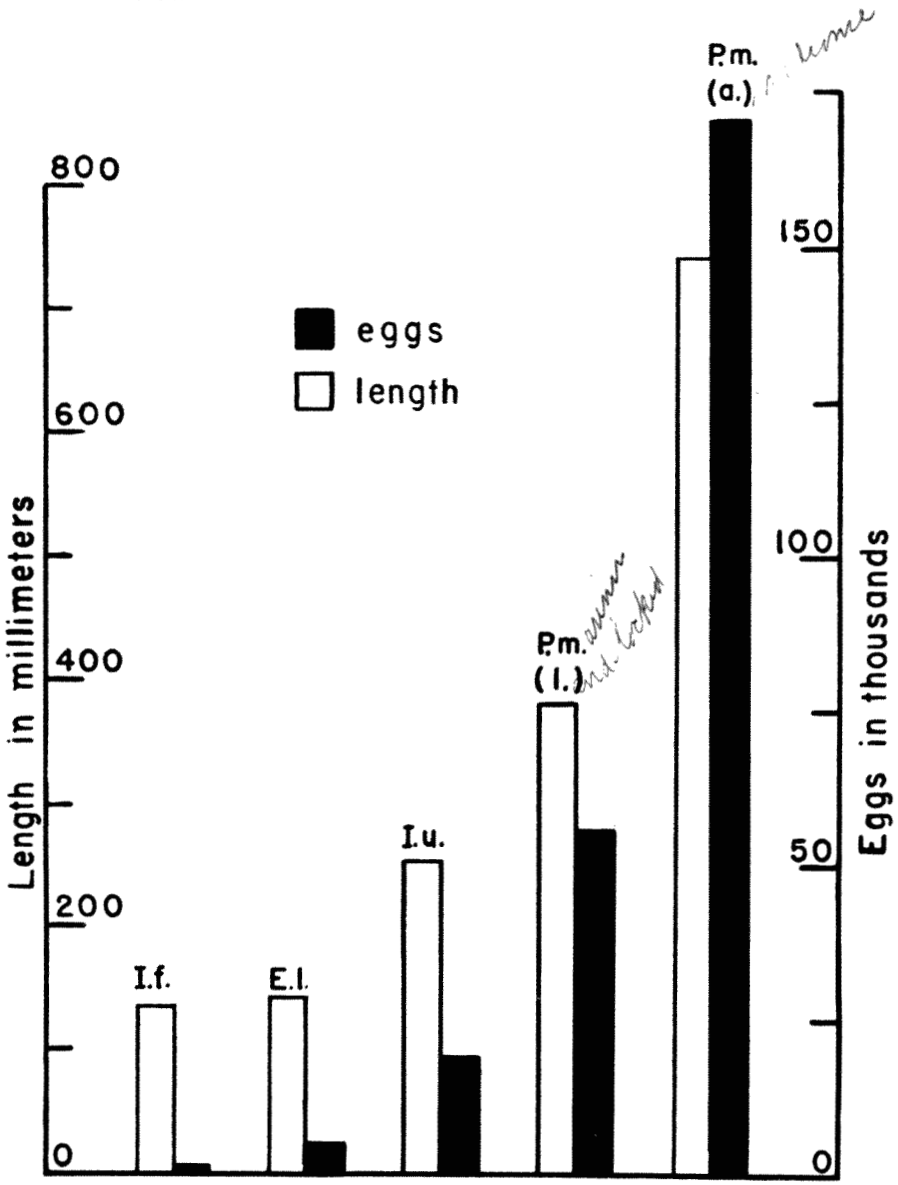

Figure 1

Correlation between the average length of female lamprey of four different species and the average number o eggs. The data for landlocked P. marinus *are those for Ontario specimens.*

The landlocked form from Ontario was collected in the Thessalon River, at Little Rapids, on June 2, 1948. These specimens were well advanced in maturity, but were not ready to spawn as yet (Table 7). Their lengths were from 330 to 437 millimeters, with an average of 384 millimeters and an average weight of 136 grams. The diameter of eggs varied from 0.80 to 0.95 millimeters, with an average of 0.86 millimeters. The number of eggs were evaluated to be from 28,891 to 74,023, with an average of 55,913. Only two of the smallest females (330-353 mm.) had less than 40,000 eggs, while the remaining (359-435 mm.) possessed between 50,000 and 75,000 eggs. The maturity index varied from 16 to 22, with an average of 20.

The specimens from Wisconsin (Table 8) were somewhat smaller, from 291 to 439 millimeters, with an average of 359 millimeters, and an average weight of 127 grams. As this sample was collected from June 9 to July 7, 1948, there was observed a pronounced variation in the diameter of the eggs, ranging from 0.75 to 1 millimeter, with an average of 0.85 millimeters. The extremes in the number of the eggs were found to be from 38,678 to 85,712, with an average of 62,870. This number is considerably higher than that found in North Channel specimens. Apparently Lake Michigan specimens display a higher fecundity. The correlation between the size of the female and the number of eggs is shown only in a broad range of length-classes. For instance, among smaller individuals (291-343 mm.) the number of eggs is less than 60,000, while in larger ones (366-439 mm.) it varies from 72,000 to 86,000. The maturity index was from 18 to 33, with an average of 25.

Gage (1928, p. 169) for three landlocked *P. marinus* from Cayuga Lake, New York, listed 63,000, 65,000 and 108,270 eggs. He considered that the two lampreys with the smaller numbers of eggs apparently had already laid a part of their eggs, as they were taken from the spawning beds. Our studies showed that these smaller numbers were directly comparable with those obtained for Ontario and Wisconsin, while 108,270 eggs were never duplicated in our material. Carl L. Hubbs in an unusually large specimen of landlocked *P. marinus* (20¾ inches) counted 78,762 eggs, (1) a number repeated among our Wisconsin specimens. On the other hand, it was rather astonishing to read in Surface (1899, p. 200), that "adult female lake lampreys lay between 25,000 and 30,000 eggs, according to size, the average being about 27,500".

The anadromous specimens from Quebec ranged in length from 660 to 841 millimeters, with an average of 743 millimeters, and an average weight of 842 grams (Table 9). This sample showed very little variation in the diameter of eggs, which was from 0.90 to 1.05 millimeters, with an average of 0.94 millimeters. The estimated number of eggs ranged from 123,873 to 258,874, with an average of 171,589. Our findings are directly comparable with 235,950 eggs, a number counted by Gage (1928, p. 169) in a specimen of anadromous *P. marinus* from Lawrence, Massachusetts.(2). It should be noted that in Quebec specimens we were unable to establish any correlation between the size of Sea lamprey and the number of eggs. The index of maturity varied from about 12 to 15, with an average of nearly 13.

(1) *This observation by Hubbs was quoted by both Schneberger (1947, p. 12) and Applegate (1947, p. 7)*
(2) *This observation by Gage was quoted also by Dees (1950).*

Table 10

Comparison between absolute fecundities of different species

Species	Number of specimens	Lamprey				Maturity Index		Ovary			
		Length in millimeters		Weight in grams				Diameter of 1 egg in mm.		Number of eggs	
		Range	Average	Range	Average	Range	Average	Range	Average	Range	Average
I. fossor	9	128–150	138	3·0–5·5	4·3	27·7–46·6	33·2	0·95–1·05	1·01	1,115–1,979	1,524
E. lamottenii	10	116–158	143	3·1–7·7	5·2	13·2–30·0	20·0	0·80–0·95	0·89	1,085–3,648	2,339
I. unicuspis	10	201–312	255	13·5–75·0	45·1	5·5–33·0	10·9	0·45–0·85	0·70	12,006–29,412	19,012
P. marinus(1)	10	291–439	359	59·0–208·5	127·2	17·7–33·0	25·1	0·75–1·00	0·85	38,678–85,712	62,870
P. marinus(2)	10	330–435	384	81·1–221·0	135·7	15·6–23·2	20·0	0·80–0·95	0·86	28,891–74,023	55,913
P. marinus(3)	10	666–841	743	560–1,145	842·0	11·6–14·7	12·8	0·90–1·50	0·94	123,873–258,874	171,589

(1) Landlocked from Lake Michigan, Wisconsin.
(2) Landlocked from North Channel, Ontario.
(3) Anadromous from the St. Lawrence River, Quebec.

Table 11

Relative fecundities of different lamprey species

Species	Maturity index	Diameter of 1 egg (mm.)	Number of eggs in 1 gram
I. fossor	33·2	1·01	1,066
P. marinus (1)	12.8	0.94	1,595
P. marinus (2)	20·0	0·86	2,088
P. marinus (3)	25·1	0·85	2,242
E. lamottenii	20·0	0·89	2,249
I. unicuspis (4)	11·2	0.73	3,839

(1) Anadromous from the St. Lawrence, River, Quebec.
(2) Landlocked from North Channel, Ontario.
(3) Landlocked from Lake Michigan, Wisconsin.
(4) Specimen No. 2 (see Table 6) was excluded from data in this table.

Comparison between Absolute and Relative Fecundities

In Table 10 we have arranged the species of lampreys in order of their increasing size. These data are graphically represented in Figure 1. It appears that the average number of eggs follows quite closely the average size of female of different species. In order of magnitude, the species are placed as follows: *I. fossor*, *E. lamottenii*, *I. unicuspis*, landlocked *P. marinus*, and anadromous *P. marinus*. Thus I. *fossor* lays the smallest number of eggs, while anadromous *P. marinus* is the most prolific.

There is another way to treat the problem of fecundity, that is, to consider how many eggs are contained in a gram of ovary of different species. This approach can be called the "relative fecundity". The number of eggs in a gram of ovary depends mainly on the size (diameter) of the eggs. In Table 11, which presents these data, there is a minor discrepancy in the case of *E. lamottenii*. Although the average diameter of eggs in this species was larger (0.89 mm.) than in landlocked *P. marinus* (0.85-0.86 mm.), the number of eggs in *E. lamottenii* was somewhat higher (2,249) than in the landlocked form (2,242 or 2,088). This was caused probably by the fact, that the number of eggs in *E. lamottenii* was counted while in the other it was evaluated.

From the point of view of relative fecundity, in order of increasing numbers of eggs, the species are arranged as follows: *I. fossor*, anadromous *P. marinus*, landlocked *P. marinus*, *E. lamottenii*, and *I. unicuspis*. Thus *I. fossor* again occupies the lowest position, while this time the most prolific is *I. unicuspis*. In Table 11 we excluded specimen No. 2 of *I. unicuspis* (see Table 6), which had rather numerous eggs (17,848) but of a very small diameter (0.45 mm.). If, however, this female should be included then the number of eggs in one gram of ovary of I. *unicuspis* would be raised to 4,528.

From the relative fecundity viewpoint, *P. marinus* occupies a place next after *I. fossor*. Among landlocked and anadromous forms of *P. marinus* there is also a pronounced difference, the former is much more prolific than the latter.

In conclusion we can repeat that both forms of *P. marinus* are very prolific from the absolute fecundity point of view. This fact explains clearly why *P. marinus*, particularly its landlocked form, can become so abundant in lakes where it becomes established. This is particularly true in the case of new habitats, such as the Great Lakes.

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