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A Dwarf Male of the Arctic Lamprey, *Lethenteron japonicum* from the Assabu River, Hokkaido, Japan

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Abstract

One dwarf male of the Arctic lamprey *L. japonicum* was captured in the Assabu River, southern Hokkaido, Japan. The body size of this specimen was that of young *L. japonicum* migrating to the sea, but the testis was maturing as in an adult. The proportional values of snout length and oral diameter were within the range of adults, but the eye diameter and tail length were within the range of the young. This individual is similar to "black variation of the precocious form" (aberr. nigra of the f. *praecox* of Berg (1948-1949)).

The Arctic lamprey *Lethenteron japonicum*, a parasitic and anadromous species, is found in Eurasian Arctic drainages from East Finmark to the western Pacific basin south to Japan and the northwestern America (Vladykov and Kott, 1979).

One specimen identified as *L. japonicum* was captured in the Assabu River in south Hokkaido, Japan. The specimen was the length of an immature juvenile and migrating to the sea for feeding, but it had a maturing testis and a nonfunctional intestine.

Only a brief description was given of dwarf individuals of *L. japonicum* by Berg (1931) and Berg (1948-1949). The purpose of this paper is to give more information based on this specimen and compare it to adults and young of this species.

Materials and methods

The scientific names of lampreys follow Vladykov and Kott (1982) and Iwata *et al.* (1985). Terminology for the various types of teeth follows Vladykov and Follett (1967). Measurement and counts were made on the left side of specimens in 5% formalin and followed the precedures outlined in Vladykov and Follett (1965) except for the snout length and intestine diameter. All measurements were expressed as percentages of the branchial length of the specimens; the branchial length was also expressed as a percentage of total length. The following abbreviations are used: TL, total length, the distance from anteriormost oral fimbria to the end of the caudal fin; B_1-B_7, branchial length, the distance from the anterior edge of the first branchial opening to the posterior edge of the last branchial opening; S, snout length, the distance from anteriormost oral fimbria to the anterior edge of the eye; O, eye diameter, the horizontal diameter of the eye; d, disc length, longitudinal diameter, measured with the disc closed; a-C, tail length, the distance from the

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posterior edge of the cloacal slit to the end of the caudal fin ; Int, intestine diameter under the anterior insertion of first dorsal fin ; GSI, the testis weight expressed as a persentage of body weight ; and GP, Length of urogenital papilla. Additionally, the testes were fixed again in Bouin's fluid. Serial paraffin sections of the testis were cut frontally at 7 μm and stained with Delafield's hematoxylin and eosin.

The specimens which had the catalogue number (HUMZ) were deposited in the Laboratory of Marine Zoology, Faculty of Fisheries, Hokkaido University. Data for each specimen used for measurement and counts are given in the following sequence : catalogue number, number of specimens, total length (mm), locality, data of collection.

Dwarf specimen : HUMZ 104489, 1, 197.2, Assabu River, 14, Apr. 1983.

Young specimens : HUMZ 104506-104510, 5, 168.2-228.4, Toufutsu lake, 22, Apr. 1980 ; HUMZ 104460-104482, 23, 152.8-214.5, Toufutsu lake, 28, Apr. 1982 ; 2, 193.2-200.4, Saru River, 15, Apr. 1984.

Adult males : 2, 421.8-466.8, Assabu River, 25, Apr. 1983 ; 4, 395.1-437.4, Toshibetsu River, 25, Apr. 1984 ; 1, 395.0, Assabu River, 11, May, 1984 ; 2, 387.5-409.0, Assabu River, 18, May, 1984 ; 2, 397.0-400.0, Hime River, 19, May, 1984 ; 4, 395.2-422.2, Assabu River, 22, May, 1984 ; 7, 364.8-533.0, Mabechi River, Iwate Pref., 26, May, 1984.

Results

Total length (*Table 1*)

Normally, mature specimens of this specimens reach about 400 mm TL. Young migrating to the sea after metamorphosis measure about 160-230 mm TL. The total length of the dwarf specimen belongs to the young.

Dentition

This specimen has bicuspid supraoral lamina, a single row of unicuspid posterial teeth and bicuspid innerlateral teeth on each side of the disc. This tooth arrangement is typical of the genus *Lethenteron* (Vladykov and Follett, 1967).

This specimen is easily distinguished from *L. kessleri* by the sharp and pointed infraoral lamina and from *L. reissneri* by the highly developed teeth (Berg, 1931 ; Berg, 1948-1949 ; Iwata *et al.*, 1985).

Trunk myomeres

The number of trunk myomeres of this specimen was 70. The number of trunk myomeres ranges from 66 to 77 in *L. japonicum* (Miyadi *et al.*, 1976 ; Iwata *et al.*, 1985).

Condition of the testes (*Fig. 1a-c*)

The sample section was obtained from an adult male lamprey 466.8 mm TL captured on 25, Apr. 1983, which possessed many spermatids and had begun spermiogenesis (Fig. 1a). A young specimen 193.2 mm TL captured on 15, Apr. 1984 had testis which contained spermatogonia only (Fukayama and Takahashi, 1982) (Fig. 1b). Since the dwarf specimen had testis which had begun spermiogenesis, it must have been maturing in spite of its smaller than normal body size (Fig. 1c).

Table 1. Proportional measurements and GSI of the dwarf male, young, and adult males of *L. japonicum*. Data show the mean values, confidence limit at 95% and their ranges (in parentheses).

	dwarf male	young	adult males
TL, mm	197.2	164.9-228.4	364.8-533
B_1-B_7/TL		N=23	N=23
	9.74	9.29±0.15	11.13±0.33
		(8.77-10.11)	(10.05-13.80)
S/B_1-B_7		N=20	N=23
	61.98	77.32±2.00	64.66±2.18
		(67.61-83.87)	(51.37-77.46)
O/B_1-B_7		N=23	N=23
	24.48	28.17±1.14	13.92±0.72
		(22.75-36.88)	(9.62-17.36)
d/B_1-B_7		N=23	N=23
	53.13	66.35±1.48	53.15±2.04
		(59.09-73.58)	(91.41-60.05)
a-C/B_1-B_7		N=23	N=23
	311.98	316.38±7.56	261.88±9.00
		(280.13-350.00)	(211.51-294.62)
Int/B_1-B_7		N=23	N=23
	5.73	17.12±0.97	2.58±0.34
		(13.56-21.43)	(1.34- 4.35)
GSI		N=23	N=23
	11.54	1.39±0.36	3.96±1.14
		(0.35- 3.51)	(0.77-12.38)
GP/B_1-B_7			N=23
	2.60		10.33±1.66
			(2.49-17.62)

The GSI of this specimen showed a high value which was not in the range of the young, but in that of adults (Table 1).

Intestine diameter (*Table 1*)

The intestine of this specimen was nonfunctional and slender in contrast with the thick and functional gut of young which were of similar size. The condition of the intestine resembled that of adult lamprey or *L. kessleri* and *L. reissneri* which are nonparasitic and landlocked species.

Body proportions (*Table 1, fig. 2*)

The proportional values of the snout and disc length of this specimen corresponded to those of adult lampreys, but the eye diameter and tail length had the proportions of young specimens.

Compared with *L. reissneri* or *L. kessleri*, the urogenital papilla was short, which is a character of adult Arctic lampreys (Iwata *et al.*, 1985).

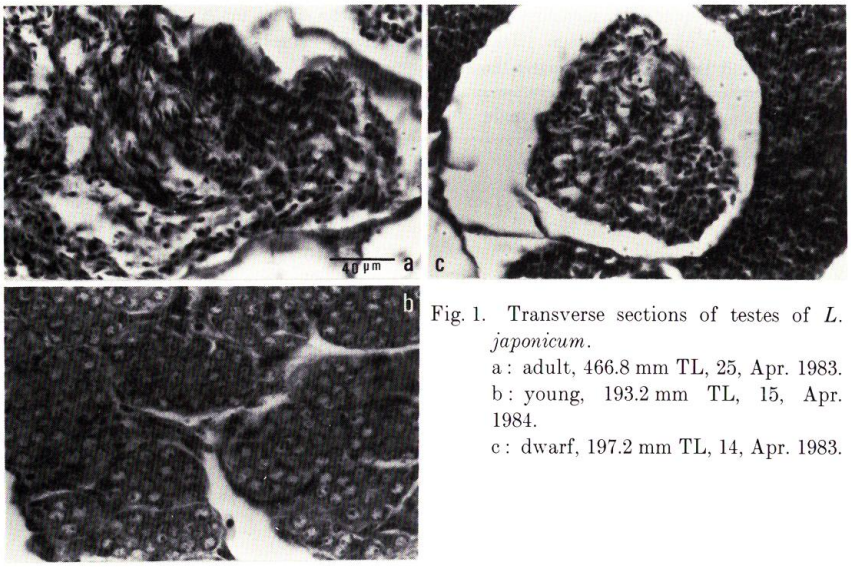

Fig. 1. Transverse sections of testes of *L. japonicum*.
a : adult, 466.8 mm TL, 25, Apr. 1983.
b : young, 193.2 mm TL, 15, Apr. 1984.
c : dwarf, 197.2 mm TL, 14, Apr. 1983.

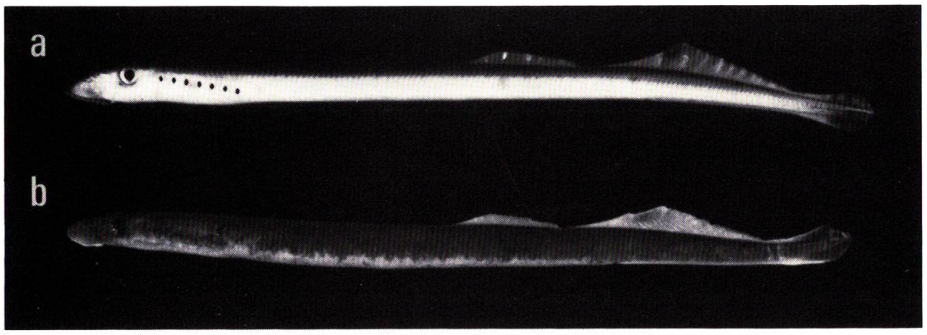

Fig. 2. a : young of *L. japonicum* (fresh specimen), 200.4 mm TL.
b : dwarf male of *L. japonicum* (preserved specimen), 197.2 mm TL.

Coloration (*Fig. 2*)

The fully pigmented caudal fin and the black dot on the anterior part of the second dorsal fin characterized this specimen as *L. japonicum*. Young Arctic lampreys have blue tinged with green on the dorsum and metallic silver ventrally, but this specimen was dark green on the dorsal side and not silver but white on the ventral side.

Discussion

L. kessleri is sympatric with *L. japonicum* in the Assabu River. Our dwarf specimen was easily distinguishable from *L. kessleri* by the sharply pointed infraoral lamina and its body proportions (Berg, 1948-1949 ; Iwata *et al.*, 1985). Since this specimen had maturing testis and a nonfunctional gut, and lacked the silvery smolt

color, it is reasonable to suppose that it would not have migrated to the sea, but would have stayed in fresh water and participated in reproduction with normal adults.

Lampreys mate after the male attaches his disc to the head of the female anterior to the eyes and wrap his tail firmly around her body (Hardisty and Potter, 1971b; Malmqvist, 1983). This spawning method was also observed in Japanese lampreys. If the sperm were expelled in this way only, as in the description by Hardisty and Potter (1971a), body length would directly affect reproductive success. Malmqvist (1983), however, reported the presence of a satellite male which was seen to circle rapidly round the tails of copulating pairs. We observed this action in the spawning behavior of three Japanese species (unpublished data). If a dwarf male behaves as a satellite male when participating in spawning with normal adult, it is possible that the dwarf male might also attain reproductive success.

In body proportions, our dwarf specimen had both young and normal adult proportions, as mentioned above. Berg (1931, 1948-1949) reported the presence of two forms within one anadromous species, one which grows normally to a large size, another which spawns at a smaller size than normal adults ("precocious form"=f. *praecox*). Further more, Berg (1948-1949) also reported an "black variation" (aberr. nigra) which was more blackish than common lampreys. According to him, this specimen could be identified as a "black variation" of the "precocious form".

It is said that nonparasitic species were derived from parasitic species (Hardisty and Potter, 1971b; Vladykov and Kott, 1979). The existence of dwarf males within the population of both parasitic and anadromous species (Hardisty and Potter, 1971b) must have some significance in the process of the speciation of nonparasitic species.

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