

Occurrence of a Sea-run Type of the Dolly Varden in the Shiretoko Peninsula, Hokkaido

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At the southern extremes of its range the Dolly Varden, *Salvelinus malma* (Walbaum), is usually non-migratory. Hokkaido is within the southern limits of its range in Asia, and the sea-run type of the Dolly Varden has not been recorded there, with the exception of two anadromous males (Hikita, 1962; Ishigaki, 1967) and one smolt of an immature female (Maekawa, 1973). Interestingly, all three individuals were collected from rivers in and around the Shiretoko Peninsula.

In 1980, we came across a silvery Dolly Varden in a river on the Shiretoko Peninsula during a survey of fish fauna in this district. The following year, we conducted a further study on the occurrence of the silvery Dolly Varden in the river and were successful in collecting some silvery ones.

The present paper reports the possibility of the transformation of the Dolly Varden into silvery smolt in eastern Hokkaido.

Observation and discussion

The present investigation was carried out from August 3rd to 4th, 1981, in the Oketchiushi River of the Shiretoko Peninsula in eastern Hokkaido (Fig. 1). The river is about 5.0 km in length with a steep gradient from the mouth upward, of the so-called "Aa" type in the stream classification of Kani (1944), and its water is clear. Three species, *S. malma*, *Oncorhynchus keta* (Walbaum) and *O. gorbuscha* (Walbaum), have been collected in the river (Komiyama, 1981). Dolly Varden were visually observed and collected in a range extending from the mouth of the river to about 400 m upstream where there was a 3.5 m high waterfall, apparently forming a barrier to upstream migration. Only resident types of the Dolly Varden have been taken from upstream.

The number of fish longer than about 10 cm

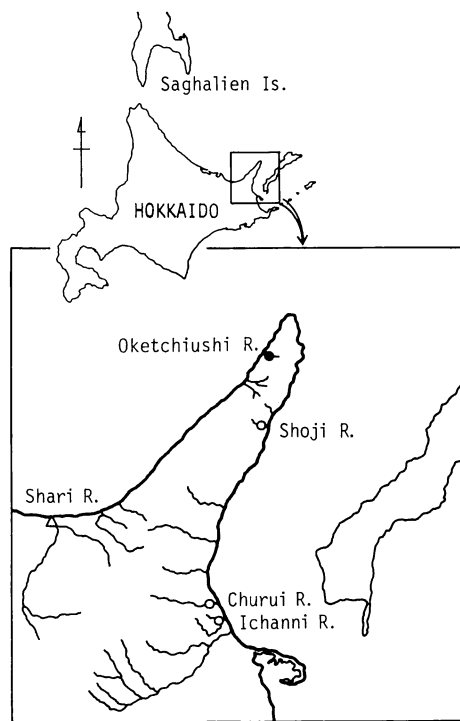


Fig. 1. Location of the Oketchiushi River in Shiretoko Peninsula, Hokkaido. ●, present collection; ○, by Hikita (1962), Ishigaki (1967) and Maekawa (1973); △, Kubo (1967) reported an anadromous individual collected from the Shari River, June 26th, 1959, but the detail characteristics have not been reported.

in total length (older than 1+ year) were counted repeatedly in two pools between the mouth to the waterfall by diving observations. Pool A, located 40 m upstream from the mouth of the river, is about 6 m at its widest width, 25 m in length, and 1 m at its deepest point, and Pool B, which is directly below the waterfall, is 8 m at its widest width, 12 m in length, and 2.5 m at its deepest point. The number of Dolly Varden in Pools A and B was 34 and 88 in mean, including 3 and 1 silvery specimens of Dolly Vardens, respectively (Fig. 2).

Eighty-six specimens of Dolly Varden including three silvery ones and 0+-year-old individuals were collected by a casting net after the diving observations. One silvery Dolly Varden escaped (about 27 cm in total length) in the sea during

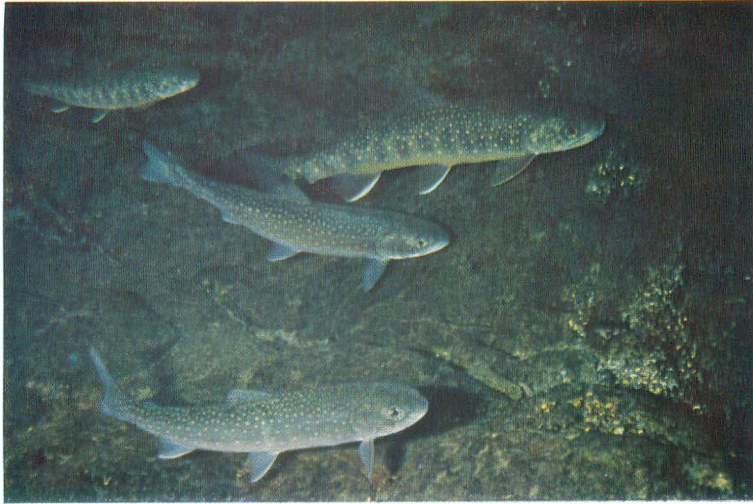


Fig. 2. Photograph taken at Pool A by skin diving observation, August 3rd, 1981. Lower two fish are silvery individuals of the Dolly Varden.

the collecting. All of the resident charrs collected were preserved in 10% formalin, and the silvery specimens were placed in 70% alcohol after fixed in 10% formalin for a day to retain the silvery coloration. Otoliths were used for determining their ages. Table 1 shows the measurements of the silvery specimens as compared with those of the sea-run individuals reported previously (Hikita, 1962; Ishigaki,

1967; Maekawa, 1973). The size of the present silvery specimens was intermediate between that of the anadromous ones from the Ichanni and Churui Rivers and smolt from the Shoji River. Numerical characters of the present silvery ones, such as the number of vertebrae and gill rakers, were fewer than those of anadromous ones from the Churui and Ichanni Rivers, as well as those of the smolt from the

Table 1. Counts and measurements of the silvery specimens from the Oketchiushi River, compared with the data of the sea-run type from eastern Hokkaido. Number of dorsal fin rays was counted from a soft-X ray radiograph.

	Ichanni R. Ishigaki, 1967	Churui R. Hikita, 1962	Shoji R. Maekawa. 1973	Present samples		
				S ₁	S ₂	S ₃
Total length (mm)	339.0	372.0	153.1	203.3	192.4	221.9
Fork length (mm)	—	359.0	—	193.0	184.6	212.5
Body length (mm)	298.0	—	127.8	172.1	188.0	165.0
Head length (mm)	64.0	—	30.0	41.0	37.2	42.6
Body depth (mm)	49.0	—	23.4	33.6	28.7	38.6
Diameter of eye (mm)	7.5	—	7.0	7.2	7.2	6.6
Number of dorsal fin rays	iii, 10	iii, 9	iii, 11	iii, 11	iii, 12	iii, 11
gill-rakers	10+12=22	10+12=22	8+11=19	7+12=19	6+12=18	7+12=19
branchiostegal rays	13, 14	11, 12	10, 11	11, 11	10, 11	10, 11
pyloric caeca	32	28	18	25	23	20
vertebrae	66	66	60	61	60	58
Sex	♂	♂	♀	♂	♀	♀
Age	—	—	—	5+	5+	3+
Stage of maturity*	—	(II)	(I)	V	II	II
Date of collecting	May 1 '64	Aug. 18 '62	Apr 23 '72	Aug. 3 '81	Aug. 3 '81	Aug. 4 '81

* according to Blackett (1968).



Fig. 3. Scale from Specimen S_3 caught in the Oketchiushi River, August 4th, 1981, as shown in Table 1. Note the 'sea-growth zone' around the edge of the scale.

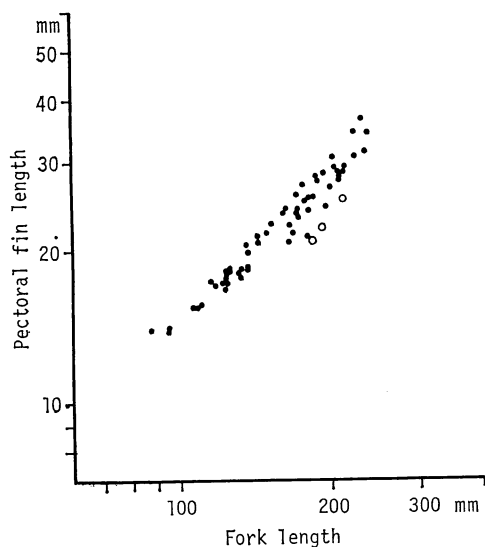


Fig. 4. Relation of pectoral fin length to fork length in the river residents (●) and the silvery Dolly Varden (○) from the Oketchiushi River.

Shoji River.

We examined the patterns of circuli in scales of the silvery specimens and compared the relative growth curves between silvery individuals and resident fish in the Oketchiushi River in order to determine whether the former were anadromous. An incipient sea-growth

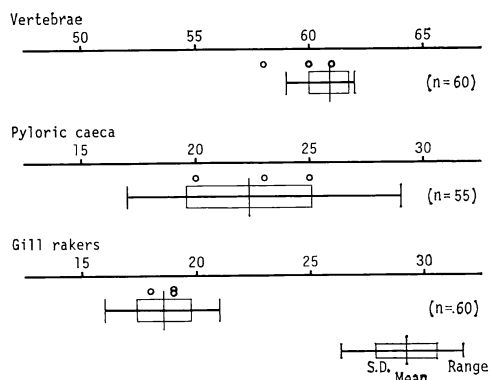


Fig. 5. Comparison of the number of vertebrae, pyloric caeca and gill rakers in three silvery individuals (shown by circles) and river resident ones of the Dolly Varden collected in the Oketchiushi River.

zone, which was distinct from the river-growth zone, could be recognized around the edge of the scales of specimens S_1 and S_2 . Specimen S_3 appeared to have a more distinct and wider sea-growth zone than in the others (Fig. 3). From the ratio of the distance of the sea-growth to the river-growth zone, the smoltification was estimated to have occurred in individuals from 157.1 to 163.7 mm in fork length. No winter zone, however, could be observed in the sea-growth zone from the border of the river-growth zone to the edge of the scale.

In the relative growth curve of the river-resident population, i.e., the relation of the fork length and the pectoral fin length, no growth inflections were observed, but the relative value was clearly lower in the present silvery specimens than in the resident ones (Fig. 4). Maekawa (1978) has recognized three inflections in the relative growth curve of the sea-run type of the Dolly Varden. Martin (1949) and Maekawa (1978) reported that the fork length of the second inflection coincided with that of smoltification in the Dolly Varden.

The stomachs of all three specimens were scanty, and the reproductive organs of specimens S_2 and S_3 were stage II representing the stage as the individual approaches full maturity according to Blackett (1968). Therefore, the present silvery charrs were thought to be anadromous individuals. Specimens S_2 and S_3 might be, at least, individuals just ascending to the river to spawn.

Ishigaki (1967) suggested that anadromous specimens probably hatched in a river located in a region farther north of Hokkaido, because they possessed significantly higher values in meristic characteristics than the river resident population. Numbers of vertebrae, pyloric caeca and gill rakers were compared for the present silvery specimens and the river resident population of the Oketchiushi River. The number of vertebrae was counted by using a soft-X ray. No significant differences in characteristics were recognized between the two groups of specimens, though number of vertebrae of specimen S_1 was somewhat less than that of the resident charrs (Fig. 5). From the present results, we speculated that the silvery specimens originated in a river in the Shiretoko district, not in a region farther north of Hokkaido. As stated by Armstrong and Morrow (1980), if the Dolly Varden has strong homing tendencies and returns to spawn in the river from which it originated, it is conceivable that maturing specimens hatched in the Oketchiushi River.

McPhail (1961) stated that *S. malma* was usually non-migratory at the southern extremes of its range, such as in Hokkaido. Even in southern Saghalien Island, however, the nearest island to Hokkaido, *S. malma* has sea-run and non-migratory populations (Ishida, 1942). Komiyama (1981, unpublished data) has collected eight specimens of silvery Dolly Varden from 4 rivers in eastern Hokkaido, in addition to the present river. From these facts, the fish might have smoltified at a relatively higher rate in and around the Shiretoko Peninsula, one of the coldest regions in Hokkaido, than we had so far known.

On the basis of our findings, we conclude that the life cycle of some of the eastern Hokkaido populations of Dolly Varden are as follows. The majority of fishes in the population are non-migratory, but there are a few sea-run individuals. Beginning at about age 3⁺, a few fish smoltify, and become silvery to descend from rivers. The duration of life in the sea may not be more than half a year. Some fish, therefore, ascend to rivers to spawn in the year when they smoltify, suggesting that they are more precocious than typical anadromous Dolly Varden in the northern region of its range.

Acknowledgments

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Literature cited

- Armstrong, R. H. and J. E. Morrow. 1980. The dolly varden charr, *Salvelinus malma*. In: Balon, E. K., ed: Charrs, pp. 99~140, figs. 1~10.
- Blackett, R. F. 1968. Spawning behavior, fecundity and early life history of anadromous Dolly Varden *Salvelinus malma* (Walbaum) in south-eastern Alaska. Alaska Dep. Fish and Game Res. Rep., 6: 1~85, figs. 1~61.
- Hikita, T. 1962. On the sea-run char, *Salvelinus malma* (Walbaum) taken from an eastern stream of Hokkaido Island. Sci. Rep. Hokkaido Fish Hatchery, 17: 59~63, figs. 1~2. (In Japanese).
- Ishida, J. 1942. *Salvelinus* in southern Saghalien. Zool. Mag., 54: 431~440, 1 fig., pls. 1~2. (In Japanese with English summary).
- Ishigaki, K. 1967. On a anadromous specimen of the Dolly Varden charr, *Salvelinus malma* (Walbaum), from the Ichanni River, eastern Hokkaido. Bull. Biogeogr. Soc. Japan, 24: 37~43, figs. 1~3. (In Japanese with English summary).
- Kani, T. 1944. Ecology of torrent-inhabiting insects. In: Furukawa, H., ed.: Insects, 1, pp. 171~317, figs. 1~18, pls. 1~2, Kenkyu-sha, Tokyo. (In Japanese).
- Komiyama, E. 1981. Freshwater fishes fauna of rivers in the Shiretoko Peninsula. In: Ohtaishi, N., ed.: Report of the survey on vertebrate communities in Shiretoko Peninsula, Hokkaido Japan, pp. 4~19, 1 fig. (In Japanese with English summary).
- Kubo, T. 1967. Ecological and physiological studies on the Dolly Varden charr (*Salvelinus malma*) in Lake Shikaribetsu, Hokkaido. Sci. Rep. Hokkaido Salmon Hatchery, 21: 11~33, figs. 1~15, pl. 1. (In Japanese with English summary).
- Maekawa, K. 1973. On a silvery smolt of the Dolly Varden *Salvelinus malma*, collected from the Shiretoko Peninsula, Hokkaido. Japan. J. Ichthyol., 20: 245~247, fig. 1. (In Japanese with English summary).
- Maekawa, K. 1978. Growth and development of

Salvelinus malma miyabei compared with other forms of *S. malma*. Japan. J. Ichthyol., 25(1): 9~18, figs. 1~7.

- Martin, W. R. 1949. The mechanics of environmental control of body form in fishes. Univ. Toronto Studies, Biol. Ser., 58: 1~72, figs. 1~24.
- McPhail, J. D. 1961. A systematic study of the *Salvelinus alpinus* complex in northern America. J. Fish. Res. Bd. Canada, 18: 793~816, figs. 1~6.

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知床半島における降海型オシロコマの出現

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1981年8月3~4日にかけて、知床半島先端にある小河川、オケツチウシ川でオシロコマを集中的に採集した結果、銀白色個体3尾を捕獲した。この標本と同河川で採集した河川残留型オシロコマの諸形質を比較した。銀白色個体の鱗には海洋生活帯が認められた。相対生長比（特に尾叉長—胸鰭長）は銀白色個体が河川残留型よりも明らかに低かった。しかし、数的形質には両者間で明らかな差はなかった。これらの結果から、銀白色個体がオケツチウシ川産の降海型湖上個体であること、知床地方において、従来考えられていたよりも、降海型は多く出現している可能性があることなどを論議した。

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