

## A Parasitological Survey of Sockeye Salmon (*Oncorhynchus nerka*) and Dolly Varden (*Salvelinus malma*) from the Ozernaya River System, Kamchatka

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**Abstract.**—Adult sockeye salmon *Oncorhynchus nerka* from the Ozernaya River near the outlet of Lake Kuril were infected with *Myxobolus arcticus* (Myxozoa) in the brain and spinal cord and with *Philonema oncorhynchi* (Nematoda) in the peritoneal cavity. Some of these sockeye salmon were affected by light visceral adhesions. This pathological condition was found in male fish only. *Myxobolus arcticus* was also found in the brain of adult Dolly Varden *Salvelinus malma* from a river flowing into Lake Kuril. There was no substantial difference in spore measurement of *M. arcticus* from salmonids among Kamchatka (Russia), Hokkaido (Japan), and British Columbia (Canada). The Dolly Varden carried *Salmincola carpionis* (Copepoda) on the roof and floor of the buccal cavity and *Anisakis simplex* (third-stage larvae) (Nematoda) on the viscera.

### Introduction

Based on the 1992 program of fisheries science and technology cooperation between Japan and Russia, two Japanese scientists (K.N. and S.U.) visited Kamchatka, Russia, in August 1992. The main purpose of their visit was to get information on various aspects of the biology of salmonids in Kamchatka and to discuss with Russian scientists the promotion of salmonid research in both nations, but they also conducted with Russian scientists a parasitological survey of salmonids from the Ozernaya River system. This survey was closely associated with the International North Pacific Fisheries Commission (INPFC): under the auspices of INPFC the Japanese scientists used parasites as biological tags for determining the ocean distribution of Asian and North American chinook salmon *Oncorhynchus tshawytscha* (Nagasawa and Urawa, 1987; Urawa and Nagasawa, 1988, 1989, 1991; Urawa et al., 1990). Furthermore, visceral adhesions, one of parasitic diseases of salmonids, are known to be commonly present in offshore-caught sockeye salmon *O. nerka* (Nagasawa, 1985, 1987), but this disease has never been

studied for sockeye salmon that have returned to Kamchatka. This paper reports the preliminary results of the Japan-Russia cooperative parasitological survey in Kamchatka.

### Materials and Methods

Thirty mature sockeye salmon *Oncorhynchus nerka* were caught with a beach seine in the Ozernaya River near the outlet of Lake Kuril on August 7, 1992 (Fig. 1). These fish were soon brought to the laboratory of the Lake Kuril Field Station and were processed by recording fork length, body weight, sex, gonad weight, infection of *Philonema oncorhynchi* (Nematoda: Philometridae), and the presence or absence of visceral adhesions. *Philonema oncorhynchi* is a causative agent of visceral adhesions of sockeye salmon (cf. Nagasawa, 1985, 1987). The brain and anterior part of spinal cord were removed from each fish and fixed in 10% formalin. Two scales were also taken from the INPFC preferred area of the body surface of each fish for later age determination (Major et al., 1972)

Ten adult Dolly Varden *Salvelinus malma* were collected in the Vychenkiya River flowing into Lake Kuril by rod and line on August 9, 1992 (Fig. 1). These fish were examined for nematodes in the body cavity and for parasitic

copepods on the body surface and in the branchial and buccal cavities, and when parasites were present, those parasites were removed and fixed in 10% formalin. The brain was also taken from each fish and fixed similarly.

The brains and spinal cords removed from the sockeye salmon and Dolly Varden were brought to Japan and examined for the presence of *Myxobolus arcticus* (Myxozoa: Myxobolidae) by using a microscope (200-400 x). For a comparison of regional variations in spore measurement of this parasite, the spores were measured from Kamchatkan, Japanese, and Canadian salmonids.

### Results and Discussion

Nine (30.0%) of the 30 sockeye salmon examined were

infected with *Myxobolus arcticus* in the brain and spinal cord (Table 1). This parasite was also found in the brain of all Dolly Varden examined (Table 2). These findings confirm the presence of *M. arcticus* in the Ozernaya River system. According to Kononov (1971), this myxosporean (as *M. neurobius*) is the most frequently occurring parasite of Kamchatkan fishes, including various salmonids (*Oncorhynchus nerka*, *O. kisutch*, *Salvelinus* spp., *Prosopium cylindraceum*, and *Thymallus arcticus*). The spores of *M. arcticus* found were pear-shaped, and there was no substantial difference in spore measurement of *M. arcticus* from salmonids from Kamchatka (Russia), Hokkaido (Japan), and British Columbia (Canada) (Table 3). Another myxosporean species, *M. neurobius*, which is a

**Table 1.** Parasites, visceral adhesions, and biological features of 30 mature sockeye salmon *Oncorhynchus nerka* from the Ozernaya River near the outlet of Lake Kuril on August 7, 1992. +, positive; -, negative.

No.	Fork length (cm)	Body weight (kg)	Sex	Gonad weight (g)	Age	<i>Myxobolus arcticus</i>	<i>Philonema oncorhynchi</i>	Visceral adhesions
1	68.0	4.50	♂	135	2.3*	+	+	-
2	62.0	3.20	♂	89	2.2	-	+	+
3	50.5	1.75	♂	87	2.2	-	+	-
4	66.5	3.95	♂	67	2.3	-	+	+
5	56.0	2.40	♂	61	2.2	-	+	-
6	52.0	1.95	♂	99	2.2	-	+	-
7	59.0	2.85	♂	67	2.2	-	+	-
8	54.5	2.15	♂	105	2.2	+	+	-
9	56.0	2.20	♂	125	2.2	+	+	-
10	50.0	1.70	♂	79	2.2	+	+	+
11	55.0	2.00	♂	87	2.2	-	+	+
12	58.5	2.80	♂	74	2.2	-	+	+
13	52.0	1.90	♂	93	2.2	-	+	-
14	51.0	1.80	♂	79	2.2	-	+	-
15	58.0	2.45	♂	84	2.2	-	+	-
16	54.0	2.40	♂	59	2.2	+	+	-
17	54.5	2.10	♂	104	2.2	-	+	+
18	57.5	2.55	♂	100	2.2	+	+	-
19	57.5	2.40	♂	45	3.2	-	+	-
20	54.5	2.80	♂	14	2.3	-	+	+
21	54.5	2.20	♀	103	2.2	-	+	-
22	64.0	3.70	♀	259	2.3	-	+	-
23	54.0	2.10	♀	129	2.2	+	+	-
24	54.5	2.05	♀	126	2.2	-	+	-
25	53.0	1.90	♀	115	2.2	-	+	-
26	58.5	2.95	♀	164	2.3	+	+	-
27	52.5	2.00	♀	128	2.2	-	+	-
28	58.5	2.65	♀	301	2.3	+	+	-
29	59.0	3.10	♀	199	2.3	-	+	-
30	54.0	2.00	♀	116	2.2	-	+	-

\* Ages were recorded according to the European system.

biological tag of Columbia River chinook salmon (Urawa and Nagasawa, 1988, 1989, 1991; Urawa et al., 1990), was not found in the Kamchatkan sockeye salmon nor Dolly Varden.

Seven sockeye salmon (23.3%) were affected by light visceral adhesions (Fig. 2, Table 1). In cases of visceral adhesions of sockeye salmon caught on the high seas of the North Pacific Ocean, visceral organs are tightly surrounded by a thick connective tissue sheath (Nagasawa, 1985), but such conditions were never found. Only male fish had visceral adhesions. All sockeye salmon examined harbored *Philonema oncorhynchi* (Fig. 3). Concerning the differ-

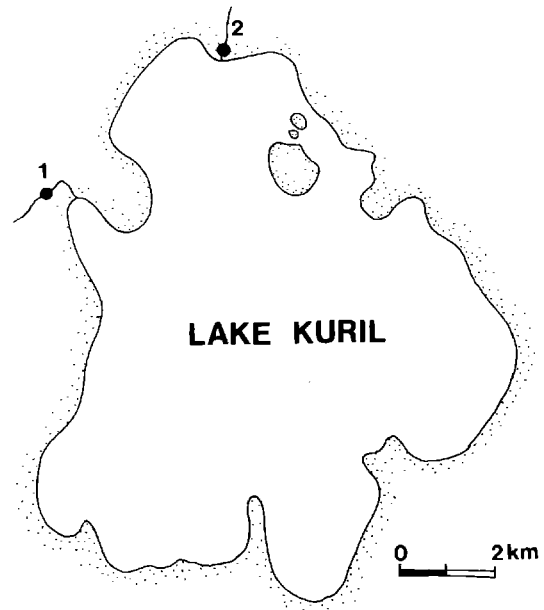


Fig. 1. Map of Lake Kuril, showing locations (filled circles) sampled for sockeye salmon (*Oncorhynchus nerka*) and Dolly Varden (*Salvelinus malma*). Sockeye salmon were caught in the Ozernaya River (location 1) near the outlet of Lake Kuril. Dolly Varden were sampled in the Vychenkiya River (location 2) flowing into Lake Kuril.

Table 2. Parasites and biological features of 10 adult Dolly Varden *Salvelinus malma* from the Vychenkiya River flowing into Lake Kuril on August 9, 1992. +, positive.

No.	Fork length (cm)	Body weight (g)	Sex	<i>Myxobolus arcticus</i>	<i>Salmincola carpionis</i>
1	43.0	650	♂	+	5*
2	41.0	550	♂	+	1
3	46.5	1,000	♂	+	2
4	46.5	750	♂	+	2
5	47.0	550	♂	+	12
6	47.0	750	♂	+	0
7	39.0	600	♂	+	0
8	39.0	550	♀	+	0
9	44.0	750	♀	+	0
10	40.0	500	♀	+	4

\* Number of copepods found.

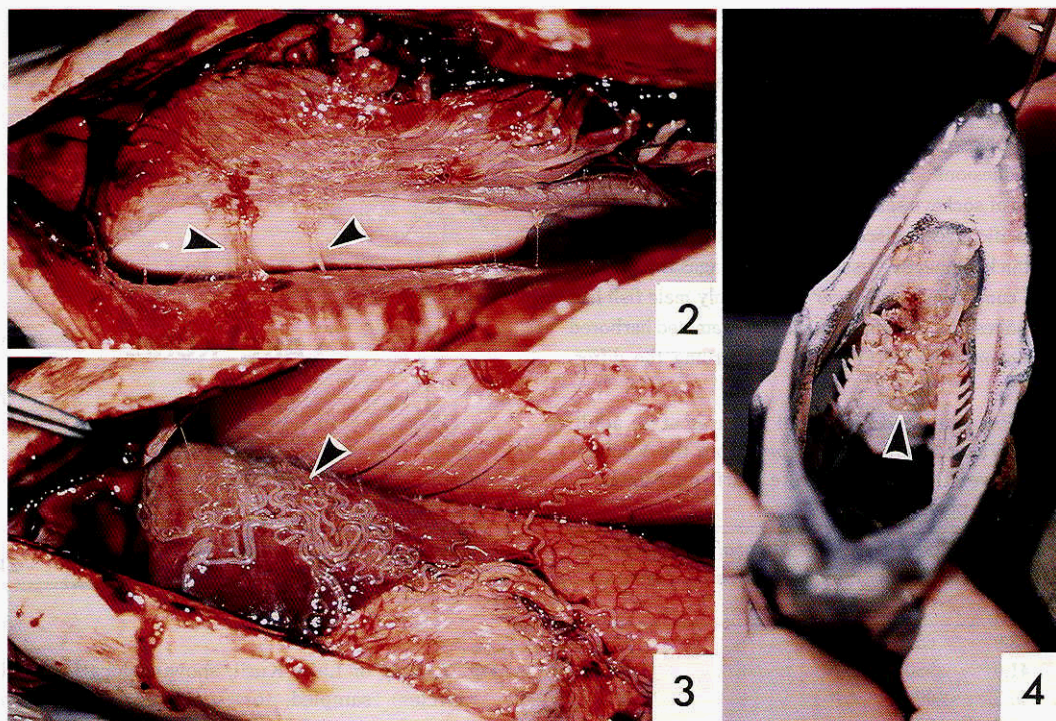
Table 3. Spore measurements of *Myxobolus arcticus* from the brain of Dolly Varden (*Salvelinus malma*) and sockeye salmon (*Oncorhynchus nerka*) from Kamchatka (Ozernaya River), Hokkaido (Chitose River), and British Columbia (Sproat Lake).

Host (Locality)	No. of spores measured	SL* <sup>1</sup>	SW* <sup>1</sup>	ST* <sup>1</sup>	PCL* <sup>1</sup>	PCW* <sup>1</sup>	NC* <sup>2</sup>	SW/SL	PCL/SW
Dolly Varden (Ozernaya River)	30	14.4±0.6 (13.3-15.6) <sup>3</sup>	10.0±0.4 (9.4-10.9)	7.4±0.3 (6.8-7.8)	8.6±0.6 (7.0-9.4)	3.7±0.3 (3.1-4.5)	8.9±0.7 (8-9)	0.70±0.04 (0.60-0.78)	0.86±0.07 (0.69-0.98)
Sockeye salmon (Ozernaya River)	30	13.8±0.6 (12.5-15.2)	8.6±0.6 (7.6-9.8)	6.6±0.4 (5.5-7.4)	8.1±0.6 (7.0-9.2)	3.2±0.2 (2.8-3.9)	9.6±0.1 (8-12)	0.62±0.03 (0.53-0.70)	0.95±0.09 (0.75-1.11)
Sockeye salmon (Chitose River)	30	13.2±0.6 (11.9-14.4)	8.4±0.5 (7.8-9.4)	6.6±0.3 (5.5-7.0)	8.3±0.5 (7.0-9.5)	3.1±0.2 (2.3-3.7)	11.0±1.0 (9-13)	0.64±0.04 (0.57-0.73)	1.00±0.07 (0.86-1.11)
Sockeye salmon (Sproat Lake)	50	14.2±0.7 (12.9-15.6)	8.6±0.5 (7.8-9.8)		8.1±0.5 (7.3-9.2)	3.4±0.2 (2.5-4.0)		0.61±0.04 (0.50-0.69)	0.96±0.07 (0.82-1.14)

\*<sup>1</sup>SL, spore length; SW, spore width; ST, spore thickness; PCL, polar capsule length; PCW, polar capsule width; in μm.

\*<sup>2</sup> NC, number of coils per polar filament.

\*<sup>3</sup> Mean±SD (range).



Figs. 2-4. Photographs of parasitized salmonids from the Ozernaya River system, Kamchatka 2, Sockeye salmon (*Oncorhynchus nerka*, male, 50.0 cm fork length) affected by light visceral adhesions (arrows) 3, Sockeye salmon (female, 53.0 cm fork length) infected with *Philonema oncorhynchi* (arrow) on the viscera. 4, Dolly Varden (*Salvelinus malma*, male, 47.0 cm fork length) infected with *Salmincola carpionis* (arrow) on the roof of the buccal cavity

ence in severity of visceral adhesions between offshore and returned sockeye salmon, Nagasawa (1987) suggested that visceral adhesions are transitory and disappear with fish maturation. He also noted that adhesions are more commonly in male fish than in female fish. Konovalov (1971) reported the infection of *P. oncorhynchi* in sockeye salmon from several Kamchatkan lakes, including Lake Kuril.

The Dolly Varden carried *Salmincola carpionis* (Copepoda: Lernaeopodidae) on the roof and floor of the buccal cavity (Fig. 4). Third-stage larvae of *Anisakis simplex* (Nematoda: Anisakidae) were also found on the viscera. Konovalov (1971) found *Anisakis* sp. (probably *A. simplex*) larvae in "diadromous *Salvelinus*" from Lake Kuril. The presence of *A. simplex* indicates that the Dolly Varden have returned to Lake Kuril after staying at sea.

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#### オゼルナヤ川水系のベニザケとオシヨロコマの寄生虫調査

長澤和也・浦和茂彦・V. A. ズビーニン

漁業分野における日本とロシアとの科学技術協力計画の一環として、1992年8月に日本人研究者がカムチャツカを訪問した際、オゼルナヤ川水系でベニザケとオシヨロコマの寄生虫調査を実施した。クリル湖の流出口に近いオゼルナヤ川で採集したベニザケ成熟魚は、脳と脊髄に粘液胞子虫類の *Myxobolus arcticus*、腹腔内に線虫類の *Philonema oncorhynchi* の寄生を受けていた。ベニザケには軽い内臓癒着症を呈した個体があり、それは雄魚だけに認められた。*Myxobolus arcticus* の寄生は、クリル湖に流入するピチェンキア川で採集したオシヨロコマの脳にも認められた。ベニザケとオシヨロコマから得た *Myxobolus arcticus* の胞子の計測値は、北海道（日本）やブリティッシュ・コロンビア州（カナダ）のベニザケから得た *Myxobolus arcticus* の胞子の計測値とほぼ同じであった。オシヨロコマは、口腔壁にカイアシ類の *Salmincola carpionis*、腹腔内に線虫類の *Anisakis simplex*（第3期幼虫）の寄生を受けていた。