

RESEARCH NOTE

A Status of *Lepeophtheirus salmonis* (Copepoda: Caligidae) on Seawater-cultured Coho Salmon (*Oncorhynchus kisutch*) and Rainbow Trout (*O. mykiss*) in Japan

Shigehiko Urawa^{*1}, Teiichi Kato^{*2}, and Akira Kumagai^{*3}

^{*1} Research Division, National Salmon Resources Center, Fisheries Agency of Japan,
2-2 Nakanoshima, Toyohira-ku, Sapporo 062-0922, Japan

^{*2} National Research Institute of Aquaculture, Fisheries Agency of Japan,
Nansei-cho, Watarai-gun, Mie 516-0108, Japan

^{*3} Fisheries Development Division, Miyagi Prefectural Government,
Honcho 3, Aoba-ku, Sendai 980-0014, Japan

Abstract.— Infection levels of the salmon louse *Lepeophtheirus salmonis* were examined for coho salmon (*Oncorhynchus kisutch*) and rainbow trout (*O. mykiss*) cultured in seawater net pens in northern Japan. The prevalence of *L. salmonis* on coho salmon gradually increased from 59.2% in late June to 84.6% in August when fish were harvested, but the mean intensity remained less than 3.2 parasites per fish. The prevalence of parasite on rainbow trout increased to 92% in November with a mean intensity of 4.1 parasites per fish. The low infection levels of *L. salmonis* among seawater cultured salmonids in Japan may be largely attributable to the complete single year class culture system harvested within one year, and to relatively low susceptibility of host fish to the parasite.

Key words: parasitic Copepoda, *Lepeophtheirus salmonis*, prevalence, coho salmon, rainbow trout

Introduction

The salmon louse *Lepeophtheirus salmonis* (Krøyer, 1837) is a marine ectoparasitic copepod infecting wild and cultured salmonids in the northern Hemisphere. The heavy parasite infections cause serious problems in marine salmonid farms in the Atlantic coasts of Scotland, Norway, Ireland, and Canada (see Boxshall and Defaye 1993). In addition, the parasite has impact on wild populations of sea trout (*Salmo trutta*) and sockeye salmon (*Oncorhynchus nerka*) (Birkeland 1996; Johnson et al. 1996).

In Japan, marine farms annually produce approximately twenty thousand tons of coho salmon (*O. kisutch*) (Mahnken 1991). Most salmon farms are located along the northeast coast of Honshu Island in the Sanriku District. In addition, several farms attempt rainbow trout (*O. mykiss*) cultures in seawater net pens in Japan. The salmon louse was recorded from these farmed coho salmon and rainbow trout

(Nagasawa and Sakamoto 1993) as well as from wild fishes (Nagasawa and Yanagisawa 1992; Nagasawa et al. 1993), but the impact of *L. salmonis* on salmonid mariculture have not been well known. The aim of the present study is to assess the infection level of *L. salmonis* on seawater-reared coho salmon and rainbow trout in Japan.

Materials and Methods

Coho salmon

Coho salmon were reared in net pens in Shizugawa Bay along the Pacific coast of northeastern Honshu (Fig. 1). Underyearling coho salmon smolts (body weight about 150 g) were stocked in seawater net pens in the middle of October, 1991, and farmed by the early August of the next year (see Mahnken 1991). Fish harvested in the Shizugawa Market were bi-weekly examined for parasites between June and August in 1992.

Rainbow trout

A marine rearing experiment was conducted for rainbow trout in Katsurakoi Harbor near Kushiro along the Pacific coast of eastern Hokkaido (Fig. 1)

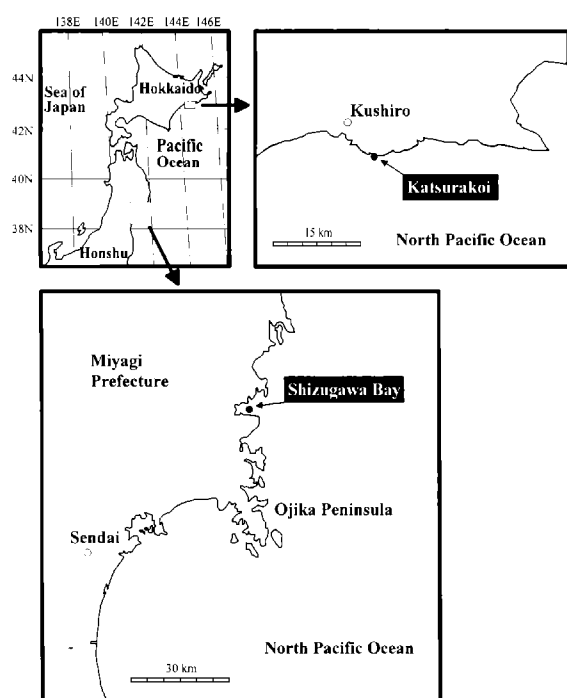


Fig. 1. Maps showing the sampling locations for parasite survey of seawater-cultured coho salmon and rainbow trout in northern Japan.

for 6 months in 1988. One thousand rainbow trout (mean weight 215 g) previously reared in a freshwater hatchery for two years were held in a seawater net pen on June 14, 1988. Fish anaesthetized after capture using MS222 were examined for parasites on September 2, October 6, and November 22, 1988. No treatment was conducted for salmon lice throughout the rearing period.

Parasite survey

Fish were examined for *L. salmonis* including

young and adult stages. The fork length and body weight of each fish were also measured. Some lice were preserved in 10% formalin for species identifications. The terms indicating the level of parasite infections (prevalence, mean intensity, and abundance) were accordance with those proposed by Margolis et al. (1982).

Results

Coho salmon

The prevalence of *L. salmonis* gradually increased from 59.2% in late June to 84.6% in August (Table 1). The mean intensity also increased to 3.2 parasites per fish in late July, but slightly decreased when water temperature became close to 20°C (Fig. 2). There were no significant relations between the

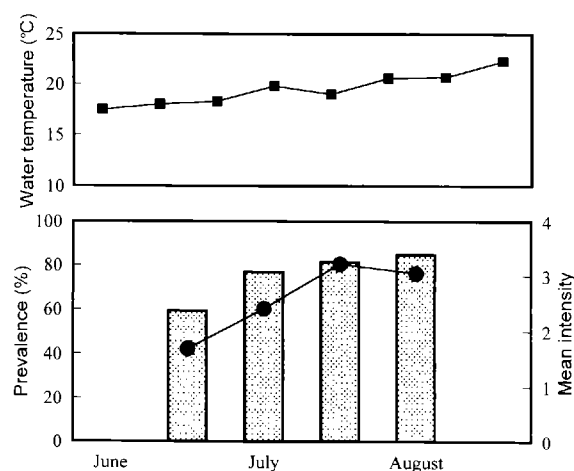


Fig. 2. Seasonal changes in prevalence (columns in %) and intensity (closed circles) of *Lepeophtheirus salmonis* on coho salmon, and surface water temperature (closed squares) in Shizugawa Bay, northeastern Honshu.

Table 1. Prevalence, intensity and abundance of *Lepeophtheirus salmonis* on coho salmon reared in Shizugawa Bay, northeastern Honshu, and on rainbow trout reared in Katsurakoi, eastern Hokkaido.

Date of	Fish size		Number of fish		Prevalence	Mean intensity	Abundance	Maximum
survey	Fork length (cm)	weight (g)	examined	infected	(%)			
Coho salmon in Shizugawa in 1992								
June 29	57.5 ± 3.5*	3,260 ± 600*	76	45	59.2	1.69 ± 1.20*	1.00 ± 1.24*	6
July 13	54.8 ± 4.8	2,780 ± 720	167	128	76.7	2.41 ± 1.47	1.85 ± 1.64	7
July 28	56.0 ± 5.3	2,800 ± 820	91	74	81.3	3.22 ± 2.28	2.62 ± 2.41	11
August 8	57.8 ± 3.8	3,110 ± 680	52	44	84.6	3.05 ± 1.80	2.58 ± 1.99	7
Rainbow trout in Katsurakoi in 1988								
September 2	27.0 ± 2.8	301 ± 119	137	3	2.2	1.00 ± 0	0.02 ± 0.15	1
October 6	30.0 ± 3.5	478 ± 188	120	60	50.0	2.48 ± 1.23	1.24 ± 1.52	6
November 22	33.7 ± 3.6	694 ± 227	123	113	91.9	4.13 ± 2.28	3.80 ± 2.46	18

*Mean ± SD.

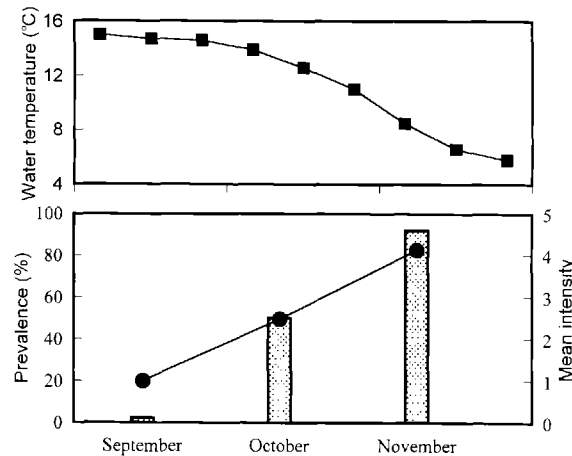


Fig 3. Seasonal changes in prevalence (columns in %) and intensity (closed circles) of *Lepeophtheirus salmonis* on rainbow trout, and surface water temperature (closed squares) in Katsurakoi Harbor, eastern Hokkaido.

parasite intensity and fish size (fork length, weight or condition factor; $p > 0.05$).

Rainbow trout

The prevalence was only 2.2% in September, but increased to 92% in November despite of decreased water temperature below 5°C (Fig. 3). The intensity also increased to average 4.1 parasites per fish with a maximum of 18 parasites per fish in November. There were no significant relations between the parasite intensity and fish size (fork length, weight or condition factor; $p > 0.05$) throughout the parasite surveys.

Discussion

Salmon louse causes serious problems to salmon culture industry in Norway, Scotland, Iceland and North America. In Japan, however, serious disease caused by sea lice has not been reported, except that *Caligus orientalis* caused heavy mortalities among pen-reared rainbow trout along the coast of Okhotsk Sea in eastern Hokkaido (Urawa and Kato 1991). The present study confirmed that the infection of *L. salmonis* is low levels on cultured coho and rainbow trout in northern Japan. Hemorrhages were observed in the perianal region of infected fish, but these might not cause severe disease.

In the North Pacific Ocean the infection level of *L. salmonis* was different among six species of Pacific salmon: pink salmon (*O. gorbuscha*) had highest infection levels, followed by steelhead trout (*O. mykiss*), chinook (*O. tshawytscha*) and coho salmon (Nagasawa et al. 1994). Salmon louse is prevalent on pen-reared Atlantic salmon and chinook

salmon (Johnson 1993), but coho salmon is more resistant to infection than these fishes (Johnson and Albright 1992a, 1992b). The low susceptibility of host fish against *L. salmonis* may result in the low level of the parasite infections on cultured coho salmon in Japan.

The Sanriku District of northeastern Honshu has an annual seawater surface temperature range from 9 to 22°C (Mahnken 1991). Then cultured salmon are completely harvested before early August to avoid the high summer water temperature exceeding the upper lethal limit for coho salmon. By comparison, seawater temperatures approach the lower lethal limit for salmonids in winter months along the Pacific coast of Hokkaido where fish are harvested by the end of November. Thus Japanese marine salmon culture is characterized by a fact that fish are reared in single year class sites for less than one year. Bron et al. (1994) found a different pattern of population dynamics of *L. salmonis* on farmed Atlantic salmon between single and multiple year class sites in Scotland. On the single year class site, mean intensity of *L. salmonis* gradually increased from one to two lice in early August to over 45 lice per fish in October of the next year. On the multiple year class site, however, numbers rose far more rapidly than on single year class sites with mean intensity reaching 40 by August and peaking at over 100 lice per fish in October of the first year. The low level of *L. salmonis* infections on farmed salmonids in Japan may be attributable to a single year culture that salmon are completely reared in single year class sites for less than one year. A main source of the initial infection may be salmon lice infecting wild chum salmon (*O. keta*), but their migration to the coastal waters of northern Japan is limited from the late August to December.

In conclusion, the infection level of *L. salmonis* is quite low among seawater cultured coho salmon and rainbow trout in Japan. It may be attributable to a single year class culture system harvested within one year and relatively low susceptibility of host fish to the parasite.

References

- Birkeland, K. 1996. Consequences of premature return by sea trout (*Salmo trutta*) infested with the salmon louse (*Lepeophtheirus salmonis* Krøyer): migration, growth, and mortality. *Can. J. Fish. Aquat. Sci.*, **53**: 2808-2813.
- Boxshall, G. A., and D. Defaye. 1993. Pathogens of wild and farmed fish: sea lice. Ellis Horwood, New York. 378 p.

- Bron, J. E., C. Sommerville, R. Wootten, and G. H. Rae. 1994. Influence of treatment with dichlorvos on the epidemiology of *Lepeophtheirus salmonis* (Krøyer, 1837) and *Caligus elongatus* Nordmann, 1832 on Scottish salmon farms. In Pathogens of wild and farmed fish: sea lice (edited by G. A. Boxshall and D. Defaye). Ellis Horwood, London. pp. 263-274.
- Johnson, S. C. 1993. A comparison of development and growth rates of *Lepeophtheirus salmonis* (Copepoda: Caligidae) on native Atlantic salmon (*Salmo salar*) and chinook salmon (*Oncorhynchus tshawytscha*). In Pathogens of wild and farmed fish: sea lice (edited by G. A. Boxshall and D. Defaye). Ellis Horwood, London. pp. 68-80.
- Johnson, S. C., and L. J. Albright. 1992a. Comparative susceptibility and histopathology of the host response of native Atlantic, chinook, and coho salmon to experimental infection with *Lepeophtheirus salmonis* (Copepoda: Caligidae). Dis. Aquat. Org., **14**: 179-193.
- Johnson, S. C., and L. J. Albright. 1992b. Effects of cortisol implants on the susceptibility and the histopathology of the responses of native coho salmon *Oncorhynchus kisutch* to experimental infection with *Lepeophtheirus salmonis* (Copepoda: Caligidae). Dis. Aquat. Org., **14**: 195-205.
- Johnson, S. C., R. B. Blaylock, J. Elphick, and K. D. Hyatt. 1996. Disease induced by the sea louse (*Lepeophtheirus salmonis*) (Copepoda: Caligidae) in wild sockeye salmon (*Oncorhynchus nerka*) stocks of Alberni Inlet, British Columbia. Can. J. Fish. Aquat. Sci., **53**: 2888-2897.
- Mahnken, C. V. W. 1991. Coho salmon farming in Japan. In Culture of salmonid fishes (edited by R. Stickney). CRC Press, London. pp. 131-149.
- Margolis, L., G. W. Esch, J. C. Holmes, A. M. Kuris, and G. A. Schad. 1982. The use of ecological terms in parasitology (report of an ad hoc committee of the American Society of Parasitologists). J. Parasitol., **68**: 131-133.
- Nagasawa, K., Y. Ishida, M. Ogura, K. Tadokoro, and K. Hiramatsu. 1993. The abundance and distribution of *Lepeophtheirus salmonis* (Copepoda: Caligidae) on six species of Pacific salmon in offshore waters of the North Pacific Ocean and Bering Sea. In Pathogens of wild and farmed fish: sea lice (edited by G. A. Boxshall and D. Defaye). Ellis Horwood, London. pp. 166-178.
- Nagasawa, K., and S. Sakamoto. 1993. Infection of the salmon louse *Lepeophtheirus salmonis* (Copepoda: Caligidae) on seawater-farmed salmonids in northern Honshu, Japan. Fish Pathol., **28**: 143-144.
- Nagasawa, K., T. Takami, and Y. Murakami. 1994. *Lepeophtheirus salmonis* (Copepoda: Caligidae) from white-spotted charr (*Salvelinus leucomaenis*), juvenile chum salmon (*Oncorhynchus keta*), and Japanese dace (*Tribolodon hakonensis*) from northern Japan. Sci. Rep. Hokkaido Fish Hatchery, **48**: 95-97.
- Nagasawa, K., and F. Yanagisawa. 1992. The salmon louse, *Lepeophtheirus salmonis*, found on a chinook salmon, *Oncorhynchus tshawytscha*, from central Honshu, Japan, with the southernmost records of their distribution. Nankiseibutsu, **34**: 49-50.
- Urawa, S., and T. Kato. 1991. Heavy infections of *Caligus orientalis* (Copepoda: Caligidae) on caged rainbow trout *Oncorhynchus mykiss* in brackish water. Fish Pathol., **26**: 161-162.

日本で海面養殖されたギンザケとニジマスにおける 橈脚類 *Lepeophtheirus salmonis* の寄生状況

浦和茂彦・加藤禎一・熊谷 明

北日本沿岸で海面生簀養殖されたギンザケおよびニジマスにおけるサケジラミ *Lepeophtheirus salmonis* の寄生レベルを調査した。宮城県志津川湾で養殖されたギンザケにおける寄生率は収穫が終了する8月には84.6%に増加したが、平均寄生数は3.2虫体以下と低かった。北海道東部の桂恋港で養殖されたニジマスにおける本虫の寄生率は飼育が終了する11月までに92%となったが、平均寄生数は4.1虫体以下でやはり低かった。欧米では養殖サケマス類におけるサケジラミの大量寄生が大きな問題となっているが、日本における本虫の低い寄生レベルは海面における飼育期間が1年以内であることと宿主の比較的低い感受性によると推定される。