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, Toyoira-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 5, 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 (Kroyer, 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)
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

<table>
<thead>
<tr>
<th>Date of survey</th>
<th>Fish size</th>
<th>Number of fish</th>
<th>Prevalence (%)</th>
<th>Mean intensity</th>
<th>Abundance</th>
<th>Maximum Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 29</td>
<td>Fork length (cm)</td>
<td>57.5 ± 3.5*</td>
<td>76</td>
<td>59.2</td>
<td>1.69 ± 1.20*</td>
<td>1.00 ± 1.24*</td>
</tr>
<tr>
<td></td>
<td>weight (g)</td>
<td>3,260 ± 600*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July 13</td>
<td>Fork length (cm)</td>
<td>54.8 ± 4.8</td>
<td>167</td>
<td>76.7</td>
<td>2.41 ± 1.47</td>
<td>1.85 ± 1.64</td>
</tr>
<tr>
<td></td>
<td>weight (g)</td>
<td>2,780 ± 720</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July 28</td>
<td>Fork length (cm)</td>
<td>56.0 ± 5.3</td>
<td>91</td>
<td>81.3</td>
<td>3.22 ± 2.28</td>
<td>2.62 ± 2.41</td>
</tr>
<tr>
<td></td>
<td>weight (g)</td>
<td>2,800 ± 820</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>August 8</td>
<td>Fork length (cm)</td>
<td>57.8 ± 3.8</td>
<td>52</td>
<td>84.6</td>
<td>3.05 ± 1.80</td>
<td>2.58 ± 1.99</td>
</tr>
<tr>
<td></td>
<td>weight (g)</td>
<td>3,110 ± 680</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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.

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. tsawytscha*) 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


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

浦和茂彦・加藤祯一・熊谷 明

北日本沿岸で海面生産養殖されたギンザケおよびニジマスにおけるサケラジラム 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。北西海岸西部の養殖場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ラ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寄生低感受性によると推定される。