Analysis of Glucose, Triglyceride and RNA/DNA Ratio to Evaluate Starvation in Hatchery-Reared and Wild Juvenile Masu Salmon, *Oncorhynchus Masou*

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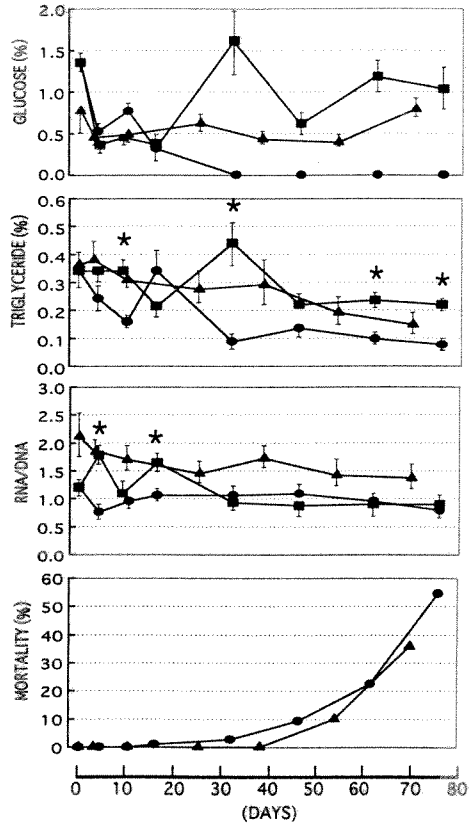
Masu salmon spend at least one year in the river after emergence. In general, survival rates in the river are not high (Nagata et al. 1984). Although the causes of their death remain unclear, starvation is considered one of major sources of mortality as has been observed in young jack mackerel, *Trachurus symmetricus* (Theilacker 1986).

Glucose and triglyceride are the main energy reserve in anchovy, *Engraulis mordax* (Håkanson 1989) and in Japanese flounder, *Paralichthys olivaceus* (Takaya 1997). RNA/DNA ratio analysis is useful for the estimation of growth rate in several species of marine fish larvae (Buckley 1984). There are few studies that clarify the relationship between mortality and body composition during starvation in salmonids. In the present study, glucose (GC) and triglyceride (TG) content and RNA/DNA ratio in the liver of hatchery-reared and wild juvenile masu salmon, reared without supply of food up to death, were analyzed to determine whether these body compositions were suitable as an indicator of starvation.

Hatchery-reared juveniles were raised in Erimo Research Branch for about four months after emergence using commercial pellets. A sample of fish were starved from 25 May 1999, and sampled for analysis on days 0, 4, 10, 16, 32, 46, 62, and 76. The rest were released into Utabetsu River near Erimo Research Branch on 25 May 1999. Fish were caught in the river for analysis on almost the same days as the starved juveniles (HS) were sampled. In addition, wild juveniles (WS) were caught in Atsuta River. They were transported to Erimo Research Branch and starved beginning 2 July 1999. Sampling for analysis occurred on days 0, 3, 10, 25, 38, 54, and 70. Mean fork lengths of HS and WS were 6.29 and 6.41 cm respectively on 0 day. The number of dead juveniles was counted every day during the experiment, and the mortality was calculated in each sampling period. More than five juveniles were used for each analysis of GC and TG content and RNA/DNA ratio.

Figure 1 shows changes in GC and TG content, RNA/DNA ratio, and mortality of hatchery-reared and wild juveniles during the experiment. In HS, GC content decreased rapidly from 0 day ($1.35 \pm 0.15\%$), and was not detected on or after 32 days. In juveniles released into the river (HR), GC content decreased from 0 to 16 days, and thereafter increased on and after 32 days. Although TG content did not change significantly from 0 to 76 days in HR, it decreased gradually during the sampling period and reached $0.08 \pm 0.01\%$ on 76 days in HS. The values of TG in HS were significantly lower than HR on 10, 32, 62, and 76 days. In both HS and HR, RNA/DNA ratio fluctuated from 0 to 16 days. Beginning on day 32,

Fig. 1. Changes in glucose and tryglyceride content RNA/DNA ratio in a liver and mortality of hatchery-reared and wild juvenile masu salmon during the experiment. Bars indicate the standard errors. Asterisk represents statistical significance between hatchery-reared juveniles released into the river and starved hatchery-reared juveniles ($p < 0.05$).
●: starved hatchery-reared juvenile ■: hatchery-reared juvenile released into the river ▲: starved wild juvenile



RNA/DNA ratio showed a constant course. In WS, GC content did not change significantly during the starvation experiment. TG content (0.16±0.03 - 0.20±0.04%) and RNA/DNA ratio (1.44±0.19 - 1.47±0.17) on day 54 and day 70, however, were significantly lower than initial values. Dead HS juveniles were observed on and after 16 days, and mortality reached 54.6% from 62 to 76 days. While dead WS juveniles were found on and after 38 days, and mortality reached 35.6% from 54 to 70 days. TG values were similar in the latter half of the experiment. The appearance of dead juveniles coincided with the time when TG reached 0.2% in both HS and WS. We interpret these results to indicate that TG content is a useful index of severe starvation in juvenile masu salmon. The change in GC content during starvation was not similar between HS and WS, and values of RNA/DNA ratio in HS tended to be lower than in WS. Thus, it is necessary to investigate the causes of these differences to establish criteria to measure starvation in hatchery-reared and wild masu salmon.

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