Fluctuations of the Zooplankton Community during Early Ocean Life of Chum Salmon in the Coastal Waters of Eastern Hokkaido, Okhotsk Sea

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Ocean conditions during the period of early ocean residence of chum salmon, may be important in determining the early marine survival. The fluctuation of zooplankton abundance might be one of the most important factors affecting on the early survival of juvenile chum salmon as the main prey of juvenile chum salmon is zooplankton. The coastal waters in the Okhotsk Sea are covered with sea ice until early spring. Therefore chum juveniles in these coastal waters experience extreme changes in the ocean environment. We started a project in 2002 to clarify the relationships between the early life ecology of juvenile chum salmon and ocean environments (Nagata et al. 2004). The surveys were conducted every ten days throughout late April to middle July in 2002 and 2003, establishing twelve stations (10–40m depths) in Abashiri coastal waters of Okhotsk Sea (Fig.1).

Zooplankton were collected at each station using vertical hauls of a Norpac net (0.45m in mouth diameter, 0.33 mm mesh size) from the near sea bottom to the surface. Water temperature and salinity were measured using the Memory STD. Chum juveniles were collected using a surface trawl net.

Average surface water temperature (SST: °C) ranged from 4.0 to 14.9°C in 2002 and from 2.2 to 14.5°C in 2003, respectively (Fig. 2a). SST was very low until late May in each area in 2003, increasing from early June rapidly. Average surface salinity (SSS: psu) ranged from 32.0 to 33.6 psu in 2002 and from 31.1 to 33.8 psu in 2003, respectively (Fig. 2b). SSS was also very low until late May in 2003, especially at 1 km off the coast. However, it increased from early June in each area. It was apparent that physical environments fluctuated largely in 2003 than 2002.

Chum juveniles were more abundant at 1 km off the coast, when the SST and SSS were 8 –10°C and 33.0–33.5 psu, respectively (Fig.2c). These optimal values of SST and SSS for chum juveniles were similar to those reported by Irie (1990). The peaks of CPUE (about > 500 inds./2 km) were observed from middle May to early June in 2002 and from early to middle June in 2003, respectively. Although residence in the bay was longer in 2002 than 2003, chum juveniles were more abundant in the small littoral zone in 2003 (Nagata et al. in press). Total zooplankton abundances were higher at 1 km than 4 km and 7 km off the coast (Fig.2d). At 1 km off the coast, the peak of total zooplankton was observed in late April (5.1x10^3 inds./m3) and middle May (6.3x10^3 inds./m3) in 2002 and, in early May (4.8x10^3 inds./m3) and middle June (5.8x10^3 inds./m3) in 2003. Both second peaks were coincident with the time when water temperature increased to 8–10°C and chum juveniles appeared in the bay. Nine dominant species in the zooplankton could be counted in both years (Fig.3). These species could be classified into two groups. One is a cold water species including Rathkea octopunctata, Pseudocalanus newmani, Acartia longiremis, Thysanoessa inermis, and Fritillaria borealis f. typica, and the other is a warm water species including Podon leuckarti, Evadne nordmanni, Mesocalanus tenuicornis and Oikopleura longicauda. R. octopunctata (hydrozoans) was more predominant in 2003 than 2002, which was the important component of the first zooplankton peak in 2003. T. inermis egg (euphausiid) also appeared from late April to middle May, and contributed to the second peak in 2002. P. newmani was the most abundant species until middle June and in years. Abundance of this species at 1 km off the coast in the second peak reached to 35–54% in 2002 and 56–57% in 2003, respectively. O. longicauda or F. borealis f. typica (appendicularians) were also predominant in the second peak of zooplankton abundance. Composition of P.
leuckarti and E. nordmanni (cladocerans) increased in early and middle July in both years. Either A. longiremis or M. tenuicornis (copepod) was predominant in early and middle July. In these dominant species, five species of P. leuckarti, E. nordmanni, P. newmani, Oikopleura spp. and F. borealis f. typica were also predominant in numerical composition of chum juvenile stomachs. In addition to these species, three cold water copepod species (Tortanus discouadatus, Metridia pacifica, Neocalanus spp.) were found to be in abundance. Although the electivity indices (Chesson’s $\alpha$) were not always high in the former five species, the indices were always high in the later three species which were not abundant in zooplankton numerical abundance. Although size measurements of zooplankton were not made in this study, the sizes were different between the former (< about 1 mm) and later species (1–5 mm).

**Fig. 2.** Averages of surface water temperature (a), surface salinity (b), catch of chum juveniles (c), abundance of total zooplankton (d) at 1 km, 4 km and 7 km off the Abashiri coast in 2002 and 2003. Bars indicate standard deviations.

**Fig. 3.** Changes in dominant species composition consisting of more than 10% in the average zooplankton abundance in each year at the 1 km, 4 km and 7 km off the Abashiri coast in 2002 and 2003. Symbols * indicate the date when the total zooplankton abundance reached to the peak at 1 km off the coast. Horizontal bars indicate the date when the chum juveniles were abundant at 1 km off coast.
Comparisons of the average abundances of these eight species during the chum juvenile residence periods showed that small size zooplankters were similar or higher in 2003 than 2002, however, the average abundance of large size zooplankton such as Neocalanus spp. was higher in 2002 than 2003.

The appearances of chum juveniles in the bay were synchronized with the increasing of small zooplankton such as cladocerans (Podon, Evadne), copepods (Pseudocalanus) and appendicularians (Oikopleura, Fritillaria), which were controlled by ocean conditions such as the water temperature and salinity. It was also known that chum juveniles began to expand their prey sizes when the fork length of juvenile reached to 50–60 mm (Okada and Taniguchi 1971). Although the abundance of the small size zooplankton dominating during the residence of chum juveniles might be fundamentally important, the considerations for the distribution and biomass of the large size zooplankton also may be important.

REFERENCES


