Interannual variations of prey resources during the early ocean life of juvenile chum salmon in four coastal areas around Hokkaido, northern Japan

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Introduction

The early life of juvenile chum salmon is a critical phase in their life history. It is believed high mortality occurs in this initial phase, which may be an important determinant of subsequent salmon population size. The state of prey environment such as zooplankton abundance and species composition is important for the growth and survival of juvenile chum salmon during their early ocean life. In order to evaluate prey environment during the early ocean life of juvenile chum salmon between March and July, 1998-2010, we conducted a long-term zooplankton monitoring in four coastal areas around Hokkaido, northern Japan. We will report interannual variations of prey environment for juvenile chum salmon during early ocean life in the each areas.

Materials & methods

Zooplankton were collected with vertical tows by a NORPAC net (0.45 m in mouth diameter, 0.33 mm mesh) from 20 m to surface at each site. If the water depth less than 20 m, the net was towed from 3 m above bottom to surface.

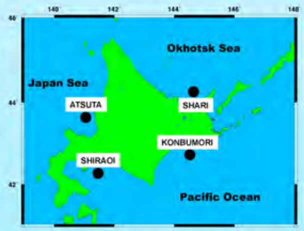

Fig. 1. Location of sampling area

Table 1. Sampling station, distance from seacoast (km) and water depth (m) at each sampling areas.

Areas	Stn. No	Distance from seacoast (km)	Depth (m)
ATSUTA Japan Sea coast	Stn. 1	0.5	10
	Stn. 2	1.0	15
	Stn. 3	2.0	20
	Stn. 4	10.0	30
SHIRAOI Western Pacific coast	Stn. 1	0.5	7
	Stn. 2	1.0	10
	Stn. 3	1.5	20
	Stn. 4	2.0	30
KONBUMORI Eastern Pacific coast	Stn. 1	0.4	15
	Stn. 2	1.3	21
	Stn. 3	3.5	40
	Stn. 4	7.8	60
SHARI Okhotsk Sea	Stn. 1	1.0	10
	Stn. 2	2.0	19
	Stn. 3	3.7	38
	Stn. 4	5.4	48

Table 2. List of occurrence species in the for coastal areas during the period from 1998 to 2010.

Hydrozoans	Mollusc	Polychaetes	Cladocerans	Calanoid copepods (>2 mm TL)	Calanoid copepods (< 2mm TL)	Other copepods
[illegible]	Gastropod larvae	Unidentified larvae	*Podon leuckarti*	*Acartia tumida*	*Acartia longiremis*	*Oithona atlantica*
Sarsia sp.	Bivalve larvae		*Podon polyphemoides*	*Calanus glacialis*	*Acartia hudsonica*	*Oithona similis*
Rathkea octopunctata			*Evadne nordmanni*	*Calanus pacificus*	*Acartia omorii*	*Oithona* spp. (copepodite)
Obelia sp.			*Evadne spinifera*	[illegible]	*Acartia steueri*	Oithonidae (nauplius)
Aglantha sp.				*Eucalanus bungii*	[illegible]	*Microsetella norvegica*
[illegible]				*Metridia pacifica*	*Centropages abdominalis*	*Microsetella rosea*
				Metridia okhotensis	*Clausocalanus arcuicornis*	*Corycaeus affinis*
				Neocalanus cristatus	*Clausocalanus pergens*	*Oncaea mediterranea*
				Neocalanus flemingeri	*Pseudocalanus minutus*	[illegible]
				Neocalanus plumchrus	*Pseudocalanus newmani*	[illegible]
				Tortanus discaudatus	*Paracalanus parvus*	
				Tortanus forcipatus	*Pseudodiaptomus inopinus*	
					[illegible]	
					Eurytemora herdmani	
					Eurytemora pacifica	
					Calanoida (nauplius)	

Cirripeds	Amphipods	Euphausiids
Balanomorpha (nauplius)	*Hyperia galba*	*Euphausia pacifica* (furcilia)
Balanomorpha (cypris)	*Themisto japonica*	*Thysanoessa* spp. (furcilia)
Rhizocephala (nauplius)	Gammaridea (unidentified)	Euphausiacea (eggs)
	Hyperiidea (unidentified)	Euphausiacea (nauplius)
	Caprella spp.	Euphausiacea (metanauplius)
		Euphausiacea (calyptopis)

Decapods	Other crustaceans	Chaetognaths	Echinoderms	Appendicularians	Fishes	Others
Caridea (zoea)	Mysidacea	*Sagitta elegans*	[illegible]	*Oikopleura dioica*	Fish eggs (*Engraulis japonicus*)	Actinotrocha larvae
Thalassinidea (zoea)	Cumacea	*Sagitta* spp.	[illegible]	*Oikopleura labradoriensis*	Fish eggs (unidentified)	Cyphonautes larvae
Anomura (zoea)	[illegible]	Sagittoidea (juvenile)	Echinoidea	*Oikopleura longicauda*	Fish larvae (unidentified)	Pilidium larvae
Brachyura (zoea)		Sagittoidea (eggs)	Ophiuroidea	*Oikopleura* spp. (juvenile)		
			Holothuroidea	*Fritillaria borealis f typica*		

ATSUTA (Japan Sea coast)

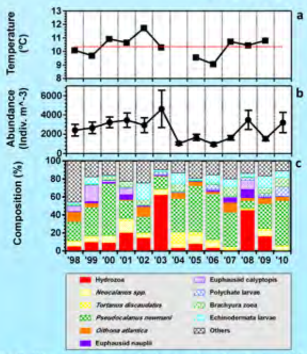

Fig. 2. Change in mean water temperature (April – June) of 3 m depth at stn. 3 (a), abundance (mean±SE) of total zooplankton (b), and composition of top 10 dominant species (c) during the period from 1998 to 2010 in the Atsuta area.

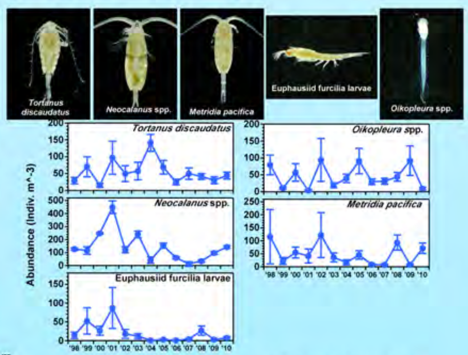

Fig. 3. Change in abundance of zooplankton species mainly found in stomach of juvenile chum salmons the Atsuta area. Error bars are standard error of the means.

SHARI (Okhotsk Sea coast)

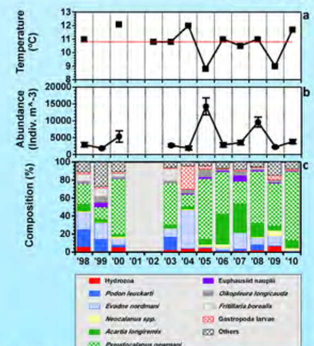

Fig. 6. Change in mean water temperature (April – June) of 3 m depth at stn. 2 (a), abundance (mean±SE) of total zooplankton (b), and composition of top 10 dominant species (c) during the period from 1998 to 2010 in the Shari area.

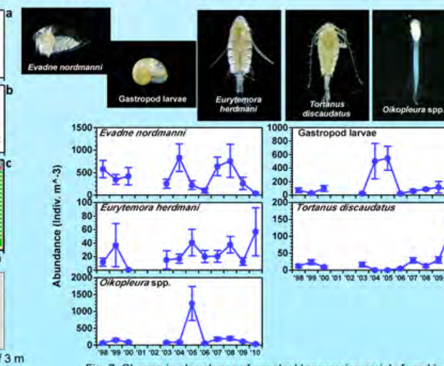

Fig. 7. Change in abundance of zooplankton species mainly found in stomach of juvenile chum salmons the Shari area. Error bars are standard error of the means.

SHIRAOI (Western Pacific coast)

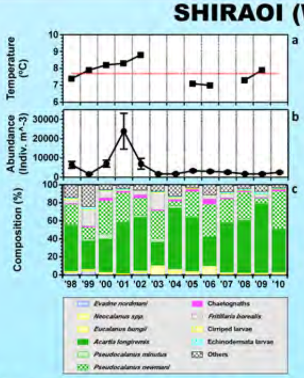

Fig. 4. Change in mean water temperature (April – June) of 3 m depth at stn. 3 (a), abundance (mean±SE) of total zooplankton (b), and composition of top 10 dominant species (c) during the period from 1998 to 2010 in the Shiraoi area.

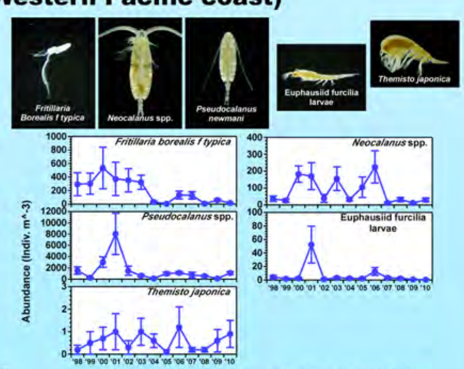

Fig. 5. Change in abundance of zooplankton species mainly found in stomach of juvenile chum salmons the Shiraoi area. Error bars are standard error of the means.

KONBUMORI (Eastern Pacific coast)

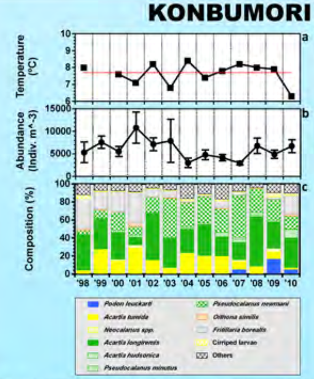

Fig. 8. Change in mean water temperature (April – June) of 3 m depth at stn. 2 (a), abundance (mean±SE) of total zooplankton (b), and composition of top 10 dominant species (c) during the period from 1998 to 2010 in the Konbumori area.

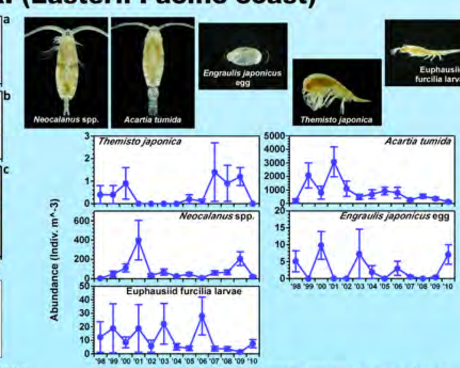

Fig. 9. Change in abundance of zooplankton species mainly found in stomach of juvenile chum salmons the Konbumori area. Error bars are standard error of the means.

Conclusion

Dominant zooplanktons were small copepods such as *Pseudocalanus newmani* in Japan Sea and Okhotsk Sea coast, and *Acartia longiremis* in the Pacific coasts. However, juvenile chum salmon fed larger zooplanktons more than 2 mm in body length. A trend of interannual variation of prey organisms was different in four coastal areas around Hokkaido.

Future works

We need to evaluate how interannual variations of abundance of prey organisms affect the growth and survival of juvenile chum salmon in each coastal waters.