Spatial and Temporal Distribution of Zooplankton in Gwangyang and Sachon Bay, Korea

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Abstract – Zooplankton dynamics were investigated based on samples collected monthly during the period between November 1998 and October 1999 at 15 stations in Gwangyang and Sachon Bay. Zooplankters were quantitatively collected with horizontal towing through the surface and oblique hauling from the bottom to surface at each station, simultaneously. A total of 88 taxa of zooplankton were distributed and 60 taxa were identified to species. Copepods showed the prosperity in species number of 52 species. Number of taxa occurred in samples hauled obliquely always showed 2~5 more species than those captured in the surface except for stations near the Namhae bridge. In waters near Namhae bridge, fast current seemed to mix waters vertically. Seasonally these differences were more distinct in the spring and summer than those in other seasons possibly due to the stratification in warmer seasons. In quantitative aspects, differences between two layers seemed to be obscure. Spatial and temporal variations in species diversity of copepods showed more prosperity in pelagic realm than those in the surface. Our collection carrying out in day time might be one of the important reason to cause these differences in zooplankton dynamics between two layers.

Key words : spatial and temporal distribution, zooplankton dynamics, vertical mixing

INTRODUCTION

Diurnal vertical migration is well studied in zooplankton (Raymont 1983). He divided vertical migration of zooplankton into ontogenetic migration and diurnal one. Marshall and Orr (1955) documented the seasonal change in vertical migration of *Calanus finmarchicus*. In the Clyde Sea, they observed that diurnal vertical migration of female *C. finmarchicus* was active in late winter and early spring, then this animal rose and formed surface swarm in April and May. Namely the pattern of vertical migration varied with season in female *C. finmarchicus*. Recently Aarseth and Schram (2002) reported the avoidance of *C. finmarchicus* against toxic radiation of ultraviolet in daytime in upper 1 m of surface waters.

Previous observations in vertical migration of zooplankton have been carried out mainly in somewhat deeper waters of some hundred meters in depth (cf. Robinson and Gomez-Gutierez 1998; Andersen *et al.* 2001). Diurnal vertical migration of zooplankton is fairly easy to be observed in freshwater ecosystem (Joo *et al.* 2002). Even in shallow waters like the Inland Sea of Japan, however, vertical migration is hardly observed in zooplankton possibly due to the vertical mixing (Onbe 1974). Proper sampling design is also necessary for observing the vertical migration of zooplankton fauna (cf. Park *et al.* 1988).

Gwangyang Bay is more or less well studied area on its environmental character due to its fast and heavy industrialization during past some decades. Although few studies have been carried out to investigate zooplankton dynamics in the bay, studies on phytoplankters (Lee *et al.* 2001) and

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benthic animals were documented (Cho *et al.* 2000; Kang *et al.* 2001). Recently intensive works to know the ecology in the bay were carried out and documented on zooplankton (Jang *et al.* 2004), phytoplankton (Kim *et al.* 2004) and some microbes (Kwon *et al.* 2004; Choi *et al.* 2004). Right inner waters of the bay is well characterized as one of the areas in its fastest tidal current among Korean coastal area. Then, Gwangyang Bay and Sacheon Bay is divided by Namhae bridge. Studies on marine animals in Sacheon Bay is less than those in Gwangyang Bay so far. Only a few studies on benthic animals was carried out (Shin and Koh 1993).

The objective of the study is to compare the distribution of zooplankton in surface waters to that in pelagic realm in shallow waters. How vertical distribution of zooplankton is complicated by vertical mixing with the current and the break of stratification is also discussed.

MATERIALS AND METHODS

Zooplankters were collected monthly during the period from November 1998 to October 1999 at 15 stations in Gwangyang and Sacheon Bay (Fig. 1). Two kinds of quantitative zooplankton samples were collected with horizontal towing at the surface and oblique hauling from the bottom (6~15 m in depth) to surface with Kitahara net of 0.1 mm in mesh aperture and 25 cm in mouth diameter equipped with flow meter in front of the net mouthat in high tide period, simultaneously. Samples were fixed with 4% neutralized formalin on board and moved to the laboratory. Sub-samples more than 1/10 amount of each sample were examined under dissecting microscope (Zeiss SV11) and zooplankters were sorted by taxa. Number of individuals of each zooplankton taxon in each subsample were converted into number per cubic meter of seawater using data of filtered waters measured by a flow meter (Hydro-Bios, Model 438 110). Species diversity indices of copepods were calculated (Shannon and Weaver 1963).

RESULTS AND DISCUSSION

A total of 88 taxa of zooplankton were distributed and 60 taxa were identified to species during the period from November 1998 to October 1999 in Gwangyang and Sacheon Bay (Table 1). Copepods showed the prosperity in species number of 52 species.

Mean number of taxa were 2~5 species more in the pelagic realm than those captured in the surface except for stations located near the Namhae bridge and Sacheon Bay (Fig. 2). St. 8 is located in front of the discharge of Hadong electrical power plant, then its is the matter of course to

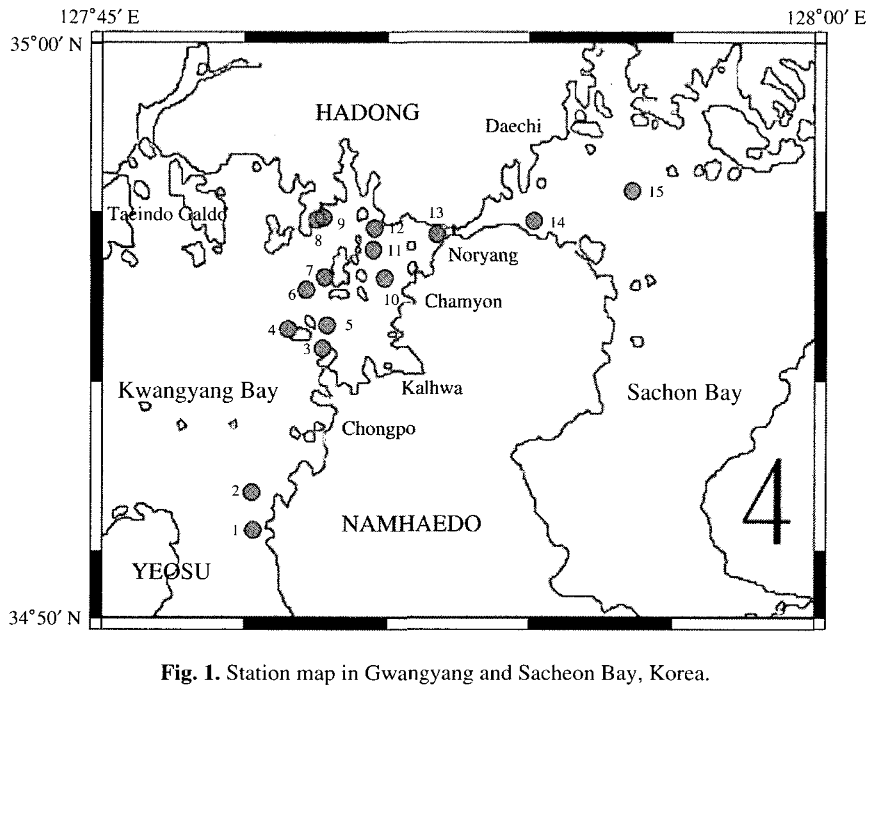

Fig. 1. Station map in Gwangyang and Sacheon Bay, Korea.

Table 1. Zooplankton taxa occurred in Gwangyang and Sachon Bay during the period from October 1998 to September 1999. Thick letter indicates taxa occurred in pelagic realm only

Protozoa	*Noctiluca scintillans*
Siphonophora	
Scyphozoa	
Chaetognatha	*Sagitta crassa, Sagitta enflata*
Cladocera	*Evadne nordmanni, Evadne tergestina, Podon leuckarti, Podon polyphemoides, Podon schmackeri*
Copepoda	*Acartia eryhraea, Acartia hudsonica, Acartia japonica, Acartia omorii, Acartia pacifica, Acrocalanus gibber, Acrocalanus longicornis, Acrocalanus monachus,* ***Calanus pacificus,*** *Calanus sinicus, Calanopia thompsoni, Centropages abdominalis, Centropages dorsispinatus, Centropages furcatus, Centropages tenuiremis, Clytemnestra rostrata, Clytemnestra scutellata, Corycaeus affinis, Corycaeus asiatcus, Corycaeus andrewsi, Corycaeus erythraeus, Corycaeus robustus, Corycaeus speciosus,* ***Eurytemora pacifica,*** *Euturpina acutifrons, Hemicyclops japonicus, Labidocera euchaeta,* ***Labidocera japonica,*** *Labidoocera rotunda, Macrosetella gracilis, Microsetella norvegica, Microsetella rosea, Oithona atlantica, Oithona brevicornis, Oithona davisae, Oithona fallax, Oithona longispina, Oithona medita, Oithona nana,* ***Oithona plumifera,*** *Oithona robusta, Oithona similis,* ***Oithona simplex,*** *Oncea conifera, Oncea media, Oncea venusta, Paracalanus aculeatus, Paracalanus crassirostris, Paracalanus elegans, Paracalanus indicus, Pseudodiaptomus inopinus, Pseudodiaptomus marinus, Sinocalanus tenellus, Temora discaudata, Temora forcipatus, Temora turbinata, Tigriopus japonicus, Tortanus gracilis, Tortanus forcipatus, Tortanus spinicaudatus, Sappirina* sp., *Miracia* sp., Unidentified *Harpaciticoida,* Copepodid, Copepoda nauplius
Amphipoda	
Mysidacea	
Euphausiacea	
Decapoda	Decapoda megalopa, Luciferidae, Other decapoda larvae, Zoea
Isopoda	
Salpidae	
Tanaidacea	Tanaid sp.
Trochophore	Trochophore larvae
Laomediidae	Laomediae larvae
Pocellanid	**Pocellanid zoea**
Echinodermata	Echinoderm larvae
Appendicularia	*Oikopluera dioica*
Cirripedia	Cirripedia cyprid, Cirripedia nauplius
Polychaeta larvae	
Mollusca larvae	
Pluteus larvae	
Fish eggs	
Fish larvae	

mix surface and bottom waters all the year round. At St. 13 just under the Namhae bridge, vertical mixing by fast current seemed to mix zooplankters which inhabited surface waters and pelagic realm. We have little idea on the result which showed the similar number of zooplankton taxa between surface and pelagic realm in Sacheon Bay.

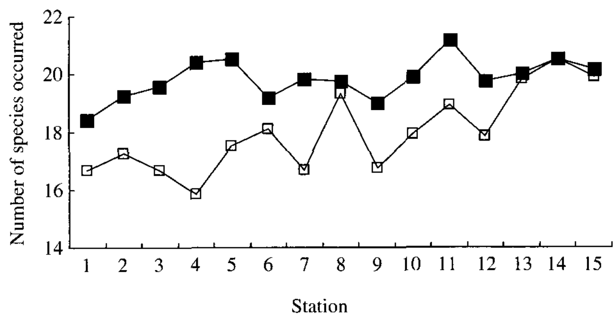

Fig. 2. Spatial variation in the mean number of zooplankton species occurred at each station in Gwangyang and Sacheon Bay, Korea during the period from October 1998 to September 1999. Solid symbol: pelagic, open symbol: surface.

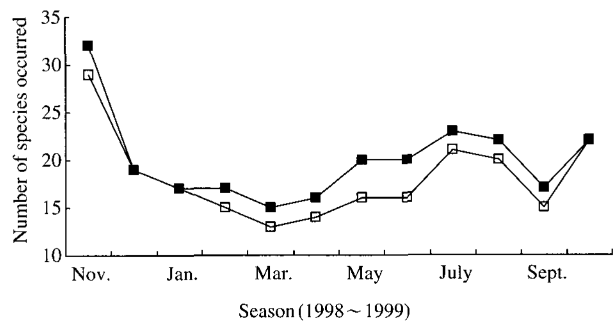

Fig. 3. Temporal variation in the mean number of zooplankton species occurred in each month in Gwangyang and Sacheon Bay, Korea during the period from October 1998 to September 1999. Solid symbol: pelagic, open symbol: surface.

Seasonally these differences were more distinct in spring and summer than other seasons possibly due to the stratification in warmer seasons (Fig. 3). This result agrees well with Marshall and Orr's report (1955). Although a major upward shift for copepod population was described to be due to the prosperity in food organisms with spring bloom of phytoplankton (Longhurst and Williams 1979).

No distinct pattern of difference in the abundance between two layers was observed.

Copepod was a dominant group of animal in the study waters. Spatial and temporal variations in the species diversity of copepods showed the more prosperity in pelagic realm than those in surface (Figs. 4, 5). These difference in zooplankton dynamics between two layers seem to be due to our collections being carried out in day time. Diurnal

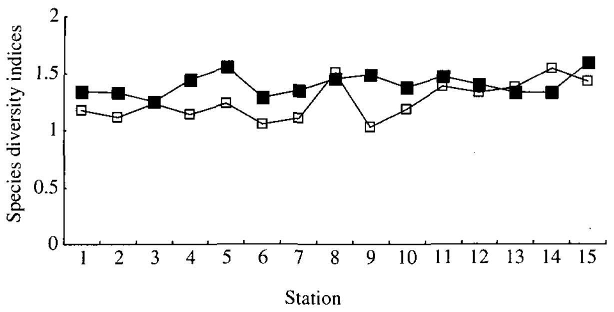

Fig. 4. Spatial variation in mean value of species diversity of copepods at each station in Gwangyang and Sacheon Bay Bay, Korea during the period from October 1998 to September 1999. Solid symbol: pelagic, open symbol: surface.

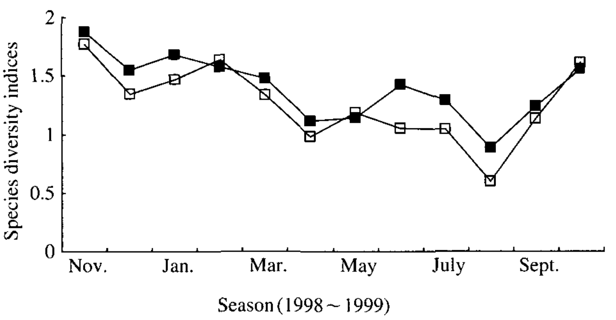

Fig. 5. Temporal variation in mean value of species diversity of copepods in each month in Kwangyang and Sacheon Bay Bay, Korea during the period from October 1998 to September 1999. Solid symbol: pelagic, open symbol: surface.

vertical migration of copepods is well summarized by Raymont (1983) where some species of copepods migrated vertically only in summer season.

I just conclude that zooplankton fauna in pelagic realm showed more prosperity in species number than that in surface waters in daytime in Gwangyang and Sacheon Bay possibly due to diurnal vertical migration. I also observed diurnal vertical migration being obscure at stations where vertical mixing occurred with fast current. Finally, stratification of seawater, I guess, seems to enhance the avoidance of zooplankton in upper some meters of surface waters in warmer season.

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