

Seasonal Distribution of Marine Cladocerans in Chinhae Bay, Korea

Kwang-Il Yoo and Se-Wha Kim*

Department of Biology, Hanyang University Seoul 133, Korea

진해만 해산 지각류의 계절적인 소강

유광일 · 김세화*

한양대학교 생물학과

Abstract

Five species of marine cladocerans, *Evadne nordmanni*, *Evadne tergestina*, *Podon leuckarti*, *Podon polyphemoides* and *Penilia avirostris*, were found in Chinhae Bay during the years 1982-83.

Incidence of *E. nordmanni* (March-May), *P. leuckarti* (April-May) in spring and of *E. tergestina* (June-December), *E. avirostris* (June-November) in summer through autumn was noticed during the present study. But *P. polyphemoides* appeared throughout the year except February.

P. avirostris was the most abundant species (21,491 indiv./m³), followed by *P. polyphemoides* and *E. tergestina*. Population of *E. nordmanni* and *P. leuckarti* was extremely poor and recorded to be less than 1,000 indiv./m³.

Seasonal change in size composition was noticed in *E. tergestina* and *P. avirostris*. Increase of length was recorded in *P. polyphemoides* when water temperature lower than 15°C.

요약 : 1982년에서 1983년에 걸쳐 진해만에서 채집, 동정된 해산 지각류는 다음의 5종이었다 : *Evadne nordmanni*, *Evadne tergestina*, *Podon leuckarti*, *Podon polyphemoides*, *Penilia avirostris*.

계절적인 출현양상을 보면 춘계에는 *E. nordmanni* (3-5월), *P. leuckarti* (4-5월) 그리고 하계에서 추계에 걸쳐서는 *E. tergestina* (6-12월), *P. avirostris* (6-11월)가 탁월하였다. 한편 *P. polyphemoides*는 2월을 제외하고 년중 출현하였다.

개체수의 분포는 *P. avirostris*, *P. polyphemoides* 그리고 *E. tergestina*의 순서로 많았고 *E. nordmanni*나 *P. leuckarti*는 1,000 개체/m³ 미만이었다.

체장조성의 계절적인 변화를 보면 *E. tergestina*와 *P. avirostris*는 수온의 상승에 따라 체장이 큰 쪽으로 증가하는 경향을 보이고 있으나, 특히 *P. polyphemoides*에서만은 수온 15°C 이하에서 체장의 증가를 보였다.

INTRODUCTION

Marine cladocerans are represented by eight species belonging to three genera; *Evadne*, *Podon* and *Penilia*. They establish a dominant component of the coastal and estuarine zooplankton in certain warm and temperate waters (Wickstead, 1963; Bosch

and Taylor, 1968; Corni, 1974; Onbé, 1974, 1978, 1985; Hernoroth and Ackefor, 1977; Poggensee and Lenz, 1981; Cheng and Chas, 1982). Although some species are widely distributed over the oceanic environment (Jorgensen, 1933; Wiborg, 1955; Gieskes, 1971; Longhurst and Seibert, 1972; Della Croce and Venugopal, 1972), most are

*Present address: Graduate School of Biosphere Sciences, Hiroshima University, Fukuyama 720, Japan.

restricted to the coastal waters where they have a particular season of planktonic occurrence, followed by complete disappearance from the plankton in rest of the year (Dolgopolskaja, 1958; Onbé, 1974, 1977).

Occurrence of seven species of marine cladocerans are recorded in Korean waters (Park, 1956; Hue, 1967; Park and Kim, 1967; Bang, 1967; Yoo and Kim, 1978; Shim and Ro., 1982; Yoo, 1984) except that of *Podon intermedius* which has not been recorded in Indo-Pacific waters.

The present study reveals the seasonal distribution of marine cladocerans in Korean waters and the effect of hydrographical condition on the abundance is reported. Morphometric index of cladocerans is also discussed.

MATERIAL AND METHOD

Quantitative zooplankton samples were collected monthly from January 1982 through December 1983 at six stations in Chinhae Bay (Fig. 1). Plankton net used were of the Marugawa Net (mouth diameter 30 cm, mesh aperture 100 μm) with the flowmeter on the center of the mouth during January 1982 to March 1983 and of the Kitahara Net (mouth diameter 22.5 cm, mesh aperture 100 μm) for the rest of the period. Samples collected by vertical haul from bottom to surface were immediately fixed with 5% buffered formalin on board.

Cladocerans were sorted from several subsamples and counted by species under dissecting microscope. The number of individuals were then converted into the number per cubic meter of water.

The hundred individuals of each species, randomly sorted from original samples, were measured in body length with ocular micrometer. All of the measurements of body length and gross length were followed by Onbé (1978).

In addition to the biological data surface

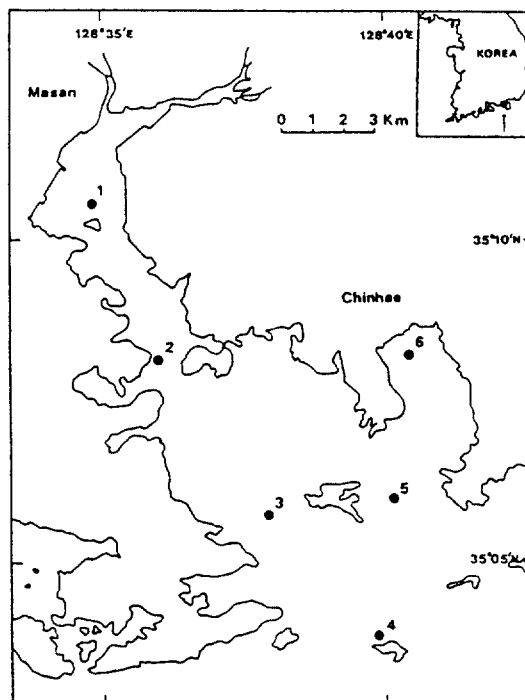


Fig. 1. Sampling stations in Chinhae Bay.

water temperature and salinity were measured.

RESULT

1. Systematic account

A total of five species, representing 2 families and 3 genera, of the marine cladocerans have been identified. The species of marine cladocerans found in the present study are listed as follows:

Phylum Arthropoda

Class Crustacea

Subclass Branchiopoda

Order Diplostraca

Suborder Cladocera

Superfamily Sidoidea BROOKS

(= Tribe Ctenopoda Sars)

Family Sididae (BAIRD)

Penilia avirostris DANA, 1849

(*Penilia schmackeri* RICHARD, 1895)

Superfamily Polyphemoidea BROOKS
(= Tribe Onychopoda SARS)

Family Podonidae MORDUKHAL-BOLTOVSKOI

Evadne nordmanni LOVEN 1836

E. tergestina CLAUS, 1868

Podon leuckarti G.O. SARS, 1862

P. polyphemoides (LEUCKART), 1859

2. Seasonal occurrence of marine cladocerans

In general marine cladocerans appear to be found in plankton community during warm season, from spring through autumn, except that of *Podon polyphemoides*. *Evadne tergestina* and *Penilia avirostris* occurred in higher temperature seasons, while the remaining two species (*Evadne nordmanni* and *Podon leuckarti*) found in earlier part of the year prior to the vernal rise of water temperature. But *Podon polyphemoides* have not inclined any particular season of occurrence (Fig. 2).

Temperature characteristics shown by each

species during the present study were illustrated in Fig. 3., which showed the range of those water temperatures at which species have appeared in plankton community and also the temperature at which its population maximum was attained.

3. Seasonal fluctuation in abundance of marine cladocerans

The population density of total marine cladocerans had its maximum of 30,930 indiv./m³ in October 1982 at St. 3, and was higher in summer and autumn than spring and winter (Fig. 4). *Penilia avirostris* was the most abundant species of marine cladocerans and showed the maximum abundance of 21,491 indiv./m³ in October 1982 at St. 1, followed by 11,311 indiv./m³ in July 1983 at St. 3 and 9,049 indiv./m³ in August 1983 at St. 1. *Penilia avirostris* established the dense population in annual peak and autumnal downward of water temperature. *Podon polyphemoides* was the second abundant species, attained the maximum density of 17,629 indiv./m³ in Oc-

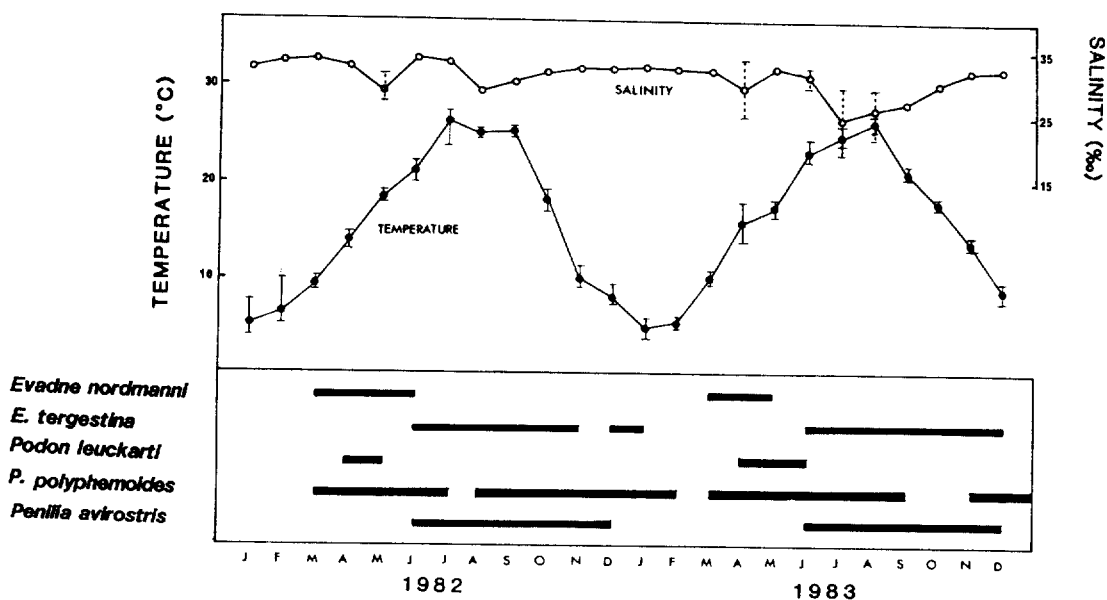


Fig. 2. Seasonal occurrence of marine cladocerans with reference to hydrographical conditions in Chinhae Bay.

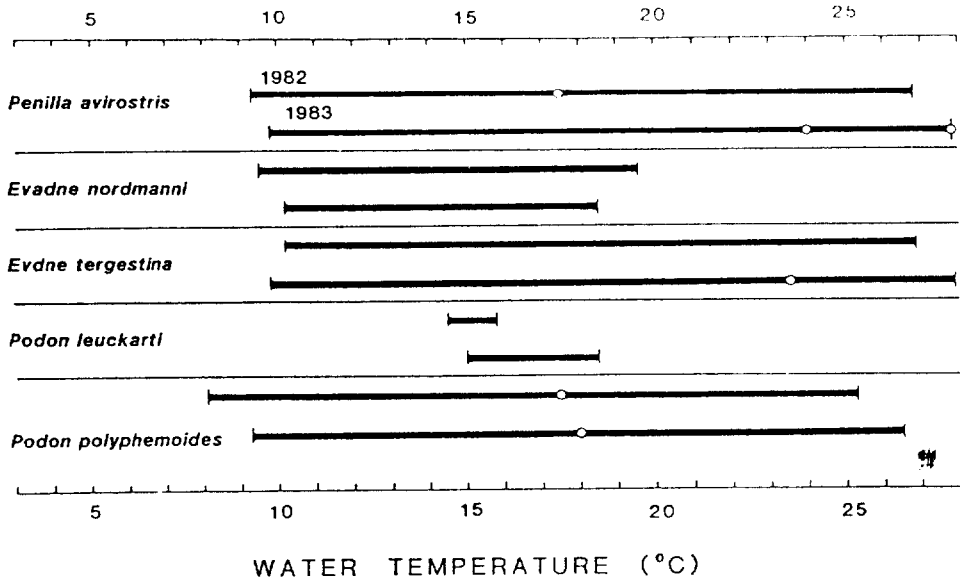


Fig. 3. Temperature characteristics of marine cladocerans in Chinhae Bay (horizontal bar shows the range of temperature during the occurrence of each species. temperature at the population maximum is denoted by a circle).

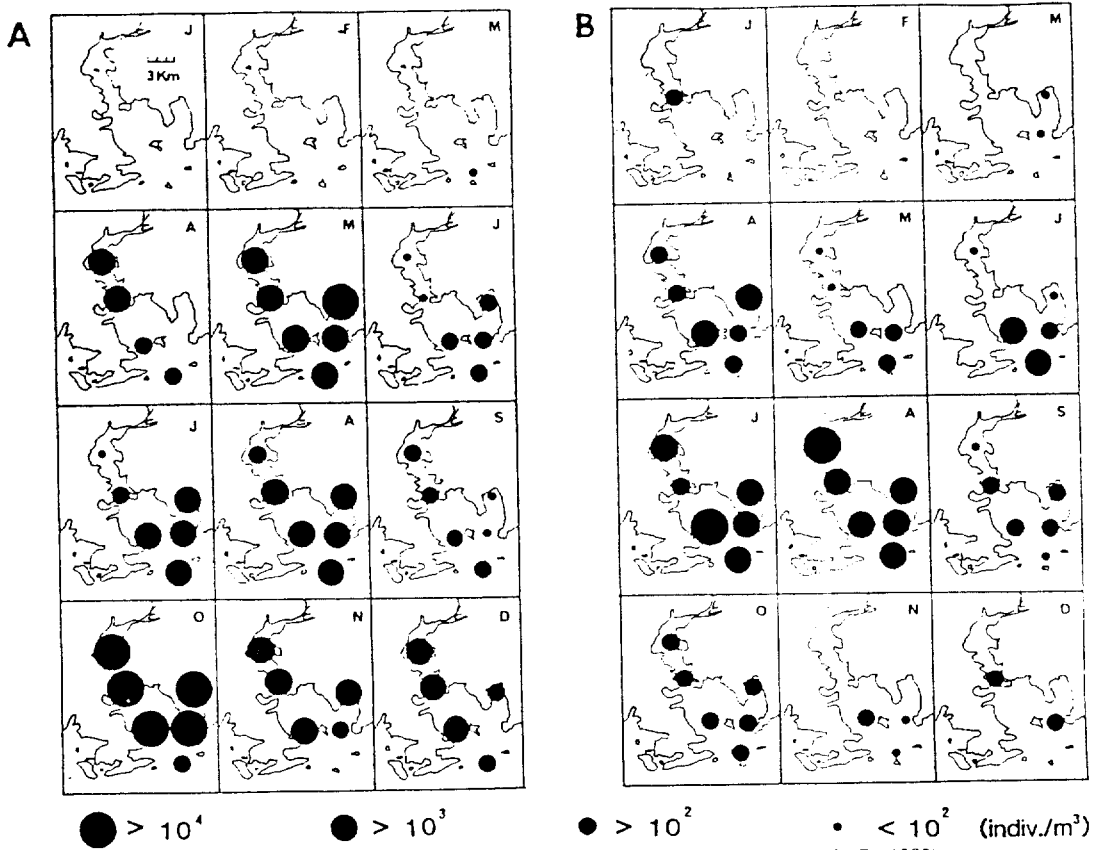


Fig. 4. Seasonal fluctuation in abundance of marine cladocerans in Chinhae Bay (A: 1982; B: 1983).

tober 1982 at St. 3, followed by 11,969 indiv./m³ in May 1982 at St. 6. High population of *Podon polyphemoides* was noticed when water temperature around 18°C irrespective of the season. The seasonal change in abundance of *Evadne tergestina* was similar to *Penilia avirostris*, but recorded to have low density of 3,779 indiv./m³ as maximum in August 1983 at St. 5. *Evadne nordmanni* and *Podon leuckarti* which appeared only in spring for a short period showed poor abundance less than 1,000 indiv./m³, hence the distinct changes of population density could not be observed during the period of occurrence.

4. Size composition of marine cladocerans

Penilia avirostris was the largest species in body length, followed in order by *Podon leuckarti*, *Evadne tergestina*, *Evadne nordmanni* and *Podon polyphemoides* (Table 1). *Penilia avirostris* with 0.40-0.80 mm in body length were comprising major portion of the population in the beginning of appearance in June, and after October through the period of disappearance, individuals smaller than 0.50 mm were seldom observed. Large individuals more than 1.00 mm were counted to be more. *Evadna tergestina* had the same tendency of increasing body length from the beginning of appearance with 0.35-0.45 mm in June through disappearance with 0.50-0.65 mm in November and December, respectively. *Podon polyphemoides* did not show any relationship between the season and body length,

but the portion of the larger individuals increased when water temperature was lower than 15°C.

DISCUSSION

In Chinhae Bay five species of marine cladocerans showed to have their own seasonal restriction of occurrence. Although *Podon polyphemoides* have occurred throughout the year, no abundant population of this species were observed in winter season. Hence, the ecological importance of this group seems to be largely limited in warm season in the investigated area.

Similar seasonal restriction of the marine cladoceran species as reported in Chinhae Bay was found in the Inland Sea of Japan (Onbé, 1968, 1974, 1977; Hirota, 1979). Among five species of marine cladocerans, *Podon polyphemoides* was noticed throughout the period of the year and the other four species were appeared in the earlier part of the year in the Inland Sea of Japan (Kim, unpublished). In contrast, seasonal distribution in Indian Ocean was quite different with *Evadne tergestina* occurring all the year and *Penilia avirostris* from September through March (Pillai and Pillai, 1975). In Chinese waters, *Penilia avirostris* and *Evadne tergestina* showed the similar pattern of seasonal occurrence, with the earlier appearance in southern waters near Formosa Strait, Hong Kong and Hainan Strait (Cheng and Chas, 1982).

Fecundity of marine cladocerans in Chinhae Bay seems to be lower than in waters of the warmer regions. Maximum abundance of *Penilia avirostris* and *Podon polyphemoides* were recorded 58,800 indiv./m³ in 1971 and 37,700 indiv./m³ in 1970 in the Inland Sea of Japan by Onbé (1974), but 21,491 indiv./m³ and 17,629 indiv./m³ in Chinhae Bay.

Penilia avirostris with 1.12 mm in body length was recorded in November 1982 at St. 3 during the present study. Similar observation was made in Sandy Hook by Della Croce and

Table 1. Size distribution of marine cladocerans in Chinhae Bay, Korea

Species	Range of body length (mm)
<i>Penilia avirostris</i>	0.32—1.12
<i>Evadne nordmanni</i>	0.20—0.57
<i>Evadne tergestina</i>	0.28—0.65
<i>Podon leuckarti</i>	0.41—0.68
<i>Podon polyphemoides</i>	0.18—0.48

Angelino (1968-1969). But in the Inland Sea of Japan 0.95 mm in body length was found to be the largest (Onbé, 1974). Larger individuals of *Podon polyphemoides* were also observed in Chinhae Bay compared with the Inland Sea of Japan. The appearance of larger individuals in Chinhae Bay might be due to the hydrographical condition, especially by low water temperature during the period of occurrence of each species.

The observation of sexual generation will help to explain the seasonal fluctuation in the abundance of marine cladoceran population.

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