The Journal of the Oceanological Society of Korea
Vol. 28, No. 1, pp. 47-51, March 1993

Distribution of the Marine Cladoceran *Evadne spinifera* in Waters Adjacent to Korean Peninsula

SE-WHA KIM[1], TAKASHI ONBÉ[2] AND KWANG IL-YOO[3]
[1]*Department of Environmental Health, Yongin University, Yongin 449-714, Korea*
[2]*Faculty of Applied Biological Sciences, Hiroshima University, Higashi-Hiroshima 724, Japan*
[3]*Department of Biology, Hanyang University, Seoul 133-791, Korea*

한반도 주변 해역에서 해산지각류 *Evadne spinifera*의 분포

김세화[1] · 遠部卓[2] · 유광일[3]
[1]용인대학교 환경보건학과
[2]廣島大學 生物生産學部
[3]한양대학교 생물학과

Distribution of the marine cladoceran *Evadne spinifera* in waters adjacent to Korea was studied on the basis of samples collected during the Cooperative Study of the Kuroshio and Adjacent Regions, 1965-1974, and during the Exploitation Research of Marine Resources on the Yellow Sea, September-October 1992. This species was mainly occurred in August and September in the Sea of Japan. Distribution in the Yellow Sea was sparse. Temperature and salinity ranged 23.42-28.24℃ and 32.11-34.20‰, respectively. Maximum abundance of 11 indiv./m^3 was recorded in coastal waters of Honshu, Japan with 26.80℃ and 32.81‰ water. *E. spinifera* was considered to be a stenothermal animal preferring high temperature.

국제 쿠로시오 공동조사 (1965-1974) 및 황해의 해양자원 개발연구 (9-10월, 1992) 기간중에 채집된 시료를 분석하여 한반도 주변 해역에서 출현하는 해산지각류 *Evadne spinifera*의 시공분포를 조사하였다. *E. spinifera*는 주로 동해에서 8, 9월에 집중적으로 출현하고 있었으며 최대출현량은 11 indiv./m^3이었고 황해에서는 9월에 산발적으로 미량 출현하였다. 본종은 수온 23.42-28.24℃, 염분 32.11-34.20‰ 범위에서 출현하였으며 26.80℃, 32.81‰에서 최대 개체군을 형성하여 고온을 선호하는 협온성종으로 밝혀졌다.

INTRODUCTION

Earlier reviews suggested that the ecological importance of marine cladocerans is generally confined to neritic waters, where this group has often established large populations in a particular time (Ramner, 1933; Wickstead, 1963; Onbé, 1974). Recent general text on plankton ecology, however, regarded some cladocerans i.e., *Evadne nordmanni, E. spinifera, E. tergestina, Penilia avirostris and Podon schmackeri,* as animals being able to extend their distribution to oceanic waters (Longhurst and Seibert, 1972; Gieskes, 1971a; Della croce and Venugopal, 1972, 1973; Kim and Onbé, 1989a,b).

Among eight known species of marine cladocerans belonging to three genera (Baker, 1938), *Evadne spinifera* is one of cladoceran species in which ecological characteristics have not been well-studied. This might possibly due to its rare occurrence and lower abudance when compared with

other cladocerans (cf. Kim, 1989). As far as we know, a report on the oceanic distribution of *E. spinifera* in the eastern Pacific (Longhurst and Seibert, 1972) was only a large-scale investigation on the ecology of this species. In contrast to its ecology remaining poorly known, confusion on the taxonomy of marine cladocerans, viz., adoption of generic names, *Pleopis* and *Pseudevadne*, to species belonging to *Evadne* and *Podon* by Mordukhai-Boltovskoi (1968, 1978), Gieskes (1971b) and Rocha (1985), seems to become clear. Since Meurice and Dauby (1983) proposed that both genera of *Evadne* and *Podon* should be valid due to the great homogeneity of the genus *Evadne* and no important divergence enough to justify the removal of *Podon polyphemoides* from the genus Podon, based on the observation of six European species using the scanning electron microscope and a numerical analysis of taxonomic distances between each species.

Previous record on the occurrence of Evadne *spinifera* was very poor in waters adjacent to Korean Peninsula; coastal waters off Honshu and Hokkaido, Japan (Kokubo, 1937; Yamazi, 1984), southern waters of the Korean Peninsula (Park, 1956) and the Yellow Sea (Yoo and Kim, 1984). The present paper covers the distribution of *E. spinifera* in waters adjacent to Korean Peninsula basis on long-term and large-scale surveys of plankton during the Cooperative Study of the Kuroshio and Adjacent Regions (CSK), 1965-1974, and the Exploitation Research of Marine Resources on the Yellow Sea (ERMRYS), September-October, 1992. Definition of its occurrence in relation to environmental conditions, i.e., surface temperature and salinity is also attempted to give.

MATERIALS AND METHODS

During the CSK, 1965-1974, a total of 3,302 International Zooplankton Samples has been collected with a standard NORPAC net (mouth diameter: 45 cm, mesh opening: 033-0.35 mm) from the upper 150 m in the northwestern Pacific Ocean (10 °S-45°N, 95-165°E) (Motoda, 1980, 1981). A total of 1,680 subsamples of cladocerans has been sorted at the National Science Museum, Tokyo, Japan and the Regional Marine Biological Centre, the University of Singapore, Singapore. All of these sorted subsamples of cladocerans were examined. Fifty four samples collected with Bongo net (mouth diameter: 60 cm, mesh opening: 0.33 mm) from the bottom to surface during the ERMRYS, September and October 1992 at 54 stations in the Yellow Sea were also examined in the present study.

Cladoceran samples were identified to species level under the dissecting microscope. Stations where *Evadne spinifera* occurred were recorded with their environmental conditions of surface temperature and salinity (Japanese Oceanographical Data Center, 1966-1967; Japan Oceanographical Data Center, 1968-1975 for CSK samples and Ocean Science & Technology Institute, 1992 for ERMRYS samples). The number of individuals of this species in each sample was, then, converted into the number per cubic meter of water using the data of the strained water estimated by flow-meter readings (cf. Kim and Onbé, 1989a). Distribution map of *E. spinifera* was, then, made in waters adjacent to Korean Peninsula.

RESULTS

During the CSK, *Evadne spinifera* occurred at 26 stations and its distribution was restricted to the Sea of Japan (Fig. 1A). During the ERMRYS, this species occurred at a single station in the Yellow Sea (Fig. 1B). Most stations where *E. spinifera* appeared were located in distant neritic waters both in the Sea of Japan and the Yellow sea. During the CSK, this species was always accompanied by other cladoceran species such as *E. tergestina* and *Penilia avirostris*. *E. spinifera* also occurred together with *E. tergestina* and *P. avirostris* in the Yellow Sea.

Temperature and Salinity for the occurrence of *Evadne spinifera* ranged 23.42-28.24℃ and 32.11-34.20‰, respectively. Fig. 2 shows the relationship between the abundance of *E. spinifera* and temperature-salinity water classes. Maximum abundance of 11 indiv./m^3 was observed in late August at

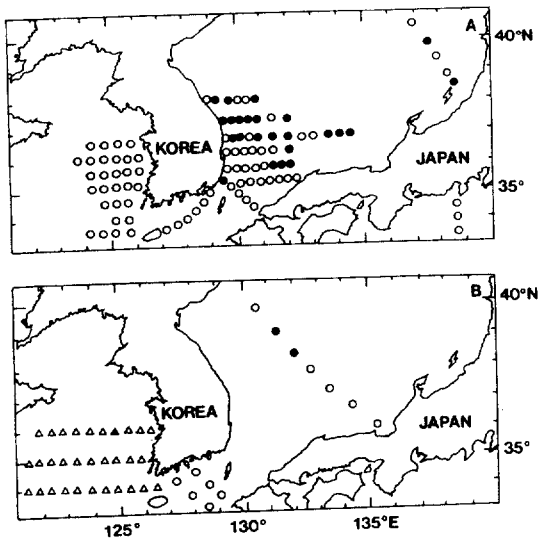

Fig. 1. *Evadne spinifera*. Seasonal distribution in waters adjacent to Korean Peninsula during the CSK (circle) and ERMRYS (triangle). A: August; B: Setember. Open symbols indicate negative stations.

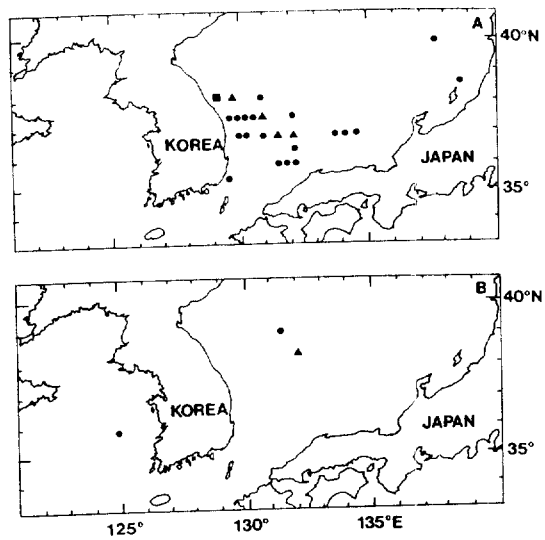

Fig. 3. *Evadne spinifera*. Seasonal change in the abundance (indiv./m^3) during the CSK and ERMRYS. A: August; B: September. Each symbol indicates various levels of abundances. circle <1, 1≤triangle<10, rectagle≥10.

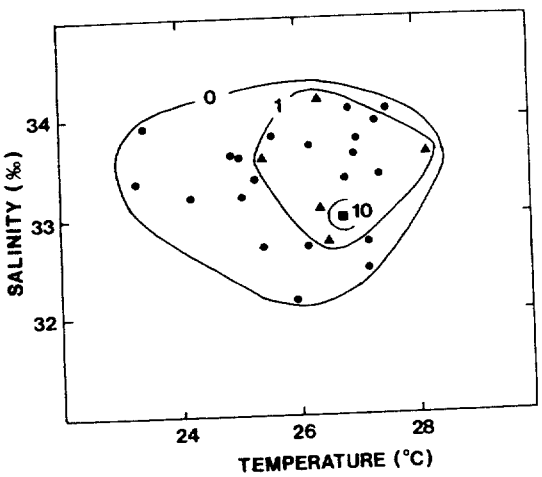

Fig. 2. *Evadne spinifera*. Relationship between the abundance (indiv./m^3) and temperature-salinity water classes of waters adjacent to Korean Peninsula. Each symbol indicates various levels of abundances. circle<1, 1≤triangle<10, rectagle≥.

a station located in the Sea of Japan, when and where temperature and salinity were 26.80℃ and 32.81‰. With the preference of warm water in this species, seasonal occurrence of *E. spinifera* was confined to warmer months of August and September in the study area (Fig. 3). In September, however, lower abundances when compared with those in former month were observed.

DISCUSSION

Since Dolgopolskaja (1958) illuminated the world distribution of seven species of marine cladocerans (Podon schmackeri was excluded), distribution of *Evadne spinifera* has been recorded in various waters of world oceans, i.e., the north Atlantic and the North Sea (Gieskes, 1971a), the eastern Pacific (Longhurst and Seibert, 1972) and the Indian Ocean (Della Croce and Venugopal, 1972). In the northwestern Pacific, however, previous records on the occurrence of *E. spinifera* are sparse and sporadic, i.e., in Korean waters (Park, 1956; Yoo and Kim, 1984), in Japanese waters (Kokubo, 1937; Yamazi, 1984) and in Chinese waters (Cheng and Chao, 1982). Then, this paper deals with its spatial and temporal distribution in large scale for the first time in the study area.

Rare occurrence of *Evadne spinifera* in a particular season, viz., in August and September at 26

stations among 3,302 collections during the CSK and a single station among 54 collections during the ERMRYS, seems to be due to its stenothermal characteristics prefering high temperature. Having a preference for high temperature in this species (23.42-28.24℃), water temperature in temperate regions such as waters adjacent to Korean Peninsula is probably low enough to exclude *E. spinifera* from local planktonic communities except warmer season. Our assumption more or less agrees well with previous reports on high temperature preference in this speices in the Indian Ocean, 18.08-25.30 ℃, (Della Croce and Venugopal, 1972), in the north Atlantic and the North Sea, higher than 15℃, (Gieskes, 1971a) and in the eastern tropical Pacific, 16-21℃, (Longhurst and Seibert, 1972).

Spatial distribution of *Evadne spinifera* in the northwestern Pacific is somewhat different from those in other oceans. Since we observed its occurrence being largely confined to distant neritic waters of the Sea of Japan and not extensible to open oceanic waters during the CSK, while this species was reported to be able to extend its distribution to open oceanic waters in the eastern tropical Pacific (Longhurst and Seibert, 1972). Moreover Gieskes (1971a) regarded *E. spinifera* as an oceanic species through his cladoceran study in the north Atlantic. The reason why this difference occurs remains obscure. Distant neritic distribution in *E. spinifera*, however, suggests that this species is not a typical neritic species in the northwestern Pacific either.

Occurrence of *Evadne spinifera* accompanied by *E. tergestina* and *Penilia* avirostris was also reported in coastal waters off Angola (Raymont, 1983). He also concerned with the abundance of *E. tergestina* being higher than that of *E. spinifera*. This observation was simillar to our results. However, in waters off the Moroccan coast, a low-temperature cladoceran of *E. nordmanni* was recorded to occur together with *E. spinifera* (Raymont, 1983). Then, accompanying pattern of *E. spinifera* with other cladocerans become somewhat confused. At least in the northwestern Pacific, we might suggest that *E. spinifera* of a warm-temperature cladoceran often occurs together with *E. tergestina* and *P. avirostris* and possibly not with low-temperature cladocerans such as *E. nordmanni*.

With a low abundance and rare occurrence during our investigation, we conclude that the ecological role of *Evadne spinifera* is less important than other cladocerans in waters adjacent to Korean Peninsula.

ACKNOWLEDGEMENT

This work was supported in part by the Ministry of Education, Science and Culture of Japan. We acknowledge with thanks all the participants in CSK cruises and CSK sorting center for their tedious task to deal with a huge amount of CSK International Zoopalnkton Samples. Thanks are also due to Dr. Y.C. Lee of Inha University for his kindness in placing ERMRYS samples at the disposal of one of us (Yoo). Mr. W.C. Lee of Hanyang University kindly sorted *Evadne spinifera* specimens from ERMRYS samples.

REFERENCES

Baker, H. M., 1938. Studies on the Cladocera of Monterey Bay. *Proc. Calif. Acad. Sci. Ser.*, **4**: 311-365.

Cheng, C. and W.C. Chao, 1982. Studies on the marine Cladocera of China. II. Distribution. *Acta Oceanol. Sinica*, **6**: 377-388 (in Chinese with English abstract).

Della Croce, N. and P. Venugopal, 1972. Distribution of marine cladocerans in the Indian Ocean. *Mar. Biol.*, **15**: 132-138.

Della Croce, N. and P. Venugopal, 1973. Penilia avirostris in the Indian Ocean (Cladocera). *Int. Revue Ges. Hydrobiol.*, **58**: 713-721.

Dolgopolskaja, M. A., 1958. Cladocera of the Black Sea. *Tr. Sevastopol', Biol. Sta., Akad. Nauk SSSR*, **10**: 27-75.

Gieskes, W. W. C., 1971a. Ecology of the Cladocera of the north Atlantic and the North Sea. *Neth. J. Sea Res.*, **5**: 342-376.

Gieskes, W. W. C., 1971b. Removal of "Podon" polyphemoides from the genus Podon. *Hydrobiol.*, **38**: 61-66.

Japan Oceanographical Data Center., 1968-1977. Data report of CSK. Nos. 104-430. Hydrogr. Dept., Mar. Safety Agen., Tokyo.

Japanese Oceanographical Data Center., 1966-1967. Preliminary data report of CSK. Nos. 2-89. Hydrogr. Div., Mar. Safety Agen., Tokyo.

Kim, S. W., 1989. Studies on the ecology of marine cladocerans in the northwestern Pacific Ocean. Ph.D. Thesis, Hiroshima University, Higashi-Hiroshima,

180pp.

Kim, S.W. and T. Onbé, 1989a. Observations on the biology of the marine cladoceran Podon schmackeri. *J. Crustaceana Biol.*, **9**: 54-59.

Kim, S.W. and T. Onbé, 1989b. Distribution and zoogeography of the marine cladoceran Podon schmackeri in the northwestern Pacific. *Mar. Biol.*, **102**: 203-210.

Kokubo, S., 1932. Taxonomy of plankton. Koseisha-Koseikaku, Tokyo, 394pp (in Japanese).

Longhurst, A.R. and D.L.R. Seibert, 1972. Oceanic distribution of *Evadne* in the eastern Pacific (Cladocera). *Crustaceana*, **22**: 239-248.

Meurice, J.C. and P. Dauby, 1983. Scanning electron microscope and computer analysis of taxonomic distances of the marine Podonidae (Cladocera). *J. Plankton Res.*, **3**: 787-796.

Mordukhai-Boltovskoi, PH.D., 1968. On the taxonomy of Polyphemidae. *Crustaceana*, **14**: 1-8.

Mordukhai-Boltovskoi, PH.D., 1978. A contribution to the taxonomy of marine Podonidae (Cladocera). *Zool. Zhur.*, **57**: 523-529 (in Russian).

Motoda, S., 1980. CSK International Zooplankton Collection. *Bull. Plankton Soc. Jap.*, **27**: 41-45 (in Japanese).

Motoda, S., 1981. CSK zooplankton specimens available for study. *Mar. Biol. Cent., Tokai Univ.*, October 1981: 1-3.

Ocean Science and Technology Institute., 1992. Cruise Report. September 17-November 2, 1992. Research Vessel: Pusan 851, Inha Univ.

Onbé, T., 1974. Studies on the ecology of marine cladocerans. *J. Fac. Anim Husb., Hiroshima Univ.*, **13**: 83-179 (in Japanese with English abstract).

Park, T.S., 1956. On the seasonal change of the plankton at Korean Channel. *Bull. Pusan Fish. Coll.*, **1**: 1-12 (in Korean with English abstract).

Ramner, W., 1933. Die Cladoceren der "Meteor"-Expedition. *Deutsche Atlantische Exped., Meteor, 1925-27*, **12**: 111-121.

Raymont, J.E.G., 1983. Plankton and productivity in the oceans. Vol. 2. Zooplankton. 2nd Ed., New York, 824pp.

Rocha, C.E.F., da., 1985. The occurrence of *Pleopis schmakeri* (Poppe) in the southern Atlantic and other marine cladocerans on the Brazilian coast. *Crustaceana*, **49**: 202-204.

Wickstead, J.H., 1963. The Cladocera of the Zanzivar area of the Indian Ocean, with a note on the comparative catches of two plankton nets. *East Afr. Agr. For. J.*, **2**: 1-66.

Yamazi, I., 1984. Illustrations of the marine plankton of Japan. Hoikusha, Tokyo, 537pp (in Japanese).

Yoo, K.I. and S.W. Kim, 1984. On the unrecorded species of marine cladoceran, *Evadne spinifera*, in Korean waters. *J. Oceanol. Soc. Kor.*, **19**: 104 (in Korean).

Accepted February 22, 1993