Population Dynamics of Dinoflagellate Community in Masan Bay with a Note on the Impact of Environmental Parameters

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The present study was carried out to clarify the population dynamics of dinoflagellate community, and the correlation between this community and environmental parameters during the period from April 1986 to March 1987 in Masan Bay, a typical semi-enclosed embayment of Korea. Dinoflagellate community in the Bay consisted of 53 taxa, representing 18 genera and 53 species. Extensive spatial and temporal fluctuation of standing crops of dinoflagellates were observed; ranging from 44 - 2,798,000 cells/l. The dinoflagellate group of 20 - 40 μm size class dominates in the Bay. The stepwise multiple correlation analysis between dinoflagellate community and environmental parameters showed that pH is the leading factor to control (influence) the fluctuation of standing crops of dinoflagellate following in order by salinity, NO_2-N and transparency.

Dinoflagellates are occasionally noticed as red tide causative organism, since their blooms injure seriously to fisheries and human-beings by its toxin. Masan Bay, which is located in the southern part of the Korean Peninsula, has been known to be the most important spawning and nursing ground of fish and shellfish for past years. Recently, it becomes, however, notorious for the eutrophications, and red tide is common due to the establishment of new industrial complex around the bay since 1970's. Most earlier investigations of red tide in the studied area have been dealing with its impact on fisheries (Park and Kim, 1967). In recent years, studies on the taxonomy and the ecology of dinoflagellates have received ever increasing attention in Masan Bay and there has been increasing documentation of taxonomical studies (Yoo, 1982; Han and Yoo, 1983a, b; Yoo and Lee, 1986). Meanwhile, ecological studies were also carried out a part of phytoplankton research program (Cho, 1978, 1981; Lee and Kwak, 1986). Population dynamics of dinoflagellate were studies as well (Yoo, 1984; Yoo and Lee, 1985). Despite their ecological importance, our knowledge on the biology of dinoflagellate, i.e., population dynamics, are still rather limited in Masan Bay. The main objective of the present study is investigating the impact of environmental parameters on their seasonal succession in Masan Bay, Korea.

Materials and Methods

Field investigations were carried out monthly during the period from April,1986 to March, 1987 at six selected stations in Masan Bay (Fig. 1). Water temperature (°C) salinity (°/ ₀₀), transparency(m), pH, dissolved oxygen(mg/l), NO_3-N (μg-at/l), NO_2-N(μg-at/l), NH_4-N(μg-at/l), and PO_4-P(μg-at/l) were measured simultaneously (Parsons et al., 1984). The stepwise multiple regression analysis between environmental parameters and dinoflagellate standing crops was performed by the SYSTAT package for the statistical analysis. In series of steps for data processing, the dependent variable is the standing crops (cell/l) of dinoflagellate, which is converted in natural logarithm, and the independent variables are the nine environmental parameters.

Results and Discussion

Species composition and standing crops of dinoflagellate.

A total of 53 taxa of dinoflagellate, representing 18 genera and 53 species was identified and classified by systematic treatment of Schiller (1933), Abe (1967a, b) and Dodge (1982).

Standing crops of dinoglagellates varied extensively; ranging from 44 to 2,789,900 cells/l at surface layer. It increased from April to August and after then decreased at surface layer, but showed very low densities at bottom layer. The difference between stations reveals that dinoflagellate standing crops in the inner part of the bay were higher than those in the outer ones.

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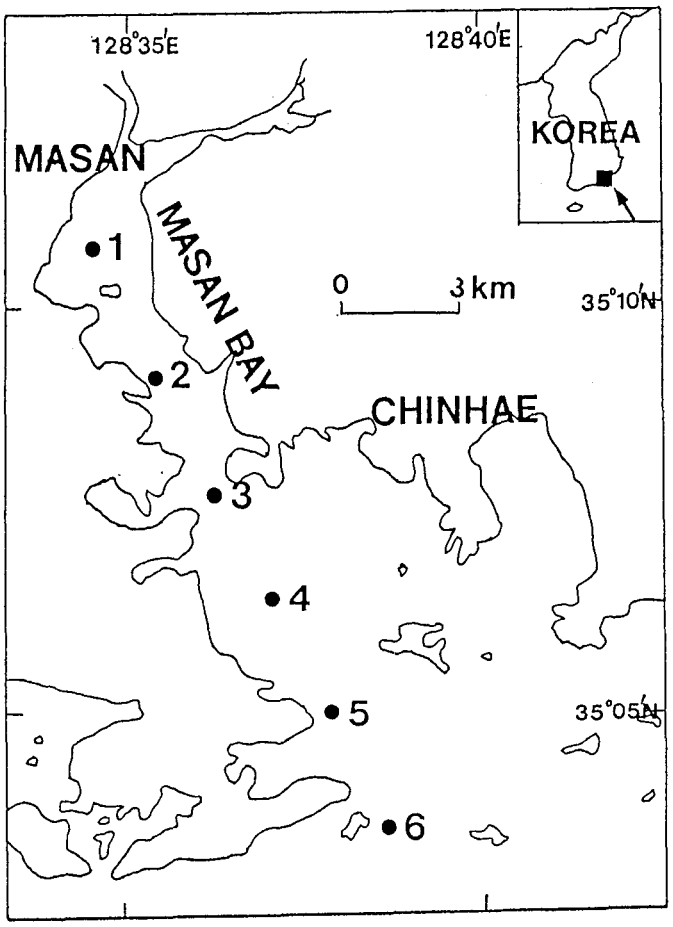

Fig. 1. Sampling stations in Masan Bay.

Standing crops of dinoflagellate were fractionated in each size class of 20 μm interval at each station. Size class of 20 - 40 μm is the highest from 64.6 % to 92.6 % at all stations due to high standing crops of genus *Gyrodinium*. At station 1, the genus *Prorocentrum*, belonging to size class of less than 20 μm, was predominant with 24.5 %. Size class of < 40 μm represented more than 89 % from st. 1 to st. 4, while st. 5 and st. 6 showed less than 80 %. So it turns out that small dinoflagellate, i.e., genus *Gyrodinium, Prorocentrum, Heterocapsa* predominated mainly the inner bay, while large species were widely distributed in the outer bay than in the inner bay.

Yoo and Lee (1985) reported that dinoflagellate of the size class of 20 - 60 μm were more abundant than those of other size classes, because the 40 - 60 μm size class of *Gymnodinium sanguineum* and *Prorocentrum micans* were most predominant at that time. In this study, the 20 - 40 μm size class was most dominant, because the dominant species was belonging to the size class of below 40 μm.

Correlations between dinoflagellate and environmental parameters.

The results of the stepwise multiple regression analysis with the total standing crops of dinoflagellates and environmental parameters are summarized in Table 1.

Table 1. Multiple correlation between dinoflagellate standing crops and environmental parameters during the surveyed period in Masan Bay.

	ALL AREA $n_{\cdot} = 132$ $R^2 = 0.489$		SURFACE LAYER $n_{\cdot} = 72$ $R^2 = 0.533$		BOTTOM LAYER $n_{\cdot} = 72$ $R^2 = 0.328$	
parameter	N. coef.	%	N. coef.	%	N. coef.	%
Water temperature			0.311	27.8	- 0.573	79.1
Salinity	- 0.259	26.0				
Transparency	- 0.140	14.0	- 0.359	32.0	- 0.224	28.1
pH	0.402	40.3	0.359	20.5		
Nitrite-N			0.108	9.7		
Nitrate-N	0.196	19.7				
Phosphate-P			0.112	10.0		

Probability = 0.000
MODEL DINO = CONSTANT + TEM + TRA + PH + DO + NO2 + NO3 + NH4 + PO4

The environmental parameters which affected the dinoflagellate dynamics are pH, salinity, nitrate (NO_3-N), transparency orderly at all stations, representing 48.9 % of importance ($r^2 = 0.489$, determination coefficient). At each layer, transparency, temperature, pH, phosphate, nitrite orderly affected the dinoflagellate standing crops, representing 53.3 % of importance ($r^2 = 0.533$) at surface layer, while at bottom layer temperature, transparency affected in 32.8 % of importance ($r^2 = 0.328$).

Yoo and Lee (1980) indicated that environmental parameters for affecting on diatom, in the same area were phosphate, transparency, chlorophyll-a, water temperature and salinity. According to Yang (1989), phosphate may be growth stimulators in the study area, because anoxic condition liberates phosphate during the phytoplankton blooms in summer seasons. In this study, temporal and spatial distribution of dinoflagellate community were correlated with water temperature at surface and bottom layers, and transparency, while nitrogen and phosphate sources affected only that of surface layer. Thus the salinity, pH, transparency, nitrogen and phosphate may be mainly related with the variation of dinoflagellate community, viz., the various sources from land run off affect the concentration of nitrogen and phosphate, and salinity as a growth stimulators. As a result, dinoflagellate dynamics may show the variations with the fluctuations of pH and transparency forming to blooms.

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