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# Eutrophication and succession of phytoplankton in reservoir of Korea - monthly variations of plankton community in Lake Soyang

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## Abstract

The community of plankton and the environmental factors were investigated in Lake Soyang from January to July 1994. The relationship between transparency and biovolume of phytoplankton was negatively correlated. Phytoplankton dominants in Lake Soyang were *Anabaena* spp., *Microcystis aeruginosa*, *Asterionella formosa*, *Asterionella gracillima Melosira distans*, *Synedra acus*, and *Asterococcus limneticus*. Zooplankton dominants were *Polyarthra* spp., *Keratella* spp., *Asplanchna placentula*, *Bosmina coregoni*, and *Daphnia longispona*. Phytoplankton and zooplankton were clearly related each other with respect to biovolume, not to numbers. *Microcystis aeruginosa* rapidly increased and *Daphnia longirostris* disappeared in July, because *Microcystis aeruginosa* secret toxic substances to *Daphnia longirostris*. Transparency decreased from January to June, but increased in July. The highest number of phytoplankton was obserbed in April, and one month later, the zooplankton reached a maximal level in population density, implicating that spring bloom of phytoplankton was good feeding condition for zooplankton.


**Key words : Monthly variation, spring bloom, phytoplankton, zooplankton**

## Introduction

Eutrophication phenomena reflects the variation of speciation community in Lake as well as the increase the cell number of plankton. On seasonal succession, a dominant phylum in plankton is known to Bascillariophyta in winter, Chlorophyta and Cyanophyta in summer through autumn. Specially, Cyanophyta blooming occurrs in eutrophic lake with high phosphorus supply and low N/P ratio (Mcqeen and Lean, 1986; Smith, 1983; Stockner *et al.*, 1988).

Some species of Cyanophyta cause a foul smell in running water and form scum on the surface of Lake. Several Cyanophyta are toxic to zooplankton, and reduce the feeding and assimilation as well as the survival and growth rate of various zooplankton. The deletion of *Daphnia* are observed in the blooming season of Cyanophyta, especially *Microcystis aeruginosa*(George and Edwards, 1974; Jones *et al.*, 1979). High fractional ratio of cyanophyta in total population of phytoplankton is found in summer(Kim *et al.*, 1988, 1989; Lee and Cho, 1994). Ecological aspects of Lake Soyang has been examined for many years (Cho, 1974; Cho and Kim, 1982, 1983; Cho *et al.*, 1989; Kim *et al.*, 1985a, 1985b, 1988, 1989; Lee and Cho, 1994). Purpose of this study is through the variation of plankton cleared phyto. and zooplankton's relationship.

## Materials and Methods

1. Description of the study area

Lake Soyang is a long and narrow reservior with the length of 60 Km' and the mean width of 0.5 Km. The shape of Lake Soyang can be classified as dendritic type, a common shape of large artificial lakes impounded at deep cannyons. The depth of Lake Soyang is the largest in Korea and its mean hydraulic residence time is one of the longest in Korea(about 0.75years) due to the relatively small inflow in comparision with its large capacity (Fig.1).

2. Methods

2.1. Environmental factors

Water temperature was measured with thermister-type thermometer and transparency was Secchi disk(ϕ 25 cm) at study site. Samples were filtered through GF/C glass filter papers. Filter papers were the stored at -20 ℃ for the analysis of chlorophyll a and filterate waters were stored in 4 ℃ not more than two days until the analysis of dissolved nutrients. Nutrients were analyzed according to Standard Methods (APHA, 1987). For the measurement of chlorophyll concentration, the filters were ground in tissue homogenizer with 5 ml of 90 % acetone, and were then centrifuged for removed turbidity. Cencentration of chlorophyll were determined by the spectrophotometric method of Lorezen (1967). Phosphate concentrations were determined by ascorbic acid method. The amount of total phosphorus was determined according to Standard Method (1987), PO4-P used Stephens (1963).

2.2. Biological facters

500 ml of water samples were fixed by Lugol's solution for the study of phytoplankton community. Phytoplankton cells were concentrated by the settling method (Sukhanova, 1978). After settling more than two weeks, supernant water was decanted by siphon, and phytoplankton was examined under light microscopes (×400), and cell number was counted with Palmer-Maloney counting chambers. Phytoplankton species were identified according tothe manual of Huber-Pestalozzi (1968), Hirose and Yamagishi (1977), 水野(1964), and Cho(1993). Zooplankton was collected by filterating the sampled water with a 100 μm mesh net, and was then fixed with 4 % formalin, and was counted under light microscopes (×400) with Palmer-Maloney counting chambers.

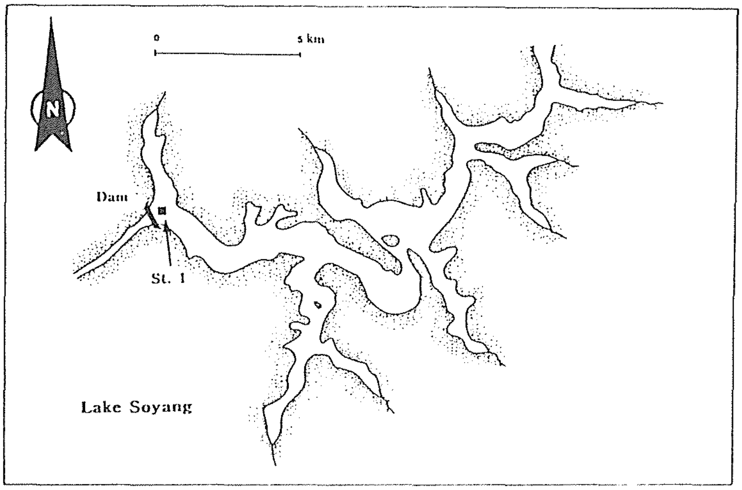


Fig. 1. Map showing the sampling sites in Lake Soyang.

## Result and discussion

Figure 2 shows surface temperature at the dam site. It is always above 4 ℃, and its highest temperature is 30.7 ℃. Transparency is high in winter when the number of plankton cell is low except the early June. This season has the lowest transparency value because of high amount of floating matter better. Spring blooming season in April has low transparency value of about 2.1 m.

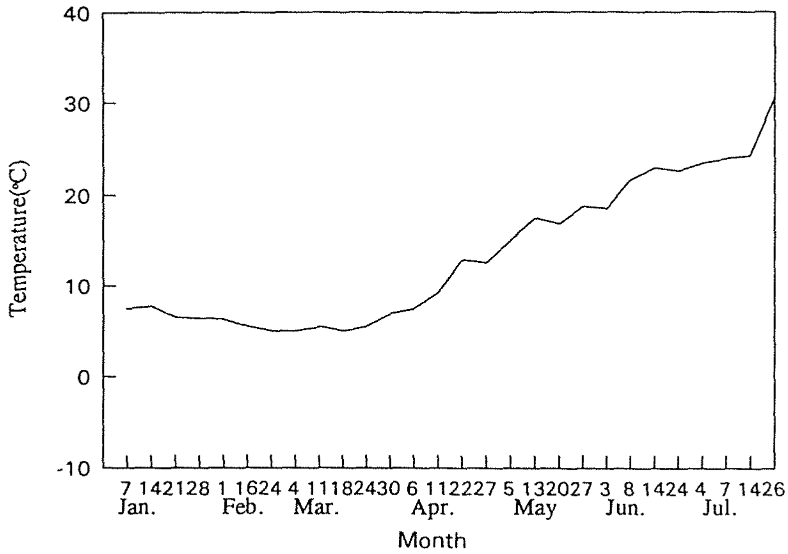


Fig. 2. Variation of water temperature at dam site in Lake Soyang (Jan. - Jul. 1994).

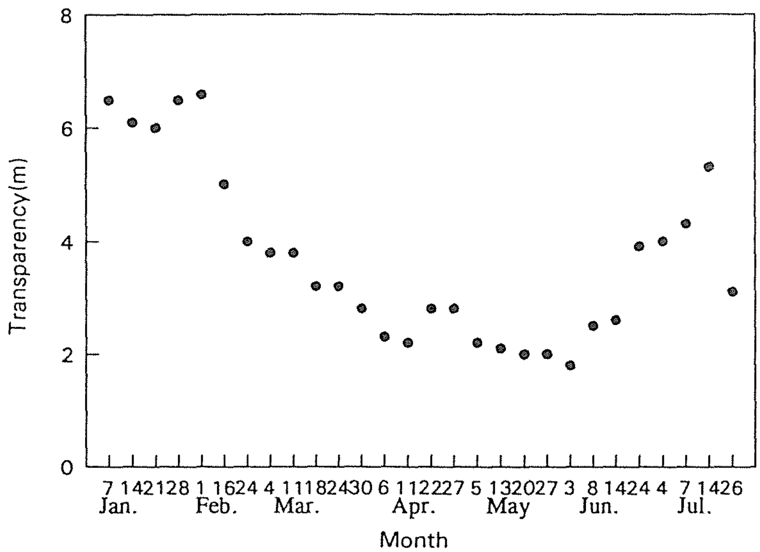


Fig. 3. Variation of Secchi disk transparency at Dam site in Lake Soyang (Jan. - Jul. 1994).

The monthly variation of phosphrus is shown in Fig. 4. The highest concentration of phosphorus was measured in a sample of the late June. Dominant at this time was *Anabaena* spp., Microcystis aeruginosa. Highest

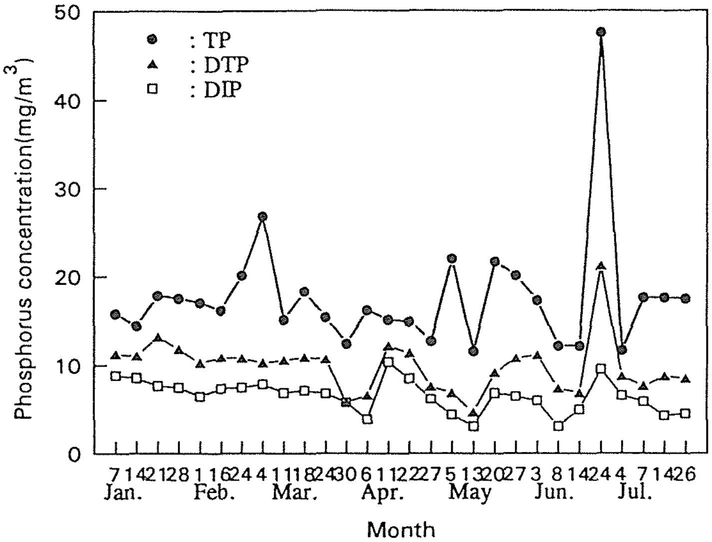


Fig. 4. Variation of phosphorus concentration at Dam site in Lake Soyang (Jan. - Jul. 1994).

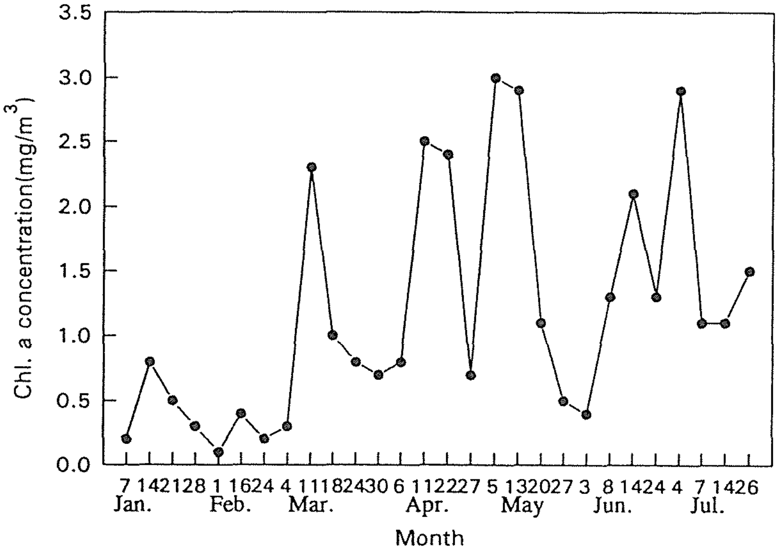


Fig. 5. Variation of Chl.a concentration at Dam site in Lake Soyang (Jan. - Jul. 1994).

phosphorus concentration at the late June is probably due to the floating of these species which accelerate the phosphorus accumulation at surface area. Concentration of chlorophyll a is largly decreased from the late May to the

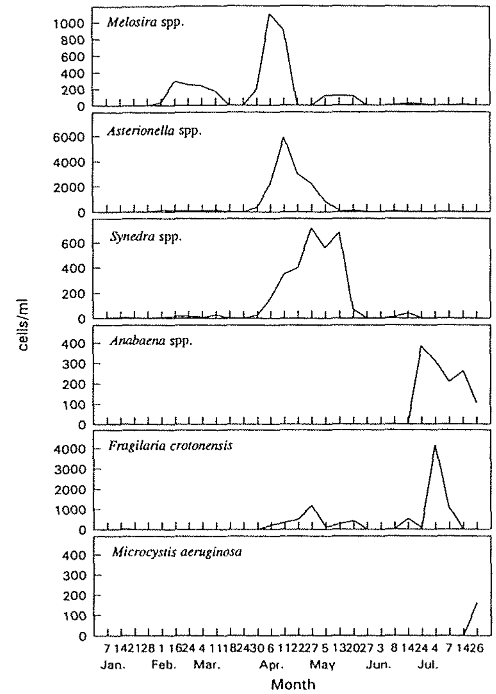


Fig. 6. Change of phytoplankton dominant species at Dam site in Lake Soyang(Jan. - Jul. 1994).

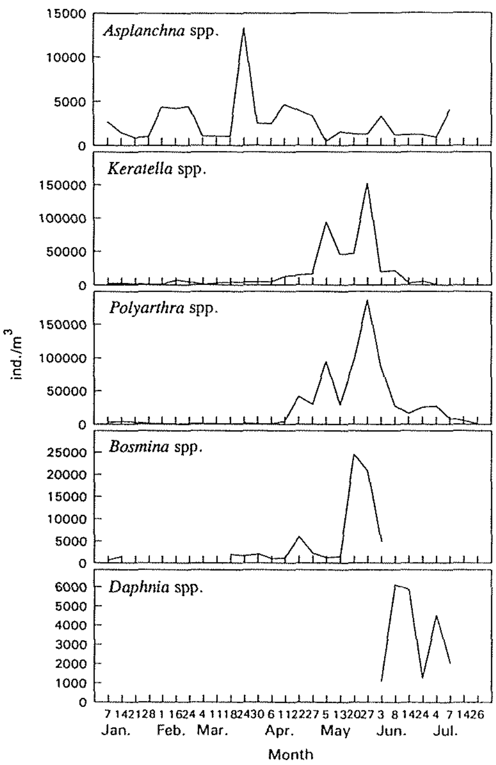


Fig. 7. Change of zooplankton dominant species at Dam site in Lake Soyang(Jan. - Jul. 1994).

early June. This season has lowest phytoplankton concentration wheareas zooplankton is very high, suggesting that this season is water clear time. Phytoplankton dominants were *Anabaena* spp., *Microcystis aeruginosa*, *Asterionella formosa*, *Asterionella gracillima*, *Melosira distans*, *Synedra acus*, and *Asterococcus limneticus*. Zooplankton dominants were *Polyarthra* spp., *Keratella* spp., *Asplanchna placentula*, *Bosmina coregoni*, and *Daphnia longispona*. Fig. 6 and 7 showed seasonal changes of those species.

Total number of zoo. and phytoplankton is shown in Fig. 8. The highest number of phytoplankton was observed in April, and one month later, the zooplankton reached a maxinal level in number, implicationg that spring bloom of phytoplankton was good feeding condition for zooplankton.

Zooplankton has specifical feeding habit and usually they cannot take species bigger than their own body. For this reason biovolume of zooplankton and phytoplankton was measured, and compared each other (Fig. 9).

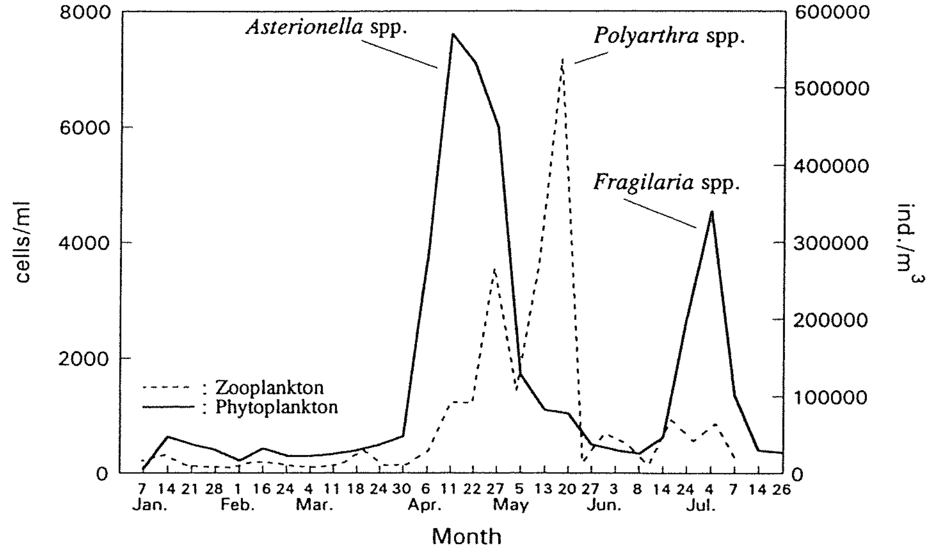


Fig. 8. Weeklv variations of phytoplankton and zooplankton at Dam site in Lake Soyang(Jan. - Jul. 1994).

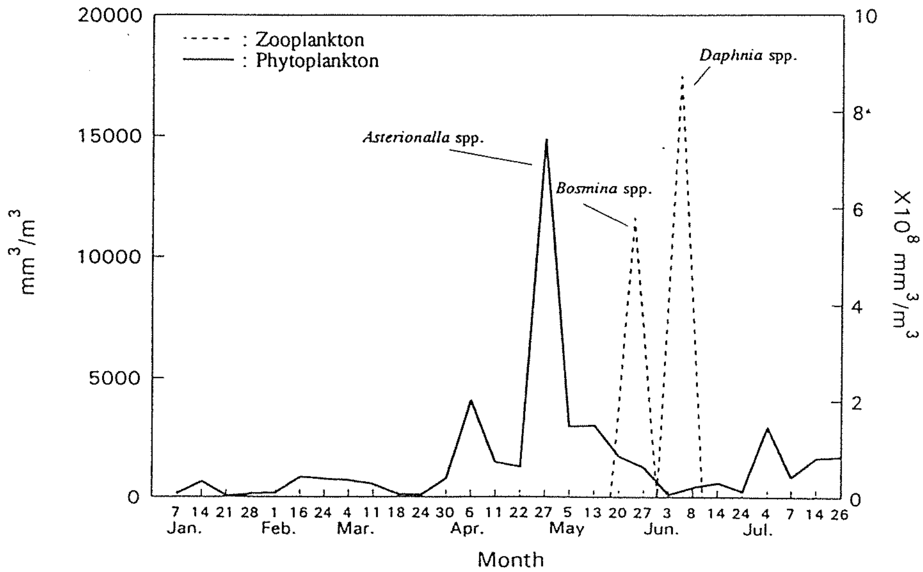


Fig. 9. The weekly variations of biovolume of phytoplankton and zooplankton at Dam site in Lake Soyang(Jan. - Jul. 1994).

It was also observed that the zooplankton's peak time follows phytoplankton's blooming. Highest number of phytoplankton was found during 11 to 22, April, but peak time in biovolume is during 27, April to 5, May. This phenomena was caused by *Synedra* spp., *Fragilaraia crotonensis*. The peak time of zooplankton was from 13 to 20, May. But biovolume's peak season was from 3 to 8, June. Dominant species of this season was *Daphnia* spp which has large biovolume. The relationship phytoplankton and zooplankton was clearly appeared on biovolume, not on cell numbers. *Microcystis aeruginosa* was rapidly increased in July because of high water temperature. At this season was disappeared *Daphnia*. In some lakes, it was showed that Cyanophyta at blooming season do not inclued *Daphnia* (George and Edwards, 1974; Jones *et al.*, 1979). *Daphnia* was identified as bacteriovores at the blooming season of Cyanophyta in Lake Soyang (Sim, Ahn, 1992). Figure 10 showed the relationship of phytoplankton' biovolume and transparency. It was negatively correlated. Figure 11 showed diversity indices of phytoplankton, which was the lowest value at Spring blooming season.

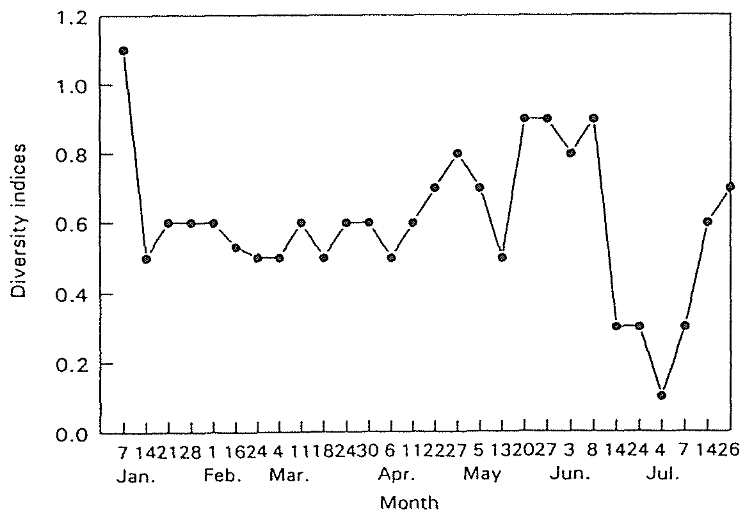


Fig. 10. The Shannon-Wiener diversity of phytoplankton at dam site in Lake Soyang(Jan. - Jul. 1994).

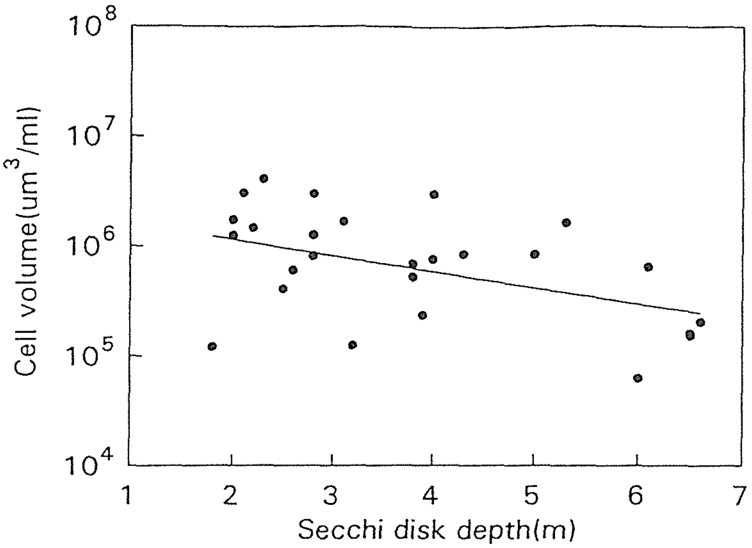


Fig. 11. Relationship between transparency and cell volume of phytoplankton at Dam site in Lake Soyang.

Conclusion

In this study, environmental factors and the ecological aspects of phytoplankton and zooplankton in Lake Soyang were weekly investigated from January to July, 1994. Water temperature was always above 4 ℃ and highest temperature was 30.7 ℃. Transparency was decreased from January to June, but increased in July. Phytoplankton dominants in Lake Soyang were *Anabaena* spp., *Microcystis aeruginosa, Asterionella formosa, Asterionella gracillima Melosira distans, Synedra acus,* and *Asterococcus limneticus.* then Zooplankton dominants were *Polyarthra trigla., Keratella* spp., *Asplanchna placentula, Bosmina coregoni,* and *Daphnia longispina.* The relationship phytopalnkton and zooplankton was clearly appeared on biovolume, not on numbers. *Microcystis aeruginosa* was rapidly increased and *Daphnia longirostris was* disappeared in July. It is considered that *Daphnia longirostris* evade *Microcystis aeruginosa.* The relationship between transparency and biovolume of phytoplankton was negatively correlated. The highest population size of phytoplankton was in April, and one month later, the zooplankton has peak times, suggesting that spring bloom of phytoplankton was good feeding condition for zooplankton.

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