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NOTE

Freshwater Ecosystem (Mulkol) and Periphytic Algal Biomass in the Tok Island, Korea

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This study was conducted to introduce the characteristics of the freshwater environment of Mulkol, considering that it is less known area about the ecosystem of the Tok Island. The salinity of freshwater in the Mulkol was less than 2.0 psu, while its periphytic algal biomass was thriving with 25.9 μg chl-*a*/cm^2. As for the nutrients in water, the content of NH_4 was higher than the rest of inorganic nitrogen components, and SRP and SRSi were much higher as 117.3 μg P/l and 4,104.6 μg Si/l respectively, than nitrogen components. Also, the ratio of N/P was found less than 1.0, revealing the condition that N was greatly limited. The high level of nutrient concentration and periphytic algal biomass at the Mulkol ecosystem could be explained as a result of natural pollution, but no full explanation was made in this study. It is a question that needs additional research in the future.

Key words : Freshwater, Nutrient, Periphyton, Biomass, Tok Island

Tok Islands, with its geographical location at the middle of the East Sea, is believed to maintain a natural ecosystem that is quite distinctive compared with the coastal ecosystem of the Korean inland. But there have not been enough research studies on the subject largely due to an island of difficult access under inclement weather conditions. As a result, only a few researches had been done on the ecosystem of island from the early 1980s, and they are mostly based on short-term observations executed from spring to autumn (ASPD, 1998-1999; KORDI, 2000; URI, 2003). This study is focused on major environmental factors and periphytic algal biomass affecting the ecological characteristics of Mulkol, the little "water trough" of island. As Mulkol is an area that has had little attention from researchers, this study may be able to provide some useful basic data about the Tok Island to be profitably exploited by future studies on the ecosystem of island.

The Korean island located in the middle of the East Sea (37° 14′18″N, 131° 52′33″E), the Tok Island consists of two main islands named Tongdo ("Eastern Island") and Seodo ("Western Island") and a number of smaller rocks dispersed around them (Fig. 1). The total area of the Tok Island as a whole is 0.18 km^2 of which Tongdo and Seodo take 0.07 km^2 and 0.10 km^2, respectively. The rest of the area, 0.1 km^2, is formed by the smaller rocks (KORDI, 2000). Recently, the island and their marine vicinity within 1 km is designated as Natural Monument No. 336 by the Korean Government and their natural environments are protected by the Korean law. Developed in 1967 for use as a drinking water resource, Mulkol is

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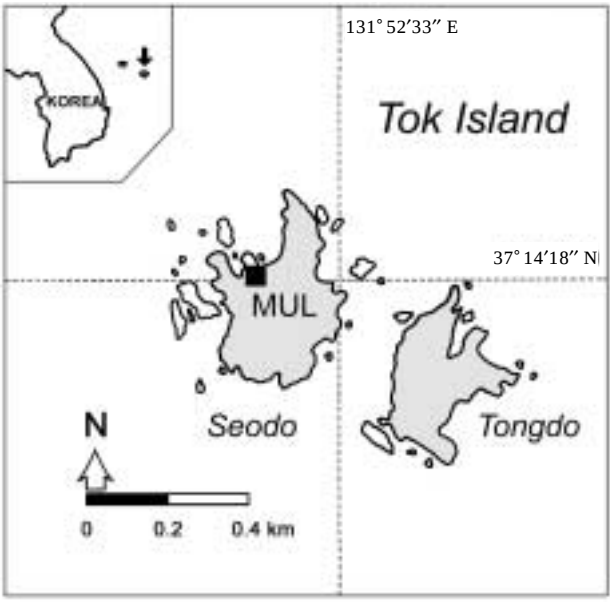

Fig. 1. Map showing sampling location for the survey of water quality and periphytic algae in the Tok Island. The Mulkol was developed in 1967, as a drinking-water resource of freshwater.

located at Seodo. It is the only freshwater system in Tok Island although the capacity of freshwater is very small. The sampling for this study was performed for three days from the 19th to 21st of August, 2003.

As for water environmental factors, water temperature, dissolved oxygen (DO), salinity and total dissolved solids (TDS) were measured by YSI-600 XL meter, while pH, conductivity and turbidity by Orion 230A meter, Conduktometer LF191-WTW and HACH 250 meter. The measurement was executed on the actual spot, and a water sample was collected directly from the water outlet. The sample was put in 4 1 plastic bottles prepared by washing them with weak hydrochloric acid solution, carried out a filtration treatment at the spot before being put in an ice-box and carried to the laboratory. The sample was analyzed as soon as it arrived at the laboratory. The analysis of inorganic nutrients such as N · P and Si in the sample water was executed by filtering it through Whatman GF/F and then via duplication according to the analytical method of Strickland and Parsons (1972) and APHA *et al.* (1995). The total inorganic nitrogen (TIN) was calculated by the total amount of $NH_4+NO_3+NO_2$. For the chl-*a* concentration, the sample

Table 1. Environmental factors in the Mulkol of the Tok Island in August 2003.

Factors \ Sampling station	Tok Island (Mulkol)
Water temperature (°C)	16.4
Dissolved oxygen (mg O_2/l)	9.4
pH	7.92
Conductivity (μS/cm)	3.2
Total dissolved solids (mg/l)	2.3
Salinity (psu)	1.9
Turbidity (NTU)	0.15
Chlorophyll-*a* (μg/l)	0.3
Total suspended solids (mg/l)	2.8
Ash-free dry matter (mg/l)	2.8

was filtered through GF/F filter before conducting a boiling extraction by using 90% ethanol solution, and the amount was obtained by calculating its absorbance with a spectrophotometer at 665 nm and 750 nm wavelength (Nusch, 1980).

Periphyton samples were collected by scrapping stone surfaces with a tooth-brush, and made up into specific amounts. Then, the samples were used to determine chlorophyll-*a*, pheopigment and organic matters (ash-free dry matter, AFDM). The quantity of photosynthetic pigments of periphyton was determined via the Lorenzen (1967) method that enables the concurrent measurement of chl-*a* and inactivated pigments after the sample was filtered through Whatman GF/C filter. AFDM was filtered through GF/C, dried at 105°C until there was no change in weight, and finally burnt for 2 to 4 hours in an electric muffle furnace at 550°C to get a loss in weight during the process (APHA *et al.*, 1995). The periphytic algal biomass was estimated by the quantity of chl-*a* per unit area (cm^2) and pheopigment, and the quantity of organic matters by AFDM.

Table 1 shows major water environmental factors measured and analyzed at the Mulkol of the Tok Island. The water temperature from the Mulkol outlet in the late summer (August) of 2003 was 16.4°C, and its DO was 9.4 mg O_2/l. The pH was 7.92, conductivity 3.2 μS/cm, total dissolved solids 2.3 mg/l, and salinity 1.9 psu, showing that it was close to the characteristics of freshwater. The total suspended matter and AFDM of the Mulkol water were 2.8 mg/l and chl-*a* was found very low as 0.3 μg/l (Table 1).

As for the nutrients with the water, the amount

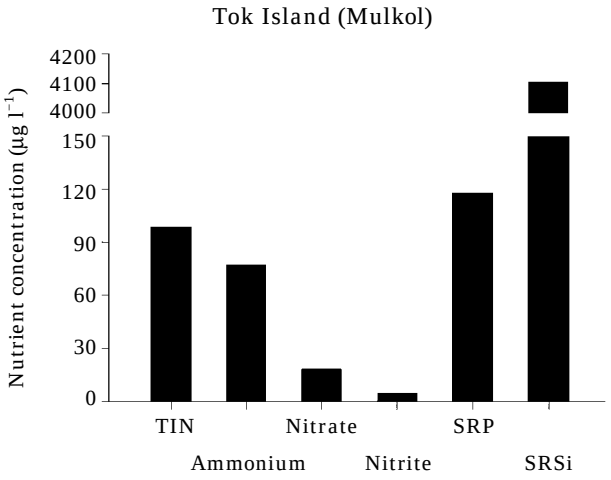

Fig. 2. Distribution of inorganic nitrogen, phosphorus and silicon nutrients in the Mulkol of the Tok Island in August 2003.

of NH_4 was 76.6 μg N/l, and NO_3 and NO_2 were 17.4 μg N/l and 4.0 μg N/l, respectively (Fig. 2). The percents of NH_4, NO_3 and NO_2 in the total inorganic nitrogen were 78.2%, 17.8% and 4.0%, respectively, which showed that the content of NH_4 was higher than that of the rest (Fig. 2). SRP was 117.3 μg P/l, while SRSi was 4,104.6 μg Si/l. These concentrations were much higher than those of nitrogen components (Fig. 2). Also, the ratio of N/P was less than 1.0, which revealed highly N-limited. A study by Kim *et al.* (2003) on the water quality of saline groundwater in the Jeju Island revealed that the concentration of inorganic phosphorus in the groundwater was high, but the difference between this study and their results is that here the concentration of nitrogen and salinity is higher.

The total photosynthesis pigments, chlorophyll *-a* and pheopigment of periphytic algal biomass from the stone substrates collected from the Mulkol outlet were 135.4 μg/cm^2, 25.9 μg/cm^2 and 109.5 μg/cm^2, respectively, while AFDM was 6.0 mg/cm^2 (Table 2). The percents of chlorophyll-a and pheopigment were 19.1% and 80.9% against the total amount of photosynthesis pigments, showing that the content of inactivated pigments was 4.2 times higher. As periphytic algal biomass from the Mulkol outlet was much higher in terms of accumulated amount in comparison with the diverse substrates at the coast, showing that its ecosystem was relatively less disturbed. An application of the classification criteria by Biggs (1996) and Dodds *et al.* (1998) revealed that it exceeded $>6\sim10$ μg chl-*a*/cm^2 and 0.05 mg AFDM/cm^2 by a great amount, showed that it was between eutrophic and hypertrophic states.

Table 2. Contents of photosynthetic pigment and organic matter of periphyton in the Mulkol of the Tok Island in August 2003.

Factors \ Sampling station	Tok Island (Mulkol)
Total photosynthetic pigment (μg/cm^2)	135.4
Chlorophyll-*a* (μg/cm^2)	25.9
Pheopigment (μg/cm^2)	109.5
Ash-free dry matter (mg/cm^2)	6.0

As the only freshwater ecosystem in the Tok Island, Mulkol showed a different water environment from that of the seawater near the islands in summer (KORDI, 2000; URI, 2003). Compared with the coastal water, the Mulkol water showed lower water temperature, pH, conductivity and salinity, while higher in DO. The finding in this study that SRP and SRSi were much higher than other nutrients in water is meaningful in that it was the first case where such a result was reported. The high Si was presumed to have come from the geological factor that the water flows out of solid foundation, but the high concentration of P was not fully explained except that the artificial water reservoir and high periphytic algal biomass may have affected the water ecosystem of Mulkol having become rich with nutrients. This subject needs further research.

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REFERENCES

APHA, AWWA, WEF. 1995. Standard Methods for the Examination of Water and Wastewater, 18th ed. American Public Health Association, Washington, DC., USA.

ASPD (Association for the Study and Preservation of the Dokdo Island). 1998. Marine Environment around the Dokdo Island in Basic study for the conservation of the marine environment and their

resources around the Dokdo Island. Dokdo Study Series No(4), p 254 (in Korean).
ASPD (Association for the Study and Preservation of the Dokdo Island). 1999. The basic study for sustainment of marine environment and fishery resources of the Tokto area. Ministry of Maritime Affairs & Fisheries. p. 544 (in Korean).
Biggs, B.J.F. 1996. Patterns of benthic algae in streams. *In*, R.J. Stevenson, M. Bothwell and R.L. Lowe. (eds.) Algal Ecology: Freshwater Benthic Ecosystems. Academic Press, San Diego, Calofornia, USA. p. 31-55.
Dodds, W.K., J.R. Jones and E.B. Welch. 1998. Suggested classification of stream trophic status: Distribution of temperate stream types by chlorophyll, total nitrogen, and phosphorus. *Water Research* **32**: 1455-1462.
Kim, S.-S., D.-K. Kim, P.-H. Lee and D.-S. Ha. 2003. Temporal and spatial variations of water quality of the coastal saline groundwaters in Jeju Island. *Korean J. Aquaculture* **16**: 15-23 (in Korean).
KORDI (Korea Ocean Research & Development Institute) 2000. The Basic Study for Ecosystem of Tok Island. Ministry of Maritime Affairs & Fisheries. BSPM 99045-00-1282-6. p. 1033 (in Korean).
Lorenzen, C.J. 1967. Determination of chlorophyll and pheo-pigments: Spectrophotometric equations. *Limnol. Oceanogr*. **12**: 343-346.
Nusch, E.A. 1980. Comparison of different methods for chlorophyll and phaeopigment determination. *Arch. Hydrobiol. Beih*. (Ergebn. Limnol.) **14**: 14-36.
Strickland, J.D. and T.R. Parsons. 1972. A Parctical Handbook of Seawater Analysis. Bulletin of Fisheries Research Board of Canada, No. 167. p. 310.
URI (The Ulleung Research Institute). 2003. A Report on The Scientific Survey for Natural Protection Area of Tok Island, Korea. Ulleung-Kun. p. 181-195 (in Korean).

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<국문적요>

독도의 담수환경 (물골)과 부착조류 생물량

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본 연구는 독도에서 식수원으로 이용되었던 담수 환경인 물골 생태계를 소개하고자 하였다. 물골 유출수의 염분도는 2.0 psu 이하이었고, 부착조류 생물량이 25.9 μg chl-*a*/cm^2 수준으로 대량 번성하여 과영양 환경을 유지하였다. 수중 영양염 중에서 질소는 NH_4의 농도가 비교적 높았고, SRP는 117.3 μg P/l, SRSi는 4,104.6 μg Si/l로서 N 성분에 비해 매우 높은 농도를 보였다. 그 결과, N/P 비는 1.0 이하로서 강한 N 제한 상태를 나타냈다. 물골에서 높은 무기 영양염 농도와 부착조류 생물량은 교란이 적은 생태계로서 자연적 오염의 영향으로 볼 수 있었으나, 본 연구를 통해 완전한 규명은 어려웠으며, 향후 이에 대한 학술적 후속 연구가 요구된다.