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The effects of floating islands planted with various hydrophytes for water quality improvement

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ABSTRACT: This study was carried out for measurement of total nitrogen and total phosphorus removal efficiency by each hydrophyte (*Scirpus tabernaemontani*, *Iris pseudoacorus*, *Phragmites australis*, *Typha angustifolia),* control and All(*Scirpus tabernaemontani*, *Iris pseudoacorus*, *Phragmites australis*, *Typha angustifolia* planted*)* 22 ℓ batch reactors. The highest total nitrogen removal efficiency was using 94.8 % of All. The highest total phosphorus removal efficiency was 85.1 % of *Typha angustifolia.*

The effects of floating islands on the changes in phytoplankton community structure were investigated in a small artificial pond. The floating islands planted with various emergent macrophytes coverd 35% of total water surface area of the pond. Total 17 genera and 25 species of phytoplankton were found in the pond, of which Dinophyceae was 1 genera and 1 species, Cyanophyceae 1 genera and 1 species, Bacillariophyceae 6 genera and 8 species, and Chlorophyceae 9 genera and 15 species. Dominant phytoplnaktons under floating islands were changed from *Aphanizomenon* sp. as a Cyanophyceae to *Golenkinia radiata*, *Kirchneriella contorta* and *Micractinium pusillum* as a Chlorophyceae for 56 days after the construction of floating islands on July 24, 2001. The changes of dominant phytoplanktons of the control without floating islands were similar to those under floating islands in July and August, but *Aphanizomenon* sp. was rapidly increased in the control sites in September. About 99% of the cell number of *Aphanizomenon* sp. was disappeared for a month after construction of floating islands. Our results showed that the floating islands could be a useful eco-technique for the control of water bloom by Cyanophyceae and Chlorophyceae in a pond ecosystem

Key words: Hydrophytes, Cyanophyceae, Plant floating island, Phytoplankton

Introduction

The wetlands is the most important ecosystem in the world. The functions of the wetlands are purification of waste water, prevention of a flood, recharging of underground water and floatage of biodiversity. But huge amount of wetlands has been destroyed by reclamation and development, and the destruction of ecosystem is so dangerous now. One of the methods for restoration wetland is floating islands which imitate floating mat which exits on the surface of natural wetland. Plant floating island was made up out

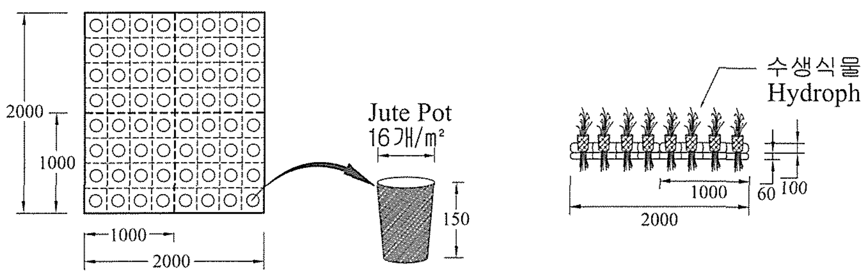

Fig. 1. Ground and side plan of Plant floating islands.

of floating frame which has floating function and matrix fixing hydrophytes root and rootstock (Fig. 1). The Plant floating island in Korea is newly developed on the basis of import and repletion of existing many technologies. Plant floating islands offere a base for growth of hydrophytes where deep water depth or steeply slanting watershed or concrete pond. In the plant floating islands, under part grow more richly than upper part. And roots of plants were absorb nutrition in the water so water quality better than where no Plant floating islands. In addition, it was studied attempt diversity and stability of ecosystem by make foodweb.

The purpose of this study is clarify ecosystem restoration, decrease water bloom and improve water quality by Plant floating islands.

Materials and Methods

1. Investigation of Water quality

It was investigated water temperature, pH, COD, TN, TP, and chlorophyll *a*. Method was based on Standard Methods (APHA·AWWA·WPCF, 1989).

2. Investigation of hydrophytes

Dried plant sample was grinded and passed though sized 1 mm sieve for total phosphorous analysis. Total phosphorous was analyzed P-compound to convert PO4 with oxidation and digestion of organic matter in sample. P concentration was determined to access spectrophotometer by ascorbic acid method. Total nitrogen analysis used for micro Kjeldahl digestion

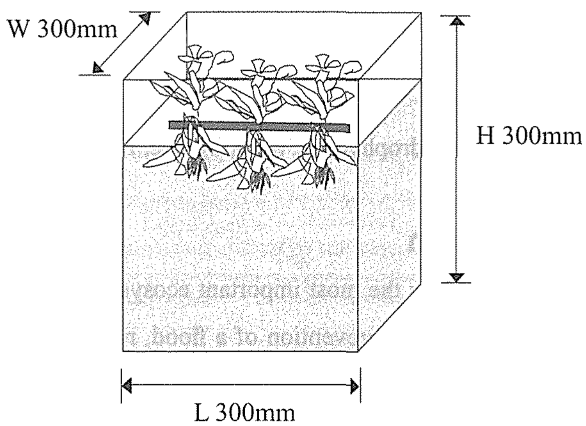

Fig. 2. Diagram of Batch reactor.

with sample prepared for total phosphorous analysis.

3. Investigation of phytoplankton

It was surveyed how the phytoplankton community changed under plant floating islands from July to September at KOWACO's pond.

A volume of 500 mℓ of water sample (preserved with Lugol's solution) were concentrated by settling method (Sukhanova, 1978). After settling for more than two weeks, supernatant water was decanted by siphon, and phytoplankton was counted under light microscopes with Palmer-Maloney counting chamber. Phyroplankton species were identified according to Huber-Pestalozzi (1968) and Hirose and Yamagishi (1977).

Results

Effect of water quality improvement

At the first time, European floating islands were focused on ecological restoration but water quality inprovemet. While the natural watershed has been reduced, floating islands were introduced for the ecological restoration. The first phenomena was increase of birds where floating islands constructed. There for the effects of water quality improvement was discovered (Nakamura, 1998). A request places of plant floating islands were eutrophic lake where rich phosphorus and nitrogen. Plant floating islands leads new water ecosystem. Effect of plant floating islands are control water bloom. Because hydrophytes of plant floating islands use for growth phosphorus and nitrogen in the water. So they are compete algae because of same food.

The experiment has been performed during 14 months from August 1998 to October 1999. There were total 6 reactors and area of 750 m^2 at factory, Assum coorporation , Jincheon, Choongbuk-Do, Korea. COD of reactor with plant floating island were 42 % lower than non installation of plant floating island. Total phosphorus and total nitrogen were 50 % lower than non installation of plant floating island. Chlorophyll *a* was 90 % lower than non installation of plant floating island (Kwon, 1999).

Pilot plant each (22ℓ) was made for the measurement of treatment efficiency by each hydrophytes. Pilot plant had no input and output like a batch type (Fig. 3). Hydrophytes of pilot plant experiment were *Scirpus tabernaemontani*, *Iris pseudoacorus*, *Phragmites australis*, and *Typha angustifolia*. They were all curtivated one year by pot. Pilot

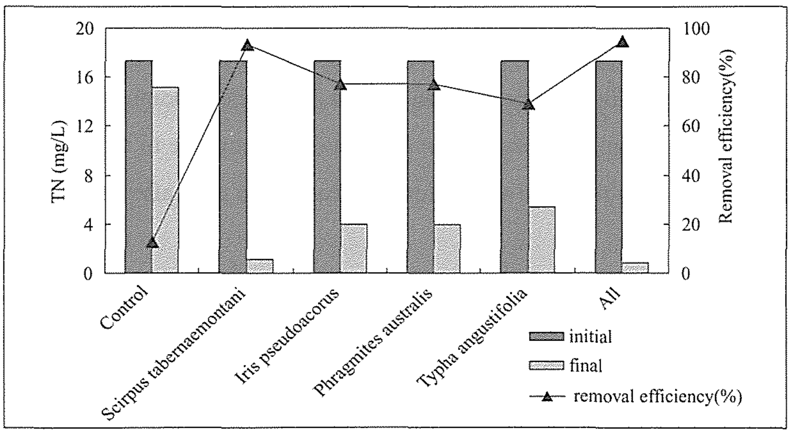

Fig. 3. Removal efficiency of total nitrogen each hydrophytes.

Table 1. Water quality of J sewage treatment plant.

Tem. (°C)	pH	DO (mg/ℓ)	BOD (mg/ℓ)	COD (mg/ℓ)	SS (mg/ℓ)	Chl. *a* *	T-N (mg/ℓ)	NH3-N (mg/ℓ)	NO2-N (mg/ℓ)	NO3-N (mg/ℓ)	T-P (mg/ℓ)	PO4-P (mg/ℓ)
26.4	7.39	4.88	4.14	24.3	1	3.34	17.38	13.15	0.854	2.919	1.54	1.466

Note. The unit of Chl.-a* is mg/m^3

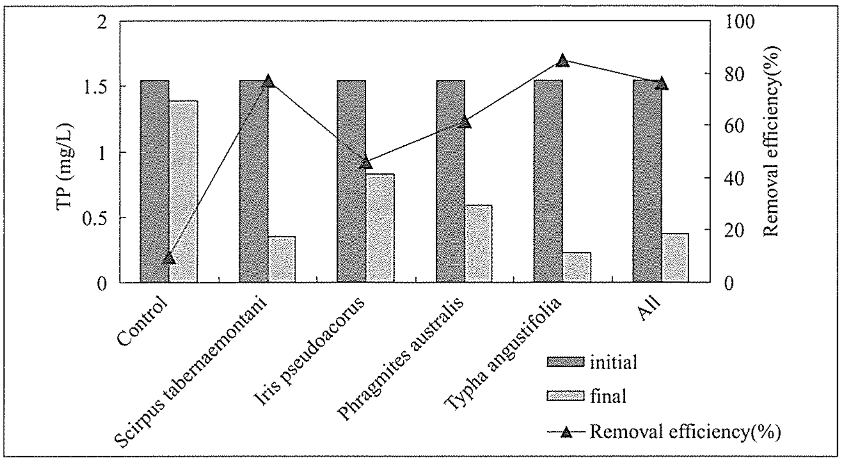

Fig. 4. Removal efficiency of total phosphorus each hydrophytes.

plants were total 6. Control, each 4 hydrophytes and all hydrophytes planted (All).

Wastewater for experiment was brought from J sewage treatment plant at Seoul.

The highest removal efficiency of total nitrogen was 94.8 % of All. And then *Scirpus tabernaemontani*, *Iris pseudoacorus* , *Phragmites australis*, and *Typha angustifolia* (Fig. 4). In Control, there was no denitrification while nitrification occurred, so removal efficiency of total nitrogen was 13 %. This phenomena was concludes by effect of algae.

The highest removal efficiency of total phosphorus was 85.1 % of *Typha angustifolia.* And then *Scirpus tabernaemontani*, All, *Phragmites australis*, *Iris pseudoacorus*, control (Fig. 4). Typha angustifolia had highest removal efficiency of total phosphorus while removal efficiency of total nitrogen was lowest.

Change of phytoplankton community

Total 17 genera and 25 species of phytoplankton were found in the KOWACO's pond, of which Dinophyceae was 1 genera and 1 species, Cyanophyceae 1 genera and 1 species, Bacillariophyceae 6 genera and 8 species, and Chlorophyceae 9 genera and 15 species. Dominant phytoplanktons under floating islands were changed from *Aphanizomenon* sp. as a Cyanophyceae to *Golenkinia radiata*, *Kirchneriella contorta*, and *Micractinium pusillum* as a Chlorophyceae for 56 days after the construction of floating islands on July 24, 2001.

Dominant phytoplanktons were shown up same change at st.1, 2, 3. St. 1 was under part of *Scirpus tabernaemontani*, *Scirpus fluviatilis* and *Lythrum anceps* planted floating island. St. 2 was under part of Iris pseudoacorus planted floating island. St. 3 was under part of *Scirpus tabernaemontani, Lythrum anceps* and *Scirpus radicans* planted floating island. But st. 4 and 5 without installation plant floating island were different change of dominant phytoplanktons compared to st. 1, 2, 3.

The cell number of *Aphanizomenon* sp. was decreased after one month plant floating islands construction (st. 1, 2, 3) from 3.6×105 cells/mℓ to 1.6×102 cells/mℓ. Removal efficiency of water bloom decrease was 99 %. Especially *Aphanizomenon* sp. cell number of st. 2 (*Iris pseudoacorus* planted) was 1/ 14 lower than other plance. St. 4, 5 (non installation plant floating island) were also decreased *Aphanizomenon* sp. from to 3.8×105 cells/mℓ to 2.5×103 cells/mℓ. But they were increased at September 3 while not increased st. 1, 2, 3. *Aphanizomenon* is blooming at summer in the eutrophic lake, and it has neural toxic matter (Watanabe *et al.*, 1994).

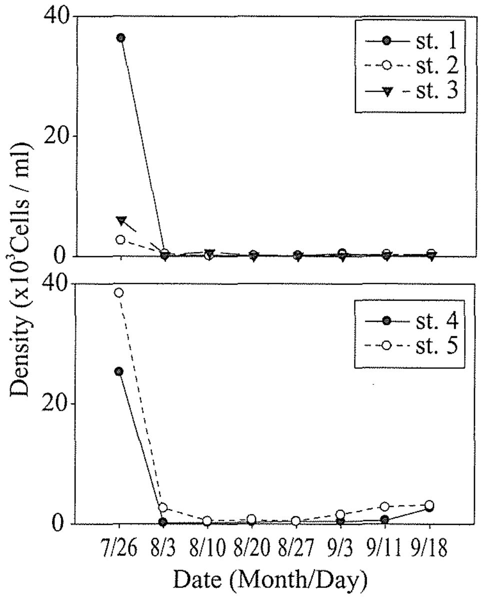

Fig. 5. Changes in cell number of *Aphanizomenon* sp. at KOWACO's pond.

Discussion

The highest removal efficiency of total nitrogen was 94.8 % of All pilot plant. And then *Scirpus tabernaemontani*, *Iris pseudoacorus* , *Phragmites australis*, and *Typha angustifolia*. The highest removal efficiency of total phosphorus was 85.1 % *Typha angustifolia*. And then *Scirpus tabernaemontani*, All, *Phragmites australis*, *Iris pseudoacorus*, and control.

Total 17 genera and 25 species of phytoplankton were found in the KOWACO's pond, of which Dinophyceae was 1 genera and 1 species, Cyanophyceae 1 genera and 1 species, Bacillariophyceae 6 genera and 8 species, and Chlorophyceae 9 genera and 15 species. Dominant phytoplanktons under floating islands were changed from *Aphanizomenon* sp. as a Cyanophyceae to *Golenkinia radiata*, *Kirchneriella contorta*, and *Micractinium pusillum* as a Chlorophyceae for 56 days after the construction of floating islands on July 24, 2001. The cell number of *Aphanizomenon* sp. were decreased after one month plant floating islands construction (st. 1, 2, 3) from 3.6×105 cells/mℓ to 1.6×102 cells/mℓ. Removal efficiency of water bloom was 99 %. Our results showed that the floating islands could be a useful eco-technique for the control of water bloom by Cyanophyceae in the pond.

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