댐 건설에 따른 어류 생태계 변화 및 보호대책에 대한 연구는 아직 초보적인 단계에 있으므로 앞으로 어류를 포함하는 생태계 전반에 걸친 보호방안의 연구가 요구된다.

S-3

Usage of bio-agent to control cyanobacterial and diatomal bloom in Pal'tang reservoir, a Korea fresh water

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Nowadays, eutrophication is accelerating due to disposal of large volumes of nutrient enriched domestic and industrial wastewaters into lakes and reservoirs. Algal blooms, one of the most representative phenomena in eutrophic or hypertrophic waters, mainly comprises cyanobacteria, diatoms, dinoflagellates and cryptomonads. In lake management, it is very difficult to quantify economic and psycho-social damage affecting daily human activities. However, it has come to be one of the biggest water management problems in the twenty-first century that the algal blooms give rise to bad odor, off-tasting water, increased turbidity and depletion of dissolved oxygen, and threatens zooplankton, fish, and ultimately, humans. Lots of efforts have been made to develop a technology for harvest or remove algae from water with the ultimate objective of preserving water quality. Recently, many countries have resorted to direct chemical methods, such as, use of cupric sulfate, dichromate and ozone, to decrease or completely remove algal biomass. However, these methods ilicit deleterious impact on the aquatic ecosystem, via a decrease in population of other plankton and even fish, and also due to generation of carcinogenic trihalomethanes, which require secondary treatment for their removal. To solve this problem, various studies on the development of bio-agents have been carried out toward pan-ecological and environmental approaches of lake water conservation.

Since the 1980s, a high abundance of cyanobacteria (*Microcystis, Anabaena, Aphanizomenon*), diatoms (*Aulacoseira, Stephanodiscus, Fragilaria, Asterionella*), dinoflagellates (*Peridinium, Ceratium*) and cryptomonads (*Cryptomonas*) have been recorded all over Korea. The blooms range in increasing severity in sluggish reservoirs used for drinking water, in the upstream of artificial dams and in small streams near metropolitan areas with slow currents, respectively. The algae used in this study are the cyanobacterium *Microcystis,* and the diatom *Stephanodiscus*. The reasons for selecting these two species are that the former is the most well represented, often occurring in warm season when water temperature is above 20^0C in Pal'tang reservoir, and the latter is prevalent in cold season at water temperatures below 20^0C. Except for the period the water is covered with ice, the phytoplankton biomass shows a high density and produces green or brown colored water with bad odor, screen chapering, and finally contributed to high sludge production. The research team of the National Research Laboratory, KISTEP, Korea (NRL), has developed a bio-agent from the water and sediment to biotechnologically control algal blooms for a period up to 10 years. We have developed and sustained over 50 biota, such as, algicidal bacteria, zooplankton and ciliates, to effectively remove the algal biomass. This paper outlines the experimental results of how much a single or a double treatment of the bio-agent decreases the density of cyanobacterium *Microcystis aeruginosa* and diatom *Stephanodiscus hantzschii*. One ciliate, *Stentor roeseli* as predators, and algicidal bacteria *Streptomyces neyagawensis* HYJMK0209-50 for *Microcystis*, and *Pseudomonas putida* for *Stephanodiscus,* were used, respectively.

Firstly, we examined the antialgal effects of the bacterium *S. neyagawensis* and the ciliate *S. roeselii* on *M. aeruginosa* in CB medium and filtered water of Pal'tang reservoir with single and double treatments. The inhibitory effect of *S. neyagawensis* on *Microcystis* was 43.4% in 5 days in CB media ($r = - 0.98$, $P<0.001$, $n=6$), which is similar to the value in filtered water (35.8%). The ciliate not significantly inhibited the algal biomass, as 39.8% in the same period ($r = - 0.17$, $P=0.75$, $n=6$) of inoculation paralleling the high growth of itself. Bacteria and ciliates often spent 4~5 days without media. However, in the mixed culture of the ciliate and the bacterium, both decreased in 2 days, may be due to negative interaction. In the combined treatment, comprising

bacterium plus ciliates, the abundance of *Microcystis* increased opposite of our expectations (r =0.99, $P<0.0001$, n=6). Our results suggest that the double application of bio-agent to remove the algal biomass is less effective than a single treatment. Thus, the algicidal bacterium *S. neyagawensis*, with its higher antialgal activity than ciliates, is more suitable for application in algal blooms with a low population of *S. roeselii*.

Secondly, an applicability of single or double treatment of algicidal bacteria *P. putida*, and heterotrich ciliate *S. roeselii* on small centric diatom *S. hantzschii*, was evaluated in laboratory. In single treatment, 81.0 % of *S. hantzschii* was inhibited by bacteria (r = - 0.87, $P<0.01$, n=7), and 67.4 % by Stentor (r = - 0.90, $P<0.005$, n=7), respectively. In combined treatment, bacteria plus *S. roeselii* effectively inhibited as 98.7% of control (r = - 0.97, $P<0.001$, n=7). Our results indicate that the combined treatment of bacteria plus *S. roeselii* is more effective in control of algal biomass *S. hantzschii* than the single treatment. Thus, an introduction of the algicidal bacterium *P. putida* and *S. roeselii* to control the diatomal bloom, *S. hantzschii* is applicable without a low or high density of both predators.

The present work clearly reveals the suitability of bio-agents such as algicidal bacteria and ciliates, in controlling algal blooms and simultaneously increasing biomass of desired organisms in lakes and reservoirs. However, it is important to consider whether single, double or more treatments of bio agents should be given in view of the fact that the bio-agents may interact amongst themselves, like a synergism and antagonism.

S-4

청계천 복원 사업, 과연 생태학적 축복인가?

홍욱희

세민환경연구소

2003 년 7 월 1 일 착공이 예정되어 있는 청계천 복원 사업은 사실상 사업 자체가 대단히 복합적인 성격을 지니고 있음에도 불구하고 일반대중들에게는 '환경친화적인 하천 가꾸기', 혹은 '자연하천 살리기' 등 지나치게 환경생태적인 측면만 강조해서 알려지고 있는 것이 사실이다. 바로 이런 점에서 싫든 좋든 청계천 복원 사업의 여파가 우리 생태학계에도 적지 않게 미칠 것으로 예상되는데, 사업이 성공적으로 완수될 경우에는 별반 문제가 없겠지만 만약 사업 추진이 제대로 되지 않는다거나 사업 추진의 결과가 서울 시민들의 기대에 크게 못미친다고 했을 때에는 생태학계도 그 비난의 유탄으로부터 결코 자유롭지 못할 것이다. 바로 이런 점을 감안해서, 우리 생태학계와 생태학자들은 청계천 복원 사업에 대해서 과연 어떤 입장을 가져야 할지 한번 정리해 보자.

첫째, 청계천 복원 사업의 본질은 도심재개발 사업이며 그 핵심은 도시계획이다. 다시 말해서 '청계천 정화와 복원'은 이 사업에 있어서 어디까지나 부수적인 부분에 불과하다고 말할 수 있다. 무릇 대도시 한 가운데서 벌어지는 모든 토목 사업은 다 개발사업인 바, 청계천 복원 사업은 비록 제목에서부터 환경보전 사업의 탈을 쓰고 있지만 그 본질은 어디까지나 도심재개발이다. 이렇게 정의해놓고 보면 생태학자들은 한결 가벼운 입장에서 이 사업을 바라볼 수 있게 된다. 이 사업 추진에 있어서 생태학자들의 역할이 지극히 제한되어 있기 때문이다.

둘째, 청계천 복원의 환경공학적, 토목공학적 성공가능성은 대단히 낮다. 단순히 청계천 복원이라는 문제만을 떼어놓고 본다면 서울시의 계획은 청계천 바닥에 불투수층 처리를 하고, 중랑천하수처리장 물과 한강물을 끌어다가 청계천 상류에서 흘려보내는 그야말로 100% 인공하천에 100% 조경시설을 보탠 것에 다름 아니다. 하지만 이런 서울시의 구상도 홍수 대책, 수질 대책, 경관확보 대책 등에서 허점투성이라는 비판에 직면해 있다.