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# The Removal Rates of the Constituents of Litters in the Littoral Grassland Ecosystems in the Lake Paldangho Ⅶ. Cadmium and Lead

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# 팔당호 연안대 초지생태계에서 낙엽 구성성분의 유실률 Ⅶ. 카드뮴과 납

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## ABSTRACT

This study was carried out to investigate the removal rates of Cd and Pb of the litters in the *Phragmites communis, Miscanthus sacchariflorus, Typha angustata, Scirpus tabernaemontani* grassland aquatic ecosystem in the lake Paldangho.

The annual production of Cd and Pb were 0.005g /m², 0.21g /m² in *P. communis*, 0.004g /m², 0.08g /m² in *M. sacchariflorus*, 0.023g /m², 0.42g /m² in *T. angustata* and 0.020g /m², 0.23g /m² in *S. tabernaemontani*, respectively.

The removal rates of Cd and Pb of the litters were 0.83, 0.85 in *P. communis*, 0.36, 0.54 in *M. sacchariflorus*, 0.61, 0.51 in *T. angustata* and 0.76, 0.71 in *S. tabernaemontani*, respectively. The times required to decay 50, 95, 99 percent of the steady state level and turnover values of cadmium on the grassland floor were 0.83, 3.60, 6.00 years in *P. communis*, 1.90, 8.24, 13.74 years in *M. sacchariflorus*, 1.15, 4.96, 8.27 years in *T. angustata* and 0.91, 3.95, 6.58 years in *S. tabernaemontani*. The times required to decay 50, 95, 99 percent of the steady state level and turnover values of lead on the grassland floor were 0.81, 3.51, 5.86 years in *P. communis*, 1.28, 5.56, 9.26 years in *M. sacchariflorus*, 1.37, 5.94, 9.90 years in *T. angustata* and 0.97, 4.21, 7.02 years in *S. tabernaemontani*.

**Key words**: Removal rate, Accumulation, Paldangho, Cadmium, Lead, *Phragmites communis, Miscanthus sacchariflorus, Typha angustata, Scirpus tabernaemontani.*

## INTRODUCTION

One of the main circulations which occurs in an ecosystem is the production, accumulation and decomposition of litters. According to Jenny, Gessel and Bingham(1959), Olson (1963), Chang *et al.*(1987), Chang *et al.*(1990c), the annual production of organic matter in the form of the litter of leaves and twigs is much higher in the tropical than in the template vegetation, but the rate of turnover of the litters is inverse relation.

Environment was affected and changed by complex industrial development and increase of automobiles. In biosphere, plant has been depended on interactive environment. A pollutant of heavy metals in plant are Cd, Pb, Fe, Mn and Zn, these are accumulated in soil of street sides, and density is different in the volume of traffic. This phenomenon is caused by the waste gas and tires of cars. The elements of Zn, Fe, Mn are essential to physiological function of plants, but excess accumulation of these elements or Cd and Pb is harmful to the plant.(Page *et al.*, 1973). Kim(1982) studied about the effect of heavy metal on the growth of various plants. Chang(1990) and Chang *et al.*(1990a, b) investigated the influence of heavy metals on air pollution by assaying the contents of Pb and Cd in the stem, litters and barks of *Salix pseudo-lasiogyne, Ginko biloba* and *Pinus densiflora,* respectively. Oohara *et al.*(1971a, b) and Chang *et al.*(1995a, b, c, d, e) investigated the energy flow and mineral cycles in the terrestrial grassland ecosystem and aquatic plant ecosystem. But theses reports did not investigate the contents of Cd and Pb in aquatic grassland.

The purpose of this study is to investigate the removal rates of Cd and Pb of the litters in *P. communis, M. sacchariflorus, S. tabernaemontani, T. angustata* in the lake Paldangho.

## MATERIALS AND METHODS

The soil samples were collected by quadrat method from L, F, H and $A_1$ horizons in the *Phragmites communis, Miscanthus sacchariflorus, Scirpus tabernaemontani* and *Typha angustata* grassland in the lake Paldangho in April, 1996. These were taken from the boxes, air-dried, and weighted. The litter productions were calculated on a dry weight basis.

The contents of Cd and Pb have been analyzed by the methods as follows; Add 60% $HClO_4$ 1ml, Conc. $HNO_3$ 5ml and Conc. $H_2SO_4$ 0.5ml to a 0.5g of dried sample in a 100ml Kjeldhal flask. Boil it shaking gently at low temperature to digest slowly. Boil for 12~15 minutes from the white fume state and then cool at room temperature. Dilute to 50ml with D.W. after filtering the cooled solution with Whatman No. 44(Allen et al., 1974). Quantify this extracted solution at 217.7nm wavelength for Cd, 228.8nm for Pb using the atomic absorption spectrophotometer.

## RESULTS AND DISCUSSION

The site selected for this study is the grassland of *P. communis, M. sacchariflorus, T. angustata* and *S. tabernaemontani* in the lake Paldangho. The production and the removal rates of cadmium and lead in the aquatic grassland floors were estimated in this area.

### 1. Characteristics of the surface soils

Total cadmium and lead contents of the surface soils for the aquatic grasslands ecosystem were given in Table 1. The average amounts of the total storage of cadmium and lead in the investigated grassland were 0.005, 0.247g /m² in *P. communis*, 0.013, 0.160g /m² in *M. sacchariflorus*, 0.038, 0.833 g /m² in *T. angustata*, and 0.025, 0.317 g /m² in *S. tabernaemontani*, respectively. As shown in Table 1, the litter production of dry weight, Cd and Pb in *T. angustata* was higher than the other grasslands studied.

### 2. The estimates of removal constant of cadmium and lead

If the accumulation of the aquatic grasslands litters in studied area reaches a steady state level, the removal constant $r$ can be calculated by the mathematical model(Chang et al., 1995a, b, c, d, e). The removal constants, $r$ for cadmium were 0.83, 0.36, 0.61 and 0.76 in the *P. communis, M. sacchariflorus, T. angustata,* and *S. tabernaemontani,* respectively (Table 2). As the Table 2 shows, the time needed to reach half loss of cadmium were 0.83, 1.90, 1.15 and 0.91 years while for 95% and 99% loss, 3.60, 6.00 in *P. communis*, 8.24, 13.74 in *M. sacchariflorus*, 4.96, 8.27 in *T. angustata*, and 3.95, 6.58 in *S. tabernaemontani*, respectively.

The removal constant $r$ for lead is 0.85, 0.54, 0.51 and 0.71 in *P. communis, M. sacchariflorus, T. angustata,* and *S. tabernaemontani,* respectively(Table 3). As the Table 3 shows, the times needed to reach half loss of lead were 0.81, 1.28, 1.37 and 0.97 years while for 95% and 99% loss, 3.51, 5.86 in *P. communis*, 5.56, 9.26 in *M. sacchariflorus*, 5.94, 9.90 in *T. angustata*, and 4.29, 7.02 in *S. tabernaemontani*, respectively. Therefore, the time needed to reach the steady state was different in each grasslands. $r$ value of this study

**Table 1.** Cadmium, lead and dry weight of the soil samples used

| Grasslands | Horizon | Dry weight (g /m²) | Cd (g /m²) | Pb (g /m²) |
|---|---|---|---|---|
| *Phragmites communis* | *L* | 3,550.4 | 0.005 | 0.211 |
| | *Css* | 810.4 | 0.001 | 0.036 |
| *Miscanthus sacchariflorus* | *L* | 3,440.0 | 0.004 | 0.081 |
| | *Css* | 2,728.9 | 0.007 | 0.069 |
| *Typha angustata* | *L* | 8,308.8 | 0.023 | 0.415 |
| | *Css* | 7,557.6 | 0.015 | 0.407 |
| *Scripus tabernaemontani* | *L* | 6,136.0 | 0.019 | 0.226 |
| | *Css* | 3,111.2 | 0.006 | 0.091 |

**Table 2.** Parameters for exponentional accumulation and removal of cadmium in grassland aquatic ecosystems

| Grasslands | Removal constants $r$ | $t_{0.50}$ (years) | $t_{0.95}$ (years) | $t_{0.99}$ (years) |
|---|---|---|---|---|
| *Phragmites communis* | 0.833 | 0.832 | 3.600 | 6.000 |
| *Miscanthus sacchariflorus* | 0.364 | 1.904 | 8.241 | 13.735 |
| *Typha angustata* | 0.605 | 1.146 | 4.959 | 8.265 |
| *Scripus tabernaemontani* | 0.760 | 0.912 | 3.948 | 6.580 |

**Table 3.** Parameters for exponentional accumulaton and removal of lead in grassland aquatic ecosystems

| Grasslands | Removal constants $r$ | $t_{0.50}$ (years) | $t_{0.95}$ (years) | $t_{0.99}$ (years) |
|---|---|---|---|---|
| *Phragmites communis* | 0.854 | 0.812 | 3.513 | 5.855 |
| *Miscanthus sacchariflorus* | 0.540 | 1.283 | 5.556 | 9.260 |
| *Typha angustata* | 0.505 | 1.372 | 5.940 | 9.900 |
| *Scripus tabernaemontani* | 0.713 | 0.972 | 4.290 | 7.015 |

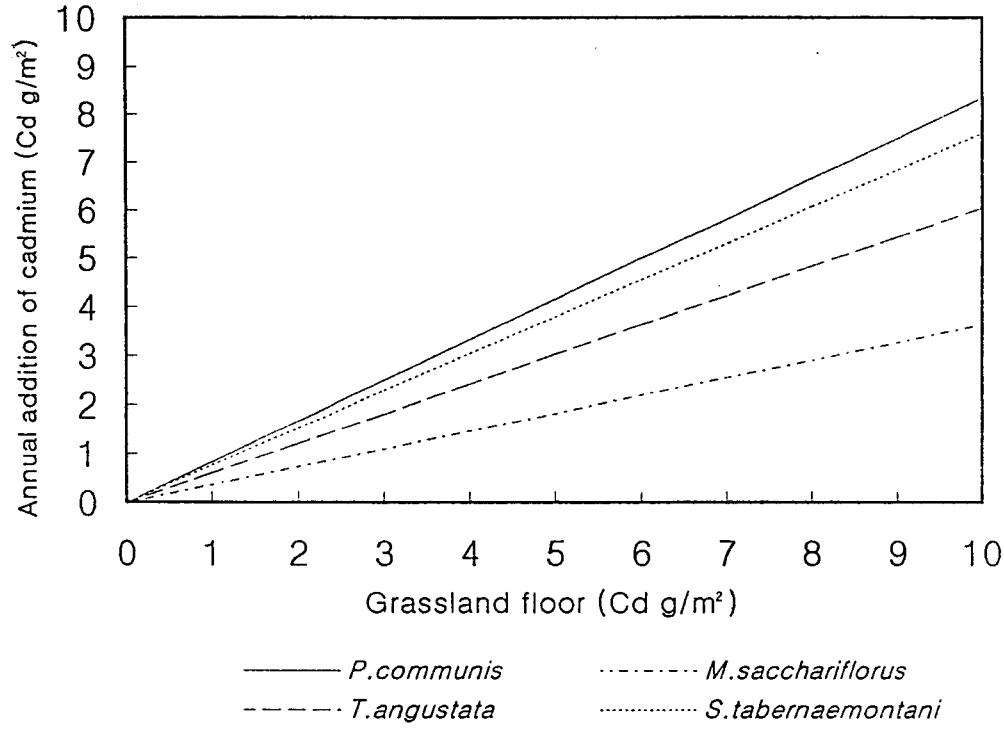



**Fig. 1.** The removal constant $r$ for cadmium in aquatic grassland in the lake Paldangho.

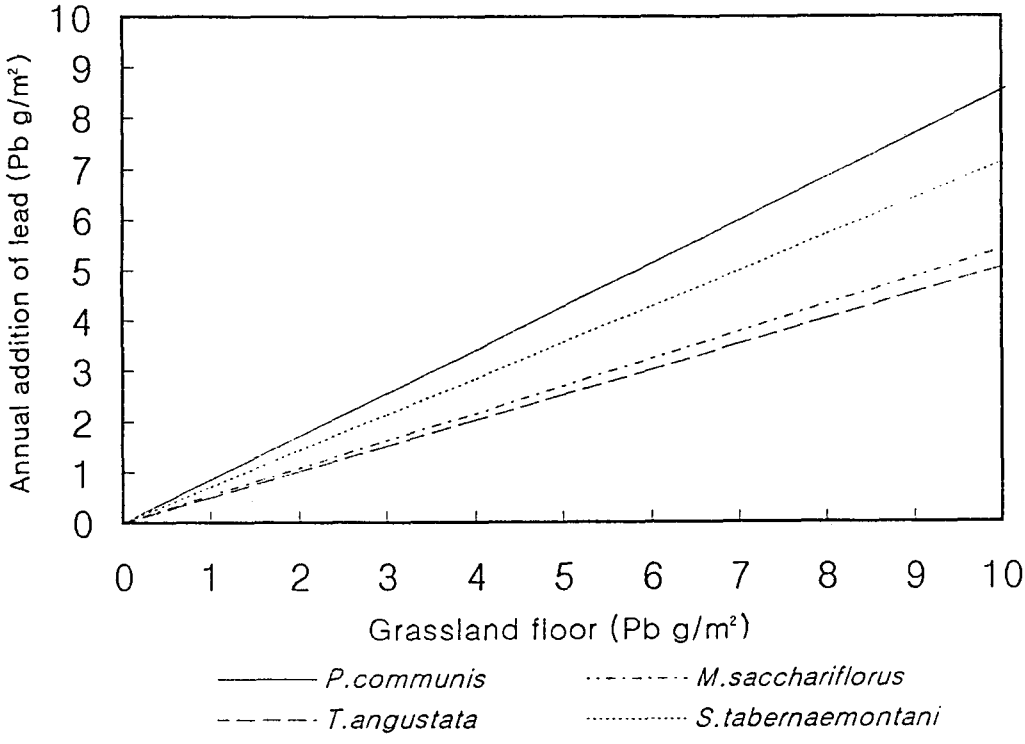



**Fig. 2.** The removal constant $r$ for lead in aquatic grassland in the lake Paldangho.

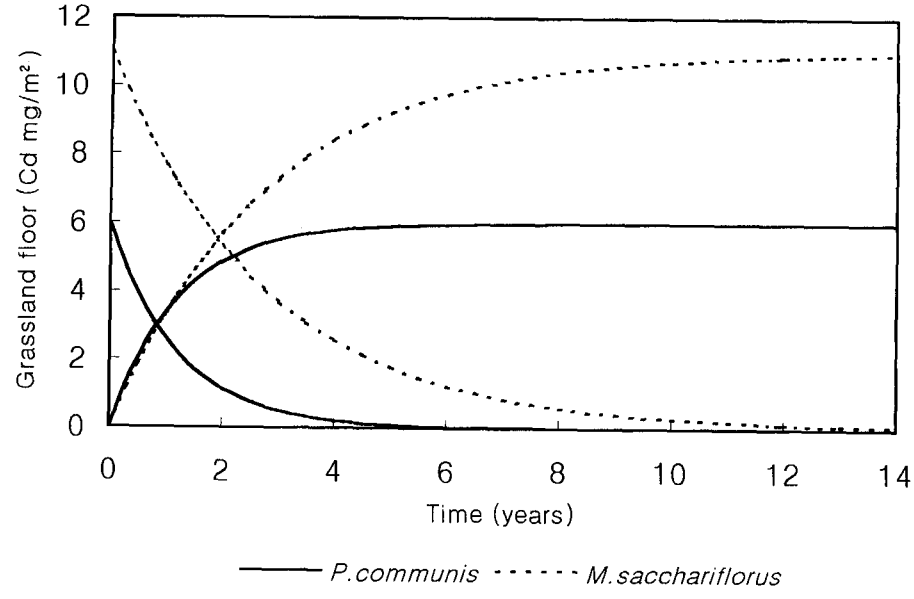
was higher than Chang' results(1995a, b, c, d, e). It can be thought that the site of Chang's study was the forest that there was no movement of mineral contents relatively, but that of this study was the aquatic environment that had been effected by rainfall and flow of river.

The removal constant $r$ for Cd and Pb is illustrated in Fig. 1 and Fig. 2. The curves for accumulation and turnover of cadmium and lead in each grassland aquatic ecosystem are shown in Fig. 3 and Fig. 4, respectively. This curve is the mirror image of the curve for accumulation of cadmium and lead on the grassland floor in Fig. 3 and Fig. 4. The levels of accumulation on the grassland floor are also obtainable from the aquatic without collection of samples and data analysis.

## 적 요

본 연구는 팔당호의 갈대, 억새, 부들, 고랭이의 수생초지군락에서 카드뮴과 납의 축적과 무기화 및 순환에 관한 것이다.

카드뮴과 납의 연생산량은 갈대군락에서 각각 005g /m², 0.21g /m² 이었고, 억새군락에서는 0.004g /m², 0.08g /m² 이고, 부들군락에서는 0.023g /m², 0.42g /m² 이고 고랭이군락에서는 0.020g /m², 0.23g /m² 이었다.



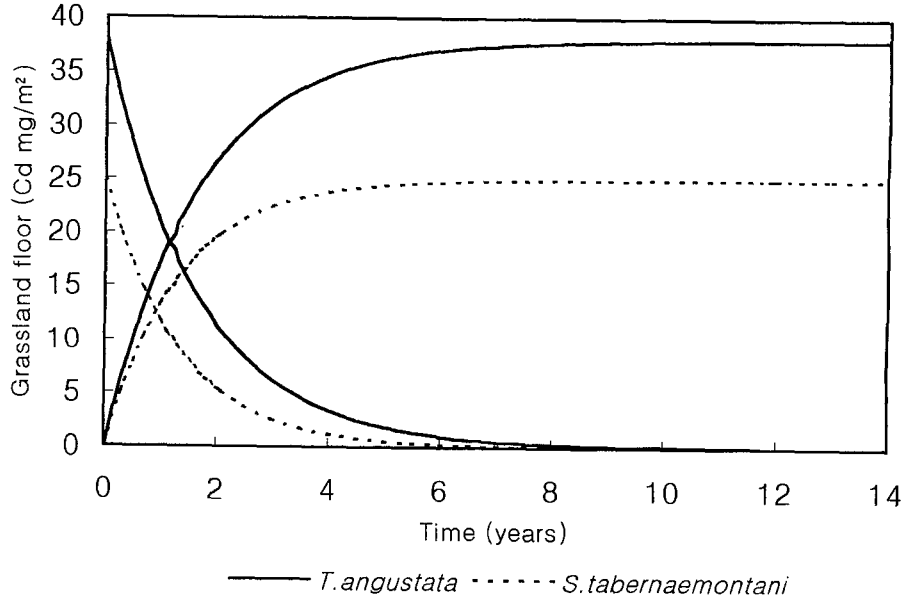




**Fig. 3.** Estimate of turnover fraction $r$ of cadmium in aquatic grasslands, from the ratio of annual addition of cadmium to a steady state accumulation of the grassland floor.

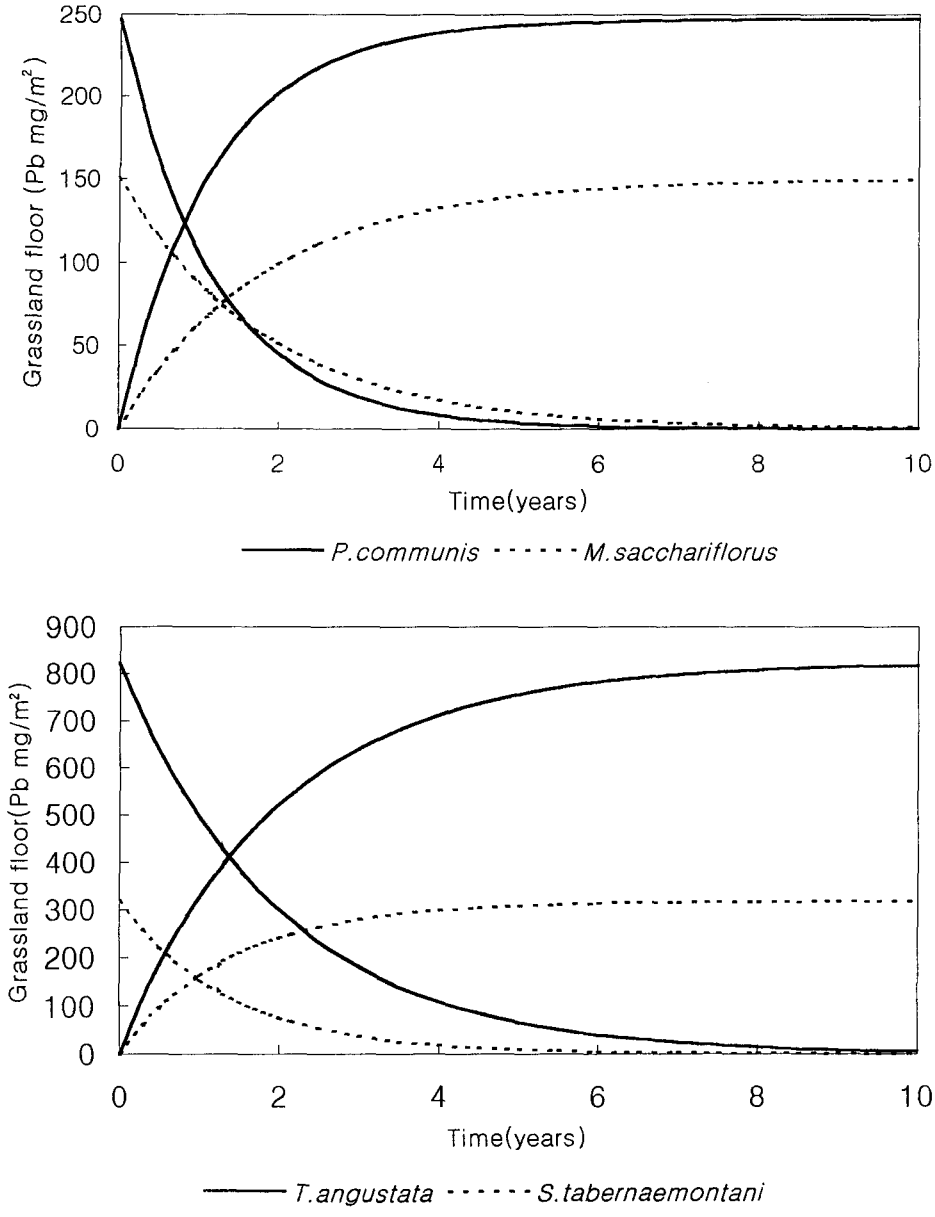



**Fig. 4.** Estimate of turnover fraction $r$ of lead in aquatic grasslands, from the ratio of annual addition of lead to a steady state accumulation of the grassland floor.

카드뮴과 납의 분해상수 $r$은 각각 갈대군락에서 0.83, 0.85, 억새군락에서 0.36, 0.54, 부들군락에서는 0.61, 0.51 이었으며 고랭이군락에서는 0.76 ,0.71 이었다.

평형상태에서 50, 95, 99 %로 분해 및 축적되는데 걸리는 시간은 각각 갈대군락에서는 0.81, 3.51, 5.86년이고, 억새군락에서는 1.28, 5.56, 9.26 년이었고, 부들군락에서는 1.37, 5.94, 9.90 년이었으며 고랭이군락에서는 0.97, 4.21, 7.02 년으로 나타났다.

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