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The Removal Rates of the Constituents of Litters in the Littoral Grassland Ecosystems in the Lake Paldangho Ⅲ. Phosphorus

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팔당호 연안대 초지생태계에서 낙엽 구성성분의 유실률 Ⅲ. 인

홍정림 · 심규철 · 장남기

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ABSTRACT

To estimate removal rate of phosphorus in aquatic grassland ecosystems of Paldangho, this investigation was conducted along with the coast of a lake. The experimental results may be summarized on communities of *Typha angustata, Miscanthus sacchariflorus, Phragmites communis,* and *Scirpus tabernaemontani* as follows.

The annual production of phosphorus for the litters in *T. angustata, M. sacchariflorus, P. communis,* and *S. tabernaemontani* grasslands were 10.252 g/m², 3.833 g/m², 2.656 g/m², and 5.210 g/m² respectively. The ratio of annual production of P accumulated on surface soils in a steady state provides estimates of the removal rate *r*. The estimated removal rates *r* of P were 0.58, 0.78, 0.68 and 0.59 in *T. angustata, M. sacchariflorus, P. communis,* and *S. tabernaemontani* grasslands respectively.

The removal and accumulation of 50, 95 and of 99% of its steady state level, the estimates for *P* of *T. angustata* were 1.195, 5.173 and 8.623 years, in *M. sacchariflorus* were 0.880, 3.842, and 6.403 years, and in *P. communis* were 1.014, 4.390, and 7.316 years respectively. In *S. tabernaemontani* grassland required period were 1.178, 5.099 and 8.500.

Key words: *T. angustata, S. tabernaemontani, P. communis, S. tabernaemontani,* Paldangho, Removal rate, Phosphorus.

INTRODUCTION

The ratio of annual production and decomposition of litters affords a reliable index to

evaluate the mineral nutrient cycles. Olson(1963) reported that many ecosystems continue to show a positive net community production for centuries perhaps and after long changes numbers and biomass of some species are reduced to minor fluctuations around a climax composition.

In aquatic plant ecosystems, soil nutrients can be also supplied by organic matters such as litters. But most supplied nutrients are lost by precipitation and flow of water. The removal of the litter productions and the losses afford a reliable index to evaluate the water purification. But there are a few reports about the addition and decomposition of the pollutants in water.

The self purification model of organic matter in the river water can be made from the bases of the decay models of the organic materials. Chang and Oh(1995) reported that removal rate of constituents of the litters of *Phragmites longivalvis* grasslands in a delta of the Nakdong River. In the grassland of the steady state the net velocity of change in the annual addition of P into soil or water is equal to the rate of the annual decay or removal. Therefore, decomposition and decay rates of the litters are suitable for forest, but in aquatic ecosystem, removal rates of the litters are more suitable concept.

In this present study, removal rates of P were investigated to elucidate the accumulation and removal of phosphorus of the grassland floors in Paldangho.

MATERIALS AND METHODS

The samples of the litters and soils were collected in the grassland composed *P. angustata, M. sacchariflorus, P. communis* and *S. tabernaemontani*. The litters were collected from the L, F, H and A_1 horizons by quadrats. Samples were air-dried and then dry-ashed in a muffle furnace at 450℃ for 4hrs. The litter production was calculated on a dry weight basis.

After ashing the litter, P have been analyzed by the molybdenum blue stannous chloride method and determined by using colorimeter.

RESULTS AND DISCUSSIONS

1. Characteristics of the surface soils

Annual production of phosphorus and the organic matter in surface soils of the *T. angustata, M. sacchariflorus, P. communis* and *S. tabernaemontani* grasslands are shown in Table 1.

The annual production of phosphorus for littters of the *T. angustata, M. sacchariflorus, P. communis* and *S. tabernaemontani* were 10.252, 3.833, 2.656 and 5.210 g /m^2 respectively.

2. The estimates of removal rate of phosphorus

Under the assumption(Oohara *et al.*, 1971 a, b, c; Chang *et al.*, 1995 a, b, c, d) that selec-

Table 1. The annual production of phosphorus and organic matter of grassland ecosystems in Paldangho

Grasslands	Horizon	Dry weight (g/m^2)	Organic matter (g/m^2)	Total P (g/m^2)
T. angustata	*L*	8,308.8	8,003.867	10.252
	Css	7,557.6	6,005.826	7.428
M. sacchariflorus	*L*	3,440.0	3,334.082	3.833
	Css	2,728.9	2,541.250	1.076
P. communis	*L*	3,550.4	3,342.382	2.656
	Css	810.4	702.684	1.231
S. tabernaemontani	*L*	6,136.0	5,963.517	5.210
	Css	3,111.2	1,968.870	3.646

ted grassland floors in the stands here may apporoximate a steady state, one method of estimating the removal rate r for phosphorus of the grass-litter can be obtained from the ratio of the vertical and horizontal coordinates of each point on Fig. 1.

The estimates of removal rates for each grassland are given by Table 2. As shown in

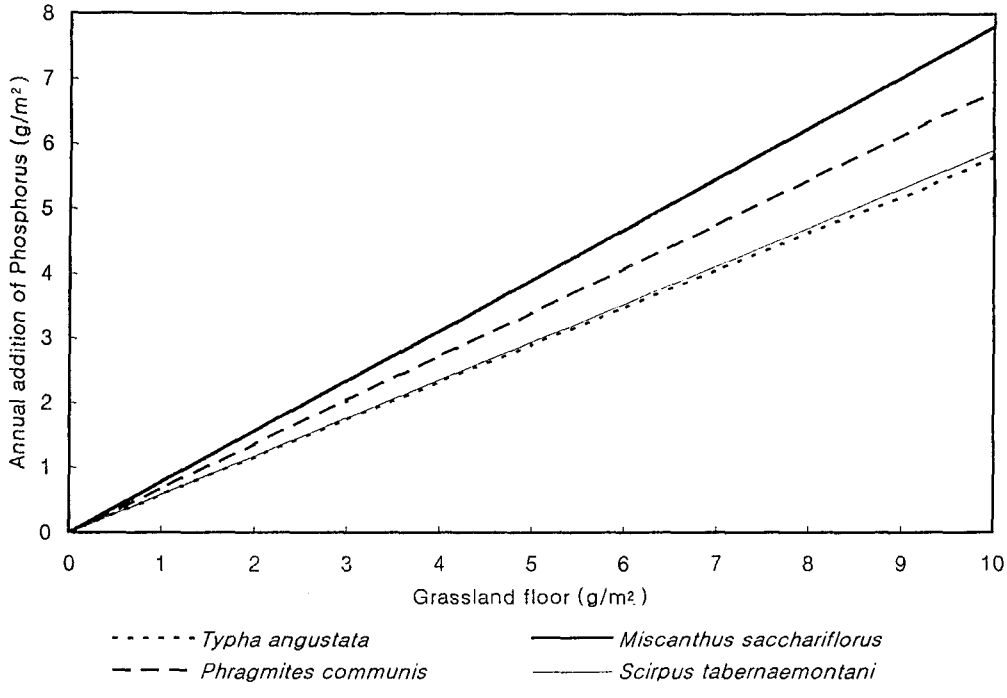

Fig. 1. Estimates of removal rates of phosphorus in grassland ecosystems from the ratio of annual addition of P to the steady state accumulation of the grassland floor.

Table 2. Parameters for exponentional accumulaton and removal of phosphorus of grassland ecosystems in Paldangho

Grasslands	Removal rates	Half time (years)	95% time (years)	99% time (years)
T. angustata	$r = 0.58$	1.195	5.173	8.623
M. sacchariflorus	$r = 0.78$	0.888	3.842	6.403
P. communis	$r = 0.68$	1.014	4.390	7.316
S. tabernaemontani	$r = 0.59$	1.178	5.099	8.500

Table 2., each grass species of which the grassland is composed had different values of r. As a fraction of the original total, removal rate r was determined by the assumption of Oohara *et al.*(1971 a, b, c) and Chang *et al.*(1995c).

The higher removal rate from the litter organic matter in the surface soils are, the more rapid return to the soil. Since removal rate, r of *M. sacchariflorus* is the highest value, phosphorus of the litters of *M. sacchariflorus* litters is the most rapid decomposed constituent element on the case of *M. sacchariflorus*, the removal rate of P was the highest value, but that of *P. communis* was the lowest among the other elements.

From this result, it suggests that each grass species are different in the chemical composition of the grass-litter and its annual addition to the mineral soil.

3. The accumulation and removal of phosphorus

The removal models of phosphorus under the grassland ecosystems of the steady state conditions can be defined as the basic concept of decomposition (Oohara *et al.*, 1971), in the case of phosphorus

$$P = P_0 e^{-rt}$$

where P_0 is the weights of phosphorus in the surface soil initially. Table 3 presents exponential equations for the four grasslands in Paldangho. The accumulation model of phosphorus on the grassland floor is also given as follows: for phosphorus(Pa)

$$Pa = \frac{Lp}{r}\ (1 - e^{-rt})$$

where Lp express the amount of an annual addition for phosphorus.

The graphical changes of accumulation and removal of P of the grassland floor were expressed in Fig. 2, 3, 4 and 5. The removal curve is the mirror image of the curve for accumulation of P of the grassland floor.

The times required to reach 50, 95, and 99 percent to the state level were the same as those required for removal of accumulated P. These periods are shown in Table 3. The increasing order of the turnover parameters for P was *M. sacchariflorus*, *P. communis*, *S.*

Table 3. Models of removal, accumulation and annual cycles for phosphorus of grassland ecosystems in Paldangho

Grasslands	Removal models	Accumulation models
T. angustata	$P = 17.680e^{-0.58t}$	$Pa = 17.680(1-e^{-0.58t})$
M. saccharifloras	$P = 4.909e^{-0.78t}$	$Pa = 4.909(1-e^{-0.78t})$
P. communis	$P = 3.887e^{-0.68t}$	$Pa = 3.887(1-e^{-0.68t})$
S. tabernaemontani	$P = 8.856e^{-0.59t}$	$Pa = 8.856(1-e^{-0.59t})$

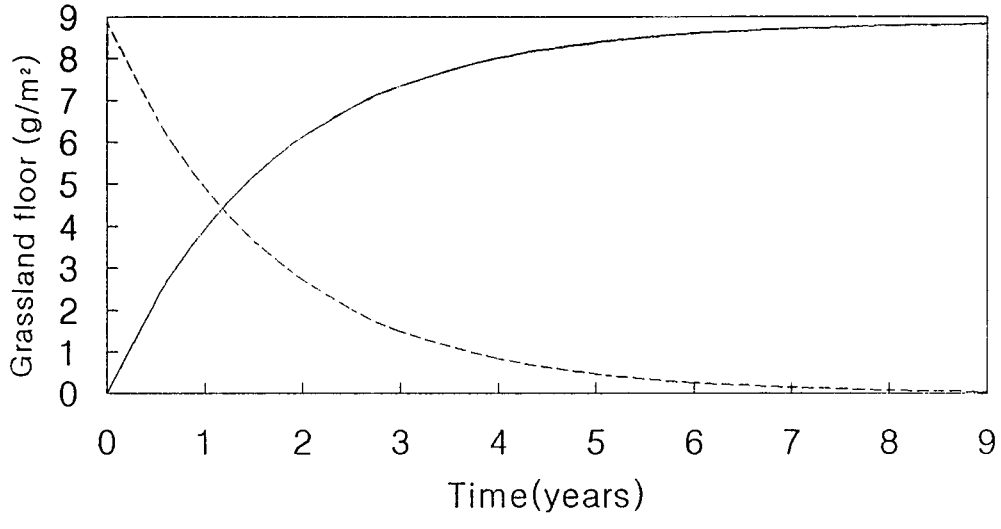

Fig. 2. The accumulation and removal for phosphorus in the grassland of *T. angustata*.

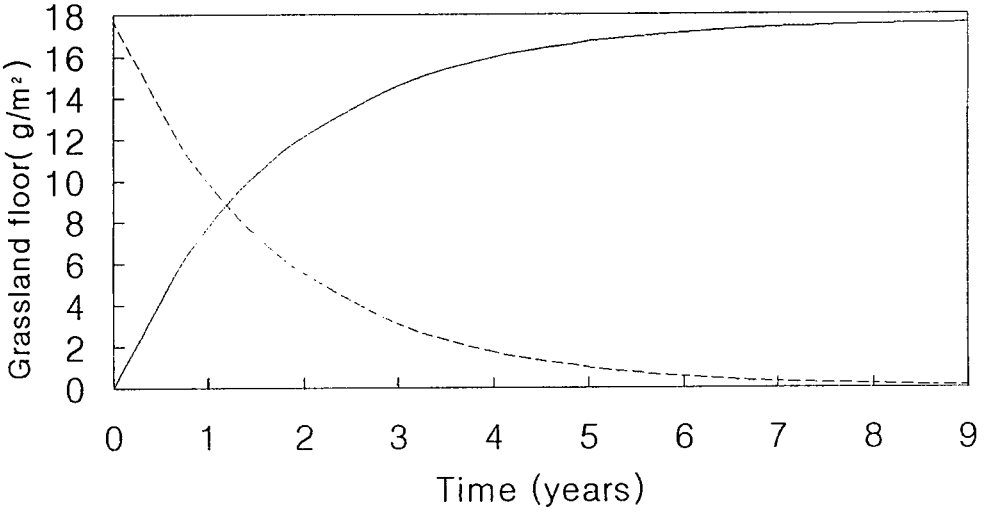

Fig. 3. The accumulation and removal for phosphorus in the grassland of *M. saccariflorus*.

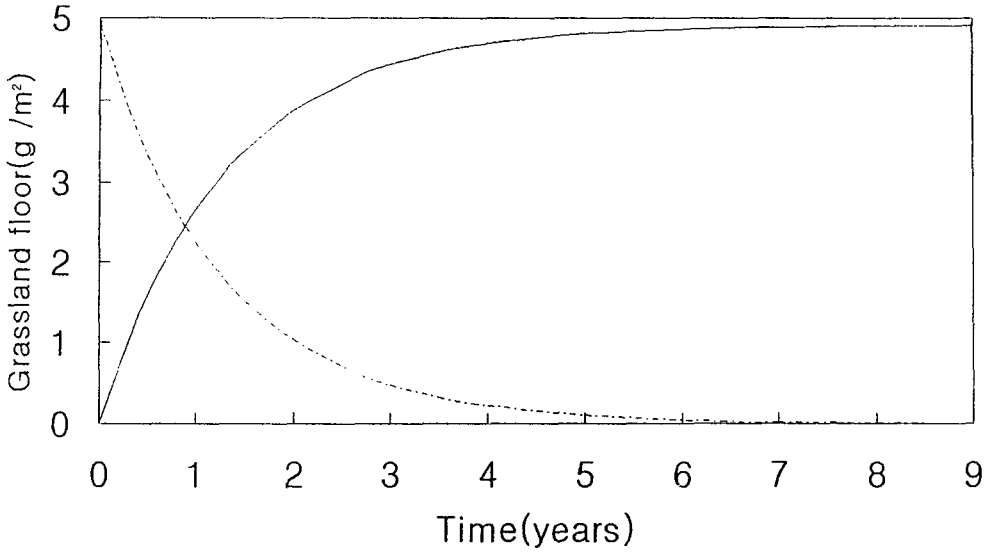

Fig. 4. The accumulation and removal for phosphorus in the grassland of *P. communis*.

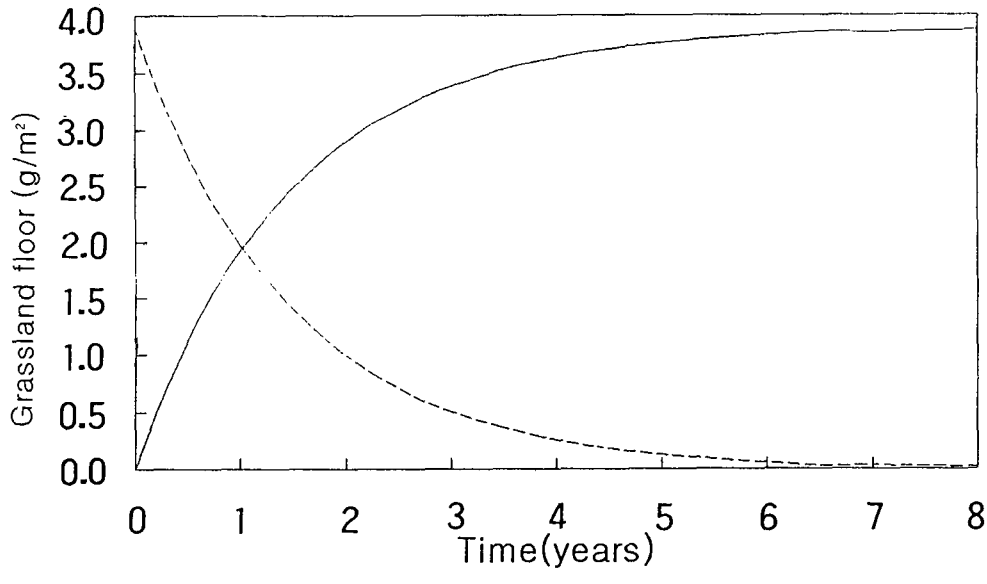

Fig. 5. The accumulation and removal for phosphorus in the grassland of *S. tabernaemontani*.

tabernaemontani and *T. angustata*.

The circulation of phosphorus in a lake ecosystems is very important to keep high productivity. Generally, phosphorus is precipitated in sediment of a lake and it exists in the inactivated or chelating forms. Some phosphorus moves from sediment to water but more amont of phosphorus is accumulated in the sediment. According to the results of present study, aquatic grassland ecosystem are very dynamic systems compared with results of

Mt. Kwanak(Chang *et al.*, 1995c). It seems resonable to suggest that the cycles for phosphorus of aquatic ecosystems are very faster than those of terrestrial ecosystems. Therefore, this means that the grasslands which cover the coast of a lake don't effect seriously on water pollution.

적 요

본 연구는 수생 초지 생태계인 팔당호에서 인의 유실상수를 호수의 연안을 따라 위치하는 초지를 통해 추정하고자 한 것으로 그 결과는 다음과 같다.

낙엽에 의한 인의 연 생산량은 부들 군락에서 10.252 g /m², 억새 군락에서 3.833 g /m², 갈대 군락에서 2.656 g /m² 이었으며 고랭이 군락에서는 5.210 g /m² 이었다.

평형상태에서 토양의 표면층에 축적된 인의 연생산비율을 유실률 r로 추정하였다. 4개의 초지 생태계에서 인의 유실, 축적 및 연순환에 대한 식은 표 3과 같다. 추정된 유실률 r은 부들 군락에서는 0.58, 억새 군락에서 0.78, 갈대 군락에서 0.68 이었으며 고랭이 군락에서 0.59이었다.

평형상태에서 50, 95, 99%로 분해 및 축적되는데 걸리는 시간은 부들군락에서 1.195, 5.173, 8.623년이며 억새군락에서는 0.888, 3.842, 6.403년이었다. 갈대군락에서는 1.014, 4.390, 7.316년이었으며 또한 고랭이 군락에서는 1.178, 5.099, 8.500년으로 각각 나타났다.

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