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Dynamics of Plant Communities under Human Impact in the Green-Belt nearby Seoul

— On the Production and Decomposition of Litters in Grassland and Forests in Mt. Guryong —

Chang, Nam-Kee, Duck-Key Lee and Joon-Ho Kim*

Dept. of Biology, College of Education, Seoul National Univ. and

** Dept. of Botanny, Seoul National Univ.*

人間干涉하의 首都圈 그린벨트 내 植物群集의 動態

—九龍山의 草地와 森林에 있어서 落葉의 生產과 分解에 關한 硏究—

張 楠 基 · 李 德 器 · 金 俊 鎬*

서울大學校 師範大學 生物敎育科 · 서울大學校 自然科學大學 植物學科*

ABSTRACT

The rates of litter production and decomposition of litters from grasslands and forests in Mt. Guryong were studied.

The annual litter production of *Glycine soja* showed the highest value 1950.88 g/m²/yr in the grasslands and that in *Quercus acutissima*, as 2202.38 g/m²/yr in the forests. The highest decay rate of the grasslands was found in *G. soja* as k = 0.713 and that of the forests was in *Salix koreensis* as k = 0.319. The Z values of k in the grasslands was higher than that in the forests.

The shortest half-time of the litter decay in the grasslands was 0.9 years in *G. soja* and the longest one of the forests was *S. koreensis* as 2.1 years and the longest of all was *Q. mongolica* as 5.2 years. In the amount of total nitrogen of litters, *G. soja* was the highest of the grasslands and *S. koreensis* was the highest of the forest. The content of the total nitrogen in litters was directly propotional to the decay rates.

INTRODUCTION

Organic matter in green plants is returned to the soil by the leaves, twigs and fruits which fall to the ground. The organic matter turns into inorganic matter such as CO_2. NO_3^-, NH_4^+ by decomposers and emits energy at the same time. One of the main circulations which occur in an ecosystem

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is the production, accumulation and decomposition of litters.

Ovington (1960) reported that most of the organic matter in soil is produced by fallen leaves. Jenny *et al.* (1949), Lousier and Parkinson (1975), and Cromark (1977) reported that the accumulation and the decomposition rates of litters differ according to the species of trees and soil environment, the amount and kinds of inorganic matters returning to the soil are dependent on the species of trees.

Mathematical models were proposed by Alive (1960), Minderman (1968), and Howard and Howard (1974) for the study on the decomposition of litters in the forests. Olson (1963) proposed the negative exponential curve model in order to calculate the decomposition constant of litters.

Olson's model has been on the decomposition rates of litters of various trees (Kim and Chang, 1965; Koh and Chang, 1981; Oh and Chang, 1981).

In this study, environmental factors of the production, accumulation and decomposition of litters in the grasslands and the forests around the foot of Mt. Guryong was investigated and compared by Olson's model.

MATERIALS AND METHODS

Study Area

Fig. 1 shows the relation between the monthly mean temperature and precipitation. Most of precipitation is concentrated during the summer season, June, July, August and September with high air temperature.

The samples of litters were collected from the south-eastern areas of Mt. Guryong, because the study area is reached the steady state of the production and decomposition of the litters, as suggested by Olson (1963) indicated.

Sample Collection and Analysis of Litter

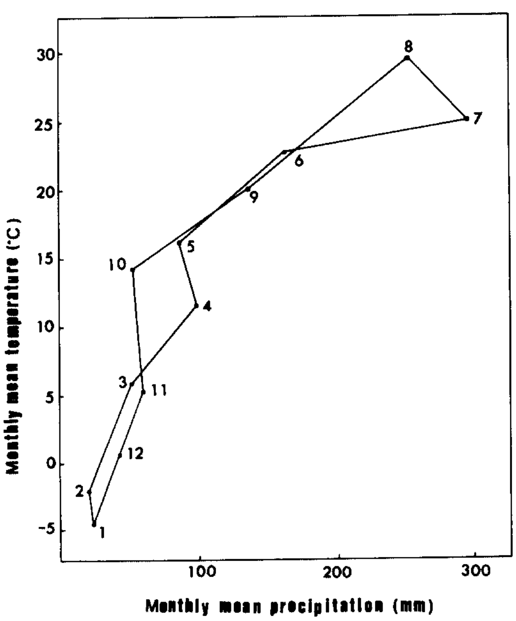

Fig. 1. The temperature-precipitation climograph at Mt. Guryong (1977-1986).

Table 1. The plants of experimental sites, Mt. Guryong

Herb and tree	Dominant species
grass	*Glycine soja*
	Spodiopogon cotulifer
	Artemisia lavandulaefolia
wood	*Salix koreensis*
	Alnus hirsuta
	Quercus acutissima
	Quercus mongolica

Stands were divided by the grassland and the forest.

According to the species (Table 1) thirty quadrates (0.25 m × 0.25 m) were placed on the grass and the forest floor then litter samples were collected from L and Css horizon separately. They were insulated in a vinyl bag and transported to laboratory. The samples were weighed for the fresh weigh, air dried, ground in a mill, sieved in a stainless steel mesh (2 mm × 2 mm) and stored in the soil jars at room temperature.

All measurement were calculated from the values of dry weigh after drying in the incubator.

Analysis of Litter Ingredients (Chapman, 1976)

(1) Dry weights and water contents were measured after drying at 105°C for 24 hrs.
(2) The pHs were measured by the Beckman pH meter.
(3) The contents of organic matter was measurd by the loss on ignition at 500-550°C for 5 hrs in the furnace. The contents of organic carbon was calculated from that of organic matter, divided by 1.732.
(4) Total nitrogen was determined by the micro-Kjeldahl method.
(5) Phosphorus was determined by the standard molybdate method using spectro-photometer after the sample were completely ashed.
(6) Sodium, potassium and calcium were determined by the flame emission method using flame photometer after they were extracted by universal extract solution.

RESULTS AND DISCUSSION

Litter Production

G. soja's amount of litter as 1950.8 g/m² is the hightest of the grassland. *Q. acutissimas* as 2202.8 g/m² is the hightest of the forests. The amount of Css layer in the forest is much higher

Table 2. The amounts of dry weight, moisture and organic matter in the litter samples

Litters	Horizon	Dry wt. (g/m²)	Moisture (%)	Organic matter (g/m²)	Organic matter (%)
G. soja	L	1950.88	6.86	1550.43	79.47
	Css	11321.26	1.79	2173.13	19.20
S. cotulfier	L	975.42	6.87	758.76	77.79
	Css	13015.66	1.78	2871.00	22.06
A. lavandulaefolia	L	953.84	7.03	868.79	91.04
	Css	10206.46	1.45	2643.26	25.90
S. koreensis	L	1178.60	7.58	1497.47	84.26
	Css	26196.60	1.39	4695.78	27.92
A. hirsuta	L	1028.96	8.26	938.38	91.10
	Css	16962.46	3.23	6360.92	37.50
Q. acutissima	L	2202.38	9.20	2037.08	92.49
	Css	25167.39	5.35	9012.72	35.81
Q. monglica	L	1465.03	7.79	1400.57	95.60
	Css	20882.03	5.93	10608.07	50.80

than that in the grassland, and in both plants the amount of Css layer is proportional to the amount of litter except *S. cotulifer* (Table 2). The litter amount of *Q. mongolica* at the 200-230m in altitude is 1465.033 g/m²/yr. indicating higher value than Jung's value (1986). It seems that the difference origin from resulting from the difference of the altitude between their study area.

The litter amount of broad leaved tree is higher than that of *P. rigida* on Mt. Gwanak by Park (1986), 692.90 g/m². This result mentioned above is congruous with the reports by Park (1970) and Lee (1980). They reported that the amount of the pine forest.

The both amount of organic matter and water content in the forest soil is higher than that in the grassland. The amount of organic matter and water content of litter layer is higher than that of accumulation layer in the grassland and in the forest. In the grassland the amount of *A. lavandulaefolia's* organic matter is the highest, as 91.04% and in the forest *Q. mongolica's* is the highest, as 95.60%.

Decomposition and Organic Matter

The rate of litter decomposition is determined by the ratio of accumulated organic matter for litter production. Decomposition constant k of Olson's (1963) litter decomposition model is inverse proportional to the time for the litter decomposition. The pH in the grassland is higher than that in the forest, and pH of the litter layer in the grassland and the forest is higher than the pH of the accumulation layer (Table 3).

Table 4 and Fig. 2 shows the mean parameters and the time for organic matter decomposition. K values in the grassland was higher than that in the forest. Specific k values of each species are congruous with the reports (Daubenmire, 1953: Green and Nye, 1959: Kim and Jang, 1965): the decomposition rates differ according to the species of trees. K values of *Q. acutissima*, 0.226, is lower than 0.274 in Haenam reported by Chang and Han (1985). This divergency is because of the differences between climatological conditions of two regimes, especially, precipitation amount (1250-1350 mm in Haenam, while 1224.5 mm in Mt. Guryong) and annual mean temperatures (13-14°C in Haenam, while 11.6°C in Mt. Guryong). The divergence of k values in different areas

Table 3. The amounts of organic carbon and pH in the litter samples

Litters	Horizon	Organic carbon (g/m²)	Soil pH	Litters	Horizon	Organic carbon (g/m²)	Soil pH
G. soja	L	895.17	6.02	*A. hirsuta*	L	541.21	4.30
	Css	1254.69	6.83		Css	3672.58	5.10
S. cotulifer	L	438.08	5.58	*Q. acutissima*	L	1176.14	4.27
	Css	1657.62	6.97		Css	5203.65	4.87
A. lavandulaefolia	L	501.38	5.48	*Q. mongolica*	L	808.34	4.05
	Css	1526.13	6.88		Css	6124.75	4.90
S. koreensis	L	864.59	5.83				
	Css	2710.61	7.25				

is in agreement with Forgel and Cromack's (1977) opinion, which is influenced by the precipitation. It seems that the k value of *Q. acutissima* in Mt. Guryong, is lower value than that the value of 0.27 reported by Lee (1980) at the altitude of 600 m is caused by the lower precipitation in Mt. Guryong than annual mean precipitation of 1369 mm in Lee's study area. The model of litter decomposition and the model of organic matter accumulation are showed in Table 6.

Table 6 shows the relation between the litter decompostion rates and the soil conditions. The amount of *G. soja's* total nitrogen is the highest in the grassland and *S. koreensis'* is the

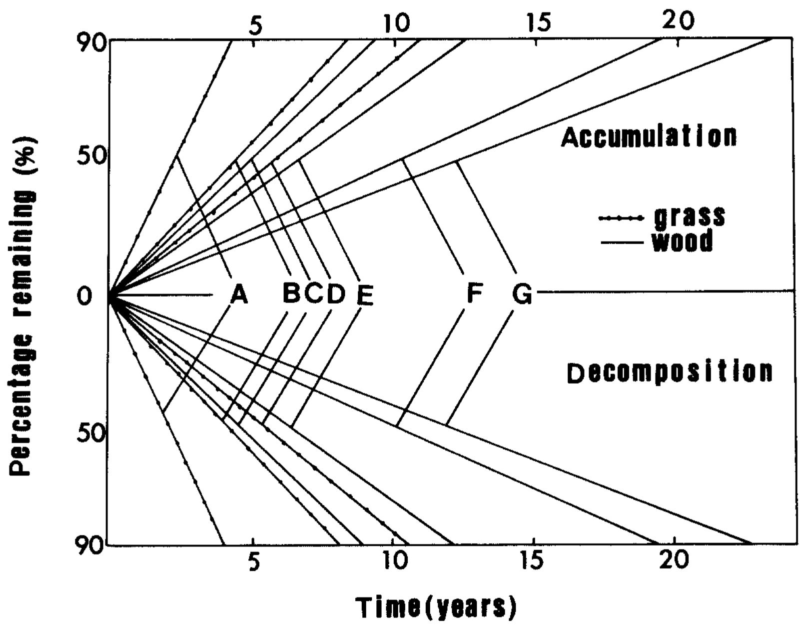

Fig. 2. The mean fractional decomposition and accumulation of litters in Mt. Guryong.
A: *Glycine soja*
B: *Artemisia lavandulaefolia*
C: *Salix koreensis*
D: *Spodiopogon cotulifer*
E: *Quercus acutissima*
F: *Alnus hirsuta*
G: *Quercus mongolica*

Table 4. The mean parameters and times for decomposition of organic matter

Litters	k	1/k	Half time	95% time	99% time
G. soja	0.713	1.403	0.972	4.208	7.013
S. cotulifer	0.264	3.788	2.625	11.364	18.939
A. lavandulaefolia	0.329	3.040	2.106	9.119	5.198
S. koreensis	0.319	3.135	2.172	9.404	15.674
A. hirsuta	0.147	6.803	4.174	20.408	34.014
Q. acutissima	0.226	4.425	3.066	13.274	22.124
Q. mongolica	0.132	7.526	5.250	22.727	37.879

Table 5. The decay and accumulation model of litters

Litters	Decay Model	Accumulation Model
G. soja	$c=1254.69e^{-0.713t}$	$c=1254.69\ (1\text{-}e\text{-}0.713t)$
S. cotulifer	$c=1657.62e^{-0.264t}$	$c=1657.62\ (1\text{-}e\text{-}0.264t)$
A. lavandulaefolia	$c=1526.13e^{-0.329t}$	$c=1526.13\ (1\text{-}e\text{-}0.329t)$
S. koreensis	$c=2710.61e^{-0.319t}$	$c=2710.61\ (1\text{-}e\text{-}0.319t)$
A. hirsuta	$c=3672.58e^{-0.147t}$	$c=3672.58\ (1\text{-}e\text{-}0.147t)$
Q. acutissima	$c=5203.65e^{-0.226t}$	$c=5203.65\ (1\text{-}e\text{-}0.226t)$
Q. mongolica	$c=6124.75e^{-0.132t}$	$c=6124.75\ (1\text{-}e\text{-}0.132t)$

highest in the forest. The amount of total nigrogen in litter layer is 2-4 times higher than that of Css layer. The contrent of phosphorus shows the lower concentration than other in-organic matters, which is due to the fact that phosphorus is more likely to form a living organism than remain in the soil in a decomposed state (Lee, 1985).

The total content of calcium is highest in *S. cotulifer* among the grass samples, *Q. mongolica* the highest among the forest samples.

The litter layer showed greater sodium and calcium contents than the accumulation layer, and the forest samples showed greater calcium contents than the grass samples. Kim *et al.* (1966) reported that the content of calcium had important effects on the decomposition of the organic matter because of its high correlation with decay rate and microbial populations. One of the reasons of low K values in the forest is the high calcium concentration.

Table 6. The contents of total N,P,K, Na and Ca in the litter samples

Litters	Horizon	N		P		K		Na		Ca	
		%	g/m²	%	g/m²	%	g/m²	%	g/m²	%	g/m²
G. soja	L	0.126	2.449	0.0287	0.559	0.0285	0.0556	0.247	4.811	0.804	15.686
	Css	0.030	3.347	0.0260	2.941	0.0182	0.2063	0.187	21.141	0.159	17.872
S. cotulifer	L	0.118	1.148	0.0223	0.218	0.0506	0.0493	0.136	1.325	0.414	4.039
	Css	0.040	5.246	0.0076	0.983	0.1053	1.3707	0.215	27.944	0.034	44.149
A. lavandulaefolia	L	0.089	0.845	0.0146	0.139	0.1033	0.0986	0.158	1.504	0.402	3.839
	Css	0.031	3.216	0.0068	0.691	0.2141	2.1854	0.225	22.924	0.295	30.088
S. koreensis	L	0.157	2.801	0.0222	0.350	0.0333	0.0592	0.221	3.929	0.493	8.846
	Css	0.035	9.207	0.0192	5.035	0.0158	0.413	0.141	37.203	0.254	6.6656
A. hirsuta	L	0.131	1.350	0.0319	0.328	0.0567	0.0583	0.142	1.458	1.290	13.271
	Css	0.046	7.853	0.0067	1.138	0.4662	0.9150	0.143	22.787	0.240	4.067
Q. acutissima	L	0.078	2.153	0.0198	0.437	0.0573	0.1262	0.143	3.155	1.022	22.503
	Css	0.054	13.615	0.0049	1.236	0.0661	1.6632	0.017	42.748	0.234	5.949
Q. mongolica	L	0.091	1.335	0.0270	0.396	0.1605	0.2351	0.401	5.879	1.308	19.167
	Css	0.053	11.188	0.0039	0.830	0.0765	1.5983	0.191	39.957	0.370	77.250

적 요

구룡산 기슭의 초지와 삼림에서 낙엽의 생산과 분해 및 무기물의 함량을 분석하여 이들의 상호 관계를 고찰한 결과는 다음과 같다.

낙엽 생산량은 초본류에서는 *G. soja* 군락이 1950.88 g/m²로 제일 많고 삼림에서는 *Q. acutissima*가 2202.38 g/m²로 제일 많았다.

종별 낙엽의 분해 상수는 초본에서는 *G. soja*가 K=0.713으로 가장 높고 삼림에서는 *S. koreensis*가 0.319로 가장 높으며 삼림에서보다 초본에서의 K값이 높게 나타났다.

낙엽의 분해 반감기는 초본의 경우 *G. soja*가 0.97년으로 가장 짧고 *S. cotuli er*가 2.62년으로 가장 길었으며 삼림의 경우에는 *S. koreensis*가 2.17년으로 가장 짧았고 *Q. mongolica*가 5.25년으로 가장 길었다.

낙엽의 총질소 함량은 초본에서는 *G. soja*가 제일 높게 나타났고 삼림에서는 *S. koreensis*가 제일 높게 나타났으며 이는 K값에 비례하고 있음을 나타내고 있다.

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