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Ecological Studies on the Montane Grassland of Mt. Soback in Korea

1. Environmental Factors and Vegetation Analysis.

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小白山 山地草原의 生態學的 研究

1. 環境要素와 植被調査

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ABSTRACT

Montane grassland at the summit of Mt. Soback, Korea, was studied to verify the relationships between environmental factors and vegetations on the different slopes.

The contents of total nitrogen and exchangeable metallic cation and thickness of A-layer of soil in the east slope were greater and thicker than those of the northwest one. Two different community types were observed one, on the east slope, was a forb community and the other, on the northwest, was a grass community. Plant height and annual production of the forb community were taller and greater than those of the grass community. These differences might be correlated with the difference of snow depth between two slopes caused by wind in winter. It is clear that the formation of the montane grassland at the study area is mainly caused by fire, wind and topography at the summit.

INTRODUCTION

According to the climatic views, there are no natural grasslands in Korea. Thus, many authors concluded that most of the grassland in Korea were due to interfering of man (Chang and Yun 1969; Park 1971). Many workers have studied on ecology of the natural and seminatural grasslands; the community distribution and analysis, the correlations between productivity and environmental factors along with the environmental gradients (Midorikawa *et al.* 1964; Iwaki *et al.* 1964; Chang *et al.* 1968; Mowbray and Oosting 1968; Park 1970, 1971; Park *et al.* 1970; Old 1969; Redmann 1975).

On the summit of considerably high mountain in Korea, there are a few montane grasslands. For a formation of the montane grassland, Oh (1968) has interpreted that it might be caused by "summit phenomenon", forming grassland or shrubs by means of the wind and the local dryness on the summit though below the timber line. A well developed montane grassland was formed at the summit of Mt. Soback. Considering the climate, this area must naturally be covered with forest instead of grassland. In this montane grassland, the communities on east-and northwest-facing slopes were quite different in physiognomy, flora and ecological features. Environmental factors such as the wind direction and the snow depth at this area during winter would critically determine the floristic composition and ecological performances on the east and northwest slopes. Cantlon (1953), studied the relationship between vegetation and microclimate on the opposite slopes, has found seasonal differences of microclimate and vegetation.

The purpose of this study, the montane grassland at Birobong, where the highest top of Mt. Soback, is to verify the correlations between environmental factors and the vegetation on both slopes.

STUDY AREA

The montane grassland studied at Birobong of 1439 m above sea level, where is the highest point of Mt. Soback, has ca. 50 ha and located at 128′ 29″ E and 36′ 57″ N or at the borderline between Gyeongbuk and Chungbuk Province, Korea (Fig. 1). Among three topographical slopes being at the summit—east, south and northwest—the northwest slope was dissimilar to the others in vegetation physiognomy and floristic composition. Comparison, therefore, was made of environmental factors and vegetation analysis between east and northwest slopes. The inclination of the east slope (about 50′) steeper than that of the northwest slope(about 20′).

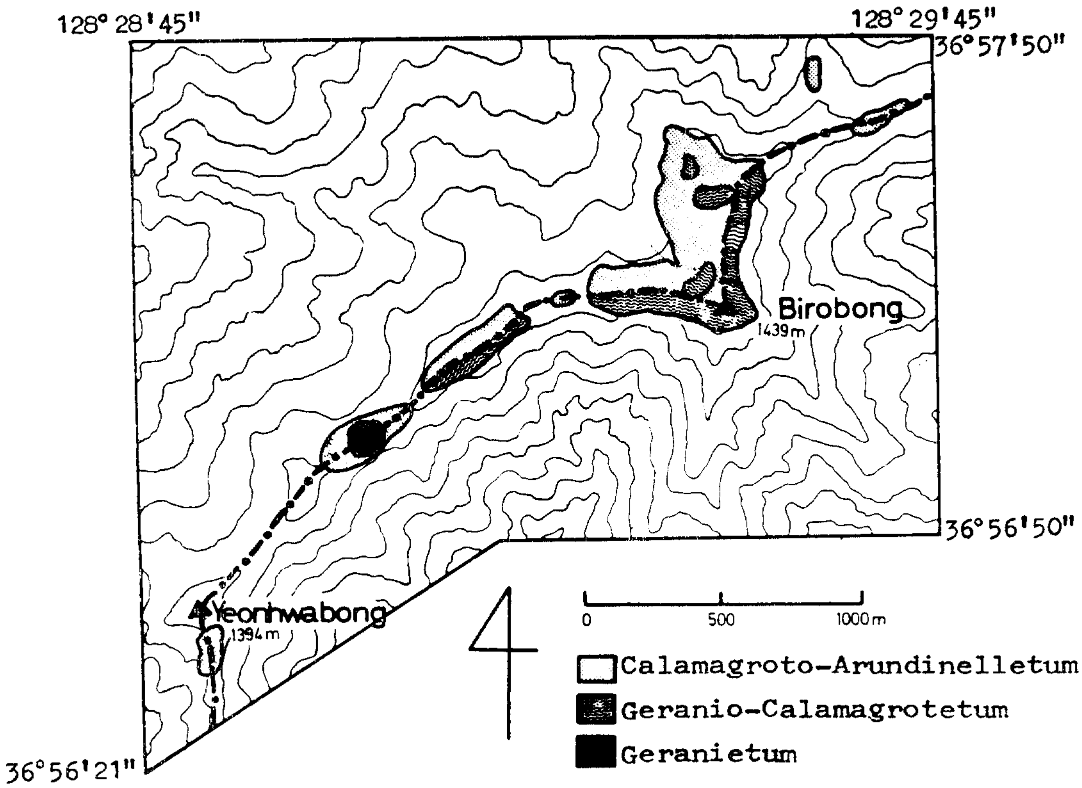

Fig. 1. Location and vegetation types of the study site.

SOIL

The soils in this area were originated from granite. Soil texture of the east slope was sandy soil; coarse sand 65.0 %, fine sand 23.3 %, silt 7.0 %, clay 4.7 % and that of the northwest was loamy sand soil; coarse sand 49.3 %, fine sand 21.6 %, silt 15.0 %, clay 14.1 %. Chemical analysis of the soil was made by the following methods. Total nitrogen was determined by semi-micro Kjehldahl method. Available phosphorus was determined by the stannousreduced molybdophosphoric blue color method. Brown(1943) method was used for the determination of meq. of exchangeable metallic cation (E.M.C.). Organic matter was determined by loss on ignition. Among the chemical properties of soil between two slopes, total nitrogen contents, meq. of E.M.C. and pH values were significantly different

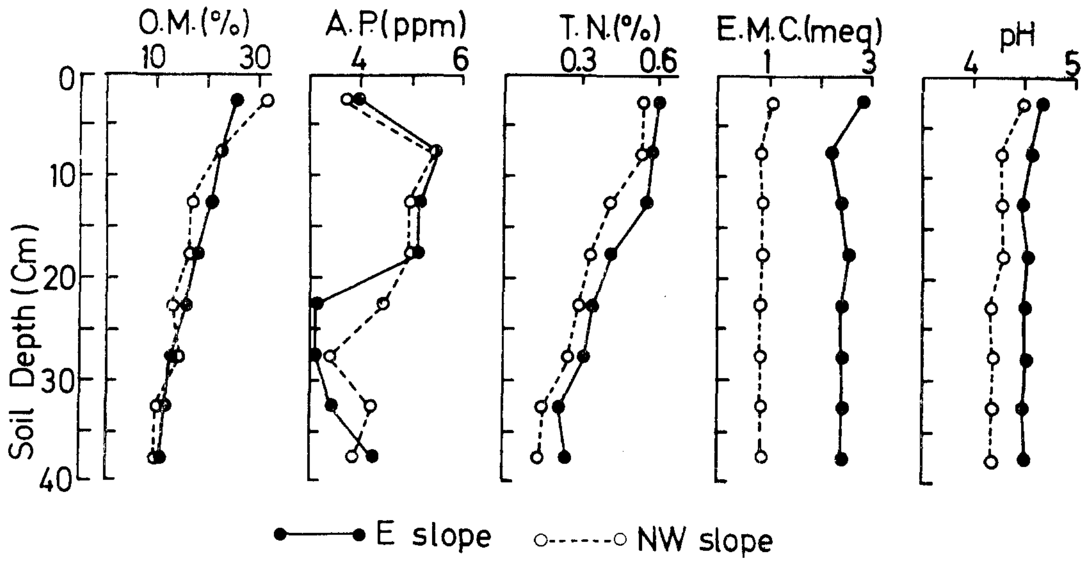

Fig. 2. Chemical properties of the soil at the study site. O.M.; organic matter, A.P.; available phosphorus, T.N.; total nitrogen, E.M.C.; exchangeable metallic cation

as depicted in Fig. 2.

Thickness of A-layer of soil, as shown in Fig. 3, was different significantly on both slopes. In the east slope, the thickness of A-layer was average 20 cm and it tended to increase with ascending slope. In the northwest, however, that was average 11 cm and tended to increase with descending slope.

CLIMATE

Herbs grown in this grassland began to sprout on the early of May and stopped growing by frost on the late of September so that the growing period was five months. The climatic data from the Korea National Astronomical Observatory at Yeonwhabong (1394m), where is about 2km apart on southwest of the study site, are summarized in Table 1. In 1976 and 1979, annual mean precipitation was 2100 mm and the wettest months were June, July and August with a monthly mean precipitation of 287, 245 and 596 mm, respectively. The monthly minimum and maximum mean temperature were −9.2°C in January and 17.3°C in August. The warmth index of the study area was 44, consequently this area was evaluated as a subarctic climatic region. The snow depth of the study site measured in March, 1976 and 1980, showed significant difference on both slopes as seen in Fig. 3; the east slope was gradually thickened with ascending slope but the northwest one was *vice versa*. Such a difference of snow depth along the slopes

Table 1. Climatic data of Mt. Soback in both 1976 and 1979 from data of the Korea National Astronomical Observatory at Yeonwhabong (1394m high), where is 2 km apart on southwest of the study site

	Temperature(°C)			Precipitation(mm)	
Month	Max.	Min.	Mean	Rain	Snow
Jan.	−8.5	−13.5	−9.2	—	63
Feb.	−2.1	−8.6	−5.2	18	245
Mar.	0.9	−5.2	−2.3	32	202
Apr.	6.7	0.7	3.8	55	33
May	14.1	5.4	10.1	134	—
Jun.	17.6	9.8	14.2	287	—
Jul.	20.4	12.3	12.5	245	—
Aug.	22.1	13.1	17.3	596	—
Sep.	15.9	9.5	12.9	106	—
Oct.	8.3	2.3	6.6	33	—
Nov.	1.3	−7.2	−1.9	292	14
Dec.	−1.2	−20.2	−5.8	22	14

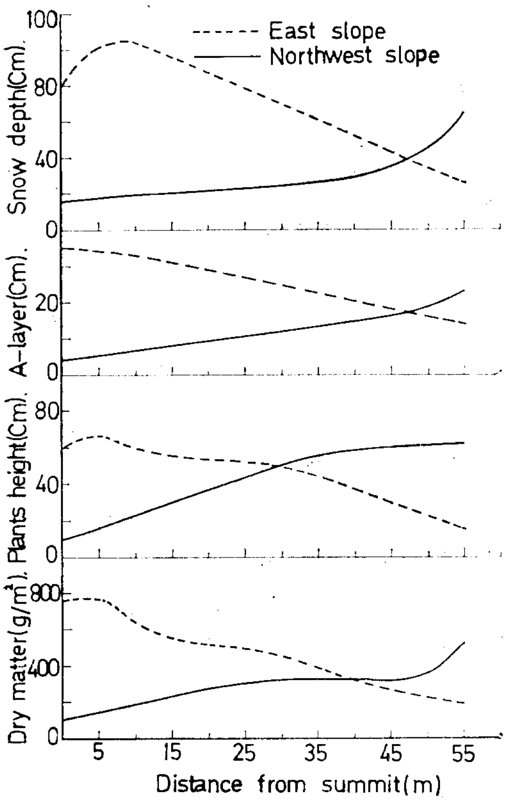

Fig. 3. Changes of snow depth, A-layer depth of the soil, plant height and dry matter production along with descending slope.

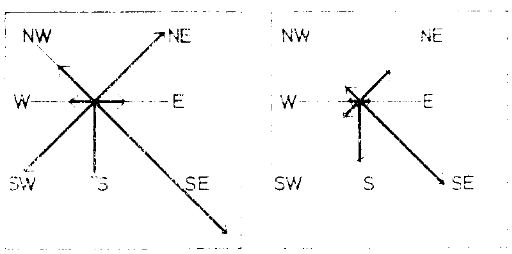

Fig. 4. The wind directions of the study area in 1976 from data of the Korea National Astronomical Observatory at Yeonwhabong (1394m), where is about 2 km apart on southwest of the study site.

would be explained with the wind direction. The most prevailing wind direction during winter at the study area was the northwester as shown in Fig. 4. The snow in the northwest slope was swept away to the lee side by the wind and piled up just below the top of the east slope. The deeper snow piled up on ground, the higher temperature would be maintained during cold weather(Odum, 1971). The different soil temperatures on both slopes during winter will allow to exist the different species of plants as will be mentioned later.

VEGETATION

For study of vegetation, sampling was made randomly 20 quadrats of 25×25 cm on both slopes monthly from May to September in 1976. These samples were classified into species and each samples were weighted after dried for 48 hr. at 80°C. The importance value of each species was based on density, frequency and dry matter sampled in August. Data of vegetation analysis of both slopes were summarized in Table 2. Vegetations were clearly divided into two types based on floristic composition and physiognomy; one, on the east slope, was forb community and the other, on the northwest, was grass community. As mentioned above it is assumed that the forbs are possible to live on the place where snow piled up deeply and consequently the soil temperature is high. But the grasses, which are more tolerable under cold weather, can tolerate under shallow snow depth during cold winter. Sims *et al.* (1978) have reported that the different herb communities were formed under the different temperatures in prairie of North America.

The forb community had 30 species mainly consisting of *Geranium eriostemon* var. *megalanthum*, *Calamagrotis arundinacea*, *Angelica megaphylla*, *Carex siderosticta* and *Pteridum aquilinum* var. *genuinum*. The unique species existing only on the forb community were 13 species, including such as *Convallaria keiskei*, *Hosta longipes*, *Lychnus cognata* etc. The mean plant height of this community was 47±12.5cm and it tended to become taller with ascending slope. Ratio in dry weight of forbs VS. grasses were 537 : 220(g/m²)(100 : 41) and total dry weight of aerial part was about 760g/m² in August.

The grass community had 22 species with major

Table 2. Vegetation analysis on the east(E) and northwest(NW) slopes

Species	Density (%)		Frequency (%)		Dry matter (%)		Importance value	
	E	NW	E	NW	E	NW	E	NW
Geranium eriostemon var. *megalanthum*	8	3	80	94	32	10	120	107
Calamagrotis arundinacea	41	39	80	94	15	34	136	157
Carex siderosticta	8	5	95	72	6	3	109	80
Veratrum japonicum	3	2	75	83	3	2	81	87
Arundinella hirta	7	14	50	72	5	26	62	112
Angelica megaphylla	3	—	50	—	9	—	62	—
Pteridium aquilinum var. *genuinum*	9	5	45	44	5	2	59	51
Bistorta vulgaris	2	1	45	72	7	1	54	74
Synurus deltoides	3	—	45	—	2	—	50	—
Hosta longipes	2	—	45	—	3	—	50	—
Artemisia stolonifera	2	—	45	—	2	—	49	—
Filipendula koreana	1	—	40	—	1	—	42	—
Viola xanthopetala	3	5	35	72	1	2	39	72
Convallaria keiskei	1	—	35	—	1	—	37	—
Vicia unijuga var. *typica*	2	2	25	22	3	4	30	28
Saussured eriophylla	2	1	20	13	2	1	24	15
Astilbe chinensis	—	2	—	61	—	2	—	65
Festuca ovina var. *vulgaris*	—	15	—	39	—	1	—	55
Chrysanthemum sibiricum	—	4	—	44	—	1	—	49
Pedicularis resupinata	—	1	—	44	—	1	—	46
Bupleurum longe-radiatum	—	1	—	22	—	1	—	24

species of *Calamagrotis arundinacea*, *Arundinella hirta*, *Geranium eriostemon* var. *megalanthum*. The unique species of this community were 5 species, including *Leontopodium japonicum*, *Luzula multiflora* and *Astilbe chinensis*. The floristic composition of the grass community in the northwest slope was simple and ecological performance was also poor compared with the forb community on the east one. The mean plant height of the grass community was 36±13.3cm and it tended to become shorter with ascending slope in contrast with that of the forb one. The dry weight of grasses exceeds that of forbs and the ratio of former vs. latter was 320 : 137(g/m^2) (100 : 44). The total dry weight of aerial part of this community was about 460g/m^2 in August. The different floristic composition caused by snow depth would carry out the different biomass, plant height and the thickness of A-layer (Fig. 3).

DISCUSSION

It is well known that grassland has yearly rainfall within range of 250 to 750mm which is too small precipitation to maintain the life form of forest, a high water table as edaphic factor and fire favor grasses in competition with woody plants in the forest region. In the study area, the warmth index was 44, representing character of the subarctic climate, and annual precipitation was about 2100mm, which is sufficient amount of water to support forest community in temperate zone. Evaluating with above reasons, this area ought to have been formed a coniferous forest instead of grassland.

We have observed a few charred timbers as traces of forest fire in part of the study area. After a fire broke out the forest, regeneration might not been made again in this area. Relationships of wind and topography to the formation of vegetation in the study site are illustrated in Fig. 5. We observed that the shrub patch occurred behind a rock and concave place (Fig. 5, A and B), where protected from wind, in spite of grasses grew on

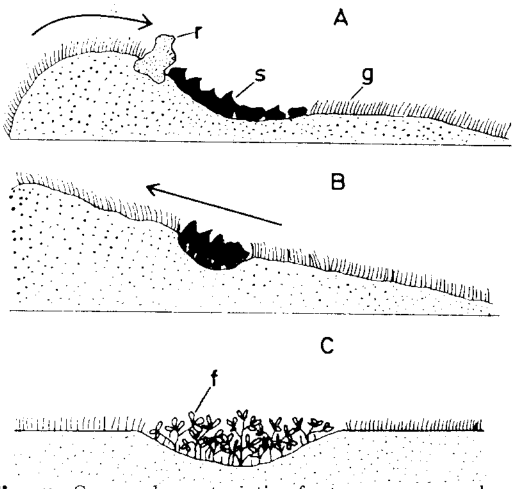

Fig. 5. Some characteristic features on grassland formation and species distribution at the study site. Arrows indicate the prevailing wind direction. r; rock, s; shrub, g; grass, f; forb.

wherever facing the wind or convex place. From these observations we can conclude that wind is one of important factors for the formation of this montane grassland. We have also observed that forb patches were grown in slightly concave places dispersed in the grass community (Fig. 5 C). Having been deeply covered with snow blown by the wind, such a concave place was protected from low temperature. As already mentioned about snow depth of the opposite slopes and the plant species composition, the grasses, in general, are more tolerant of low temperature than the forbs. Thus, the depth of snow cover is also one of the most important factors to determine species distribution, physiognomy and ecological performances in this montane grassland. Consequently, it is concluded that the grassland of Mt. Soback has been occurred by means of combined conditiions of fire, wind and topography.

摘　　要

小白山 山頂의 東斜面과 北西斜面에서 山地草原과 環境要素와의 관계를 調査하였다. 土壤의 全窒素 含量, 置換性 陽이온량, 그리고 A層의 두께는 두 사면에서 현저한 차이가 있었다.

調査地域의 草原은 東斜面의 廣葉草本型과 北西斜面의 狹葉草本型으로 구분되었으며 前者는 後者에 比하여 草長이 길고 年純生産量이 많았다. 이러한 차이는 겨울동안 바람에 의해 形成된 눈 깊이의 차이와 有意한 관계가 있었다.

이 地域의 草原은 主로 산불, 바람 그리고 山頂의 地形的 特性에 의해서 形成된 것으로 解析되었다.

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