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The Energy Flow and Mineral Cycles in a *Zoysia japonica* and *Miscanthus sinensis* Ecosystem on Mt. Kwanak 1. The Standing Crop and Production Structure

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관악산의 잔디와 억새 생태계에 있어서 에너지의 흐름과 무기물의 순환 1. 현존량과 물질 생산구조

장남기 · 김정석 · 심규철 · 강경미

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ABSTRACT

A *Zoysia japonica* and *Miscanthus sinensis* grasslands of north-west side on Mt. Kwanak were investigated. The most important species in this area were *Zoysia japonica* and *Miscanthus sinensis*. These two species contributed greatly to the standing crops of live material, which were in excess of 598.4g/m² and 698.7g/m² during the growing season, respectively. This value would be increased if the production of the moss and algal mats which cover the soil surface during the growing season was included. The productive structures of the *Zoysia japonica* and *Miscanthus sinensis* grasslands were short and long height types of the grasslands, respectively.

Key words: Standing crop, Production structure.

INTRODUCTION

The grassland in Korea has been studied by many investigators but most publications on the subjects have been merely lists of plants containing little quantitative information (Chang and Yun, 1994, 1995; Chang and Rim, 1995; Kim *et al.*, 1969; Park, 1967). Most of the grasslands found in South Korea are not natural, as climate, soil, and altitude do not permit the occurrence of grasslands, apart from the delta area under the river, salt marshes and seashore grass vegetation.

Consequently, the grasslands generally consist of grasses, herbs, bushes and trees, the latter being in a state of regeneration after the nearly complete deforestation of Korea.

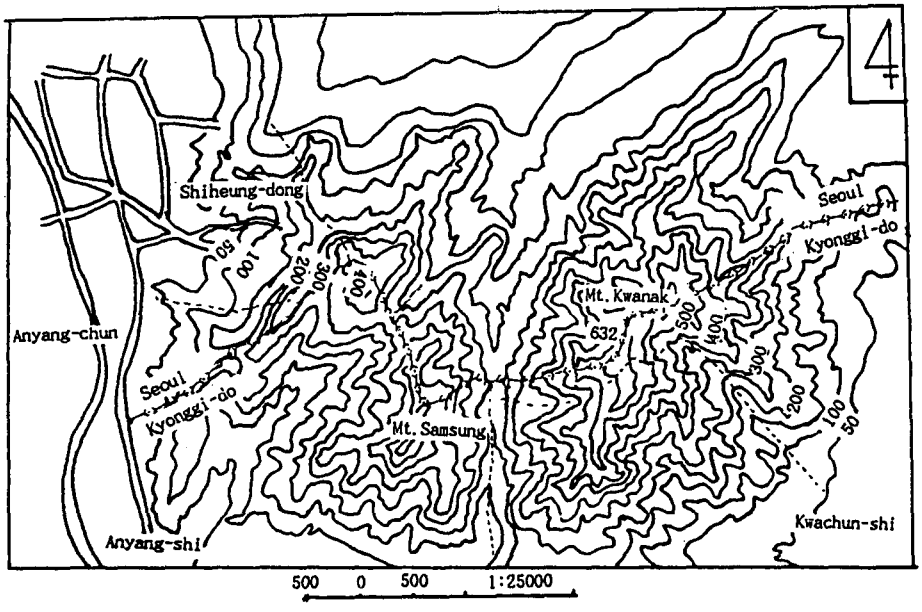

Fig. 1. Areas studied on Mt. Kwanak near Seoul city.

The criteria, therefore, for the selection of stands was that the area occupied by grasses is more than two-thirds of the stand and shows no signs of disturbance, such as grazing, plowing or mowing. The litter, L, fermentaion, F, humus, H, and A1 layers were developed by the *Zoysia japonica* and *Mischanthus sinensis* grassland on the soils.

The purposes of this study were to characterize two communities and investigate the standing crops and production structures of grass communities on Mt. Kwanak, especially with regard to the grassland ecosystems. Such information is prerequisite to the integration of data concerning production in temperate climates.

DESCRIPTION OF THE STUDIED AREA

The stands investigated in this study lie on Mt. Kwanak in Seoul city in the central part of Korea(Fig. 1). The stands are on the slopes facing north-west in the piedmont. The west side is dissected by narrow valley from other two sides and has a sandy loam soil of granitic origin. The ridge and upper slopes of the north and north-west sides consist of sandy loam soil, too.

The climate of Mt. Kwanak, 10 miles from the study area, is rather continental. It is characterized by hot, rainy summer and cold, dry winter. The summer months of June, July, and August are relatively hot with the maximum temperature as high as 30°C. December to February are potentially very cold with mean monthly temperature of 6.5 degrees below zero.

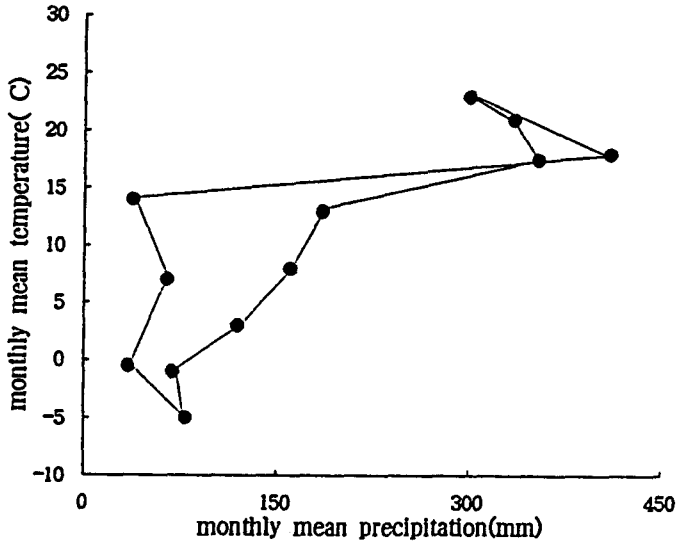

Fig. 2. Hythergraph for Mt. Kwanak area.

Precipitation approximates 720mm for the summer months, about 60% of the annual rainfall, and averages around 240mm/month during June, July and August. The rainy season is regarded as starting in the middle of June and ending with the first of August. Winter is relatively dry. Monthly mean maximum temperature and mean precipitation values are presented for Mt. Kwanak area in Fig. 2. As it will be seen from Fig. 2, wet season lasts from July until August and there is usually a little dry season during winter, from December to February.

METHODS

On each of the two slopes, five transect tapes were run from the upper to the lower part of the slope. Ten quadrats(0.5m by 0.5m or 0.25m by 0.25m) for each slope were spaced uniformly along the tapes.

The cover and frequency of occurrence of each species were obtained by recording the species present in each quadrat on August 30, 1995, throughout the growing season. The production of grasslands of *Zoysia japonica* and *Miscanthus sinensis* was estimated by clipping all plant materials from a series of 25 pairs of quadrats in which the partners were identical with the exception that one member of each pair had been clipped while its partner remained unclipped. Care was taken to sample a quadrat only once.

The oven dry weight of the living material of each species and the dead material of all species in the total sample were then determined. Dead leaves, stems and other parts were removed from living plants and incorporated into the latter category. The standing

crops as a production was estimated by the sum of the dry weights per square meter during an interval of growing days in the sampling period.

RESULTS AND DISCUSSIONS

1. Analysis of production

The florae of two grassland on the north-west side of Mt. Kwanak were composed of two dominant species of *Zoysia japonica* (잔디) and *Miscanthus sinensis*(억새), and several occurrence species of *Ambrosia artemisiifolia* var. *elatior*(돼지풀), *Capsella bursa-pastoris*(냉이), *Equisetum arvense*(쇠뜨기), *Viola mandshurica*(제비꽃) and *Persicaria blumel*(개여뀌) in the former grassland, and *Spodiopogon cotulifer*(기름새), *Weigela subsessilis*(병꽃나무), *Artemisia lavandulaefollia*(참쑥), *Stephanandra incisa*(국수나무), *Rubus crataegifolus*(산딸기), *Aster yomena*(쑥부쟁이) and *Arusinella hirta*(새) in the latter.

In the *Zoysia japonica* and *Miscanthus sinensis* grassland, the standing crops of living material on August 30, 1995, were 598.4g /m^2 and 698.7g /m^2, respectively.

This result is slightly different from the reports of Park(1967), Kim *et al.* (1969), Chang and Yun(1994, 1995), and Chang and Rim(1995). A comparison of the oven dry weights of various species indicated that *Zoysia japonica* or *Miscanthus sinensis* in each grassland contributed to most of the live material. Oven dry weights corresponded closely with the percentages of cover, possibly because many of the species, including the dominants, remained vegetative in these stands. It seems that as a result of high temperature and abundant soil moisture from July to August most species showed vigorous growth in this period. The annual production during one year interval was estimated by taking the annual net increases in weights of individual species. Yields are presented as grams of oven dry weight per square meter and are based on living areal parts only, with dead parts removed.

The extent which the algal and moss mats contribute additionally to the total community production is currently unknown, as is the interrelationship between these two grasslands. Since grasses such as *Zoysia japonica* and *Miscanthus sinensis* contributed 95.1~97.0% of the live standing crop in the annual interval, the productions were dependent upon their growth rates.

From the production structures of *Zoysia japonica* and *Miscanthus sinensis* grasslands in Fig. 3, it is clear that the growth of those grasses was closely related to the amount of solar radiation. *Zoysia japonica* and *Miscanthus sinensis* are the most important C4 plant species on the north-west side, but this importance declines conspicuously toward the cool sites. On the wet sides, it is displaced by *Miscanthus sinensis,* which is more important than *Zoysia japonica* on the wet sides.

2. Productive structure

The productive structure of *Zoysia japonica* and *Miscanthus sinensis* grassland on the

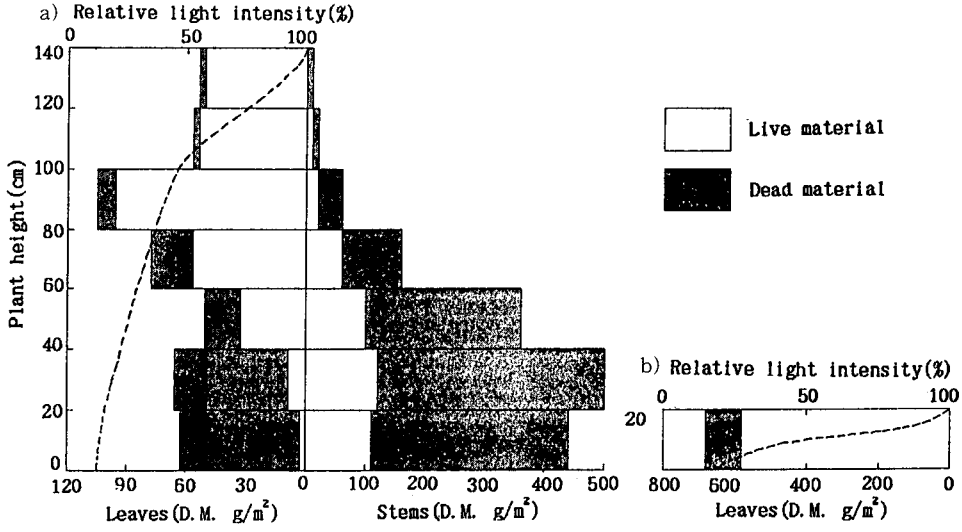

Fig. 3. Productive structure of *Zoysia japonica* and *Miscanthus sinensis* grasslands on Mt. Kwanak on August 30, 1995(a) *Miscanthus sinensis* b) *Zoysia japonica*).

Table 1. Soil properties of L, F, H, A1 and mineral soil layers of a *Zoysia japonica* grassland on Mt. Kwanak

Horizon & depth(cm)	pH	Water content (%)	Organic matter (%)	Total nitrogen (%)	Available P (ppm)	Exchangeable K (ppm)
L	6.00	23.00	71.77	0.68	143.2	563
F	5.02	58.50	35.93	1.53	56.8	544
H	5.43	36.40	16.52	0.80	24.4	444
A1	5.74	12.96	12.96	0.10	13.7	375
0~ 5	5.06	7.50	1.69	0.17	12.1	432
5~10	5.75	7.53	2.28	0.06	8.9	430
10~15	5.53	7.75	1.63	0.05	6.5	396
15~20	5.80	7.45	1.72	0.03	6.1	387
20~25	5.28	7.97	1.00	0.01	5.8	401
25~30	5.55	8.16	1.43	0.02	5.2	386

north-west side of Mt. Kwanak should be considered(Fig. 3). From inspection of the relationship between leaves production and relative light intensity, it can be said that the production has relation directly with the height production of the grasses.

As the *Miscanthus sinensis* grassland in the Fig. 3 shows the average amount of dry matter yield of leaves of the 80~100 cm height was significantly highest of those of all the grass heights. The amount of dry matter yield of stems form 0~20 cm to 120~130 cm decreased with increasing height at the *Miscanthus sinensis* grassland. The productive structure of the *Zoysia japonica* and *Miscanthus sinensis* grasslands has high significant difference with the short height of 0~20 cm and the long height of 120~130 cm, respect-

Table 2. Soil properties of L, F, H, A1 and mineral soil layers of *Miscanthus sinensis* grassland on Mt. Kwanak

Horizon & depth(cm)	pH	Water content (%)	Organic matter (%)	Total nitrogen (%)	Available P (ppm)	Exchangeable K (ppm)
L	5.70	59.73	53.4	0.92	79.4	570
F	4.89	59.58	45.5	0.82	42.9	563
H	4.57	25.08	8.0	0.20	22.0	456
A1	5.50	18.20	4.5	0.10	17.1	450
0~ 5	6.39	14.83	2.5	0.14	13.6	437
5~10	6.61	11.42	2.0	0.05	7.3	421
10~15	6.17	11.80	2.3	0.05	6.1	432
15~20	5.76	13.01	2.5	0.01	5.4	467
20~25	5.30	12.48	2.3	0.02	7.6	452
25~30	5.30	12.76	2.2	0.03	6.4	479

ively(Park, 1967 ; Chang and Yun, 1994, 1995 ; Chang and Rim, 1995).

3. Analysis of soil properties

The data concerning chemical properties of soils under the *Zoysia japonica* and *Miscanthus sinensis* grasslands on the north-west side of Mt. Kwanak are presented in Table 1 and Table 2.

As Table 1 and 2 show, the amounts of organic matter, total nitrtogen, available phosphorus and exchangeable potassium in L, F, H and A1 horizons on the floors of the *Zoysia japonica* and *Miscanthus sinensis* grasslands were significantly higher than that in mineral soil layers, but it is evident that the increase was restricted mainly to the upper 0~5 cm of the soil profile. As would be expected, organic matter, total nitrogen, available phosphorus, exchangeable potassium content decreased with increasing depth at both grasslands, however, in deeper layers the differences between the two grasslands were not clear. According to Kim(1975), the productivity of a site is represented by the soil and the grassland and forest type it supports.

적 요

본 연구는 관악산의 서북사면에 분포하고 있는 잔디군락과 억새군락의 현존량과 연생산성을 조사하였다. 그 결과 잔디가 우점종인 초지에서는 598.4g /m²였고 억새가 우점종인 초지에서는 698.7g /m²였다. 물질생산구조는 잔디군락의 경우 단초형의 특징을 나타내었고 억새군락의 경우는 전형적인 장초형을 나타내었다.

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