〈Article〉

A Phytosociological Study of the Forest Communities on Mt. Kwanak, Seoul

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관악산의 산림군락에 관한 식물사회학적 연구

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ABSTRACT

As part of the study of the structure and the successional trends of our temperate forests, a quantitative survey was made of the relatively well conserved forest stands on Mt. Kwanak, Seoul

Three community types were observed; the *Pinus densiflora-Quercus mongolica* community, the *Pinus densiflora* community, and the *Quercus mongolica* community. Evidence suggests that the dominance of *Pinus densiflora* and *Quercus mongolica* will continue in the *Pinus densiflora-Quercus mongolica* community, however, in the *Pinus densiflora* community the dominant species, *Pinus densiflora*, is now being replaced by *Quercus mongolica*. The trend toward an increase in *Acer pseudo-sieboldianum* var. *koreanum*, *Fraxinus rhynchophylla*, *Carpinus cordata*, and *Acer mono* is observed in the *Quercus mongolica* community.

An analysis of the overall composition of the forest reveals that the upper story is mostly occupied by *Quercus mongolica* and *Pinus densiflora*, the shrub layer by *Rhododendron schlippenbachii* and *Lespedeza maximowiczii*, and the herb layer by *Spodiopogon cotulifer* and *Artemisia keiskeana*.

Quercus mongolica may cover most part of the forest, gradually excluding *Pinus densiflora*. *Acer pseudo-sieboldianum* var. *koreanum*, *Fraxinus rhynchophylla*, *Carpinus cordata*, and *Acer mono* are increasing in importance with the potentiality of developing into major canopy components. With the diversification of the physical habitat *Cephalotaxus koreana* and *Magnolia sieboldii*, the species which had almost completely been eliminated from the forest through the severe interferences, have reappeared.

INTRODUCTION

Mt. Kwanak is the dominant mountain on the southern outskirts of Seoul. It is thus not surprising that there have been reports on its forest vegetation. Unfortunately all of them have been concerned with floristic enumeration, not with the plant communities therein.

During the Korean War in the 1950's, almost all of the forest vegetation of Mt. Kwanak was ruthlessly disturbed. Nevertheless, this vegeta-

tion could be regarded as a favorable one for phytosociological studies of our temperate forest communities. Because of the continuous protection by Seoul National University Forests there are a wide range of seral communities with little human interferences since the massive destruction in the 1950's, Therefore I studied the structure and successional trends of the forest communities of Mt. Kwanak.

Vascular plant voucher specimens have been identified with the help by my advisor, Dr. T. B. Lee, and piled up in the Herbarium of the College of Agriculture, Seoul National University. The nomenclature follows Lee (1969).

I wish to express my heartful thanks to my advisor, Prof. T.B. Lee and Prof. K.B. Yim for their suggestions at the inception of this study, and to Prof. C.M. Kim and Prof. R.H. Robinson for their constructive criticisms of a preliminary draft of the manuscript. I also wish to acknowledge the helps given by Mr. N.S. Cho in the analysis of the soils and the assistances from the rangers of the University Forests in the field work. Financial support has been obtained in the form of scholarship from the Ministry of Science and Technology.

PHYSIOGRAPHY OF THE STUDY AREA

Mt. Kwanak is located at 37°25′—37°27′N, 126°55′—127°0′ E. The summit of the peak is 629 m above sea level (Fig. 1).

The meteorological data collected by the R.O.K. Air Force Weather Squadron, 6km northwest to the center of the study area, show that the annual average precipitation is 1141.9 mm, more than two thirds of which is distributed through the growing season. Summer showers are sudden and intense. The estimated annual mean temperature is 10.7°C. The average date for the last killing frost in spring is around the end of April, and for the first killing frost, around the end of October.

Brown Forest Soils, chiefly derived from granite and gneiss, are typical of this region, but are generally shallow. Many rock outcrops occur on the south facing slopes and on the ridges owing to the severe erosion following the heavy destruction of vegetation during the Korean War.

The stands of *Quercus mongolica* and *Pinus densiflora*, are occupied on the undulating northern and southern exposures respectively.

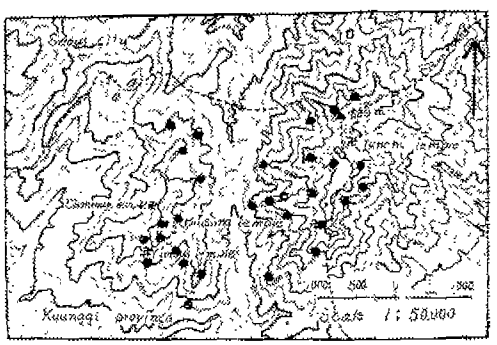

Fig. 1. Topographic map of Mt. Kwanak, Seoul. Black spots indicate the location of the quadrats.

METHODS

The forest of the study area was delimited subjectively, according to its physiognomy, into three community types; *Pinus densiflora-Quercus mongolica* community, *Pinus densiflora* community and *Quercus mongolica* community. Ten quadrats were laid out on relatively undisturbed areas of each community type. Tree data taken in 10m by 10m quadrats included diameter at breast height, crown cover as percentage of quadrat surface, frequency, and density. The last three properties were obtained for shrubs in 4m by 4m quadrats and for herbs in 1m by 1m quadrats, both of which were nested in the fixed corner of the tree quadrats. All species occurring in the quadrats were classified according to Raunkiaerian life forms (Raunkiaer 1934)

Topsoil samples from each quadrat (0—10 cm below the surface) were oven dried at 105—110°C, sifted through a 2 mm sieve and sent to the Central Forest Experimental Station. Water holding capacity was represented by the weight of water contained in the 100 cc drained sample (Wilde · Voigt 1955) Loss on ignition was determined using a muffle furnace at 575±25°C for 6 hours. Soil pH was measured with a pH meter (TOA, model-HM-5A). The content of exchangeable Ca and Mg was established by titration with Ethylene Di-amine Tetra-Acetate, and the content of K, with a Coleman Flame Photometer.

Sampling was done in August when most of the plants were near their greatest crown cover for the year.

RESULTS AND DISCUSSIONS

1. The structure and dynamic status of the communities.

A) *Pinus densiflora-Quercus mongolica* community.

This community occurs largely on the ridges and on the steep slopes, frequently as scattered patches where almost all of the topsoil was washed away as a consequency of the extensive destruction of the vegetation about 20 years ago.

Dwarf *Pinus densiflora* and sprout-originated *Quercus mongolica* dominate this community, with *Juniperus rigida* being mixed with high frequency (six out of ten quadrats). The fact that the second most important tree species as *Quercus mongolica* as well as *Quercus serrata* are largely of sprout origin logically leads to the conclusion that this community was derived from oak-dominated forest through the openings of the forest by human disturbances, thus favouring the rapid invasion of high light demanding species, e.g. *Pinus densiflora* and *Juniperus rigida*, now the most abundant and widespread.

The shrub understory includes seventeen species, with *Rhododendron schlippenbachii*, *Smilax china*, *Lespedeza cyrtobotrya*, and *Rhododendron mucronulatum* the most common throughout the community. *Buxus microphylla* var. *koreana* for. *elongata* is widely scattered but depressed in size.

Nine species of grasses observed in the quadrats. *Arundinella hirta*, *Themeda triandra* var. *japonica* are bunch grasses that grow better in the open, but the other grasses seemed to prefer the shaded habitat. *Artemisia keiskeana* was the most important forb among the ten species appearing in the quadrats (Table 1). Generally the herb layer was sparse throughout the forest communities.

In order to reveal the dynamic status of this community, the populations of all component tree species were analysed by D.B.H. classes which can be regarded as age classes (Cain 1932, 1959, Daubenmire 1968) in Table 2. *Pinus densiflora* and *Quercus mongolica* enjoy the largest populations, and their abundant production of seedlings can be expected to maintain their predominance as long as the community remains open. *Quercus serrata*, *Q. variabilis* *Q. acutissima*, *Alnus hirsuta* and *Styrax japonica*, as they are lacking in seedlings, will finally be replaced when the established individuals die. It is quite reasonable to conclude that this lack of seedlings reflects an adverse change in the environment which is thus no longer favourable to these species (Daubenmire 1968)

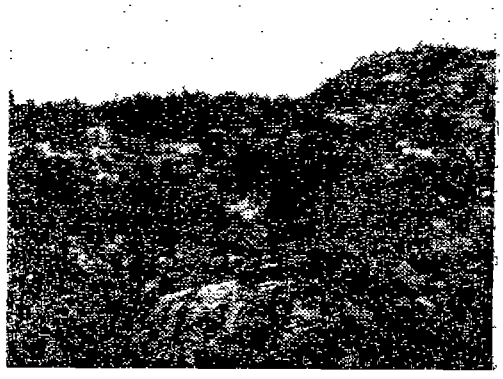

Fig. 2. *Pinus densiflora-Quuercus mongolica* community.

Table 1. Frequency, coverage and density of plants in the *Pinus densiflora-Quercus mongolica* community, Mt. Kwanak.

Species	Frequency (1)	Coverage (2)	Density (3)
Trees			
Pinus densiflora	100	43	886
Quercus mongolica	90	29	530
Quercus serrata	50	6.5	132
Juniperus rigida	60	5	180
Quercus variabilis	40	5	79
Alnus hirsuta	10	5	54
Styrax japonica	20	1	24
Sorbus alnifolia	30	+(4)	54
Quercus aliena	10	+	30
Quercus acutissima	10	+	12
Shrubs			
Rhododendron schlippenbachii	70	11	47
Lespedeza cyrtobotrya	100	8	55
Rhododendron mucronulatum	60	4	27
Smilax china	30	2.5	8
Buxus microphylla var. *koreana* for. *elongata*	40	1	8
Stephanandra incisa	40	1	10
Corylus heterophylla	20	1	5
Weigela subsessilis	70	+	12
Lespedeza maximowiczii	10	+	2
Securinega suffruticosa	10	+	1
Rhus japonica	10	+	1
Cocculus trilobus	10	+	2
Lespedeza thunbergii var. *intermedia*	10	+	1
Viburnum erosum	10	+	2
Indigofera kirilowi	10	+	5
Smilax sieboldii	10	+	2
Callicarpa japonica	10	+	3
Grasses			
Arundinella hirta	60	8.5	101
Andropogon brevifolius	30	7.5	662
Spodiopogon cotulifer	40	4	30
Carex humilis	50	2	15
Miscanthus sinensis var. *purpurascens*	20	2	12
Calamagrostis arundinacea	20	1	10
Themeda triandra var. *japonica*	10	+	5
Festuca obina	10	+	4
Carex ciliato-marginata	10	+	3
Forbs			
Artemisia keiskeana	30	5	55
Aster scaber	10	+	1
Chrysanthemum boreale	20	+	4
Isodon inflexus	10	+	1
Youngia denticulata	10	+	1
Atractylodes japonica	20	+	2
Gentiana scabra var. *buergerii*	10	+	1
Patrinia villosa	10	+	3
Ostericum grosseserratum	10	+	1
Viola grypoceras	10	+	5

(1) Frequency based on 10 quadrats

(2) Crown cover as percentage of the quadrat surface covered by vertical projection of the crown. Data based on 10 quadrats

(3) Density on 10 quadrats, 10m by 10m each for trees, 4m by 4m each for shrubs and 1m by 1m each for herbs

(4) + indicates less than 1 per cent coverage

Table 2. Population analysis of trees by size classes in the *Pinus densiflora-Quercus mongolica* community, Mt. Kwanak. (Density on ten quadrats, 10m by 10m each)

Species	Size classes in centimeters D.B.H.			
	Seedlings	Up to 5	6-10	11-15
Pinus densiflora	330	454	96	6
Quercus mongolica	246	254	30	
Quercus serrata		132		
Quercus variabilis		64	15	
Quercus aliena	6	24		
Quercus acutissima		12		
Juniperus rigida	18	130	32	
Sorbus alnifolia	12	42		
Alnus hirsuta		54		
Styrax japonica		24		

B) *Pinus densiflora* community.

This community is mainly distributed on the southern exposures where the topsoils are comparatively shallow and rocky. It is especially well developed around the several Buddhist temples scattered throughout the study area, the vegetation of which survived the destruction of war. *Pinus densiflora* is dominant in the overstory cover. The overwhelming number of *Quercus mongolica* appearing in the understory would see to indicate that the species is rapidly increasing its population, except in the local areas of very rocky site where *Juniperus rigida* and *Sorbus alnifolia* are common.

The shrub understory includes twenty species, with *Lespedeza maximowiczii*, *L. cyrtobotrya*, *Rhododendron schlippenbachii*, and *Indigofera kirilowi* being the most common. Five species of grasses and six of forbs appeared in the quadrats (Table 3).

The future trend of this community can be predicted from Table 4. When the number of seedlings and small trees below 10cm in D.B.H. are compared, it goes without saying that the dominant species, *Pinus densiflora*, is now being replaced by *Quercus mongolica*. And what is more, the ubiquitous dead and dying pine trees resulting from severe infestations by pine caterpillar (*Dendrolimus spectabilis*) and pine gall-midge (*Thecodiplosis japonensis*) seem to be another evidence of this replacement (Fig. 4).

Acer pseudo-sieboldianum var. *koreanum*, *Fraxinus rhynchophylla*, and *Acer mono*, judging from their abundance in the *Quercus mongolica* community (Tables 5,6), will increase provided that *Quercus mongolica* develops into the leading dominant species of this community. The oak groups and *Prunus serrulata* var. *pubescense* will remain longer in this community because of their special ability to sprout. The other tree species producing few seedlings will finally dwindle away with *Juniperus rigida* and *Sorbus alnifolia* lingering on the xeric sites where their abundant seedlings are found. As a whole, the trend of this community is apparently a shift from the predominance of *Pinus densiflora* to *Quecus mongolica*.

Fig. 3. *Pinus densiflora* community

Fig. 4. The ubiquitous dead and dying *Pinus densiflora* infested with pine caterpillar and pine gall-midge.

Table 3. Frequency, coverage, and density of plants in the *Pinus densiflora* community, Mt. Kwanak.

Species	Frequency (1)	Coverage (2)	Density (3)
Trees			
Pinus densiflora	100	74	209
Quercus mongolica	100	64.5	1,113
Quercus variabilis	30	5.5	54
Acer pseudosieboldianum var. *koreanum*	40	5	90
Prunus serrulata var. *pubescens*	40	4	46
Sorbus alnifolia	10	2.5	54
Quercus serrata	20	2.5	54

Species	Frequency (1)	Coverage (2)	Density (3)
Acer mono	10	2.5	8
Styrax japonica	20	1	45
Kalopanax pictus	20	1	78
Juniperus rigida	30	+(4)	20
Fraxinus rhynchophylla	20	+	16
Quercus acutissima	10	+	18
Castanea crenata	10	+	18
Shrubs			
Lespedeza maximowiczii	50	7.5	35
Lespedeza cyrtobotrya	50	5	31
Rhododendron schlippenbachii	50	5	30
Indigofera kirilowi	40	4.5	51
Rhododendron mucronulatum	60	3	31
Stephanandra incisa	40	3.5	27
Corylus heterophylla	30	1.5	14
Lindera obtusilova	30	1.5	5
Smilax china	30	+	6
Symplocos chinensis for. *pilosa*	30	+	5
Zanthoxylum schinifolium	20	+	3
Lespedeza thunbergii var *intermedia*	10	+	8
Euonymus alatus	10	+	5
Viburnum erosum	10	+	4
Callicarpa japonica	10	+	3
Weigela florida	10	+	3
Corylus sieboldianus	10	+	2
Weigela subsessilis	10	+	1
Cocculus trilobus	10	+	1
Clematis mandshurica	10	+	1
Grasses			
Carex humilis	70	11	44
Spodiopogon cotulifer	70	8.5	93
Carex ciliato-marginata	30	1.5	65
Calamagrostis arundinacea	40	1.5	32
Miscanthus sinensis	20	+	5
Forbs			
Artemisia keiskeana	60	5	76
Melampyrum roseum	30	2.5	15
Viola rossii	20	+	3
Atractylodes japonica	10	+	1
Chrysanthemum boreale	10	+	1
Aster scaber	10	+	1

(1)(2)(3)(4): See footnote, Table 1.

Table 4. Population analysis of trees by size classes in the *Pinus densiflora* community, Mt. Kwanak (Density on ten quadrats, 10m by 10m each.).

Species	Size classes in centimeters D.B.H.							
	Seedlings	Up to 5	6-10	11-15	16-20	21-25	26-30	31-35
Pinus densiflora	84	57	35	9	2	10	9	3
Quercus mongolica	416	588	107	1	1			
Acer pseudo-sieboldianum var. *koreanum*	30	60						
Fraxinus rhynchophylla	6	10						
Acer mono	2	4	2					
Quercus serrata		54						
Quercus variabilis		42	12					
Quercus acutissima		18						
Prunus serrulata var. *pubescens*	6	37	3					
Sorbus alnifolia	18	36						
Juniperus rigida	7	13						
Styrax japonica		45						
Kalopanax pictus		42	36					
Castanea crenata		15	3					

C) *Quercus mongolica* community

This community occupies largely northern exposures, especially where the topsoils are thicker and contain abundant amounts of organic matter.

Quercus mongolica is the obvious dominant making up 93 per cent of the plant cover. The data in Table 5 and 6 show the increasing tendency of *Acer pseudo-sieboldianum* var. *koreanum*, *Fraxinus rhynchophylla*, *Carpinus cordata*, *Acer mono*, and *Philladelphus shrenckii*, giving the promise of becoming predominant in this community(Oh 1959) Only a few individuals of *Pinus densiflora* and *Juniperus rigida* were seen on old, deep deposits, the absence being apparently due to natural succession rather than human disturbance. The more diversified environmental condition of this community is evidenced by its floristic composition(McArthur 1965) ; sixty-five species were identified on the quadrats laid out in this community, but only forty-five in the *Pinus densi-flora* and forty-six in the *Pinus densiflora-Quercus mongolica* community. With the diversification, *Cephalotaxus koreana* and *Magnolia sieboldii*, the species which had almost been removed from the forest through the destruction, have reappeared. *Quercus acutissima*, *Q. serrata*, and *Prunus serrulata* var. *pubescens* will remain longer in this community because of their shoots originating from the roots or stem bases of old trees. *Euonymus sieboldianus*, *Styrax japonica*, *Cornus walteri*, *Sorbus alnifolia*, *Castanea crenata*, *Juniperus rigida*, *Populus*, *davidiana*, and *Pinus densiflora* will disappear from the stands when the established individuals die. They produced few seedlings and what is more, their sprouting abilities are not spectacular.

Rhododendron schlippenbachii, *Lespedeza maximowiczii*, *Euonymus alatus*, and *Lindera obtusiloba* are the most common among the shrub understory species. The herb cover is very sparse and most is provided by *Spodiopogon cotulifer*. *Athyrium nipponicum* and *Artemisia keiskeana*.

Fig. 5. *Quercus mongolica* community.

Table 5. Frequency, coverage and density of plants in the *Quercus mongolia* community, Mt. Kwanak.

Species	Frequency (1)	Coverage (2)	Density (3)
Trees			
Quercus mongolica	100	93	444
Acer pseudo-sieboldianum var. *koreanum*	90	27	533
Prunus serrulata var. *pubescens*	70	7.5	24
Fraxinus rhynchophylla	70	6	154
Euonymus sieboldianus	30	2	29
Quercus serrata	40	1.5	16
Cornus walteri	20	1	7
Cephalotaxus koreana	20	+	45
Carpinus cordata	20	+	43
Acer mono	20	+	53
Quercus acutissima	20	+	24
Magnolia sieboldii	20	+	6
Sorbus alnifolia	20	+	5
Philadelphus schrenckii	10	+	34
Styrax japonica	10	+	18
Pinus densiflora	10	+	1
Castanea crenata	10	+	1
Populus davidiana	10	+	1
Juniperus rigida	10	+	1
Shrubs			
Euonymus alatus	40	4	13
Rhododendron schlippenbachii	30	9	16
Lespedeza maximowiczii	80	8.5	38
Symplocos chinensis for. *pilosa*	20	3.5	9

Species	Frequency (1)	Coverage (2)	Density (3)
Lindera obtusiloba	30	3.5	46
Rhododendron mucronulatum	40	3	10
Zanthoxylum schinifolium	20	2.5	6
Corylus sieboldianus	30	2	8
Stephanandra incisa	40	1.5	11
Rhus verniciflua	40	1.5	9
Callicarpa japonica	40	1.5	10
Tripterygium regelii	10	1.5	8
Parthenocissus tricuspidata	40	1.5	4
Actinidia arguta	30	1.5	3
Lespedeza cyrtobotrya	30	1(4)	9
Weigela florida	30	+	13
Indigofera kirilowi	20	+	2
Lonicera praeflorense	10	+	5
Weigela subsessilis	10	+	2
Vitis amurensis	10	+	2
Deutzia parviflora	10	+	1
Buxus microphylla var. *koreana*	10	+	1
Clematis heracleifolia	10	+	1
Grasses			
Spodiopogon cotulifer	60	14.5	159
Carex ciliato-marginata	30	3.5	102
Carex humilis	50	3	23
Calamagrostis arundinacea	40	1	17
Forbs			
Athyrium nipponicum	30	6.5	22
Artemisia keiskeana	60	6.5	60
Viola rossii	30	3	18
Hemerocallis minor	20	1.5	3
Aster scaber	20	1.5	3
Disporium smilacium	40	1	25
Potentilla freyniana	20	+	3
Eupatorium japonicum	20	+	2
Isodon inflexus	10	+	3
Viola albida var. *chaerophylloides*	10	+	3
Synulus deltoides	10	+	2
Melampyrum roseum	10	+	2
Asplenium incisum	10	+	2
Arisaema amurense var. *serratum*	10	+	2
Atractylodes japonica	10	+	1
Cephalanthera longibracteata	10	+	1
Lysimachia barystachys	10	+	1
Asarum sieboldii	10	+	1
Pseudostellaria heterophylla	10	+	1

(1), (2), (3), (4) : see footnote, Table 1.

Table 6. Population analysis of trees by size classes in the *Quercus mongolica* community, Mt. Kwanak (Density on 10 quadrats, 10m by 10m each.).

Species	Size classes in centimeters D.B.H.					
	Seedlings	Up to 5	6-10	11-15	16-20	Above 21
Quercus mongolica	150	194	70	25	4	1
Acer pseudo-sieboldianum var. *koreanum*	319	195	19			
Fraxinus rhynchophylla	101	48	4	1		
Carpinus cordata	42		1			
Acer mono	33	20				
Philladelphus schrenckii	24	10				
Cephalotaxus koreana	45					
Magnolia sieboldii	6					
Quercus acutissima		24				
Prunus serrulata var. *pubescens*		17	5	2		
Quercus serrata		12	3	1		
Euonymus sieboldianus		29				
Styrax japonica		18				

Species	Size classes in centimeters D.B.H.					
	Seedlings	Up to 5	6-10	11-15	16-20	Above 21
Cornus walteri		6	1			
Sorbus alnifolia		5				
Castanea crenata		1				
Juniperus rigida		1				
Populus davidiana		1				
Pinus densiflora			1			

2. The overall composition of the forest.

The forest stands, which can be assigned to three community types, are distributed intermingled with each other over the whole area. Generally, the *Pinus densiflora-Quercus mongolica* community is found on the ridges and on the steep slopes, the *Pinus densiflora* community on the southern exposures, and the *Quercus mongolica* community on the northern.

The data obtained from all the quadrats in the three community types were synthesized to represent the overall composition(Table 7). The figures reveal that *Quercus mongolica* is the leading dominant species of this forest and *Pinus densiflora*, the subdominant. Important shrubs are *Rhododendron schlippenbachii*, *Lespedeza maximowiczii*, *Lespedeza cyrtobotrya*, *Lindera obtusiloba* and *Rhododendron mucronulatum*. They are fairly common, but provide only a small amount of cover throughout the area. Nine species of grasses and thirty-one of forbs were observed in the quadrats, but their cover was sparse, the most being provided by *Spodiopogon cotulifer*, *Artemisia keiskeana* and *Carex humilis*. Other plants were seen, but not sampled. The life form distribution of species of plants was: Phanerophytes, 30.1% ; chamaephytes, 3.4% ; hemicryptophytes, 28.3% ; geophytes, 15.6% ; hydrophytes and helophytes, 1.7%; therophytes, 19.9% (The details are available when requested).

Table 7. The composition of the forest of Mt. Kwanak, Seoul (1)

Species	Frequency (2)	Coverage (3)	Density (4)	Life foms (5)
Trees.				
Quercus mongolica	96.6	62.2	2,087	Ph
Pinus densiflora	66.6	39	1,096	〃
Acer pseudo-sieboldianum var. *koreanum*	50	10.3	623	〃
Prunus serrulata var. *pubescens*	36.6	10.3	70	〃
Quercus serrata	36.6	4	202	〃
Fraxinus rhynchophylla	30	3.5	170	〃
Quercus variabilis	23.3	3.5	133	〃
Juniperus rigida	33.3	1.8	201	〃
Alnus hirsuta	3.3	1.8	54	〃
Shrubs				
Rhododendron schlippenbachii	50	8.3	93	〃
Lespedeza maximowiczii	46.6	5.3	75	〃
Lespedeza cyrtobotrya	60	4.6	95	〃
Rhododendron mucronulatum	53.3	3.3	68	〃
Stephanandra incisa	40	1.8	48	〃
Lindera obtusiloba	20	1.6	51	〃
Indigofera kirilowi	23.3	1.5	58	〃
Euonymus alatus	16.6	1.3	18	〃
Herbs				
Spodiopogon coutulifer	56.6	9	282	H
Artemisia keikeana	50	5.5	191	G
Carex humilis	56.6	5.3	82	H
Arundinella hirta	20	2.8	101	G
Miscanthus sinensis var. *purpurascens*	26.6	2.6	9	H
Andropogon brevifolius	10	2.5	662	Th
Azhyrium nipponicum	10	2.1	21	G
Carex ciliato-marginata	23.3	1.6	172	H
Calamagrostis arundinacea	33.3	1.2	61	H

(1) : Includes all plants sampled, but only with 1% or more cover percentage.
(2), (3), (4) : Data based on 30 quadrats.
(5) : Ph, phanerophytes; Ch, chamaephytes; H, hemicryptophytes; Th, therophytes.

3. The successional trends

The population of each tree species in the forest was analysed by means of D.B.H.-classes for the interpretation of the successional trends (Table 8).

The figures in Table 8 reveal the clear evidence of a shift from an antecedent forest to a subsequent one that promises to be the climax. If the climax species is defined as one which has the permanent possession of the habitat (Daubenmire 1968) *Quercus mongolica* can be the climax species, judging from its copious production of seedlings, from the abundance of its small size classes, and from the scattered existence of older and larger D.B.H. individuals that have survived the destruction.

Pinus densiflora, most of which flushed into the forest with the opening of the vegetation, still produces abundant seedlings and their survival is satisfactory. But as the seedlings are strikingly intolerant of shade, so soon die when overtopped, this species will be finally eliminated. The rampant pine caterpillar and pine gallmidge seem to accelerate this replacement.

When the number of seedlings and small trees below 5cm in D.B.H. are taken into consideration, *Acer pseudo-sieboldianum* var. *koreanum*, *Fraxinus rhynchophylla*, *Carpinus cordata*, and *Acer mono* will increase with the potentiality of becoming major canopy constituents, while *Styrax japonica*, *Alnus hirsuta*, *Kalopanax pictus*, *Euonymus sieboldianus*, *Castanea crenata*, *Cornus walteri*, and *Populus davidiana* can be regarded as disappearing relics of an earlier stage in succession. For them the environment seems to have changed adversly and can no longer be considered favourable.

The disappearance of *Quercus serrata*, *Q. variabilis*, *Q. acutissima*, *Q. aliena*, and *Prunus serrulata var. pubescens* will be long postponed because of their sprouting ability. *Juniperus rigida* and *Sorbus alnifolia* will occupy the xeric sites as long as the vegetation remains open.

The appearance of seedlings of *Cephalotaxus koreana* and *Magnolia sieboldii* can be attributable to the diversification of the environment through succession (Appendix)

Table 8. Population analysis of trees by size classes in the forest of Mt. Kwanak (Synthesized).

Species	Size classes in centimeters. D.B.H.								
	Seedlings	up to 5	5-10	11-15	15-20	21-25	36-30	31-35	36-40
Quercus mongolica	812	1,036	207	26	5			1	
Pinus densiflora	414	511	132	15	2	10	9	3	
Acer pseudo-sieboldianum var. *koreanum*	349	255	19						
Fraxinus rhynchophylla	107	58	4	1					
Carpinus cordata	42		1						
Acer mono	35	24	2						
Cephalotaxus koreana	45								
Magnolia sieboldiana	6								
Quercus serrata		198	3	1					
Quercus variabilis		106	27						

Species	Size classes in centimeters D.B.H.								
	Seedlings	Up to 5	6-10	11-15	16-20	21-25	26-30	31-35	36-40
Prunus serrulata var. *pubescens*	6	54	8	2					
Quercus acutissima		54							
Quercus aliena	6	24							
Juniperus rigida	25	144	32						
Sorbus alnifolia	30	83							
Styrax japonica		87							
Alnus hirsuta		54							
Kalopanax pictus		42	36						
Euonymus sieboldianus		29							
Castanea crenata		16	3						
Cornus walteri		6	1						
Populus davidiana		1							

摘 要

우리나라 온대지방 산림식생의 구조와 천이에 관한 연구로서, 관악산의 산림을 대상으로 식물사회학적인 조사를 하였다.

조사지역의 산림은 소나무-신갈나무군락, 소나무군락 및 신갈나무군락 등으로 구분되며 소나무-신갈나무군락은 신갈나무군락의 파괴적지에 소나무, 노간주나무 등 강한 양수수종이 침입하여 형성한 군락으로 현 우점종인 소나무, 신갈나무가 당분간 그 지위를 유지할 것이며 소나무 군락에서는 현 우점종인 소나무가 신갈나무에 의하여 추방되어지고 있는 경향을 보였다. 신갈나무 군락에서는 쪽은단풍, 물푸레, 까치박달, 고로쇠나무 등이 장차 이 군락의 우점종으로 까지 발달할 잠재적 가능성을 보였고 개비자, 함박꽃나무 등 심한 인위적 간섭으로 달미암아 거의 자취를 감추었든 수종들이 환경의 다양화와 더불어 다시 나타나기 시작하였다.

전반적으로 보아 관악산의 산림은 신갈나무와 소나무가 상층수관에서 우점하며 교목층에서 철쭉, 초본층에서 기름새가 우점하는 구조를 가지고 있으며, 좁은단풍, 물푸레, 까치박달 등이 산림내에서 그들의 세력을 확장하여가고 있으며 소나무는 점점 쇠퇴하여 가는 추세인 것 같다.

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Appendix. Some analysis of soil properties in each community type

Factors \ Community types	Pine-oak community	Pine community	Oak community
Water holding capacity (%)	43.7	46.9	49.1
Humus content (%)	4.9	8.9	14.3
pH	5.5	5.4	5.4
Exchangeable Ca (me/100g)	2.1	2.8	4.7
Exchangeable Mg (me/100g)	1.3	1.0	1.0
Exchangeable K (me/100g)	0.54	0.59	0.86