Jour. Korean For. Soc. 89(4) : 470 - 479. 2000
韓國林學會誌 89(4) : 470 - 479. 2000

Classification of Vegetation Units and Its Detailed Mapping for Urban Forest Management[1]

- On Mt. Moodeung in Kwangju, Korea -

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都市林 管理를 爲한 植生單位區分과 精密植生圖 作成[1]

- 光州廣域市 無等山을 中心으로 -

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ABSTRACT

Management units of forest vegetation established on Mt. Moodeung (1,186.8m), a typical urban forest at Kwangju city located in the southwestern Korea, was classified phytosociologically and its spatial distribution mapped out with special reference to its ecological conservation and management. Management units of this area were classified into three categories; twenty-one higher units, ten lower units and nine lowest units, giving a total of 31 zones. Total area for detailed mapping was 2,779.5ha, of which natural vegetation accounted for 2192.0ha (78.9%), residing in most part of this area, artificial vegetation for 159.1ha (5.7%), and non-forested area including arable area, burned area and others for 428.4ha (15.5%). The ratio of natural forest element showed 93.2%, which is much higher when compared with those of other urban forests.

Key words : vegetation units, ecological characteristics, a detailed vegetation map, natural forest element

要 約

光州廣域市의 대표적인 都市林인 無等山에 발달하고 있는 山林植生의 保全과 管理를 목적으로 植物社會學的인 방법에 의해 그 管理單位가 구분되고 그것의 空間的 分布가 精密하게 地圖化되었다. 이 지역의 山林植生管理單位는 上位 21個 單位, 下位 10個 單位 그리고 最終下位 9個 單位로 구분되었으며, 總 31개의 管理區域이 결정되었다. 精密植生圖 작성면적은 2,779.5ha이며, 그 중 自然植生이 78.9%인 2,192.0ha로 대부분을 차지하고 있었으며, 人工植生과 無立木地가 각각 5.7%인 159.1ha, 15.5%인 428.4ha로 나타났다. 自然林要素率은 타 지역의 도시림에 비교하여 볼 때 아주 높은 93.2%로 나타났다.

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INTRODUCTION

International attention to forest and forestry has recently focused on degradation and protection of the urban forest. From this point of view, urban forests are as noteworthy ecosystems as coral reefs, mire vegetation and tropical rain forests. The urban forest may be defined as the sum of all woody and associated vegetation in and around dense human settlements, ranging from small communities in rural settings to metropolitan region (Miller, 1997). The urban forest is part and parcel of the human environment, and, according to DeGraaf (1974), provides habitat for a great diversity of wildlife in the city. The concept of an urban forest is best understood when viewing cities from the air. The density of the urban forest varies with patterns of land use in urban areas. Rowntree (1984) suggests that three factors determine overall urban forest sturcture : urban morphology, natural factors, and management. Urban forest management is the establishment and care of this resource. The USDA Forest Service (1990) defines the management of the urban forest as the planning for and management of a community's forest resources to enhance the quality of life. Urban forests are usually managed at the ecosystem level, with the typical management unit defined as a community consisting of similar vegetation on a relatively uniform site. Classification of forest vegetation has been based solely on dominant trees, as in silvicultural systems for the major forest type of the urban area. Little use has been made of indicator plants or plant associations. In recent years, however there have been considerable advances in forest vegetation classification and in the inference of management implications from such ecological association. That these associations are mappable adds to their usefulness in forestry. Vegetation mapping is sometimes used to protect forestland, as well as rare and endangered species and ecosystem. A detailed vegetation mapping provides the information for a tool and methods available to look at, study and map the forest resources in cities (Kuchler, 1967; Hampe, 1982; Toyohara, 1984). In general classification system, both understory and overstory vegetation are considered, as compared with the Finnish system that relies strictly on understory plants or those of the United States, which use only trees. The fundamental ecological unit in the classification scheme is the forest community, which is a collective term for those physical environments capable of supporting a particular dominant plant association. Vegetation units are useful in predicting forest site characteristics. Vegetation units can also aid in determining which species to plant or favor on a particular site, and in predicting the rate of development of new forest cover following logging. Vegetation units are founded upon the fact that plant communities are meaningful integrators of interacting environmental factors (soils, landform, and climates). These units are interpreted in terms of predicting succession trends, potentials for vegetative productivity, and management opportunities and limitations. Therefore, to document and understand vegetation units of urban forest are very important.

The area of the urban forest in Korea is relatively small compared with that of mountain forest. Management experience and research information that can be applied to management of urban forests is limited (Lee, 1995; Cho, 1997; Cho and Cho, 1998; Cho et al., 1999). There are few reports classifying and mapping of forest vegetation in Korea, with special reference to the ecological management of urban forests. In particular, there are not much works on the detailed vegetation mapping in the view of vegetation ecology. The main purposes of this research are to classify and map in detail the forest vegetation units of Mt. Mudeung as to be a standard model site for ecological conservation and management of urban forest in Kwanju area.

STUDY AREA AND METHODS

Mt. Mudeung is located in the suburban of Kwangju, southwestern Korea between latitudes 35°

06′ 21″ to 35° 10′ 16″ N and longitudes 126° 59′ 49″ to 127° 01′ 34″ E. The highest elevation is 1,186.8m above sea level. Geologically, it mainly consists of andesite and the Mesozoic formations are scattered locally. Climatically, it is warm-temperate in lowlands and cool-temperate in areas at higher elevation, with an average annual temperature of 12.8℃. Average annual rainfall is 1,356.9 millimeters and is higher than 1,274mm the average of the country (KMA, 1998). The land use types of the study area were mountains 75%, rocks 10.5% and others 19%.

The natural forest vegetation of the study area includes the deciduous broad-leaved forest and the intermediate conifer forest formations. Ranges of the vertical distribution of these forest formations are known as follows : the first is developed at higher elevations than about 400m and the second at lower elevations than 400m. In the present time, however, the greater part of these climax forest formations have mostly been destroyed and replaced by secondary forests, artificial forest vegetation and others.

Pinus densiflora, Quercus serrata, Q. mongolica, Q. acutissima, Lindera erythrocarpa and *Q. variabilis* usually dominates natural forest vegetation and *Chamaecyparis obtusa, Cryptomeria japonica* in artificial forest vegetation. Most of the understory vegetation was ericaceous plants such as *Rhododendron* spp., initial species in succession stage, in which evergreen plants sparsely appears.

In the present study, phytosociological treatment was made from April 1997 to July 1998 by the method of ZM School. Two hundred forty-six records, whose plot size was usually about 10 × 10 m, were obtained for this study, and records previously reported were additionally used. The topography of the study area and sampled plots are shown in Fig. 1. The taxonomic nomenclature of species followed Lee (1985). Classification of vegetation units was accomplished by the floristic-structural releves, which were established using the floristic-physiognomic approach introduced by Braun-Blanquet (Braun-Blanquet 1964; Muller-Dombois & Ellenberg 1974). A detailed vegetation map at a scale of 1 : 5,000 was made by field survey. It was made based on the identification of the plant communities at the intervals of 25m in the field.

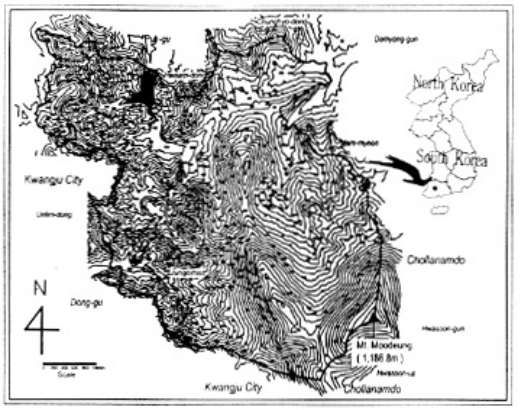

Fig. 1. Map showing the study area. Black marks indicate the sampled plots.

RESULTS AND DISCUSSION

1. Classification of vegetation units

The vegetation units of the forests studied in the study area can be divided into twenty-one communities with correspond to the association or rare and imperiled community, and they are further subdivided into ten groups which correspond to the subassociation, and nine subgroups which correspond to the variants (Table 1). A description of the vegetation units and their subordinate units is made as follows.

1) Natural vegetation units : twelve communities, ten groups and nine subgroups

These forests ranges from the xerophytic Pinus densiflora-dominated vegetation at the drier low elevations to the mesophytic *Quercus serrata-Lindera erythrocarpa*-dominated vegetation at the moister and *Q. mongolica*-dominated vegetation at the moderate moister high elevations.

Pinus densiflora community is developed on the lower land (< 400m elevation) with thin soil some-

Table 1. A Table of Management units for the forest vegetation in Mt. Moodeung, Kwangju City(based on floristic composition)

Natural forest vegetation

I. *Pinus densiflora* community
- I-A. *Spodiopogon sibiricus - Vaccinium oldhami* group
  - I-A-1. *Quercus mongolica* subgroup
  - I-A-2. *Cymbidium goeringii* subgroup
- I-B. *Sasa borealis - Sorbus alnifolia* group
  - I-B-1. *Callicarpa japonica - Cornus controversa* subgroup
  - I-B-2. *Carex okamotoi - Sapium japonicum* subgroup

II. *Quercus mongolica* community
- II-A. *Rhododendron schlippenbachii - Magnolia sieboldii* group
- II-B. *Disporium smilacinum - Smilax nipponica* group

III. *Q. serrata - Lindera erythrocarpa* community
- III-A. *Sasa borealis - Acer pseudo-sieboldianum* group
  - III-A-1. *Rhododendron mucronulatum* subgroup
  - III-A-2. *Cornus kousa - Meliosma myriantha* subgroup
  - III-A-3. *Hydrangea serata* for. *Acuminata - Actinidia rufa* subgroup
- III-B. *Miscanthus oligostachyus* var. *longiberbis - Zanthoxylum schinifolium* group

IV. *Q. acutissima* community
- IV-A. *Phryma leptostachya* var. *asiatica - Rhus succedanea* group
  - IV-A-1. *Linope platyphylla - Robinia pseudo- acacis* subgroup
  - IV-A-2. *Athyrium yokoscense* subgroup
- IV-B. *Sasa borealis - Sorbus alnifolia* group

V. *Q. dentata* community

VI. *Q. variabilis* community
- VI-A. *Trachelospermum asiaticum* var. *intermedium* group
- VI-B. *Stewartia koreana - Acer pseudo-sieboldianum* group

VII. *Fraxinus rhynchophylla* community

VIII. *Zelkova serrata - Celtis choseniana* community

IX. *Q. aliena* community

X. *Carpinus tschonoskii* community

XI. *Salix koreensis* community

XII. *Celtis choseniana* community

Artificial forest vegetation

XIII. *Robinia pseudo-acacia* forest

XIV. *Chamaecyparis obtusa* forest

XV. *Cryptomeria japonica* forest

XVI. *Castanea crenata* forest

XVII. *Alnus firma* forest

XVIII. *Populus tomentigiandulosa* forest

XIX. *Pinus rigida* forest

XX. *Pseudosasa japonica* forest

XXI. *Acer saccharinum* forest

Vegetation units	I				II	III						IV				V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	Frequency
	A		B		A	B	A			B		A		B			A	B															
Management no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Character & differential species group																																
1 *Pinus densiflora*	V35	V35	V35	V35		II+1	V1	I+1	III		III+	III+1	II	11	IV1	IV+2			I1							IV1	21		II12			53.9
Disporum smilacinum	III1	III+3	IV+3	III+1	I+	V+1		II+1	II+1			II+1	III		II	IIIr2		II+	I+							III+2	2+		II12			33.2
Lespedeza maximowiczii var. *tomentella*	III+3	II+1	I+	IV+	I+	III+2		I+		2+2	III12	III+2	I+	11	II+1	II+1			I+		I +					II+1	2+	2+	III2			30.7
Pyrola japonica	II+	II+	II+	II+	I+			I+				III+				IIr										II+			I+			14.1
2 *Spodiopogon sibiricus*	IVr2	IV1	I+	I+		II+			21		III+	IV+2	I1	12	II+1	II+			I+1		I +					II+1	2+1	2+	III+1			34.0
Lindera glauca	IIr1	IV1	I+	II+		I1	I+	I+1	I+		IV+	III+2	V+1	1+	IV+1	IVr1	1+	I+	III+							IIk1	2+		II+			32.8
Corylus heterophylla var. *thunbergii*	II+	IV+1			I+			I+		2+	II1	III+1	IV+1		IV+1	II+1			III+				2+			III+1		2+	II+1			27.0
Albizzia julibrissin	II+1	III+1	I1			I1	I1	I1			II1	III+1		11	III+1			V1	III+1		II +1			21		III+	2+	2+	I+			26.6
Pteridium aquilinum var. *latiusculum*	IVr+	IVr1		III+				I+		2+		III+1	I+		I+	I+			II+2		III+2					IIr+			IIr+			25.7
Artemisia keiskeana	IVr+	IVr2		IIr+					I+		IIIr+	II+	II+1	1+												II+			II+			23.2
Juniperus rigida	VI2	II+1		II+			I1				II+	I+	I+													I+	2+		I+			17.8
Vaccinium oldhami	III+2	II+1	I1		I1	II+1					V+				I2	I2										II+1	22		I1			15.4
3 *Cymbidium goeringii*	II+	III+	I+	I+								III+							I+				21						III+	21		11.6
4 *Sorbus alnifolia*		II+	III+2	III+	I+	II+1	III+1	III+1	II+2	21		II+1	IV+1		I+	I+	1+	III+1	I+							III+	21		I+			25.3
Acer pseudo-sieboldianum		I+	IV+2	II+1	V+2	I2	IV+1	IV2	II+1			II	I+			IV+2	12	I2														21.2
5 *Sapium japonicum*			III+1			I+	II+1	IV+1	I+						I+	II+	11	I1	I2										I+			10.4
Carex okamotoi			III+3	I+				I+								II1		I1											I+			4.6
6 *Quercus mongolica*	III+1		I1	I+	V24	V24			II+1	I2		IV+1		I1																		16.6
symplocos chinensis var. *pilosa*	II+1	II+	III+2	III+	IV+1	III+1	III+2	III+2	III+2		II1	I+2		1+		II+										II+	2+		II+2			26.6
Ariseema amurense var. *serratum*			I+		V+	III+		II+	IVr1								1+	III+														12.9
Corylus sieboldiana		I+	I+	II+	IVr1	II+	II+1	I+1	III+2				I1			II+		I+														12.4
7 *Acer mono*			I+		IIr1	I+	II+1	IIr1	IIIr2									I1														9.1
Rhododendron schlippenbachii				I1	III+4	I1	I+1								I2	I1																5.6
Magnolia sieboldii					III+1	I+	I+	I+	I+																							3.7
Syringa reticulata var. *mandshurica*					IIIr+			I+	2+																							2.9
8 *Aster scaber*	II+	II+	I+	II+	III+			I+	I+			III+		1+	III+	I+													I+			19.1
Athyrium niponicum	II+		I+		IV+3																		2r									6.2
Smilax nipponica			I+		III+1			I+																								3.3
Trigonotis nakaii				I1	III+1			I+																								2.5
Artemisia stolonifera				I+	III+							I+																				2.1
Isodon excisus				I+	III+							I+																				2.1
Carex spp.					II23																				3+							1.2
9 *Quercus serrata*	IVr2	V+2	V+2	V+2			V14	V14	IVr2	212	III1	III+2	II+		II+1	IV+2		II+1	III+2	11						IV+1	2+1	21	IV+1			61.8
Lindera erythrocarpa	IIr1	IIIr2	IVr1	IV+	IV+1	III+1	III+2	V+2	V+4	213		IIIr1	IIr1		I+	V+1		IV12	III+2			1+		2+	3r+	II			II+1			46.1
10 *Viburnum erosum*	IV+2	IV+2	IV+2	III+1			III+	II+1	II+1		III+	III+1	IV+1		II+1	IV1		III+1	I+							IV+1			II+1			39.4
Ligustrum obtusifolium	I+	III+1	III+1	I+	I+	I+	III+	II+	V+1		V+2	IV+1	III+		I+	I+		V+1	III+1		I +		2+	3+	IV+			II+1			37.3
Sasa borealis		I3	III+3	V35	IV15	III+4	V15	V25	III+4		I2	IV15			III4	IV15		IV15	III+4	13				3+	II+2			I1			35.7
Viburnum dilatatum		III+1	IV+1	III+	I+		III+	I+	III+1			III+1			II+	I+		III+1	III+1		I +				III+1			II+			29.0
Staphylea bumalda		I+	I+		I+	I+	II+	II+	III+1		II2	I2			I+			+III+1	III+1						I1							13.7
11 *Rhododendron mucronulatum*	IVr3	I+3	II+1	III+2	I1		III12	I1				I1			I2	II12				11						III+1		21	I2			24.9
Fraxinus sieboldiana	II+1	I+	II+1	IV+1	III+1	III+	III+1	I+				I+	I1		I1	II+1			I+							I+	2+		I+			18.3
12 *Ilex macropoda*	I+	I1	I+2	III1	I+			II+2				I+				II+1			I1								2+					8.7
Cornus kousa			I2		III+1			III+1	I+								1+									I+						6.6
Meliosma myriantha			II+1	I+			I1	II+2					I+					I1														5.4
13 *Hydrangea serata* for. *acuminata*					II+	II+		I+	III+2			I1					1+	I+	I+													7.5
Actinidia rufa					I+	I1		I+	III+2									I1				11					2+					5.8
Pseudostellaria heterophylla					IIr1			I+	III+2				I+					II+	I+													6.6
Polygonatum humile			Ir+		Ir+				II+																				I+			4.6
Deutzia glabrata			I+		I+	I+		I+	II1																							3.7
Cephalotaxus koreana			I+			I+		I+	II+1										I+													3.3
14 *Zanthoxylum schinifolium*	II+1	III+1	I+	II+		I+			I+	2+1	III+	IVr+	I+	1+	II+	II+		I+	I+							III+	2+		II+1			26.8
Rubus corchorifolius	II+1	I+1	I+							2+	III+	II+1				I+									3+	II+	21		I+			11.8
Cocculus trilobus	Ir+	I+	I+	I+						2+	IIIr	II+1	I+						I+										Ir+			10.8
Hemerocallis fulva		I+								2+					II+											IIr+			IIr+			9.1
Sanguisorba officinalis		I+		I+		I+				2+		III+							I+		I +		4+			II+			I+			8.7
Miscanthus oligostachyus var. *longiberbis*		I+				III2		I1		22									I+		I +		4+			I1			I1			8.3
Rubus crataegifolius	I+		I1			II1				2+		I+	I+						I+		I +	I+	41						I1			8.3
Arundinella hirta	I+									22				11																		2.5
15 *Quercus acutissima*	II+2	IIr1	I1	II1				I1	I2		V25	V25	V35		IV12	II1		III1	II+1		I +	I1			3+	IV12		21	I1			32.4
16 *Carex humilis*	II+	IIr1	II+	I+	II13	I1		I+	III+1		IVr+	IIr1	I+		II+			I+								IIr+	2+		I1			19.1
Rhus succedanea	III+2	II+1	II+1								IV+1	III+1	I+		I+	IV+1		I1								II+1	2+		I1			18.7
Phryma leptostachya var. *asiatica*		Ir+									V+	II+												2r	3r	IIr						7.1
17 *Carex siderosticta*	Ir1	II+1	IIr1	I+		I+	I+	I+	II+1		III+		I+			I+										I+			I+			12.4
Paederia scandens		I+	II+	I+					IIr+		IVr+		I+					I+							3+							8.7
Linope platyphylla			I+			I+					Vr3							II+1	I+							I+							7.5
Lespedeza bicolor	II+							I1		21	IV+								I+							I2			I+			5.8
Artemisia princeps* var. *orientalis											IIr		I+						I1		I 1					IIr						3.7
Diospyros kaki	i12										III3																					1.7
18 *Athyrium yokoscense*		I1	II+1		II12	I1	I1		II+4	2+		II+2							I+						3+				II2			10.4
19 *Quercus dentata*	I+	I+		I+			I+	I+	I+1			II+1	I1	13	II+														I1			7.5
20 *Quercus variabilis*	III+2	II+2	I1	III+1				II+3			II1	I1			V23	V34			I1						3+	I1			I1			22.8
Platycarya strobilacea		II+1	II+1	III+1		I1		II+1	I+		II+1				III+2	II+1		I1	II1	1+									I+			17.4
Linnaea borealis		II+	I+	I+							II+	II+			III+	I+			II+						3r	IIIr+			II+			17.0
21 *Trachelospermum asiaticum* var. *intermedium*	I+3	II12										II+3	II+1		IV+2			III+3	I1	11				23	34		2+		I+1			12.0
22 *Stewartia koreana*			I+	III+1	I+		III+1	III+1	I+							II12																8.7
23 *Fraxinus rhynchophylla*		IIr1	I+	II+	V+2	I1			II+1	III+1	21		I1	II1	11		I+	14			II+1					II+1							20.3
Dryopteris crassirhizoma					I+	I1												11															1.2
24 *Cornus controversa*		II+1	III+2	II+				II+1	II+1			I+	I+						III2						3+	II+1	2+		I+			15.8
Zelkova serrata			I+					I+1	II12				I1		I1				V23		I1			2+	3r+	I+						9.1
Celtis choseniana		I+	I1	I+			I1	I1	III+2			I+				I+			V13			13										9.5
Rhamnus davurica			I+			I+		II+				II+			I+	I+			III+1	I+						I+			I+			8.3
Orixa japonica			I+				I+	I1				I+	I+						III+2	III+2	I +				3+	I+						7.5
Philadelphus schrenckii				I+			I+	I+	II+1			I+							III+														5.4
Cudrania tricuspisata								I1				I+1	I+						III+1	I+1		1+				I+							5.0
25 *Callicarpa japonica*	I+	III+1	III+1	I+			II+	II+	IV+2	2+		III+	II+		III+1	II+			III+1	III+2					3+	II+	2+		I+			29.9
Quercus aliena	I+1	III+1	I+	I+			I1		I13	2+	IV+2	IV+2	I+		III1	II+1		I1	IV14	12	I +				3+1	IV+1			I+1			28.2
Parthenocissus tricuspidata	Ir+	II+1	I1			I+		I+	II+2	21	II+	II+1	I+		I+	I+			III+2					2r		III+2			I+2			18.7
Akebia quinata		Ir+				I+	I1	I+	III+2		II+	II+	III+r		II+1			IVr1	III+2		I 1				3+	III+1			I+			16.2
26 *Carpinus tschonoskii*	I1	II+3	I1				I1								II+	I1		I1	I1	14					31	III+1			II+3			11.6
27 *Rosa multiflora*		I+			I+	I1	I+	I1				I+	I+		II+1			III	II+2		III2	11			3+	III+1	21	21	I+			14.1
Pueraria thunbergiana	Ir+	I+									II1	I+	I+					I+	III+3		II3				3+	II+			II+1			8.7
Clematis apiifolia		I+						I+			II+	I+	I+		I+				II+2		III2		41			IIr			IIr+			8.3
Salix koreensis						I+	I+												III14		V14	12	41										4.1

<Table 1. Continued>

Management no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
28 *Robinia pseudo-acacia*	I+										IIII2	I+1							I+		I +	11	43			II1	212		I+1			6.6
Boehmeria spicata		I+						I+	I+									I+	II+1		II 1		41		3r	II+						5.4
Galium spurium			I+			I+		I+1										II					41									2.5
Spiraea prunifolia var. simplicoflora												I+							I+		I +		4+			I+			I+			2.1
Farsicaria thunbergii																			II2		II12		43									1.2
29 *Chamaecyparis obtusa*			I+	I+																				25	31							2.5
30 *Cryptomeria japonica*			I1						I1																335							2.1
Asperula maximowiczii				I+		I+																			33							1.2
31 *Castanea crenata*	II+1	II+1	I1	II+							II1	I+2	I+		I2	II+1		I1									V34	21	21	I12			19.1
32 *Alnus hirma*					I2														I1								223						1.7
Alnus hirsuta							I1	I2																			21						1.7
33 *Populus tomentiglandulosa*																										I1		234					1.2
34 *Pinus rigida*	I1	I12	I2									I1													31				V35			9.1
35 *Pseudosasa japonica*												I2			I5			I5							31			23		25		3.3
36 *Acer saccharinum*																						11									15		0.4
Companions																																
Styrax japonica	IV+3	V+3	V+2	V+2	II12	IV+2	V+2	V+3	V13	21		IV12	V14		III+1	V+2		IV12	III+2		I 1	12		2+	3+	V+3	212	21	II13			68.9
Prunus sargentii	IV+1	V+1	III+1	III+1	II+1	I2	V+2	IV+2	IV+2	22	V+2	IV+2	IV+1		V+1	V+1	1+	III1	III+1	11		11			31	IV+1	2+	21	III+			61.8
Smilax china	V+	VI1	IV1	IV+1	I+	I+	V+	II+	IV+		V+	IV+1	IV+		III+1	V+1		I+	II+					2+	3+	IV+1	2+		III+1			56.4
Stephanandra incisa	I+3	III+1	IV+1	III+1	III+	II+1	III+	III+	IV+1	21	IV+2	IV+2	V+1			III+			III+2		II 12	11				IV+2	21	22	I+			44.0
Lindera obtusiloba	I1	II+1	II+	III+1	VI2	II+	II+	III+1	III+2	21	IV+1	III+	IV+1		II+1	III+		I+	II+1	11					3r	III+						36.5
Oplismenus undulatifolius	IIII1	IIII2	II+2	I+			I1	I+			VI2	IV1	II+1		IV1	II12		III+1	II+2		I 2				3r+	III+3	212	22	II+			33.2
Melica onoei	II+	IV+1	II+	I+	I+			I+	I+		III	III+1			IV+1	I+		II+	II+					2+		II+			III+			26.1
Weigela subsessilis		I+	II+1	I+	III+	III+2	II+2	III+1	III+2	2+1		I+1	I+			II+		I+	II+							II+			I2			20.3
Euonymus alatus for. *Ciliato-dentatus*		I+	II+		II+		I1	I+	IIII1		V+	II+1	II+		II+1			III+	I+							III+1						17.8
Rhus trichocarpa	I+1	III+1	I1	II+								II+1			I+	I+			I+	11				2+		III+2		21	II+1			17.0
Carex lanceolata	II+	I+	I+	II+		III+4		I+			VI3	II+1	III+	11	II+	II+		I1								I+	21					16.2
Carex ciliato-marginata	I1	II+2	IIII1				III+					II+1	II+		I1	I1		I1						2+	3r	III+2			I1			14.9
Viola rossii	I+	I+	II+	I+	I+	III+1	IIII+		II+	2+		I+			I+				I+						3+	III+						14.9
Smilax riparia var. ussuriensis		II+	II+	I+		I+		I+	I+			II+	IIII			I+		II+											II+	1+		14.1
Indigofera kirilowii	II+1	II+1										I+	II+1		II+				I+							III2	2+	2+	I+			14.1
Metaplexis japonica	I+	II+1							I+			II+1			II+	I+			I+						2r	II+	2+1		I+			12.4
Rhododendron yedoense var. poukhanense		I+2	I+	I+	I+	III13	III		I+			I+	I+	13												III+2						11.6
Isodon inflexus		I+	I+			I+						II+	I+		II+	II+			I+							II+		2+	II+			11.6
Amoeblosis bravoeduncutata var. heteropi	II+	I+	I+					I+	II1		II	I+	I+			II+			I+							II+	2+					11.2
Morus bombycis			II+1		IIII1	II+1		II+	II+	21		I+						I+								I+						10.4
Veratrum maackii var. japonicum		II+	II+			IV+1			II+	2+									I+							II+		2+	I+			10.0
Atractylodes japonica	I+	II+										I+														III+			I+			10.0

note : 243 species omitted.

what dry conditions. This established on the outcrop of the ridge part is recognized as an edaphic climax (Lee 1995a, b), but this would be succeeded by *Q. serrata* rather than be maintained as edaphic climax considering the characteristics of habitat with comparatively deep soil and the species composition. This is further subdivided into two groups and four subgroups by a combination of the species groups 2~5 and *Trachelospermum asiaticum* var. *interme - dium, Stewaritia koreana, Cornus controversa* and *Callicarpa japonica* of the species groups 21, 22, 24, 25.

Quercus mongolica community is widely dis - tributed throughout the study area, and developed on the moderate dry to xeric sites, ranging vertically from 700m to top. This has a wide range of ther - mal distribution, WI 18-11 (Yim and Kira, 1975), and is the character species of the cool-temperate deciduous broad-leaved forest zone in Korea, which includes almost all areas of the mountain. This was originally described *Rhododendron sclippenbachii - Q. mongolica* community (Kim and Yim, 1988), although it differs from the subordinate. The current composition of tree species corresponds to the natural spectrum as regards the dominant distribution among the species. This means that the stand composition correspond to the natural development steps that take place in a natural forest. This is further subdivided into two groups by occurrence of the species groups 7, 8, and 23. This is assumed to be the potentially natural forest vegetation.

Quercus serrata - Lindera erythrocarpa mixed community is characteristically developed on the moderate to mesic stony sites, ranging vertically from 350 to 650m, but can be ascend to higher elevations along valley sites. This is assumed topoedaphic climax. This community is made up of the potentially natural forest association, yet some economically vital tree species are promoted. This is further subdivided into two groups and three subgroups by occurrence of the species groups 11, 12, and 13 and its combination.

Quercus acutissima community is mostly devel - oped on the foot to the middle slopes of the mountain, ranging vertically from 200 to 400m. Soil moisture ranges from moderate fresh to moderate dry. Miyawaki et al. (1978) identified Quercetum acutisimo - serrate association in Japan. This seems to be changed into *Q. serrata* forest due to the distribution and development stages of the young trees. This is further subdivided into two groups and two subgroups by occurrence of the species groups 17, 18, and *Callicarpa japonica* of the species group 25, Sorbus alnifolia of the species

group 4 and Sasa borealis of the species group 10.

Quercus dentata community is locally developed on the steep slope-land or burned area of the southern aspect. This is a pioneer community, which generally introduced after *Pinus densiflora* forest lost by fire. In the shrub layer, *Rhododendron yedoense* var. *poukhanense* characteristically appears and plant species of Pine forests or burned areas are frequently found. This seems to be changed into *Q. serrata* forest due to the distribution and development stages of the young trees. This is further subdivided into two groups and two subgroups by occurrence of the species groups 17, 18, and *Callicarpa japonica* of the species group 25, *Sorbus alnifolia* of the species group 4 and Sasa borealis of the species group 10.

Quercus variabilis community is mostly developed on the sunny mountainside and xeric sites at lower elevation, ranging vertically from 200 to 400m. In the shrub layer, *Sasa borealis* characteristically appears. Due to dominance of *Sasa borealis* in the shrub layer, potentially natural tree species is not developed in the ground layer. This is further subdivided into two groups by occurrence of *Acer pseudosiboldianum* of the species group 4, *Trachelospermum asiaticum* var. *intermedium* of the species group 21 and *Stewaritia koreana* of the species groups.

Fraxinus rhynchophylla community is mostly developed on the site conditions similar to *Q. serrata* and *L. erythrocarpa* at higher elevation 800m. In the floor layer, ferns like *Pyrrosia linearifolia, Lepisorus thunbergianus, Polystichum tripteron,* and *Polystichum braunii* characteristically appears. The current combination of species fully coincides with the potentially natural combination. No exploitation was determined on this community and therefore no anthropogenic disturbance appears in the forest structure either. This, however, does not exclude much earlier exploitation interventions, which at present can only be subject to speculation.

Zelkova serrata - Celtis choseniana community is mostly developed on the depression of the lower parts of the slope and mesic stony sites, ravines, ranging vertically from 300 to 400m. This is a relict community showing the species compositions similar to *C. sinensis - Z.* serrata community (Choi and Park, 1985) and Acero - Zelkovetum serrate assoc. nov. (Kim and Yim, 1988).

Quercus aliena community is mostly developed on the depression sites or around the valley, ranging vertically from 200 to 250m, which showed the site conditions similar to *Quercus serrata - Lindera erythrocarpa* community. This seems to be continued for long due to site conditions, but eventually changed into *Q. serrata* forest, the potentially natural tree species in this area.

Carpinus tschonoskii community is locally developed on the site conditions similar to *Quercus serrata - Lindera erythrocarpa* community and Q. aliena community.

Salix koraiensis community is mostly developed on the mesic sites like reservoir or the lower parts of the valley. In the floor layer, mesic plants characteristically appear. This seems to be continued for long due to unique site conditions.

Celtis choseniana community is mostly developed on the most steep of the lower part of the slope near the valley at lower elevation. This seems to be continued for long due to unique site conditions.

2) Artificial vegetation units : nine communities, no subordinate units

These forests are mostly planted on the lower parts of the slope, roadside, residential area and the burned area.

Robinia pseudo-acacia community is mostly planted on the lower parts of the slope, roadside and inhabitant area for erosion control, ranging vertically from 200 to 400m. Plants occurring to the disturbed area like *Miscanthus oligostachyus* var. *longiberbis, Rubus crataegifolius, Clematis apiifolia, Lonicera japonica,* and *Achyranthes japonica* are often found. This seems to be changed into *Q. serrata* forest.

Chamaecyparis obtusa community show a

maximum deviation from potentially natural state. Species composition of the subtree and shrub layer is very poor due to high degree of closure. The tree cover is constituted by non-local or exotic species. The ground vegetation is constituted by a high percentage of alien introduced species or is entirely non-existent due to the absence of light.

Cryptomeria japonica community are identical with *Chamaecyparis obtusa* community in vegetation composition and utilization. In the floor layer, *Trachelospermum asiaticum* var. *intermedium* characteristically dominates and the seedling and saplings of *Zelkova serrata, Cornus controversa* and *Q. aliena* introduced in naturally.

Castanea crenata community is collectively planted around human habitation and temple. In the present time, this seems shortly to be declined due to its ecological age in the sites and interspecific competition with native species such as *Q. acutissima, Q. aliena* and *Q. serrata*. This seems to be changed into *Q. serrata* forest.

Alnus firma community is mostly planted on the south facing area. A. firma was inclined to fall down of itself due to its ecological age. This seems shortly to be declined due to its ecological age in the sites and interspecific competition with native species such as *Q. serrata, Q. mongolica, Sorbus alnifolia* and *Styrax japonica*. This seems to be changed into *Q. serrata* forest.

Populus tomentiglandulosa community is in the excessive interspecific competition with *Q. serrata* and *Q. acutissima*. In the subtree and shrub layer, *Styrax japonica, Rhus trichocarpa, Rhododendron mucronulatum, Stephanandra incisa,* and *Rosa multiflora* usually appears. The floor layer is dominated by *Oplismenus undulatifolius*. This seems to be changed into *Q. serrata* forest.

Pinus rigida community is mostly planted on the burned area that *P. densiflora* forest destroyed by forest fire. In tree layer, *P. densiflora* remnant species is scattered here and there. This seems to be changed into *Q. mongolica* forest or *Q. serrata* forest according to the site conditions.

Bamboo community is mostly planted on residential area for shelterbelt. In the floor layer, species compositions are very poor due to the excessive crown closure. *Cymbidium goeringii* is scattered here and there.

Acer saccharinum community is built-up by a single story and lack natural forest formation phases. In the floor layer, no plants occurred due to human interference excepting *A. saccharinum*. This seems to be continued for long without human interferences. The composition of tree species is formed by non-local tree species.

2. Vegetation units and site conditions

Fig. 2 shows the major site conditions such as the slope aspect, the slope degree and the ratio of exposed rocks to higher vegetation units (based on community level) respectively. In the aspects of the slope, *P. densiflora* community and *Q. acutissima* community showed the omnidirectional distribution, *Q. mongolica* community all directions excepting the south direction, *Q. serrata - Lindera erythrocarpa* community, *Fraxinus rhynchophylla* community, *Salix koraiensis* community in the northern directions, *Q. dentata* community in the southwestern direction, *Carpinus tschonoskii* community in the northeastern directions, and *Celtis choseniana* community in the *Carpinus tschonoskii* community and *Celtis choseniana* community is distributed from 30% to 40%, *Pinus densiflora* community is distributed above 30%, *Quercus serrata - Lindera erythrocarpa* community below 30%, *Q. dentata* community, *Q. variabilis* community and *Fraxinus rhynchophylla* community from 20% to 30%. In the ratio of exposed rocks, *F. rhynchophylla* community shows the highest value, 80%, *Q. serrata* community, *Q. mongolica* community and *Zelkova serrata* community 20 to 50%, *P. densiflora* community, *Q. acutissima* community, *Q. dentata* community and others below 10%.

3. Stratification and DBH by vegetationunits

Fig. 3 shows DBH and stratification by each

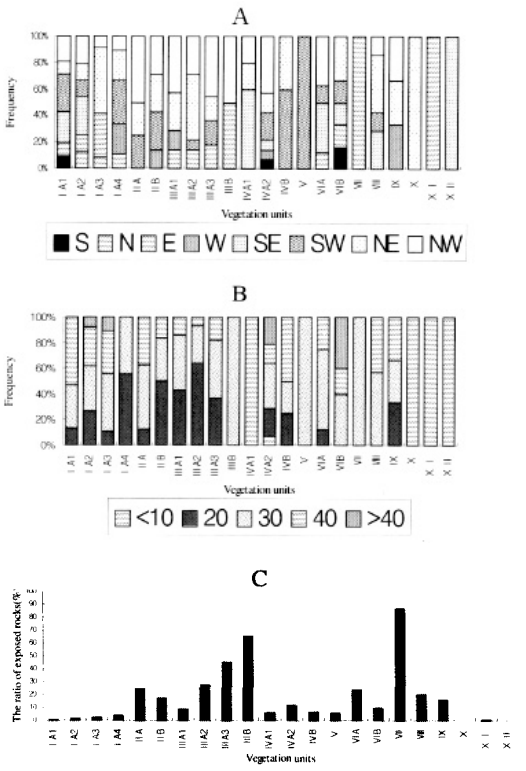

Fig. 2. Frequency distribution of the slope aspects (A) and the slope degree (B), and the ratio of exposed rocks (C) by natural vegetation units (each roman numerals Ⅰ ~ Ⅻ are explained on Table 1).

vegetation units, respectively. In the DBH, the tree layer shows above 15cm, the subtree layer 3 to 6cm and the shrub layer below 2cm. *P. densiflora* community shows greater DBH than others. In the stratification, considering the height of the tree layer as 100, most communities show the subtree layer 40% and the shrub layer 10%.

4. Constant class by vegetation units

According to the constancy diagram of Fig. 4, the lower classes (Ⅰ, Ⅱ) have ninety-eight point two percentages in the forest plants occurring to this area, the mid-classes (Ⅲ) one percentage, and the higher classes (Ⅳ, Ⅴ) only zero point eight percentage. It shows that species of the higher-constancy classes can readily replace one another in different stands of the same communities and dominate broadly. But, plant species, having the lower classes are distributed sparsely in the disturbed sites or the extremely limited sites.

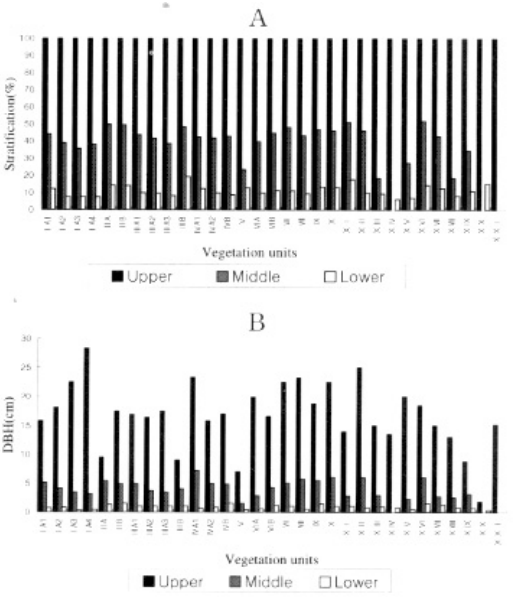

Fig. 3. Stratification (A) and DBH (B) by vegetation units (each roman numerals Ⅰ ~ ⅩⅪ are explained on Table 1).

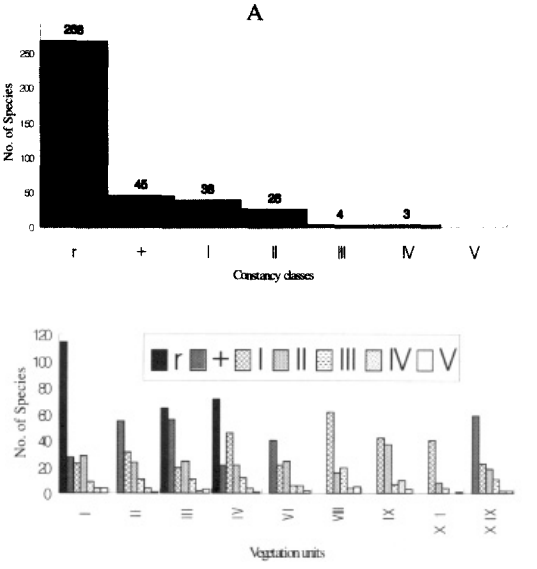

Fig. 4. Constancy classes diagram of component species (A) and no. of species of major communities (B) by constancy classes.

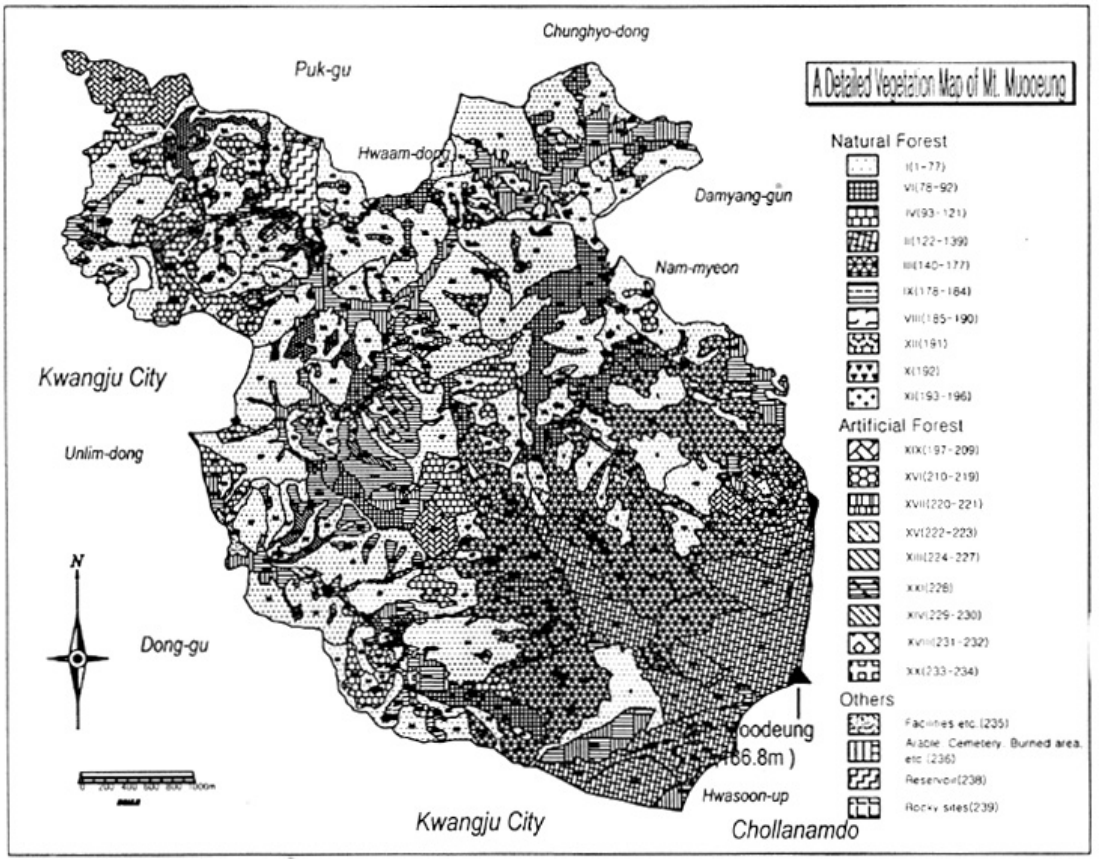

Fig. 5. A detailed vegetation map of Mt. Mudeung in Kwangju city, Korea. (each roman numerals I ~ XXI are explained onTable 1)

5. A detailed vegetation mapping

As a sample of the basic map for the ecological conservation and management of forest vegetation in various urban areas of Kwangju, a detailed vegetation map at a scale of 1 : 5,000 was made in the study area, based on floristic composition and structure of the vegetation units, by the phyto-sociological methods (Fig. 5). In drawing units, vegetation units classified showed by the borderline, color, pattern and serial numbers.

Total area for detailed mapping was 2,779.5ha, of which natural vegetation accounted for 2192.0ha (78.9%), the largest portion, artificial vegetation for 159.1ha (5.7%), and others such as arable land, burned area, and reservoir for 428.4 ha (15.4%). The ratio of natural forest element at 83.6% showed that this area was mainly comprised of natural

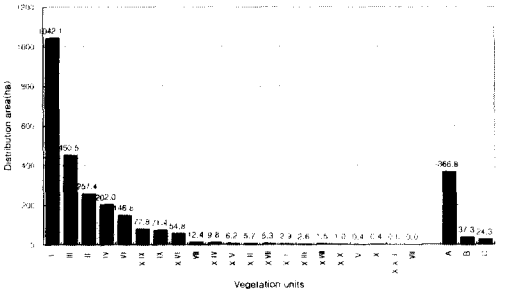

Fig. 6. Distribution area by the higher vegetation units (Roman numerals are explained on Table 1; A, B and C indicates unstocked land(A), facilities (B) and reservoir(C) respectively).

vegetation such as *Pinus densiflora* community, *Quercus* spp. community. This is higher than that of Mt. Apsan 72.6%, Mt. Kwanak 70% and Mt. Inwang 55% (Cho, 1997; Cho and Cho, 1998; Cho et al., 1999). The distribution area by vegetation

units was highest at *P. densiflora* community (1042.1 ha), lowest at *Fraxinus rhynchophylla* community (0.015ha)(Fig. 6).

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