한국환경생태학회지 28(6): 741-750, 2014
Korean J. Environ. Ecol. 28(6): 741-750, October 2014
pISSN 1229-3857 eISSN 2288-131X
http://dx.doi.org/10.13047/KJEE.2014.28.6.741

Phytosociological Community Classification of Mountain Ridge from Guryongryeong to Mt. Yaksu in the Baekdudaegan, Korea[1a]

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백두대간의 구룡령에서 약수산 마루금의 식생구조 특성에 관한 연구[1a]

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ABSTRACT

To investigate the vegetation structure of mountain ridge from Guryongryeong to Mt. Yaksu, 22 plots (100 ㎡) installed with random sampling method were surveyed. Three groups of *Quercus mongolica-Acer pseudosieboldianum* community, *Q. mongolica* community, *Cornus controversa-Q. mongolica* community were classified by cluster analysis. *Q. mongolica* was a major woody plant species in the ridge area from Guryongryeong to Yaksusan and *Carpinus cordata* and *C. controversa* was partly occupied in some area. High positive correlations showed between *Q. mongolica* and *Symplocos chinensis* for. *pilosa*, *Rhododendron schlippenbachii*; *Tilia amurensis* and *Tilia mandshurica*, *Symplocos chinensis* for. *pilosa*; *Tilia mandshurica* and *S. chinensis* for. *pilosa*, *R. schlippenbachii*; *Betula costata* and *Acer mono*; *Symplocos chinensis* for. *pilosa* and *Rhododendron schlippenbachii*, and relatively high negative correlations showed between *A. pseudosieboldianum* and *S. chinensis* for. *pilosa*, *R. schlippenbachii*. Species diversity(H') of investigated groups were ranged 0.8170～1.1446 and it was lower compared to those of the ridge area of the national parks in Baekdudaegan.

KEY WORDS: CLUSTER ANALYSIS, Quercus mongolica, SPECIES DIVERSITY

요 약

백두대간 구룡령-약수산 마루금에 22개의 방형구(100㎡)를 설정하여 식생을 조사하였다. 식생군집을 분석한 결과 신갈나무-까치박달나무-당단풍나무군집, 신갈나무군집, 층층나무-신갈나무군집 등 3개의 군집으로 분류되었다. 백두대간 구룡령-약수산 마루금은 대부분 신갈나무가 우점하고 있었으며, 일부지역에서 까치박달나무와 층층나무 등이 혼효하고 있었다. 수종간의 상관관계에서 신갈나무와 노린재나무, 철쭉; 피나무와 찰피나무, 노린재나무; 찰피나무와 노린재나무, 철쭉; 거제수나무와 고로쇠나무; 노린재나무와 철쭉 등의 수종 간에는 높은 정의 상관이 인정되었다. 당단풍나무와

1 접수 2014년 10월 13일, 수정(1차: 2014년 12월 8일), 게재확정 2014년 12월 9일
Received 13 October 2014; Revised (1st: 8 December 2014); Accepted 9 December 2014
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노린재나무, 철쭉 등의 수종 간에는 높은 부의 상관이 인정되었다. 조사지의 군집별 종다양성 지수는 0.8170~1.1446범위로 백두대간에 위치한 국립공원들의 능선부 식생구조 보다는 약간 낮게 나타났다.

주요어: 식생구조, 신갈나무, 종다양성

INTRODUCTION

Baekdudaegan divides Korea into east and west and it is recognized by many people in Korea as an iconic mountains. This unique topography divides our traditional lifestyles and geographic perspectives. Baekdudaegan starts from Byeongsabong (2,744m) of Mt. Baekdu to Cheonwangbong (1,915m) of Mt. Jiri without crossing any valleys or rivers. Its length is about 1,400km and altitude of this region is about 100 to 2,744m (Cho, 2002).

Korea stretches from south to north, and cold current and warm current flow around Korea. During the winter, the cold-wind blows from northwest and the warm-wind blows from south in the spring. Therefore, it shows different and diverse floras in each regions of Korea. There are various floras such as temperate plants, subtropical plants, and subpolar plants because of the sea on three sides. Some northern plants move to south and some southern plants move to north because of subpolar climate, temperate climate, and warm temperate climate in Korea. Thus, there are many Korea endemic, endangered and rare plants, and animals throughout Mt Baekdu, Mt. Seolak, Mt. Odae, Mt. Taebaek, Mt. Sobaek, Mt. Jiri etc. in Baekdudaegan.

As people recognize the importance of Baekdudaegan, a lot of studies about Baekdudaegan, which includes survey and concept of Baekdudaegan (Korea Forest Service and Korean Geographical Society, 1997), forest status of the Baekdudaegan (Forestry Administration and Green Korea United, 1999), settings of efficient management range of Baekdudaegan (Korea research institute for human settlements, 2000), natural ecosystem conservation and damaged land restore plan of Baekdudaegan (Korea Forest service, 2001), natural ecosystems survey and management plan of Baekdudaegan (Korea Forest service, 2002) etc. have been conducted. Furthermore, many studies on the vegetation characteristics in Baekdudaegan have been carried out. Yun *et al.*(2010) studied about the vegetation distribution and community characteristics on the Sobaeksan National Park. Park *et al.*(2009) reported on the vegetation types and floristic composition of native conifer forest in the ridge of the Baekdudaegan. Lee *et al.*(2014) investigated on the community structure of *Pinus desiflora* and *Quercus mongolica* forest in Jochimryeong to Shinbaeryeong of the Baekdudaega. Despite these much research, study on the vegetation properties from Guryongryeong to Mt. Yaksu, which is adjacent to Guryongryeong ecological tunnel, have not been carried out. Therefore the purpose of this study was to find out the vegetation structure, importance value, DBH distribution, and species diversity of the mountain ridge from Guryongryeong to Mt. Yaksu and to provide a management plan for the future.

MATERIALS AND METHODS

1. Setting of survey area

A preliminary vegetation survey was conducted on June 23 in 2011. Formal surveys were conducted from June 3 to August 5 between Guryongryeong (1,013m) and Mt.

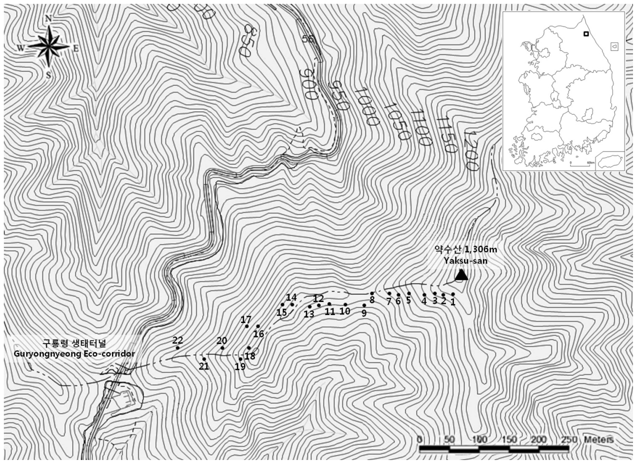

Figure 1. Location of plots surveyed from Guryongryeong to Mt. Yaksu in the Baekdudaegan

Yaksu (1,306m) of Baekdudaegan. A total of 22 plots were surveyed in this area (Figure 1).

2. Investigation of the vegetation and environmental factor

The survey area was from Guryongryeong to Mt. Yaksu. A total of 22 plots (10 × 10m quadrat) were installed with a random sampling method and major environmental factors, soil characteristics, and vegetation for each quadrat were surveyed. Vegetation survey was conducted according to overstory layer, midstory layer, and understory layer divided by position of canopy. In the overstory layer and midstory layer, kinds of tree, population, and diameter at breast height (DBH) were measured. Kinds of tree and cover degree in the understory layer were investigated. To know the relationship between growth rates of tree and environmental factors, altitude, aspect, slope, litter layer (soil depth), and height of overstory layer were examined.

According to the meteorological data of 20 years of Inje weather station, which is adjacent to this research area, the average annual temperature and annual precipitation were 10.1℃ and 1,210.7㎜, respectively. Most of the precipitation was concentrated from Jun to September. Highest average temperature and lowest average temperatures were 16.4℃ and 4.7℃, respectively.

3. Cluster analysis and correlation between species

With population according to species collected from each plots, we tried to classify the survey plots using entire species collected from overstory layer, midstory layer, and understory layer by the method of Ludwig and Reynolds (1988). Percent Dissimilarity (P.D) was applied to calculate the distance among the surveyed plots. To investigate correlations among interspecific or environmental factors collected from 22 plots, SPSS 17.0 program was used.

4. Analysis of forest community

Importance Percentage (I.P.), which was calculated with following equation as (relative density + relative cover degree + relative frequency)/3, was calculated using vegetation data surveyed at mountain ridge of from Guryongryeong to Mt. Yaksu. Mean Importance Percentage (M.I.P.) was calculated with an equation considering the size of the population as (overstory layer I.P. × 3 + midstory layer I.P. × 2 + understory layer I.P.)/6 (Curtis and Mclantosh, 1951). Species diversity, which shows a measure of the diversity of species composition, was comprehensively compared by species diversity (H’), evenness (J’), and dominance (D) calculated by Shannon’s formula (Pielou, 1975).

RESULTS AND DISCUSSION

1. Forest environment and characteristic of Species composition

Table 1 shows the major environmental factors and the numbers of species. The survey plots were installed by considering current vegetation at natural forests from Guryongryeong to Mt. Yaksu, which is a part of Baekdudaegan. There are located between altitudes 1,106 m to 1,275 m. The slop and litter layer were about 15° to 45° and 3 to 5 ㎝, respectively. The height of the tree was between 9 to 15.6 m in the overstory layer, 3.5 to 7.8 m in the midstory layer, and 0.6 to 2.2 m in the understory. Depending on the story, the DBH was between 15.5 to 40 ㎝ in the overstory layer and 4.7 to 12.4 ㎝ in the midstory layer. The average DBH in the overstory layer and midstory layer were 28.1㎝ and 7.5㎝, respectively. Species numbers per each plot (100㎡) of woody plants to be composed of overstory layer, midstory layer, and understory layer were from 5 to 14. This result indicates that there exists a big difference in the numbers of species among the investigated plots. It is likely that the difference results from different seedling occurrence because the surveyed sites are located in mountain ridge and the height of the tree of overstory layer is very high. Current study shows similar results with several previous studies, which were conducted in the same area and showed 2 to 10 species in Mt. Cheongok (Choi, 2002), 4 to 12 species between from Gitdaebong to Mt. Cheongok (Choo *et al.*, 2002), 2 to 12 species between from Mt. Daedeok to Guemdaebong (Kim *et al.*, 2003), 6 to 14 species in subalpine areas of Mt. Deogyu (Kim & Choo, 2004), and 4 to 15 species in Dangol valley of Mt. Taebaek located in Baekdudaegan (Cho *et al.*, 2005). However, it shows slightly low than 11 to 26 species in nature conservation area in Mt. Gyeryong national park, 13 to

Table 1. Description of physical features and vegetation for each plot

Plot number		1	2	3	4	5	6	7	8	9	10	11
Altitude(m)		1,275	1,269	1,257	1,247	1,228	1,206	1,220	1,192	1,191	1,190	1,193
Aspect		S	N	W	W	NE	NE	NW	NE	NE	N	NW
Slope(°)		20	45	30	40	40	25	40	15	15	15	15
Litter depth(cm)		4	3	5	4	5	4	3	5	5	4	3
Number of species		7	7	9	8	8	14	6	7	11	8	9
	Height(m)	11	11	12.5	11.5	14	15	12.5	11	11	11	9
O. L.[1]	Mean DBH(㎝)	21.1	27.3	27.1	25	30.3	25.5	33.2	29.3	20.5	30.2	31.8
	Coverage(%)	45	30	30	15	15	15	10	15	20	20	60
	Height(m)	3.5	6	6.5	8	6	6	6	7.5	6.5	5.7	5.8
M. L.[2]	Mean DBH(cm)	7.7	7.3	6.3	10.6	4.7	5.4	8.5	11.0	12.4	6.7	11.3
	Coverage(%)	10	25	30	15	15	15	40	35	20	20	30
U. L.[3]	Height(m)	1.5	1.6	1.7	1.7	0.6	0.6	2	2.2	1.5	1.3	1.6

Plot number		12	13	14	15	16	17	18	19	20	21	22
Altitude (m)		1,194	1,196	1,201	1,196	1,189	1,181	1,189	1,185	1,166	1,149	1,106
Aspect		N	N	NW	SE	E	S	SW	SE	SW	E	SE
Slope (°)		15	20	40	15	45	25	15	15	15	35	35
Litter depth(cm)		4	3	4	3	3	3	3	3	3	4	4
Number of species		12	8	9	11	9	7	5	6	8	6	6
	Height(m)	10.2	13	10	12	13.4	15	15.6	12.5	10	11	10
O. L.	Mean DBH(㎝)	27.1	15.5	18.5	26.2	35.6	38.1	40	33.3	22.6	32.4	26.7
	Coverage(%)	25	25	45	30	40	35	30	35	25	15	45
	Height(m)	3.6	3.5	7	7	7.8	7.6	6.5	6.8	6.5	7	7
M. L.	Mean DBH(㎝)	6.5	5.6	6.1	7.8	8.6	8.2	5.9	6.1	5.0	5.3	7.3
	Coverage(%)	20	15	35	25	25	20	20	20	30	10	25
U. L.	Height(m)	0.9	1.3	1.5	1.8	2	1.9	1.6	1.8	1.5	1.6	0.7

O. L.1: Overstory layer, M. L.2: Midstory layer, U. L.3 : Understory layer

20 species between from Donghak temple and Nammaetap of Mt. Gyeryong, and 8 to 20 species between Suryeong and Sosagogae located in Baekdudaegan (Choo & Kim, 2004).

2. Structure of forest community

1) Cluster analysis

Figure 2 shows the result of the cluster analysis based on the data of 22 plots collected between Guryongryeong and Mt. Yaksu. The phylogenetic tree did not show much difference among the surveyed plots because the survey areas are relatively narrow and the geographical characteristics did not show much difference. However, they were classified into three groups with dominant species such as *Quercus mongolica* community, mixed forest community of subalpine zone species, and another mixed forest community by the slope and direction of the surveyed areas. *Carpinus cordata*, *Cornus controversa*, *Acer pseudosieboldianum*, and *Tilia amurensis* were relatively major species in this study area. Group I, which includes 13 plots, was *Q. mongolica*-*C. cordata*-*A. pseudosieboldianum*-*T. amurensis* community. Group II, which has big and old tree of *Q. mongolica* including 7 plots, was typical subalpine ridge community. This group contains *Q. mongolica* as a major species and *T. amurensis*, *Rhododendron schlippenbachii* etc. as minor species. Group III, which contains 2 plots, was *C. controversa*-*Q. mongolica* community with *A. pseudosieboldianum*, *Betula costata*, *R. schlippenbachii* etc. as minor species. These results indicate that the vegetation structure of the subalpine zone between Guryongryeong and Mt. Yaksu is *Q. mongolica*-*C. controversa*-*C. cordata* community. Between Guryongryeong and Mt. Yaksu located in Baekdudaegan, the dominant species was *Q. mongolica*. This result was similar with some results such as Dosolbong in Mt. Sobaek (Kim *et al*., 1993), Balbatjae-Birobong in Mt. Sobaek (Park *et al*., 1993), Birobong-Horyeongbong in Mt. Odae (Kim *et al*., 1996a), Daecheongbong-Socheongbong in Mt. Seolak (Kim *et al*., 1997), Daecheongbong-Hangyeryeong (Kim & Baek, 1998a), Pijae-Doraegijae in Mt. Taebaek (Oh & Park, 2002), Gitdaebong-Mt. Cheongok(Choo *et al*., 2002), Nogodan-Goribong (Kim & Choo, 2003). However, unlike previous results, this survey areas showed that *Quercus mongolica* grows as a dominant species with *C. cordata* and *Cornus controversa*..

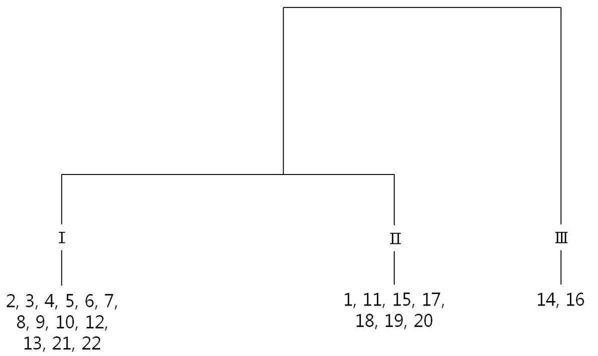

Figure 2. Dendrogram of Twenty two plots Surveyed at Guryongryeong-Mt. Yaksu

2) Analysis of Importance Percentage

Based on the cluster analysis, Importance Percentage (I.P.) and Mean Importance Percentage (M.I.P.) on the major species in three groups were calculated. Table 2 shows I.P. and M.I.P. value calculated based on the size of the tree. The highest M.I.P. in Group I was *Q. mongolica* as 18.79% followed by *C. cordata*, *A. pseudosieboldianum*, and *T. amurensis*. In group II, the highest M.I.P. was *Q. mongolica* as 42.02% followed by *T. amurensis*, and *R. schlippenbachii*, and *Symplocos chinensis* for. *pilosa*were

In the last Group III, unlike two groups, which was dominant by one species, two species as *C. controversa* and *Q. mongolica* were dominant. M.I.P. value of *C. controversa* and *Q. mongolica* was 27.83% and 24.43%, respectively. Minor dominant species in the group III were *A. pseudosieboldianum*, *B. costata*, and *R. schlippenbachii*. *C. controversa* and *Q. mongolica* in the group III might compete until they become dominant species. However, it is likely that *Q. mongolica* might eventually be dominant species in this community.

Depending on the story, the highest I.P. of overstory layer in the Group Ⅰ was *Q. mongolica* as 36.05% followed by *T. amurensis*, *C. cordata*, *B. costata*, and *T. mandshurica*. In the midstory layer in group Ⅰ, I.P. of *A. pseudosieboldianum* is the highest as 31.98% followed by *C. cordata*, *Magnolia sieboldii*, and *T. amurensis*. The highest I.P. of understory layer in group Ⅰ was *R. schlippenbachii* as 40.61% followed by *Sasa borealis*, *Pinus koraiensis*, and *M. sieboldii*. Therefore, in the group I *Q. mongolica* was relatively dominant in overstory layer than those of other species. *A. pseudosieboldianum* and *C. cordata* in the midstory layer might compete until to be the dominant species in the future. In understory, *R. schlippenbachii* might be maintained as a dominant species. Therefore, it seems that it is not easy to expand other species such as *P. koraiensis*, *M. sieboldii, Vaccinium hirtum* var. *koreanum*. etc. in this story.

The highest I.P. in the overstory layer in the group II was *Q. mongolica* (66.85%) followed by *T. amurensis*, *P. koraiensis*, *Tilia manshurica* etc.. The I.P. of *Q. mongolica* was also the highest as 25.81% in the midstory layer in group II followed by *T. amurensis*, *R. schlippenbachii*, *A. pseudosieboldianum*, *S. chinensis* for. *pilosa*. etc.. However, in the understory, the I.P. of *R. schlippenbachii* was the highest as 51.0% followed by *S. chinensis* for., *V. hirtum* var. *koreanum*., *Rhododendron mucronulatum* etc.. Therefore, group II was concluded that *Q. mongolica* is the most dominant species in the overstory layer and midstory layer. However, in the midstory layer, *R. schlippenbachii* might be maintained as a dominant species for long time, if they are not artificial disturbance. In the group III, the I.P. of *Q. mongolica* was the highest as 37.50% in the overstory layer. The next highest I.P in the second group was *C. controversa* followed by *B. costata*, *Acer pictum* subsp. *mono* etc. In the midstory layer of the group III, the I.P. of *C. controversa* was the highest as 37.82% followed by *A. pseudosieboldianum*, *Q. mongolica*, *Ilex macropoda, and R. schlippenbachii* showed the highest I.P. as 61.32% in the understory. The next highest species was *A. pseudosieboldianum* followed by *Sambucus williamsii* var. *coreana*., *R. mucronulatum.*

In summary of the above results, *Q. mongolica* was the most dominant species in the overstory layer of group III. However, in the midstory layer, it seems that both *A. pseudosieboldianum* and *C. controversa* might compete

Table 2. Importance percentage (I.P.) and mean importance percentage (M.I.P.) of major woody plants for each plant community

Scientific name	Group Ⅰ				Group Ⅱ				Group Ⅲ			
	O.*	M.*	U.*	M.I.P.*	O.*	M.*	U.*	M.I.P.*	O.	O.*	M.*	U.*
Quercus mongolica	36.05	2.30		18.79	66.85	25.81		42.02	37.5	17.02		24.43
Carpinus cordata	9.55	23.87		12.73		5.87	2.06	2.3				
Acer pseudosieboldianum	0.90	31.98	1.48	11.35		11.87	2.06	4.3		29.73	12.89	12.06
Tilia amurensis	15.22	8.81		10.55	13.63	23.96		14.8				
Rhododendron schlippenbachii		1.01	40.61	7.10		13.72	51.00	13.07			61.32	10.22
Magnolia sieboldii		14.92	6.88	6.12		1.56		0.52				
Tilia manshurica	7.80	3.05	1.48	5.16	5.11	6.24		4.64				
Pinus koraiensis	4.79	2.02	7.42	4.31	7.68		2.06	4.18				
Betula costata	7.83			3.91					20.82			10.41
Fraxinus rhynchophylla	5.01	1.08		2.87	4.12			2.06				
Acer mono	3.04	1.25	2.97	2.43					11.24			5.62
Abies koreana	1.62	3.66	1.48	2.28			2.06	0.34				
Taxus cuspidata	2.42	1.4		1.67								
Sasa borealis			9.41	1.57								
Acer triflorum	2.25		1.48	1.37								
Cornus controversa	0.90	2.25		1.20	2.61	1.93		1.95	30.44	37.82		27.83
Acer komarovii		1.40	2.97	0.96								
Pyrus pyrifolia	1.77			0.89								
Vaccinium hirtum var. *koreanum*			5.28	0.88			9.82	1.64				
Viburnum wrightii			3.92	0.65			2.06	0.34				
Syringa reticulata var. *mandshurica*		0.99	1.48	0.58								
Philadelphus schrenkii			2.97	0.49								
Symplocos chinensis for. *pilosa*			2.97	0.49		9.04	12.37	5.08				
Spiraea fritschiana			2.97	0.49								
Maackia amurensis	0.86			0.43								
Rhododendron mucronulatum			1.48	0.25			6.19	1.03			12.89	2.15
Weigela subsessilis			1.48	0.25								
Stephanandra incisa			1.26	0.21			4.12	0.69				
Lespedeza maximowiczii							4.12	0.69				
Spiraea blumei							2.06	0.34				
Ilex macropoda										15.42		5.14
Sambucus williamsii var. *coreana*											12.89	2.15

O.*: Overstory layer, M.*: Midstory layer, U.*: Understory layer, M.I.P.*: Mean importance percentage

until they become dominant species. In the understory, *R. schlippenbachii* might be maintained as a dominant species for long time with weak competition along with *A. pseudosieboldianum*, *S. williamsii* var. *coreana*, and *R. mucronulatum.*

3) Interspecific correlation

Table 3 shows the result of interspecific correlation calculated by consideration of the frequency distribution using the data collected from 22 plots. It showed relatively high positive correlations between *Q. mongolica* and *S. chinensis* for. *pilosa R. schlippenbachii*; *T. amurensis* and *T. mandshurica*, *S. chinensis* for. *pilosa*; *T. mandshurica* and *S. chinensis* for. *pilosa*, *R. schlippenbachii*; *B. costata* and *A. pictum* supsp. *mono*; *S. chinensis* for. *pilosa* and *R. schlippenbachii.* Positive correlations were observed between *Q. mongolica* and *T. amurensis*, between *A. pseudosieboldianum* and *C. cordata*, between *T. amurensis* and *R. schlippenbachii*, and between *M. sieboldii* and *Taxus cuspidata* etc. Relatively high negative correlation showed between *A. pseudosieboldianum* and *S. chinensis* for. *pilosa*, *R. schlippenbachii* and so on. Negative correlations

Table 3. Pearson's product-moment correlation between all pair wise combinations of major woody plants

	sp.1	sp.2	sp.3	sp.4	sp.5	sp.6	sp.7	sp.8	sp.9	sp.10	sp.11	sp.12	sp.13	sp.14	sp.15
sp.1		-.230	.393*	-.324	-.325	.002	.075	-.122	.081	-.329	-.327	-.456*	-.222	.645**	.509**
sp.2			-.253	.261	.092	-.200	.143	.481*	-.450*	-.089	-.029	-.139	.059	-.597**	-.497**
sp.3				-.052	-.112	-.273	.122	-.311	.706**	-.327	-.320	-.426*	-.044	.593**	.489*
sp.4					.146	-.082	.148	.011	-.141	-.164	-.172	-.198	.311	-.233	-.223
sp.5						-.110	-.018	-.332	-.172	.258	.285	.289	.443*	-.276	-.345
sp.6							-.161	-.222	-.176	.221	-.140	.258	-.066	-.032	.003
sp.7								.067	-.174	-.213	-.045	-.256	.252	-.192	-.288
sp.8									-.269	-.061	-.124	-.143	-.125	-.325	-.161
sp.9										-.179	-.042	-.215	-.014	.574**	.598**
sp.10											-.049	.916**	.079	-.251	-.240
sp.11												.268	-.131	-.157	-.251
sp.12													.034	-.302	-.289
sp.13														-.178	-.170
sp.14															.868**
sp.15															

*: $p \le 0.05$, **: $p \le 0.01$

sp.1: *Quercus mongolica*, sp.2: *Acer pseudosieboldianum*, sp.3: *Tilia amurensis*, sp.4: *Abies koreana*, sp.5: *Magnolia sieboldii*, sp.6: *Cornus controversa*, sp.7: *Pinus koraiensis*, sp.8: *Carpinus cordata*, sp.9: *Tilia mandshurica*, sp.10: *Betula costata*, sp.11: *Fraxinus rhynchophylla*, sp.12: *Acer pictum* subsp. *mono*, sp.13: *Taxus cuspidata,* sp.14: *Symplocos chinensis* for. *pilosa,* sp.15: *Rhododendron schlippenbachii*

was observed between *Q. mongolica* and *A. pictum* subsp. *mono*; *A. pseudosieboldianum* and *T. mandshurica*; *T. amurensis* and *A. pictum* subsp. *mono* etc..

4) DBH distribution

Table 4 shows the DBH distribution of major woody plants for each plant communities classified by the cluster analysis. The forest succession might be estimated by DBH distribution analysis, which is an indirect expression way such as stand dynamics and age of tree (Harcombe and Mark, 1978).

In Group I, *A. pseudosieboldianum* was much such as seedling or small diameter tree, but *C. cordata* was relatively distributed less. Therefore, the I.P. of *A. pseudosieboldianum* might be increased. Because seedling or small diameter tree of *B. costata*, *T. cuspidata*, and *C. controversa* etc. did not exist, the I.P. of *B. costata*, *T. cuspidata*, and *C. controversa* might be decreased. However the I.P. of *M. sieboldii* might be eventually increased.

In Group II, *Q. mongolica* showed relatively uniform distribution such as seedling, small diameter tree, middle diameter tree, large diameter tree. Therefore, I.P of *Q. mongolica* and *T. amurensis* might be increased for long time, if there are not any artificial disturbance whereas, the I.P. of *C. cordata*, *Fraxinus rhynchophylla*, *P. koraiensis*, *C. controversa* might be decreased for a while without any artificial disturbance.

In GroupIII, *Q. mongolica* appeared a lot such as seedling and small diameter tree whereas, *C. controversa* and *B. costata* was hardly distributed. Therefore the I.P. of *Q. mongolica* in this forest might be continually increased, but the I.P. of *C. controversa* and *B. costata* might be decreased in the future. These results indicate that these survey areas are typical subalpine vegetation of Korea.

5) Species Diversity

Table 5 shows the species diversity indices of three plant communities. A total of 29 species, which are the highest numbers of species among three communities, were found in the group I. Group II and group III were 18 and 11 species, respectively.

Gene diversity (H') in group I, group II, and group III were 1.1446, 0.9197, and 0.8170, respectively. Maximum species diversity (H' max), which was calculated by common logarithm, was 1.4472 in group I, 1.2553 in group II, and 1.0414 in group III. Evenness (J′), which was calculated by following an equation (Gene diversity (H')/

Table 4. The DBH distribution of major woody species for each plant community

Group	Scientific name	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
Ⅰ	*Betula costata*			7	2	2	2	1					
	Abies koreana		2	2									
	Carpinus cordata	18	9	9	9	2	1	1					
	Acer pseudosieboldianum	69	14	1	1								
	Fraxinus rhynchophylla	4		1	2		2		1				
	Quercus mongolica	9	8	4	7	7	9	8	4	4	2	1	1
	Pinus koraiensis	10		2			1						
	Taxus cuspidata				1		1			1			
	Tilia mandshurica	2		3	4		2	1	2				
	Cornus controversa			1	1								
	Tilia amurensis	5	8	5	7	3	2	1	1				1
	Magnolia sieboldii	67	6										
Ⅱ	*Carpinus cordata*		1	2	3								
	Acer pseudosieboldianum	11	4	2									
	Fraxinus rhynchophylla		3	2	4								
	Quercus mongolica	6	6	11	21	5	5	5	9	11	8	2	3
	Pinus koraiensis				1	3				2			
	Tilia mandshurica	4	3	3	1								
	Cornus controversa			1	2	2							
	Tilia amurensis	13	11	8	13	7	5	2	2				
	Magnolia sieboldii	2		1									
Ⅲ	*Betula costata*			1	1	1	2						
	Acer pictum subsp. mono	1		2	1								
	Acer pseudosieboldianum	6	1										
	Ilex macropoda	2		2	1								
	Quercus mongolica	2	2	4	2	3	2			1			
	Cornus controversa		1	4	2	1							

D1: 2 < DBH ≤ 7, D2: 7 < DBH ≤ 12, D3: 12 < DBH ≤ 17, D4: 17 < DBH ≤ 22, D5: 22 < DBH ≤ 27, D6: 27 < DBH ≤ 32, D7: 32 < DBH ≤ 37, D8: 37 < DBH ≤ 42, D9: 42 < DBH ≤ 47, D10: 47 < DBH ≤ 52, D11: 52 < DBH ≤ 57, D12: 57 < DBH(unit; ㎝)

Maximum species diversity (H' max)), was 0.7909 in group I followed by group III and group II.

The species diversity of this study was from 0.8170 to 1.1446. These values are slightly lower than 1.0316～1.1776 in Hyangjeokbong of Mt. Deogyu National Park (Kim & Choo, 2004), 0.9574～1.2845 between form Nogodan to Goribong (Kim & Choo, 2003), 0.9586~1.1814 in Mt. Dongdae, Doonobong, and sangwangbong of Mt. Odae National Park (Kim & Choo, 2004), 0.9273~1.2167 in Taech'ongbong and Hangyeryong of Mt. Seorak National Park (Kim & Baek, 1998a), 1.0572～1.0931 in Myeongseongbong and Deokpyengbong of Mt. Jiri national park (Kim *et al*., 2000), 1.2973～1.4633 in Sangwonsa, Birobong, and Horyeongbong in Mt. Odae national park (Kim *et al*., 1996b), and 0.9580～1.2845 between from Nogodan to Goribong; (Kim & Choo, 2003), whereas it showed similar result with several studies such as 0.7506～1.1512 between Suryeong and Sosagogae (Choo & Kim, 2004) and 0.991 in Jangunbong of Mt. Taebaek (Kim & Baek, 1998b).

Table 5. Species diversity indices of three plant communities

Group	No. of plots (100㎡) (ea)	No. of species (ea)	Species diversity (H′)	H′max	Evenness (J′)	Dominance (D)
Ⅰ	13	29	1.1446	1.4472	0.7909	0.2091
Ⅱ	6	18	0.9197	1.2553	0.7327	0.2673
Ⅲ	2	11	0.8170	1.0414	0.7845	0.2155

When dominance value is over 0.9, it is called one species dominant. When dominance value is between 0.3 ～0.7, two or three species are dominant. Dominance value below 0.3 indicates that several species are dominant (Whittaker, 1965). In this study the dominance value was between 0.2091～0.2673, showing regions between Gyryongryeong and Mt. Yaksu are dominated by several species.

ACKNOWLEDGEMENT

This work was supported by Gyeongnam National University of Science and Technology(2013)

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