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Vegetation Structure of Deciduous Broad-leaved Forest at the Beomeosa(Temple) Valley in Kumjungsan, Busan[1a]

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부산 금정산 범어사계곡 낙엽활엽수림의 식생구조[1a]

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ABSTRACT

The purpose of this study is to investigate the structure of vegetation dominated by deciduous broad-leaved trees at the Beomeosa(Temple) Valley of Mt. Kumjungsan in Busan. To this end, 28 plots were set up and surveyed. The result analyzed by TWINSPAN, one of the classification technique, showed that the communities were divided into six groups which are *Carpinus tschonoskii*-Deciduous broad-leaved forest community(Ⅰ), *Quercus serrata-C. tschonoskii* community(Ⅱ), *C. tschonoskii-Q.s serrata-Pinus densiflora* community(Ⅲ), *C. tschonoskii-Quercus serrata-Q. mongolica* communtiy(Ⅳ), *Q. serrata*-Deciduous broad-leaved forest community(Ⅴ) and *Chamaecyparis obtusa-C. tschonoskii* community (Ⅵ). Species diversity ranged from 0.3832 to .0450. The lowest diversity was *Chamaecyparis obtusa* community(Ⅵ) but the highest was *Carpinus tschonoskii*-Deciduous broad-leaved forest community(Ⅰ) and *Q. serrata*-Deciduous broad-leaved forest community(Ⅴ). The average number of species was 6.8±3.2 in the unit area(100㎡). *Carpinus tschonoskii* community at the Beomeosa Valley of Mt. Geumjeongsan was a climatic climax forest having a value to preserve, so a continuous management will be needed.

KEY WORDS: TWINSPAN, SPECIES DIVESITY, Carpinus tschonoskii COMMUNITY, CLIMATIC CLIMAX

요 약

부산 금정산 범어사계곡의 낙엽활엽수가 우점하는 군락의 식생구조를 분석하기 위해 단위면적 100㎡의 조사구 28개를 설정하고 조사를 실시하였다. Classification기법중의 하나인 TWINSPAN을 이용하여 군락을 분류한 결과, 개서어나무-낙엽활엽수군락(군락 Ⅰ), 졸참나무-개서어나무군락(군락 Ⅱ), 개서어나무-졸참나무-소나무군락(군락 Ⅲ), 개서어나

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a 이 논문은 2010년 본 학회 학술대회 제20권 2호 발표(Kim *et al.*, 2010) 후 심사를 거쳐 발전시킨 것임.
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무-졸참나무-신갈나무군락(군락 Ⅳ), 졸참나무-낙엽활엽수군락(군락 Ⅴ), 편백-개서어나무군락(군락 Ⅵ)의 6개 군락으로 최종 분리되었다. 군락별 종다양도는 0.3832~1.0450의 범위이었으며 인공식재한 편백나무가 우점하는 군락 Ⅵ의 종다양도가 가장 낮았고 개서어나무와 기타 낙엽활엽수가 우점하는 군락 Ⅰ과 군락 Ⅴ의 종다양도가 가장 높았다. 단위면적당(100㎡) 종수는 6.8±3.2종이었다. 금정산 범어사계곡의 개서어나무군락은 기후극상림으로써 보전가치 높으므로 지속적인 보전관리대책이 요구된다.

주요어: TWINSPAN, **종다양도**, **개서어나무군락**, **기후극상**

INTRODUCTION

Kumjungsan is located on the southern tip of Nakdong-Jeongmaek(a range of mountains), which is coming down along the eastern coast of Korea. It spans Dongrae-gu, Kumjung-gu, Buk-gu of Busan City and Yangsan-gun in South Gyeongsang Province. Total area is 51.7㎢. Geographically, it is located between 129° 02′ ~ 129° 07′ east longitude and 35° 12′ ~ 35° 17′ north latitude. Study site is deciduous broad-leaved forest including *Carpinus tschonoskii* which is widely grown over Beomeosa Valley in Kumjung-gu, Busan. Topographically, stony slopes of valley type is widely distributed in the Beomeosa Valley, and this area is well worth preserving when it comes to natural degree of vegetation.

Study on plant community in Kumjungsan area was firstly conducted by Lee(1954), who provided result of studies about flora in around Kumjungsan. Following studies mainly on flora were done by Kim *et al*.(1997).

Many studies to evaluate ecological value of plant community were conducted. Kim *et al*.(1993) conducted ecological study of plant community on eastern slope of Kumjungsan. Nam(1994) studied flora of Kumjungsan and structure of main vegetation. Also, Jang(2005) studied plant community and changes in Kumjungsan. However, they were mainly about characteristics and changes in the community dominated by *Pinus densiflora* and *Quercus* spp. In addition to these studies, based on the plant sociology of forest in Busan, Lee(2003) studied plant distribution and current issues on Kumjungsan and suggested, for main vegetation distribution, *Quercus dentata* community on the ridge, communities dominated by *Pinus densiflora*, *Quercus mongolica* and other *Quercus* spp. on the main slope, *Carpinus tschonoskii* on the valley and *Quercus variabilis* in low-lying ground with severe human interference.

Areas which are dominated by *Carpinus tschonoskii* and deciduous broad-leaved trees in some areas of Beomeosa Valley of Kumjungsan are climate climax forest, having a high ecological value to preserve. However, since these areas are highly likely to be artificially damaged, detailed ecological studies and management plans are required(Lee, 2003).

Carpinus tschonoskii belongs to climatic climax forest of southern cool temperate zone(Kil *et al*., 2000) and also grown in Mt. Hallasan and Seonunsan(Kim and Yim, 1986), Daedunsan(Kim *et al*., 1988) and Jirisan. *Carpinus tschonoskii* community is also seen in some areas of Kumjungsan. However, there was no study on the ecological structure of *Carpinus tschonoskii* community and deciduous broad-leaved tree community on Beomeosan Valley in Kumjungsan.

In this study, we analyzed plant community of deciduous broad-leaved forest, which is widely located in Beomeosa Valley of Kumjungsan and intended the study result to be used for basic data for preservation and recovery of deciduous broad-leaved forest community in Beomeosa Valley in the future.

MATERIALS AND METHODS

1. Study Site

In order to study plant community dominated by deciduous broad-leaved trees in the Beomeosa Valley of Kumjungsan, we conducted preliminary and main studies in June~November of 2009. Study plots on the areas dominated by *Carpinus tschonoskii* and *Quercus serrata* were set up considering areas where damages from mountain climbers, and nature was well preserved. Total number of study plots was 28 and size of each plot was 10m×10m(100㎡).

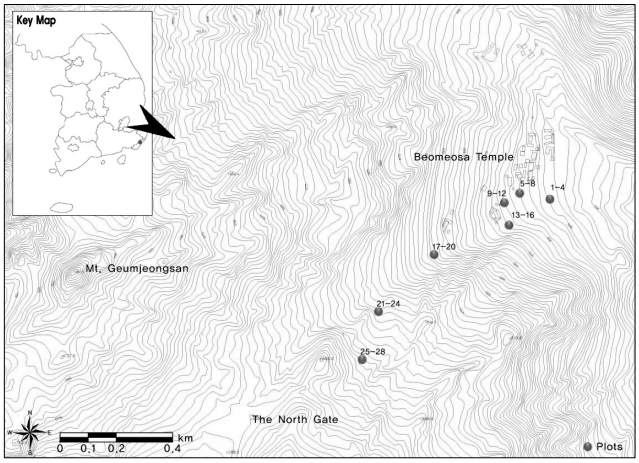

Figure 1. The location map of the survey plots in the Beomeosa Valley

2. Study and Analysis Method

1) Vegetation and Environmental Factors

To study forest community in Beomeosa Valley of Kumjungsan, Busan, we set up study plots in areas which were changed in the plant community and environment. Study was done by layers which are the canopy, understory and shrub layer. Trees have top crown were categorized as the canopy layer, trees with diameter of breast height (DBH) of less than 2㎝ as the understory layer, and other trees as shrub layer. In the canopy and understory layer, DBH of trees in a square sized 10m×10m was measured. In the shrub layer, width of trees was measured in a small overlapped square of 5m×5m in size. Location, degree of slope, degree of tree canopy closure and tree height were measured for each study plot to get general information.

2) Analysis of Vegetation Structure

To compare relative dominance of trees based on the result of plant community study, Importance Percentage (I.P.)(Brower and Zar, 1977) which was converted into percentage by combining I.V.(Importance Value) of Curtis and McIntosh(1951), was calculated by each layer. I.P. was calculated by the formular of (relative density+relative coverage)/2. M.I.P.(Mean Importance Percentage), which provides weights to each layer considering the size of a tree, was obtained by the formular of ((canopy layer I.P.×3) + (understory layer I.P.×2) + (shrub layer I.P.×1))/6.

Based on I.P. analysis result, classification analysis(Hill, 1979b) and DCA ordination analysis(Hill, 1979a) by TWINSPAN was conducted. Three kinds of species diversities, Shannon's, Simpson's and Hurlbert's index, have applied for analyzing(Pielou, 1977; Cox, 1976). Similarity index was compared and analyzed based on result of plant communities and Whittaker(1956)'s formular (2C/A+B) was used to analyze similarity index.

RESULTS AND DISCUSSION

1. Overview of Study Area

Weather data for the last 17 years about Busan city shows annual average temperature of 14.7℃, annual average precipitation of 1,574.6㎜, annual average precipitation days of 995 days, and annual average humidity of 64.9% (KMA, 2010).

Table 1. General description of the physical features and vegetation of the study plots

Community		Ⅰ	Ⅱ	Ⅲ	Ⅳ		Ⅴ		Ⅵ
Plot number		17~20	1~8	9~12	24	26~28	21~23	25	13~16
Altitude(m)		440	310	340	510	550	510	550	330
Aspect		N45E	N60E	N60E	N60E	N20E	N60E	N20E	N60E
Slope(°)		17	10	10	18	10	18	10	10
Canopy	Height(m)	15	20	20	22	18	18	18	20
	Mean DBH(cm)	40	45	45	25	28	22	28	45
	Coverage(%)	70	70	70	70	80	25	80	70
Understory	Height(m)	8	9	9	8	8	7	8	9
	Mean DBH(cm)	10	12	12	8	10	8	10	12
	Coverage(%)	30	20	20	20	50	8	50	25
Shrub	Height(m)	2.0	1.5	1.0	1.0	1.2	20	1.2	1.0
	Coverage(%)	20	10	10	5	40	1.0	40	15

Following shows general information on study plots in Beomeosa Valley in Kumjungsan, Busan. Study plots were located at an altitude of 310~550m and mainly face northeast. Degree of slope ranges 10°~18°. Height of the canopy layer was 15~22m and the understory layer 7~9m. DBH of the canopy layer ranged from 22 to 45cm and that of the understory layer ranged from 8 to 12cm.

2. Classification and Ordination Analysis

Classification and ordination analysis were conducted to classify communities of the study plots. For classification, we used TWINSPAN(Figure 2) and DCA(Figure 3) for ordination. Purpose of ordination is to summarize data(Orloci, 1978) and indicate similarity or difference of samples depending on the distance on the coordinates. This is a method to find out inherent factors(Luwig and Reynolds, 1988).

Classfication analysis categorized study plots into 6 communities. Indicator species in the first level was *Maackia amurensis*(*Ma*) to the left and *Chamaecyparis obtusa*(*Co*) to the right side. Indicator species in the second level was *Zelkova serrata*(*Zs*) to the left and *Stewartia koreana*(*Sk*), *Carpinus cordata*(*Cc*), and *Quercus*

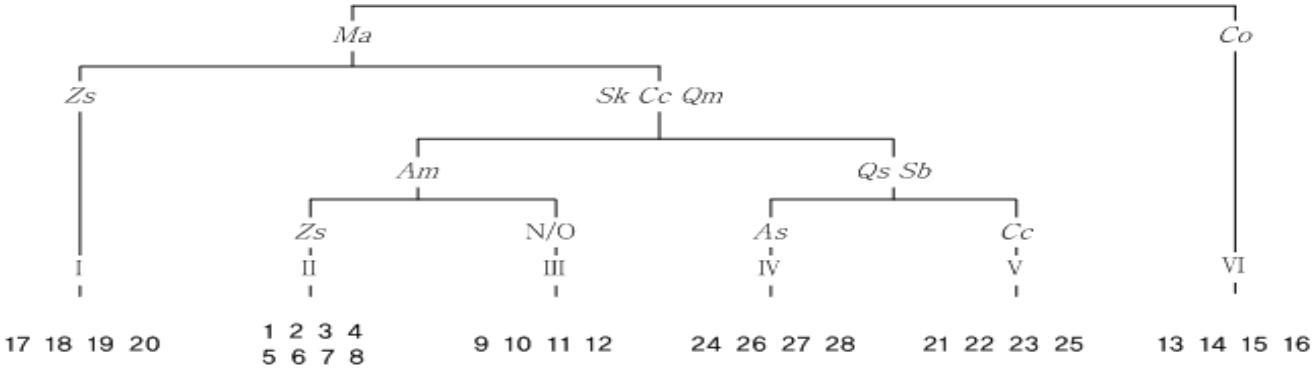

Figure 2. The dendrogram of classification by TWINSPAN using twenty-eight plots in the Beomeosa Valley

(Ma: *Maackia amurensis*, Co: *Chamaecyparis obtusa*, Zs: *Zelkova serrata*, Sk: *Stewartia koreana*, Cc: *Carpinus cordata*, Am: *Acer mono*, As: *Acer pseudo-sieboldianum*, Qm: *Quercus mongolica*, Qs: *Quercus serrata*, Sb: *Sasa borealis*)

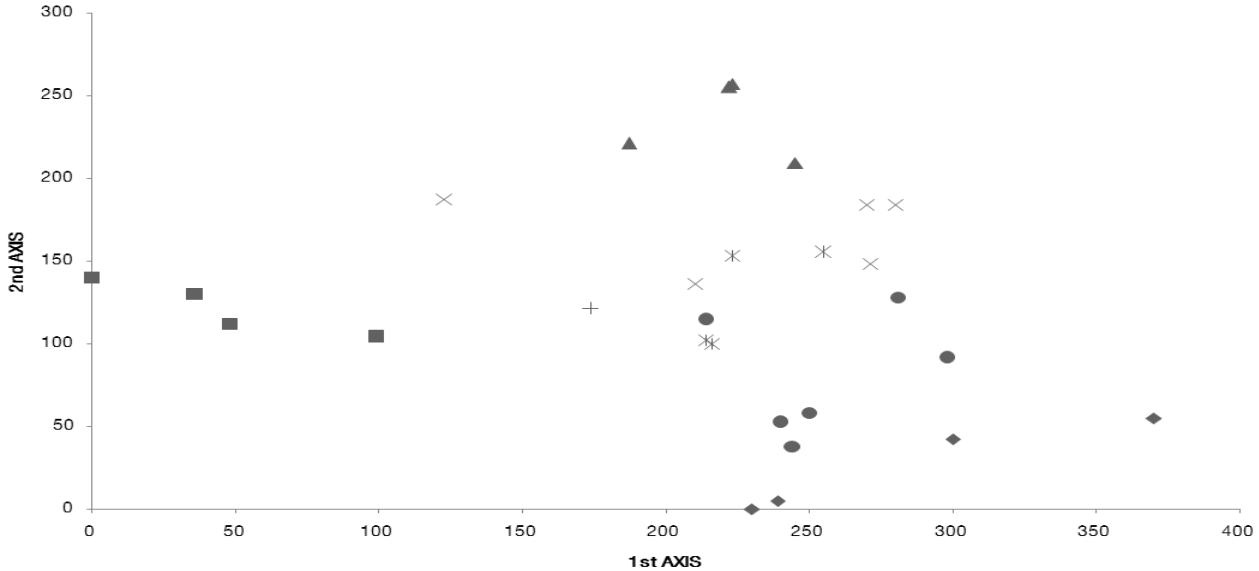

Figure 3. DCA ordination of twenty eight plots in the Beomeosa Valley

(◆: Community Ⅰ, ●: Community Ⅱ, ×: Community Ⅲ, ✳: Community Ⅳ, ▲: Community Ⅴ, ■: Community Ⅵ)

mongolica(*Qm*) to the right. In the third level, the group divided by *Stewartia koreana*, *Carpinus cordata* and *Quercus mongolica* in the second level was divided into left group by *Acer mono*(*Am*) and right group by *Quercus serrata*(*Qs*) and *Sasa borealis*(*Sb*).

All six communities which were finally categorized were as follows; Community Ⅰ *Carpinus tschonoskii*-Deciduous broad-leaved forest community, Community Ⅱ *Quercus serrata-C. tschonoskii* community, Community Ⅲ *Carpinus tschonoskii-Q. serrata-Pinus densiflora* community, Community Ⅳ *Carpinus tschonoskii-Quercus serrata-Q. mongolica* communtiy, Community Ⅴ *Q. serrata*-Deciduous broad-leaved forest community, and Community Ⅵ *Chamaecyparis obtusa-C. tschonoskii* community.

When this is compared with ordination analysis result, deciduous broad-leaved forest community of Beomeosa Valley shows similar environmental gradient except for the communities dominated by *Pinus densiflora* and *Chamaecyparis obtusa*, and species composition difference caused by local environmental discrepancy was shown in the undersotry and shrub layer.

3. Vegetation Analysis by Community

Table 2 shows I.P. and M.I.P. of six communities by layer classified by TWINSPAN method of classification.

Study plot No. 17, 18, 19, and 20 fall under Community Ⅰ *Carpinus tschonoskii*-Deciduous broad-leaved forest community. For the details of each layer, in the canopy layer *Carpinus tschonoskii*(I.P. 34.4%), *Zelkova serrata* (I.P. 27.0%), *Q. serrata*(I.P. 16.4%), and Acer mono(I.P. 14.9%) were main species and *Q. serrata*(I.P. 23.0%), *Acer pseudosieboldianum*(I.P. 18.0%), and *Maackia amurensis* (I.P. 12.2%) were main species in the understory layer. In the shrub layer, *Deutzia glabrata*(I.P. 52.0%), *Callicarpa japonica*(I.P. 34.3%), and *Symplocos chinensis* for. *pilosa* (I.P. 13.7%) were dominant species.

Study plot No. 1~8 fall under Community Ⅱ *Quercus serrata-Carpinus tschonoskii* community. In the canopy layer, *Quercus serrata*(I.P. 66.7%)and *C. tschonoskii*(I.P. 28.8%) were main species. In the understory layer, *Styrax japonicus*(I.P. 23.6%), *Lindera erythrocarpa*(I.P. 19.4%), and *Zelkova serrata*(I.P. 17.9%) were main species and *C. tschonoskii* were also seen. In the shrub layer, *Sasa borealis*(I.P. 36.9%) was dominant.

Study plot No. 9~12 come under Community Ⅲ, where *Carpinus tschonoskii-Quercus serrata-Pinus densiflora* community were dominant species. In the canopy layer, *C. tschonoskii*(I.P. 47.7%), *Q. serrata*(I.P. 32.2%), and *P. densiflora*(20.1%) appeared. In the understory layer, *Lindera erythrocarpa*(I.P. 44.6%)and *Q. serrata*(I.P. 33.4%) were main species. Nine species were seen in the shrub layer, with *Callicarpa japonica*(I..P. 26.6%)and *Akebia quinata* (I.P. 18.4%) as dominant species.

Four study plots No. 24, 26, 27 and 28 fall under Community Ⅳ, which was *Carpinus tschonoskii-Quercus serrata-Q. mongolica* community. In the canopy layer, *Q. serrata*(I.P. 38.6%) showed highest dominance index but was not seen in the understory and shrub layer. I.P. of *C. tschonoskii* was 32.6% in the canopy and 28.5% in the understory layer. *Lindera erythrocarpa*, *Stewartia koreana*, *Fraxinus rhynchophylla*, and *Prunus sargentii* also appeared in the canopy layer. In the understory layer, *C. tschonoskii* had the highest dominance index and *Sorbus alnifolia*(I.P. 23.6%) was another main species. In the shrub layer, *Deutzia glabrata*(I.P. 57.0%) and *Sasa borealis* (I.P. 33.1%) were dominant.

Four study plots No. 21, 22, 23 and 25 come under Community Ⅴ,*Q. serrata*-Deciduous broad-leaved forest community. There were ten species in the canopy layer, showing biggest number of species among study plots. *Quercus serrata*(I.P. 34.3%) and *Carpinus tschonoskii*(I.P. 25.8%) were main species and *Prunus sargentii*, *Ilex macropoda*, *Stewartia koreana*, and *Fraxinus rhynchophylla* also appeared. In the understory layer, *Acer pseudosieboldianum* (I.P. 25.5%) and *Carpinus cordata*(I.P. 19.3%) were main species. In the shrub layer, *Stephanandra incisa*(I.P. 60.5%) showed high dominance index. Compared to other communities, Community Ⅴ showed the biggest number of species and were the best in terms of preservation of nature. Especially, *Carpinus cordata*, which is climax species in succession, was seen in the canopy layer.

Community Ⅵ, *Chamaecyparis obtusa-C. tschonoskii* community includes study plots No. 13~16. Planted *Chamaecyparis obtusa*(I.P. 56.9%) were dominant in some areas and *Carpinus tschonoskii*(I.P. 21.6%), *Pinus densiflora* (I.P. 14.3%), and *Quercus serrata*(I.P. 7.2%) were shown in the canopy layer, however, there were neither understory nor shrub layer. After deciduous broad-leaved forest in the southern coast of Korea had been damaged, *Chamaecyparis*

Table 2. Importance percentage of woody species by the layer in each community

Comm.	Species \ Layer	C[1]	U[1]	S[1]	M[1]	Species \ Layer	C[1]	U[1]	S[1]	M[1]
Ⅰ	*Euonymus alatus* for. *ciliatodentatus*	-	10.33	-	3.44	*Maackia amurensis*	7.32	12.17	-	7.72
	Carpinus tschonoskii	34.40	-	-	17.20	*Acer mono*	14.88	-	-	7.44
	Quercus serrata	16.35	23.02	-	15.85	*Acer pseudo-sieboldianum*	-	17.99	-	6.00
	Zelkova serrata	27.04	-	-	13.52	*Symplocos chinensis* for. *pilosa*	-	-	13.66	2.28
	Celtis jessoensis	-	7.21	-	2.40	*Styrax japonica*	-	11.44	-	3.81
	Deutzia glabrata	-	-	52.04	8.67	*Callicarpa japonica*	-	-	34.30	5.72
	Sorbus alnifolia	-	9.79	-	3.26	*Weigela subsessilis*	-	8.07	-	2.69
Ⅱ	*Euonymus alatus* for. *ciliatodentatus*	-	-	4.68	0.78	*Lespedeza maximowiczii*	-	-	1.10	0.18
	Carpinus tschonoskii	28.81	8.32	-	17.18	*Rhus succedanea*	-	3.99	0.69	1.45
	Quercus serrata	66.72	-	-	33.36	*Rhus trichocarpa*	-	-	1.10	0.18
	Zelkova serrata	4.47	17.87	1.85	8.50	*Rhus sylvestris*	-	5.47	-	1.82
	Celtis jessoensis	-	9.44	2.51	3.57	*Styrax japonica*	-	23.55	-	7.85
	Morus bombycis	-	-	0.77	0.13	*Ligustrum obtusifolium*	-	-	0.63	0.11
	Lindera obtusiloba	-	-	10.99	1.83	*Callicarpa japonica*	-	3.99	14.10	3.68
	Lindera glauca	-	7.99	-	2.66	*Viburnum erosum*	-	-	11.28	1.88
	Lindera erythrocarpa	-	19.39	11.20	8.33	*Sasa borealis*	-	-	36.92	6.15
	Deutzia parviflora	-	-	2.18	0.36					
Ⅲ	*Pinus densiflora*	20.14	-	-	10.07	*Deutzia parviflora*	-	-	8.13	1.36
	Euonymus alatus for. *ciliatodentatus*	-	-	2.43	0.41	*Stephanandra incisa*	-	-	5.50	0.92
	Carpinus tschonoskii	47.65	-	-	23.83	*Rhus succedanea*	-	-	16.03	2.67
	Quercus serrata	32.22	33.44	-	27.26	*Styrax japonica*	-	8.20	5.10	3.58
	Celtis jessoensis	-	3.49	-	1.16	*Callicarpa japonica*	-	10.23	26.58	7.84
	Akebia quinata	-	-	18.38	3.06	*Sasa borealis*	-	-	15.09	2.52
	Lindera erythrocarpa	-	44.64	2.75	15.34					
Ⅳ	*Carpinus tschonoskii*	32.61	28.45	-	25.79	*Sapium japonicum*	-	7.11	1.28	2.58
	Quercus mongolica	16.80	-	-	8.40	*Acer pseudo-sieboldianum*	-	13.19	1.70	4.68
	Quercus serrata	38.63	-	-	19.32	*Stewartia koreana*	4.66	-	-	2.33
	Lindera obtusiloba	-	-	2.23	0.37	*Styrax obassia*	-	3.81	-	1.27
	Lindera erythrocarpa	3.65	-	-	1.83	*Styrax japonica*	-	15.09	2.53	5.45
	Deutzia glabrata	-	-	56.99	9.50	*Fraxinus rhynchophylla*	1.68	-	-	0.84
	Stephanandra incisa	-	-	1.11	0.19	*Callicarpa japonica*	-	-	1.11	0.19
	Sorbus alnifolia	-	23.62	-	7.87	*Sasa borealis*	-	-	33.06	5.51
	Prunus sargentii	1.94	8.72	-	3.88					
Ⅴ	*Pinus densiflora*	2.94	9.66	-	4.69	*Ilex macropoda*	3.04	-	-	1.52
	Alnus japonica	2.05	-	-	1.03	*Acer mono*	-	4.67	-	1.56
	Carpinus cordata	-	19.26	-	6.42	*Acer pseudo-sieboldianum*	-	25.52	6.21	9.37
	Carpinus tschonoskii	25.82	10.78	-	16.50	*Stewartia koreana*	6.57	-	-	3.29
	Quercus serrata	34.34	6.00	-	19.17	*Styrax japonica*	1.99	12.72	-	5.24
	Lindera erythrocarpa	6.00	-	12.71	5.12	*Fraxinus rhynchophylla*	13.28	5.17	-	8.36
	Stephanandra incisa	-	-	60.51	10.09	*Callicarpa japonica*	-	-	6.21	1.04
	Prunus sargentii	3.98	-	-	1.99	*Sasa borealis*	-	-	14.37	2.40
	Rhus succedanea	-	6.79	-	2.26					
Ⅵ	*Pinus densiflora*	14.32	-	-	14.32	*Carpinus tschonoskii*	21.59	-	-	21.59
	Chamaecyparis obtusa	56.94	-	-	56.94	*Quercus serrata*	7.16	-	-	7.16

[1] C: Importance percentage in Canopy layer, U: Importance percentage in Understory layer, S: Importance percentage in Shurb layer, M: Mean importance percentage

obtusa, *Pinus rigida*, and *Cryptomeria japonica* have been forested(Oh *et al.*, 2004). Likewise, in Beomeosa Valley of Kumjungsan, after forests had been damaged, *Chamaecyparis obtusa* was planted and *Carpinus tschonoskii*, *Quercus serrata* and other deciduous broad-leaved trees were introduced. Therefore, succession to these species was expected. However, since next generation species have not appeared yet in the understory and shrub layer, recovery and management plants for these species should be also considered.

Studies on six plant communities of Beomeosa Valley of Kumjungsan, Busan, which was stony slopes deciduous broad-leaved forest community, found out that *Carpinus tschonoskii* and *Qercus serrata* were dominant in the canopy layer, and *Zelkova serrata, Acer mono, Ilex macropoda*, *Stewartia koreana*, *Fraxinus rhynchophylla*, and *Pinus densiflora* were seen. In the understory layer, *Acer pseudosieboldianum*, *Carpinus cordata*, *Carpinus tschonoskii*, *Styrax japonicus*, and *Lindera erythrocarpa* appeared. Deciduous broad-leaved tree community which was in good condition in terms of nature, had *Carpinus tschonoskii*, a climate climax species, and deciduous broad-leaved trees as dominant species. In the understory layer, *Carpinus tschonoskii*, a climatic climax species, and *Carpinus cordata* appeared and they were expected to keep growing. However, the understory and shrub layer in an area with planted *Chamaecyparis obtusa* were not grown well, requiring ecological management for these communities.

Deciduous broad-leaved forest community in Beomeosa Valley of Kumjungsan in Busan is highly worth preserving as climatic climax forest(Lee, 2003). Huge rocks with size of 2.5~4m in diameter were located in the ground layer of the forest. Soil exposure was very limited with less than 10%. Result of this study corresponded to the preceding study showing that deciduous broad-leaved tree community dominated by *Carpinus tschonoskii* had *Quercus serrata*, *Carpinus cordata*, *Zelkova serrata*, and *Stewartia koreana* together(Um *et al.*, 2009). Beomeosa Valley is well worth preserving with nature degree of vegetation of grade Ⅳ and degree of green naturality of grade 7~8.

4. Species Diversity Analysis

Analysis on species diversity of six communities showed that Community Ⅰ and Community Ⅴ showed high Shannon and Simpson index. In the canopy layer, *Carpinus tschonoskii-Q. serrata* were dominant and various species were grown in the understory and shrub layer. In the Community Ⅱ, Ⅲ, and Ⅳ, *Carpinus tschonoskii* and *Quercus serrata* were dominant species in the canopy layer. However, in the understury and shrub layer a single species had high dominance index and especially dominance index of *Sasa borealis* in the shrub layer was high, showing low species diversity. Community Ⅵ had *Chamaecyparis obtusa* and *Pinus densiflora* as dominant species and no species in the understory and shrub layer, having low diversity index of 0.3832. This study result is very similar to that of a preceding study conducted by Kim and Choi(2007) about plant community of coastal forest of Haeundae in Busan. It was also similar to the result of study done by Lee *et al.*(1999) about deciduous broad-leaved forest in Mt. Nojasan of Geoje-do, showing species diversity index of 0.9075~1.1951.

5. Number of Species and Individuals Analysis

Average number of individuals and species per unit area(100㎡) of 28 plots in Beomeosa Valley were analyzed by layer(Table 4). Regarding average number of individuals,

Table 3. Various diversity indices analysis in six communities

Community	H'(Shannon)	Simpson'	P.I.E.[1]	J'(evenness)	D'(dominance)	H'max
Ⅰ	1.0450	11.9153	0.9161	0.9117	0.0883	1.1461
Ⅱ	0.8672	3.9525	0.7470	0.6782	0.3218	1.2788
Ⅲ	0.9070	6.1152	0.8365	0.8142	0.1858	1.1139
Ⅳ	0.7441	3.4804	0.7127	0.6048	0.3952	1.2304
Ⅴ	1.0404	8.4839	0.8821	0.8289	0.1711	1.2553
Ⅵ	0.3832	1.9301	0.4819	0.6365	0.3635	0.6021

[1] P.I.E.: the Probability of Interspecific Encounter

Table 4. Descriptive analysis of the number of species and population of twenty eight plots in the Beomeosa valley(Unit: 100㎡)

Descriptive analysis	No. of individuals				No. of species			
	Tree	Understory	Shrub	Total	Tree	Understory	Shrub	Total
Mean	5.0±4.0	3.1±2.7	29.7±25.7	37.8±30.5	2.8±1.7	2.1±1.6	2.6±2.3	6.8±3.2
Median	4	3	16	22	2	2	2	6.5
Mode	1	1	0	20	2	1	0	6
Maximum	14	9	224	243	8	6	6	13
Minimum	1	0	0	4	1	0	0	2

Table 5. Similarity index(%) between communities

Community	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
Ⅱ	51.42				
Ⅲ	43.51	65.93			
Ⅳ	53.66	49.85	51.46		
Ⅴ	40.14	50.92	55.68	52.06	
Ⅵ	14.38	14.38	21.54	14.38	19.07

the canopy layer had number of individuals of 5.0±4.0, the understory layer 3.1±2.7. For number of species per layer, the canopy, understory and shrub layer showed 2.8±1.7, 2.1±1.6, and 2.6±2.3 species respectively.

6. Similarity Index

Similarity index indicates difference or similarity between study plots or communities. If the similarity index is 20% or below, communities are different from each other, and if it's 80% or above, communities are alike. The result of similarity index analysis on six communities (Table5) shows that Community Ⅵ, which was dominant by *Chamaecyparis obtusa* and *Pinus densiflora*, had low index of 14.38~19.07% with other communities, showing difference. Remaining five communities had *Carpinus tschonoskii* and *Quercus serrata* as dominant species in the canopy layer, showing similarity, however, the index was low in the undersotry and shrub layer due to species composition. Community Ⅱ and Community Ⅲ showed the highest similarity index with 65.93%.

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