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The Analysis and Management of Phytosociological Vegetation Structure about Evergreen Broad-leaved Temple Forest, Korea

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Introduction

The vegetation studies about temple forest were insufficient. There were a fewpapers about Evergreen broad-leaved forest having meaning of temple forest until now. But most of the papers are composed with the types of local vegetation structures and communities (Oh etc, 1996; Chang etc, 1988). This result means it is so difficult to do the prediction about the succession of vegetation and potential natural vegetation in the future, and it is also difficult to manage Evergreen Broad-leaved Temple Forest (EBLTF). According to these matters , We make clear the vegetation structure of temple forest composed with evergreen broad-leaved forest(EBLF) and warm-temperate deciduous broad-leaved forest mixed with vegetation elements of evergreen broad-leaved forest(mixed SBLF). We also carried out this study with the purpose how we lead and maintain the vegetation for species diversity and stability under the point of view about the change of vegetation structure According to the global environmental change.

Materials and methods

1. Vegetation study

Vegetation research was carried outin total 101 stands, temple forests (EBLTF) of 10 places: Ssanggye-sa(SG), Mihwang-sa(DM), Daeheung-sa(DD), Nameun-sa(NE), Geumtap-sa(GG), Seonahm-sa(SS), Hwaeom-sa(GH), Neungga-sa(GN), Choneun-sa(GC), Bulgap-sa(YB). Especially, we confirmed the EBLF of 62 stands and mixed SBLF of 39 stands in total 101 stands (figure 1). We did research the vegetation of EBLTF based on the phytosociological method (Braun-blanquet, 1964).

In case of the analysis of vegetation structure, we analyzed the EBLTF structure based on the new Korea evergreen broad-leaved forest vegetation classification system under the basison Japan Evergreen broad-leaved forest system already given papers and the analysis data of temple forest vegetation structure in the southern part of Korea (LEE etc, 2009; 2010). For the analysis of more specific vegetation structure, we carried out

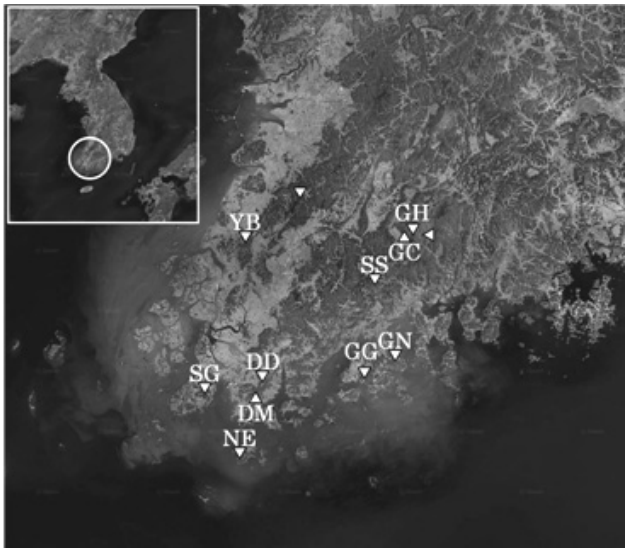

Figure 1. Research areas

the analysis of BC ordination with the quantification results of vegetation researches through PC-ORD4.41.

For the analysis about relationship between EBLF vegetation structure and environmental conditions, we did the analysis of CCA ordination and classification with the degree and aspect of slope, elevation (m) and soil condition (T.N.(%),pH, Organic Matter(g/kg), P(mg/kg), Exchangeable Cations (cmol+/kg; K, Ca, Mg)).

2. Life form analysis

We analyzed Numata's life form of total appearance species quantified (numata M, 1969; LEE, 1996). It is preferably more important to analyze the quantification data of appearance species in each layer than the number of appearance species for the occupying structure analysis of actual life form in present vegetation.

3. Species diversity analysis

We analyzed the species diversity with Shannon diversity index and evenness J.

We tried to make clear what kind of vegetation type is suitable for high stability, potential naturality and species diversity based on the diversity and evenness.

Results

We confirm 170 species in EBLF, 223 species in mixed SBLF and total 279 species in EBLTF.

1. Vegetation structure analysis

We confirmed three vegetation types of EBLTF: Dendropanaco-Quercetum acutae Association (ass.), Ardisio-Castanopsietum sieboldii ass. under Camellietea japonicae Class as climatic climax forest (EBLF) and *Quercus serrata-Quercus variabilis* comm. as warm-temperate deciduous broad-leaved forest type including the vegetation elements of evergreen broad-leaved forest (mixed SBLF).

Dendropanaco-Quercetum acutae ass. is composed with typical subassociation(subass.), Quercetum serratae

Table1. phytosociological vegetation table

			NE2	DD4, NE1	DM3, DD2	DM5, DD8, NE1	NE17, SG14	SG3	DD10, SS2, GH5, YB4, GN1,DM1, GC1	DD6, DM9	NE, GG1
			Dendropanaco-Quercetum acutae				Ardisio-Castanopsietum sieboldii		Q.serrata-Q.variabilis comm.		C. japnoica forest
			Typical subass.		Quercetum serratae subass.		Quercetum acutae subass.	Typical subass.	Camellia japnoica group		
				Torreyetum nuciferae variant	Typical subgroup	Aceretum palmatum variant			Torreya nucifera subgroup	Pinus densiflora subgroup	
DQ	*Dendropanaco-Quercetum acutae Character species*										
T1T2SH	*Quercus acuta Thunb. ex Murray for. acuta*	DQ	2	V	V	V	V		III	V	1
T2SH	*Neolitsea aciculata (Blume) Koidz.*	DQ	2	III		II	III			+	1
T2SH	*Machilus japonica Siebold et Zucc. ex Meisn.*	DQ	2	V		IV	II				
T1T2SH	*Dendropanax morbiferus H.Lev.*	DQ		II		III	II		+		
T1SH	*Daphniphyllum macropodum Miq.*	DQ		I		II	I				
AC	*Ardisio-Castanopsietum sieboldii Character species*										
T1T2SH	*Castanopsis sieboldii (Makino) Hatus.*	AC				+	V	3			1
T1T2SH	*Akebia quinata (Thunb.) Decne.*	AC	2	I		+	V	3	I		2
T1T2SH	*Quercus salicina Blume*	AC					IV	3		I	
H	*Cymbidium goeringii (Rchb.f.) Rchb.f.*	AC		I			IV	3	+		1
H	*Dryopteris hikonensis (H.Ito) Nakaike*	AC					III	3	r		
H	*Dioscorea quinqueloba Thunb.*	AC		I		+	II	1		I	
SH	*Elaeagnus glabra Thunb.*	AC					III	1		+	
T1S	*Ilex integra Thunb.*	AC				+	III		r		
SH	*Ficus oxyphylla Miq. ex Zoll.*	AC					III	1			1
Ca	*Camellietea japonicae Character species*										
T2SH	*Trachelospermum asiaticum (Siebold & Zucc.) Nakai var. asiaticum*	Ca	1	V	II	V	V	3	IV	II	2
T1T2SH	*Camellia japonica L.*	Ca	2	V	IV	V	V	3	IV	IV	2
H	*Ophiopogon japonicus (L.f.) KerGawl.*	Ca		III	I	V	V	3	II	II	2
T1T2SH	*Eurya japonica Thunb.*	Ca	1		V	IV	V	2	II	IV	
H	*Liriope platyphylla F.T.Wang & T.Tang*	Ca				III			IV	II	
SH	*Ardisia japonica (Thunb.) Blume*	Ca		I	III	V	IV	2	II	II	
T2SH	*Ligustrum japonicum Thunb. var. japonicum*	Ca	1	III	III	IV	V	3	I	III	1
T1T2SH	*Cinnamomum japonicum Siebold ex Nees*	Ca	2	V	I	IV	V	3	+	I	1
T1T2SH	*Machilus thunbergii Siebold & Zucc.*	Ca		II	III	IV	IV	3	II	IV	1
T2SH	*Hedera rhombea (Miq.) Bean*	Ca		II		II	I	2	+	I	2
H	*Dryopteris bissetiana (Bak.) C.Chr.*	Ca		I	I	IV	III		II	II	
T1T2SH	*Neolitsea sericea (Blume) Koidz.*	Ca	1	IV	II	IV	I	3	II	+	
T2SH	*Kadsura japonica (L.) Dunal*	Ca		IV	II	IV	III	2	I	I	
T1T2SH	*Actinodaphne lancifolia (Siebold & Zucc.) Meisn.*	Ca		II	III	IV	II	1	+	I	
H	*Dryopteris erythrosora (D.C.Eaton) Kuntze*	Ca				II	III	2	r		
T2S	*Quercus myrsinifolia Blume*	Ca					+				
SH	*Aucuba japonica Thunb.*	Ca				+			r		
H	*Ardisia crenata Sims*	Ca				+					
T2.S	*Gardneria insularis Nakai*	Ca					+				
H	*Ilex rotunda Thunb.*	Ca							r		
QQ	*Q.serrata-Q.variabilis comm. Character species*										
T1T2SH	*Quercus serrata Thunb. ex Murray*	QQ			V	V	II	3	V	V	
T1T2SH	*Quercus variabilis Blume*	QQ			III	III	II	2	V	IV	
T2SH	*Vaccinium oldhamii Miq.*	QQ			IV	II	r		II	IV	
T1T2SH	*Ilex macropoda Miq.*	QQ			II	II			II	IV	
QQ	*the element of Q.serrata-Q.variabilis forest (Warm-temperate deciduous broad-leaved forest)*										
T1T2SH	*Smilax china L.*	QQ	1		IV	II	IV	1	V	IV	2
SH	*Viburnum erosum Thunb.*	QQ			V	III	III		IV	V	
T1T2SH	*Styrax japonicus Siebold & Zucc.*	QQ	1	I	V	III	III	3	IV	V	
T1T2SH	*Carpinus laxiflora (Siebold & Zucc.) Blume var. laxiflora*	QQ		I	III	I	+		V	II	
SH	*Lindera obtusiloba Blume var. obtusiloba*	QQ			III	+	r	1	IV	V	
T1T2SH	*Lindera erythrocarpa Makino*	QQ	1	I	III	+	+	1	II	II	2
T2SH	*Sapium japonicum (Siebold & Zucc.) Pax & Hoffm.*	QQ		I	IV	IV	+		IV	IV	
T1T2SH	*Carpinus tschonoskii var. eximia (Nakai) Hatus.*	QQ		II	I	IV	II	1	III	III	
T1T2SH	*Rhus tricocarpa Miq.*	QQ		I	I	+			III	II	
H	*Disporum smilacinum A.Gray*	QQ				+	+		III	II	
SH	*Stephanandra incisa (Thunb.) Zabel var. incisa*	QQ							III	II	
SH	*Zanthoxylum schinifolium Siebold & Zucc.*	QQ				+	r		II	+	1
T1T2SH	*Cornus kousa F.Buerger ex Miquel*	QQ	1		I	I	II		II	II	1
T2SH	*Pourthiaea villosa (Thunb.) Decne. var. villosa*	QQ			II	+	+		II	I	
T1T2SH	*Quercus acutissima Carruth.*	QQ			I		r		+	II	
H	*Viola albida var. chaerophylloides (Regel) F.Maek. ex Hara*	QQ							II	+	2
H	*Syneilesis palmata (Thunb.) Maxim.*	QQ							II		
T1T2SH	*Castanea crenata Siebold & Zucc.*	QQ							I	+	
SH	*Euonymus oxyphyllus Miq.*	QQ			I	II	+		I	II	1
SH	*Viburnum dilatatum Thunb. ex Murray*	QQ							I	I	
SH	*Corylus sieboldiana Blume var. sieboldiana*	QQ							I	I	
H	*Aster scaber Thunb.*	QQ							I	I	
Pd	*the element of Pinus densiflora forest*										
T1T2SH	*Pinus densiflora Siebold & Zucc.*	Pd			II	II	II		IV	V	
SH	*Lespedeza maximowiczii C.K.Schneid.*	Pd				+	r		III	III	
T2SH	*Fraxinus sieboldiana Blume*	Pd			II	I			II	V	
SH	*Rhododendron mucronulatum Turcz. var. mucronulatum*	Pd			I	+	+		II	IV	
SH	*Rhododendron schlippenbachii Maxim.*	Pd							+	I	
SH	*Rhododendron mucronulatum var. ciliatum Nakai*	Pd							+		
Z	*the element of Torreya nucifera*										
T1T2SH	*Zelkova serrata (Thunb.) Makino*	Z	1	III		II	+		III		
T1T2SH	*Torreya nucifera (L.) Siebold & Zucc.*	Z		IV		III	r		IV	I	1
T1T2SH	*Acer palmatum Thunb. ex Murray*	Z		II		III	I	2	III		
SH	*Callicarpa japonica Thunb.*	Z		I		I	+		III		1
T1T2SH	*Meliosma myriantha Siebold & Zucc.*	Z		I		III		2	IV	II	
SH	*Ligustrum obtusifolium Siebold & Zucc.*	Z			I			1	II	I	1
SH	*Alangium platanifolium var. trilobum (Miq.) Ohwi*	Z		II		II	r		+		
T1SH	*Parthenocissus tricuspidata (Siebold & Zucc.) Planch.*	Z		III		II			+	I	
SH	*Staphylea bumalda DC.*	Z				+			r		
T1T2SH	*Cornus controversa Hemsl. ex Prain*	Z		III		I			I		
H	*Cyrtomium fortunei J.Sm.*	Z		II					r		
H	*Dryopteris lacera (Thunb.) O. Kuntze*	Z		I		+			I		
SH	*Orixa japonica Thunb.*	Z		I							
T1T2SH	*Celtis sinensis Pers.*	Z					r				
T1T2SH	*Aphananthe aspera (Thunb.) Planch.*	Z		I		+			r		
T1T2S	*Cornus macrophylla Wall.*	Z	1				r		r		
SH	*Celtis jessoensis Koidz.*	Z							r		
S	*Hovenia dulcis Thunb.*	Z							r		
	appearance species(etc)		8	20	22	34	49	13	141	69	31

subass. and Torreyetum nuciferae variant, *Q. serrata* typical subgroup and Aceretum palmatum variant etc. as subunits.

In case of Ardisio-Castanopsietum sieboldii ass., it is divided into *Quercus acuta* subass. and typical subass.. Some stands of *Camellia japonica* were also confirmed.

In case of *Q.serrata-Q.variabilis* comm., *C. japonica* group as the elements of evergreen broad-leaved forest was confirmed and was separated to two subunits (*Torreya nucifera* subpgroup and *Pinus densiflora* subgroup) again (Table 1).

1) BC ordination analysis about EBLTF

We confirmed that EBLTF was divided into 3 wide areas, *Castanopsis sieboldii* forest, *Quercus acuta* forest and warm temperate deciduous broad-leaved forest. Some mixed areas between *C. sieboldii* and *Q. acuta* forests were existed (Figure 2).

2) Typical evergreen broad-leaved forest (EBLF) analysis

(1) Classification

EBLF vegetation structure classification system is composed as two forest types(*Q. acuta* forest and *C.sieboldii* forest). In case of subunits in *Q. acuta*

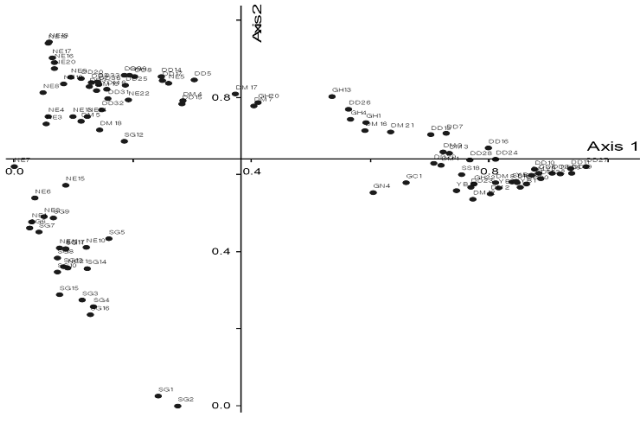

Figure 2. BC ordination of EBLTF

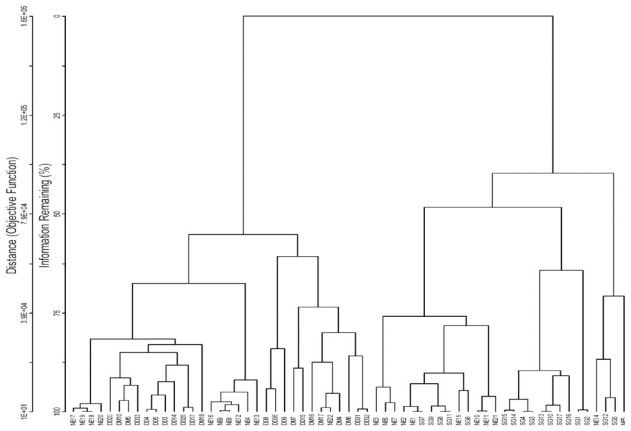

Figure 3. Classification of EBLF

forest, it is classified as two subunits: *Q. acuta* forest type influenced by only the vegetation elements of evergreen broad-leaved forest and *Q. acuta* forest type influenced relatively by the elementsof warm-temperate deciduous broad-leaved forest or the low influence of *Q.acuta*. In case of *C.sieboldii*forest, it is divided into the first forest type influenced by the elements of *Q. acuta* forest and second forest type without the influence of *Q. acuta* forest (figure 3).

As a result of BC ordination and Classification analysis, most of all is dominated by evergreen broad-leaved forest and the vegetation elements of warm-temperate deciduous broad-leaved forest is existed in some of areas. But in case of mixed SBLF, this forest hasthe capabilities of succession from deciduous forest to evergreen forest even if now is dominated by deciduous broad-leaved tree.

(2) CCA ordination

EBLTF is divided into two forest types (*Q. acuta* and *C. sieboldii*forests) by Elevation. In case of correlation with soil condition (P and pH), it exists the influence of the vegetation elements of warm-temperate deciduous forest in EBLF vegetation structure(figure 4,5).

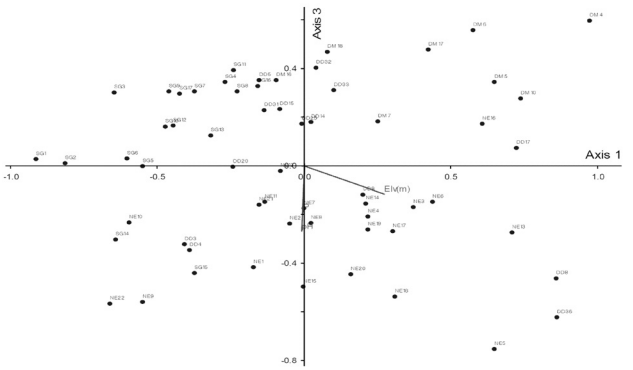

Figure 4. CCA ordination of EBLF (1)

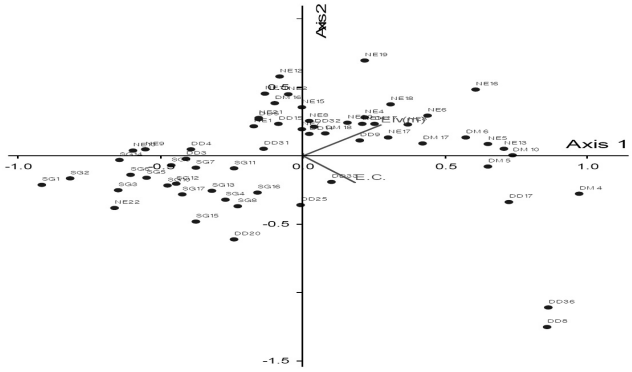

Figure 5. CCA ordination of EBLF (2)

2. Numata's life form analysis

Tree layer (90.37) and shrub layer (60.7) occupied large area relatively (figure 6). R1-2 species such as *Sasa borealis* on herb layers dominated as low percentage (6%). But on only herb layer, R1-2 species occupied over 60%. Actually, shrub and subtree species (*S. borealis* and *Pseudosasa japonica*) were appeared on herb layer. This means the vegetation structure will be simply by the expansion of *S. borealis* and *P. japonica*areas if the management of forest is not conducted(figure 7).

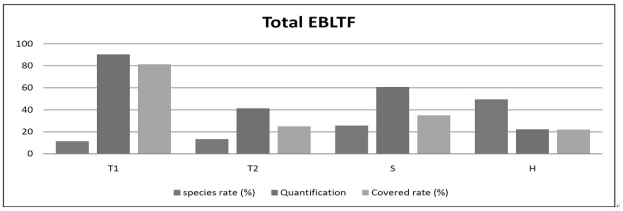

Figure 6. The structure of total EBLTF

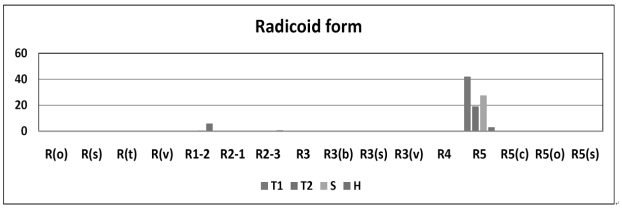

Figure 7. Numata's radicoid form

3. Species diversity analysis

Mixed SBLF type represented higher species diversity than EBLF type. But, it is corollaries that mixed SBLF including the vegetation elements of evergreen broad-leaved forest presents higher species diversity relatively. The one thing important here is all of EBLF and mixed SBLF will be succession toward climatic climax forest (evergreen broad-leaved forest). According to this anticipation, we need to lead the present forest types (EBLF & mixed SBLF) into evergreen broad-leaved forest. Especially, the forest types should be lead into high species diversity and evenness alike.

To lead present temple forest into the vegetation types (SG17, NE2, NE20, DD3, NE6, DM17, NE22 etc.) which EBLF and mixed SBLF each other intersect, is appropriate vegetation management direction in the longer term against the climatic change and vegetation change(climatic climax forest) (figure 8).

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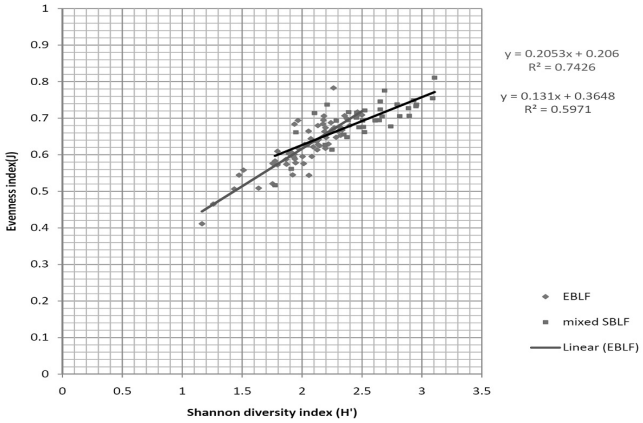

Figure 8. Species diversity of EBLTF

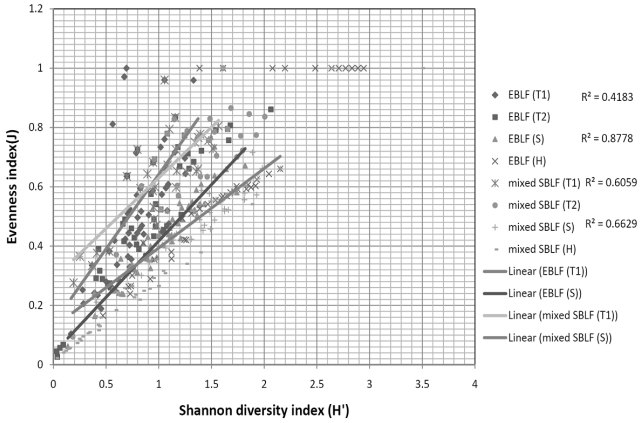

Figure 9. Species diversity by layers

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