

Phytosociological Classification of Plant Communities in Mt. Naejang, Southwestern Korea

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內藏山 植物群集의 植物社會學的 分類

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ABSTRACT

The forest vegetation of Mt. Naejang, southwestern Korea were classified into ten associations in four alliances of one order by Z-M school method as follows:

Quercetalia serrato-mongolicae ord. nov.

Rhododendro-Pinion densiflorae all. nov.

Rhododendro mucronulati-Pinetum densiflorae Kim et Yim 1986

Acero-Quercion mongolicae all. nov.

Rhododendro-Quercetum mongolicae assoc. nov.

Carpinion laxiflorae Kim et Yim 1986

Quercetum variabilis Kim et Yim 1986

Carpinetum laxiflorae Kim et Yim 1986

Carpinetum tschonokii Kim et Yim 1986

Daphniphyllum macropodum community

Quercus aliena-Carpinus tschonokii community

Corno-Zelkovion serratae all. nov.

Corno-Linderetum erythrocarpa assoc. nov.

Torreyo-Zelkovetum serratae assoc. nov.

Acero-Zelkovetum serratae assoc. nov.

On the other hand, four groups and six subgroups were divided by the species association, and their groups and subgroups showed the coincidence with the alliances and associations, phytosociological units.

INTRODUCTION

Mt. Naejang national park area is largely covered with hornbeam (*Carpinus*) forest and oak (*Quercus*) forest but pine (*Pinus*) forest in disturbed area. Hornbeam forests have been recognized as a distinct forest vegetation in cool-temperate zone in Korea, that is, *Carpinus laxiflora* and *Carpinus tschonokii* are character species in middle and southern part of cool-temperate zone, respectively (Uyeki, 1933; Yim, 1977b; Kim and Yim, 1986b). Mongolian oak

(*Quercus mongolica*) is widely distributed throughout southeastern Siberia, Mongolia, Manchuria and Korea (Miyawaki *et al.*, 1983) and has been also recognized as a dominant species in middle part of cool-temperate zone in Korea (Baek and Yim, 1983; Choi and Yim, 1984; Yim and Baik, 1985). Mongolian oak has been found in more cool area and more xeric area than those of hornbeam species (Yim, 1977b; Jang and Yim, 1985; Yim and Kim, 1985). Japanese red pine (*Pinus densiflora*) is usually found at disturbed area or rocky area.

Hornbeam forest, oak forest and pine forest are main communities in cool-temperate zone of Korea. However, these vegetations are not yet fully recognized in phytosociological and ecological viewpoints. To clarify these problems, the study on the forest vegetation of Mt. Naejang was carried out by the Zürich-Montpellier school method (Z-M method) and association analysis.

We thank Mr. Jae-Ki Ko for his assistances in the field works.

STUDY AREA

In Mt. Naejang area (ca. 75.8 km², 35°24'30"-35°31'15"N and 126°48'40"-126°56'20"E) there are two main peaks, Sinseonbong (763 m) of Naejang temple area and Backhagbong (722 m) of Backyang temple area (Fig. 1). The mountains chiefly formed from andesites, Kyeongsang volcanic rocks in the Cretaceous period, are characterized by steep slopes or rock ridges, thin soil layer and variation of stream water volume, especially in upper part. The soils of the

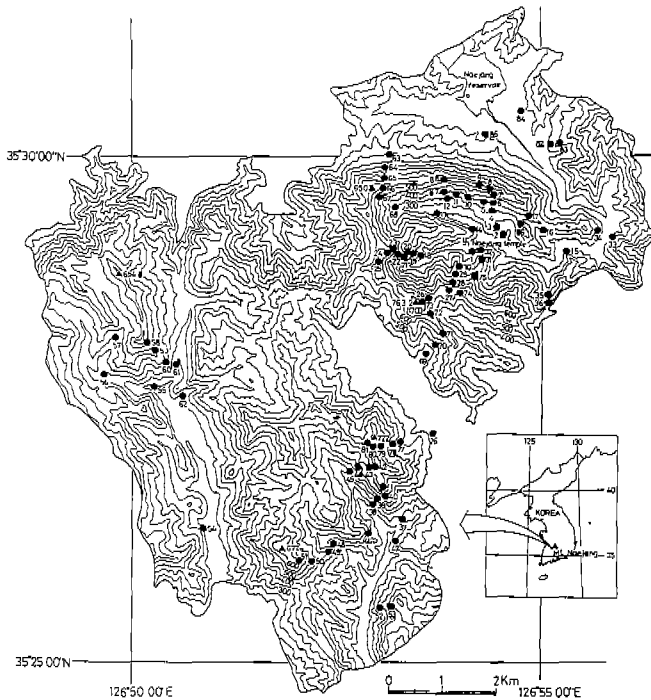


Fig. 1. Map showing the study sites. Arabian numerals: relevé numbers in Tables 2-9.

mountain show the variations of stony loam and stony sandy loam in the upper part, gravelly loam and gravelly sandy loam in lower part and sandy loam in flat land (Office of Rural Development, 1975).

For a long time, many trees had been repeatedly cut for the use of house building or fire wood. Herbaceous plants had also been grazed for domestic animals, collection of edible plants and shifting agriculture. However, before national park settlement in 1971, the forest has been preserved under laws of natural conservation.

Kira's warmth index $107.3^{\circ}\text{C} \cdot \text{month}$ (Yim and Kira, 1975), Thornthwaite's moisture index 53.9 (Yim and Kira, 1976), mean annual temperature 12.5°C and mean annual precipitation 1263.9 mm (Fig.2) based on the data of Jeongju meteorological station, ca. 10 km northwest of the mountain were referred to the discussion.

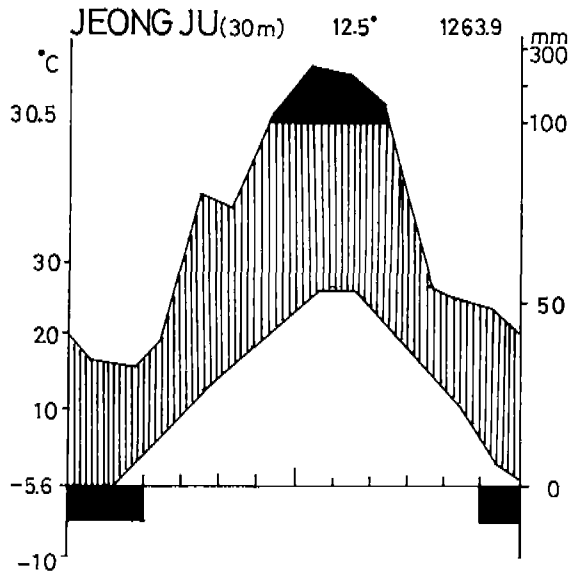


Fig. 2. Climate diagram of Jeongju near Mt. Naejang. The two curves chart monthly mean temperature ($^{\circ}\text{C}$) and precipitation (mm); barring where the precipitation curve lies above the temperature curve presumably represents humid season and black area (mean monthly precipitation in excess of 100 mm) perhumid season, and black boxes indicate months with a mean daily minimum below 0°C , cold season. Additional information in the figure includes elevation, mean annual temperature, mean annual precipitation, mean daily temperature maximum of the warmest month, and mean daily temperature minimum of the coldest month.

METERIALS AND METHODS

Vegetation survey. By the Z-M method the eighty six relevés were selected (Braun-Blanquet, 1964; Wegerer, 1974; Miyawaki *et al.*, 1981) during 1985-1987 (Fig.1). $10\text{ m} \times 10\text{ m}$ ($5\text{ m} \times 5\text{ m}$, $15\text{ m} \times 15\text{ m}$ or $20\text{ m} \times 20\text{ m}$ on occasion) size quadrat in minimal area was set randomly

at every relevé. The dominance and sociability of vascular plant species and habitat conditions in each relevé were described. The plant name was recorded according to Lee (1979).

Tabulation. By tabular comparison method (Küchler, 1967; Shimwell, 1971; Mueller-Dombois and Ellenberg, 1974; Toyohara, 1977; Suzuki *et al.*, 1985) plant communities were classified. To determine the vegetational units of the forest, the communities classified were compared with those of other regions (Miyawaki *et al.*, 1983; Yim and Baik, 1985; Kim and Yim, 1986a).

Correlation analysis between species. Species associations were determined with the χ^2 test by the use of a 2×2 contingency table (Shimwell, 1971; Kershaw, 1973; Krebs, 1978) and species constellation based on χ^2 values was prepared by methods of Agnew (1961) and Kershaw (1964). The results of correlation analysis between species were compared with vegetational units classified by tabular comparison method.

RESULTS AND DISCUSSION

Hierarchy of Mt. Naejang forest vegetation. The forest vegetation of Mt. Naejang area was divided into eight associations in four alliances of one order and two communities and their associations were also subdivided into several subassociations as follows:

Quercetalia serrato-mongolicae ord. nov.

Rhododendro-Pinion densiflorae all. nov.

Rhododendro mucronulati-Pinetum densiflorae Kim et Yim 1986

Acero-Quercion mongolicae all. nov.

Rhododendro-Quercetum mongolicae assoc. nov.

Typical subassoc., *Rhododendron yedoense* var. *poukhanense* subassoc. and *Sasa borealis* subassoc.

Carpinion laxiflorae Kim et Yim 1986

Quercetum variabilis Kim et Yim 1986

Typical subassoc. and *Sasa borealis* subassoc.

Carpinetum laxiflorae Kim et Yim 1986

Typical subassoc., *Hydrangea serrata* for. *acuminata* subassoc. and *Sasa borealis* subassoc.

Daphniphyllum macropodum community

Carpinetum tschonokii Kim et Yim 1986

Typical subassoc. and *Sasa borealis* subassoc.

Quercus aliena-*Carpinus tschonokii* community

Corno-Zelkovion serratae all. nov.

Corno-Linderetum erythrocarpae assoc. nov.

Hydrangea serrata for. *acuminata* subassoc. and *Sasa borealis* subassoc.

Torreyo-Zelkovetum serratae assoc. nov.

Typical subassoc., *Thea sinensis* facies and *Sasa borealis* subassoc.

Accro-Zelkovetum serratae assoc. nov.

Typical subassoc. and *Sasa borealis* subassoc.

In the above hierarchy system one new order, three new alliances and four new associations were found as marked with "nov." (Table 1).

Nature of various units. The character species of Quercetalia serrato-mongolicae ord. nov. are mentioned such as *Quercus mongolica*, *Quercus serrata*, *Viola acuminata*, *Fraxinus rhynchophylla*, *Smilax china*, *Disporum smilacinum*, *Prunus sargentii* and *Carex siderosticta*. *Quercus mongolica* and *Quercus serrata* were known as the species with a wide range of thermal distribution, Warmth index (WI) 18–111 in the former and WI 40–122 in the latter (Yim, 1977a) and the character species of cool-temperate deciduous broadleaf forest zone. *Pinus densiflora*, *Carpinus laxiflora*, *Carpinus tschonoskii*, *Zelkova serrata*, *Quercus variabilis* and *Quercus monolica* showed their characteristics of distributional range along the climatic, topographic and edaphic conditions in the mountain. This order is similar to Quercetalia serrato-grosserratae in Japan. However, the latter differs from the former in character species with *Quercus serrata*, *Prunus sargentii*, *Viburnum dilatatum*, *Castanea crenata*, *Pourthiaea villosa*, *Corylus sieboldiana* and *Callicarpa japonica* (Miyawaki et al., 1983).

Rhododendro-Pinion densiflorae all. nov. is characterized with *Pinus densiflora*, *Rhododendron yedoense* var. *poukhanense*, *Vaccinium oldhamii*, *Juniperus rigida* and *Rhus verniciflua* as in Mt. Seonun (Kim and Yim, 1986a). This alliance is similar to Pinion densiflorae Suz.-Tok. 1966 in Japan but differs in character species composition, having *Pinus densiflora*, *Vaccinium oldhamii*, *Juniperus rigida* and *Lyonia ovalifolia* var. *elliptica* as the character species (Miyawaki et al., 1983). Rhododendro mucronulati-Pinetum densiflorae is included in this new alliance in the mountain.

The character species of Acero-Quercion mongolicae all. nov. include some species such as *Quercus mongolica*, *Artemisia keiskeana*, *Carex lanceolata*, *Viola dissecta* var. *chaerophylloides*, *Fraxinus sieboldiana* and *Acer pseudo-sieboldianum*. *Quercus mongolica* was known as character species of middle parts of cool-temperate deciduous broadleaf forest zone with WI 46–90 optimal range (Yim, 1977a). This species has been found at the more xeric-upper parts of the slope than in hornbeam species and usually accompanied with *Acer pseudo-sieboldianum* as in Mt. Seolag, Mt. Chiri and Mt. Gyeryong (Jang and Yim, 1985; Yim and Kim, 1985; Song, 1985). This alliance is distinguished from other alliances by the presence of *Quercus mongolica*, *Artemisia keiskeana*, *Carex lanceolata*, *Viola dissecta* var. *chaerophylloides*, *Fraxinus sieboldiana* and *Acer pseudo-sieboldianum* as character species. In the new alliance Rhododendro-Quercetum mongolicae is included in the mountain.

In Carpinion laxiflorae Kim et Yim 1986 *Carpinus laxiflora*, *Styrax obassia*, *Sapium japonicum*, *Euonymus sachalinensis*, *Acer pseudo-sieboldianum* var. *koreanum*, *Lindera obtusiloba* and *Styrax japonica* are observed as character species. *Carpinus laxiflora* was known as character species of southern and middle parts of cool-temperate deciduous broadleaf forest with optimal range of WI 76–89 (Yim and Kim, 1985) and found at middle and lower slopes of the mountain. *Carpinus laxiflora*, *Carpinus tschonoskii*, *Quercus variabilis* and *Quercus aliena* showed different ecological behaviors among them in climatic, topographic and edaphic conditions as in Mt. Seonun (Kim and Yim, 1986a). The alliance includes three associations, Quercetum variabilis,

Carpinetum laxiflorae and Carpinetum tschonoskii, and two communities, *Daphniphyllum macropodium* and *Quercus aliena*-*Carpinus tschonoskii* community.

In Corno-Zelkovion serratae all. nov., *Zelkova serrata*, *Staphylea humalda*, *Zanthoxylum piperitum*, *Acer mono*, *Thalictrum acutaefolium*, *Oplismenus undulatifolius*, *Celtis sinensis*, *Cornus controversa* and *Lindera erythrocarpa* are determined as character species. They occur near the mountain stream and on the well drained stony slopes as in Mt. Seonun (Kim and Yim, 1986a). This alliance differs from Zelkovion-serratae Miyawaki et al. 1977 in Japan except *Zelkova serrata*. In the Japanese alliance *Zelkova serrata*, *Meliosma tenuis*, *Celtis jessoensis*, *Acer carpinifolium*, *Kerria japonica*, *Lindera obtusiloba*, *Cornus brachypoda*, *Ostrya japonica*, *Parabenzoin praecox*, *Philadelphus satsumi*, *Athyrium niponicum* and *Euonymus fortunei* are found as the character species (Miyawaki et al., 1983). In the new alliance three associations, Corno-Linderetum erythrocarpac, Torreyo-Zelkovetum serratae and Acero-Zelkovetum serratae are discriminated.

Plant associations.

Rhododendro mucronulati-Pinetum densiflorae Kim et Yim 1986 (Table 2).

Pinus densiflora, *Rhododendron mucronulatum*, *Milium offusum* and *Festuca ovina* as character species occur more abundantly at the lower parts of the mountain, disturbed and poor habitat such as hillock, exposed ridge and dry area. In the tree layer of the association *Quercus variabilis*, *Quercus serrata*, *Prunus sargentii*, *Juniperus rigida* and *Castanea crenata* are found as companion species with lower coverage and in shrub layer *Rhododendron mucronulatum*, *Rhododendron yedoense* var. *poukhanense*, *Lespedeza bicolor*, *Rosa multiflora*, *Symplocos chinensis* for. *pilosa* and *Stephanandra incisa* as shrubby species, *Quercus aliena*, *Quercus dentata*, *Styax japonica*, *Albizia julibrissin*, *Rhus verniciflua*, *Corylus heterophylla* var. *thunbergii*, *Fraxinus rhynchophylla* and *Carpinus tschonoskii* as tree saplings. The herb layer is composed of some constant species such as *Milium offusum*, *Artemisia keiskeana*, *Festuca ovina*, *Smilax china*, *Carex lanceolata*, *Pteridium aquilinum* var. *latiusculum*, *Disporum smilacinum*, *Aster scaber*, *Melampyrum roseum*, *Agrimonia pilosa* and *Smilax nipponica*. *Lillium tsingtauense*, *Atractylodes japonica* and *Partrinia scabisaeifolia* are rarely found. Similar floristic composition is also found in Mt. Seonun (Kim and Yim, 1986a). Therefore, the pine association of this mountain belongs to the Rhododendro mucronulati-Pinetum densiflorae Kim et Yim 1986.

Rhododendro-Quercetum mongolicae assoc. nov. (Table 3).

The character species, *Quercus mongolica*, *Rhododendron schlippenbachii*, *Melampyrum roseum* and *Ainsliaea acerifolia* occur on the upper parts of the slopes and somewhat xeric sites in the mountain as in Mt. Seolag, Mt. Chiri and Mt. Gyeryong (Yim and Baik, 1985; Jang and Yim, 1985; Song, 1985). The mongolian oak forest developed at elevations above 600 m in the mountain is proposed here as a new association, Rhododendro-Quercetum mongolicae, as a climatic climax. In the tree layer of the forest *Quercus variabilis*, *Fraxinus sieboldiana*, *Quercus serrata*, *Platycarya strobilacea*, *Carpinus laxiflora* and *Prunus sargentii* are found with companions in

Table 1. Synthesis table of forest communities on Mt. Naejang, Korea
Quercetalia serrato - mongolicae ord. nov.

- I. *Rhododendro - Pinion densiflorae* all. nov.
 A. *Rhododendro mucronulati* - *Pinetum densiflorae* Kim et Yim 1986
- II. *Acero - Quercion mongolicae* all. nov.
 A. *Rhododendro - Quercetum mongolicae* ass. nov.
- III. *Carpinion laxiflorae* Kim et Yim 1986
 A. *Quercetum variabilis* Kim et Yim 1986
 B. *Carpinetum laxiflorae* Kim et Yim 1986
 C. *Daphniphyllum macropodium* community
 D. *Carpinetum tschonoskii* Kim et Yim 1986
- IV. *Corno - Zelkovion serratae* all. nov.
 A. *Corno - Linderetum erythrocarpae* ass. nov.
 B. *Torreyo - Zelkovetum serratae* ass. nov.
 C. *Acero - Zelkovetum serratae* ass. nov.

Community	I		III			IV			
	A	A	A	B	C	D	A	B	C
Number of releves	7	14	26	6	3	11	6	7	6
Average number of species	29	29	27	25	23	34	29	30	26

Differential species groups

1. <i>Fraxinus rhynchophylla</i>	III	II	III	I	1	II	IV	II	r
<i>Viola acuminata</i>	I	IV	II	III	1	III	V	II	III
<i>Smilax china</i>	V	III	V	III	1	V	II	II	
<i>Disporum smilacinum</i>	III	IV	II	IV	2	II	II	II	r
<i>Prunus sargentii</i>	III	II	III	II	1	IV		r	
<i>Carex siederostica</i>	II	III	II	II		II			
<i>Quercus serrata</i>	III	III	V	III	2	IV	r	r	r
2. <i>Pinus densiflora</i>	V	II	I			r			
<i>Juniperus rigida</i>	III								
<i>Rhododendron yedoense</i>									
var. <i>poukhanense</i>	III	III	I			I			
<i>Rhus verniciflua</i>	III	I	II			III	II	r	
3. <i>Quercus mongolica</i>		V	II						
<i>Artemisia keiskeana</i>	IV	IV	r			r			
<i>Carex lanceolata</i>	V	IV	III						
<i>Viola dissecta</i> var. <i>chaerophylloides</i>	I	IV	III	I	1	III	r	II	r
<i>Fraxinus sieboldiana</i>	I	IV	III	II	1	III	r		
<i>Acer pseudo-sieboldianum</i>		IV	IV	III	2	IV	r		r
4. <i>Carpinus laxiflora</i>		II	III	V	2	I	III	r	r
<i>Styrax obassia</i>		II	I	IV	1	II	r		r
<i>Sapium japonicum</i>		II	II	III	3	IV	III		II
<i>Euonymus sachalinensis</i>		I	I	IV	1	II	II	II	II
<i>Acer pseudo-sieboldianum</i> var. <i>koreanum</i>				II	1	IV		V	III
<i>Lindera oblusiloba</i>		IV	V	V	3	IV	V	III	V
<i>Styrax japonica</i>	V	III	IV	II		IV	II	r	
5. <i>Zelkova serrata</i>			III			II	III	IV	V
<i>Staphylea bumalda</i>		I	I			II	III	II	III
<i>Zanthoxylum piperitum</i>			I	III		I	II	II	II
<i>Acer mono</i>		II	I	III	1	II	IV	II	V
<i>Thalictrum acutaefolium</i>			I	II		II		V	IV
<i>Oplismenus undulatifolius</i>	I	II	IV	IV	1	III	V	V	V
6. <i>Rhododendron mucronulatum</i>	III	II	II	II					
<i>Festuca ovina</i>	III	II							
<i>Milium effusum</i>	IV	II	r			r			
7. <i>Rhododendron schlippenbachii</i>		V	II	III		II			
<i>Melampyrum roseum</i>	III	IV	I			II	r		
<i>Ainsliaea acerifolius</i>	III	I	II	1	II	III	r	II	

8.	<i>Quercus variabilis</i>	III	V	V	II	II	r	r	r	
	<i>Lespedeza bicolor</i>	IV	III	III		3	r	r	r	
	<i>Indigofera kirilowii</i>	III	III	III	IV					
9.	<i>Viburnum dilatatum</i>	I	III	III	V	3	III	V	III	r
	<i>Symplocos chinensis</i>	II	II	II	III	1	II	r	r	
	for. <i>pilosa</i>		I	II	IV	1	II		II	r
	<i>Rhus trichocarpa</i>									
10.	<i>Daphniphyllum macropodum</i>			r		3			II	r
11.	<i>Carpinus tschonoskii</i>	III	II	II	I	1	V	r	r	r
	<i>Meliosma myriantha</i>						II	II	III	r
	<i>Stephanandra incisa</i>	II		I	II		IV	r	III	r
12.	<i>Lindera erythrocarpa</i>		I	III	IV	2	IV	V	III	V
	<i>Cornus controversa</i>		II	II	II	2	IV	V	II	III
	<i>Arisaema amurense</i>				I	1		III		
	<i>Alangium platanifolium</i>									
	var. <i>macrophyllum</i>			r	II	1	r	IV	III	IV
13.	<i>Torreya nucifera</i>						I	II	V	IV
	<i>Adenocaulon himalaicum</i>						I	I	III	r
	<i>Disporum sessile</i>								III	II
14.	<i>Polysticum tripteron</i>				I	2	r	IV	r	III
	<i>Hydrangea serrata</i>									
	for. <i>acuminata</i>				I	1	r	II		III
	<i>Celtis sinensis</i>			I			II	III	r	IV
15.	<i>Sasa borealis</i>		IV	V	III	3	IV	IV	III	IV
	<i>Lysimachia clethroides</i>	II	III	II	I	1			II	II
	<i>Platycarya strobilacea</i>	I	II	III			II			II
	<i>Dioscolea batatas</i>			II	III		I	II	III	
	<i>Galium trachispermum</i>	I	II		II	1	IV	IV	III	
	<i>Corylus heterophylla</i>									
	var. <i>thunbergii</i>	III			r		II			r
	<i>Castanea crenata</i>	II		r			II			
	<i>Codonopsis lanceolata</i>		I	II			II			
	<i>Vitis flexuosa</i>		II	I			II	r	r	
	<i>Smilax nipponica</i>	III	II	I			II	II	r	
16.	<i>Pteridium aquilinum</i>									
	var. <i>latiusculum</i>	V	III	II			II			
	<i>Aster scaber</i>	III		II			I			
	<i>Sorbus alnifolia</i>	III		II					r	r
	<i>Miscanthus sinensis</i>									
	var. <i>purpurascens</i>	III	II	r						
	<i>Atractylodes japonica</i>	II	III	r						
	<i>Lespedeza maximowiczii</i>	I	II	III			I			
17.	<i>Quercus aliena</i>		I	II			III		III	II
	<i>Smilax sieboldii</i>	I		I	I	2		II	II	r
	<i>Meliosma oldhamii</i>				I	1		II		r
	<i>Desmodium oxyphyllum</i>		I	r			III	III	III	II
	<i>Persicaria filiformis</i>							II	II	II
	<i>Flaxinus mandshurica</i>				II			II		r
	<i>Rhus chinensis</i>						I	II	II	
	<i>Ampelopsis brevipedunculata</i>	I	I	I						
	var. <i>heterophylla</i>			I			r	II	II	r
	<i>Akebia quinata</i>			I			I	r	III	III
	<i>Parthenocissus tricuspidata</i>			r				r	II	III

var. japonica	H:	.	+	+	+	.	.	.
Youngia denticulata	H:	.	+	+	+	.	.	.
Isodon inflexus	H:	.	+	.	+	+	.	.
Sorbus alnifolia	S:	.	+	+	.	+	.	.
Viola manshurica	H:	.	+	+	.	.	+	.
Miscanthus sinensis								
var. purpurascens	H:	.	+	+	.	+	.	.
nemerocalis fulva	n:	.	.	+	.	+	+	.
Rosa multiflora	S:	+	.	.	.	.	+	.
Symplocos chinensis for. pilosa	S:	.	+	.	+	.	.	.
Stephanandra incisa	S:	.	.	.	+	.	+	.
Castanea crenata	T2S:	.	.	+	+	.	.	+
Patrinia scabisaefolia	H:	+	.	.	.	+	.	.
Prunella vulgaris								
var. lilacina	H:	.	+	+	.	.	.	.
Lysmachia clethroides	H:	.	.	+	.	+	.	.
Lillium tsingtauense	H:	.	.	.	.	+	+	.
Atractylodes japonica	H:	.	+	.	.	+	.	.
Pueraria thunbergiana	H:	.	.	.	.	+	+	.
Robinia pseudo-acacia	S:	+	.	+	.	.	.	.

Rare species: *Zanthoxylum schinifolium*(1:S→), *Rhus chinensis*(1:S→), *Prunus ishdozana*(4:S→), *Oplismenus undulatifolius*(1:H-1.2), *Youngia sonchifolia*(1:H→), *Artemisia princeps* var. *orientalis*(1:H→), *Erigeron amunus*(4:H→), *Artemisia japonica*(4:H→), *Artemisia sylvatica*(3:H→), *Solidago virga-aurea* var. *asiatica*(3:H→), *Cymbidium goeringii*(3:H→), *Ostericum sieboldii*(3H:→), *Syneilesis palmata*(3:H→), *Platycarya strabilacea*(5:H→), *Lilium leichtlinii* var. *tigrinum*(5H→), *Araria elata* (1:T2→), *Viburunum dilatatum*(6:S→), *Pyrus calleryana* var. *fauriei*(6:S→), *Securinega suffruticosa*(6:S→), *Euonymus alatus*(6:S→), *Morus bombycis*(6:S→), *Spiraea prunifolia* var. *simpliciflora*(6:S→), *Scilla scilloides*(6:H→), *Galium trachispermum*(6:H→), *Viola acuminata*(6:H→), *Viola dissecta* var. *chaerophylloides*(6:H→), *Lilium cernuum*(6:H→), *Meehania urticifolia*(6:H→), *Vitis coignetiae*(6:H→), *Quercus acutissima* (7T1→), *Fraxinus sieboldiana*(7:S→), *Lespedeza maximowiczii*(7;s-1.2), *Smilax sieboldii*(4:H→), *Platycodon grandiflorum*(2:H→), *Sanguisorba officianalis*(2:H→).

Data of survey: Relevé No. 52; Aug.8, 1985, No.63; May17, 1986, No.76; Jun.8, 1986, NO.82-85; Jun.22, 1986.

Note: L; lower part of slope, M; middle part of slope, U; upper part of slope.

Table 3. Vegetation table of Rhododendro - Quercetum mongolicae

Quercetalia serrato - mongolicae ord. nov.

Acero - Quercion mongolicae all. nov.

Rhododendro - Quercetum mongolicae ass. nov.

a. Typical subassociation

b. Rhododendron yedoense var. poukhanense subassociation

c. Sasa borealis subassociation

Serial number	a					b				c				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Relevé number	74	42	65	71	26	58	72	75	81	73	22	25	24	66
Altitude(m)	600	650	500	570	750	550	670	500	720	680	550	720	650	600
Slope aspect	SW	W	NW	S	SE	S	E	N	N	S	E	E	SE	S
Slope degree	40	22	35	30	30	38	35	45	10	25	35	25	25	35
Topography	U	U	M	U	T	U	T	U	T	T	U	T	U	U
Quadrat size(m ²)	100	100	100	100	100	25	100	100	100	100	100	100	100	100
Height of tree-1 layer(m)	11	10	12	17	10	5	8	15	8	15	10	8	11	8
Coverage of tree-1 layer(%)	80	70	80	90	75	75	60	60	85	85	60	50	70	95
dbh of highest tree(cm)	15	18	17	22	14	8	14	30	19	35	17	15	18	18
Height of tree-2 layer(m)	6	7	5	7	6	.	4	8	.	5	6	5	7	4
Coverage of tree-2 layer(%)	70	50	70	65	45	.	20	75	.	80	80	70	60	10
Height of shrub layer(m)	2	3	2	2	3	2	2	2	2	2	3	2	3	2
Coverage of shrub layer(%)	85	80	75	90	85	50	98	90	90	68	30	85	30	45
Height of herb layer(m)	0.5	0.5	0.5	0.5	0.8	0.5	0.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Coverage of herb layer(%)	90	90	50	80	40	60	98	40	100	90	80	95	90	100
Number of species	34	30	30	40	17	18	33	23	23	39	24	31	31	19

Character species of association

Quercus mongolica	T1:	4.4	3.3	3.3	4.4	3.3	3.3	4.4	3.3	.	5.5	3.3	2.2	3.3	3.3
	T2:	2.2	1.2	2.2	3.3	1.2	.	2.3	.	5.5	4.4	.	2.2	.	.
	S:	+	.	+	+	+	1.2	+	.	3.3	+	.	+	.	.
Rhododendron schlippenbachii	T2:	+	.	.	.	.	.	.	+	2.3	1.1	+	.	+2	+
	S:	2.2	2.2	3.3	.	2.3	.	1.2	1.2	3.3	2.2	1.2	1.2	+2	+
Melampyrum roseum	H:	3.3	1.2	.	.	1.2	.	4.4	1.2	.	3.3	+	.	+	2.2
Ainsliaea acerifolia	H:	.	1.2	+	2.3	.	.	.	.	2.3	+	+	.	.	.

Differential species of subassociations

Rhododendron yedoense var. poukhanense	S:	+	.	1.2	.	.	.	3.3	3.3	+	+
Sasa borealis	H:	+	.	+	.	.	.	1.2	3.3	2.2	2.2	3.3	3.3	5.5	

Character species of alliance

Acer pseudo-sieboldianum	T2:	+2	.	1.2	1.2	.	.	.	1.2	1.2	.	2.2	1.2	.	+
	S:	+	+	+	+	.	.	+	2.2	2.2	1.1	.	.	.	.
Carex lanceolata	H:	.	+	+	+	1.2	+	+	+	4.4	2.2	.	1.2	2.2	.
Artemisia keiskeana	H:	.	+	.	.	+	.	+	+	+	+	+	+	+	+
Fraxinus sieboldiana	T2:	.	.	.	.	.	.	+	1.2	.	.	+	.	2.3	+
	S:	.	.	+	+	.	.	2.2	1.2	1.2	+	+	.	1.2	+
Viola dissecta var. chaerophylloides	H:	+	+	+	+	.	+	+	.	+	+	.	.	.	+
Disporum smilacinum	H:	3.3	+	1.2	1.3	.	2.2	+	.	2.2	1.2	+2	.	2.2	2.2
Viola acuminata	H:	+	+	+	+	.	.	+	.	+	+	+	.	+	.
Carex siderostica	H:	+	+	.	2.3	.	.	+	.	1.2	1.2	.	+	+	.
Quercus serrata	T1T2:	.	1.2	.	±	+	.	1.2	1.2	.	.	.	1.2	2.2	.
Smilax china	H:	.	+	.	.	.	.	.	.	+	+	.	+	+	+
Prunus sargentii	T1T2:	+	±	+2	+	.	.	.	.	.	.	.	.	.	.
Fraxinus rhynchophylla	T2 S:	+	.	.	±	.	.	.	.	.	.	.	.	.	.

Companions

Quercus variabilis	T1:	2.2	3.3	2.2	2.2	2.2	2.2	1.2	1.2	.	1.1	.	.	1.2	3.3
	T2S:	.	+	1.2	+	±	±	.	.	.	.	.	.	+2	.
Mándera oblusiloba var. latiusculum	S:	1.2	+	+	+	.	+	+	+	.	+	+	+	.	.
	H:	.	+	+	+	.	.	+	+	+	+	+	.	.	.
Artemisia sylvatica	T2S:	±	.	.	2.3	.	+2	.	±	.	.	1.2	.	+	.
Styrax japonica	H:	1.2	.	+	+	.	+	.	.	+	2.3	.	+	.	.
Isodon inflexus	H:	.	.	+	+	+	.	+	+	.	.	+	.	+	.
Hosta longipes	H:	.	.	+	+	+	.	+	+	.	.	+	.	+	.
Lysimachia clethroides	H:	+	+	+	+	.	+	.	.	.	+	.	+	.	+
Indigofera kirilowii	H:	.	.	+	1.3	.	+	.	.	.	+	1.3	1.2	+	.

<i>Lespedeza bicolor</i>	H:	.	.	+	.	+	.	+	+	+	+	.	.	.	2.3
<i>Viburnum dilatatum</i>	S:	+	.	.	+	+	.	+	+	.	1.1	.	.	.	.
<i>Platycarya strobilacea</i>	T2S:	.	.	±	+	±	.	.	.	+	.	.	+.1	+.2	.
<i>Rhododendron mucronulatum</i>	S:	.	+	.	.	1.2	.	.	.	.	.	1.2	1.2	+	.
<i>Atractylodes japonica</i>	H:	+	+	.	+	+	.	+	.	.	.	.	.	.	+
<i>Styrax obassia</i>	T2:	1.2	.	.	.	.	.	.	.	.	.	.	.	1.2	.
	S:	1.2	.	.	.	+	.	.	.	.	1.1	.	+	+	.
<i>Symplocos chinensis</i> for. <i>pilosa</i>	S:	+	.	+	1.2	.	.	+	.	.	+	.	.	.	.
<i>Aster scaber</i>	H:	.	+	.	+	.	.	.	.	.	+	+	.	.	.
<i>Carpinus laxiflora</i>	T1:	.	.	.	.	+.2	.	.	2.2	.	.	+.2	.	+	.
	T2:	.	.	.	.	+.2	.	.	1.2	.	.	.	.	+.2	.
	S:	+	.	.	.	+	.	.	+	.	.	+	.	+	.
<i>Pinus densiflora</i>	T1S:	.	.	.	.	.	+	±	.	.	.	+	±	+.1	.
<i>Smilax nipponica</i>	H:	+	.	.	+	.	.	.	+	+	.	.	.	.	.
<i>Milium offusum</i>	H:	.	.	.	+	.	.	+	.	+	.	.	.	.	+
<i>Carpinus tschonoskii</i>	T2S:	+	±	.	.	.	.	+.2	.	.	2.2	.	.	.	.
<i>Carex okamotoi</i>	H:	.	.	2.2	+	.	.	2.2	+	.	.	.	.	.	.
<i>Vaccinium oldhamii</i>	S:	.	.	+	.	.	.	1.2	.	+	.	.	.	.	.
<i>Acer mono</i>	T2S:	+	.	.	±	.	.	.	.	.	.	±	.	.	+.2
<i>Lespedeza maximowiczii</i>	S:	.	.	.	.	+	1.2	.	.	.	.	.	.	+	+
<i>Oplismenus undulatifolius</i>	H:	1.2	.	.	+	.	.	.	.	.	1.1	.	.	.	.
<i>Clematis mandshurica</i>	H:	+	.	.	+	.	.	.	.	.	+	.	.	.	.
<i>Festuca ovina</i>	H:	.	.	.	+	.	.	2.2	+	.	.	.	.	.	.
<i>Galium trachyspermum</i>	H:	+	.	+	+	.	+	.	.	.	.	.	.	.	.
<i>Partrinia villosa</i>	H:	.	+	.	.	+	.	.	.	.	.	.	.	.	.
<i>Stephanandra incisa</i>	S:	.	.	.	.	.	.	.	.	.	+	.	+	.	.
<i>Miscanthus sinensis</i> var. <i>purpurascens</i>	H:	.	.	.	.	.	+	.	.	.	.	.	.	+	.
<i>Chrysanthemum zawadskii</i> var. <i>latilobum</i>	H:	.	.	.	.	.	+	.	.	.	.	.	.	+	.
<i>Cornus controversa</i>	T2S:	.	.	.	+	.	.	.	.	.	.	+	±	.	.
<i>Asarum sieboldii</i>	H:	.	.	.	.	.	.	.	+	.	.	.	.	.	.
<i>Syneilesis palmata</i>	H:	.	.	.	+	.	.	.	.	.	1.1	.	.	.	.
<i>Galium spurium</i>	H:	.	.	.	.	.	.	.	+	.	.	+	.	.	.
<i>Synurus deltoides</i>	H:	.	.	.	+	.	.	.	+	.	.	.	.	.	.
<i>Sapium japonicum</i>	T2S:	.	±	.	.	.	.	.	.	.	.	.	.	.	+.2
<i>Pyrola japonica</i>	H:	.	.	+	.	.	.	.	.	.	.	.	.	.	+
<i>Vitis flexuosa</i>	H:	.	.	.	.	.	+	.	.	.	.	.	.	.	+
<i>Hemerocallis</i>	H:	+	+	.	.	.	.	.	.	.	.	.	.	.	+

Rare species: *Cornus kousa*(12:T1+), *Rhus chinensis*(12:T2-1.2,S+), *Lilium tsingtauense*(12:H+), *Rubus crataegifolius*(12:H+), *Sedum polystichoides*(12:H+), *Potentilla flagarioides* var. *major* (12:H+), *Astilbe chinensis* var. *davidii*(12:H+), *Lindera erythrocarpa*(10:T2+,S+), *Iris nertschinskia*(10:H+), *Peucedanum terebithaceum*(7:H+), *Agrimonia pilosa*(7:H+), *Adenophora lamarckii*(7:H+), *Vitis coignetiae*(13:H+), *Liliope spicata*(13:H+), *Pueraria thunbergiana*(13:H+), *Adenophora triphillia* var. *japonica*(2:H+), *Desmodium oxyphyllum*(2:H+), *Aconitum chiisanense* (2:H+), *Staphylea bumalda*(1:H+), *Zanthoxylum schinifolium*(1:H+), *Euonymus sachalinensis*(4:S+), *Vitis thunbergii* var. *sinuata*(4:H+), *Rubus corchorifolius*(4:H+), *Codonopsis lanceolata* (4:H+), *Rhus trichocarpa*(11:T2-1.2), *Viscum album* var. *coloratum*(11:H+), *Saussurea seoulensis* (11:H+), *Ligustrum ibota*(6:S+), *Etsholtzia splendens*(6:H+), *Castanea crenata*(2:T1+), *Quercus aliena*(2:T2+), *Alnus hirsuta*(2:S+), *Rhus verniciflua*(8:S+), *Davallia nariesii*(8:H+), *Actinidia arguta*(14:T2+).

Date of survey: Relevé No.22-26; Aug.5,1985, No.42; Aug.7,1985, No.58; Aug.9,1985, No.65-66; May 17, 1986, No.71-75; May 25,1986, No.81; Jun.8,1986.

Note: M; middle part of slope, U; upper part of slope, T; top.

Table 5. Vegetation table of *Carpinetum laxiflorae*¹⁾ and *Daphniphyllum macropodium* community²⁾

Quercetalia serrato - mongolicae ord. nov.

Carpinion laxiflorae Kim et Yim 1986

1. *Carpinetum laxiflorae* Kim et Yim 1986

a. Typical subassociation

b. *Hydrangea serrata* for. *acuminata* subassociation

c. *Sasa borealis* subassociation

2. *Daphniphyllum macropodium* community

	1			2					
	a	b	c	1	2	3			
Serial number	1	2	3	4	5	6	7	8	9
Relevé number	16	27	29	51	21	36	1	31	13
Altitude(m)	300	650	450	600	500	400	250	400	280
Slope aspect	SW	N	N	N	E	N	N	N	N
Slope degree(°)	15	33	33	40	30	35	30	35	40
Topography	L	U	M	U	U	U	L	M	M
Quadrat size(m ²)	225	225	225	100	100	100	225	100	225
Height of tree-1 layer(m)	14	14	16	14	13	10	20	14	13
Coverage of tree-1 layer(%)	80	90	75	65	85	85	90	55	70
dbh of highest tree(cm)	39	22	63	26	65	25	67	37	45
Height of tree-2 layer(m)	7	8	8	8	7	6	8	8	7
Coverage of tree-2 layer(%)	40	40	50	70	60	50	60	90	30
Height of shrub layer(m)	3	3	3	3	3	3	5	3	2
Coverage of shrub layer(%)	25	30	30	90	45	30	15	15	30
Height of herb layer(m)	0.5	0.5	0.5	0.8	0.8	0.8	0.8	0.8	0.5
Coverage of herb layer(%)	50	70	60	70	50	80	60	85	40
Number of species	37	27	14	15	22	32	25	22	23

Character species of association

<i>Carpinus laxiflora</i>	T1:	3.3	3.3	3.2	4.4	3.2	4.4	4.4	2.2	.
	T2:	+2	1.2	.	2.2	+	.	3.3	.	.
	S:	+	.	.	+	+	.	.	.	.
<i>Viburnum dilatatum</i>	S:	+	+	+	+	+	1.2	+2	+	+2
<i>Rhus tricarpa</i>	S:	+	+	.	.	+	+	+	.	.
<i>Symplocos chinensis</i> for. <i>pilosa</i>	S:	+	+	.	.	.	+	.	+	.

Differential species of subassociations

<i>Hydrangea serrata</i>	S:	.	.	3.3	.	.	.	+	.	.
for. <i>acuminata</i>										
<i>Sasa borealis</i>	S:	.	.	.	3.3	3.3	3.3	4.4	4.4	.

Differential species of community

<i>Daphniphyllum macropodium</i>	T2:	.	.	.	.	.	.	+1	4.4	2.2
	S:	.	.	.	.	.	.	+2	+2	+
	H:	.	.	.	.	.	.	+2	.	+

Character species of alliance

<i>Lindera obfusiloba</i>	T1S:	+	+	+	+	1.2	1.2	1.2	+	+	+
<i>Stylax obassia</i>	T2:	.	+2	1.2	.	+2	+	.	+	.	
<i>Sapium japonicum</i>	T2S:	.	.	+	+	+	+	1.2	+2	+2	
<i>Euonymus sachalinensis</i>	T2S:	.	+	+	.	r	+	.	.	+	
<i>Stylax japonica</i>	T2:	2.3	.	.	.	+2	.	.	.	.
<i>Acer pseudo-sieboldianum</i> var. <i>koreanum</i>	T1T2:	+	+	.	1.2	.	.	.	.	2.2

Character species of order

<i>Dsporum smilacinum</i>	H:	+	.	.	+	+	+	.	+2	+
<i>Quercus serrata</i>	T1:	+2	.	.	1.2	2.2	.	1.2	1.1	.
	T2:	+	.	.	+	.	.	.	.	.
<i>Viola acuminata</i>	H:	+2	.	.	2.2	.	+	.	+	.
<i>Smilax china</i>	H:	+	.	.	.	+	+	.	+	.

<i>Prunus sargentii</i>	T1: 1.2	.	.	.	.	.	.	.	.
<i>Carex siederstroica</i>	H:	.	.	.	.	2.2	.	.	.
<i>Fraxinus rhynchophylla</i>	T2:	+	.	.	.	.	.	.	+
Companions									
<i>Lindera erythrocarpa</i>	T1:	+	2.2	.	.	.	+	.	1.2 1.1
	T2S:	±	±	.	±	±	.	.	+
<i>Oplismenus undulatifolius</i>	H:	2.2	.	.	.	+	1.2	+	2.2
<i>Acer pseudo-sieboldianum</i>	T2S:	.	.	.	.	±	1.2	1.2	+
<i>Acer mono</i>	T1S:	±	±.2	1.1	.	.	.	1.1	.
<i>Indigofera kirilowi</i>	H:	+	.	.	.	.	+	+	.
<i>Cornus controversa</i>	T1:	.	2.2	2.2	.	.	.	.	1.1 1.2
<i>Zanthoxylum piperitum</i>	T2S:	+	.	.	.	.	+	±	.
<i>Dioscorea batatas</i>	H:	+	+	.	.	.	.	.	.
<i>Rhododendron schlippenbachii</i>	S:	.	.	.	1.2	1.2	+	.	.
<i>Polystichum tripterum</i>	H:	.	.	.	.	.	.	+	.
<i>Arisaema ringens</i>	H:	.	+	.	.	.	.	.	1.2
<i>Fraxinus sieboldiana</i>	T1T2:	1.2	.	.	.	±.2	.	.	.
<i>Galium trachispermum</i>	H:	+	.	.	.	.	+	.	.
<i>Ainstiaea acerifolia</i>	H:	.	+	.	.	.	.	.	±.2
<i>Alangium platanifolium</i>									
<i>var. macrophyllum</i>	S:	.	+	+	.	.	.	.	±.2
<i>Smilax sieboldii</i>	H:	.	.	.	.	.	.	.	+
<i>Carpinus tschonoskii</i>	T1:	.	+	.	.	.	.	.	2.2
<i>Actinidia arguta</i>	T2:	.	.	.	.	.	.	.	±.1
<i>Arisaema angustatum</i>									
<i>var. peninsulæ</i>	H:	+	+	.	.	.	.	.	.
<i>Vitis amurensis</i>	H:	+	.	.	.	.	.	.	.
<i>Thalictrum acutaefolium</i>	H:	+	.	.	.	.	.	.	.
<i>Stephanandra incisa</i>	S:	.	+	.	.	.	.	.	.
<i>Flaxinus mandshurica</i>	T1:	.	+	1.1	.	.	.	.	.
<i>Quercus variabilis</i>	T2S:	.	.	.	.	.	.	.	.
<i>Rhododendron mucronulatum</i>	S:	.	.	.	1.2	1.2	.	.	.
<i>Albizia julibrissin</i>	T2H:	±.2	.	.	.	.	.	.	.
<i>Viola dissecta</i>									
<i>var. chaerophylloides</i>	H:	+	.	.	.	.	.	.	.
<i>Athyrium squamigerum</i>	H:	.	.	.	.	.	.	.	.
<i>Lysimachia clethroides</i>	H:	.	.	.	.	.	.	.	.
<i>Arisaema amurense</i>	H:	.	+	.	.	.	.	.	1.1

Rare species: *Quercus aliena*(1:T1-2.2,S-+), *Weigelia subsessilis*(1:S-+), *Platicarya strobilacea*(6:T1-1.2), *Lespedeza bicolor*(6:S-+,H-+), *Lespedeza maximowiczii*(6:S-+), *Disporum viridescens*(2:H-+), *Thalictrum aquilegifolium*(2:H-+), *Vicia unijuga*(2:H-+), *Clematis apiifolia*(2:H-+), *Pseudostellaria palibiniana*(2:H-+), *Bidens bipinnata*(2:H-+), *Vitis flexuosa*(1:H-+), *Syneilesis palmata*(1:H-+), *Liriope platyphylla*(1:H-+), *Hosta longipes*(1:H-+), *Prunella vulgaris var. lilacina*(1:H-+), *Spodiopogon cotulifer*(1:H-+), *Ampelopsis brevipedunculata var. heterophylla*(6:H-+), *Lespedeza cyrtobotrya*(5S-+), *Quercus mongolica*(4:T1-+), *Chrysanthemum indicum*(1:H-+), *Liriope spicata*(1:H-+), *Aster scaber*(1:H-+), *Carex lanceolata*(4:H-1.2), *Staphylea bumalda*(2:T2-+,S-+), *Polygonatum odoratum var. pluriflorum*(2:S-+), *Zelkova serrata*(7:T2-+.1), *Callicarpa japonica*(7:S-2.1), *Carpinus cordata*(7:T2-+.1), *Cornus kousa*(8:T2-+.1), *Cornus walteri*(7:T1-+.1), *Lindera oblusiloba*(9:S-+), *Cephalotaxus koreana*(7:H-+), *Euonymus macroptera*(7:T2-+), *Celtis sinensis*(7:S-2.1), *Cimicifuga beracleifolia*(3:H-+), *Oxalis obtriangulata*(9:H-+), *Davallia mariesii*(9:H-+), *Clerodendron trichotomum*(3;H-+), *Sorbus alnifolia*(9:T2-+).

Date of survey: Relevé No.13; Aug.4,1985, No.16,29; Aug.5,1985, No.31,36; Aug.6,1985, No.51; Aug.8,1985, No. 1; Jun.6,1985.

Note: L; lower part of slope, M; middle part of slope, U; upper part of slope.

Companions												
Lindera erythrocarpa	T2:	.	+ .2	.	.	.	1.2	+	1.2	.	.	+
	SH:	.	+ ±	+	±	+	.	+	2.2	.	.	1.2
Acer pseudo-sieboldianum	T2:	.	.	+	2.3	2.3	.	1.2	2.2	+ .2	+	.
	S:	.	.	+ .1	.	2.2	.	2.2	2.2	+	.	.
Cornus controversa	T1:	1.1	.	.	1.2	.	.	.	+ .1	.	.	.
	T2S:	.	+	.	+	±	.	+ ±	.	.	.	±
Galium trachyspermum	H:	+	+	+	+	.	+	+	+	.	.	+
Rhus verniciflua	T2S:	.	.	+	.	+ ±	.	+	+	.	±	+ ±
Viburnum dilatatum	S:	.	.	.	.	+	+	+	+	1.2	.	+
Lespedeza bicolor	H:	.	+	.	.	+	+	+	1.3	.	.	+
Viola dissecta												
var. chaerophylloides	H:	.	+	+	+	.	+	.	+	.	.	+
Oplismenus undulatifolium	H:	.	2.2	.	+	+	+	+	.	.	.	2.2
Fraxinus sieboldiana	T2S:	.	.	± +	+ .2	+	.	.	+	.	+	.
Carex lanceolata	H:	+	.	+	.	+	.	.	+	.	.	+
Desmodium oxyphyllum	H:	+	.	+	.	+	+	+	.	.	.	.
Cephalanthera longibracteata	H:	.	.	+	+	.	.	+	.	.	.	+
Convallaria keiskei	H:	.	.	.	.	.	+	.	+	+	.	+
Staphylea bumalda	S:	.	.	.	.	.	+	+	.	.	+	+
Thalictrum acutaefolium	H:	.	+	.	+	.	+	.	.	.	.	+
Castanea crenata	T1T2:	.	1.1	.	±	.	1.2	.	.	+	.	.
Weigelia subsessilis	S:	.	.	+	.	.	.	+	.	.	.	+
Symplocos chinensis for. pilosa	S:	.	.	+	.	.	.	.	.	.	+	.
Albizia julibrissin	T1S:	.	.	+	+	.	+ .1	.	.	.	.	.
Acer mono	T1T2:	.	.	1.2	+	.	+ .1	.	.	.	.	+
Rhododendron schlippenbachii	S:	.	.	.	.	1.2	.	+	+	.	.	.
Callicarpa japonica	S:	.	+	.	+	.	.	+	.	.	.	.
Ainsliaea acerifolia	H:	.	.	.	.	.	.	+	+	.	.	+
Smilax nipponica	H:	.	.	.	+	.	.	+	.	.	.	+
Pteridium aquilinum												
var. latiusculum	H:	.	.	.	.	+	.	+	.	.	.	+
Vitis flexuosa	H:	.	+	.	.	.	.	.	+	.	.	+
Melampyrum roseum	H:	+	.	.	.	+	.	.	+	.	.	.
Codonopsis lanceolata	H:	.	.	.	.	+	+	.	.	.	.	3.3
Zelkova serrata	T1T2:	2.2	1.2	.	1.1	.	.	.	.	.	.	.
Rhus trichocarpa	T2S:	.	.	.	+ ±	.	.	.	.	+ .2	+	.
Seltis sinensis	T1T2:	.	±	.	±	.	+ .2	.	.	.	.	.
Platycarya strobilacea	T1:	.	.	.	.	.	1.2	.	.	.	1.2	+
Corylus heterophylla												
var. thunbergii	S:	.	+ .2	.	+	.	.	.	.	.	.	+
Quercus variabilis	T1:	.	1.2	.	1.1	.	.	.	.	.	1.2	.
Alnus hirsuta	S:	.	+	+	.	.	.	.	.	.	.	.
Carpinus cordata	T2S:	.	.	.	+	.	.	+	±	.	.	.
Lysimachia clethroides	H:	.	.	+	.	.	.	.	.	.	.	+
Cocculus trilobus	H:	.	+	+	.	.	.	.	.	.	.	.
Arisaema angustatum												
var. peninsulae	H:	.	1.2	.	.	.	+	.	.	.	.	.
Athyrium squamigerum	H:	.	.	.	.	+	.	+	.	.	.	.
Viola manshurica	H:	+	.	.	.	.	.	+	.	.	.	.
Adenocaulon himalaicum	H:	.	.	.	.	+	.	+	.	.	.	.
Malus baccata	T2:	.	+ .2	.	.	.	.	+	.	.	.	.
Rhododendron yedoense												
var. poukhanense	S:	.	.	.	.	1.2	.	1.2	.	.	.	.
Vitis coignetiae	H:	.	+	.	.	.	.	.	±	.	.	.
var. maculata	H:	.	+	.	.	.	.	.	±	.	.	.
Hosta longipes	H:	.	.	.	+	+	.	.	.	.	.	.
Saussurea seoulensis	H:	.	.	.	.	+	.	.	.	.	.	+
Vicia unijuga	H:	.	.	.	.	.	+	.	.	.	.	+
Torreya nucifera	T2S:	.	1.2	.	.	.	+	±	.	.	.	.
Rhus chinensis	S:	.	+	.	.	.	+	.	.	.	.	.
Ligustrum ibota	S:	.	.	.	.	.	+	.	.	.	.	2.2
Zanthoxylum piperitum	S:	.	+	.	.	.	+	.	.	.	.	.

<i>Arisaema amurense</i>	H:	.	.	.	+	.	+	.	.	.	.	.
<i>Asarum sieboldii</i>	H:	.	.	.	.	.	+	.	.	.	.	+
<i>Isodon inflexus</i>	H:	.	.	.	.	.	+	.	.	.	.	+
<i>Aster scaber</i>	H:	.	.	.	.	.	+	.	.	.	.	+
<i>Lespedeza maximowiczii</i>	S:	.	.	.	+	.	.	.	.	.	.	+
<i>Syneilesis palmata</i>	H:	.	.	.	+	.	.	.	.	.	.	+
<i>Dioscolea batates</i>	H:	.	+	.	.	.	.	.	.	.	.	+
<i>Akebia quinata</i>	H:	.	+	.	.	.	.	.	.	.	.	+
<i>Pueraria thunberiana</i>	H:	.	+	.	.	.	.	.	.	.	.	+

Rare species: *Alangium platanifolium* var. *macrophyllum*(7:S→), *Lastrea thelypteris* (7:H→), *Osmunda japonica*(7:H→), *Davallia mariesii*(7:H→), *Zingiber mioga*(7:H→), *Lstrea laxa*(7:H→), *Disporum smilacinum*(8:H→), *Betula schmidtii*(8:T2→), *Corylus sieboldiana*(5:S→), *Galium pogonanthum*(5:H→), *Hemerocallis fulva*(5:H→), *Aster scaber*(5:H→), *Artemisia keiskeana*(5:H→), *Artemisia princeps*(1:H→), *Ilex macropoda*(9:T1→.1,T2→), *Cornus kousa*(9:T2→), *Rubus crataegifolius*(6:S→), *Rosa multiflora*(6:S→), *Clematis trichotoma*(6:H→), *Saussurea grandifolia*(6:H→), *Arisaema heterophyllum*(6:H→), *Pseudostellaria palibiniana*(6:H→), *Tilia amurensis*(4:T2→), *Meliosma oldhamii*(4:S→), *Patrinia villosa*(4:H→), *Liliope platyphylla*(4:H→), *Maackia amurensis*(2:S→), *Etsholtzia splendens*(2:H→), *Liliope spicata*(2:H→), *Commelina communis*(2:H→), *Asparagus schoberoides*(2:H→), *Pinus densiflora*(10:T1→.2, T2→), *Aralia elata*(11:S→), *Hydrangea serrata* var. *acuminata*(11:S→,H→), *Euonymus alatus*(11:S→), *Vitis thunbergii* var. *sinuata*(11:H→), *Veratrum maackii* var. *japonicum*(11:H→), *Securinega suffruticosa*(11:H→), *Poris verticillata*(11:H→), *Millium effusum*(11:H→), *Patrinia scabisaefolia*(11:H→), *Disporum sessile*(11:H→), *Agrimonia pilosa*(11:H→), *Ampelopsis brevipedunculata* var. *heterophylla*(11:H→), *Arabis glabra* (11:H→), *Phiopogon japonicus*(11:H→), *Lathyrus davidii*(11:H→), *Cephalanthera falcata*(11:H→), *Atractylodes japonica*(11:H→), *Geranium sibiricum*(11:H→), *Clematis mandshurica*(11:H→), *Tricyrtis dilatata*(11:H→).

Date of survey: Relay No.2-6; Aug.4,1985, No.45; Aug.7,1985, No.54; Aug.9,1985, No.69, 89; May25,1986, No.77-79; Jun.8,1986, No.86; Jul.17,1986.

Note: L; lower part of slope, M; middle part of slope V; valley, F; flatland.

Table 7. Vegetation table of Corno - Linderetum erythrocarpae
 Quercetalia serrato - mongolicae ord. nov.

Corno - Zelkovion serratae all. nov.

Corno - Linderetum erythrocarpae ass. nov.

a. Hydrangea serrata for. acuminata subassociation

b. Sasa borealis subassociation

Serial number	a			b		
	1	2	3	4	5	6
Releve number	68	28	32	43	33	35
Altitude(m)	350	550	300	600	250	330
Slopr aspect	SE	N	N	SW	N	N
Slope degree(°)	5	35	35	28	30	27
Topography	L	M	M	V	L	L
Quadrat size(m ²)	100	225	100	225	100	225
Height of tree-1 layer(m)	22	15	11	16	10	15
Coverage of tree-1 layer(%)	80	80	80	70	80	85
dbh of highest tree(cm)	36	28	33	31	22	39
Height of tree-2 layer(m)	8	7	6	8	5	7
Coverage of tree-2 layer(%)	40	40	50	60	60	50
Height of shrub layer(m)	2	3	3	3	2	3
Coverage of shrub layer(%)	30	30	25	50	40	25
Height of herb layer(m)	0.5	0.5	0.8	0.8	0.8	0.8
Coverage of herb layer(%)	40	60	75	80	85	80
Number of species	22	24	25	33	36	32

Character species of association

Lindera erythrocarpa	T1:	3.2	3.2	2.2	3.3	2.2	2.2
	T2S:	±	.	.	2.2	.	+
Cornus controversa	T1:	3.2	+	2.2	+	.	2.2
	T2S:	+ ±	.	.	+	.	+
Alangium platanifolium	S:	+	1.2	.	1.2	.	1.2
var. macrophyllum	H:	+	+	.	.	.	+
Arisaema amurense	H:	+	+	+	.	.	.

Differential species of subassociations

Hydrangea serrata	u.	0.2	0.2	±	.	.
var. acuminata						
Polysticum tripterum	H:	2.3	+	.	+	.
						+
Sasa borealis	H:	.	.	+	3.3	4.4
					3.3	

Character species of alliance

Oplismenus undulatifolius	H:	+	+	+	+	+	+
Acer mono	T1:	.	1.2	.	1.2	+	2.2
	T2:	.	+	.	.	.	2.2
Staphylea bumalda	S:	2.3	.	.	+	+	.
Zelkova serrata	T1:	2.1	.	.	.	.	+
	T2S:	1.2	.	.	+ ±	.	+
Zanthoxylum piperitum	S:	.	.	.	+	+	.

Character species of order

Viola acuminata	H:	+	+	+	.	+	+
Fraxinus rhynchophylla	T1S:	.	.	1.1	1.1	±	+
Disporum smilacinum	H:	.	+	.	.	.	+

Companions

Viburnum dilatatum	S:	.	+	+	+	+	+
Lindera oblusiloba	T2S:	+	+ .2	.	+	1.1	+
Daphniphyllum macropodum	T2S:	1.2	.	1.2	.	.	.
Meliosma myriantha	T1S:	±	.	2.2	.	.	.
Celtis serrata	T1:	.	+	.	3.3	.	+
Clematis apiifolia	H:	.	+	+	.	+	.
Desmodium oxyphyllum	H:	.	.	+	+	.	+
Ainsliaea acerifolia	H:	+	.	.	.	+	+
Sapium japonicum	T2S:	.	+ ±	1.2	.	±	.
Carpinus laxiflora	T1T2:	.	1.1	+ ±	.	.	+ ±

<i>Meliosma oxyphyllum</i>	T2:	.	.	.	+	+ .1	.
<i>Euonymus sachalinensis</i>	T2S:	.	+	±	.	.	.
<i>Albizzia julibrissin</i>	T1:	.	.	+	.	.	+
<i>Persicaria filiforma</i>	H:	+	.	.	+	.	.
<i>Galium trachyspermum</i>	H:	+	1.2	.	+	+	.
<i>Athyrium conilii</i>	H:	+	.	.	.	+	.
<i>Smilax china</i>	H:	.	.	.	+	+	.
<i>Isodon inflexus</i>	H:	.	+	.	+	.	.
<i>Dioscolea batates</i>	H:	.	.	.	+	+	.
<i>Vitis coignetiae</i>	H:	.	.	.	+	.	+
<i>Smilax nipponica</i>	H:	.	+	.	.	+	.
<i>Rhus chinensis</i>	S:	.	.	+	.	+	.
<i>Polygonatum odoratum</i>							
var. <i>pluriflorum</i>	H:	.	.	+	.	.	+
<i>Styrax japonica</i>	T2:	.	.	.	.	1.2	+
<i>Torreya nucifera</i>	S:	.	.	.	.	1.2	+
<i>Ampelopsis brevipedunculata</i>	H:	.	.	.	.	+	+
var. <i>heterophylla</i>							
<i>Smilax sieboldii</i>	H:	.	.	.	.	+	+
<i>Faxinus mandshurica</i>	T1:	.	1.2	.	+	.	.

Rare species: *Cornus walteri*(4:T1-1.1), *Pseudostellaria pali-*
biniana(6:H→), *Zanthoxylum schinifolium*(4:S→), *Acer pseudo-*
sieboldianum(2:T1→,T2→), *Actinidia arguta*(2:T1→, S→), *Sor-*
bus alnifolia(2:T2→), *Flaxinus sieboldiana*(3:T1→), *Stylax*
obassia(3:T1→,T2→), *Clerodendron trichotomum*(3:T2→,S→),
Davallia mariesii(1:H→), *Dryopteris crassirhizoma*(1:H-2.2),
Disporum sessile(1:H→), *Athyrium squamigerum*(1:H→), *Oxalis*
obtriangulata(1:H→), *Arisaema ringens*(4:H→), *Cayratia japo-*
nica(4:H→), *Boehmeria nivea*(4:H→), *Persicaria vulgaris*(4:H→
+), *Pilea mongolica*(4:H→), *Impatiens textori*(4:H→), *Sedum*
polystichoides(4:H→), *Potentilla frexyniana*(4:H→), *Colylus*
sieboldiana(3:T2→), *Lespedeza bicolor*(3:S→), *Hosta longipes*
(3:H→), *Rubus crataegifolius*(3:H→), *Quercus serrata*(5:T1-
1.2,T2→), *Maackia amurensis*(5:T1→), *Carpinus tschonoskii*(5:
T1→), *Corylus heterophylla* var. *thunbergii*(5:T2→.1,S→),
Symplocos chinensis(5:S→), *Stephanandra incisa*(5:S→), *Isodo-*
n excisus(5:H→), *Parthenocissus tricuspidata*(5:H→), *Osmund*
a japonica(5:H→), *Viola dissecta* var. *chaerophylloides*(5:H→)
Atractylodes japonica(5:H→), *Melampyrum roseum*(5:H→), *Lili-*
ope spicata(6:H→), *Arisaema angustatum* var. *peninsulae*(6:H→)
Vitis flexuosa(6:H→), *Akebia quinata*(6:H→), *Cocculus trilobus*
(6:H→), *Urtica thunbergiana*(6:H→), *Rubia akane*(6:H→).

Date of survey: Relevé No.28; Aug.5,1985, No.32-35; Aug.6,1985,
No.43; Aug.7,1985, No.68; May17,1986.

Note: L; lower part of slope, M; middle part of slope, V; valley.

Table 8. Vegetation table of *Torreya - Zelkovetum serratae*
Quercetalia serratae - mongolicae ord. nov.
Corno - Zelkovion serratae all. nov.
Torreya - Zelkovetum serratae ass. nov.
a. Typical subassociation
b. *Thea sinensis* facies
c. *Sasa borealis* subassociation

	a			b		c	
	1	2	3	4	5	6	7
Serial number	1	2	3	4	5	6	7
Relevé number	12	87	38	39	46	48	47
Altitude(m)	370	400	300	400	300	300	200
Slope aspect	S	SW	S	S	SE	E	N
Slope degree(°)	20	15	25	40	25	20	25
Topography	L	M	M	M	M	M	L
Quadrat size(m ²)	225	400	225	225	225	225	225
Height of tree-1 layer(m)	12	20	13	17	12	13	16
Coverage of tree-1 layer(%)	93	90	75	70	65	90	80
dbh of highest tree(cm)	74	76	48	35	43	45	38
Height of tree-2 layer(m)	.	.	7	8	.	8	9
Coverage of tree-2 layer(%)	.	.	45	50	.	40	25
Height of shrub layer(m)	1.5	1.5	3	3	3	3	3
Coverage of shrub layer(%)	20	10	25	30	85	35	40
Height of herb layer(m)	0.5	0.3	0.5	0.5	0.8	0.8	0.8
Coverage of herb layer(%)	100	90	60	70	80	95	90
Number of species	29	26	28	25	37	30	32

Character species of association

<i>Torreya nucifera</i>	T1:	5.5	5.5	3.3	3.2	4.4	4.3	3.3
	T2:	.	.	+2	.	.	1.2	+2
	S:	+	.	+	.	+	+	.
<i>Adenocaulon himalaicum</i>	H:	3.3	5.5	.	.	.	+	.
<i>Disporum sessile</i>	H:	1.2	1.3	.	.	.	.	+

Differential species of subassociations

<i>Thea sinensis</i>	S:	.	.	.	.	3.3	.	.
<i>Sasa borealis</i>	H:	+	.	.	.	2.2	3.3	3.3

Character species of alliance

<i>Oplismenus undulatifolius</i>	H:	.	1.3	2.2	2.2	2.2	+	+
<i>Thalictrum acutaefolium</i>	H:	+	1.2	+	.	+	+	+
<i>Zelkova serrata</i>	T1:	.	.	+	1.1	.	.	2.1
	T2S:	±	.	+ ±	2.2	+ ±	.	.
<i>Zanthoxylum piperitum</i>	S:	.	.	.	.	1.2	+	.
<i>Staphylea bumalda</i>	S:	.	.	.	.	+	.	+
<i>Acer mono</i>	T2S:	.	.	.	.	+ ±	+ ±	.

character species of order

<i>Viola acuminata</i>	H:	.	.	+	.	+	.	.
<i>Smilax china</i>	H:	+	.	.	.	+	.	.
<i>Fraxinus rhynchophylla</i>	S:	+	.	+	.	.	.	.

Companions

<i>Acer pseudo-sieboldianum</i> var. <i>koreanum</i>	T1:	.	1.2	2.2	3.2	1.1	+	3.2
	T2S:	.	.	1.2	1.2	±	+ ±	.
<i>Alangium platanifolium</i> var. <i>macrophyllum</i>	S:	+2	.	1.2	.	.	+	1.2
<i>Albizia julibrissin</i>	S:	+	.	.	.	+	+	+
<i>Viburnum dilatatum</i>	S:	.	.	+	.	+	+	+
<i>Dioscolea batatas</i>	H:	.	.	+	.	+	+	+
<i>Akebia quinata</i>	H:	.	.	+	.	+	+	+
<i>Meliosma myriantha</i>	T2S:	±	±	.	.	.	.	+
<i>Stephanandra incisa</i>	S:	+	.	.	.	+	+	.
<i>Lindera erythrocarpa</i>	T1S:	.	±	+	.	.	±	.
<i>Lindera obtusiloba</i>	S:	.	.	1.2	.	+	.	+

<i>Galium trachyspermum</i>	H:	.	.	+	.	+	+	+
<i>Commelina communis</i>	H:	.	.	+	+	+	.	.
<i>Ligusturum ibota</i>	S:	.	.	.	+	.	+	+
<i>Quercus aliena</i>	T1S:	.	.	.	.	+	±	1.2 1.2
<i>Desmodium oxyphyllum</i>	H:	.	+	.	.	.	+	+
<i>Disporum smilacinum</i>	H:	.	+	.	.	.	.	+
<i>Isodon inflexus</i>	H:	.	+	.	.	.	.	+
<i>Patrinia villosa</i>	H:	.	+	.	.	.	.	.
<i>Vitis coignetiae</i>	H:	.	.	.	.	+	+	.
<i>Lysmachia clethroides</i>	H:	.	.	.	.	+	+	.
<i>Cornus controversa</i>	T1:	.	.	.	.	+	2.2	.
<i>Osmunda japonica</i>	H:	.	.	.	+	.	.	1.2
<i>Trachelospermum asiaticum</i>								
var. <i>intermedium</i>	S:	.	.	.	.	2.2	+	2.3
<i>Hedera rhombea</i>	S:	.	.	.	.	+	+	+
<i>Orixa japonica</i>	S:	.	.	.	.	+	+	+
<i>Ampelopsis brevipedunculata</i>								
var. <i>heterophylla</i>	H:	.	.	+	.	+	.	.
<i>Smilax sieboldii</i>	H:	.	.	+	+	.	.	.
<i>Liriope platyphylla</i>	H:	+	.	.	.	.	.	+
<i>Viola dissecta</i>								
var. <i>chaerophylloides</i>	H:	+	+	.	.	.	.	.
<i>Aster scaber</i>	H:	+	.	.	.	.	.	+
<i>Parthenocissus tricuspidata</i>	H:	+	.	.	+	.	.	.
<i>Potentilla flagaroides</i>								
var. <i>major</i>	H:	+	.	.	.	.	+	.
<i>Rhus chinensis</i>	S:	.	.	.	+	+	.	.
<i>Euonymus sachalinensis</i>	S:	.	+	+	.	.	.	.
<i>Cudrania tricuspidata</i>	S:	.	.	1.2	.	+	.	.
<i>Kalopanax pictus</i>	S:	+	.	+	.	.	.	.
<i>Rhus tricocarpa</i>	S:	1.2	.	.	.	1.2	.	.
<i>Persicaria filiforma</i>	H:	+	.	.	+	.	.	.

Rare species: *Chionanthus retusa*(3:T1→), *Corylus heterophylla* var. *thunbergii*(3:S→), *Cherodendron trichotomum*(3:S→), *Quercus variabilis*(4:T1-2.2), *Pyrus pyrifolia*(4:T2→), *Sorbus alnifolia*(4:T2→), *Smilax nipponica*(1:H→), *Isodon excisus*(4:H→), *Bidens bipinnata*(1:H→), *Persicaria vulgaris*(1:H→), *Vicia unijuga*(1:H→), *Arabis glabra*(1:H→), *Arisaema amurense*(1:H→), *Disporum viridescens*(1:H→), *Vitis flexuosa*(1:H→), *Cocculus trilobus*(3:H→), *Amphicarpaea edgeworthii* var. *perma*(3:H→), *Lilium leichtlinii* var. *tigrinum*(3:H→), *Cayratia japonica*(3:H→), *Symplocos chinensis*(4:S→), *Artemisia princeps* var. *orientalis*(4:H→), *Asparagus schoberioides*(4:H→), *Morus bombycis*(4:H→), *Persicaria hydropiper*(4:H→), *Ainsliaea acerifolia*(4:H→), *Zingiber mioga*(4:H→), *Boehmeria nivea*(4:H→), *Achyranthes japonica*(4:H→), *Plantago asiatica*(4:H→), *Oxalis corniculata*(4:H→), *Zanthoxylum schinifolium*(5:S→), *Lespedeza maximowiczii*(5:S→), *Clerodendron trichotomum*(5:S→), *Syneilesis palmata*(5:H→), *Youngia denticulata*(5:H→), *Artemisia keiskeana*(5:H→), *Dioscorea quinqueloba*(5:H→), *Rhus verniciflua*(7:T2→), *Tripterygium regelii*(7:S→), *Acanthopanax sessiliflorus*(7:S→), *Liriope spicata*(7:H→), *Poris verticillata*(7:H→), *Pyrola japonica*(7:H→), *Menispermum dauricum*(7:H→), *Celtis sinensis*(6:T1-2.2), *Pururus sargentii*(6:T1→), *Carpinus laxiflora*(6:T2→), *Callicarpa japonica*(6:S→), *Rubus coreanus*(6:H→), *Clematis apiifolia*(6:H→), *Alaria elata*(2:S→), *Carpinus tschonoskii*(2:S→), *Boehmeria tricuspis*(2:S→), *Rubus crataegifolius*(2:S→), *Broussonetia kazinoki* var. *humilis*(2:S→), *Clematis trichotoma*(2:H→), *Polysticum tripteris*(2:H1.3), *Lastrea thelypteris*(2:H→), *Cephalanthera falcata*(2:H→), *Arisaema angustatum* var. *peninsulae*(2:h→), *Vitis amurensis*(2:H→), *Securinega suffruticosa*(2:S→, 3:S→).
Date of survey; Relevé No.12; Aug.4, 1985, No.38-39; Aug.7, 1985, No.46-48; Aug.8, 1985, No.87; Jul.17, 1986.

Note: L; lower part of slope, M; middle part of slope.

Table 9. Vegetation table of *Acero - Zelkovetum serratae*
Quercetalia serrato - mongolicae ord. nov.

Corno - Zelkovion serratae all. nov.

Acero - Zelkovetum serratae ass. nov.

a. Typical subassociation

b. *Sasa borealis* subassociation

Serial number	a			b		
	1	2	3	4	5	6
Releve number	14	40	37	11	30	67
Altitude(m)	290	500	220	400	350	500
Slope aspect	NE	SW	S	S	N	SE
Slope degree(°)	20	28	27	15	35	37
Topography	L	M	L	V	L	M
Quadrat size(m ²)	225	100	225	400	225	400
Height of tree-1 layer(m)	13	16	14	17	16	25
Coverage of tree-1 layer(%)	65	70	85	80	85	75
dbh of highest tree(cm)	27	43	32	68	36	47
Height of tree-2 layer(m)	7	8	8	7	10	8
Coverage of tree-2 layer(%)	45	50	65	50	45	45
Height of shrub layer(m)	2	3	3	3	3	3
Coverage of shrub layer(%)	25	50	20	40	30	40
Height of herb layer(m)	0.8	0.5	0.5	0.8	0.8	0.8
Coverage of herb layer(%)	25	40	75	70	45	30
Number of species	17	30	30	30	22	26

Character species of association

Zelkova serrata	T1:	4.4	3.2	3.2	3.2	2.2	3.3
	T2S:	±	+	.	+ ±	.	.
Polystichum tripteron	H:	+	.	.	+	1.2	.
Acer mono	T1:	1.2	2.2	+	2.2	+	1.2
	T2:	+	.	.	.	.	+
Celtis sinensis	T1:	1.2	.	+	2.2	+	.
	S:	.	.	+	.	.	.
Hydrangea serrata for. acuminata	H:	2.2	.	.	+	+	.

Differential species of subassociation

<i>Sasa borealis</i>	H:	.	.	+	3.3	2.2	2.3
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Character species of alliance

<i>Oplismenus undulatifolius</i>	H:	1.2	+	3.3	2.2	.	+
<i>Thalictrum acutaefolium</i>	H:	+	.	+	+	.	+
<i>Staphylea bumalda</i>	S:	.	.	+	+	.	+
<i>Zanthoxylum piperitum</i>	H:	.	+	.	.	.	+

Character species of order

<i>Viola acuminata</i>	H:	.	.	+	+	.	+
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Companions

<i>Alangium platanifolium</i> var. <i>macrophyllum</i>	S:	1.2	.	.	1.2	1.2	+
<i>Torreya nucifera</i>	T2:	.	+ .2	+ .2	.	.	.
	T1S:	±	2.1	.	+	.	.
<i>Lindera erythrocarpa</i>	T1:	+	+	.	1.1	+	1.2
	T2:	.	+	.	1.2	.	+
	S:	+	.	+	+	.	2.2
<i>Lindera oblusiloba</i>	T2:	1.2	.	.	+	.	2.2
	S:	1.2	1.2	+	+	.	+
<i>Cornus controversa</i>	T1S:	.	.	+ .2	±	.	1.2
<i>Akebia quinata</i>	H:	.	+	+	+	.	.
<i>Parthenocissus tricuspidata</i>	H:	+	+	+	.	.	.
<i>Acer pseudo-sieboldianum</i> var. <i>koreanum</i>	T1:	1.1	.	2.2	2.2	.	.
	T2:	+	.	2.2	+	.	.
<i>Isodon excisus</i>	H:	+	.	.	+	.	.
<i>Disporum sessile</i>	H:	.	.	+	+	.	.
<i>Persicaria hydropiper</i>	H:	.	.	+	+	.	.
<i>Achyranthes japonica</i>	H:	.	+	+	.	.	.
<i>Persicaria filiformis</i>	H:	.	.	+	+	.	.
<i>Plantago asiatica</i>	H:	.	.	+	+	.	.

<i>Rhus verniciflua</i>	T2S:	.	.	+	±	.	.
<i>Lysimachia clethroides</i>	H:	.	+	.	+	.	.
<i>Desmodium oxyphyllum</i>	H:	.	+	+	.	.	.
<i>Disporum viridescens</i>	H:	.	.	.	+	+	.
<i>Ainsliaea acerifolia</i>	H:	.	.	.	.	+	+
<i>Sapium japonicum</i>	T2S:	+	±	1.2	.	.	.
<i>Styrax japonica</i>	T1S:	.	.	.	±	+	1.2
<i>Euonymus sachalinensis</i>	S:	.	.	.	.	+	+
<i>Corylus heterophylla</i>	S:	.	.	1.1	.	.	+
<i>Quercus aliena</i>	T1:	.	.	+	.	.	+

Rare species: *Styrax obassia*(6:T1-1.2), *Quercus variabilis* (6:T1-+), *Lespedeza bicolor*(6:T2-+), *Carpinus tschonoskii* (6:T1-+, S-+), *Actinidia arguta*(6:S-+), *Fraxinus mandshurica*(5:T1-3.3), *Carpinus laxiflora*(5:T1-2.2, S-+), *Carpinus cordata*(5:T2-1.2), *Meliosma myriantha*(5:T2-+), *Quercus serrata*(5:T2-+), *Sorbus alnifolia*(5:S-+), *Viburnum dilatatum*(5:S-1.2), *Daphniphyllum macropodum*(5:S-+), *Chionanthus retusa*(2:T1-3.2), *Cornus walteri*(2:T1-1.1), *Meliosma oldhamii* (2:T2-+), *Ligustrum ibota*(2:S-+), *Rhus trichocarpa*(2:S-+), *Morus bombycis*(2:S-+), *Clerodendron trichotomum*(2:S-+), *Melilotus suaveolens*(2:S-+), *Viola dissecta* var. *chaerophylloides*(6:H-+), *Arthraxon hispidus*(6:H-+), *Smilax sieboldii* (6:H-+), *Ampelopsis brevipedunculata* var. *heterophylla*(6:H-+), *Isodon inflexus*(5:H-+), *Polygonatum odoratum* var. *pluriflorum*(5:H-+), *Rubia akana*(2:H-+), *Liliope spicata*(2:H-1.2), *Caulophyllum robustum*(2:H-+), *Clematis apiifolia*(2:H-+), *Arisaema angustatum* var. *peninsulae*(2:H-+), *Clematis trichotoma*(2:H-+), *Cayratia japonica*(2:H-+), *Disporum smilacinum*(2:H-+), *Stephanandra incisa*(3:S-+), *Echinops setifer*(3:H-+), *Adenocaulon himalaicum*(3:H-+), *Fraxinus rhynchophylla*(4:T1-2.2), *Viola mandshurica*(3:H-+), *Acer pseudo-sieboldianum*(4:T2-+), *Bidens bipinnata*(4:H-+), *Galium trifidum*(4:H-+), *Galium trachyspermum*(4:H-+), *Arisaema amurense*(4:H-+), *Trachelospermum asiaticum* var. *intermedium*(6:H-+), *Lycoris radiata*(4:H-+), *Orixa japonica*(4:S-+).

Date of survey: Releve' No. 11-14; Aug. 4, 1985, No. 37, 40; Aug. 7, 1985, No. 30; Aug. 5, 1985, No. 67; May 17, 1986.

Note: L; lower part of slope, M; middle part of slope, V; valley.

lower coverage. The shrub layer of 3 m height is chiefly composed of *Rhododendron schilppenbachii*. The herb layer is dominated by *Disporum smilacinum*, *Melampyrum roseum* and several sedges. This association include three subassociations:

- a. Typical subassociation without differential species.
- b. *Rhododendron yedoense* var. *poukhanense* subassociation with differential species, *Rhododendron yedoense* var. *poukhanense*.
- c. *Sasa borealis* subassociation with differential species, *Sasa borealis*.

Quercetum variabilis Kim et Yim 1986 (Table 4).

Character species: *Quercus variabilis*, *Lespedeza bicolor* and *Indigofera kirilowi*. They occur more abundantly on the sunny steep mountainside and xeric hillside. High constants are *Lespedeza bicolor*, *Indigofera kirilowi* and *Smilax china* after pionier species. This indicates that *Quercus variabilis* forests develope secondarily when the forests are destroyed by some causes. The forests are regarded as a topographic or edaphic climax. The character species of this association are the same as those in Mt. Seonun (Kim and Yim, 1986a). In the upper tree layer of *Quercus variabilis* forest of about 17 m tall and over 56 cm in dbh, *Quercus serrata*, *Platycarya strobilacea* and *Prunus sargentii* are observed in lower coverage. The lower tree layer is usually rather open, where *Carpinus laxiflora* is sometimes scattered. The shrub layer covered with *Lindera obtusiloba*, *Vibrunum dilatatum* and *Acer pseudo-sieboldianum* and the herb layer is dominated by *Smilax china* and several sedges. There are two subassociations:

- a. Typical subassociation without differential species.
- b. *Sasa borealis* subassociation with differential species, *Sasa borealis*.

Carpinetum laxiflorae Kim et Yim 1986 (Table 5).

Carpinus laxiflora, *Vibrunum dilatatum*, *Symplocos chinensis* for. *pilosa* and *Rhus trichocarpa* are determined as character species. They occur on the middle parts of the slopes and somewhat mesic site of the mountain as in Mt. Chiri and Mt. Seonun (Jang and Yim, 1985; Kim and Yim, 1986a). *Carpinus laxiflora* forests developed at elevations 400 m–600 m may be a climatic climax in this mountain, considering its optimal range in thermal distribution (Yim, 1977a; 1977b). In the tree layer of *Carpinus laxiflora* with about 20 m tall and over 60 cm in dbh trees, companion tree species such as *Lindera erythrocarpa*, *Quercus serrata*, *Acer mono* and *Cornus controversa* are observed in low coverage. The shrub layer is dominated by *Lindera obtusiloba* and *Vibrunum dilatatum* of about 3 m height and the herb layer by *Sasa borealis* occurred at relatively mesic site. The association is subdivided into three subassociations by the combinations of the differential species:

- a. Typical subassociation without differential species.
- b. *Hydrangea serrata* for. *acuminata* subassociation with differential species, *Hydrangea serrata* for. *acuminata*.
- c. *Sasa borealis* subassociation with differential species, *Sasa borealis*.

Daphniphyllum macropodum community (Table 5).

The community was distinguished from others by *Daphniphyllum macropodum*, differential species. The species occurs more abundantly on the lower parts of the slopes and valley of Mt. Nacjang, northern limit of evergreen broadleaf forest (Park, 1974). The presence of this species in this mountain is attributed to climatic fluctuation which favored the northern migration of southern evergreen forest species as case of *Camellia japonica* in Mt. Seonun (Kim and Yim, 1987).

Carpinetum tschonoskii Kim et Yim 1986 (Table 6).

Character species: *Carpinus tschonoskii*, *Acer pseudo-sieboldianum* var. *koreanum*, *Stephanandra incisa* and *Meliosma myriantha*. *Carpinus tschonoskii* as the character species for southern part of cool-temperate deciduous broadleaf forest zone in Korea (Uyeki, 1933) is overlapped in WI 47–121 of their thermal distribution range with *Carpinus laxiflora* (Yim, 1977a). However, the optimal range of two species apparently differs each other. The former occurs on more warm and more mesic sites than the latter (Jang and Yim, 1985; Kim and Yim, 1986a). The species are found almost at elevation below 400 m in the mountain as in Mt. Seonun (Kim and Yim, 1986a). The tree layer of the association is composed of *Carpinus tschonoskii* tree of 20 m over in height and over 70cm in dbh and companion tree species such as *Lindera erythrocarpa*, *Prunus sargentii*, *Cornus controversa*, *Quercus serrata* and *Quercus aliena*. The shrub layer of 3 m high is covered with shrubby species of *Sapium japonicum*, *Stephanandra incisa* and *Lindera obtusiloba* and tree saplings of *Lindera erythrocarpa*, *Acer pseudo-sieboldianum* var. *koreanum* and *Fraxinus sieboldiana*. The herb layer is largely dominated by *Sasa borealis*. This association is subdivided into two subassociations by the differential species:

- a. Typical subassociation without differential species.
- b. *Sasa borealis* subassociation with differential species, *Sasa borealis*.

Quercus aliena-Carpinus tschonoskii community (Table 6).

Differential species, *Quercus aliena* occurs more abundantly on the lower parts of the slope, valley and flatland. High constant species in this community are *Stephanandra incisa*, *Lindera obtusiloba* and *Oplismenus undulatifolius*.

Corno-Lindera *erythrocarpa* assoc. nov. (Table 7).

Lindera erythrocarpa, *Cornus controversa*, *Arisaema amurense* and *Alangium platanifolium* var. *macrophyllum* as character species usually occur on the lower parts of the slope, ravines, shade and humid sites. Considering the distribution of these species, the association seems to be a topographic or edaphic climax. In the tree layer of this association *Lindera erythrocarpa* and *Cornus controversa* often become about 22 m tall and 30–40 cm in dbh and *Fraxinus rhynchophylla*, *Zelkova serrata* and *Sapium japonicum* are found as companion species. The shrub layer with *Alangium platanifolium* var. *macrophyllum*, *Viburnum dilatatum* and *Lindera obtusiloba* is usually scattered and the herb layer is dominated by *Sasa borealis*, *Oplismenus undulatifolius* and

Polysticum tripteron. This association is subdivided into two subassociations by the combination of the differential species:

- a. *Hydrangea serrata* for. *acuminata* subassociation with differential species, *Hydrangea serrata* for. *acuminata* and *Polysticum tripteron*.
- b. *Sasa borealis* subassociation with differential species, *Sasa borealis*.

Torreyo-Zelkovetum serratae assoc. nov. (Table 8).

Torreya nucifera, *Adenocaulon himalaicum* and *Disporum sessile* were determined as character species. *Torreya nucifera* of evergreen broadleaf tree occurs on the lower parts of the slope, which is the distributional northern limit of the species in Mt. Naejang (Park, 1974; Lee and Lee, 1974). The presence of this species in the mountain is attributed to climatic fluctuations which favored the northern migration of southern evergreen forest species as case of *Daphniphyllum macropodum* forest. The association is similar to Torreyo radicans-Zelkovetum serratae of Japan in a sense but different in character species composition except *Zelkova serrata* (Miyawaki *et al.*, 1983). In the tree layer of the association *Torreya nucifera* trees of 17 m tall and over 70 cm in dbh, and companion tree species such as *Acer pseudo-sieboldianum* var. *koreanum*, *Zelkova serrata* and *Cornus controversa* are found. The shrub layer is open, where *Trachelospermum asiaticum* var. *intermedium*, *Hedera rhombea*, *Orixa japonica* and saplings of maple tree are scattered, and the herb layer is covered with *Adenocaulon himalaicum*, *Disporum sessile* and *Sasa borealis*. This association is subdivided into three subassociations by the combinations of differential species:

- a. Typical subassociation without differential species.
- b. *Thea sinensis* facies with differential species, *Thea sinensis*.

Thea sinensis is a man-introduced plant and it was planted on the forest floor around the Baekyand temple.

- c. *Sasa borealis* subassociation with differential species, *Sasa borealis*.

Acer-Zelkovetum serratae assoc. nov. (Table 9).

Acer mono, *Polysticum tripteron*, *Hydrangea serrata* for. *acuminata* and *Celtis sinensis* are character species. They commonly occur on the lower parts of the slope and mesic stony sites, ravines. It means that the association is a topographic or edaphic climax in this mountain. In the tree layer of the association *Acer mono* and *Zelkova serrata* tree of 17 m tall and over 60 cm in dbh and companion tree species such as *Lindera erythrocarpa*, *Celtis sinensis*, *Cornus controversa* and *Acer pseudo-sieboldianum* var. *koreanum* are found. The shrub layer with *Lindera obtusiloba* and saplings of *Lindera erythrocarpa* is usually rather open and the herb layer is dominated by *Oplismenus undulatifolius* and *Sasa borealis*. This association is subdivided into two subassociations by the combination of differential species:

- a. Typical subassociation without differential species.
- b. *Sasa borealis* subassociation with differential species, *Sasa borealis*.

Species association. Chi-square tests of species association by 2×2 contingency table were

run with all species pairs for the thirty nine species, character species of associations found in classification. The positive correlations obtained were diagrammatically represented in the form of a two-dimensional arrangement of species, a species constellation (Fig. 3). From the constellation, four major groups of positively correlated species were recognized (shaded in Figure 3), which might be regarded as alliances. There are three intermediate species between four groups, *Fraxinus rhychophylla*, *Smilax china* and *Quercus serrata*. This group might be regarded as one order, because the four groups are not completely independent from another. Some groups were divided into several subgroups, which might be recognized as an association:

Group 1. (upper left-hand side of the Figure 3): *Pinus densiflora*, *Juniperus rigida*, *Rhododendron yedoense* var. *poukhanense*, *Festuca ovina*, *Millium effusum* and *Rhododendron mucronulatum*.

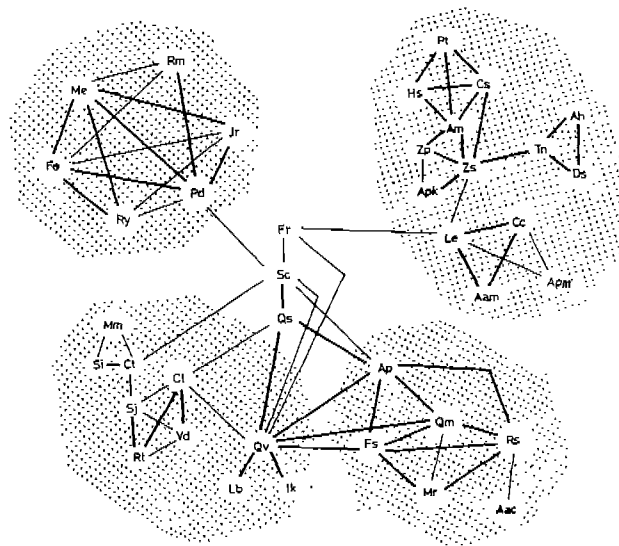


Fig. 3. Species constellation showing positive correlations between 39 species from forests of Mt. Naejang.

Single line represents $5\% > p > 1\%$, double $p < 1\%$ for chi-square values. Aac: *Amsliaea acerifolia*, Aam: *Arisaema amurense*, Ah: *Adenocaulon himalaicum*, Am: *Acer mono*, Ap: *Acer pseudo-sieboldianum*, Apk: *Acer pseudo-sieboldianum* var. *koreanum*, Apm: *Alangium plataniifolium* var. *macrophyllum*, Cc: *Cornus controversa*, Cl: *Carpinus laxiflora*, Cs: *Celtis sinensis*, Ct: *Carpinus tshonoskii*, Ds: *Disporum sessile*, Fo: *Festuca ovina*, Fr: *Fraxinus rhychophylla*, Fs: *Fraxinus sieboldiana*, Hs: *Hydrangea serrata* for. *acuminata*, Ik: *Indigofera kirilowi*, Jr: *Juniperus rigida*, Lb: *Lespedeza bicolor*, Le: *Lindera erythrocarpa*, Me: *Millium effusum*, Mm: *Meliosma myriantha*, Mr: *Melampyrum roseum*, Pd: *Pinus densiflora*, Pt: *Polysticum tripterum*, Qm: *Quercus mongolica*, Qs: *Quercus serrata*, Qv: *Quercus variabilis*, Rm: *Rhododendron mucronulatum*, Rs: *Rhododendron schlippenbachii*, Rt: *Rhus tricoarpa*, Ry: *Rhododendron yedoense* var. *poukhanense*, Sc: *Smilax china*, Si: *Stephanandra incisa*, Sj: *Sapium japonicum*, Tn: *Torreya nucifera*, Vd: *Vibrunum dilatatum*, Zp: *Zanthoxylum piperitum*, Zs: *Zelkova serrata*.

Group 2. (lower left-hand side of the Figure 3)

Subgroup 1): *Meliosma myriantha*, *Stephanandra incisa* and *Carpinus tschonoskii*.

Subgroup 2): *Sapium japonicum*, *Rhus tricarpha*, *Viburnum dilatatum* and *Carpinus laxiflora*.

Subgroup 3): *Lespedeza bicolor*, *Indigofera kirilowi* and *Quercus variabilis*.

Group 3. (upper right-hand side of the Figure 3): *Zelkova serrata*, *Acer pseudo-sieboldianum* var. *koreanum* and *Zanthoxylum piperitum*.

Subgroup 1): *Acer mono*, *Celtis sinensis*, *Polysticum tripterum* and *Hydrangea serrata* for. *acuminata*.

Subgroup 2): *Torreya nucifera*, *Adenocaulon himalaicum* and *Disporum sessile*.

subgroup 3): *Lindera erythrocarpa*, *Cornus controversa*, *Arisaema amurense* and *Alangium platanifolium* var. *macrophyllum*.

Group 4. (lower right-hand side of the Figure 3): *Quercus mongolica*, *Acer pseudo-sieboldianum*, *Fraxinus sieboldiana*, *Rhododendron schlippenbachii*, *Melampyrum roseum* and *Ainsliaea acerifolia*.

Group 1 was found on areas destroyed by human activity and the hillock and exposed ridge line, dry and poor habitat of the mountain. The distributional range of this group was coincided with that of Rhododendro-Pinion densiflorae in classification by Z-M method.

Group 2 was found at mesic-fertile sites in elevations below 600 m and coincided with Carpinion laxiflorae. Subgroup 1 of the group occurred on lower parts of the slope and mesic sites, subgroup 2 on middle parts of the slope and subgroup 3 on sunny and xeric hillsides, and they were coincided with Carpinetum tschonoskii, Carpinetum laxiflorae and Quercetum variabilis, respectively.

Group 3 was found at the well drained stony slopes near stream and coincided with Corno-Zelkovion serratae. Subgroup 1 of the group occurred on the lower parts of the slope and mesic stony sites, subgroup 2 on lower parts of the slope and subgroup 3 on lower parts of the slope, ravines, shade and humid sites, and they were coincided with Acero-Zelkovetum serratae, Torreyo-Zelkovetum serratae and Corno-Linderetum erythrocarpae, respectively.

Group 4 developed at xeric-sterile sites of elevation above 600 m and this was coincided with Acero-Quercion mongolicae.

As mentioned above, the results of correlation analysis between species were reflected to the phytosociological classification units by floristic composition.

摘 要

1985년부터 1987년까지 內藏山 國立公園의 森林植生을 Z-M法으로 調査하여 1個의 群目, 4個의 群團과 10個의 群集 單位를 識別하였다. 이들을 다른 地域의 植生資料들과 比較 檢討한 結果 內藏山 森林植生の 分類體系는 다음과 같다.

출참나무-신갈나무群目(*Quercetalia serrato-mongolicae* ord. nov.)

진달래-소나무群團(*Rhododendro-Pinion densiflorae* all. nov.)

진달래-소나무群集(*Rhododendro mucronulati-Pinetum densiflorae* Kim et Yim 1986)

- 당단풍-신갈나무群團(Accro-Quercion mongolicae all. nov.)
 철쭉꽃-신갈나무群集(Rhododendro-Quercetum mongolicae assoc. nov.)
 서어나무 群團(Carpinion laxiflorae Kim et Yim 1986)
 굴참나무群集(Quercetum variabilis Kim et Yim 1986)
 서어나무群集(Carpinetum laxiflorae Kim et Yim 1986)
 개서어나무群集(Carpinetum tschonokii Kim et Yim 1986)
 갈거리나무群落(*Daphniphyllum mecropodum* community)
 갈참나무-개서어나무群落(*Quercus aliena-Carpinus tschonokii* community)
 층층나무-느티나무群團(Corno-Zelkovion serratae all. nov.)
 층층나무-비목나무群集(Corno-Linderetum erythrocarpaee assoc. nov.)
 비자나무-느티나무群集(Torreyo-Zelkovevium serratae assoc. nov.)
 고로쇠나무-느티나무群集(Acero-Zelkovetum serratae assoc. nov.)

이들중 참참나무-신갈나무群目, 진달래-소나무群團, 당단풍-신갈나무群團, 층층나무-느티나무群團, 철쭉꽃-신갈나무群集, 층층나무-비목나무群集, 비자나무-느티나무群集과 고로쇠나무-느티나무群集은 품종들에 의해서 새로命名되었다. 한편 重要種들의 相關分析에 의한 種結合으로 群(group)과 亞群(subgroup)은 各各 分類法에 의한 群團(alliance) 그리고 群集(association)과 一致하였다.

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