Korean J. Ecol. 9(4) : 209~223, 1986

Classification of Forest Vegetation of Seonunsan Area, Southwestern Korea

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Z-M 方式에 의한 禪雲山地域의 森林群集 分類

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ABSTRACT

The forest stands of Seonunsan area, South-western Korea, were classified into three alliances and nine communities by the Z-M school scheme. Of these one alliance and four associations were recognized in this study, that is, an alliance, Carpinion laxiflorae and four associations, Carpinetum tschonoskii, Quercetum variabilis, Carpinetum laxiflorae and Rhododendro mucronulati-Pinetum densiflorae.

Hierarchy of Seonunsan area forest vegetation by Z-M scheme was as fallows: Pinion densiflorae Suz.-Tok. 1966. 1. Rhododendro mucronulati-Pinetum densiflorae ass. nov., 2. *Pinus thunbergii* community.

Carpinion laxiflorae all. nov., 1. *Quercus serrata-Carpinus tschonoskii* community, 2. *Quercus aliena-Carpinus tschonoskii* community, 3. Carpinetum tschonoskii ass. nov., a. Typical subass., b. *Sasa borealis* subass., 4. Quercetum variabilis ass. nov., a. *Sasa borealis* subass. b. Typical subass., 5. Carpinetum laxiflorae ass. nov..

Zelkovion serratae Miyawaki *et al.*, 1977., 1. Orixo-Zelkovetum serratae Miyawaki et H. Tohma 1975., a. Typical subass., b. *Thea sinensis* facies, 2. *Thea sinensis-Camellia japonica* community.

INTRODUCTION

Several phytosociological descriptions on the forest vegetations of South Korea were reported (Kil and Kim, 1984; Yim and Baik, 1985; Jang and Yim, 1985; Yim and Kim, 1985; Kim *et al.*, 1986), but none on the forest vegetation of Seonunsan area.

The mountain is largely covered with hornbeam forest and oak forest in the undisturbed area, while pine forest in the disturbed area. Hornbeam (*Carpinus*) forests have been reco-

gnized as a distinct forest vegetation in cool temperate zone in Korea. *Carpinus laxiflora* forest and *C. tschonoskii* forest are indicator species in middle and southern part of cool temperate zone of Korea (Uyeki, 1933; Yim, 1977b). However, the distribution ranges of these two hornbeam species are overlapped in most area (Yim, 1977a, b), but the distributional center of the two species differ from each other apparently. In the Piagol of Mt. Chiri, Korea, *C. laxiflora* community on the upper part and *C. tschonoskii* community on the lower part were mainly found (Jang and Yim, 1985).

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 viewpoint. To clarify these problems, first of all, the study on the forest vegetation of Seonunsan area was carried out by the Zürich-Montpellier method (Z-M school method).

We thank Prof. Bong-Sup Kil for his helpful comments on the manuscript and Mr. Eui-Shik Jeon and Jae-Ki Ko for their helps in the fields.

STUDY AREA

In Mt. Seonun area, provincial park of Chollabukdo(ca. 43.7km^2, 35°27′20″~35°32′00″N, 126°33′00″~126°38′40″E), these are five main peaks, Soyo (442.2m), Kyeongsu (444.0m), Kaeibbal (335.7m), Cheongyong (313.7m) and Pihak (307.4m) (Fig. 1).

The upper part of the mountain is largely characterized by steep slopes or rock ridges, and the soils of upper parts in the mountain are stony loam and the soils of lower parts gravelly loam (Office of Rural Development, 1975).

For a long time, most trees in the mountain had been repeatedly cut for the use of charcoal or house building and heating. The undergrowth of the forest has been grazed by domestic animals, and has been subjected to collecting of edible plants picking and burning for field crop. Since 1979, however, the lumbering, grazing and firing for fuel have been almost abandoned and the plantation of *Pinus thunbergii* thereafter established.

The natural forest vegetation dominated by *C. tschonoskii* now remains in a extremly restricted area only around the Seonun temple.

The data of Gochang meteorological station, ca. 10km east of Seonunsan area are available. Kira's warmth index 107.1°C·month (Yim and Kira, 1975) and Thornthwaite's moisture index 46.4 (Yim and Kira, 1976) were based with mean annual temperature, is 12.8°C, and mean annual precipitation 1,107mm. And climatic diagram by Yim and Kim(1983) and climograph by Yim(1972) were refered to the discussion (Fig. 2).

FIELD SURVEY AND TABULATION

Thirty seven relevé were selected (Fig. 1) (Braun-Blangquet, 1964; Werger, 1974; Miyawaki *et al.*, 1981) and one quadrat (5m×5m, 10m×10m or 15m×15m) was set randomly at every relevé, and dominance and sociability occured for vascular plant species in the area were recorded.

By tabular comparison method (Shimwell, 1971; Mueller-Dombois and Ellenberg, 1974; Küchler, 1967; Suzuki *et al.*, 1985; Toyohara, 1977) plant communities were classified. To determine the vegetational units of the forest, their the communities classified were compared with those of other region (Yim and Baik, 1985; Miyawaki *et al.*, 1983). The nomenclature of the species was based on 'Illustrated Flora of Korea' (Lee, 1979).

Fig. 1. Map showing the study sites. Number: Relevé number in table 1, 2 and 3.

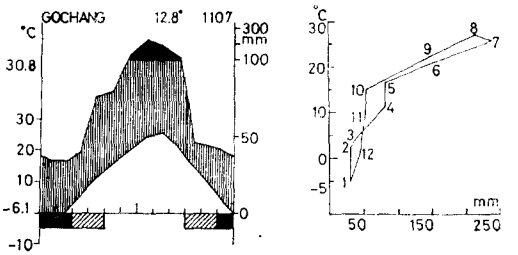

Fig. 2. Climatic diagram (left) and climograph (right) of Gochang near Seonunsan area.

RESULT AND DISCUSSION

The forest vegetation of Seonunsan area was divided into three alliances, five associations and four communities, and four associations were also subdivided into several lower units, subassociations, as follows:

Hierarchy of Mt. Seonun forest vegetation

Pinion densiflorae Suz.-Tok. 1966.

1. Rhododendor mucronulati-Pinetum densiflorae ass. nov.
2. *Pinus thunbergii* community

Carpinion laxiflorae all. nov.

1. *Quercus serrata-Carpinus tschonoskii* community
2. *Quercus aliena-Carpinus tschonoskii* community
3. Carpinetum tschonoskii ass. nov.
   a. Typical subass.
   b. *Sasa borealis* subass.
4. Quercetum variabilis ass. nov.
   a. *Sasa borealis* subass.
   b. Typical subass.
5. Carpinetum laxiflorae ass. nov.

Zelkovion serratae Miyawaki *et al.*, 1977.

1. Orixo-Zelkovetum serratae Miyawaki et H. Tohma 1975.
   a. Typical subass.
   b. *Thea sinensis* facies
2. *Thea sinensis-Camellia japonica* community

Among the vegetation units of above hierarchy system, Carpinion laxiflorae and Carpinetum tschonoskii, Carpinetum laxiflorae, Quercetum variabilis and Rhododendro mucronulati-Pinetum densiflorae, are recognized as a new alliance and new associations, respectively.

(1) Pinion densiflorae Suz.-Tok. 1966 (Table 1)

Character species: *Pinus densiflora*, *Rhododendron schlippenbachii*, *Vaccinium oldhamii*, *Juniperus rigida* and *Lespedenza bicolar*.

According to Miyawaki *et al.* (1983), Pinion densiflorae has character species, *Pinus densiflora*, *Vaccinium oldhamii*, *Juniperus rigida* and *Lyonia ovalifolia* var. *elliptica* in Japan, as like as in Korea. Therefore, the pine forest of this mountain belongs to the Pinion densiflorae Suz.-Tok. 1966.

1. Rhododendro mucronulati-Pinetum densiflorae ass. nov.

Character species: *Pinus densiflora*, *Rhododendron mucronulatum*.

Table 1. Vegetation table of Rhododendro mucronulati - Pinetum densiflorae[1] and Pinus thunbergii community[2] on Mt. Seonun, Korea

Pinion densiflorae Suz.-Tok. 1966

1. Rhododendro mucronulatum - Pinetum densiflorae ass. nov.
2. Pinus thunbergii community

		1								2	
Serial number		1	2	3	4	5	6	7	8	9	10
Releve' number		16	14	5	15	17	30	27	28	37	38
Altitude(m)		70	100	250	120	120	90	300	250	20	70
Slope aspect		.	W	SW	E	E	S	S	SW	S	S
Slope degree(°)		2	20	8	16	18	10	20	20	5	10
Topography		F	U	M	L	L	L	U	U	L	L
Quardrat size(m^2)		100	25	25	25	100	100	100	100	100	100
Height of tree-1 layer(m)		9	6	5	8	9	10	10	11	15	15
Coverage of tree-1 layer(%)		55	80	80	75	60	75	60	85	85	85
dbh of highest tree		23	12	12	14	18	16	19	34	30	28
Height of tree-2 layer(m)		6	.	.	5	5	6	6	7	.	.
Coverage of tree-2 layer(%)		20	.	.	65	40	40	40	50	.	.
Height of shrub layer(m)		2	1.5	1.5	1.5	2	2	2	2	2	2.5
Coverage of shrub layer(%)		85	70	80	80	80	85	95	40	30	25
Height of herb layer(m)		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Coverage of herb layer(%)		60	60	60	45	70	80	65	70	90	95
Number of species		22	23	26	31	29	28	28	29	20	14
Character species of association:											
Pinus densiflora	T1	5.5	4.4	5.5	4.4	3.3	5.5	4.4	3.3	1.1	.
	T2S	+ +	.	.	.	+	2.2	.	+.2	.	+
Rhododendron mucronulatum	S	+.2	.	2.2	+.2	+.2	2.2	1.1	+.2	.	+
Differential species of community:											
Pinus thunbergii	T1	.	.	.	.	.	.	.	.	5.5	5.5
	T2	.	.	.	.	.	.	.	.	2.2	+.2
	S	.	.	.	.	.	.	.	.	1.1	1.2
Character species of alliance:											
Vaccinium oldhamii	S	.	1.1	+.2	.	1.1	+.2	+.2	1.1	.	+.2
Rhododendron schlippenbachii	S	+.2	.	+.2	.	1.2	.	+.2	.	.	.
Juniperus rigida	T2S	.	.	1.2	+.1	+.1	1.2	.	+.1	.	.
Lespedeza bicolar	S	+.2	+	+.2	+.2	+.2	+	+.2	+.2	+	.
Character and differential species of upper units:											
Indigofera kirilowi	S	+	.	+.2	.	.	+	2.2	2.2	+	+.2
Pteridium aqilinum var. latiusculum	H	1.2	+.2	1.2	+	1.2	.	1.2	+.2	+	+
Lespedeza maximowiczii	S	+.2	1.2	.	1.2	+	1.2	1.2	.	1.2	+
Melampyrum roseum	H	+.2	.	.	+.2	+.2	+	+.2	.	.	.
Festuca ovina	H	1.2	.	.	+.2	.	+.2	.	+.2	.	.
Patrinia villosa	H	+	+	+	+	+	.	+	.	.	.
Companions:											
Quercus variabilis	T1	.	.	.	.	1.1	.	1.1	1.1	.	.
	T2	.	.	.	.	1.1	.	1.1	1.1	.	.
	S	.	.	+	.	+	+	+	+	.	.
Smilax china	H	+	.	+	+	.	+	+	+	+	+
Quercus serrata	T2	.	.	+	1.1	r	.	+.1	+.1	.	.
	S	1.1	+	+	+	+	.	+	+	.	.
Prunus sargentii	T2S	+	+	.	.	+	+ +	+	.	.	+
Platycarya strobilacea	T1	.	+	.	+.1	.	.	.	+.1	.	.
	T2	.	.	.	.	1.1	.	.	+	.	.
	S	.	.	.	.	+.1	+	+	+	.	.
Lindera oblusiloba	S	.	+	.	.	.	.	+	+	.	.
Viburnum dilatatum	S	+	.	.	.	.	+	.	+	.	.
Quercus acutissima	T1S	+	±	.	.	.	.	.	.	+	.
Rhus tricocarpa	S	.	+	.	+	.	.	.	.	+	.
Rhus verniciflua	S	.	.	.	r	+	r	.	.	.	.
Potentilla fragarioides var. major	H	.	+	.	+	+	.	.	+	+	+
Aster scaber	H	.	.	+	+	+	+	+	+	.	.
Styrax japonica	S	.	.	.	.	.	+	.	r	+	+
Patrinia scabiosaefolia	H	+	.	+	+	.	.	+	.	+	.
Atractylodes japonica	H	.	+	.	.	.	+	1.2	+	.	.
Stephanandra incisa	S	.	+	+	1.2	.	.	.	.	.	2.2
Albizzia julibrissin	S	.	+	.	.	.	+	+	.	+	.
Cocculus trilobus	H	.	+	+	+	.	.	.	.	+	.
Ostericum sieboldii	H	+	.	+	.	.	+	+	.	.	.
Elsholtzia splendens	H	.	+	.	+	+	.	.	.	.	.
Sanguisorba officanalis	H	.	.	+	.	.	+	.	.	.	.
Artemisia sylvatica	H	.	.	.	.	.	+	+	+	.	.
Carpinus tschonoskii	S	+	.	+	.	+	.	.	.	.	.
Lysimachia barystachys	H	.	.	.	.	+	.	.	.	+	+
Arundinella hirta	H	.	.	1.2	.	.	.	+	.	+	.
Carex siderosticta	H	.	.	+	1.2	+	.	.	.	.	.
Smilax nipponica	H	.	+	.	+	.	.	.	+	.	.
Malus baccata	T1T2	.	.	.	.	+.1	±	.	.	.	.
Kilium effusum	H	.	+	.	.	+	.	.	+	.	.
Corylus heterophylla var. thunbergii	S	r	.	.	+	r	.	.	.	.	.
Osmunda japonica	H	.	.	+	+	+	.	.	.	.	.
Viola manshurica	H	.	.	+	.	.	+	.	.	.	.
Fraxinus sieboldiana	T2S	.	.	.	.	.	.	+	± +	.	.
Carex lanceolata	H	.	+.2	.	.	.	1.2	.	.	.	.
Fraxinus rhynchophylla	T2S	.	.	.	.	+	±	.	+ +	.	.
Quercus aliena	T2	r	.	.	+.1	.	.	.	1.1	.	.
Rhus chinensis	S	.	.	.	1.1	+	.	.	.	.	.

Rare species: Artemisia keiskeana(3:H-+,9:H-+), Carpinus laxiflora (7:S-+), Viola dissecta var. chaerophylloides(4:H-+), Platycodon grandifolorum(3:H-+,6:H-+), Viola acuminata(4:H-+), Sorbus alnifolia (8:T2-+), Oplismenum undulatifolius(8:H-+), Disporum smilacinum(8:H-2.2), Pueraria thunbergiana(6:H-+,9:H-+), Arabis glabra(6:H-+,7:H-+), Angelica decursiva(3:H-+,5:H-+), Dioscolea batates(8:d-+), Isodon inflexus(6:H-+,8:H-+), Bidens bipinnata(4:H-+), Rosa multiflora(4:S-r), Corylus sieboldiana(8:S-r), Acer pseudo-sieboldianum(7:S-r), Castanea crenata(10:S-+), Zanthoxylum piperitum(4:S-r), Commelina communis(9:H-+), Veratrum maackii var. japonicum(4:H-+,5:H-+), Clerodendron trichotomum (4:S-r), Artemisia princeps var. orientalis(1:H-+,2:H-+).

Date of survey: Releve'No.5;Aug.24,1985, REleve'No.14-17;Aug.25,1985, Releve'No.27-30;Aug.26,1985, Releve'No.37-38;May16,1986.

Note: T:top, R:ridge, U:upper part of slope, M:middle part of slope, L:lower part of slope, V:valley, F:flatland.

These character species occur more abundantly at the low parts of the mountain which is destroyed by human activity or the hillock and exposed ridge line, dried and poored habitat. Generally speaking, *Pinus densiflora* is one of the pioneer species which invade in the bare land.

In the tree layer, Pinetum densiflorae, *Quercus variabilis*, *Q. acutissima*, *Prunus sargentii* and *Plantycarya strobilacea* etc. are found as a companion species. These species have low cover value within the canopy layer.

The shrub layer is composed of shrubby trees such as *Rhododendron mucronulatum*, *Lespedeza bicolor*, *Indigofera kirilowi*, *Lespedeza maximowiczii* and *Vaccinium oldhamii* and of tree saplings such as *Juniperus rigida* and *Rhus trichocarpa*.

The herb layer, as composed of some constant species such as *Festuca ovina*, *patriinia villosa*, *Melampyrum roseum* and *Smilax china* and *Atractylodes japonica*, *Patrinia scabiosaefelia* and *Lysimachia barystachys* are rarely found. Floristic composition mentioned above also found in *Pinus densiflora-Rhododendron mucronulatum* subcommunity of Mt. Seolag (Yim and Baik, 1985).

According to Miyawaki *et al.* (1983), Japanese pine alliance, Pinion densiflorae is classified into four associations, that is, Rhododendro-Pinetum densiflorae, Rhododendro macrocepali-Pinetum densiflorae, Rhododendro weyrichii-Pinetum densiflorae and Rhododendro reticulati-Pinetum densiflorae. The character species of their associations, *Rhododendron kaempferi*, *R. dilatatum*, *R. weyrichii* and *R. reticulati* are not distributed in this mountain. Between Korean pine forest and Japanese forest distinct differences exist in character species. Therefore, we propose here as a new association, Rhododendro mucronulati-Pinetum densiflorae.

2. *Pinus thunbergii* community

Differential species: *Pinus thunbergii*.

This community is distinguished from other communities by the presence of the differential species, such as *Pinus thunbergii* and it occure commonly in southern Korea (Kim and Kil, 1983; Kil and Kim, 1984) and it is a man-introduced vegetation by plantation in the lower parts of mountain.

(2) Carpinion laxiflorae all. nov. (Table 2, Fig. 3)

Character species: *Carpinus laxiflora*, *Fraxinus rhynchophylla*, *Sapium japonicum*, *Meliosma myriantha*, *Prunus sargentii*, *Aster scaber* and *Smilax nipponica*.

Carpinus laxiflora has a wide range of thermal distribution, the range of 45~120°C·month in terms warmth index (Uyeki, 1933; Yim, 1977a). Therefore, it seems that southern and middle pats of cool temperate deciduous broadleaf forest zone has a wide distri butional species *C. laxiflora*, as the indicator species of these subzones. In these subzones, companion species, *C. laxiflora*, *C. tschonoskii*, *Quercus variabilis*, *Q. aliena*, and *Q. serrata*, have the differential positions of their peak frequency in the different habitat. These species may be topographic or edaphic climax species. Consequently, the oak-hornbeam

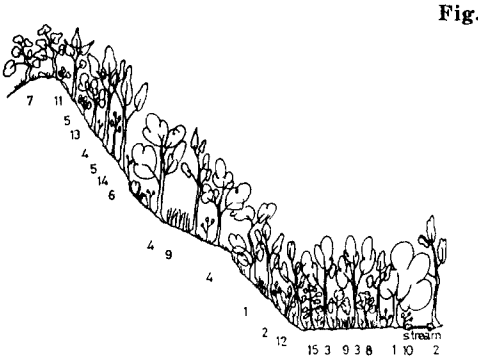

Fig. 3. Projection diagram of an oak-hornbeam forest in low part and northwestern slope of Seonunsan area.
1. *Zelkova serrata* 2. *Quercus aliena* 3. *Carpinus, tschonoskii* 4. *Carpinus laxiflora* 5. *Quercus variabilis* 6. *Quercus serrata* 7. *Pinus densiflora* 8. *Acer pseudo-sieboldianum* var. *koreanum* 9. *Sasa borealis* 10. *Orixa japonica* 11. *Rhododendron mucronulatum* 12. *Styrax japonica* 13. *Lespedeza bicolar* 14. *Platycarya strobilacea* 15. *Cornus controversa.*

forest of this mountain is proposed here as a new alliance, C a r p i n i o n l a x i f l o r a e.

This alliance is distinguished from other by the presence of the character species, *Carpinus laxiflora, Fraxinus rhynchophylla, Sapium japonicum, Meliosma myrianta, Prunus Sargentii, Aster scaber* and *Smilax nipponica.*

1. *Quercus serrata-Carpinus tschonoskii* community.

Differential species: *Quercus serrata.*

This community is distinguished from other by the presence of the differential species, *Quercus serrata.* This species occurs Commonly on the deep soil and middle parts of the slopes in this mountain. High constant species are *Carex siderosticta* and *Disporum smilacinum.* It seems that *Quercus serrata* forest is a secondary forest in this mountain.

2. *Quercus aliena-Carpinus tschonoskii* community.

Differential species: *Quercus aliena.*

This species occurs more abundantly at the low parts of the slopes, valley and flat land. High constant species are *Stephanandra incisa* and *Oplismenus undulatifolius.* This community is distinguished from others by the presence of the differential species, *Quercus aliena.*

3. C a r p i n e t u m t s c h o n o s k i i ass. nov. (Fig. 4)

Character species: *Carpinus tschonoskii, Acer pseudo-sieboldianum* var. *koreanum* and *Ainsliaea acerifolia.*

Uyeki (1933) mentioned *Carpinus tschonoskii* as the character species for southern part of cool-temperate zone. Though the distribution range of *C. tschonoskii* overlap with *C. laxiflora* in the warmth index 45~120°C·month (Yim, 1977a), the distributional center of *C. tschonoskii* differ from *C. laxiflora* apparently. The former occurs on lower parts of the slopes and on more moist site in this mountain as the case of Mt. Chiri (Jang and Yim, 1985). It seems that *C. tschonoskii* is formed the natural forest as a climax species in this mountain. Therefore, the *C. tschonoskii* forest of the mountain is proposed here as a new association, C a r p i n e t u m t s c h o n o s k i i.

This association is distinguished from other by the presence of the character species, *Carpinus tschonoskii, Acer pseudo-sieboldianum* var. *koreanum* and *Ainsliaea acerifolia.* The association is subdivided into two lower units, subassociations, depending on the

topography and the floristic composition.

a. Typical subassociation

In the tree layer of *C. tschonoskii*, *Quercus aliena*, *Acer pseudo-sieboldianum* var. *koreanum*, *Zelkova serrata*, *Lindera erythrocarpa* and *Meliosma myriantha* etc. are found with lower coverage.

The shrub layer is composed of shrub species such as *Stephandra incisa*, *Ligustrum obtusifolium*, *Staphylea bumalda* and *Viburnum dilatum* and of saplings such as *Fraxinus rhynchophylla*, *Sapium japonicum* and *Lindera oblusiloba*.

In the herb layer, as constant species *Oplismenus undulatifolius*, *Trachelospermum asiaticum* var. *intermedium*, *Liriope platyphylla*, *Milletia japonica* and *Smilax china*. *Ainsliaea acerifolia*, *Lillium tsingtauense*, *Smilax nipponica* and *Viola acuminata* are often found.

Fig. 4. An association of *Carpinus tschonoskii* in low part of Seonunsan area.

b. *Sasa borealis* subassociation

Differential species: *Sasa borealis*.

This subassociation occurs on the humid and gravelly loam soil as well and is differentiated from the other by the prominent dominance of *Sasa borealis*. Herbaceous species such as *Trachelospermum asiaticum* var. *intermedium*, *Liriop platyphylla*, *Smilax china* and *Smilax nipponica* are frequently found in the herb layer, but the coverage of these species are low.

4. Quercetum variabilis ass. nov.

Character species: *Quercus variabilis*, *Lespedeza bicolar* and *Indigofera kirilowi*.

These species occur more abundantly on the sunny and xeric hill side. *Quercus variabilis* occurs commonly on the sunny steep mountainside. High constant are *Lespedeza bicolar*, *Indigofera kirilowi*, *Aster scaber*, *Smilax china*, *Smilax nipponica*, *Rhus chinensis* and *Lysimachia barystachys*, after pioneer species disturbed.

These facts seem to indicate that *Quercus variabilis* forest developed secondarily on the deep soil when the forests are destroyed by some causes. As the forests have been conserved and occured commonly on the dried and steep slopes, these forests may be regarded topographic or edaphic climax. This association is distinguished from other by presence of the character species, *Quercus variabilis*, *Lespedeza bicolar* and *Indigofera kirilowi*. Therefore, we propose here as a new association, Quercetum variabilis.

In the upper tree layer of *Quercus variabilis*, *Pinus densiflora*, *Quercus serrata*, *Prunus sargentii* and *Plactycarya strobilacea* are found in low coverage. The lower tree layer is

usually rather open, where *Carpinus laxiflora* is sometimes scattered. The shrub layer covered with *Lindera oblusiloba*, *Vibrnum dilatatum* and *Acer pseudo-sieboldianum* var. *koreanum* The herb layer is dominated by *Aster scaber*, *Carex siderosticta*, *C. lanceolata* and *Smilax china*.

This association is subdivided into two subassociations with the basis of the topography and the floristic composition:

a. *Sasa borealis* subassociation with character species, *Sasa borealis*

b. Typical subassociation with out character species.

5. C a r p i n e t u m l a x i f l o r a e ass. nov.

Character species: *Carpinus laxiflora*.

This community is distinguished from other by the presence of the differential species, *Carpinus laxiflora*. This species occurs on above the middle parts of the slopes and on somewhat mesic site on the mountain as Mt. Chiri (Jang and Yim, 1985). The distribution range of *C. laxiflora* in terms of Kira's warmth index was the range of 45~120°C·month (Yim, 1977a) but its optimal range was 76~89°C·month and 18~15% in soil water content (Yim and Kim, 1985). It seems that the *C. laxiflora* forest occurs in mesic-warm sites and that the species is formed the natural forest in the middle part of cool-temperate zone (Uyeki, 1933; Yim, 1977b). Consquently, the *C. laxiflora* forest of the mountain is proposed here as a new association, C a r p i n e t u m l a e i f l o r a e.

High constant in this association are *Carex siderosticta*, *Lindera oblusiloba*, *Fraxinus rhynchophylla* and *Styrax obassia* as the case of *C. laxiflora* community of Mt. Seolag (Yim and Baik, 1985). *Sasa boealis* occurs on some places in this communities. It seems that this species distribution is related to the humidity.

(3) Z e l k o v i o n s e r r a t a e Miyawaki *et al.*, 1977 (Table 3)

Character species: *Zelkova serrata*, *Lindera erythrocarpa*, *Liriope platyphylla*, *Arisaema amurense*, *Cornus controversa* and *Celtis sinensis*.

These species occur near the mountain stream and on the well drained stony slope. Character species of the zelkova forest in the mountain are mostly same as those of Z e l k o v i o n s e r r a t a e in Japan (Miyawaki *et al.*, 1983). Therefore, the zelkova forest in the mountain belongs to an alliance, Z e l k o v i o n s e r r a t a e Miyawaki *et al.*, 1977.

1. O r i x o-Z e l k o v e t u m s e r r a t a e Miyawaki et H. Tohma 1975.

Character species: *Zelkova serrata*, *Lilium tsingtauense*, *Trachelospermum asiaticum* var. *intermedium*, *Hedera rhombea*, *Lycoris rodiata*, *Ophiopogon japonicus* and *Oriya japonica*.

These species occur on the lower part of the slope, shade and humid sites with loam soil. The tree species other than *Zelkova serrata* in the tree layer are *Carpinus tschonoskii*, *Quercus aliena*, *Acer pseudo-sieboldianum* var. *koreanum*, *Acer mono* and *Celtis sinensis*. A few of these species, *Carpinus tschonoskii* and *Quercus aliena*, have occupied high cover with *Zelkova serrata*. The shrub layer is composed most of woody species such as *Orixa japonica*, *Staphylea bumalda* and *Ligustrum obrusifolium* and young trees such as *Lindera erythrocarpa* and *Acer pseudo-sieboldianum* var. *koreanum*. In the herb layer, there are

Table 3. Vegetation table of Orixo-Zelkovetum serratae[1] and Thea sinensis - Camellia japonica community[2] on Mt. Seonun, Korea

Zelkovion serratae Miyawaki et al 1977

1. Orixo-Zelkovetum serratae Miyawaki at H. Tohma 1975
   a. Typical subass.
   b. Thea sinensis facies
2. Thea sinensis - Camellia japonica community

		1					2	
		a			b			
Serial number		1	2	3	4	5	6	7
Releve'number		6	35	33	34	31	2	1
Altitude(m)		180	30	30	80	50	80	90
Slope aspect		S	.	.	N	SE	S	S
Slope degree(°)		16	.	.	5	25	18	15
Topography		V	R	F	R	L	L	L
Quardrat size(m^2)		100	225	225	225	225	100	100
Height of tree-1 layer(m)		12	23	18	20	14	12	6
Coverage of tree-1 layer(%)		90	95	95	85	95	40	85
dbh of highest tree(cm)		20	64	36	32	28	50	14
Height of tree-2 layer(m)		7	8	8	8	8	8	.
Coverage of tree-2 layer(%)		75	75	65	70	40	95	.
Height of sarub layer(m)		2	2	2	2	2	1	1
Coverage of sarub layer(%)		30	65	95	75	90	40	30
Height of herb layer(m)		0.5	0.8	0.5	0.5	0.8	0.5	0.5
Coverage of herb layer(%)		70	95	80	95	95	50	80
Number of species		34	27	39	40	34	30	34
Character species of association:								
Zelkova serrata	T1	4.4	5.5	5.5	5.5	5.5	.	.
	T2	+	.	.	.	+	.	.
	S	+	.	+	1.1	.	r	r
Lilium tsingtauense	H	+	+	+	+	+	.	.
Trachelospermum asiaticum var. intermedium	S	1.2	+.2	.	+.2	+.2	.	.
Hedera rhombea	S	.	+.2	+.	+.2	.	+.2	+.2
Lycoris rolfiae	H	1.2	1.2	+.2	.	+.2	.	.
Ophiopogon japonicum	H	+.2	+.2	.	.	+.2	+	+
Orixa japonica	S	1.2	2.2	1.2	+	1.2	1.2	.
Differential species of subass.:								
Thea sinensis	S	.	.	.	3.3	4.4	3.3	3.3
Differential species of association:								
Camellia japonica	T1	.	.	.	.	.	2.2	2.2
	S	.	.	.	.	.	1.2	1.2
Character species of subass.:								
Lindera erythrocarpa	T2S	+	+	.	+	+	.	.	.
Liriope platyphylla	H	1.2	+	+	+	+	+.2	+	+
Arisaema amurense	H	+	.	+	.	+	+	+
Cornus controversa	T1S	2.2	+	+	+	+	.	.	.
Jellis sinensis	T1T2	+.1	+.1	+	.	.	.	.	.
Character and differential species of lower units:									
Acer pseudo-sieboldianum var. koreanum	T1	1.1	1.1	2.2	1.1	1.1	.	.
	T2	+	3.3	2.2	1.1	1.2	.	.
	S	.	1.2	+.2	+	.	+	+
	H	.	1.3	2.2	.	.	.	.
Acer mono	T1T2	.	+	+	+	1.1	.	.
	S	.	+	.	.	r	.	
Staphylea bumalda	S	.	+	+	+	+	.	.
Ligustrum obtusifolium	S	1.2	+.2	1.3	1.3	1.2	.	+
Smilax china	H	+	.	.	.	.	+	+
Styrax japonica	T2	1.1	+	1.1	1.1	.	.	.
Lindera oblusiloba	T2S	+	+	+	.	.	1.1	1.1
Viburnum dilatatum	S	+	.	+	1.1	.	.	.
Companions:								
Carpinus tschonoskii	T1	+	1.1	2.2	2.2	2.2	.	.
	T2	.	+	1.1	1.1	.	.	.
	S	.	+	1.1	2.2	.	.	.
Quercus aliena	T1	.	2.2	2.2	2.2	2.2	.	.
Milletia japonica	H	+	.	+	+	+	+	+
Quercus variabilis	S	.	+	.	.	r	.	
Prunus sargentii	T1	+	.	1.1	.	1.1	.	.
Stephanandra incisa	S	1.2	.	2.3	1.2	.	.	.
Oplismenus undulatifolius	H	+	+	.	.	+	2.2	1.1
Akebia quinata	H	+	+	+	.	+	.	+
Viola dissecta var. chaerophylloides	H	.	.	+	+	+	+	.
Persicaria filiforme	H	.	+	+	.	+	+	.
Alangium plantanifolium var. macrophyllum	S	.	.	+	.	+	+	+
Disporum viridescens	H	+	.	.	+	.	.	+
Galium pogonanthum	H	.	1.2	+	.	+	.	.
Smilax nipponica	H	.	.	+	+	.	.	+
Viola acuminata	H	.	.	+	.	.	+	+
Bidens bipinnata	S	.	.	.	+	.	+	+
Codonopsis lanceolata	H	+	.	+	1.2	+	.	.
Osmunda borealis	H	.	.	.	1.2	1.2	+	+
Rosa multiflora	S	+	.	+	r	.	.	.
Euonymus oxyphyllus	S	.	.	+	.	+	.	.
Acer palmatum	S	.	.	.	+	2.1	.	.
Weigela subsessilis	S	.	+	.	+	.	.	.
Lespedeza cyrtobotrya	H	+	.	.	.	+	.	.
Platycarya strobilacea	S	+	.	.	+	.	.	.
Carex lanceolata	H	+	.	.	.	1.2	.	.
Albizzia julibrissin	S	.	.	.	.	+	.	+
Clinopodium chinense	H	.	.	.	2.2	.	.	1.2
Corylus sieboldiana	S	.	.	+	+	.	.	.

Rare species: Meliosma myriantha(6:S-+), Carium japonicum(5:S-+), Acer pictum(3:H-+), Aganum sieboldii(4:H-+), Galium gracilens (4:H-+), Desmodium oxphyllum(2:-+), Carpinus cordata(4:T2-+, S-+), Styrax obassia(7:S-r), Carex siderosticta(4:H-+), Carex lilium var. latiolaculum(4:H-+), Carex siderosticta(4:H-1.2), Fraxinus rhynchophylla(3:S-2.1), Malus baccata(3:S-+), Rhus verniciflua(6:S-+), Lilium cernuum(2:H-+,7:H-+), Joreulus triebus(1:H-+,6:H-+), Fraxinus sieboldiana(3:S-+), Corylus heterophylla var. thunbergii (3:S-r,7:S-r), Osmunda japonica(1:H-+), Angelica decursiva(1:H-+, 4:H-+), Dioscolea batatas(5:H-+,7:H-+), Ixeron inflexus(3:H-+), Rhododendron schlipenbachii(4:H-r), Asterisum sieboldii(1:H-+), Castanea crenata(1:S-1.1,4:S-r), Zanthoxylum piperitum(5:S-+, 7:S-1.1), Commelina communis(7:H-+), Veratrum maackii var. Japonicum(3:H-+), Cleodendron trichotomum(5:S-r,9:s-r), Artemisia princeps var. orientalis(2:H-+), Torreya nucifera(6:S-+,7:T1-5.5), Cayratia japonica(6,7:H-+), Desmodium fallax(6,7:H-+), Smilax sieboldii(6,7:H-+)

Date of survey: Releve' No.1-6;Aug.24,1985, Releve' No.31-34; May 11,1986, Releve' No.35;May 16,1986.

Note: T:top, R:ridge, U:upper part of slope, M:middle part of slope, L:lower part of slope, V:valley, F:flatland.

some constant such as *Lilium tsingtauense*, *Trachelospermum asiaticum* var. *intermedium*, *Hedera rhomber*, *Lycoris rodiata*, *Codonopsis lanceolata*, *Liliope platyphylla* and *Milletia japonica*. *Ophiogon japonica* and *Arisaema amurense* are often found.

Character species of this association in this mountain is similar with those of in Japan (Miyawaki *et al.*, 1983). As mentioned, zelkova forest of the mountain belongs to an association, Orixo-Zelkovetum serratae Miyawaki et H. Tohma 1975. This association is subdivided into two lower units with the basis of the topography and floristic composition:

a. Typical subassociation without character species

b. *Thea sinensis* facies which has character species, *Thea sinensis*.

T. sinensis is a man-introduced plant and it was planted on the lower parts of the mountain instead of destroyed undergrowth of the forest around the Seonun temple.

2. *Thea sinensis-Camellia japonica* community

Differential species: *Thea sinensis* and *Camellia japonica*.

The tree layer is chiefly composed of *Camellia japonica* which often reaches about 6 m tall and over 50 cm in dbh. In this forest, *T. sinensis* is always constant. The camellias are believed to have been planted after AD 577 together with the tea plants. Their undergrowth are poor. Tea plant, ivy, *Sasa borealis* and *Ophiopogon japonicus* grow around the camellia grove and *Euonymus fortunei* var. *radicans* grows on nearby rock. A stand of *Lycoris rodiata* grows behind the temple.

摘 要

1985年 8月부터 1986年 8月까지 禪雲山의 森林 植生을 Z-M 學派의 方法으로 調査하여 9個의 群落單位를 識別하였다. 이들을 다른 地域의 植生資料들과 比較 檢討한 結果 禪雲山의 森林群落의 植生分類體系는 다음과 같다.

소나무 群團(Pinion densiflorae Suz.-Tok. 1966)

1. 진달래-소나무 群集(Rhododendro mucronulati-Pinetum densiflorae ass. nov.)
2. 곰솔 群落(*Pinus thunbergii* community)

서어나무 群團(Carpinion laxiflorae all. nov.)

1. 졸참나무-개서어나무 群落(*Quercus serrata-Carpinus tschonoskii* community)
2. 갈참나무-개서어나무 群落(*Quercus aliena-Carpinus tschonoskii* community)
3. 개서어나무 群集(Carpinetum tschonoskii ass. nov.)
   a. 典型 亞群集(Typical subass.)
   b. 조릿대 亞群集(*Sasa borealis* subass.)
4. 굴참나무 群集(Quercetum variabilis ass. nov.)
   a. 조릿대 亞群集(*Sasa borealis* subass.)
   b. 典型 亞群集(Typical subass.)
5. 서어나무 群集(Carpinetum laxiflorae ass. nov.)

느티나무 群團(Zelkovion serratae Miyawaki *et al.* 1977).

1. 상산-느티나무 群集(Orixo-Zelkovetum serratae Miyawaki et H. Tohma 1975).

a. 典型 亞群集(Typical subass.)

b. 차나무 facies(*Thea sinensis* facies)

2. 차나무-동백나무 群落(*Thea sinensis-Camellia japonica* community)

이들중 진달래-소나무 群集, 서어나무 群團, 개서어나무 群集, 굴참나무 群集과 서어나무 群集은 著者들에 의해 命名되었다. 또 이들 群集의 種組成的 構造的 그리고 外觀的 環境 特徵을 記述하였다.

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(*Received December 5, 1986*)

Table 2. Vegetation table of Quercus serrata - Carpinus tschonoskii community[1], Quercus aliena - Carpinus tschonoskii community[2], Carpinetum tschonoskii[3], Quercetum variabilis[4], and Carpinetum laxiflorae[5] on Mt. Seonun, Korea

Carpinion laxiflorae all. nov.
1. Quercus serrata - Carpinus tschonoskii community
2. Quercus aliena - Carpinus tschonoskii community
3. Carpinetum tschonoskii ass. nov.
   a. Typical subass.
   b. Sasa borealis subass.
4. Quercetum variabilis ass. nov.
   a. Sasa borealis subass.
   b. Typical subass.
5. Carpinetum laxiflorae ass. nov.

		1		2			3					4								5	
							a			b		a			b						
Serial number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Releve' number		32	19	13	6	11	10	16	20	12	3	9	23	4	24	21	22	7	29	26	36
Altitude(m)		40	100	60	130	100	100	150	40	40	80	120	180	160	200	150	200	150	180	280	100
Slope aspect		NW	NW	W	N	NE	SE	NW	NW	N	S	N	NE	E	SE	SE	NE	S	W	S	SE
Slope degree(°)		10	15	7	3	8	3	16	7	10	3	17	22	15	25	22	20	26	24	35	20
Topography		L	M	L	V	V	M	M	L	L	F	L	V	V	V	M	U	S	M	M	M
Quardrat size(m^2)		100	225	49	25	100	100	225	225	225	100	100	225	100	100	100	100	100	100	100	100
Height of tree-1 layer(m)		12	18	8	7	15	14	17	15	16	13	10	18	9	9	8	12	13	15	16	18
Coverage of tree-1 layer(%)		75	85	70	85	75	70	80	85	85	85	75	65	80	85	65	70	70	60	75	85
dbh of highest tree		16	58	12	14	22	42	35	64	28	48	21	54	17	23	16	22	24	21	22	36
Height of tree-2 layer(m)		6	8	5	.	8	8	9	9	9	8	5	8	5	6	6	6	6	7	5	8
Coverage of tree-2 layer(%)		65	60	50	.	70	55	65	70	65	65	50	60	60	60	50	50	50	45	70	75
Height of shrub layer(m)		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Coverage of shrub layer(%)		70	50	50	70	40	40	45	30	30	50	65	50	55	30	60	60	60	50	25	80
Height of herb layer(m)		0.5	0.8	0.5	0.5	0.5	0.8	0.8	0.5	0.8	0.5	0.8	0.8	0.8	0.5	0.5	0.5	0.5	0.5	0.5	0.8
Coverage of herb layer(%)		80	70	35	60	65	65	55	70	90	70	80	95	65	45	45	40	60	65	40	95
Number of species		22	29	34	27	23	28	39	37	46	25	27	27	40	28	27	24	21	23	26	23
Differential species of communities:																					
Quercus serrata	T1	3.3	3.3	.	1.1	.	+	.	+	1.1	.	1.1	1.1	.	.	1.1	1.1	1.1	+	+	.
	T2	+	1.2	.	.	.	+	.	.	.	.	+	.	+	.	+.1	+	+	+	+	.
	S	+	.	.	+	.	+	.	.	.	.	+	.	+	+	+	.	+	+	+	.
Quercus aliena	T1	+	.	3.3	3.3	4.4	2.2	+	2.2	1.1	2.2	.	.	1.1	.	.	.	.	1.1	.	1.1
	T2	+	.	3.3	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	1.1
	S	.	.	+	+	+	.	.	.	.	+	.	.	+	.	.	.	.	+	.	+
Character species of associations:																					
Carpinus tschonoskii	T1	2.2	2.2	1.1	2.2	1.1	4.4	4.4	3.3	3.3	4.4	+	.	+	.	.	.	.	.	.	.
	T2	+	.	1.1	1.1	.	+	1.1	1.2	1.2	2.2	.	+.1	+	.	.	.	.	.	.	.
	S	2.2	.	+	1.1	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Acer pseudo-sieboldianum var. koreanum	T1	.	.	.	.	.	.	.	1.1	1.1	.	.	.	.	.	.	.	.	.	.	.
	T2	.	.	.	.	+	.	2.2	+	1.2	2.2	.	.	.	.	.	.	.	.	.	.
	S	.	.	.	.	+	.	+	+	+	+	+	+	.	.	.	.	+	.	.	+
Ainsliaea acerifolia	H	.	.	.	.	+	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.
Quercus variabilis	T1	2.2	2.2	+	+	.	+	1.1	.	.	.	3.3	3.3	3.3	3.3	4.4	3.3	5.5	4.4	1.1	1.1
	T2	2.2	.	+	.	.	.	+	.	.	.	+	.	+	1.2	3.3	2.2	2.2	+	+	+
	S	.	.	+	.	.	.	.	.	.	.	+	.	+	+	+	.	+	.	+	.
Lespedeza bicolor	H	.	.	+	.	.	.	+	.	.	.	.	+.2	+.2	+.2	+	.	1.2	1.2	.	.
Indigofera kirilowi	H	.	.	+	.	.	.	+	.	.	.	+	.	+	+	+	1.2	+	+	+	1.2
Carpinus laxiflora	T1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	3.3	3.3
	T2	.	.	.	.	.	.	+	.	+	.	.	+.1	.	1.1	.	+	.	.	3.3	3.3
	S	.	+	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	+.2	2.3
Differential species of subassociation:																					
Sasa borealis	H	.	.	.	.	.	.	+	+	3.3	3.3	.	.	3.3	2.3	.	.	.	.	.	4.4
Character species of alliance:																					
Fraxinus rhynchophylla	T1T2	.	.	.	.	2.2	1.1	.	.	.	+	.	.	+	.	.	.	±	.	.	+
	S	+	.	+	+	.	.	.	.	+	.	+	.	+	.	.	.	.	+	.	+
Sapium japonicum	S	.	+	.	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.
Meliosma myriantha	T2	.	+	.	.	.	.	+	+	1.1	+	1.1	.	.	.	.	.	.	.	.	.
	S	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Prunus sargentii	T1S	1.1	.	±	.	.	.	+	+	+	.	±	.	+	.	.	.	±	+.1	1.1	.
	T2	+	+	.	.	+	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.
Aster scaber	H	+	+	+	+	+	.	.	.	.	+	.	+	+	+	+	+	.	+	+	.
Smilax nipponica	H	.	+	.	.	.	+	+	+	+	.	+	.	+	+	.	.	.	.	+	.
Character and differential species of upper units:																					
Ligustrum obtusifolium	S	.	.	.	+	+	+	.	+	+	+	.	.	1.2	.	.	.	.	.	.	.
Staphylea bumalda	S	.	+	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Smilax china	H	.	+	+	.	+	+	+	+	+	+	+	.	+	+	+	+	+	.	+	+
Lindera obtusiloba	T2S	.	+	.	.	+	±	+	±	+	.	+	+	+	±	+	+	.	+	+	1.2
Platycarya strobilacea	T1S	+	.	.	1.1	.	.	±	+	.	+	.	.	+	±	1.1	.	.	.	.	.
	T2	+	.	.	.	.	.	.	.	.	.	.	.	.	2.2	.	.	.	+	2.2	.
Viburnum dilatatum	S	+	+	+	.	+	.	1.2	.	+	.	1.2	1.2	+	.	+	1.2	+	1.3	.	+
Styrax japonica	T2	.	1.1	.	.	.	2.2	+	.	+	1.2	+	+	+	.	.	.	.	2.2	.	.
	S	.	.	.	.	.	+	.	.	+	.	+	.	.	.	.	+	.	+	.	.
Fraxinus sieboldiana	T2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.
	S	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	1.2	1.2	.	.	1.2
Companions:																					
Zelkova serrata	T2S	±	.	.	+	+	+	1.1	.	+	±	.	.	.	.	.	.	.	.	.	.
Stephanandra incisa	S	.	+	.	1.2	1.2	+	+	.	+	2.3	1.1	.	1.2	.	.	.	.	.	.	.
Oplismenus undulatifolius	H	.	+	1.2	.	2.3	+	2.3	1.2	.	2.3	+	+	.	.	.	.	.	+	.	.
Lindera erythrocarpa	T1	.	.	.	.	.	.	+	+	2.2	.	.	.	.	.	.	.	.	.	.	.
	T2	.	+	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.
	S	.	+	.	.	.	.	+	+	+	.	.	.	.	.	.	+	.	.	+	.
Trachelospermum asiaticum var. intermedium	H	+	.	.	.	+	.	2.3	+	+	.	.	.	.	.	.	.	.	.	.	.
Liriope platyphylla	H	.	.	.	+	.	+	.	1.2	1.3	+	.	+	.	.	+	+	.	.	+	.
Millotia japonica	H	.	1.2	.	.	+	.	.	+	.	+	.	.	+	.	.	.	.	.	1.2	.
Lillium tsingtauense	H	+	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Acer mono	T1S2	.	±	.	.	.	.	1.1	1.1	.	.	.	.	.	.	.	.	.	.	.	.
Acer pinnatifida	T2S	.	.	+	.	.	1.1	.	+	±	.	+	.	.	.	.	.	.	.	.	.
Athyrium niponicum	H	.	+	+	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.
Celtis sinensis	S1T2	.	.	.	.	.	.	+	2.2	±	+	.	.	.	.	.	.	.	.	.	.
Carpinus cordata	T2S	.	.	.	.	.	.	±	+	+	±	.	.	.	.	.	.	.	.	.	.
Atractylodes japonica	H	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	+
Pinus densiflora	T1S	.	.	1.1	±	.	.	.	.	.	+	1.1	2.2	1.1	1.1	2.2	+	±	1.1	.	+
Lelampyrum roseum	H	.	.	.	+	.	.	.	.	.	.	.	.	+	+	+	+	+	.	.	.
Etsholtzia splendens	H	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	+	.	.	.	.
Pyrola japonica	H	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.
Rhododendron mucronulatum	S	.	.	+	.	+	.	.	.	.	.	.	.	+	1.2	+	1.1	1.2	+	1.2	+
Pteridium aquilinum var. latiusculum	H	.	.	+	+	+	.	.	.	+	.	+	.	+	+	+	+	.	+	+	+
Lespedeza maximowiczii	H	+	.	+	.	1.2	.	.	.	.	.	+	1.2	+	.	+	+	.	+	.	.
Carex siderosticta	H	2.3	1.2	+	+	.	.	+	.	.	.	+	.	+	1.2	.	+	+	.	1.2	1.3
Carex lanceolata	H	+	.	.	.	.	+	+	.	+	.	.	+	+	+	.	+	+	+	+	.
Sorbus alnifolia	S	.	+	.	+	r	.	.	.	+	.	+	r	.	.	+	+	.	+	.	.
Artemisia sylvatica	H	.	.	1.2	.	.	.	.	.	.	.	.	+	.	+	.	.	1.2	+	+	.
Viola acuminata	H	.	+	.	+	.	+	.	.	+	+	+	+	+	.	.	.	.	+	.	+
Disporum smilacinum	H	+	+	+	.	.	.	.	.	+	.	+	.	+	.	.	+	.	.	.	+
Rhus verniciflua	T2S	.	.	.	+	.	.	+	.	+	±	.	.	r	.	+	.	.	.	.	.
Pueraria thunbergiana	H	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.
Arthraxon hispidus	H	+	.	+	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Albizzia julibrissin	T1S	.	±	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Malus baccata	T2S	.	.	r	r	.	.	±	.	±	.	.	.	.	+	r	+	.	.	+	.
Alatis glabra	H	.	.	+	.	.	.	±	+	.	.	.	.	+	+	.	.	±	.	.	.
Dioscolea batates	H	.	.	+	.	.	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.
Acer pseudo-sieboldianum	T2	.	1.1	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.
Acer palmatum	T2S	.	.	.	.	.	.	±	+	.	.	.	.	.	.	.	.	.	.	.	.
Corylus heterophylla var. thunbergii	S	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.
Isodon inflexus	H	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca ovina	H	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	+	+	.
Rhus chinensis	S	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	+	.
Sanguisorba officianalis	H	+	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	+	r	.
Styrax obassia	S	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.
Cornus controversa	T2S	.	.	.	.	.	+	.	.	.	.	+	.	.	r	.	.	.	.	.	+
Lysimachia barystachys	H	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	±
Meliosma oldhamii	T1	.	.	.	.	.	.	+	.	+	.	+	.	.	.	+	.	.	.	+	.
Cocculus trilobus	H	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.
Osmunda japonica	H	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Angelica decursiva	H	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.
Viola manshurica	H	.	.	+	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.

Rare species: Potentilla fragaricides(4:H-+,19:H-+), Commeliana communis(9:H-+,15:H-+), Juniperus rigida(4:S-r, 12:S-r), Viola dissecta var. chaerophylloides(4:H-+,9:H-+), Euonymus sachalinensis(4:S-+,9:S-+), Hedera rhombea (8:H-+,9:H-+), Arisaema amurense var. serratum(6:H-+,8:H-+), Akebia quinata(8:H-+,9:H-+), Clerodendron trichotomum (2:S-+), Alangium platanifolium var. macrophyllum(8:S-+,9:S-+), Persicaria filiforma(8:H-+,9:H-+), Disporum viridescens(8:H-+,9:H-+), Ophiopogon japonicus(9:H-+), Asarum sieboldii(2:H-+,8:H-+), Weigela subsessilis(1:S-+), Artemisia prinseps var. orientalis(9:H-+), Galium gracilens(3:H-+,9:H-+), Desmodium oryphyiium(3:H-+,5:H-+), Cayratica japonica(6:H-+), Desmodium fallax(8:H-+), Smilax sieboldii(9:H-+), Codonopsis lanceolata(4:H-+), Arundinella hirta(3:H-+), Quercus acutissima(1:T2-+), Platycodon grandiflorum(4:H-+), Milium effusum(10:H-+), Bidens bipinnata(8:H-+,9:H-+), Rosa multiflora(9:S-+), Patrinia scabisaefolia(3:H-+,6:H-+), Rhododendron schlipenbachii (1:S-+,11:S-+), Corylus sieboldiana(3:S-+,20:S-+), Zanthoxylum piperitum(3:S-+).

Date of survey: Releve'No.3-11;Aug.24,1985, Releve'No.12-20;Aug.25,1985, Releve'No.24-29;Aug.26,1985, Releve'No. 32;May11,1986, Releve'No.36;May16,1986.

Note: T:top,R:ridge,U:upper part of slope,M:middle part of slope,L: lower part of slope, V:valley, F:flatland.