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Syntaxonomy of Evergreen Broad-leaved Forests in Korea

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Abstracts - A survey of syntaxa of vegetation of evergreen broad-leaved forests in Korea, class Camellietea japonicae is presented. 399 relevé s were arranged two phytosociological tables, each representing an alliance. A synoptic table comprising all alliances is presented. The vegetation of evergreen broad-leaved forests is divided into three alliances including twelve new associations: (1) Querco-Castanopsion all. nov., split into four associations, Castanopsietum sieboldii, Quercetum acutae, Quercetum myrsinaefoliae and Litseetum japonicae; (2) Machilo-Camellion all. nov., separate into ten associations, Machiletum thunbergii, Pittosporetum tobirae, Aucubetum japonicae, Neolitsetum sericeae, Euryetum emarginatae, Elaeagnetum macrophyllae, Camellietum japonicae, Theo-Camellietum japonicae, Raphiolepietum umbellatae and Daphniphylletum macropodae; (3) Dendropanaco-Castanopsion sieboldii including one association, Hosto minoris-Castanopsietum sieboldii. The alliances are floristically and ecologically characterized and their distribution in Korea shown on the map. [Camellietea japonicae, Coldness Index, Dendropanaco-Castanopsion sieboldii, Distribution, Machilo-Camellion, Querco-Castanopsion, Syntaxonomy, Warm Temperate Zone].

INTRODUCTION

In Korea all vegetation maps presented agree in recognizing the subalpine conifer forests in the northern mountainous area, the evergreen broad-leaved forests along the southern coast and the deciduous broad-leaved forests in-between (Yim 1977b). The distribution of evergreen broad-leaved forest in Korea coincides with climatic pattern especially thermal climate in terms of Kira's (1945) Coldness Index (CI, unit: °C · /month), warm temperate zone (Yim and Kira 1975), whose northern limit at CI=−10 (Yim 1977b). The distribution ranges of the evergreen broad-leaved plant communities plotted against altitude and latitude in Korea occurs only above CI=−10 (Yim 1995).

This region shows the high air temperature (annual mean 14°C) and much precipitation (mean annual 1,500mm). The climatic conditions has led to establishment of evergreen broad-leaved plants, but many of them relicts of past climatic periods (Tsukada 1974; Yim 1983). The warm temperate evergreen broad-leaved forest is well-known class Camellietea japonicae as in Japan and China (Miyawaki *et al.* 1983; Fang 1988). Although the flora or physiognomy of evergreen broad-leaved forest in Korea is similar to that in other regions, the floristic composition at the level of plant communities is quite different from those in other regions Chemical composition of forest soils as well as thermal climate and duration of sunlight play a role in structuring the floistic composition and diversity relations in communities (Zechmeister and Mucina 1994).

The syntaxonomy or ecology of communities at evergreen broad-leaved forest in Korea is unsatisfactory and still controversial. The main purpose of this study is to show the syntaxa of evergreen broad-leaved forest in Korea and their ecology. A large selection of relevés from warm temperate zone of Korea is used for the construction of a new syntaxonomic system and ecological/geographical interpretation.

MATERIALS AND METHODS

399 relevés, all made according to Braun-Blanquet (1964), were ramdomly selected from published tables describing the various communities of evergreen broad-leaved forests known to us (App. 1). By tabular comparison method (Küchler 1967; Shimwell 1971; Mueller-Dombois and Ellenberg 1974; Suzuki *et al.* 1985) the relevés were classified and documented in the synoptic tables. The constancy of a species was determined by calculating the proportion of the number of relevés per a synoptic table to the total numbers of relevés for a given community. Only those communities were included into our synoptic tables, for which at least five relevés were available. The syntaxa, alliances and associations classified were compared with those of orther region (Miyawaki *et al.* 1983). Distribution map (Fig. 1) was compiled from the available literatures (App. 1) as well as from field surveys by authors. All scientific name of plants was quoted from Lee (1979).

RESULTS AND DISCUSSION

There is obvious difference between the communities of the class Camellietea japonicae in Korea and those of Japan and China. The distinction can be detected if especially their floristic composition is considered. Evergreen species such as *Quercus acuta, Quercus myrsinaefolia, Aucuba japonica, Neolitsea sericea, Eurya emarginata, Elaeagnus macrophylla, Rapiorepis umbellata, Castanopsis cuspidata* var. *sieboldii, Machilus thunbergii, Pittosporum tobira* and *Litsea japonica* used as character species of Camellietea japonicae form associations individually in Korea. Their habitats and distributional optima are different from one another. Communities of this evergreen forest usually have a dominant tree layer including dwarf shrubs. Species diversity of most communities is high more than any communities in deciduous broad-leaved forest in Korea. Only in heavily shaded sites, bryophyte, algae and lichens are inhabitable. In many cases their cover and biomass hardly exceeds 5%. This may partly be so because they were missed in the samples. Some species are occurred in the forest, e.g. *Paederia scandens, Mollutus japonicus, Euscaphis japonica, Ligustrum obtusifolium* and *Callicarpa japonica* var. *luxulians*. Nevertheless there are few class character species. They are deciduous species of Quercetea mongolicae class dominated in middle part of Korea. This may partly be so because they were included in companions of the tables. The summarized syntaxonomic system of evergreen vegetation in Korea is presented in Table 2 and Table 4~5.

Table 1. Thermal conditions at the northern and upper limits of distribution of eleven evergreen broad-leaved species in Korea. WI=Warmth index, CI=Coldness index (°C · month)

Species	WI	CI	Annual mean temperature (°C)
Quercus glauca	104.5	−7.7	11.5
Quercus myrsinaefolia	106.5	−5.6	12.9
Quercus acuta	107.2	−6.7	12.9
Castanopsis cuspidata var. *sieboldii*	108.8	−5.1	13.1
Machilus thunbergii	108.2	−5.8	13.3
Actinodaphne lancifolia	106.4	−6.7	12.5
Neolitsea sericea	107.1	−6.6	12.7
Cinnamomum camphora	104.7	−5.9	12.5
Irex integra	107.4	−6.0	13.1
Camellia japonica	108.9	−6.5	13.1
Ligstrum japonicum	109.5	−6.4	13.3

Sources of data: Yim (1977a)

Synecological characteristics of class and order

Camellietea japonicae Miyawaki et Ohba 1963 (Table 2)

The evergreen species such as *Camellia japonica, Cinnamomum japonicum, Castanopsis cuspidata* var. *sieboldii, Machilus thunbergii, Hedera rhombea, Trachelospermum asiaticum* var. *intermedium, Ardisia japonica, Ligustrum japonicum, Eurya japonica* form the evergreen broad-leaved forest dominated by them in the southern coast of Korea. Of them, *Camellia japonica* have a wide distribution. The northern limits of its distribution in Korea is 35° 30′N. The geographical limits of evergreen species' distribution are correlated with thermal conditions such as annual mean temperature, warmth index (WI) and coldness index (CI). CI is the factor which is most closely correlated with the northward (or upward) limit of distribution of warm-temperate evergreen species (Yim 1977a). The critical CI values range between −5.1 and −7.7 with an overall average of −6.3 (Table 1). Kira (1948) pointed out that the thermal condition needed

Table 2. Synoptic table of the Camellietea japonicae (alliances)

1=Querco-Castanopsion, 2=Machilo-Camellion, 3=Dendropanaco-Castanopsion sieboldii.

Column	1	2	3
Number of relevés	187	186	26
Querco-Castanopsion			
Ardisia crenata	II	·	II
Callicarpa mollis	III	·	·
Irex integra	II	·	·
Neolitsea aciculata	I	·	·
Castanopsis cuspidata var. *thunbergii*	II	·	V
Pyrola japonica	I	·	·
Elaeagnus glabra	I	·	·
Michella undulata	I	·	·
Arisaema heterophyllum	I	·	·
Bulbophyllum drymoglossum	I	·	·
Pyrrhosia lingua	I	·	·
Machilo-Camellion			
Farfugium japonicum	·	II	·
Rubus ribesioides	·	II	·
Gynostemma pentaphyllum	·	II	·
Rosa wichuraiana	·	I	·
Lonicera japonica	·	II	·
Carex boottiana	·	I	·
Viburnum japonica	·	I	·
Euonymus fortunei var. *radicans*	·	I	·
Dendropanaco-Castanopsion sieboldii			
Castanopsis cuspidata var. *sieboldii*	V	·	V
Dendropanax morbifera	II	III	IV
Quercus acuta	II	I	III
Dryopterys saxifraga	·	·	II
Selaginella involvens	·	·	II
Loxogramma salicifolia	·	·	II
Hosta minor	·	·	II
Camellietea japonicae			
Camellia japonica	IV	IV	V
Hedera rhombea	III	III	V
Trachelospermum asiaticum var. *intermedium*	IV	IV	V
Ardisia japonica	III	III	V
Ligustrum japonicum	III	III	III
Eurya japonica	III	III	V
Cinnamomum japonicum	III	III	I
Ophiopogon japonicus	III	II	III
Lemmaphyllum micriphyllum	III	II	III
Ficus erecta	II	III	I
Kadusura japonica	II	II	I
Machillus japonica	I	I	·
Ficus nipponica	II	I	II
Dryopteris bissetiana	I	I	·
Stauntonia hexaphylla	II	I	II
Cyrtomium falcatum	I	I	II
Trachelospermum asiaticum var. *majus*	II	I	·
Lepisorus thunbergianus	I	I	·
Arisaema robustum	I	I	·
Buxus microphylla var. *insularia*	I	I	·
Calanthe discolor	I	I	·
Companions			
Paederia scandens	II	II	I

Table 2. Continued

Mollutus japonicus	I	I	I
Arisaema japonica	II	II	·
Liriop platyphylla	I	I	I
Euscaphis japonica	I	I	II
Ligustrum obtusifolium	I	I	I
Callicarpa japonica var. *luxurians*	I	I	II
Cymbidium goeringii	I	I	·
Disporum smilacinum	I	I	·
Ophiopogon jaburan	I	I	·
Isachne globosa	I	I	·
Caesalpinia japonica	·	I	·

Table 3. Summary of the synecology of the alliances within Camellietea japonicae in Korea. The data on pH, electric conductivity (E.C, μmho/cm), water content (W.C, %), soil organic matter (O.M, %), total nitrogen (T-N, mg/g) and phosphate (PO_3-P, mg/100 g) concern forest soil

Alliance	pH	E.C	W.C	O.M	T-N	PO_3-P	Slope	Aspect	Altitude (m)
Querco-Castanopsion	5.7	98	26.0	13.2	1.23	2.39	15~20	S~SE	100~370
Machilo-Camellion	5.8	133	30.1	14.4	1.95	3.74	5~10	N~NE	~100

Sources of data: Ihm *et al.*(1992)

for the occurrence of evergreen forest was a range of CI between 0 and −10, which suggests an explanation for the limited distribution of this forest in southern coast of Korea. The remaining northern distribution of evergreen forests, now preserved as natural monuments such as Ulsan CI=−9.3, Kochang CI=−14.0 and Chongup CI=−15.0 (Yim and Kira 1975), seems to support the hypothesis. It may thus be tentatively concluded that the critical value of CI −10 delimits the distribution of evergreen forest in Korea as well as in Japan (Yim 1977b).

The characteristic species of Korean evergreen forest such as *Machilus thunbergii, Castanopsis cuspidata* var. *sieboldii, Quercus acuta, Camellia japonica,* etc., clearly indicate that evergreen forest in Korea has a strong resemblance to that in south-western Japan (Miyawaki *et al.* 1983). Therefore, their taxonomical status belongs to the class Camellietea japonicae Miyawaki et Ohba 1963. Only one order, Camellietalia japonicae is included in this class.

Camellietalia japonicae Oda et Sumata 1966

Two lower-rank syntaxa, Myrsino-Castanopsietalia sieboldii and Camellietalia japonicae, were distinguished within the class Camellietea japonicae in Japan. *Myrsine sequinii, Symplocos lucida, Maesa japonica, Rumohra aristat, Camellia sasanqua, Elaeocarpus sylvestris* var. *ellipticus, Chloranthus glaber*, etc. are the character species of the former (Fujiwara 1981). Of them, however, *Elaeocarpus sylvestris* var. *ellipticus, Chloranthus glaber* and *Rumohra aristat* are only found in Korea. The characteristic species group of the lower-rank syntaxon of evergreen forest in Korea such as *Camellia japonica, Castanopsis cuspidata* var. *sieboldii, Eurya japonica, Neolitsea sericea, Ardisia crenata*, etc., is similar with character species group of the order Camellietalia japonicae Oda et Sumata 1966 in Japan (Miyawaki *et al.* 1983).

This order includes three alliances, Querco-Castanopsion, Machilo-Camellion and Dendropanaco-Castanopsion sieboldii in Korea (Table 2).

Synecological characteristics of alliances

Querco-Castanopsion all. nov. (Table 2-1 and Table 4)

Holotype: Castanopsietum sieboldii

Character species: *Ardisia crenata, Callicarpa mollis, Ilex integra, Neolitsea aciculata, Castanopsis cuspidata* var. *thunbergii, Pyrola japonica, Elaeagnus glabra, Mitchella undulata, Arisaema heterophyllum, Bulbophyllum drymoglossum* and *Pyrrhosia lingua.*

Synecology: Communities of this alliance are dominated by *Quercus acuta, Castanopsis cuspidata* var. *sieboldii, Quercus myrsinaefolia* and *Litsea japonica* in different area, respectively.

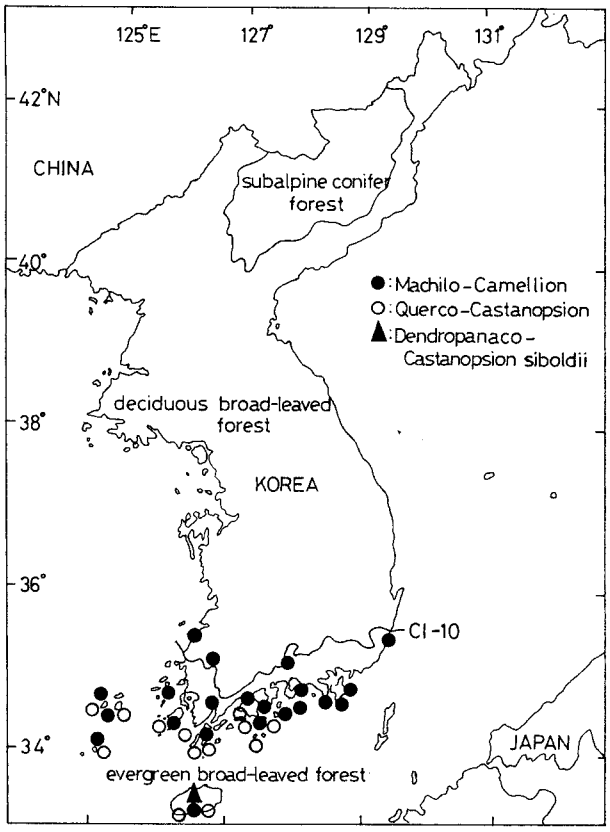

Fig. 1. Map showing the distribution of the Querco-Castanopsion, Machilo-Camellion and Dendropanaco-Castanopsion sieboldii communities in Korea.

Low contents of water, organic matter, phosphate, total nitrogen, electric conductivity and pH in the soil are characteristic environmental features (Table 3). The species diversity of these communities is high. There are many character species of the alliance, including *Ardisia crenata, Callicarpa mollis, Ilex integra, Neolitsea aciculata, Castanopsis cuspidata* var. *thunbergii, Pyrola japonica, Elaeagnus glabra, Mitchella undulata, Arisaema heterophyllum, Bulbophyllum drymoglossum, Pyrrhosia lingua* etc., all showing both high cover and fidelity. The species composition and combination of the alliance differ from that of the evergreen broad-leaved forests in Japan and China. The preserved forests of Querco-Castanopsion are formed with the trees of the tree height 12~19.5 m, forest coverage 90~100% and diameter at breast height (dbh) of trees 20.4~40.2 cm. Querco-Castanopsion stands may distribute on 15~20° in slope degree, 100~370 m in altitude and S~SE in slope aspects at southern parts of 34°30′N in Korea (Table 3 and Fig. 1). Associations belonging to the alliance can be found predominantry at higher altitudes and on precipitous cliffs and steep slopes. The new alliance proposed here, Querco-Castanoption, includes four new associations, Castanopsietum sieboldii, Litseetum japonicae, Quercetum acutae and Quercetum myrsinaefoliae.

Machilo-Camellion all. nov.(Table 2-2 and Table 5)

Holotype: Camellietum japonicae

Character species: *Farfugium japonicum, Rubus ribesioideus, Gynostemma pentaphyllum, Rosa wichuraiana, Lonicera japonica, Carex boottiana, Viburnum japonica* and *Euonymus fortunei* var. *radicans.*

Synecology: Communities of this alliance are dominated by *Camellia japonica, Machilus thunbergii, Pittosporum tobira, Acuba japonica, Neolitsea sericea, Eurya emarginata, Elaeagnus macrophylla, Raphiorepis umbellata* in different area, respectively. High contents of water, organic matter, phosphate, total nitrogen, elecrtic conductivity and pH in the soil are characteristic environmental features (Table 3). The species diversity of these communities is high. The character species group of this alliance contains *Farfugium japonicum, Rubus ribesioideus, Gynostemma pentaphyllum, Rosa wichuraiana, Lonicera japonica, Carex boottiana, Viburnum japonica, Euonymus fortunei* var. *radicans*, etc., all showing both high cover and fidelity. The species composition and combination of the alliance in evergreen broad-leaved forests show different from that of the neighbor countries, Japan and Chaina. The Machilo-Camellion forests preserved show the tree height 12.4~13.2m, forest coverage 95~100% and dbh of trees 32.6~33.8 cm. Machilo-Camellion stands may distribute on 5~10° in slope degree, below 100 m in altitude and N~NE in slope aspects at northern parts of 34°30′N in Korea (Table 3 and Fig. 1). Associations belonging to the alliance show a wide latitudial distribution.

The new alliance, Machilo-Camellion, contains eight new associations, Machiletum thunbergii, Pittosporetum tobirae, Acubetum japonicae, Neolitsetum sericeae, Euryetum emarginatae, Elaeagnetum macrophyllae, Camellietum japonicae and Raphiolepietum umbellatae and two published associations, Theo-Camellietum japonicae and Daphniphylletum macropodae.

Table 4. Synoptic table of the Querco-Castanopsion. Roman figures indicate 20% constancy classes (Braun-Blanquet, 1964). Sources of data: See Appendix 1

1=Castanopsietum sieboldii, 2=Quercetum acutae, 3=Quercetum myrsinaefoliae, 4=Litseetum japonicae.

Column	1	2	3	4
No. of relevés	107	37	5	38
Castanopsietum sieboldii				
Castanopsis cuspidata var. *sieboldii*	V	.	.	.
Quercetum acutae				
Quercus acuta	II	V	.	.
Quercetum myrsinaefoliae				
Quercus myrsinaefolia	.	.	V	.
Litseetum japonicae				
Litsea japonica	I	.	.	V
Querco-Castanopsion				
Ardisia crenata	II	I	II	I
Callicarpa mollis	III	I	IV	.
Ilex integra	II	I	II	I
Neolitsea aciculata	I	I	.	I
Castanopsis cuspidata var. *thunbergii*	II	I	.	.
Pyrola japonica	II	I	.	.
Elaeagnus glabra	I	.	.	.
Michella undulata	I	I	.	.
Arisaema heterophyllum	I	I	.	I
Bulbophyllum drymoglossum	I	.	.	.
Pyrrhosia lingua	I	.	.	.
Camellietea japonicae				
Camellia japonica	IV	IV	IV	III
Hedera rhombea	III	III	II	II
Trachelospermum asiaticum var. *intermedium*	IV	V	IV	I
Ardisia japonica	IV	III	II	I
Ligustrum japonicum	IV	III	I	II
Eurya japonica	III	III	IV	.
Cinnamomum japonicum	III	III	III	II
Opiopogon japonicus	III	III	II	II
Lemmaphyllum microphyllum	III	III	.	I
Ficus erecta	III	I	.	I
Kadusura japonica	II	II	II	I
Machilus japonica	I	III	III	.
Ficus nippinica	II	II	.	.
Dryopteris bissetiana	I	I	II	.
Stauntonia hexaphyllum	II	II	.	I
Cyrtomium falcatum	I	I	II	II
Trachelospermum asiaticum var. *majus*	II	I	.	III
Lepisorus thunbergianus	I	I	.	.
Arisaema robustum	I	I	.	.
Buxus microphylla var. *insularis*	I	I	I	.
Calanthe discolor	.	I	.	.
Companios				
Paederia scandens	II	I	II	II
Mollotus japonicus	I	I	.	II
Arisaema japonica	II	I	.	II
Liriop platyphylla	I	I	.	I
Euscaphis japonica	I	I	.	.
Ligustrum obtusifolium	I	I	.	I
Callicarpa japonica var. *luxurians*	I	I	.	I
Cymbidium goeringii	I	II	I	.

Table 4. Continued

Disporum smilasinum	I	I	.	.
Ophiopogon jabran	I	I	.	.
Isachne globosa	I	I	.	.
Euonymus japonica	II	I	.	II
Daphniphyllum macropodum	I	III	.	I
Dendropanax morbifera	II	II	.	.
Lozoste lancifolia	I	I	.	.
Machilus thunbergii	II	I	.	I
Pittosporum tobira	I	I	.	I
Aucuba japonica	I	I	.	.
Neolitsea sericea	I	I	.	I
Elaeagnus macrophylla	I	.	.	I
Raphiolepis umbellata	I	I	.	.

Table 5. Synoptic table of the Machilo-Camellion. See Table 4

1=Machiletum thunbergii, 2=Pittosporetum tobirae, 3=Acubetum japonicae, 4=Neolitsetum sericeae, 5=Euryetum emarginatae, 6=Elaeagnetum macrophyllae, 7=Camellietum japonicae, 8=Theo-Camellietum japonicae, 9=Raphiolepietum umbellatae, 10=Daphniphylletum macropodae.

Column	1	2	3	4	5	6	7	8	9	10
No. of relevés	56	29	8	14	5	10	46	7	6	5
Machiletum thunbergii										
Machilus thunbergii	V	III	III	I	.	.	I	.	I	I
Pittosporetum tobirae										
Pittosporum tobira	I	V	.	.	.	.	I	.	I	.
Euonymus fortunei var. *radicans*	.	II	.	.	.	.	I	.	.	.
Aucubetum japonicae										
Aucuba japonica	.	.	V	I	.	.	.	.	.	I
Neolitsetum sericeae										
Neolitsea sericea	.	.	I	V	.	.	.	.	I	.
Viburnum japonica	.	.	.	II	.	.	I	.	.	.
Euryetum emarginatae										
Eurya emarginata	.	.	.	.	V	.	.	.	.	.
Elaeagnetum macrophyllae										
Elaeagnus macrophylla	I	I	I	I	.	V	I	.	I	.
Camellietum japonicae										
Sageretia theezans	.	.	.	.	.	.	III	.	.	.
Theo-Camellietum japonicae										
Thea sinensis	.	.	.	.	.	.	.	V	.	.
Kerria japonica	.	.	.	.	.	.	.	III	.	.
Pseudosasa japonica	.	.	.	.	.	.	.	V	.	.
Raphiolepietum umbellatae										
Raphiolepis umbellata	.	.	.	.	.	.	.	.	V	.
Rubus trifidus	.	.	.	.	.	.	.	.	III	.
Daphniphylletum macropodae										
Daphniphyllum macropodum	.	.	.	.	.	.	.	.	.	V
Machilo-Camellion										
Farfugium japonicum	II	I	III	I	I	II	III	.	.	.
Rubus ribesioideus	II	I	II	II	.	III	II	.	III	.
Gynostemma pentaphyllum	II	II	I	II	.	II	I	.	.	.
Rosa wichuraiana	I	.	.	.	.	.	II	.	.	.
Lonicera japonica	II	II	.	.	.	III	III	.	.	.
Carex boottiana	I	.	.	II	I	III	I	.	.	.

Table 5. Continued

Camellietea japonicae										
Camellia japonica	IV	III	V	V	I	·	V	V	V	II
Hedera rhombea	III	III	II	IV	·	·	III	·	III	III
Trachelospermum asiaticum var. *intermedium*	IV	IV	IV	III	·	II	III	V	V	II
Ardisia japonica	IV	IV	IV	II	·	·	II	·	II	II
Ligustrum japonicum	II	III	III	I	·	·	III	·	V	I
Eurya japonica	III	II	III	II	·	·	III	·	I	II
Cinnamomum japonicum	III	III	III	II	·	·	II	·	I	·
Ophiopogon japonicus	II	III	I	I	·	·	II	·	·	·
Lemmaphyllum microphyllum	I	III	·	IV	·	I	I	·	II	·
Ficus erecta	III	III	I	I	·	·	I	·	·	·
Cadusura japonica	II	II	II	II	·	·	II	·	·	·
Machilus japonica	I	I	I	·	·	·	I	·	·	·
Ficus nipponica	I	II	·	I	·	·	I	·	III	·
Dryopteris bissetiana	I	I	I	II	·	·	I	·	·	·
Stauntonia hexaphylla	II	I	II	II	I	·	I	·	I	·
Cyrtomium falcatum	II	I	·	II	I	I	I	·	·	·
Trachelospermum asiaticum var. *majus*	I	II	·	II	·	·	II	·	·	·
Lepisorus thunbergianus	·	I	·	·	·	·	·	·	I	·
Arisaema robustum	I	I	·	II	·	·	·	·	I	·
Buxus microphylla var. *insularis*	I	·	·	I	·	·	I	·	·	·
Calanthe discolor	I	·	I	I	·	·	·	·	·	·
Companions										
Paederia scandens	II	II	II	II	I	III	III	III	II	·
Mollotus japonicus	II	I	II	II	I	I	I	·	V	·
Arisaema japonica	II	II	II	II	I	·	I	IV	II	II
Liriop platyphylla	I	I	·	I	·	·	I	·	I	·
Euscaphis japonica	I	·	II	I	·	I	I	·	I	·
Ligustrum obtusifolium	I	I	I	II	·	I	III	·	III	·
Callicarpa japonica var. *luxurians*	I	I	I	I	II	II	I	·	·	·
Cymbidium goeringii	I	I	·	·	·	·	I	·	I	·
Disporum smilacinum	I	·	·	I	·	·	I	IV	·	·
Ophiopogon jaburan	I	II	I	I	·	I	·	·	I	·
Isachne globosa	I	I	I	·	·	·	I	·	I	·
Caesalpinia japonica	·	I	·	I	·	I	I	·	·	·
Euonymus japonica	II	III	II	I	·	·	I	·	I	·
Daphniphyllum macropodum	I	·	III	I	I	·	I	·	·	·
Dendropanax morbifera	I	II	II	II	·	·	I	·	·	I
Lozoste lancifolia	I	·	·	I	·	·	·	·	·	·
Castanopsis cuspidata var. *sieboldii*	·	III	I	·	·	·	·	·	·	I
Litsea japonica	II	II	I	I	I	·	I	·	I	·

Dendropanaco-Castanopsion sieboldii Kim *et al.* 1994 (Table 2-3)

Character species: *Castanopsis cuspidata* var. *sieboldii, Dendropanax morbifera, Quercus acuta, Dryopteris saxifraga, Selaginella inbolvens, Loxogramma salicifolia* and *Hosta minor.*

Synecology: This alliance, Dendropanaco-Castanopsion sieboldii is distinguished from others by the character species such as *Castanopsis cuspidata* var. *sieboldii, Dendropanax morbifera, Quercus acuta, Dryopteris saxifraga, Selaginella inbolvens, Loxogramma salicifolia* and *Hosta minor.* The forests occur on middle parts of the southern slopes of Mt. Halla, Cheju island, Korea. The southern slopes of Mt. Halla is often enveloped in fog and cloud. The specific differences are the cause of this environment (Kim *et al.* 1994). The alliance Dendropanaco-Castanopsion sieboldii includes one association, Hosto minoris-Castanopsietum sieboldii.

Synecological characteristics of associations

Castanopsietum sieboldii assoc. nov. (Table 4-1)

Synonym: *Camellia japonica-Castanopsis cuspidata* var. *sieboldii* community (Kim *et al.* 1987; Kim *et al.* 1990), *Ardisia japonica-Castanopsis cuspidata* var. *sieboldii* community (Kim *et al.* 1989), *Castanopsis cuspidata* var. *sieboldii* community (Kim and Oh 1992).

Lectotype: Relevé no. 59 in the table 3 prepared by Kim *et al.* (1987).

Character species: *Castanopsis cuspidata* var. *sieboldii*

Differential species: *Ophiopogon jaburan, Ardisia japonica* and *Trachelospermum asiaticum* var. *majus.*

Synecology: The character and differential species, *Castanopsis cuspidata* var. *sieboldii, Ophiopogon jaburan, Ardisia japonica* and *Trachelospermum asiaticum* var. *majus* occur more abundantly on the upper parts of the slopes and somewhat xeric sites and poor habitats such as hillock and exposed ridges in the mountain. In the tree layer of the association *Quercus acuta, Machilus thunbergii* and *Castanopsis cuspidata* var. *thunbergii* are found as companion species with lower coverage and in shrub layer *Ardisia crenata, Callicarpa mollis, Ilex integra, Ardisia japonica, Ligstrum japonicum, Eurya japonica, Cinamomum japonicum, Ficus erecta* and *Camellia japonica* as shrubby species. The herb layer is composed of some constant species such as *Hedera rhombea, Trachelospermum asiaticum* var. *intermedium, Ophiopogon japonicus, Lemmaphyllum microphyllum. Pyrola japonica, Michella undulata, Arisaema heterophyllum, Bulbophyllum drymoglossum, Pyrrhosia lingua*, etc. are rarely found. This is the type association of Querco-Castanopsion.

Quercetum acutae assoc. nov. (Table 4-2)

Synonym: *Daphniphyllum macropodum-Quercus acuta* community (Kim and Jang 1989), *Quercus acuta* community (Kim *et al.* 1989), Quercus acuta subassociation (Kim 1991).

Lectotype: Relevé no. 36 in the table 1 manufactured by Kim and Jang (1989).

Character species: *Quercus acuta*

Differential species: *Cinnamomum japonicum*

Synecology: *Quercus acuta* and *Cinnamomum japonicum* as character and differential species occur on the upper parts of the slope and poor sites such as hillock, exposed ridge and dry area. The forests show the 8~15 m in tree height, 90~95% in coverage and 23 cm in mean dbh of trees. In the shrub layer of the forest *Camellia japonica, Neolitsea sericea* and *Eurya japonica* are found as constant species. The herb layer is covered with *Lemmaphyllum microphyllum, Hedera rhombea, Trachelospermum asiaticum* var. *intermedium* and *Stauntonia hexaphylla. Dryopteris bissetiana, Cyrtomium falcatum* and *Lepisorus thunbergianus* are rarely found.

Quercetum myrsinaefoliae assoc. nov. (Table 4-3)

Synonym: *Quercus myrsinaefolia* community (Kim *et al.* 1989).

Lectotype: Relevé no. 15 in the table 3 organized by Kim *et al.* (1989).

Character species: *Quercus myrsinaefolia*

Synecology: *Quercus myrsinaefolia* is determined as character species. The forests occurred upper parts of the mountains show 75% in coverage, 8.5 m in mean tree height, 10 cm in mean dbh of trees and low species richness. The constancy of *Eurya japonica, Callicarpa dichotoma* and *Camellia japonica* in shrub layer and of *Trachelospermum asiaticum* var. *intermedium* and *Hedera rhombea* in herb layer is high.

Litseetum japonicae assoc. nov. (Table 4-4)

Synonym: *Litsea japonica-Camellia japonica* community (Kim *et al.* 1990), *Litsea japonica* community (Kim *et al.* 1989; Kim and Oh 1993).

Lectotype: Relevé no. 20 in the table 2 established by Kim *et al.* (1989).

Character species: *Litsea japonica*

Differential species: *Cyrtomium falcatum* and *Callicarpa japonica* var. *luxurians.*

Synecology: *Litsea japonica, Cyrtomium falcatum* and *Callicarpa japonica* var. *luxurians* are proposed as character and differential species. The forests occur on precipitous cliffs and steep slopes. In the shrubby forests on the cliffs of the coast *Cinnamomum japonicum, Raphiolepis umbellata* and *Aster spathulifolius* are frequentry found.

Machiletum thunbergii assoc. nov. (Table 5-1)

Synonym: *Machilus thunbergii* community (Kim and Jang 1989; Kim and Oh 1990a, b, 1991, 1992), *Camellia japonica-Machilus thunbergii* community (Kim *et al.* 1987).

Lectotype: Relevé no. 34 in the table 1 constituted by Kim and Jang (1989).

Character species: *Machilus thunbergii*

Differential species: *Ophiopogon japonicus, Arisaema robustum* and *Dryopteris bissetiana*

Synecology: The association is distinguished from others by *Machilus thunbergii, Ophiopogon japonicus, Arisaema robustum* and *Dryopteris bissetiana*, character and differential species. These species occur on the lower parts of the slope and somewhat mesic sites such as ravine and valley. The coverage of the forest shows 80~90%. In the tree layer of this association *Machilus thunbergii* trees often become about 16 m tall and 25~30 cm in dbh and *Eurya japonica, Cinamomum japonicum, Ficus erecta, Mollutus japonicus* and *Ardisia japonica* are found as companions. *Euonymus japonica, Daphniphyllum macropodum, Buxus microphylla* var. *insularis, Machilus japonica* and *Dendropanax morbifera* are rarely found. The herb layer is dominated by *Trachelospermum asiaticum* var. *intermedium, Hedera rhombea* and *Ardisia japonica. Stauntonia hexaphylla, Ophiopogon japonicus, Paederia scandens, Liriop platyphylla, Ophiopogon jaburan, Lemmaphyllum microphyllum, Kadsura japonica, Ficus nipponica, Trachelospermum asiaticum* var. *majus and Dryopteris bissetiana* are usually scattered.

Pittosporetum tobirae assoc. nov. (Table 5-2)

Synonym: *Pittosporum tobira* community (Kim 1986; Kim *et al.* 1990).

Lectotype: Relevé no. 26 in the table 1 constructed by Kim (1986).

Character species: *Pittosporum tobira* and *Euonymus fortunei* var. *radicans*.

Differential species: *Farfugium japonicum* and *Ficus erecta*.

Synecology: The association includes the character species of *Pittosporum tobira* and *Euonymus fortunei* var. *radicans* and some differential species such as *Farfugium japonicum* and *Ficus erecta. Pittosporum tobira* occurs on hillock, steep ascent and wind-exposed places at the coast. The shrubbery of *Pittosporum tobira* shows the coverage 85% and the tree height 2.5 m. The emergent frequency of *Machilus thunbergii, Castanopsis cuspidata* var. *sieboldii, Litsea japonica, Camellia japonica, Ligustrum japonica, Cinnamomum japonicum* and *Euonymus japonica* in shrub layer is high. In the densed herb layer *Lonicera japonica, Hedera rhombea, Trachelospermum asiaticum* var. *intermedium, Ardisia japonica, Ophiopogon japonicus and Lemmaphyllum microhpyllum* are found frequentry.

Aucubetum japonicae assoc. nov. (Table 5-3)

Synonym: *Aucuba japonica* community (Kim 1986).

Lectotype: Relevé no. 35 in the table 1 framed by Kim (1986).

Character species: *Aucuba japonica*

Synecology: Character species, *Aucuba japonica* occurs more abundantly on the lower parts of the slope, valley and damp and shady area. In the low forest *Daphniphyllum macropodum, Machilus thunbergii*, and *Camellia japonica* are found as companion species. The herb layer is covered with *Trachelospermum asiaticum* var. *intermedium, Paederia scandens* and *Arisaema japonica*.

Neolitsetum sericeae assoc. nov. (Table 5-4)

Synonym: *Neolitsea sericea* community (Kim and Park 1988; Kim and Oh 1991).

Lectotype: Relevé no. 43 in the table 1 formed by Kim and Park (1988).

Character species: *Neolitsea sericea* and *Viburnum japonica*.

Synecology: *Neolitsea sericea* and *Viburnum japonica* are proposed as character species. *Hedera rhombea* and *Lemmaphyllum microphyllum* are also found as differential species in the forest. The forests occur on the lower parts of the slopes, hill areas, cliffs of the coast and mesic stony sites. The thicked tree layer of the association is composed of 8 m trees in average height and 25 cm in dbh. But the forests have a scatteredly shrub layer and thin herb layer. Average number of species in the plots is twenty seven.

Euryetum emarginatae assoc. nov. (Table 5-5)

Synonym: *Eurya emarginata* community (Kim and Park 1988).

Lectotype: Relev no. 54 in the table 1 founed by Kim and Park (1988).

Character species: *Eurya emarginata*

Synecology: *Eurya emarginata* is calculated as character species. The shrubby forests composed of *Eurya emarginata* occur on the places exposed the northeasterly wind. In the denses shrub layer *Camellia japonica, Daphniphyllum macropodum* and *Litsea japonica* are found and *Farfugium japonicum, Carex boottiana, Stauntonia hexaphylla* and *Cyrtomium falcatum* are scattered.

Elaeagnetum macrophyllae assoc. nov. (Table 5-6)

Synonym: *Elaeagnus macrophylla* community (Kim and Oh 1993).

Lectotype: Relevé no. 17 in the table 2 prepared by Kim and Oh (1993).

Character species: *Elaeagnus macrophylla*

Synecology: *Elaeagnus macrophylla* is determined as character species of this association. The shrubby forests composed with *Elaeagnus macrophylla* occur on pastures and discontinued farm lands. The herb layer covered with *Rubus ribesioideus, Gymnostemum pentaphyllum, Lonicera japonica, Carex boottiana, Trachelospermum asiaticum* var. *intermedium, Lemmaphyllum microphyllum* and *Paederia scandens.*

Camellietum japonicae assoc. nov. (Table 5-7)

Synonym: *Camellia japonica* community(Kim *et al.* 1987; Kim and Jang 1989; Kim *et al.* 1990; Kim and Oh 1990b, 1992, 1993).

Lectotype: Relevé no. 22 in the synoptic table 1 constructed by Kim and Jang (1989).

Character species: *Camellia japonica* and *Sargeretia theezans.*

Synecology: As the character species, *Camellia japonica* and *Sargeretia theezans* are proposed. The tree layer of *Camellia japonica* composed with 5 m in average tree height and 85% in canopy coverage. In the tree layer *Ligustrum japonicum, Eurya japonica, Cinnamomum japonicum* and *Mollutus japonicus* are abundantly found. *Farfugium japonicum, Rubus ribesioideus, Lonicera japonica, Hedera rhombea, Trachelospermum asiaticum* var. *intermedium* etc. are occurred in the herb layer and *Viburnum japonica, Euonymus fortunei* var. *radicans, Kadsura japonica, Ficus nipponica, Stauntonia hexaphylla* and *Buxus microphylla* var. *insularis* are rarely found. This is the typical association of Machilo-Camellion and two upper-rank syntaxa. The camellia forests are widely distribute in warm temperate zone of Korea.

Theo-Camellietum japonicae Yim et Kim 1992 (Table 5-8)

Lectotype: Relevé no. 165 in the synoptic table 3-2 organized by Kil and Kim (1996).

Character species: *Camellia japonica, Thea sinensis, Trachelospermum asiaticum* var. *intermedium, Kerria japonica* and *Pseudosasa japonica.*

Synecology: This associations distributed on lower slopes in southern parts of the Mt. Chiri and Mt. Seonun (Kim and Yim 1986) are composed of trees of 8~10 m in tree height and 20~30 cm in dbh. *Smilax china, Oplismenus undulatifolius, Asarum sieboldii, Disporum smilacinum, Paederia scandens, Persicaria filiforme, Arisaema angustatum* var. *peninsulae, Euonymus sachalinensis* are often found under the tree layer.

Raphiolepietum umbellatae assoc. nov. (Table 5-9)

Synonym: *Raphiolepis umbellata* community (Kim 1986; Kim *et al.* 1990).

Lectotype: Relevé no. 39 in the synoptic table 1 organized by Kim (1986).

Character species: *Raphiolepis umbellata* and *Rubus trifidus.*

Synecology: *Raphiolepis umbellata* and *Rubus trifidus* are appeared as character species. The shrubby forests composed of *Raphiolepis umbellata* occur on the upper parts of the northern slopes. The coverage of canopy shows 90% and of herb layer 30%. In the shrubbery *Camellia japonica, Ligustrum japonicum, Trachelospermum asiaticum* var. *intermedium, Rubus ribesioideus* and *Hedera rhombea* are found abundantly.

Daphniphylletum macropodae Kil et Kim 1996 (Table 5-10)

Lectotype: Relevé no. 31 in the synoptic table 3-3 organized by Kil and Kim (1996).

Character species: *Daphniphyllum macropodum*

Synecology: The association is distinguished from others by *Daphniphyllum macropodum,* character species. The forest occurs more abundantly on the lower parts of the slopes and valley of Mt. Naejang, northern limit of evergreen broad-leaved forest in Korea. The presence of this species in this area is attributed to climatic fluctuation which favored the northern migration of southern evergreen forest species as case of *Camellia japonica* (Kim and Yim 1988; Kil and Kim 1966).

Hosto minoris-Castanopsietum sieboldii Kim *et al.* 1994

Character species: *Dendropanax morbifera, Dryopteris saxifraga, Selaginella involvens, Quercus acuta,* and *Loxogramma salicifolia.*

Differential species: *Acer palmatum, Ainsliaea apiculata, Daphniphyllum macropodum, Hosta*

minor, Lycopodium serratum, Carpinus tschonoskii, Neolitsea aciculata and *Lindera obtusiloba.*

Synecology: The forests of this association occur on middle parts of the southern slopes of Mt. Halla, cloud and fog zone. The tree layer is covered with *Castanopsis cuspidata* var. *sieboldii, Quercus acuta* and *Carpinus thonoskii* are abundantly found. The distributions of *Hosta minor, Dendropax morbifera* and deciduous broad-leaved species such as *Acer palmatum* differ from of those in Japan (Kim *et al.* 1994). The tree layer become about 14 m in tree height and 90% in canopy coverage. 9 m and 50% in subtree layer and less than 1m and 40% in herb layer.

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한국 상록활엽수림의 군집분류

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적 요 - 우리나라 상록활엽수림의 식생인 동백나무군강(Camellietea japonicae)에 대한 군집분류 체계의 수립을 시도하였다. 여러 저자들에 의한 399 식생조사 자료로 2개의 식물사회학적인 표를 작성하고 군단을 정리한 바, 한국의 상록활엽수림 식생은 현재 15개의 군집을 포함하는 3개의 군단으로 구분되었다. 즉, (1) 신칭 가시나무-잣밤나무군단(Querco-Castanopsion all. nov.)은 구실잣밤나무군집(Castanopsietum sieboldii), 붉가시나무군집(Quercetum acutae), 가시나무군집(Quercetum myrsinaefoliae)과 까마귀쪽나무군집(Litseetum japonicae) 등 4개의 군집으로 나누어지고 (2) 신칭 후박나무-동백나무군단(Machilo-Camellion all. nov.)은 10개의 군집 즉, 후박나무군집(Machiletum thunbergii), 돈나무군집(Pittosporetum tobirae), 식나무군집(Aucubetum japonicae), 참식나무군집(Neolitsetum sericeae), 우묵사스레피군집(Euryetum emarginatae), 보리밥나무군집(Elaeagnetum macrophyllae), 동백나무군집(Camellietum japonicae), 차나무-동백나무군집(Theo-Camellietum japonicae), 다정큼나무군집(Raphiolepietum umbellatae)과 굴거리군집(Daphniphylletum macropodae)이 그것이다. 또 (3) 황칠나무-구실잣밤나무군단(Dendropanaco-Castanopsion sieboldii)은 하나의 군집인 좀비비추-구실잣밤나무군집(Hosto minoris-Castanopsietum sieboldii)을 포함하고 있다. 이들 군단의 식물종조성, 생태학적 특성을 기술하고 그들의 분포를 나타내는 지도를 작성했다.

App. 1. Sources of relev s for synoptic tables 2 and 4~5. ①=Hong-do isl., ②=Daehuksan-do isl., ③=Sohuksan-do isl., ④=Daekukhul-do isl., ⑤=Ui-do isl., ⑥=Cho-do isl., ⑦=Pogil-do isl., ⑧=Soan-do isl., ⑨=Oinaro-do isl., ⑩=Kumo-do isl., ⑪=Komun-do isl., ⑫=Mt. Seonun-san, ⑬=Mt. Chiri-san, ⑭=Mt. Naejang-san, ⑮=Cheju isl. in Korea

Community	No. of relevés	Source	Region
Querco-Castanopsion (187 rel.)			
Castanopsietum sieboldii	18	Kim (1986)	①
	8	Kim & Jang (1989)	②
	10	Kim & Park (1988)	③
	5	Kim & Oh (1993)	④
	14	Kim *et al.* (1987)	⑤
	9	Kim & Oh (1990a)	⑥
	5	Kim *et al.* (1989)	⑦
	5	Kim & Oh (1992)	⑧
	5	Kim & Oh (1991)	⑨
	21	Kim & Oh (1990b)	⑩
	7	Kim *et al.* (1990)	⑪
Quercetum acutae	8	Kim (1986)	①
	6	Kim & Jang (1989)	②
	8	Kim & Park (1988)	③
	3	Kim & Oh (1990a)	⑥
	12	Kim *et al.* (1989)	⑦
Quercetum myrsinaefoliae	5	Kim *et al.* (1989)	⑦
Litseetum japonicae	5	Kim & Park (1988)	③
	5	Kim & Oh (1993)	④
	5	Kim & Oh (1990a)	⑥
	5	Kim *et al.* (1989)	⑦
	18	Kim *et al.* (1990)	⑪
Machilo-Camellion (186 rel.)			
Machiletum thunbergii	6	Kim (1986)	①
	5	Kim & Jang (1989)	②
	10	Kim & Park (1988)	③
	6	Kim *et al.* (1987)	⑤
	5	Kim & Oh (1990a)	⑥
	10	Kim & Oh (1992)	⑧
	3	Kim & Oh (1991)	⑨
	6	Kim & Oh (1990b)	⑩
	5	Kim *et al.* (1990)	⑪
Pittosporum tobirae	9	Kim (1986)	①
	15	Kim & Oh (1990b)	⑩
	5	Kim *et al.* (1990)	⑪
Aucubetum japonicae	7	Kim (1986)	①
	1	Kim *et al.* (1990)	⑪
Neolitsetum sericeae	3	Kim & Oh (1991)	⑨
	11	Kim & Park (1988)	③
Euryetum emarginatae	5	Kim & Park (1988)	③
Elaeagnetum macrophyllae	5	Kim & Park (1988)	③
	5	Kim & Oh (1993)	④
Camellietum japonicae	6	Kim & Jang (1989)	②
	5	Kim & Oh (1993)	④
	18	Kim *et al.* (1989)	⑦
	5	Kim & Oh (1992)	⑧
	5	Kim & Oh (1990b)	⑩
	7	Kim *et al.* (1990)	⑪
Theo-Camellietum japonicae	2	Kim & Yim (1986)	⑫

App. 1. Continued

Community	No. of relevés	Source	Region
	5	Yim & Kim (1992)	⑬
Raphiolepietum umbellatae	6	Kim (1986)	①
Daphniphylletum macropodae	1	Kim *et al.* (1990)	⑪
	4	Kim & Yim (1988)	⑭
Dendropanaco-Castanopsion sieboldii (26 rel.)			
Hosto minoris-Castanopsietum sieboldii	26	Kim *et al.* (1994)	⑮