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Fagus forests in East Asia

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Abstract

Fagus forests in Asia have unique patterns compared with other parts of the world. Japanese *Fagus* forests, especially *Fagus crenata* forests, have species corresponding to those in European forest as well as forests in the USA; *Fagus* forests in China, however, are different from *Fagus* forests elsewhere, except Mexico. In China, especially Yunnan and Sichuan, and on Taiwan, many evergreen species also occur, as in Mexican *Fagus* forests. In the Japanese Archipelago the *Fagus* forests differ significantly on the Pacific and Japan Sea sides. In particular, snow depth results in different species compositions and different *Sasa* species on the forest floor. In Korea, there is only *Fagus multinervis* forest on the island Ulleung-do; it makes coppice forests. *Fagus* forests in China have six main *Fagus* species (one subspecies and one variety are not generally accepted, but these names are used in this paper, following HUKUSIMA et al. 2013): *Fagus lucida, F. engeliana, F. longipetiolata, F. hayatae, F. hayatae* ssp. *pashanica*, *F. hayatae* var. *zhejiangensis*, and *F. chienii*. *Fagus* forests on the mainland and on Taiwan have different species composition, and the forests in China differ from the east coast to the inland west. HUKUSIMA et al. recognized the *Fagus* forests in China as one class, an evergreen broad-leaved forest type (HUKUSIMA et al. 2013), but the class name was invalid. Comparison with deciduous *Quercus* forests in Asia suggested two classes in mainland China: Quercetea variabili-brevipetiolatae Tang, Fujiwara et You in Box et Fujiwara 2015 (with a Quercetalia fabri-brevipetiolatae S. Suzuki et al. 2006 and an Indocalamo latifolii-Fagion zhejiangensis Hukusima et al. 2013); and a Fagetea engleriano-lucidae class nov.. In Taiwan there is also a class Yushanio nitakayamensis-Fagetea hayatae class nov. The Korean *Fagus* forests were included in the Japanese *Fagus* class, but the Fagetea multinervis class nov., was independent from the Querco-Fagetea crenatae Miyawaki et al.1968 in Japan, based on endemic species identified in this paper.

Key words: temperate deciduous forest, subtropical mountain forest, *Fagus* and deciduous *Quercus*, Ulleung-do, mixed forest with *Fagus* and evergreen *Quercus*, China, Korea, Japan.

1. Introduction

The distribution and composition of *Fagus* forests in Asia represent a microcosm of *Fagus* forests of the Northern Hemisphere – but the *Fagus* forests in Asia have some unique aspects. These are caused by the maritime environments of Japan, Ulleung-do (Korea) and Taiwan, and continental effects in China. *Fagus* forests in Taiwan are in a subtropical climate and occur on steep topography, where they are mixed with subtropical evergreen-tree species (HUKUSIMA et al. 2005, 2013). This phenomenon is similar to the Mexican *Fagus* forests (PETERS 1997; WILLIAMS-LINERA et al. 2003, RODRIGUES-RAMIREZ et al. 2013) with evergreen *Quercus, Cleyera,* deciduous *Clethra*, etc., but it is only a physiognomic similarity.

The forests of temperate Asia were classified into three types: cool-temperate, typical temperate (intermediate temperate, middle temperate), and warm-temperate deciduous and

[warm-temperate] evergreen forests (FUJIWARA & HARADA 2015). Previously, *Fagus* forests have been classified usually as cool-temperate forests (KIRA 1976, 1991, 2011; OKITSU 2000, 2003, MIYAWAKI (ed.) 1981-88, NAKASHIZUKA 2003, etc.). Based on comparison of *Fagus* and *Quercus* forests, *Fagus* forests are classified here as typical-temperate forests. Cool-temperate forests were shown to be mixed forests with deciduous *Quercus* and *Picea* (FUJIWARA & HARADA 2015).

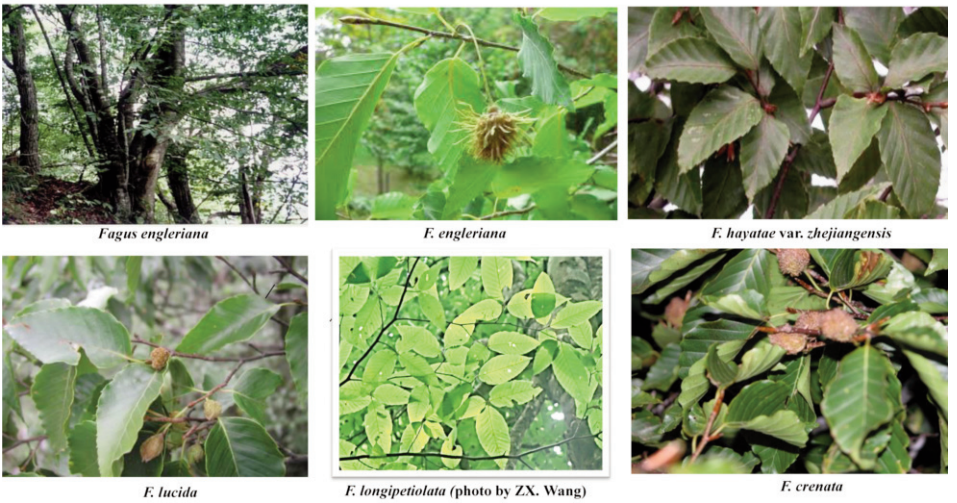

Figure 1: *Fagus* species in East Asia (part 1).

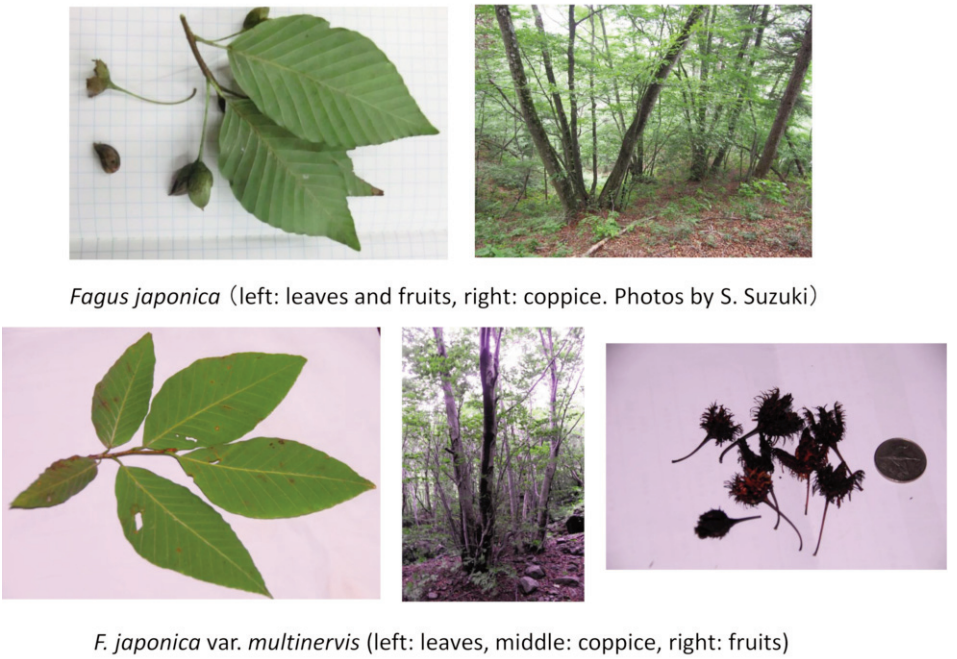

Figure 2: *Fagus* species in East Asia (part 2).

The *Fagus crenata* zone in Japan was recognized by TANAKA (1887) and HONDA (1912), and was suggested to occur in T hoku and southern Hokkaid . The composition and types of *Fagus* forests in Japan have been studied well by T. SUZUKI (1949a,b), who summarized forest vegetation in Japan (SUZUKI 1966), Taiwan (SUZUKI 1954) and East Asia more generally (SUZUKI 1952). Since then, the species composition of *Fagus* forests has been described phytosociologically by MIYAWAKI et al. (1964, 1968, 1972, etc.), MIYAWAKI ed. (1981-1988), Yo. SASAKI (1964, 1970), Ya. SASAKI (1984), HUKUSIMA et al. (1984, 1995, 2001), ISHIZUKA & SAIT (1992), S. SUZUKI (2002a, 2006), S. SUZUKI & MIYAWAKI (2001), and others. For Korea, KIM SD et al. (1986) summarized *Fagus* forests on Ulleung-do, an island in the Sea of Japan. KIM JW (1988, 1992, 2012) and KIM JW et al. (2012) also detailed Korean *Fagus* forests. In China, WU et al. (1980, 1995) described *Fagus* forests. PETERS (1997) described *Fagus* forests not only in China but throughout the Northern Hemisphere, in detail and with forest profiles. Finally, *Fagus* forests in Asia were summarized in a book by HUKUSIMA et al. (2013). Deciduous *Quercus* forests were described in Japan and Korea by HOSHINO (1998) and S. SUZUKI (2002a,b), and over wider parts of Asia by KRESTOV et al. (2006), S. SUZUKI et al. (2003), and by FUJIWARA & HARADA (2015).

Until now, *Fagus* forests have been studied only where *Fagus* was dominant. If we want to understand the similarity and dissimilarity of *Fagus* forest types clearly, though, we must compare with similar types of deciduous forest, such as deciduous *Quercus* forests (also dominated by Fagaceae). Here, 5488 relevés made following the method of BRAUN-BLANQUET (1964) and FUJIWARA (1987) have been compared. Deciduous *Quercus* forests in Asia were discussed already (FUJIWARA & HARADA 2015). Tables of *Fagus* forests in Japan were collected from published literature (MIYAWAKI ed. et al. 1981-88), data from other parts of Asia (S. SUZUKI 2002a, b, 2006, etc.) were added, and the data were analyzed again (Table 1). Here *Fagus* forests were discussed with deciduous *Quercus* forests and characteristics are clarified.

Nine species of *Fagus* occur in Asia: *F. chienii* W.C. Cheng, *F. hayatae* Palib. ex Hayata, *F. hayatae* ssp. *pashanica* (C.C. Yang) R. Peter (taxonomically a synonym of *F. hayatae*), *F. hayatae* var. *zhejiangensis* M.C.Liu & M.H.Wu ex Y.T.Chang & C.Huang, *F. lucida* Rehder & E.H.Wilson, *F. engeliana* Seemen ex Diels, *F. longipetiolata* (Y.T.Chang) Y.T.Chang, *F. multinervis* Nakai, *F. crenata* Blume, and *F. japonica* Maxim (Figure 1, 2 .)

F. hayatae ssp. *pashanica* and *F. hayatae* var. *zhejiangensis* are not accepted as species (WU & RAVEN 1999, The Plant List: http://www.theplantlist.org), but these two species were used here, following HUKUSIMA et al. 2013. Unfortunately, *Fagus chienii* forest could not be found and there are no records of this forest type.

2. Study area and methodology

Phytosociological data on *Fagus crenata* forests were published over ten years in eight book volumes (MIYAWAKI ed. 1981-1988). Based on these data plus those collected from other publications, *Fagus japonica* forest data were compared in a table. Korean data were introduced from KIM S.D. et al. (1986). For China, data were added from WANG & FUJIWARA (2006), other sources excluding Japanese *Fagus crenata*, and from HUKUSIMA et al. (2013) for deciduous *Quercus* forests in Asia. Deciduous *Quercus* forests in Asia were organized and published already (FUJIWARA & HARADA 2015). The data collected from *Fagus* forests were also organized and compared with Japan, Korea and China in a synoptic table. Then this synoptic table was added to the original synoptic table of published *Quercus* forests in Asia because only main species were included in the published table. When we decide the

final classification, it will be necessary to compare forests with similar life forms and habitats. In total, 5488 relevés were compared. For this comparison, synoptic tables were constructed for forest types with similar compositions, based on the following averaging method: 1) Roman numerals in the synoptic table were changed to decimal Arabic numbers as follows: V = 5, IV = 4, III = 3, II = 2, I = 1, + = 0.5, r = 0.25, no number in cell = zero. 2) Average values of the integrated synoptic columns were obtained as integers by the Excel function ROUND and then changed back to Roman numerals (as above). The results are shown in Table 1 and Figure 3.

The climates and environments of Asian *Fagus* forests were described and also analyzed by FANG (2006) and SHEN et al. (2015). Characteristic environments in Japan involve two opposing situations of heavy snowfall and rainfall on the Japan Sea side and 1000-1500mm rainfall on the Pacific side. China and Korea have less than 1500mm of rainfall per year, and their climates range from mountain-subtropical to temperate. These characteristics produce the differences in the *Fagus* forests in Asia. FANG (2006) compared several temperature indices as well.

3. Results: Classification of *Fagus* forests in Asia

Because the number of pages is limited, only class, order and alliances of *Fagus* forests are discussed here. Japanese *Fagus* forests belong to two alliances, one order and one class. *Fagus* forest in Korea belongs in one alliance, one order and one class. Chinese *Fagus* forests belong to three classes, three orders and six alliances.

1) Korea

a. Fagetea multinervis class nov. (Table 1, running no. 1)

Synonym: none

Diagnostic taxa: *Fagus multinervis, Acer takesimense, Acer okamotoanum, Anemone maxima, Prunus takesimensis, Polystichum retroso-paleaceum* var. *coraiense, Tilia insularis, Ligustrum foliosum, Lilium hansonii, Viola takeshimana, Dystaenia takeshimana, Allium victorialis* var. *platyphyllum*

Holotype: Fagetalia multinervis SD Kim, Kimura et YJ Yim 1986

Fagetalia multinervis belonged to the former Fagetea crenatae Miyawaki, Ohba et Murase 1964, which in this paper has been changed to Querco-Fagetea crenatae. The *F. multinervis* forest does not have many diagnostic taxa of Querco-Fagetea crenatae and is composed mainly by endemic species and common species of deciduous forest in the Far East and Japan. A Fagetea multinervis class nov. is established.

Fagus forest on Ulleung-do is the only *Fagus* forest in Korea. Ulleung-do is located only 120km from the east coast of South Korea. It is a volcanic island, formed from a stratovolcano that rose from the sea bottom. The top is 984m above sea level. The center of the island is steep, unstable and foggy. This moist environment permits the development of *Fagus multinervis* forest. *F. multinervis* is actually *F. japonica* var. *multinervis* (Naki) Y.N. Lee. It is similar to *F. japonica*.

Only one order and one alliance are classified in Korea.

b. Fagetalia multinervis SD Kim, Kimura et YJ Yim 1986

Synonym: none

Diagnostic taxa: same as for the class.

Holotype: Hepatico-Fagion multinervis SD Kim, Kimura et YJ Yim 1986

c. Hepatico-Fagion multinervis SD Kim, Kimura et YJ Yim 1986

Synonym: none

Diagnostic taxa: same as for the class.

Holotype: Hepatico-Fagetum multinervis SD Kim, Kimura et YJ Yim 1986

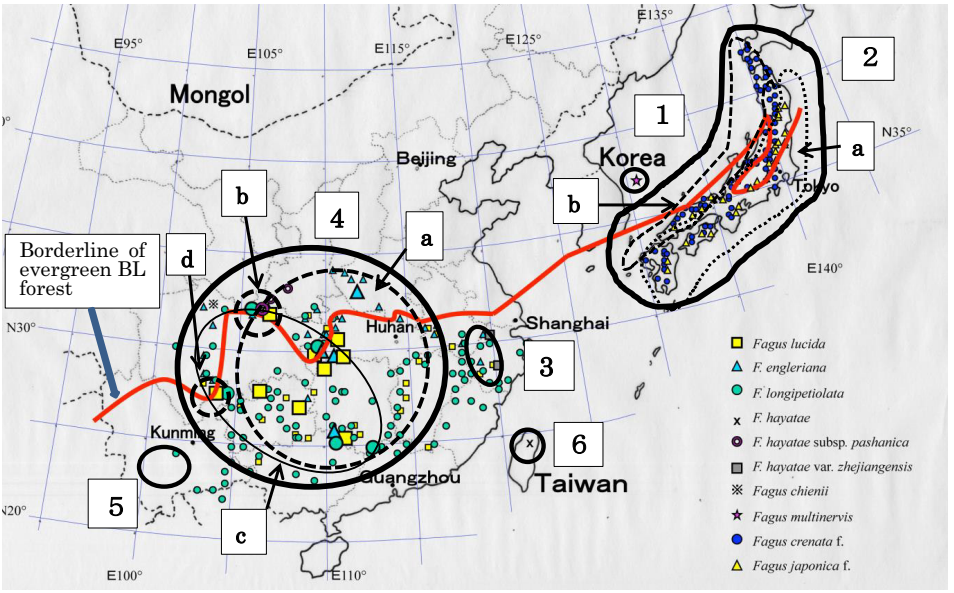

Figure 3: Distribution of *Fagus* forests in East Asia. 1: Fagetea multinervis, Fagetalia multinervis, Hepatico-Fagion multinervis; 2: Querco-Fagetea crenatae, Saso-Fagetalia crenatae, a: Sasomorpho-Fagion crenatae, b: Saso kriensis-Fagion crenatae; 3: Quercetea valiabili-brevipetiolatae, Quercetalia fabri-brevipetiolatae, Indo calamo-Fagion zhejiangensi; 4: Fagetea longipetiolato-lucidae, Fagetalia longipetiolato-lucidae, a: Aceri davidii-Fagion lucidae, b: Calantho fimbriatae-Fagion englerianae, c: Fagion lucido-longipetiolatae, d: Qiongzheo tumidinodae-Fagion englerianae; 5: Class and order are not decided, Ardisio hypargeriae-Castanopsion fabri; 6: Yushanio nitakayamensis-Fagetea hayatae, Fagetalia hayatae, Fagion hayatae

2) Japan

a1. Querco-Fagetea crenatae Miyawaki, Ohba, Okuda, Nakayama et Fujiwara1968 (Table 1, running nos. 2-18)

Synonyms: Saso-Fagetea Suz.-Tok. 1966, Fagetea crenatae Miyawaki, Ohba et Murase 1964

Diagnostic taxa: *Schizophragma hydrangeoides, Viburnum furcatum, Quercus mongolica* var. *crispula, Viburnum wrightii, Ilex macropoda, Acanthopanax sciadophylloides, Tilia japonica, Acer sieboldianum, Rhus ambigua, Fraxinus lanuginosa, Magnolia obovata* var. *hypoleuca, Acer japonicum, Hydrangea paniculata, Acer rufinerve, Struthiopteris niponica, Symplocos coreana, Clethra barbinervis, Corylus sieboldiana*

Holotype: Saso-Fagetalia crenatae Suzuki 1966 ex Sasaki 1970

The unit Fagetea crenatae has been used since 1964, but when Miyawaki, Ohba et Murase proposed it, in the Tanzawa region in Japan, they did not name the order. MIYAWAKI et al. (1968) realized a *Fagus* forest system and the Querco-Fagetea was proposed, with *Fagus* and *Ulmus* forests plus descriptions of associations, alliances, orders and class. After that, they worried about pre-emptive rights of nomenclature, but again Fagetea crenatae was supported and has been used until recently.

Here Querco-Fagetea crenatae Miyawaki, Ohba, Okuda, Nakayama et Fujiwara1968 was accepted.

b. Saso-Fagetalia crenatae Suz.-Tok. ex Miyawaki, Ohba, Okuda, Nakayama et Fujiwara 1968 (Table 1, Running nos. 2-14)

Synonym: Saso-Fagetalia Suz.-Tok. 1966

Diagnostic taxa: *Fagus crenata, Acer micranthum, Lindera umbellata, Betula grossa, Carex reinii, Hydrangea petiolaris, Skimmia japonica* var. *intermedia* f. *repens, Paris tetraphylla*.

Holotype: Saso kurilensis-Fagion crenatae Miyawaki et al. 1968

This order was named by T. SUZUKI (1966), without tables. MIYAWAKI, OHBA, OKUDA, NAKAYAMA et FUJIWARA 1968 used Saso-Fagetalia Suz.-Tok. 1966 and classified a new alliance: Saso kurilensis-Fagion. SUZUKI (1966) did not show the table. Saso-Fagetalia Suz.-Tok. 1966 is invalid and Saso-Fagetalia is newly valid in MIYAWAKI et al. 1988. Yo. SASAKI (1970) summarized Japanese *Fagus* forests with a synoptic table, but also Saso-Fagetalia crenatae Suzu.Tok. 1966 was used. FUJIWARA & HARADA (2015) compared *Quercus* forests throughout eastern Asia and separated *Quercus mongolica* var. *crispula* forests from the Quercetalia serratae-grosseserratae, according them to the Saso-Fagetalia crenatae and Carpinio-Quercetalia grosseserratae Hoshino 1998

c-1. Sasomorpho-Fagion crenatae Miyawaki, Ohba et Murase 1964 (Table 1, Running nos. 2-10)

Synonym: none

Diagnostic taxa: *Sasamorpha borealis, Abelia spathulata, Pourthiaea villosa* var. *laevis, Pieris japonica, Prunus incisa, Acer palmatum* var. *amoenum, Stewartia monadelpha*.

Holotype: Saso kurilensis-Fagetum crenatae Suz.-Tok. 1949

The Sasomorpho-Fagion crenatae occurs in Ky sh , Shikoku and on the Pacific side of Honsh . Precipitation is below about 1500mm, and snow depth in winter is less than 50cm on the Pacific side. Usually *Fagus* occurs in the tree layer with *Quercus mongolica* var. *crispula* and other species, such as species of *Acer, Tilia* and *Prunus*. Sites dominated by *Fagus* are not many. *Fagus* seedlings also are few, due to decreased germination resulting from insect damage to seeds where there is less snow (SHIMANO 2007, SHIMANO & OKITSU 1994). Effects of desiccation, rodents, fungi and bacteria were strong in areas with little snow (SHIMANO & MASUZAWA 1995, 1998; HONMA 1998, 2001, 2003).

Species of this alliance are also common to the former Quercetea serrato-grosseserratae Miyawaki et al 1971. Most of diagnostic taxa were from the Sasomorpho-Fagion crenatae. Comparison with all deciduous *Quercus* forests suggested that species from lower or drier sites should be separated as a Viburno dilatatae-Quercetea serratae Fujiwara et A. Harada 2015. The diagnostic species are *Q. serrata*, *Viburnum dilatatum, Eurya japonica, Akebia trifoliata, Prunus jamasakura, Ardisia japonica, Styrax japonica, Pertya scandens, Aucuba*

japonica, and *Lyonia ovalifolia* var. *elliptica* (Table1, Running nos. 19, 20). Sometimes some of these species can be seen in *Fagus crenata* forest on the Pacific side, which makes for confusing dissimilarities.

Fagus japonica forests occur mainly on the Pacific side. *F. japonica* forest and mixed forests with *Tsuga sieboldii* and *Abies firma* were included in the Tsugenion sieboldii Suz.-Tok. 1953 ex suball. nov.

c1-1 Fagenion japonicae suball. nov. (Table 1, Running nos. 2-6)

Synonym: Tsugion sieboldii Suzu.-Tok. 1952, Rhododendro wadanum-Fagion japonicae S. Suzuki 2006

Diagnostic taxa: *Stewartia pseudo-camellia, Rhododendron kaempferi, Abies firma, Ainsliaea acerifolia* var. *subapoda, Hydrangea hirta, Hamamelis japonica, Evodiopanax innovans, Tsuga sieboldii, Meliosma myriantha, Rhododendron dilatatum, Acer crataegifolium, Torreya nucifera*

Holotype: Carici-Fagetum japonicae Suz.-Tok.1949

Fagus japonica and *Tsuga sieboldii* forests were discussed as different forest types and different alliances (T. SUZUKI 1952; S. SUZUKI 2002a,b, 2006; T. SUZUKI & MIYAWAKI 2001). Tsugion sieboldii Suzu.-Tok. 1952 did not show a table and was invalid. Even these forests were treated differently from the Sasomorpho-Fagion crenatae.

Fagus japonica occurs below *F. crenata* forests and sometimes makes mixed forests in T hoku involving both *Fagus* species (Fagetum crenato-japonicae). *F. japonica* makes coppice when it occurs on unstable steep slopes, which is similar to *F. japonica* var. *multinervis*. Especially on rocky or steep slopes with shallow soil, *F. japonica* makes mixed forests with *Tsuga sieboldii* or *Abies firma*. Such severe topographic or soil conditions produce non-dominant *Fagus* forests.

c1-2 Sasamorpho-Fagenion crenatae suball. nov. (Table 1, Running nos. 7-10)

Synonym: none

Diagnostic taxa: Same as in Sasamorpho-Fagion crenatae excluding taxa of Tsugenon sieboldii.

Holotype: Corno-Fagetum crenatae Miyawaki, Ohba et Murase 1964

Forests of this suballiance occur in Ky sh , Shikoku and Pacific Honsh . Sometimes *Fagus crenata* is dominant in the canopy, but *Quercus mongolica* var. *crispula* also mixes in.

HUKUSIMA et al. described Sasomorpho-Fagion crenatae as involving evergreen broad-leaved trees and conifers. This is mainly the Tsugion sieboldii, but *F. crenata* and evergreen *Quercus* (*Q. acuta, Q. salicina*) also make mixed forests in middle to southern Japan.

c 2 Saso-Fagion crenatae Miyawaki, Ohba et Murase 1964 (Table 1, Running nos. 11-14)

Synonym: Fagion crenatae Nakano 1942

Diagnostic taxa: *Sasa kurilensis, Ilex leucoclada, Mitchella undulata, Arachniodes mutica, Plagiogyria matsumureana, Vaccinium japonicum, Lindera umbellata* var. *membranacea,*

Tripterospermum japonicum, Aucuba japonica var. *borealis, Cephalotaxus harringtonia* var. *nana, Acer mono* var. *mayrii, Ilex crenata* var. *paludosa, Magnolia salicifolia, Daphniphyllum macropodum* var. *humile*.

Holotype: Saso kurilensis-Fagetum crenatae Suz-Tok. 1949

The *Fagus* forests on the Japan Sea side of Honsh have evergreen shrubs such as *Aucuba japonica* var. *borealis, Cephalotaxus harringtonia* var. *nana, Ilex crenata* var. *paludosa* and *Daphniphyllum macropodum* var. *humile*. These species can survive coldness in the snow. The Japan Sea side has more than 1m snow depth, with an average of 2-3m. Snow makes a good environment for the *Fagus*-dominated forests of the Japan Sea side. Snow pressure helps *Fagus* growth. *F. crenata* can tolerate snow pressure by growing upright even from sections of bent, nearly reptant stems. This strategy shows why *F. crenata* makes dominant forests in deep-snow areas, where the other species cannot tolerate the snow pressure (HONMA 1997).

3) Central eastern China

a 1 Quercetea variabili-brevipetiolatae Tang, Fujiwara et You in Box et Fujiwara 2015 (Table 1, Running nos. 21-29)

Synonym: none

Diagnostic taxa: *Lindera glauca, Quercus serrata* var. *brevipetiolata* (=*Q. glandulifera* var. *brevipetiolata*), *Aster ageratoides, Dalbergia hupeana, Symplocos paniculata, Platycarya strobilacea, Liriope spicata, Rubus corchorifolius, Euonymus alatus, Lespedeza formosa, Adenophora trachelioides, Euscaphis japonica*

Holotype: Pistasio-Quercetalia variabilis Tang, Fujiwara et You in Box et Fujiwara 2015

Middle China north of the Huai He (the Huai River, a tributary of the Yangtze River) has deciduous forests and no more evergreen *Quercus* or *Castanopsis* forests. These forests are different from *Quercus mongolica* in northern China. BOX (2015) delimited the warm-temperate forest zone by mean warmest-month temperature of at least 25°, Warmth Index of at least 90, and mean temperature of the coldest month -5°. In these areas most natural forests were destroyed and remain only as small nature reserves around temples. This is the situation from middle Zhejiang to Shaanxi, eastern Gansu, Hebei, and Henan. Mainly *Quercus variabilis* composes these forests, and the southern part of this area has more deciduous species, such as *Quercus serrata* var. *brevipetiolata, Q. aliena, Q. fabri,* etc. Many *Acer* species also occur in this area. These forests are assigned to the Quercetea variabili-brevipetiolatae Tang, Fujiwara et You in Box et Fujiwara 2015**.** *Fagus hayatae* var. *zhejiangensis* forest also belongs to this class.

b-1 Quercetalia fabri-brevipetiolatae S. Suzuki, Nakamura, Kawano, X. Wang et Da 2003 (Table 1, Running nos. 24-27)

Synonym: none

Diagnostic taxa: *Lindera reflexa, Rhododendron simsii, Fraxinus chinensis, Acer davidii, Castanea henryi, Acanthopanax evodiaefolius*

Holotype: Sasamorpho sinicae-Quercion brevipetiolatae S. Suzuki, Nakamura, Kawano, X. Wang et Da 2003

Montane deciduous *Quercus* forests in middle China are classified in this order. The evergreen broad-leaved forest region has much more moisture than the northern *Q. variabilis*

forests, and more deciduous *Quercus* species occur in this region (FUJIWARA & HARADA 2015). Deciduous *Quercus* forests occurring above 1000m (to 1600m) are summarized in this order. *Fagus zhejiangensis* forests occur on concave slopes next to ridges.

c-1 Indocalamo latifolii-Fagion zhejiangensis Hukusima, Matsui, Nishino, Pignatti, Yang, Lu, Kim, Yoshikawa, Honma et Wang 2013 (Table 1, Running no. 27),

Synonym: none

Diagnostic taxa: *Fagus hayatae* var. *zhejiangensis, Sapium japonicum, Ainsliaea macroclinidioides, Dioscorea bulbifera, Schima superba, Magnolia cylindrica, Tripterospermum chinense, Rhododendron latoucheae, Litsea coreana* var. *sinensis, Eurya rubiginosa* var. *attenuata, Indocalamus latifolius, Acer elegantulum, Liriope graminifolia, Prunus serrulata, Schisandra henryi, Lithocarpus harlandii, Photinia paniculata, Carex chinensis, Calamagrostis arundinacea* var. *ciliata*

Holotype: Carici lanceolatae-Fagetum zhejiangensis Hukusima et al. 2013

WANG & FUJIWARA (2003) described two types of *Fagus hayatae* var. *zhejiangensis* forest at Shihaishan and Qingliangfeng Nature Reserves in Zhejiang Province. Only three relevés were taken in each of these areas. More relevés are required to determine associations. HUKUSIMA et al. decided these relevés from a synoptic table (WANG & FUJIWARA 2003) for two associations and made a new alliance: Indocalamo latifolii-Fagion hayatae var. zhejian-gensis. This name should be Indocalamo latifolii-Fagion zhejiangensis. The sites represent typhoon tracks, and the strong winds and low winter temperatures make a severe environment. Deciduous species drop leaves in winter and tolerate low temperature. *Fagus hayatae* var. *zhejiangensis* makes a dominant forest. The forest composition is very similar and familiar for Japanese because some common species (*Sapium japonicum, Toxicodendron trichocarpa, Dioscorea bulbifera, Pieris japonica*. *Clethra brevinervis, Carex lanceolata*) are scattered in the forests. Similar genera also occur in these forests, such as *Callicarpa, Meliosma, Schima, Photinia, Eurya* and *Liriope*. The first impression of these forests was that they belong to the Japanese *Fagus crenata* class. After we compared these forests with deciduous *Quercus* forests, though, it was found that *Fagus hayatae* var. *zhejiangensis* forests are in fact warm-temperate deciduous forests.

4) Middle to south China

a 1. Fagetea engleriano-lucidae class nov. (Table 1, Running nos. 28-42)

Synonym: Litseo elongatae-Fagetea sp. div. Hukusima, Matsui, Nishino, Pignatii, Yang, Lu, Kim, Yoshikawa, Honma et Wang 2013

Diagnostic taxa: *Fagus lucida, Fagus engleriana, Sorbus folgneri, Acer oliverianum, Cyclobalanopsis multinervis, Acanthopanax evodiaefolius, Quercus glandulifera, Viburnum sympodiale, Dryopteris labordei, Acer sinense, Smilax stans, Ilex pernyi, Hydrangea anomala, Acer davidii, Rhododendron hypoglaucum*.

Holotype: Fagetalia engleriano-lucidae ord. nov.

Most *Fagus* forests in China are classified into Litseo elongatae-Fagetea sp. div. Hukusima, Matsui, Nishino, Pignatii, Yang, Lu, Kim, Yoshikawa, Honma & Wang 2013. In this paper, *Fagus hayatae* var. *zhejiangensis* forests in Zhejiang, *Fagus lucida* forests in Yunnan, and *Fagus hayatae* forests on Taiwan are separated from that class. The name Litseo elon-

gatae-Fagetea sp. div. is an invalid name, so here, the Fagetea engleriano-lucidae was named anew. One order is classified.

b 1 Fagetalia engleriano-lucidae ord. nov. (Table 1, Running nos. 28-42)

Synonym: Sinarundinario nitidae-Fagetalia sp. div. Hukusima Matsui, Nishino, Pignatii, Yang, Lu, Kim, Yoshikawa, Honma et Wang 2013

Diagnostic taxa: Same as the class taxa.

Holotype: Calantho fimbriata-Fagion englerianae all. nov.

The name Litseo elongatae-Fagetalia sp. div. is invalid, so here Fagetalia engleriano-lucidae was named anew.

Chinese *Fagus* forests are composed of evergreen subtropical species from genera such as *Litsea, Lithocarpus*. *Ilex*, and *Eurya*, plus *Illicium*. In Japan, similar types of *Fagus* forests occur in Hakone (central Japan), the Kii Peninsula, and Ky sh . These forests have evergreen *Quercus acuta* or *Q*. *salicina* in the canopy; *Illicium anisatum, Camellia japonica, Eurya japonica* and *Symplocos myrtacea* in the subcanopy or shrub layer; and *Ardisia japonica* in the herb layer. These evergreen species are from the Camellietea japonicae and occur also at higher elevation. This is a geographical phenomenon. Chinese *Fagus* forests do not follow normal East Asian zonation because the zonal typical-temperate forest region in China is too dry. *Fagus* forests occur mostly as patches in valleys or on ridges with fog.

c 1 Aceri davidii-Fagion lucidae Wang Z-X, Fujiwara et Lei 2005 (Table 1, Running nos. 28-31)

Synonym: none

Diagnostic taxa: same as the diagnostic taxa of the order.

Holotype: Sinarundinario nitidae-Fagetum lucidae Wang, Fujiwara et Lei 2005

These *Fagus lucida* forests occurring on middle and upper slopes at 1300-2000m on the Guizhou Plateau and southern mountains in Hunan and Guangxi are classified in this alliance. In the Baodagong-shan Nature Reserve (33° 30' N), *Fagus lucida* forests occur in patches within *Quercus variabilis* forests along valleys or on foggy ridges. At Fanjingshan (27° 53' N, 2336m, in Guizhou), evergreen broad-leaved forests cover the mountains. *Fagus lucida* forest occurs around 1600m where it is often foggy. In Kuankuoshui Nature Reserve (28° 12' N), *Fagus lucida* forests develop on northern slopes and evergreen broad-leaved forests occur on southern slopes. Mangshan (24° 56' N) and Nanshan (26° 7' N) have patchy *Fagus lucida* forests in valleys. The forest floor there is covered by bamboo species: *Sinarundinaria chungii, S*. *lanshanensis, S*. *nitida, Indosasa shibataeoides* .

c 2 Calantho fimbriatae-Fagion englerianae all. nov. (Table 1, Running nos. 32-34)

Synonym: Abelio englerianae-Fagion Hukusima, Matsui, Nishino, Pignatti, Yang, Lu, Kim, Yoshikawa, Honma et Wang 2013

Diagnostic taxa: *Stewartia sinensis, Viburnum betulifolium, Euonymus giraldii, Helwingia chinensis, Acer laxiflorum, Calanthe fimbriata, Rhododendron micranthum, Prunus pilosiuscula, Holboellia fargesii, Ilex chinensis, Epimedium sagittatum, Berberis dielsiana, Sorbus xanthoneura*.

Holotype: Euonymo porphyrei-Fagetum englerianae Hukusima, Matsui, Nishino, Pignatti, Yang, Lu, Kim, Yoshikawa, Honma et Wang 2013

Since the name Abelio englerianae-Fagion is invalid in order to no species name of *Fagus*, Calantho fimbriatae-Fagion englerianae was named here.

Northern Sichuan has high mountains. *Fagus lucida, F. engleriana* and *F. engleriana* ssp. *pashanica* forests occur at Nanjian (1100-1760m) and south of Shaanxi (HUKUSIMA et al. 2013). In this area, forests dominated by *F. engleriana, Quercus glandulifera* and *Q. spinosa* grow in a mosaic pattern on lower mountain slopes and along rivers. *F. lucida* dominates on upper slopes. *F. engleriana* ssp. *pashanica* occurs on steep hills and mountain ridges (HUKUSIMA et al. 2013). The climate of this area is relatively warm and has relatively low rainfall (ca. 1000mm per year).

c-3 Fagion lucido-longipetiolatae all. nov. (Table 1, Running nos. 35-40)

Synonym: none

Diagnostic taxa: *Fagus longipetiolata, Camellia cuspidata, Rhododendron* sp., *Symplocos* sp., *Camellia pitardii, Symplocos botryantha*

Holotype: Sinocalamuso giganteo-Fagetum lucidae Hukusima et al. 2013

This new alliance should be discussed further because it has two undecided species *(Rhododendron* sp. and *Camellia* sp.). *Fagus longipetiolata* forest was distributed widely on low subtropical mountains but was mostly destroyed by human activity (WU 1980; CAO et al. 1995, WANG 2004). Now it remains as small islands only at relatively high elevation, ca. 1200-1400m in Hubei (Houe Nature Reserve), Hunan (Mangshan Nature Reserve), Guangxi (Liluo Forest Station), and Sichuan. *Fagus longipetiolata* also occurs at low elevation (900-1300m) in the Fanjingshan Nature Reserve. *Fagus lucida* forests are also included in this alliance. *F. lucida* forest occurs at 1800-2400m in the Sanjiankou Nature Reserve.

c 4 Qiongzheo tumidinodae-Fagion englerianae Fujiwara et A. Harada 2015 (Table 1, Running nos. 41-42)

Synonym: Qiongzheo tumidinodae-Fagion Hukusima, Matsui, Nishino, Pignatti, Yang, Lu, Kim, Yoshikawa Honma et Wang 2013

Diagnostic taxa: *Machilus ichangensis, Schima crenata, Ilex intermedia* var. *fangli, Camellia grijsii, Symplocos caudata Rubus chroosepalus, Tripterospermum cordifolium, Allantodia hirtipes, Symplocos anomala, Sorbus coronata, Acanthopanax evodiaefolius* var. *gracilis*.

Holotype: Sinocalamo-Fagetum lucidae Hukusima et al. 2013

The name Qiongzheo tumidinodae-Fagion is invalid, so here the Qiongzheo tumidinodae-Fagion englerianae was named anew.

Two associations are included, but HUKUSIMA et al. (2013) had described three associations in this alliance. After discussing the table and classification, and comparing with *Quercus* forests, one association (Sinocalamuso giganteo-Fagetum lucidae Hukusima et al. 2013) was moved to the Fagion lucido-longipetiolata all. nov. This alliance occurs in Yunnan at an elevation of 1600-2400m; the rainfall is ca. 1000mm per year. Evergreen trees are mostly dominant (16-25%) (HUKUSIMA et al. 2013). Four relevés of two associations represent forest dominated by *Catanopsis platicantha*, with more than 50% tree cover. These associations should be compared with evergreen forests in Yunnan.

5) Middle Yunnan

HUKUSIMA et al. (2013) described *Fagus lucida* forest in Yunnan that had few deciduous species and mostly evergreen broad-leaved species. Therefore they did not decide that the order and class would belong to evergreen broad-leaved forests.

a 1 Class is not decided

b 1 Order is not decided.

c 1 Ardisio hypargeriae-Castanopsion fabri Hukusima, Matsui, Nishino, Pignatti, Yang, Lu, Kim, Yoshikawa, Honma et Wang 2013

Synonym: none

Diagnostic taxa: *Polygala tricornis, Ardisia hypargyera, Symplocos glandulifera, Smilax grandulicaulis, Cinnamomum burmannii, Castanopsis fabrii, Lasianthus biermannii, Acer wilsonii, Euonymus mengtzeunus, Cimonobambusa utilis, Elatosterma papillosum, Lithocarpus megalophyllus*.

Holotype: Prismatomerio henry-Lithocarpetum naiadari Hukusima, Matsui, Nishino, Pignatti, Yang, Lu, Kim, Yoshikawa, Honma et Wang 2013

This type is quite different from other *Fagus* forests in China. This alliance was omitted from Table 1.

6) Taiwan

a 4 Yushanio nitakayamensis-Fagetea hayatae class nov. (Table 1, Running nos. 49, 50)

Synonym: Litseo elongatae-Fagetea sp. div. Hukusima, et al. 2013

Diagnostic taxa: *Fagus hayatae, Yushania nitakayamensis, Stauntonia purpurea, Neolitsea acuminatissima, Osmanthus heterophyllus, Rubus shinkoensis, Acanthopanax evodiaefolius* var. *pseudoevodiaefolia, Plagiogyria formosana, Acrophorus stipellatus, Illicium tashiroi, Daphniphyllum macropodum, Dryopteris formosana, Quercus sessilifolia, Camellia tenuifolia, Viburnum urceolatum, Symplocos lancifolia*.

Holotype: Fagetalia hayatae Hukusima, Lu, Matsui, Nishio, Pignatti 2005

Fagus forests in Taiwan were summarized into the Litseo elongatae-Fagetea sp. div. HUKUSIMA et al. 2013, which includes all *Fagus* forests in China and Taiwan. Comparison of *Fagus* and *Quercus* forests suggested that Taiwan has quite different diagnostic taxa. Therefore the Yushanio nitakayamensis-Fagetea hayatae is established here.

One association, one alliance, two subassociations and one order were classified (HUKUSIMA et al. 2013). *Fagus* forests in Taiwan occur on ridges at elevations of 1300-2000m south of Mt. Chuchushan and in the area of Mt. Thunshan (HUKUSIMA et al. 2013).

b-3 Fagetalia hayatae Hukusima, Lu, Matsui, Nishio, Liu, Pignatti 2005

Synonym: none

Diagnostic taxa: same as for the class.

Holotype: Yushania-Fagion hayatae Suz.-Tok. ex Hukusima, Lu, Matsui, Nishio, Pignatti 2005

c-6 Fagion hayatae Suz.-Tok. ex Hukusima et al. 2005

Diagnostic taxa: same as for the order.

Holotype: Yushania-Fagion hayatae, Suz.-Tok. ex Hukusima,et al. 2005

Fagion hayatae was classified by T. SUZUKI (1954), with an association: Indocalameto-Fagetum hayatae on Mt. Lala, from northern Taiwan. There the *F. hayatae* trees are all growing in the vicinity of evergreen broad-leaved forests (HUKUSIMA et al. 2005). The forest floor is covered by the bamboo *Yushania nitakayamensis*.

The distribution of *Fagus hayatae* in Taiwan is extremely limited, being restricted to the northeastern part of the island (24° 30'N, 121° 27'E) (HSIEH 1989; HUKUSIMA et al. 2013). *F. hayatae* is dominant in the canopy but is mixed with evergreen *Quercus* species. Evergreen tree species are dominant in the subcanopy. The shrub layer has dominant *Yushania nitakayamensis*. The herb layer is dominated by *Dryopteris formosana* and *Elastoma* species.

4. Discussion

Fagus forests in Asia were described several times (PETERS 1997, BOX et al. 1995, BOX & FUJIWARA 2012, KOLBEK et al. 2003, HUKUSIMA et al. 2005, 2013, etc.).

The comparison of *Fagus* and other deciduous forests in East Asia showed similarities and differences between these two types of forest. The *Fagus* forest on Ulleung-do (Korea) is especially unique and independent from the other forests. Japanese *Fagus* forests, with two *Fagus* species, are similar to the typical-temperate and cool-temperate deciduous *Quercus* forests. In particular, *Fagus* as temperate forest and deciduous *Quercus* have three types: cool-temperate, typical temperate and warm-temperate. The zonation has been discussed for a long time (BOX 1995, BOX & FUJIWARA 2004, 2012, 2013; FUJIWARA & HARADA 2015; HÄMET-AHTI et al. 1974; HONDA 1912; KIRA 1945, 1949, 1976, 1977, 1991, 2011; NAKANISHI 1977; NAKANO 1942; NOZAKI & OKUTOMI 1990; NUMATA 1974; NUMATA et al. 1972; OHNO 1977; OKITSU 2000, OKUTOMI & HOSHINO 1983; T. SUZUKI 1952, 1954, 1966; TANAKA 1887; WADA 1977, 1982a, 1982b). Most studies confused cool-temperate and typical-temperate forest for *Fagus*. When we compare *Fagus* and deciduous *Quercus* forest in East Asia, the difference will be clear from forest species composition and climate comparison. In Japan, growing-season warmth rather than winter temperature is generally seen as the control on the distribution of *Fagus* species (FANG & LECHOWICZ 2006). Precipitation amounts and snow accumulation also affect Japanese *Fagus* forests (FANG & LECHOWICZ 2006; FANG & YODA 1990; MATSUI et al. 2004). FANG & LECHOWICZ (2006) gave basic data in an appendix. This was very useful and proved the results. BOX (2015) tried a quantitative comparison of climate data. Most scientists suggested that *Fagus* forest is a cool-temperate forest, but *Fagus* is not more resistant to cold than is *Quercus mongolica* var. *crispula*. *Fagus* forests in East Asia are typical-temperate forests.

In China, the continental location produces more complicated differences, involving climate, substrate, geohistory and topography. These environmental matrices decide the distribution of *Fagus* forests unique in China. FANG & LECHOWICZ (2006) suggested that effects of high winter temperatures can influence the distribution of temperate tree species.

Two good environmental analyses have appeared, namely by FANG & LECHOWICZ (2006) and by SHEN et al. (2015). SHEN et al. suggested that the dry spring in China (drought due to the time lag between spring warming and the onset of monsoonal precipitation) limits the distribution of *Fagus* in China (GUO & WERGER 2010).

Table 1. Synoptic table of *Fagus* and *Quercus* forests in East Asia (●shows evergreen species, K: Korea, J:Japan, C: China, T: Taiwan, R: Russia).

Running number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Country	**K**	**J**	**J**	**J**	**J**	**J**	**J**	**J**	**J**	**J**	**J**	**J**	**J**	**J**	**J**	**J**	**J**
Number of relevés	**24**	**96**	**31**	**21**	**46**	**31**	**54**	**56**	**207**	**32**	**11**	**340**	**268**	**134**	**345**	**163**	**317**
Diagnostic taxa of Fagetea multinervis (SD Kim, Kimura et YJ Yim 1986) stat class nov. Fujiwara et A. Harada 2015:																	
Fagus multinervis	V	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Acer takesimense	V	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Acer okamotoanum	V	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Anemone maxima	V	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Prunus takesimensis	IV	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Polystichum retroso-paleaceum var. *coraiense*	IV	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Tilia insularis	III	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Ligustrum foliosum	III	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Lilium hansonii	III	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Viola takeshimana	III	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Dystaenia takeshimana	III	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Allium victorialis var. *platyphyllum*	III	·	·	·	·	·	·	·	·	·	·	r	·	·	·	·	I
Diagnostic taxa of Querco-Fagetea crenatae Miyawaki, Ohba, Okuda, Nakayama et Fujiwara 1968:																	
Schizophragma hydrangeoides	II	II	II	III	IV	III	III	II	II	IV	II	III	III	III	III	II	III
Viburnum furcatum	II	II	·	II	I	III	II	III	II	IV	V	V	V	V	III	III	II
Quercus mongolica var. crispula	·	IV	IV	IV	II	IV	II	II	III	III	IV	III	II	V	IV	V	V
Viburnum wrightii	·	III	IV	IV	II	III	II	II	II	III	II	I	I	III	III	III	I
Ilex macropoda	·	IV	IV	IV	III	III	II	II	III	·	II	r	+	III	II	II	·
Acanthopanax sciadophylloides	·	III	III	IV	III	III	II	III	II	IV	IV	IV	IV	V	II	II	I
Tilia japonica	·	I	I	II	+	I	II	II	II	IV	IV	II	II	I	I	I	IV
Acer sieboldianum	·	III	IV	IV	IV	V	II	II	V	III	III	I	II	IV	II	III	·
Rhus ambigua	·	I	III	+	II	II	II	III	IV	IV	II	III	IV	III	III	II	IV
Fraxinus lanuginosa	·	III	III	IV	II	II	IV	IV	IV	III	V	III	III	II	III	II	II
Magnolia obovata var. *hypoleuca*	·	II	II	II	II	II	+	II	I	·	+	II	II	II	III	I	III
Acer japonicum	·	IV	II	IV	r	III	I	I	·	II	IV	IV	V	III	III	I	III
Hydrangea paniculata	·	II	II	II	r	·	II	I	I	·	II	II	II	II	I	III	III
Acer rufinerve	·	III	II	III	I	III	II	II	II	II	IV	II	II	II	II	II	·
Struthiopteris niponica	·	I	·	I	III	V	II	+	III	II	V	II	III	IV	III	II	I
Symplocos coreana	·	·	II	II	II	IV	III	IV	IV	III	·	r	+	III	I	III	·
Clethra barbinervis	·	IV	V	V	IV	IV	III	III	III	III	III	II	II	IV	II	IV	·
Corylus sieboldiana	·	I	III	+	I	III	I	r	·	·	·	I	II	II	IV	II	·
Diagnostic taxa of Saso-Fagetalia crenatae Suz-Tok ex Miyawaki et al. 1968:																	
Fagus crenata	·	IV	I	V	III	II	V	V	V	V	V	V	V	V	II	II	·
Acer micranthum	·	III	+	IV	II	I	II	IV	II	II	V	I	I	III	·	II	·
Lindera umbellata	·	III	IV	IV	III	V	III	III	·	II	IV	r	r	IV	II	I	·
Betula grossa	·	II	II	III	III	III	+	II	II	II	II	r	+	I	·	I	·
Carex reinii	·	II	III	I	II	III	r	II	I	II	III	r	r	·	·	I	·
Hydrangea petiolaris	V	·	I	I	I	·	II	IV	III	III	II	III	III	I	I	·	III
Skimmia japonica var. *intermedia* f. *repens*	·	·	·	r	+	III	II	I	II	II	III	III	III	III	I	I	I
Paris tetraphylla	·	I	+	I	·	I	II	II	II	II	IV	III	II	I	I	·	I
Diagnostic taxa of Sasomorpho-Fagion crenatae Miyawaki, Ohba et Murase 1964:																	
Sasamorpha borealis	·	III	II	III	III	·	II	IV	IV	III	·	r	·	·	·	II	·
Abelia spathulata	·	II	IV	II	I	II	III	III	I	·	I	r	r	·	·	I	·
Pourthiaea villosa var. *laevis*	·	I	I	I	II	III	III	III	III	III	I	r	r	I	II	II	·
● *Pieris japonica*	·	I	II	III	III	II	II	III	I	·	·	·	·	II	I	I	·
Prunus incisa	·	·	+	+	r	·	III	III	·	·	·	·	·	·	·	I	·
Acer palmatum var. *amoenum*	·	·	III	II	II	r	III	II	·	·	·	r	r	·	I	I	II
Stewartia monadelpha	·	·	·	·	II	·	II	II	IV	II	·	·	·	·	·	I	·
Diagnostic taxa of Tsugeinon sieboldii _ (Suz.-Tok. 1953) stat suball. nov. Fujiwara et A. Harada 2015:																	
Fagus japonica	·	IV	V	V	III	V	r	+	·	·	I	r	·	I	·	·	·
Stewartia pseudo-camellia	·	II	III	III	I	III	+	·	I	I	I	·	r	I	·	I	·
Rhododendron kaempferi	·	III	IV	III	II	II	I	I	I	·	I	I	r	I	I	II	·
Abies firma	·	II	IV	I	IV	II	·	+	II	·	·	r	·	·	·	I	·
Ainsliaea acerifolia var. *subapoda*	·	II	III	IV	r	r	II	r	·	·	III	I	+	·	·	I	·
Hydrangea hirta	·	II	IV	IV	III	II	II	II	·	I	·	r	+	I	I	I	·
Hamamelis japonica	·	III	II	+	I	II	r	r	·	I	+	r	r	I	·	I	·
Evodiopanax innovans	·	III	r	+	I	I	·	r	·	·	·	+	r	I	I	·	·
Tsuga sieboldii	I	I	II	IV	IV	I	r	I	II	I	·	r	r	·	·	I	·
Meliosma myriantha	·	I	V	III	II	III	·	+	·	·	·	r	r	·	·	·	·
Rhododendron dilatatum	·	I	IV	III	II	·	·	r	·	·	·	·	r	·	·	·	·
Acer crataegifolium	·	·	III	I	I	III	r	r	·	·	+	r	r	I	·	·	·
● *Torreya nucifera*	·	I	III	r	II	r	·	+	·	·	·	·	·	·	·	·	·
Acer mono var. *marmoratum*	·	·	III	·	I	+	r	r	·	·	I	·	r	·	·	I	·
Deutzia scabra	·	·	III	·	I	·	·	·	·	·	·	·	·	·	·	·	·
Parabenzoin praecox	·	·	III	r	+	I	II	II	·	·	·	·	·	·	·	·	·
Callicarpa mollis	·	·	III	r	I	II	·	r	·	·	·	·	r	·	·	·	·
Carex fernaldiana	·	·	r	·	+	·	IV	I	·	II	·	·	·	·	·	I	·
Aster dimorphophyllus	·	·	·	·	·	·	III	r	·	·	·	·	·	·	·	·	·

18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
K	J	J	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	K	R,C	R,C	C	C	C	T
57	1002	637	33	46	26	13	13	9	7	23	17	10	7	3	6	3	5	10	5	3	3	11	2	5	380	545	259	58	18	71	17
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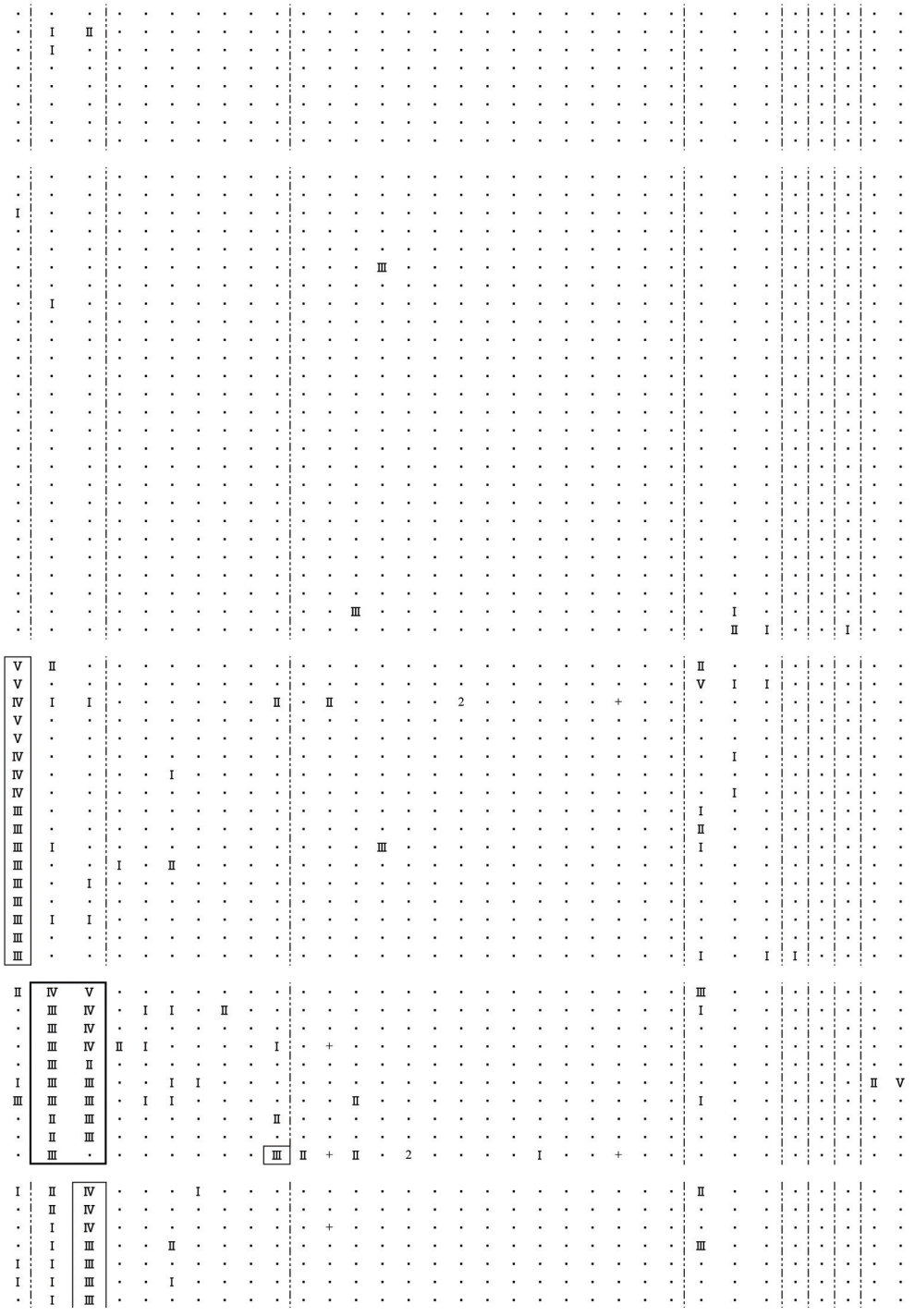
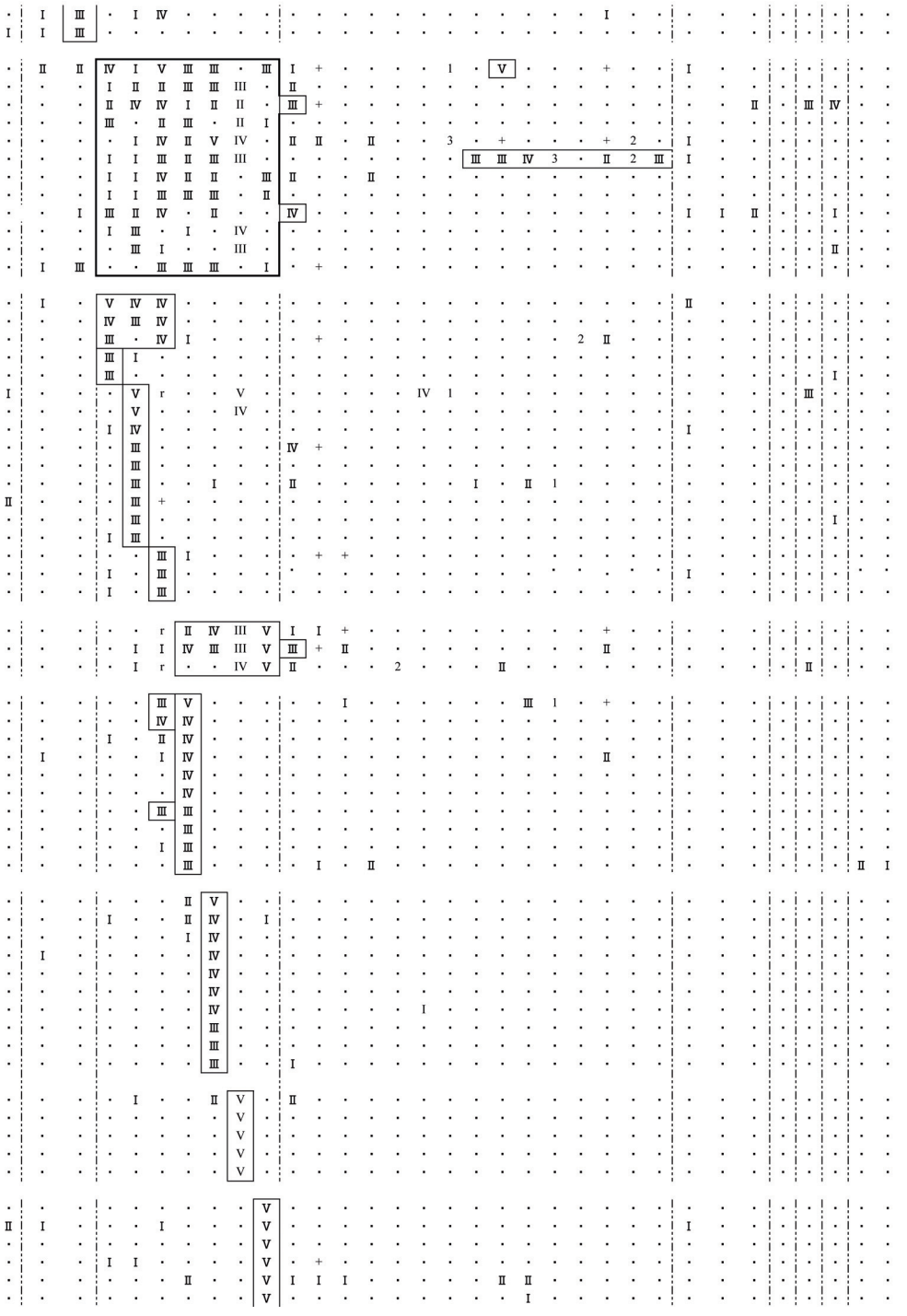
Continued

Aconitum japonicum	·	·	·	r	·	·	III	·	·	·	·	·	·	·	·	·	·
Euonymus sieboldianus	·	·	r	·	r	·	III	I	I	·	·	r	r	·	I	I	I
Parabenzoin trilobum	·	·	·	·	III	II	·	·	IV	·	·	·	r	I	·	I	·
Styrax shiraiana	·	·	·	·	II	r	r	r	III	·	·	·	·	I	·	I	·
Hydrangea macrophylla var. *acuminata*	·	·	I	+	+	I	I	+	III	I	·	r	r	II	·	I	·
Abies homolepis	·	I	+	II	·	·	I	II	I	V	II	r	+	·	·	II	·
Acer shirasawanum	·	I	·	·	·	·	II	II	I	IV	·	r	r	I	·	I	·
Chamaecyparis pisifera	·	·	·	·	·	·	·	r	·	III	+	r	r	·	·	·	·
Diagnostic taxa of Saso kurilensis-Fagion crenatae Miyawaki et al. 1968:																	
Sasa kurilensis	II	I	·	·	·	+	·	·	·	·	V	IV	IV	II	I	·	I
● *Ilex leucoclada*	·	·	·	·	·	II	·	·	·	·	II	III	III	III	I	·	·
Mitchella undulata	II	·	·	·	+	II	·	r	·	·	III	II	II	I	I	·	·
Arachniodes mutica	·	I	·	I	·	I	r	r	·	I	IV	II	III	II	·	·	·
Plagiogyria matsumureana	·	·	·	·	·	III	·	·	·	·	II	III	II	III	·	·	·
Vaccinium japonicum	·	I	·	r	II	II	·	·	I	·	III	II	II	III	·	·	·
Lindera umbellata var. *membranacea*	·	I	+	·	·	I	·	·	·	·	III	IV	V	II	III	·	·
Tripterospermum japonicum	·	I	r	r	I	II	r	r	·	I	III	II	II	III	II	I	I
● *Aucuba japonica* var. *borealis*	·	·	·	·	·	II	·	·	·	·	·	II	IV	II	II	·	I
● *Cephalotaxus harringtonia* var. *nana*	·	·	·	·	r	II	·	·	·	·	·	II	III	II	III	·	I
Acer mono var. *mayrii*	·	·	·	·	·	I	·	·	·	·	·	II	II	I	III	·	II
● *Ilex crenata* var. *paludosa*	·	·	·	·	r	III	·	r	·	·	·	II	II	II	III	·	I
Magnolia salicifolia	·	·	·	·	II	III	·	·	I	·	·	III	II	IV	I	·	·
Daphniphyllum macropodum var. *humile*	·	·	·	·	r	I	·	·	·	·	I	II	II	II	I	·	I
Rhododendron quinquefolium	·	II	r	r	·	·	II	I	·	II	IV	·	·	·	·	·	·
Thujopsis dolabrata	·	·	·	·	·	·	·	·	·	·	IV	r	r	·	·	·	·
Rhododendron semibarbatum	·	II	III	II	I	II	·	r	·	·	III	r	r	·	·	·	·
Acer distylum	·	II	II	III	·	+	+	+	·	·	III	I	I	·	·	·	·
Enkianthus subsessilis	·	II	·	I	r	I	·	r	·	·	III	r	·	·	·	·	·
Cacalia hastata var. *orientalis*	·	·	·	·	·	·	·	·	·	·	·	+	r	·	·	·	IV
Vitis coignetiae	·	·	r	·	·	·	r	·	·	I	·	I	r	·	I	I	IV
Magnolia praecocissima var. *borealis*	·	·	·	·	·	·	·	·	·	·	·	r	r	·	I	·	III
Cirsium kamtschaticum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	III
Abies sachalinensis	·	·	·	·	·	·	·	·	·	·	·	r	·	·	·	·	III
Actinidia kolomikta	·	·	r	·	·	·	·	·	·	·	·	r	r	·	·	·	III
Cardamine leucantha	·	·	·	·	·	·	·	·	·	·	·	r	r	·	·	·	III
Diagnostic taxa of Saso quelpaertensis-Quercetalia crispulae Fujiwara et A. Harada in Box et Fujiwara 2015:																	
Carpinus laxiflora	·	II	III	II	III	II	r	II	I	·	II	+	r	II	I	I	I
Acer pseudosieboldianum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Cornus kousa (*Benthamidia japonica*)	·	I	III	I	I	II	II	II	I	I	II	r	+	I	II	I	·
Sasa quelpaertensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Asarum maculatum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Taxus cuspidata*	II	·	·	·	·	·	·	·	·	·	·	+	r	·	·	·	I
Carex ciliatomarginata	·	·	·	·	·	·	·	·	·	·	·	·	r	·	·	·	·
Cacalia auriculata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Vaccinium koreanum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Viola chaerophylloides	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Lindera erythrocarpa	·	·	·	·	I	I	·	·	·	·	·	·	·	I	·	·	·
Desmodium podocarpum	II	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Viola hondoensis	II	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Anemone asiatica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Kadsura japonica*	·	·	·	·	·	r	·	·	·	·	·	·	·	·	·	·	·
Lycopodium chinense	·	·	·	·	r	·	·	·	·	·	·	·	·	·	·	·	·
Ligularia fischeri	·	·	·	·	·	·	r	·	·	·	·	·	·	·	·	·	·
Diagnostic species of Viburno dilatatae-Quercetea serratae Fujiwara et A. Harada in Box et Fujiwara 2015:																	
Quercus serrata	·	I	II	+	r	II	·	·	·	·	·	r	r	·	II	·	I
Viburnum dilatatum	·	I	III	+	+	I	II	I	·	·	·	r	r	I	II	I	I
● *Eurya japonica*	·	·	·	·	I	III	·	r	·	·	·	r	r	I	I	·	·
Akebia trifoliata	·	·	II	·	r	I	II	+	·	·	·	r	r	·	II	·	·
Prunus jamasakura	·	·	r	r	I	II	r	r	·	·	·	·	r	·	I	·	·
● *Ardisia japonica*	·	·	·	·	I	III	·	·	·	·	·	I	I	II	II	·	·
Styrax japonica	·	·	+	·	I	II	I	I	I	I	·	r	r	I	II	I	·
Pertya scandens	·	·	II	r	+	·	r	r	·	·	+	·	·	·	·	·	·
● *Aucuba japonica*	·	·	r	·	·	r	·	·	·	·	·	·	·	I	·	·	·
Lyonia ovalifolia var. *elliptica*	·	II	II	r	II	II	r	r	I	·	+	r	r	I	I	I	·
Diagnostic species of Carpino tschonoski-Quercion serratae Fujiwara et Harada in Box et Fujiwara 2015:																	
Callicarpa japonica	·	I	V	+	II	II	I	I	·	·	+	+	r	I	II	I	·
Oplismenus undulatifolius var. *japonicus*	·	·	+	·	r	·	I	·	·	·	·	·	·	·	·	·	·
Dioscorea tokoro	·	·	I	r	·	·	r	·	·	·	·	·	r	·	I	·	·
Stephanandra incisa	·	·	III	r	r	·	II	+	·	·	·	·	·	·	·	·	·
● *Hedera rhombea*	·	·	r	·	·	·	·	·	·	·	·	r	r	·	·	·	·
Akebia quinata	·	·	r	·	·	·	r	·	·	·	·	·	·	·	·	·	·
Pleioblastus chino	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·



Continued

Quercus acutissima	·	·	·	·	·	·	r	·	·	·	·	·	·	·	·	·	·	·	·
Zanthoxylum piperitum	·	·	I	·	r	·	I	I	·	·	·	r	r	·	II	·	I		
Diagnostic taxa of Quercetea variabili-brevipetiolatae Tang, Fujiwara et You in Box et Fujiwara 2015:																			
Lindera glauca	·	·	r	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Quercus serrata var. *brevipetiolata (=Q. glandulifera* var. *brevipetiolata)*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Aster ageratoides	·	·	·	r	·	·	III	I	·	·	·	·	·	·	·	·	·	·	·
Dalbergia hupeana	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Symplocos paniculata	·	·	·	·	·	·	·	·	·	·	·	r	r	·	·	·	·	·	·
Platycarya strobilacea	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Liriope spicata*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Rubus corchorifolius	·	·	·	·	·	r	·	·	·	·	·	·	·	·	·	·	·	·	·
Euonymus alatus	·	·	r	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	I
Lespedeza formosa	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Adenophora trachelioides	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Euscaphis japonica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic taxa of Pistacio chinensis-Quercetalia variabilis Tang et al. in Box et Fujiwara 2015:																			
Quercus variabilis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Pistacia chinensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Trachelospermum jasminoides*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Grewia biloba var. *parviflora*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Rhamnus globosa	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Carpinus turczaninovii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Forsythia suspensa	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Quercus aliena	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Carex subpediformis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Cotinus coggygria var. *pubescens*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Schisandra sphenanthera	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Smilax sieboldii	·	·	I	·	+	·	·	·	·	·	·	r	·	·	I	·	·		
Adenophora polyantha	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Clematis florida	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diospyros kaki var. *sylvestris*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Celtis sinensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Ilex cornuta*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic species of Quercetalia fabri-brevipetiolatae S. Suzuki, Nakamura, Kawano, X. Wang et Da ex Fujiwara et A. Harada in Box et Fujiwara 2015:																			
Lindera reflexa	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Rhododendron simsii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Fraxinus chinensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic species of Liquidambaro formosanae-Quercion fabri Fujiwara et A. Harada in Box et Fujiwara 2015:																			
Liquidambar formosana	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Quercus fabri	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Pinus massoniana	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Vaccinium bracteatum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Cunninghamia lanceolata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Loropetalum chinense	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Serissa serissoides	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Castanopsis sclerophylla*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Premna macrophylla	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Symplocos sumuntia*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic species of Sasamorpho sinicae-Quercion brevipetiolatae S. Suzuki, Nakamura, Kawano, X. Wang et Da ex Fujiwara et A. Harada in Box et Fujiwara 2015:																			
Hydrangea angustipetala	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Castanea seguinii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Stephanandra chinensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Pourthiaea villosa	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Sasamorpha sinica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Dendrobenthamia japonica var. *chinensis*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Corylus heterophylla var. *sutchuensis*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Pterostyrax corymbosus	·	·	·	·	r	I	·	·	·	·	·	·	·	·	·	·	·	·	·
Lonicera modesta	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Veratrum schindleri	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Differential species of *Quercus aliena* var. *acuteserrata* community:																			
Quercus aliena var. *acuteserrata*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Viburnum plicatum var. *tomentosum*	·	·	r	·	·	·	+	r	·	·	·	·	·	·	·	·	·	·	·
Smilax trachypoda	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Saussurea cordifolia	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Calamagrostis sinelatior	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic species of Indocalamo latifolii-Fagion zhejiangensis Matsui, Nishino, Pignatti, Yang, Lu, Kim, Yoshikawa, Honma et Wang 2013:																			
Fagus hayatae* var. *zhejiangensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Sapium japonicum	·	·	I	·	II	II	·	·	I	·	·	·	r	·	I	·	·		
Ainsliaea macroclinidioides	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Dioscorea bulbifera	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Schima superba*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Cyclobalanopsis nubium*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·



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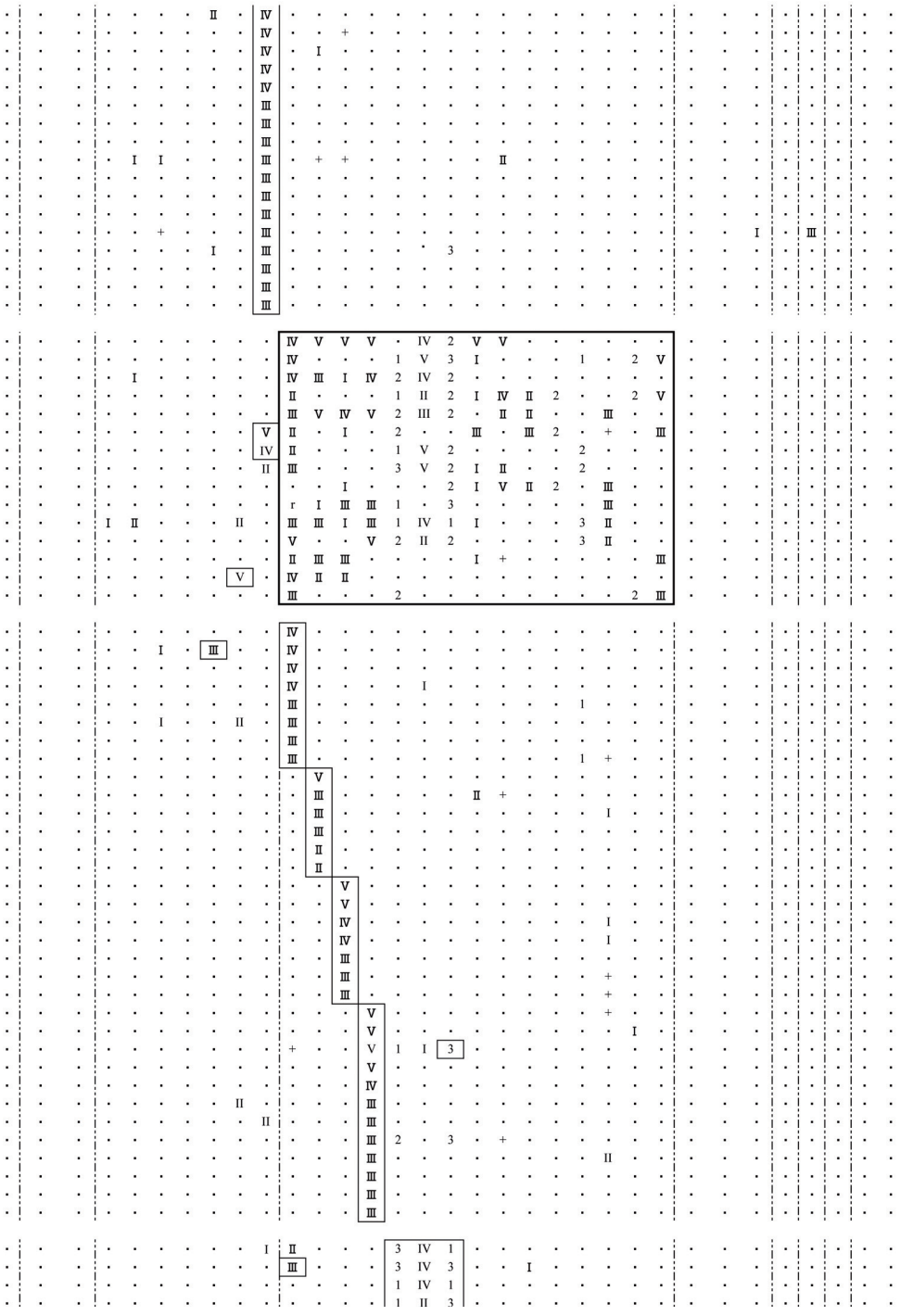
Magnolia cylindrica	. . . . .
Tripterospermum chinense	. . . . .
Rhododendron latoucheae	. . . . .
● *Litsea coreana* var. *sinensis*	. . . . .
● *Eurya rubiginosa* var. *attenuata*	. . . . .
Indocalamus latifolius	. . . . .
Acer elegantulum	. . . . .
● *Liriope graminifolia*	. . . . .
Prunus serrulata	. . . . .
● *Schisandra henryi*	. . . . .
● *Lithocarpus harlandii*	. . . . .
● *Photinia paniculata*	. . . . .
Calamagrostis arundinacea	. . . . .
Abelia dielsii	. . . . .
● *Photinia parvifolia*	. . . . .
Carex chinensis	. . . . .
Calamagrostis arundinacea var. *ciliata*	. . . . .
Diagnostic taxa of Fagetalia longipetiolato-lucidae ord. nov, Fagetea longipetiolato-lucidae class nov. Fujiwara et A. Harada 2015:	
Fagus lucida	. . . . .
Fagus engleriana	. . . . .
Sorbus folgneri	. . . . .
Acer oliverianum	. . . . .
● *Cyclobalanopsis multinervis*	. . . . .
Acanthopanax evodiaefolius	. . . . .
Quercus glandulifera	. . . . .
Viburnum sympodiale	. . . . .
● *Dryopteris labordei*	. . . . .
Acer sinense	. . . . .
Smilax stans	. . . . .
● *Ilex pernyi*	. . . . .
Hydrangea anomala	. . . . .
Acer davidii	. . . . .
Rhododendron hypoglaucum	. . . . .
Associations of Aceri davidii-Fagion lucidae Z.X. Wang, Fujiwara et Lei 2005:	
Carpinus cordata var. *chinense*	. . . . .
Castanea henryi	. . . . .
Euonymus alatus	. . . . .
Polystichum neolobatum	. . . . .
Polygonatum cyrtonema	. . . . .
Carex sendaica	. . . . .
Parathelypteris nipponica	. . . . .
Tupistra chinensis	. . . . .
Sinarundinaria chungii	. . . . .
● *Illicium simonsii*	. . . . .
Symplocos adenopus	. . . . .
● *Actinodaphne reticulata*	. . . . .
Carpinus pubescens	. . . . .
Viburnum corymbiflorum	. . . . .
Sinarundinaria lanshanensis	. . . . .
Clethra faberi	. . . . .
Erythroxylum kunthianum	. . . . .
Indosasa shibataeoides	. . . . .
Callicarpa brevipes	. . . . .
Manglietia fordiana	. . . . .
Fordiophyton faberi	. . . . .
Symplocos crassifolia	. . . . .
Sarcopyramis bodinieri	. . . . .
Sinarundinaria nitida	. . . . .
● *Plagiogyria atenoptera*	. . . . .
Betula insignis	. . . . .
Magnolia biondii	. . . . .
Nyssa sinensis	. . . . .
Taxus chinensis	. . . . .
Symplocos stapfiana	. . . . .
Viburnum ichangense	. . . . .
● *Ilex latifrons*	. . . . .
Asarum ichangense	. . . . .
Diagnostic taxa of Calantho fimbriatae-Fagion englerianae all. nov. Fujiwara et A. Harada 2015:	
Stewartia sinensis	. . . . .
Viburnum betulifolium	. . . . .
Calanthe fimbriata	. . . . .
Euonymus giraldii	. . . . .



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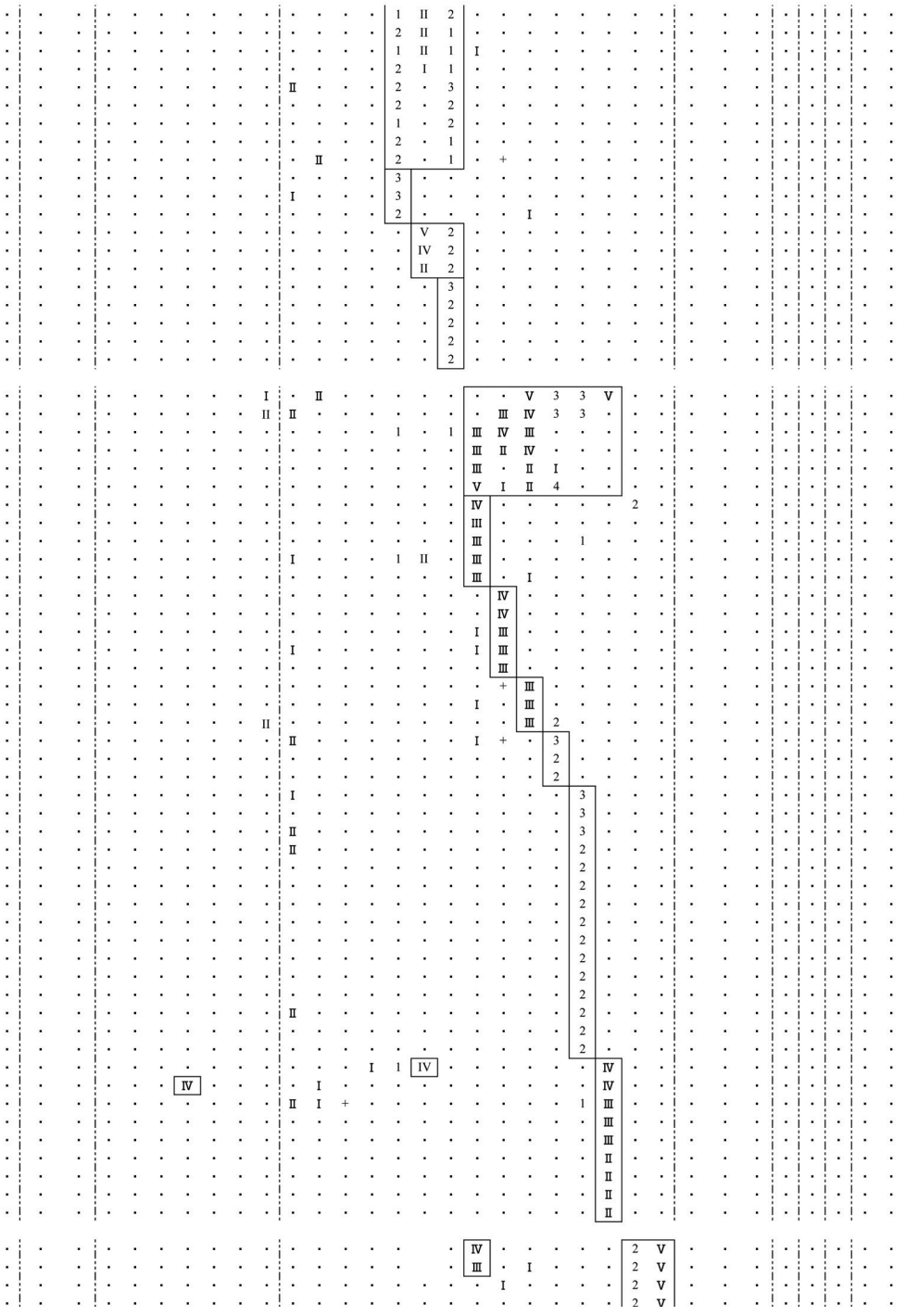
Helwingia chinensis
*Rhododendron bricranthum**
Acer laxiflorum
Prunus pilosiuscula
Holboellia fargesii
Ilex chinensis
Epimedium sagittatum
Berberis dielsiana
Sorbus xanthoneura
Fagus hayatae subsp. *pashanica*
Rubus bambusarus
Hugeria vaccinioides
Euonymus pourphyreus
Quercus spinosa
Acer ginnala
Pedicularis nasturtifolia
Meliosma veitchiorum
Cacalia roborowskii
Ilex szechwanensis
Acer palmatum

Diagnostic taxa of Fagion lucido-longipetiolatae all. nov. Fujiwara et A. Harada 2015:

Fagus longipetiolata
● *Camellia cuspidata*
Rhododendron sp.
Symplocos sp.
● *Camellia pitardii*
Symplocos botryantha
● *Camellia* sp.
Sinocalamus giganteus
● *Polystichum makinoi*
Athyrium wardii
Gallium asperuloides var. *hoffmeister*
Sinarundinaria complanata
● *Illicium ternstroemioides*
● *Ophiopogon mairei*
● *Aucuba chinensis*
Lepisorus thunbergianus
● *Neolitsea aurata*
Quercus sp.
● *Cyclobalanopsis stewardiana (Q. stewardiana)*
Quercus engleriana
Cymbidium sinense
Polypodium argutum
Cayratia japonica
Phoebe sheareri
Platycarya strobilacea
Padus wilsonii
Cercis chinensis
Bletilla striata
Primula ovalifolia
Saxifraga stolonifera
Toona ciliata
Phoebe neurantha
Disporopsis pernyi
Aesculus wilsonii
Acer amplum
Zingiber mioga
Elatostema sessile
● *Symplocos laurina*
● *Woodwardia japonica*
Smilax cocculoides
● *Dryopteris ternuicula*
● *Machilus oreophila*
Clethra bodinieri
Indosasa laevigata
Acer wilsonii
Sorbus keissleri

Diagnostic taxa of Qiongzheo tumidinodae-Fagion englerianae all. nov. Fujiwara et A. Harada 2015:

● *Castanopsis platyacantha*
Qiongzhea tumidinoda
● *Machilus ichangensis*
● *Schima crenata*



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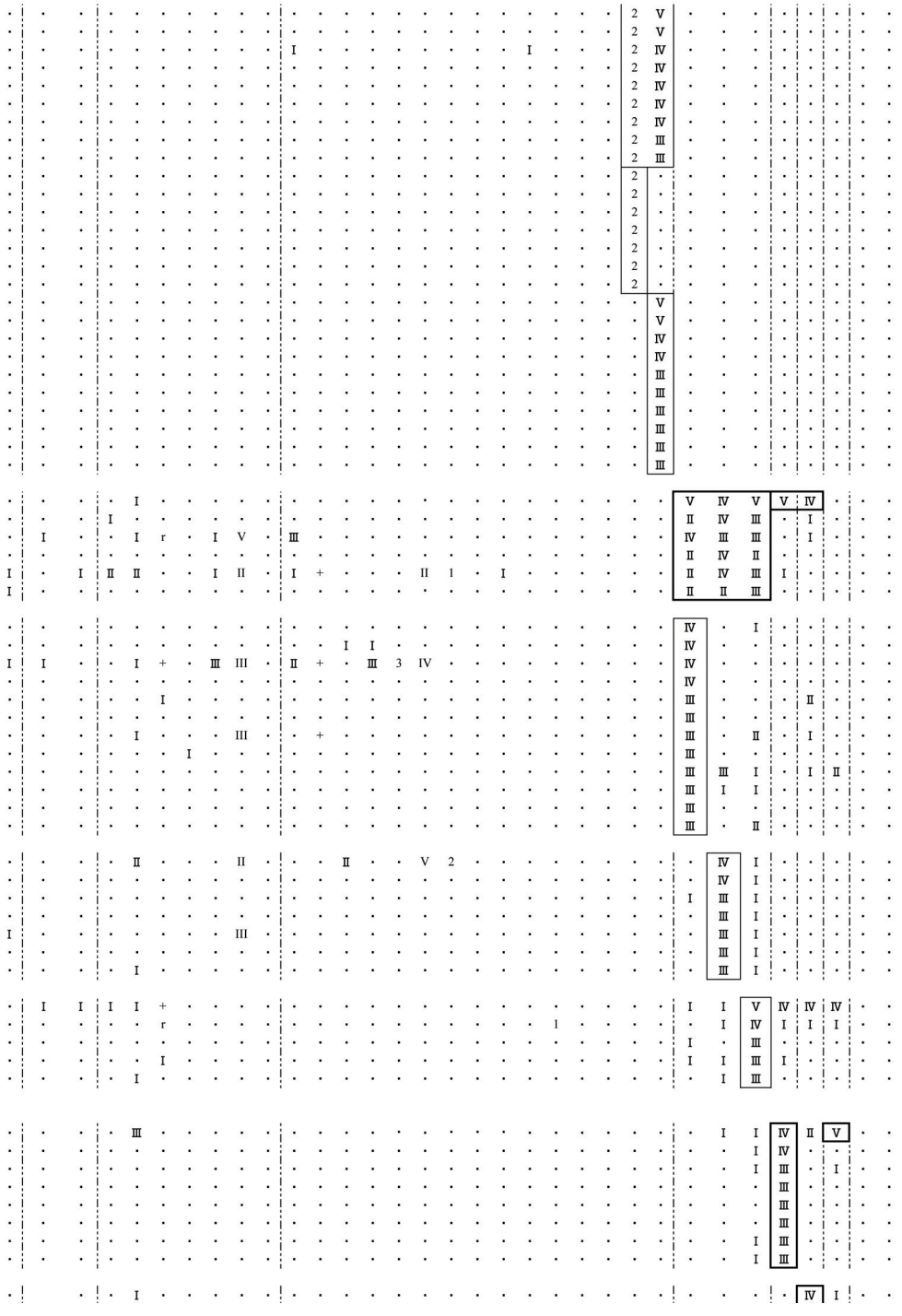
● *Ilex intermedia* var. *fangli*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Camellia grijsii*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Symplocos caudata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Rubus chroosepalus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Tripterospermum cordifolium	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Allantodia hirtipes	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Symplocos anomala	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Sorbus coronata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Acanthopanax evodiaefolius var. *gracilis*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Neolitsea chuii*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Lepisorus bicolor	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Athyrium delavayi	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Dichroa febrifuga	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Polypodiastrum dielsianum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Toxicodendron radicans var. *hispidus*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Sorbus sargentiana	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Lindera subcaudata var. *hemsleyana*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Neolitsea chinensis*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Manglietia duclouxii*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Panicum brevifolium	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Microsorium buergerianum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Ophiopogon bockianus*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Elatostema lineolatum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Holboellia angustifolia	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Hydrangea yunnanensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Evodia rutaecarpa var. *bodinieri*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic taxa of Quercetea mongolicae Song ex Krestov, Song, Nakamura et Verkholat 2006:																		
Quercus mongolica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Tilia amurensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Carex siderosticta	·	·	+	II	r	·	r	·	·	·	·	r	r	·	I	I	I	
Pinus koraiensis	·	·	·	·	·	·	·	·	·	·	·	r	·	·	·	·	·	
Acer mono	·	·	·	·	r	+	II	II	·	I	·	I	II	I	I	I	III	
Maackia amurensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic taxa of Aceri pseudosieboldii-Quercetalia mongolicae Song ex Takeda et al. 1994:																		
Rhododendron schlippenbachii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Symplocos chinensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Lindera obtusiloba	·	I	III	r	I	III	r	r	·	·	·	r	r	I	I	I	·	
Ainsliaea acerifolia	·	·	r	·	r	+	·	·	·	·	·	r	r	·	·	·	·	
Weigela florida	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Cerasus sachalinensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Melampyrum roseum	·	·	·	·	r	·	·	·	·	·	·	·	·	·	·	·	·	·
Lespedeza maximowiczii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Corylus mandshurica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Astilbe chinensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Tripterygium regelii	·	·	·	·	·	·	·	·	·	I	+	I	+	·	·	·	·	·
Calamagrostis brachytricha	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic taxa of Tilio amurensis-Pinetalia koraiensis Kim ex Krestov et al. 2006:																		
Schisandra chinensis	·	·	·	·	·	·	·	·	·	·	·	r	·	·	·	·	II	
Acanthopanax senticosus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	I	
Philadelphus tenuifolius	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Acer tegmentosum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Maianthemum bifolium	·	·	r	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diarrhena mandshurica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Fraxinus mandshurica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic taxa of Lespedezo bicoloris-Quercetalia mongolicae Krestov et al. **em Fujiwara etA. Harada in Box et Fujiwara 2015:**																		
Lespedeza bicolor （var. *acutifolia*）	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	I	
Corylus heterophylla	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Atractylodes ovata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Pteridium aquilinum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Polygonatum involucratum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic taxa of Poo nemoralis- Quercetalia mongolicae Zhi-Rong, Fujiwara, Ohno et Zhao 2010,																		
Querco mongolicae-Betuletea davuricae Ermakov et Ptelin in Ermakov 1997:																		
Spiraea pubescens	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Poa nemoralis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Paeonia lactiflora	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Dictamnus alpus var. *dasycarpum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Artemisia sacrorum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Artemisia tanacetifolia	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Thalictrum minus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Vicia pseudo-orobus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic taxa of Spiraeo trilobatae-Quercion mongolicae Tang, Fujiwara et A. Harada in Box et Fujiwara 2015:																		
Spiraea trilobata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·



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Deutzia grandiflora	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Thalictrum thunbergii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Myripnois dioica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Saussurea nivea	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Rhamnus davurica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic taxa of Quercetea wutaishanicae You et Fujiwara 2008 prov.:																	
Quercus wutaishanica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Agrimonia pilosa	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diagnostic taxa of Fagion hayatae Suz.-Tok. ex Hukusima, Lu, Matsui, Nishio, Pignatti 2005; Fagetalia hayatae Hukusima et al. 2005 Yushanio nitakayamensis-Fagetea hayatae class nov. Fujiwara et A. Harada 2015:																	
Fagus hayatae	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Yushania nitakayamensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Stauntonia purpurea*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Neolitsea acuminatissima*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Osmanthus heterophyllus*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Rubus shinkoensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Acanthopanax evodiaefolius var. *pseudoevodiaefolia*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Plagiogyria formosana*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Acrophorus stipellatus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Illicium tashiroi*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Daphniphyllum macropodum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Dryopteris formosana*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Quercus sessilifolia	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Camellia tenuifolia*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Viburnum urceolatum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Symplocos lancifolia	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Viburnum luzonicum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Oxalis acetosella	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Pourthiaea villosa var. *parvifolia*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Eurya crenatifolia	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Tripterospermum lanceolata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Parathelypteris japonica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Peracarpa carnosa	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Coptis quinquefolia	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Elaeocarpus japonicus*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Enkianthus perlata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Eurya leptophylla	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Ardisia crispa*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Damnacanthus angustifolius var. *stenophyllus*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Symplocos macrostroma	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Symplocos cochinchinensis subsp. *laurina*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Neolitsea aciculata*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Helicia cochinchinensis*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Lasianthus japonicus*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
● *Litsea acuminata*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Pellionia arisanensis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Prunus phaeosticta	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Rhododendron formosanum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Common species of *Quercus-Fagus* forests in East Asia:																	
Kalopanax pictus	I	II	II	I	I	I	I	II	II	II	II	I	I	I	II	II	V
Sorbus alnifolia	·	II	I	r	I	II	r	·	·	·	I	II	II	II	III	II	IV
Cornus controversa	II	·	III	r	+	I	II	+	II	I	I	I	I	I	II	I	II
Disporum smilacinum	·	II	III	II	I	III	I	·	I	·	III	II	II	II	III	II	I
Rhus trichocarpa （=*Toxicodendron trichocarpum*）	·	III	II	I	II	III	r	I	I	·	III	III	III	III	II	I	II
Athyrium yokoscense	I	I	II	IV	+	r	IV	II	·	III	+	+	r	·	·	III	I
Carpinus tschonoskii	·	I	III	I	II	II	II	I	II	·	I	r	r	I	I	I	·
Prunus grayana	·	I	II	II	+	II	r	·	·	I	I	III	IV	I	III	I	·
Castanea crenata	·	I	II	I	I	II	r	r	·	·	I	r	r	I	III	I	·
Fraxinus sieboldiana	·	II	III	+	I	II	·	r	·	·	·	r	r	I	I	I	·
Viburnum erosum	·	·	IV	+	II	II	+	r	I	·	·	r	r	I	I	I	·
Carex lanceolata	·	·	·	·	·	·	·	·	·	·	·	r	·	·	I	I	I
Smilax china	·	·	II	·	r	II	+	·	·	·	·	r	r	I	II	I	·
Aster scaber	·	·	+	·	r	·	r	·	·	·	·	·	·	·	I	·	·
Carpinus cordata	·	I	IV	II	I	·	I	I	I	·	+	+	r	·	I	I	III

Other species are omitted.

Rh. bricranthum* (Hukusima et al. 2013) is probably *Rh. micranthum

Fagus forests in Japan and Korea are still preserved**.** CAO et al. (1995) suggested that *Fagus* species in south-Chinese montane belts were once more widespread. Palaeobotanical studies suggest that these beech species survived in mountain valleys during the Ice Ages and spread to higher altitude and to the north during interglaciations (KONG et al. 1977, 1992; ZHU 1979; ZHONG et al.). In eastern China, the original forests in the lowland and hilly regions have been converted to farmland or to secondary or plantation forests (WU 1980; CAO et al. 1995). Relict *Fagus* forests are very important nowadays as local environmental indicators and also for preserving biodiversity. Phytosociological data show how relict *Fagus* forests will correspond to climate changes and/or age history.

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