

2.1 Introductory Notes

Table 3.1 is a synoptic table of the forests dominated by the genus *Fagus* in East Asia. According to Table 3.1, the phytosociological system of beech forests in East Asia was classified as in Table 3.9 and the distribution map of the classified classes, orders, alliances and associations was depicted as Fig. 2.1. In Table 3.1, 68 species categorized as the species group 49 are the common species occurring in the beech forests in East Asia, although there is a regional bias. Many of the 68 species are character species of beech forests in each region.

Species constantly found in the beech forests in Ulleungdo Island are: *Dryopteris crassirhizoma*, *D. fortunei* var. *radicans*, *Disporum sessile*, and *Viola selkirkii*.

Commonly found in the beech forests both in Taiwan and Japan are: *Viburnum furcataum*, *Rhus ambigua*, *Ardisia japonica*, *Parathelypteris japonica*.

Species distributed in China, Taiwan and Japan, but not in Ulleungdo Island are: *Hydrangea paniculata*, *Sorbus alnifolia*, *Oxalis griffithii*, *Acer mono*, *Athyrium wardii*, *Clethra barbinervis*, *Ilex macropoda*, *Lindera umbellata*, *Cornus kousa*, *Vaccinium japonicum*. Moreover, these species are highly frequent in the *F. crenata* forests in Japan.

Common species in the beech forests in China and Taiwan are: *Daphniphyllum macropodum*, *Ardisia crenata*, *Cleyera japonica*, *Maesea japonica*, *Plagiogyria euphlebia*, *Skimmia reevesiana*, *Peracarpa carnosae*, *Symplocos sumuntia*, *Smilax lanceifolia* var. *opaca*. There are many evergreen, broad-leaved species. Moreover, *Daphniphyllum macropodum* and *Ardisia crenata* in Japan are growing in the evergreen, broad-leaved forests rather than in the beech forests.

In the synoptic table (Table 3.1c), it is possible to have an outlook on the classification of the beech forests in East Asia into 51 vegetation units. Each of the units was compared with each of the vegetation unit that have been proposed in the published literature, with regards to the similarities of the species composition. As a result of this comparison, we were able to organize the phytosociological

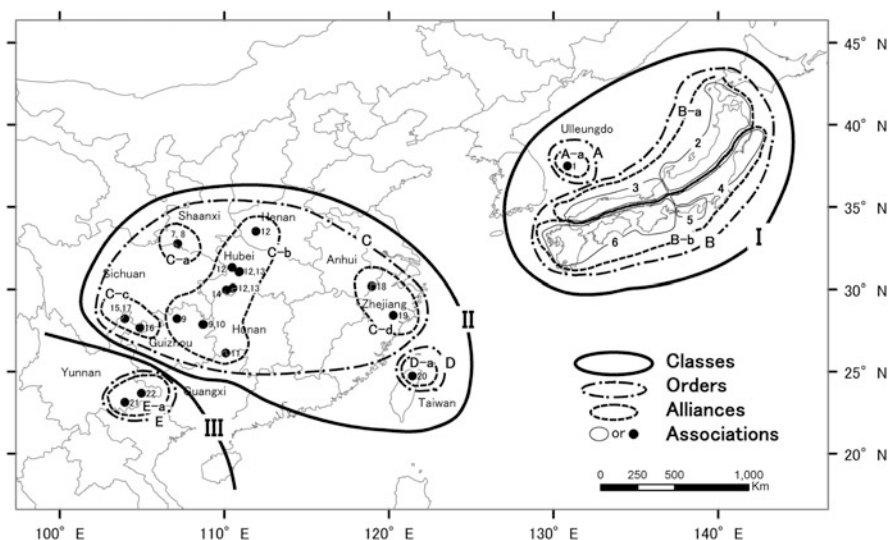


Fig. 2.1 Distributions of classes, orders, alliances and associations for the beech forests in East Asia

classification, including new vegetation units (Table 3.9, Fig. 2.1). For the East Asian forests with dominance in the tree layer of species of the genus *Fagus*, it was possible to organize the classification of the plant communities in the following syntaxonomical treatment.

The first vegetation class (*Fagetea crenatae*) includes all beech forests recognized in Japan and on the Korean Ulleungdo Island, associations no. 1–6, distributed among 2 orders and 3 alliances.

The second vegetation class (*Litseo elongatae-Fagetea*) includes the beech forests with prevalence of deciduous species, recognized in China: associations 7–20, distributed among 2 orders and 4 alliances.

The third vegetation class is still incompletely known (and consequently still unnamed); it includes the beech forests with prevalence of evergreen species, recognized in South China: associations 21–22, belonging to 1 order and 1 alliance. In the following chapters, all these vegetation units are described and discussed.

2.2 I. *Fagetea crenatae* (Miyawaki et al. 1964) (Run. No. 1–27)

Character species: *Hydrangea petiolaris*, *Schizophragma hydrangeoides*, *Sorbus commixta*, *Disporum smilacinum*, *Kalopanax pictus*, *Viburnum wrightii*, *Trillium smallii*, *Tripterosperrum japonicum*, *Smilax nipponica*, *Styrax obassia*, *Mitchella undulata*, *Maianthemum dilatatum*.

This class was described for the beech forests of Japan by Miyawaki et al. in 1964. As a result of our revision, it becomes clear to be confirmed that all Japanese

F. crenata forests and *F. multinervis* forests on Ulleungdo Island, Korea, fit into this class. In addition, the composition of the forests distributed over Jeju Island, the Korean Peninsula and northeastern China, where species of *Fagus* are not present, was reported instead to be with *Quercus mongolica* as dominant tree. A comparison of the forest composition of the *Q. mongolica* forests of Jeju Island (Yun et al. 2008), reveals the presence of many common species, suggesting those forests could be included in this class. Song (1988) defined this class as *Quercetea mongolicae* (Song 1988) from a study of the Korean conifer-broad-leaved mixed forests, and this was supported by Takeda et al. (1994). On the other hand, in the similar *Quercus mongolica* forests in North Korea, Kolbek et al. (2003) revised the concept of the *Querco-Fagetea crenatae* (Miyawaki et al. 1968) proposed by Miyawaki et al. (1968). In northeast China, Wang et al. (2006) recognizes *Quercetea mongolicae* (Song 1988). Wang et al. (2006) also defined *Querco mongolicae-Betuletea davuricae* (Wang et al. 2006) as a new independent class. A comparison of the reports by Kolbek et al. (2003) and Wang et al. (2006) with the association tables for beech forests presented in this study shows that many species not found in *Fagus* classes, such as *Quercus mongolica*, *Vitis amurensis*, *Carex nanella*, *Lespedeza bicolor*, *Pinus koraiensis*, *Philadelphus schrenkii*, *Tilia amurensis*, *Maackia amurensis*, *Athyrium crenatum*, *Artemisia keiskeana*, *Deutzia glabrata*, *Rhododendron mucronulatum*, and *Polygonatum involucreatum*, are common and are present at characteristically high constancies. Furthermore, there are many species that are not distributed in beech forests, indicating that the compositional differences are large. Hence, this class can be judged to be a distinct class. However, an interesting point to note is that where *Quercus mongolica* var. *grosseserrata* forests (Hoshino 1998; Suzuki 2002) come into contact with beech forests at lower elevations in Japan, many species common to the *Quercus mongolica* forests are found. To explain these relations, it is necessary to examine not only current climatic factors but also historical factors dating from the Quaternary period.

As to the floristic composition, it has to be pointed out that the proportion of deciduous flora is high, and that of evergreen broad-leaved flora is extremely low in this class. This represents a major difference between the characteristics of this class and the *Litseo elongatae-Fagetea* sp. div.cl. nov. class seen in beech forests in China and Taiwan.

This class includes two orders: *Fagetalia multinervis* (Kim et al. 1986) (*F. multinervis* order) defined by Kim et al. (1986) on Ulleungdo Island (Korea) and *Saso Fagetalia crenatae* (Suzuki 1966) (*Fagus-Sasa* order) in Japan defined by Suzuki (1966). Many of the character species of this order are common to the two abovementioned orders; however, *Tripterospermum japonicum*, *Euonymus alatus* fo. *ciliato-dentatus*, *Smilax nipponica*, *Styrax obassia*, *Mitchella undulata*, *Maianthemum dilatatum*, *Asperula odorata*, *Polystichum retroso-paleaceum* and *Viola kusanoana* are limited to the beech forests distributed on Ulleungdo Island and in Japan on the Japan Sea side of Honshu Island, and are extremely rare on the Pacific Ocean side of Japan, suggesting that Ulleungdo Island and the Japan Sea side of Japan were historically closely connected.

Fig. 2.2 Landscape of *Fagus multinervis* forests on Ulleungdo Island, Korea. The beech forests grow at an elevation of 300 m or above



2.2.1 A. *Fagetalia multinervis* (Kim et al. 1986) (Run. No. 1–5)

Character species: *Acer okamotoana*, *Acer takesimense*, *Prunus takesimensis*, *Asperula odorata* (= *Galium odoratum*), *Arisaema amurense*, *Polystichum retroso-paleaceum*, *Viola kusanoana*, *Solidago virga-aurea* var. *gigantea*, *Ligustrum foliosum*, *Dystaenia takesimana*, *Aster glehnii*, *Athyrium brevifrons*.

Ulleungdo Island is located in the Sea of Japan, ca. 100 miles off the coast of the Korean peninsula and at a larger distance from the western coast of Hondo. On Ulleungdo, the coastal areas below an elevation of approximately 50 m is covered of evergreen broad-leaved forest with dominant *Persea thunbergii*, whereas the habitats at higher elevation are covered with a deciduous broad-leaved forest (Fig. 2.2). The order *Fagetalia multinervis* includes all the units in the deciduous broad-leaved forests distributed on Ulleungdo and it was already named as the upper units of the *F. multinervis* forest association by Kim et al. (1986). Further on, there is no beech forest plant community on the Korean Peninsula that can be included in this order. *Hepatico-Fagion multinervis* (Kim et al. 1986) is the only alliance belonging to this order.

A-a. *Hepatico-Fagion multinervis* (Kim et al. 1986) (Run. no. 1–5)

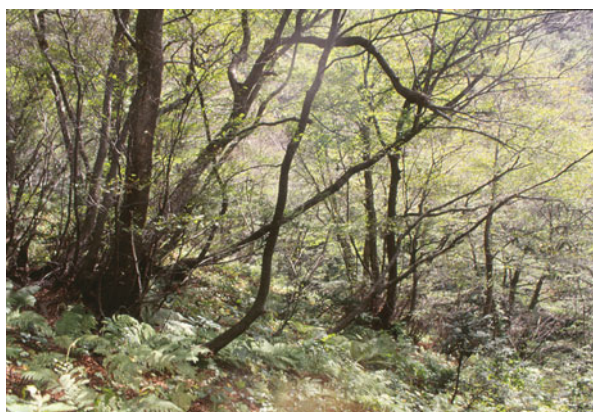
Character species: The character species are the same as those of the order.

This alliance was defined by Kim et al. (1986). According to the authors' data, the *Dystaenio takeshimanae*-*Aceretum okamotoanae* prov. association, where *Hovenia dulcis*, *Cornus brachypoda*, *Acer takesimense*, *Zelkova serrata*, *Aralia cordata*, *Osmorhiza aristata* and *Cyrtomium fortunei* are indicated as character species, is distributed at the lower elevation areas of Ulleungdo Island from 50 to 350 m above sea level. This alliance includes this association (which has not the character of a beech forest) and the *Hepatico-Fagetum multinervis* (Kim et al. 1986), widespread on higher altitude (350–820 m).

1. *Hepatico-Fagetum multinervis* (Kim et al. 1986) (Run. no. 1–5)

Character species: *Fagus multinervis*, *Hepatica maxima*, *Allium victorialis* var. *platyphyllum*, *Tilia insularis*, *Botrychium multifidum* var. *robustum*, *Lilium hansonii*, *Viola hondoensis*, *Taxus cuspidata*, *Ulmus laciniata*.

Fig. 2.3 Inner view of *Fagus multinervis* forest on the middle slope (Ulleungdo Island, Korea). The beech forms multiple trunks. The understory is dominated by herbs and ferns such as *Rumohra standishii* with *Hepatica maxima*, *Allium victorialis* var. *platyphyllum* and *Maianthemum dilatatum*



Type relevé: Kim et al. (1986), Tab. 1, Relevé reference number 17 (Elevation 820 m, Ulleungdo).

This association was recorded and named by Kim et al. (1986) on Ulleungdo Island (Figs. 2.3, 2.4 and 2.5). Even the relevés published in Kim (1988) were carried out on this island. The climate of Ulleungdo is warm and humid. The annual mean temperature of 11.5 °C at 357 m elevation (corresponding to 8 °C at 1,000 m, but the island has not such elevate mountains) is relatively high in comparison with temperatures of the beech forests in Japan (Table 3.4); rainfall is relatively low (1,371 mm), indeed the elevate atmospheric humidity is maintained by the isolated location in the middle of the sea. The beech forests distributed on the highlands above an elevation of 350 m have been little impacted by humans, and remain in a predominantly natural state.

The Hepatico-Fagetum multinervis is characterized by the abovementioned character species with *Fagus multinervis*, *Hepatica maxima* and *Tilia insularis*, all endemic to the island. In addition, although they are not character species, *Dystaenia takesimana*, *Acer okamotoana*, *Ligustrum foliosum* and *Prunus takesimensis* are also endemic to Ulleungdo, indicating the high endemism of the flora in this island.

Pteridophytes, such as *Rumohra standishii*, *Polystichum tripterum* and *Polystichum retroso-paleaceum*, which are character species in Japanese ravine forests, are predominant on the forest floors in this association. This confirms that this island experiences a warm, wet, typical oceanic climate. Kim et al. (1986) sorted this association into the *Rumohra standishii* subass. (Running number. 1), *Sasa kurilensis* subass. (Run. no. 2), typical subass. (Run. no. 3) and *Rhododendron brachycarpum* subass. (Run. no. 4), with Kim (1988) later recognizing the same subassociations. Our addition of new data obtained by the authors to the previous data published by Kim et al. (1986) and Kim (1988) resulted in the recognition of an additional subassociation: *Celtis jessoensis* subass. (Run. no. 5).

The structural characteristics of this association include the dominance of deciduous species such as *Fagus multinervis*, *Acer okamotoana* and *A. takesimensis*.

Fig. 2.4 *Fagus multinervis* forest growing on the gentle upper slope and the ridge (Ulleungdo Island, Korea). *S. kurilensis* often dominates the shrub layer of *F. crenata* forests in Japan, on the Sea of Japan side. Both of the forest physiognomy look similar



Fig. 2.5 Leaves of *Fagus multinervis* Nakai of Ulleungdo Island. Its leaves are similar to the leaves of the Japanese beech *Fagus japonica* Maxim.; however, *Fagus multinervis* has larger cupules and no hairs on the inferior side of leaves



in the canopy layer, with herbaceous species such as *Allium victorialis* var. *platyphyllum*, *Hepatica maxima* and *Maianthemum dilatatum* and pteridophytes such as *Rumohra standishii*, *Polystichum tripterum* and *Polystichum retrosopaleaceum* forming the forest floor. Evergreen trees and shrubs have a reduced presence (1–3 %). Very significant is the high presence of geophytes with rhizomes (30 %) or with bulbs (4 %), the highest values in the beech forests of East Asia. Very diffused are also the perennial herbs (hemicryptophytes) with a total of over 33 % and climbers (12.5 %).

2.2.2 B. Saso-Fagetalia (Suzuki 1966) (Run. No. 6–27)

Character species: *Fagus crenata*, *Acanthopanax sciadophylloides*, *Magnolia obovata*, *Fraxinus lanuginosa*, *Quercus mongolica*. var. *grosseserrata*, *Skimmia japonica* var. *intermedia* f. *repens*, *Acer rufinerve*, *Tilia japonica*, *Acer sieboldianum*, *Acer micranthum*, *Paris tetraphylla*, *Smilacina japonica*, *Acer*

Fagetea crenatae Miyawaki, Ohba *et* Murase 1964

Saso-Fagetalia Suz.-Tok. 1966

Fagion crenatae Suz.-Tok. 1952

- Saso *kurilensis*-Fagetum *crenatae* Suz.-Tok. 1949
- *Lindero umbellatae*-Fagetum *crenatae* Horikawa *et* Sasaki 1959

Sasamorpho-Fagion *crenatae* Miyawaki, Ohba *et* Murase 1964

- Sapo *japonici*-Fagetum *crenatae* Sasaki 190
- Corno-Fagetum *crenatae* Miyawaki, Ohba *et* Murase
- Sasamorpho-Fagetum *crenatae* Suz.-Tok. 1949



Fig. 2.6 Distribution map of the five beech forest associations in Japan

japonicum, *Dryopteris sabaei*, *Carex dolichostachya* var. *glaberrima*, *Prunus grayana*, *Corylus sieboldiana*, *Sasa senanensis*, *Betula grossa*, *Symplocos coreana*, *Acer shirasawanum*, *Carpinus japonica*, *Stewartia pseudo-camellia*.

This order was named by Suzuki (1966). It is characterized by the above species; however, *Symplocos coreana*, *Lindera umbellata*, *Acer shirasawanum*, *Carpinus japonica* and *Stewartia pseudo-camellia* are not distributed in the association Saso *kurilensis*-Fagetum *crenatae* (Suzuki 1949). This order includes the *F. crenata* forests and parts of the *F. japonica* forests distributed over the mountain zone in Japan (Fig. 2.6), and it comes into contact at higher elevations with communities belonging to the order Abieti-Piceetalia (Miyawaki et al. 1968), a part of class, Vaccinio-Piceetea (Braun-Blanquet et al. 1939), which is distributed over the highlands (Braun-Blanquet et al. 1939). However, the species composition of Saso-Fagetalia has not much in common with the character species of the order, Abieti-Piceetalia.

On the other hand, at lower elevations it comes into contact with *Quercetalia serratae*-*grosseserratae* (Miyawaki et al. 1971), and to the north with forests of the order *Carpino cordatae*-*Quercetum grosseserratae* (Takeda et al. 1983), where species of the genus *Quercus* are dominant. These forests are sometimes impacted

by man, and tend to be second growth. Of these, *Quercetalia serratae-grosseserratae* (Miyawaki et al. 1971), which often grows close to beech forests, contains many significant species such as *Euonymus oxyphyllus*, *Euonymus alatus* f. *ciliatodentatus*, *Callicarpa japonica*, *Struthiopteris nipponica*, *Rhus trichocarpa*, *Rhododendron kaempferi*, *Carpinus laxiflora*, *Clethra barbinervis*, *Ilex macropoda*, *Carpinus tschonoskii*, *Hydrangea hirta*, *Schisandra repanda*, *Pourthiaea villosa* var. *laevis*, *Viburnum phlebotrichum*, *Ilex crenata* and even *Fagus japonica*, which have high degrees of constancy in this order. In addition, in some lowland areas, this order comes into contact with natural evergreen forests of *Illicio-Quercetalia acutae* (Fujiwara 1981), of the class *Camellietea japonicae* (Miyawaki and Ohba 1963). This order contains some species that penetrate slightly into the beech forests, but otherwise it has little in common with the beech forests. In addition, in the same mountain zone, but growing in the valleys, are found the ravine woodlands, which are sorted into another order *Fraxino-Ulmetalia* (Suzuki 1966). Species central to that order, but often appearing in *Saso-Fagetalia* (Suzuki 1966) are *Aesculus turbinata*, *Pterocarya rhoifolia*, *Panax japonicus*, *Polystichum tripterum*, *Leptogramma mollissima*, *Ligustrum tschonoskii*, *Peracarpa carnosa* var. *circaeoides* and *Hydrangea macrophylla* var. *acuminata*. Also, separated by the topographical features is the coniferous order *Pinetalia pentaphyllae* (Suzuki 1966), which is distributed across the ridge tops.

This order includes two alliances; *Fagion crenatae* (Suzuki 1952) on the Japan Sea side of Japan and *Sasamorpho-Fagion crenatae* (Miyawaki et al. 1968) on the Pacific Ocean side of this country.

B-a. *Fagion crenatae* (Suzuki 1952) (Run. no. 6–15)

Character species: *Cephalotaxus harringtonia* var. *nana*, *Plagiogyria matsumureana*, *Ilex crenata* var. *paludosa*, *Daphniphyllum macropodum* var. *humile*, *Carex foliosissima*, *Sasa palmata*, *Arachniodes mutica*, *Magnolia salicifolia*, *Lindera umbellata* var. *membranacea*, *Acer palmatum* var. *matsumurae*, *Viola vaginata*, *Sasa kurilensis*, *Hamamelis japonica* var. *obtusata*, *Ilex leucoclada*, *Aucuba japonica* var. *borealis*, *Heloniopsis orientalis*

This alliance is distributed in Honshu and southern Hokkaido on the Japan Sea side from 37° 50' to 42° 50'N and 136° 40' to 142° 55'E. It was defined by Suzuki (1952) to include all the beech forests in Japan. However, as the compositions of the forests on the Japan Sea side and those on the Pacific Ocean side differ significantly, Miyawaki et al. (1968) redefined the Suzuki alliance into two separate alliances; *Saso kurilensis-Fagion crenatae* and *Sasamorpho-Fagion crenatae*. Later, Hukusima et al. (2001) renamed the Japan Sea side beech forest alliance as *Fagion crenatae* (Suzuki 1952), in order to respect the principle of priority.

In the canopy layer of the beech forests in this alliance, *F. crenata* is always dominant, while the sub-canopy layer is always dominated by *Acer* species. Another characteristic of the forests in this alliance is that under the particular shrub layer with dominance of *Sasa* species, a second layer exists, where evergreen shrub species occur, such as *Cephalotaxus harringtonia* var. *nana*, *Ilex crenata* var. *paludosa*, *Daphniphyllum macropodum* var. *humile*, *Ilex leucoclada* and *Aucuba japonica* var. *borealis*, all of which are character species of this alliance. Most of

these species originate from areas on the Pacific Ocean side of Japan and have adapted to the climate on the Japan Sea side, where the snowfall is much greater. In this region, the climate is cold-temperate, with annual mean temperatures of 6° to 9°; heavy snow falls in winter are frequent with up to 2 m and more.

The associations included in this alliance are characterized by the prevalence of broad leaved deciduous trees (ca. 26 %) and shrubs (23 %), together with perennial herbs (Hemicryptophytes 27 %, Geophytes 20 %). The alliance Fagion crenatae includes two associations: Saso kurilensis-Fagetum crenatae (Suzuki 1949) and Lindero umbellatae—Fagetum crenatae (Horikawa et Sasaki 1959).

2. Saso kurilensis-Fagetum crenatae (Suzuki 1949) (Run. no. 6–10)

Character species: *Rhododendron albrechtii*, *Acer mono* var. *mairii*; *Acer tchonoskii*, *Streptopus streptopoides* var. *japonicus*.

Type relevé: Hukusima et al. (1984), Tab. 2, Relevé reference number HB 40, in Mt. Yulap (Elevation 490 m, Hokkaido).

This association (Figs. 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, and 2.14) is distributed across the Hokuriku and Tohoku regions, and on the Oshima Peninsula in Hokkaido from 36° to 43°N and approx. 136° to 142°E. The association, described by Suzuki (1949a) for the Hokkaido area, occurs in the central and northern regions of Honshu and in southern Hokkaido, mainly on the Japan Sea side, from 200 to 1,700 m in the south and close to sea level in the northernmost areas. This climax community is the most typical beech forest in Japan, very uniform in species composition and occurring over large areas.

In this association, Hukusima et al. (1995) distinguished five subassociations: typicum (Run. no. 6), carpinetosum (Run. no. 7), aesculetosum (Run. no. 8), abietetosum (Run. no. 9) and sasetosum (Run. no. 10).

Canopy layer is always dominated by *Fagus crenata*, and sub-canopy layer with *Acer japonicum* and *A. tchonoskii*. Upper shrub layer always with dominance of *Sasa kurilensis* and other species including *Lindera umbellata* and *Viburnum furcatum*. Lower shrub layer with evergreen broad-leaved shrubs, such as *Ilex leucoclada*, *Ilex crenata* var. *paludosa*, *Cephalotaxus harringtonia* and *Aucuba japonica* var. *borealis*, together with *Carex dolichostachya* and *Smilacina japonica*. In the sasetosum subassociation, which grows on the flat mountain ridges with volcanic ash soil in the Kitakami Mountains, Tohoku region, the shrub layer occasionally lacks scrub bamboo grasses and is dominated by forbs.

The ecological conditions for this association are characterized by very intense rain (1,700–3,000 mm yearly rainfall) and in the cold season heavy snowfalls: up to 3 m.

3. Lindero umbellatae—Fagetum crenatae (Horikawa et Sasaki 1959) (Run. no. 11–15)

Character species: *Euonymus lanceolatus*, *Torreya nucifera* var. *radicans*, *Cryptomeria japonica*, *Menziesia ciliicalyx*.

Type relevé: Sasaki (1964), Table 6, Relevé reference number Mt. Daisen, no. 4 (Elevation 1,100 m).

This association is distributed in the Chugoku region on the Japan Sea side of Japan and on the lowlands in the Hokuriku area of Chubu, in a range from 34° 20' to

Fig. 2.7 A typical *Fagus crenata* forest (Saso kurilensis-Fagetum crenatae) on the Sea of Japan side (Tambara highland, Gumma Prefecture, Japan). On the Sea of Japan side, beech forests are widely distributed within 200–1,700 m elevation



Fig. 2.8 A typical summer view of the internal *Fagus crenata* forest (Saso kurilensis-Fagetum crenatae, Tambara highland, Gumma Prefecture), the beech forest which is typical for the Japanese sea side. The tallest beech trees are over 20 m; in the understory, *Sasa kurilensis* and *Sasa senanensis* are dominant

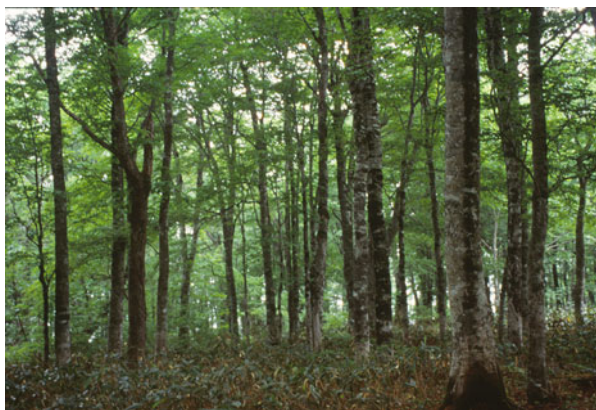


Fig. 2.9 *Fagus crenata* forest in Autumn (Saso kurilensis-Fagetum crenatae, Tambara highland, Gunma Prefecture)

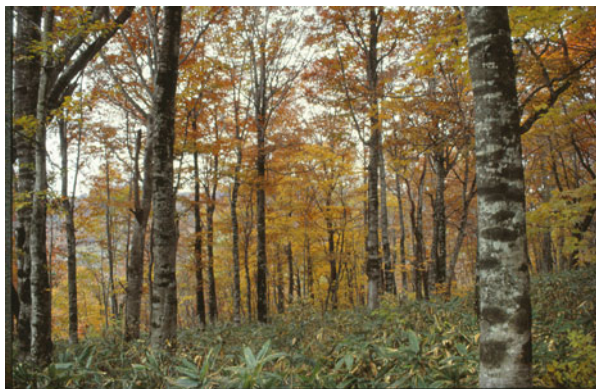


Fig. 2.10 An internal view of the beech forest on the Sea of Japan side (Saso kurilensis-Fagetum *crenatae*) with *Cryptomeria japonica* in Mt. Hakusan, Ishikawa Prefecture, Japan



Fig. 2.11 *Fagus crenata* forest in early Spring on the Sea of Japan side (Tadami town, Fukushima Prefecture, Japan). In the *F. crenata* forest on the Sea of Japan side, the dense growth of evergreen broad-leaved shrubs is characteristic. Snow melt earlier around the boles of trees and evergreen broad leaved shrubs of *Camellia japonica* subsp. *rusticana* and *Ilex crenata* var. *radicans* have started to grow



Fig. 2.12 *Camellia japonica* subsp. *rusticana* appearing after the snow melt



Fig. 2.13 *Camellia japonica* subsp. *rusticana* flowering under cold temperature, immediately after the snow melt. Leaves bent by the snow pressure have not been recovered yet



37° 40'N and from 131° 80' to 137° 10'E. It was recorded by Horikawa and Sasaki (1959) in the Geihoku area in Hiroshima prefecture, located in the Chugoku region, situated in western Honshu. As few of the mountains in this area have sufficient elevation for *F. crenata* forests to grow, the associations are observed only sporadically. In addition to the character species, this association contains character species of the *Fagion crenatae* (Suzuki 1952) alliance, although fewer of these character species are observed towards the west. On the other hand, this association on the Pacific Ocean side blends with an increasing number of species from the *Sasamorpha-Fagion crenatae* (Miyawaki et al. 1968) alliance. Four subassociations are classified under this association: *typicum* (Run. no. 11), *polystichetosum* (Run. no. 12), *rhododendretosum* (Run. no. 13) and *torpetaleietosum* (Run. no. 14). The *F. japonica* forests (Figs. 2.15, 2.16, 2.17, and 2.18) have been classified as the association, *Torreya-Fagetum japonicae* (Nakanishi et al. 1970). However, because of the similarity in their composition with the *Lindero umbellatae-Fagetum crenatae*, we now classify it as *Lindero umbellatae-Fagetum crenatae torreyetosum* (Run. no. 15), a subassociation of this association. Although the composition is basically similar to *Saso kurilensis-Fagetum crenatae* (Suzuki 1949), *Cryptomeria japonica* is occasionally seen in the canopy layer in this association.

The ecological conditions for this association correspond to a moderately cool, rainy climate, with yearly mean temperatures of ca. 8 °C at 1,000 m elevation and average rainfall 2,300–2,700 mm (Table 3.4). Snowfall during the cold season is lesser intensive than in *Saso kurilensis-Fagetum crenatae*, and mostly remains in the range of 1 m to about 2 m.

B-b. *Sasamorpha-Fagion crenatae* (Miyawaki et al. 1964) (Run. no. 16–27)

Character species: *Sasamorpha borealis*, *Abies homolepis*, *Acer palmatum* var. *amoenum*, *Rhododendron quinquefolium*, *Abelia spathulata*, *Acer tenuifolium*, *Stewartia monadelpha*, *Carex fernaldiana*.

This alliance (Miyawaki et al. 1964) is distributed across all areas of Kyushu and Shikoku, and the Pacific Ocean side of Honshu, in a range from 31° 30' to 39° 50'

Fig. 2.14 Leaves of *Fagus crenata* are of moderate size, and a little thicker than those of *Fagus japonica*. It has a shorter peduncle than *Fagus japonica*



Fig. 2.15 Physiognomy of the *Fagus japonica* forest in Oshika village, Nagano Prefecture, Japan. *F. japonica* mainly distributes on the slopes of the Pacific Ocean side of Japan. Their canopy shows in general a not uniform structure



Fig. 2.16 Multi-stemmed *Fagus japonica* can grow on steep slopes of coarse gravel, on which scrub bamboos are missing



Fig. 2.17 Leaves in *Fagus japonica* are larger than in *Fagus crenata*, thinner and with many veins; cupules are smaller and with longer peduncles



Fig. 2.18 Leaves of *F. japonica* at the lower side have long condensed hair on the veins



and 130° 20' to 142°E. Although the distribution area of this alliance extends over a wide area, the mountain environment suitable for beech forest growth does not continue throughout the region; therefore, the associations of this alliance appear sporadically and the species composing each plant community reflect the flora of each region. The alliance is characterized by the character species noted above; however, *Stewartia monadelphæ* and *Carex fernaldiana* are not observed in the Sasamorpho-Fagetum crenatae (Suzuki 1949).

The associations of this alliance develop under conditions of cool, rainy climate, but, as a difference to the previous alliance (Fagion crenatae), during the cold season snowfall is relatively limited and in average not reaching 1 m. Average yearly temperatures (Table 3.4) in general are ca. 8 °C at 1,000 m elevation, whereas rainfall is variable (see the different associations).

In the canopy layer, evergreen broad-leaved species such as *Quercus acuta*, *Q. salicina*, *Illicium religiosum* and *Eurya japonica* appear among *F. crenata*, as well as evergreen conifer species such as *Abies firma*, *Tsuga sieboldii* and *Torreya nucifera*. Although the forest floor is often dominated by *Sasamorpho borealis*,

Sasa nipponica prevails on the forest floor in the Kanto region. As these scrub bamboo species have a high degree of coverage, the herb layer is often not well developed.

4. Sasamorpho-Fagetum crenatae (Suzuki 1949) (Run. no. 16–19)

Character species: This is the typical association without character species.

Type relevé: Suzuki (1949b), Table 2, Relevé number. M5, Tonakayama/Shirokura National forest, Shizuoka Prefecture (Elevation 1,490 m).

This association is known from the inland areas of central Honshu to the inland Kanto regions and the Pacific Ocean side of the Tohoku region, in a range from 35° 10' to 39° 50' and 137° 20' to 142° E. This association, recorded by Suzuki (1949b), is the typical association showing the basic characteristics of the alliance, Sasamorpho-Fagion crenatae. As this association occasionally adjoins *Sasa kurilensis*-Fagetum crenatae (Suzuki 1949) on the Japan Sea side, it often contains the main species of that association, such as *Acer japonicum*, *Dryopteris sabaei*, *Prunus grayana*, *Vaccinium japonicum*, *Lindera umbellata* var. *membranacea* and *Acer palmatum* var. *matsumurae*. However, *Stewartia monadelphica* and *Carex fernaldiana*, which are character species of the alliance, are seldom recorded. Hukusima et al. (1995) classified this association into three subassociations; typicum (Run. no. 16), aucubetosum (Run. no. 17), and enkianthetosum (Run. no. 18). In addition, the floristic composition of the *F. japonica* forests distributed over Mt. Oomuro at the foot of Mt. Fuji, suggests that these forests are to be included in the Sasamorpho-Quercetum crenatae association, as an additional subassociation oxalietosum (Run. no. 19). Species richness in the canopy layer is high, with evergreen conifer species *Abies homolepis*, *Tsuga sieboldii* and *Abies firma*, along with *Quercus mongolica* var. *grosseserrata*. However, the sub-canopy layer is not well developed. The shrub layer is made up of scrub bamboo such as *Sasamorpho borealis* and *Sasa nipponica*. Therefore, the development of the herb layer is extremely poor.

The inland areas where Sasamorpho-Fagetum develops are humid, but the total yearly rainfall (1,300–2,000 mm) is inferior than in the areas of the following associations (3,000 mm and more).

5. Corno-Fagetum crenatae (Miyawaki et al. 1964) (Run. no. 20–22)

Character species: *Prunus incisa*, *Parabenzoin praecox*, *Plectranthus umbrosus*, *Aster ageratoides* var. *harae* f. *leucanthus*, *Aster dimorphophyllus*, *Enkianthus campanulatus*.

Type relevé: Miyawaki et al. (1964), Table 2-13, Relevé reference number 52, Mt. Shiragatake in Tanzawa, Kanagawa Prefecture (Elevation 1,380 m).

This association occurs in a limited area in central Honshu on the Pacific Ocean side of Japan, in a range from 34° 50' to 36° N and from 137° 50' to 139° 10' E. The association, named by Miyawaki et al. (1964), is distributed across an area referred to as the Fossa Magna, where relatively recent volcanic mountains, such as Mt. Fuji, are situated. Reflecting the moist oceanic climate of the area and elevate rainfall, this association contains species that form ravine forests (Fraxino-Ulmetalia Suz.-Tok. 1967), such as *Viola bissetii*, *Aster ageratoides* var. *harae* f. *leucanthus* and *Plectranthus umbrosus*. Under this association, Hukusima et al.

Fig. 2.19 Landscape of the *Fagus crenata* forest (*Sapio japonici*—*Fagetum crenatae*) in Mt. Takanawa, Shikoku, Japan. The beech forests on the Pacific Ocean side are distributed in scattered mountain areas



(1995) classified three subassociations; typicum (Run. no. 20), sasetosum (Run. no. 21), and cacalietosum (Run. no. 22). Although *F. crenata* is dominant in the canopy layer, *Cornus kousa* often grows in the sub-canopy layer. *Sasamorpha* and *Sasa hayatae* are dominant in the shrub layer. However, in the subassociations of sasetosum and cacalietosum, which develop on flat ridges with thick volcanic ash soil, the shrub layer lacks scrub bamboo and is dominated by forbs.

6. *Sapio japonici*-*Fagetum crenatae* (Sasaki 1970) (Run. no. 23–27)

Character species: *Parabenzoin trilobum*, *Enkianthus cernuus* f. *rubens*, *Styrax shiraiana*, *Lindera sericea* var. *glabrata*, *Hydrangea luteo-venosa*.

Type relevé: Miyawaki (1981), Table 132, Relevé reference number C80, Mt. Kunimi, Shiiba Village, Miyazaki Prefecture (Elevation 1,370 m).

This association (Figs. 2.19, 2.20, 2.21, and 2.22) occurs in Kyushu, Shikoku, the Kii Peninsula, and the Tokai region on the Pacific Ocean side of Japan, in a range from 31° 30' to 35° 10'N and 130° 20' to 137° 50'E. The climate (Table 3.4) is relatively warmer than in the previous associations (mean temperature 9–10 °C at 1,000 m elevation), with abundant rainfall (up to 3,000–3,600 mm yearly). This association contains evergreen species, more frequently as usual among the *F. crenata* forest associations in Japan. Evergreen broad-leaved species such as *Quercus acuta*, *Q. salicina* and *Illicium religiosum*, as well as evergreen conifer species such as *Abies firma* and *Tsuga sieboldii* normally occur in the canopy and sub-canopy layers of this association; in the shrub layer, evergreen species such as *Pieris japonica*, *Skimmia japonica*, *Eurya japonica*, *Neolitsea sericea* and *Camellia japonica* are often present. Another characteristic of this association is that some species are closely related to species widespread in beech forests of southwestern China, such as those seen in Yunnan Province, Sichuan Province, and Guizhou Province. Hukusima et al. (1995) in this association distinguish four different subassociations: typicum (Run. no. 23), occurring throughout all the area of distribution, leucosceptretosum (Run. no. 24), which is diffused only in Kyushu, cacalietosum (Run. no. 25) in Shikoku, and aceretsum (Run. no. 26) observed in Shikoku and the Kii Peninsula. Although further evaluation is still required, in this

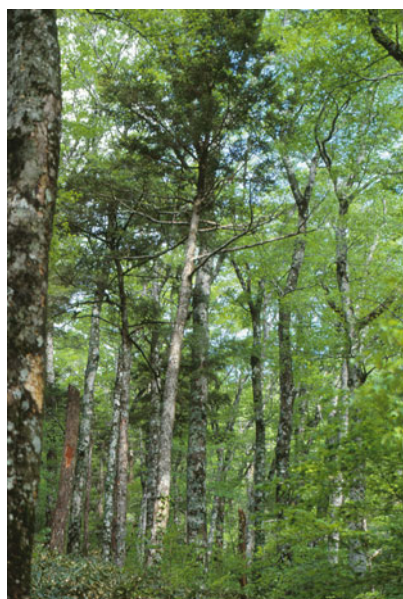
Fig. 2.20 Internal view of *Sapio japonici*—*Fagetum crenatae* (Mt. Hikosan, northern part of Kyushu). The understory is dominated by *Sasamorpha borealis*. *Fagus crenata* is endemic to Japan and it usually has a single trunk



Fig. 2.21 Internal view of beech forests in Mt. Shiratori, middle Kyushu, Japan (*Sapio japonici*—*Fagetum crenatae*). *Parabenzoïn trilobum* and *Symplocos coreana* are regularly dominant in the sub-canopy layer



Fig. 2.22 Mixed *Fagus crenata*-*Abies homolepis* forest (*Sapio japonici*-*Fagetum crenatae*) at higher elevation of Mt. Ishizuchi, Shikoku. In the canopy layer beech is dominant, but it is often mixed with *Abies homolepis*



study we classified *Styraci shiraianae*-*Fagetum japonicae* Y. Sasaki in Miyawaki (1981) as a subassociation, *styracetosum* (Run. no. 27), because of its similarity in species composition. In *leucosceptretosum* (Run. no. 24) and *cacalietosum* (Run. no. 25), which often occur on flat mountain ridges with volcanic ash soil, the shrub layer with scrub bamboo is often absent. This vegetation, in the herb layers, contains the same species that form ravine forests belonging to *Fraxino-Ulmetalia* Suz.-Tok., 1967.

2.3 II. *Litsea elongata*-*Fagetea* sp. div. cl. Nov. (Run. No. 28–48)

Character species: *Fagus longipetiolata*, *Litsea elongata*, *Smilax discotis*, *Parathelypteris glanduligera*, *Ardisia crispa*, *Dendropanax chevalieri*, *Rubus buergeri*, *Symplocos lancifolia*, *Dennstaedtia scabra*.

The vegetation of this class is composed by all beech forests in China, south of the Yellow River (Yangtze), excluding the southernmost examples in Yunnan province; with the differentiated order *Fagetalia hayatae* (Hukusima et al. 2005), vegetation of this class extends also to the northern portion of Taiwan.

The character species of this class include the deciduous beech, *Fagus longipetiolata*, as well as the evergreen species *Litsea elongata*, *Ardisia crispa*, *Symplocos lancifolia* and *Dennstaedtia scabra*. Many of the species frequently occurring in the associations belonging to this class, are diffused also in Japan, e.g. *Daphniphyllum macropodum*, *Cleyera japonica*, *Maesa japonica*, *Ardisia crenata*, *Liriope platyphylla*, *Lepisorus thunbergianus* and *Dryopteris erythrosora*. However, in Japan these species do not grow in the beech forests but in the evergreen woodland communities belonging to the class *Camellietea japonicae* (Miyawaki et Ohba 1963). This indicates that the beech forests in China have important similarities and close relationships, not only with the deciduous Japanese beech forests but also with the evergreen broad-leaved forests in Japan.

Forests belonging to this class do not cover a continuous area, because they mostly occur at higher elevation in the mountain ranges, so that they are scattered over a wide zone. Thus, the species composition of these forests is highly diversified, and they in general do not share many species in common.

The majority among the species occurring in these plant communities are evergreen and the proportion of deciduous flora is not so large as in the beech forests of Japan. This tendency increases as the latitude decreases.

The associations belonging to this class are assembled in two orders, which are both newly described here: *Sinarundinario nitidae*—*Fagetalia* including the beech forests of China and a second order, *Fagetalia hayatae* (Hukusima et al. 2005) which is endemic in Taiwan.

At the more meridional latitudes in Yunnan Province, near to the Tropic, the beech forests contain even more elements of the evergreen flora and thus lack the deciduous nature that is characteristic for the forests with dominance of *Fagus*; here another type of vegetation appears, where the species of the genus *Fagus* together with few other deciduous elements occur, among prevailing components of the

evergreen broad-leaved forests: here we have the transition to a different, still unnamed vegetation class (see associations 21–22).

2.3.1 C. Sinarundinario nitidae–Fagetalia sp. div. (Run. No. 28–46)

Character species: *Fraxinus chinensis*, *Pyrola decorata*, *Stewartia sinensis*, *Viburnum sympodiale*, *Paederia scandens*, *Lindera glauca*, *Acanthopanax evodiaefolius*, *Ilex penryi*, *Sinarundinaria nitida*, *Sorbus folgneri*, *Acer sinense*, *Viburnum betulifolium*, *Polystichum neolobatum*, *Fagus lucida*, *Smilax stans*, *Viola schneideri*, *Ophiopogon bodinieri*, *Camellia pitardii*, *Quercus oxyodon*, *Lithocarpus cleistocarpus*, *Symplocos botryantha*, *Pinus armandii*, *Dryopteris labordei*, *Acer oliverianum*, *Fagus engleriana*, *Eurya brevistyla*, *Lithocarpus hancei*, *Symplocos caudata*, *Ophiopogon mairei*, *Machilus ichangensis*, *Symplocos anomala*, *Reineckia carnea*, *Plagiogyria stenoptera*, *Rubus malifolius*, *Hydrangea anomala*, *Quercus stewardiana*, *Eurya muricata*, *Rhododendron mariesii*, *Polygonatum odoratum*, *Schima superba*, *Rhododendron latoucheae*, *Carpinus viminea*, *Lindera reflexa*, *Symplocos stellaris*, *Quercus gracilis*, *Arthraxon hispidus*, *Parthenocissus heterophylla*, *Dryopteris fuscipes*, *Ophiorrhiza japonica*, *Camellia cuspidata*, *Ilex wilsonii*, *Smilax glabra*, *Rhododendron simsii*.

This order includes the beech forests in all areas of Central and South China, South of the Yellow River, except for Taiwan (Fig. 2.1). Reflecting the wide diversity in the flora of China, there are many character species in this order. Only *Fraxinus chinensis*, *Pyrola decorata*, *Stewartia sinensis*, *Viburnum sympodiale*, *Paederia scandens* and *Acanthopanax evodiaefolius* are diffused over all the areas of distribution of this order, whereas all other species have a limited geographical range or are absent from one alliance or another. The diversified distribution of character species demonstrates how the environment characteristics of each region are reflected in the local beech forests. In other words, the floristical composition of the vegetation units is locally limited, and common character species diffused across the wider region are mostly lacking.

The climate has a warm-temperate and humid character, clearly differing from the cold-temperate climate of the beech forests in Japan. Temperatures in 1,000 m elevation range from 10 °C to about 16 °C and annual rainfall from 900 to 1,600 mm (Table 3.4). For the plants, this means lesser rain and more transpiration in comparison with the conditions in the beech forests of Japan. Indeed, rain is mostly concentrated in (late) summer and trees are not exposed to important water stress; on the contrary, these are in general conditions favourable for elevate photosynthesis, and giving a chance of survival to some representatives of the evergreen subtropical flora. In fact, evergreen species range from 14 to 25 % in the tree layer and from 6 to 17 % in the shrub layer, whereas the corresponding values in Japan were 1–2 % and 2–3 %.

The isolated communities of *Fagus* sp. div., scattered in a large portion of the Chinese mainland, are to be considered a precious reserve of biodiversity (not limited to plant life). In particular, the inflorescences of the shrub bamboo

Sinarundinaria nitida (= *Fargesia nitida*), are the preferred food of the Giant Panda, and consequently the communities bearing a dense thicket of this bamboo, often included in natural reserves or National Parks, are among the most important factors for the survival of the remaining populations of this mammal, worldwide considered an icon for species highly endangered of extinction.

This order contains four alliances (see Fig. 2.1):

C-a. *Abelio englerianae*—*Fagion* all. nov. (associations 7–8) in the Shaanxi and Sichuan Provinces, North-Western China.

C-b. *Aceri davidii*—*Fagion lucidae* (Wang et al. 2005) (associations 9–14) in the Guizhou, Guangxi, Henan, Hubei Provinces in the central area of China.

C-c. *Qiongzheo tumidinodae*—*Fagion* all. nov. (associations 15–17) in Hunan Province and in the northern part of Yunnan, South-Western China.

C-d. *Indocalamo latifolii*—*Fagion hayatae* var. *zhejiangensis* all. nov. (associations 18–19) in the Zhejiang Province, Eastern China.

C-a. *Abelio englerianae*—*Fagion* all. nov. (Run. no. 28–30)

Character species: *Rhododendron bricranthum*, *Prunus pilosiuscula*, *Euonymus giralddii*, *Calanthe fimbriata*, *Abelia engleriana*, *Quercus glandulifera*, *Acer laxiflorum*, *Holboellia fargesii*, *Epimedium sagittatum*, *Lonicera pseudoprotterantha*, *Ainsliaea triflora*, *Berberis dielsiana*.

Located at about 32–33°N and 106–107°E, Nanjiang is situated in northern Sichuan Province, and to the south of the mountains of Shaanxi Province. This is a relatively restricted territory at the north-western edge of China. In this area, forests dominated by *Fagus engleriana*, *Quercus glandulifera* and *Q. spinosa* grow in a mosaic pattern on the lower slopes of the mountains and along the rivers. Forests dominated by *Fagus lucida* grow mainly on the upper slopes, and *Fagus hayatae* ssp. *pashanica* occurs on the steep hills and mountain ridges. It is a characteristic of this area that these three species of beech inhabit different environments.

This area is situated in a relatively warm part of the Sichuan basin, but with relatively low rainfall (about 1,000 mm yearly). Deciduous species are the principal component of the tree layer (30 %) and in the shrub layer (20 %), whereas evergreen species occur with a lower presence (15 % and about 8 % respectively, cfr. Table 3.9); in the herb layer, hemicryptophytes and geophytes are prevailing.

This alliance contains the following two associations.

7. *Euonymo porphyrei*—*Fagetum englerianae* ass. nov. (Run. no. 28–29)

Character species: *Euonymus pourphyreus*, *Quercus spinosa*, *Acer ginnola*, *Rubus pungens*

Type relevé: Relevé reference, page 153–158: number SHI 9, Nanjan in Sichuan (Elevation 1,640 m).

This association (Figs. 2.23, 2.24, and 2.25) was observed in Nanjan in Sichuan Province between 31° 50' and 32° 45'N, and 106° 27' and 107° 10'E. The association, when growing around rivers, is often made up of *Fagus engleriana*. Under the particular ecological conditions of this community, *Fagus engleriana* grows, sprout from the root with multi-trunked individuals, with in general not over 40 cm in

Fig. 2.23 Landscape of *Fagus engleriana* forests in Nanjiang, northern Sichuan Province, China. They often distributes on the lower slopes and along the river



Fig. 2.24 Internal view of *Fagus engleriana* forest. *F. engleriana* has multiple trunks. On the forest floor often grow *Abelia dielsii*, *Viburnum betulifolium* and *Lonicera pseudoproterantha* (Nanjiang, Northern Sichuan Province)



Fig. 2.25 Leaves and cupules of *Fagus engleriana*. This species has thin and large leaves, and peduncles are long



diameter. In the mostly deciduous canopy, *Quercus glandulifera*, which is an evergreen species, grows among *Fagus engleriana*, and occasionally can expand as the dominant species in the arboreal layer. Although the middle layers are not well developed, the forest floor is dominated by deciduous flora such as *Abelia dielsii*, *Viburnum betulifolium* and *Lonicera pseudoproterantha*. On the upper slopes, *Fagus lucida* is mixed with *F. engleriana* in the canopy layer, and also *Quercus glandulifera* occasionally occurs. The forest floor is dominated by the shrub bamboo *Sinarundinaria nitida*. The relevés of this association can be ordered in two subassociations: typical subass. (Run. no. 28), also considered as *Carpinus polyneura* subassociation, and *Pedicularis nasturtifolia* subass. (Run. no. 29).

8. *Vaccinio henryi*-Fagetum *hayatae* subsp. *pashanicae* ass. nov. (Run. no. 30)

Character species: *Fagus hayatae* subsp. *pashanica*, *Rubus bambusarum*, *Hugeria vaccinioides*, *Vaccinium henryi*, *Daphniphyllum angustifolium*.

Type relevé: Relevé reference, page 153–158: number SHI 3, Nanjan in Sichuan Province (Elevation 1,450 m).

This association (Figs. 2.26, 2.27, and 2.28) was observed in Nanjan, Sichuan Province, between 31° 50' and 32° 45'N, 106° 27' and 107° 10'E. We decided to describe this forest type as *Vaccinio henryi*-Fagetum, a new syntaxon, because of the fact that in this case *Fagus hayatae* subsp. *pashanica* is dominant, something not previously reported. This association grows on the steep slopes of valleys, occasionally on precipitous slopes with rock-exposed surfaces. It often adjoins forests of *Pinus armandii*, and often it grows mixed with this species. The trunk of *F. hayatae* subsp. *pashanica* in the canopy layer of this forest communities is generally thin, reaching about 30–40 cm in diameter at the maximum, but the trees can reach 30 m in height. In the sub-canopy layer, the degree of dominance of *Rhododendron hypoglaucom* and *R. bricranthum* is high. The forest floor is not well developed. However, sometimes a sporadic and limited growth of *Sinarundinaria nitida* can be observed and evergreen trees such as *Eurya brevistyla* and *Quercus oxyodon* often occur together with deciduous species such as *Enkianthus chinensis* and *Lonicera ovalifolia* var. *elliptica*.

C-b. *Aceri davidii*—Fagion *lucidae* (Wang et al. 2005) (Run. no. 31–41)

Character species: *Quercus multinervis*, *Acer davidii*, *Lonicera japonica*, *Lithocarpus henryi*, *Enkianthus serrulatus*, *Carex filicina*, *Polygonatum cyrtoneura*, *Ainsliaea henryi*, *Acer flabellatum*, *Litsea pungens*, *Pterygocalyx volubilis*, *Rubus trianthus*, *Viola davidii*, *Mahonia japonica*, *Viburnum ichangense*.

This alliance, recorded by Wang et al. (2005), consists of forests dominated by species of the genus *Fagus*, intermittently distributed among evergreen-dominated forests in the mountainous areas; deciduous and evergreen trees are about with the same frequency (20 %) or deciduous are a feeble prevalence, see Table 3.1b. In the shrub layer, deciduous species are mostly prevailing.

The distribution ranges of the associations belonging to this alliance extend from 1,300 to 2,000 m above sea level. The beech forests in this region grow on the upper areas of the north side of steep slopes. In the associations making up this alliance, the canopy layer is always mixed with evergreen trees, and the ratio of beech trees in the canopy layer is highest in *Sinarundinaria nitida*-Fagetum *lucidae* distributed

Fig. 2.26 Landscape of *Fagus hayatae* subsp. *pashanica* forests in Nanjiang, Northern Sichuan Province, China. The forests grow on the steep slopes of valleys. On the ridge sometimes they grow together with *Pinus armandii*



Fig. 2.27 *Fagus hayatae* subsp. *pashanica* has thin and tall trunks. Sometimes it becomes 30 m in height with 30–40 cm in diameter. Forest floor contains *Rhododendron bricranthum* or *R. hypoglaucum*, but no scrub bamboos

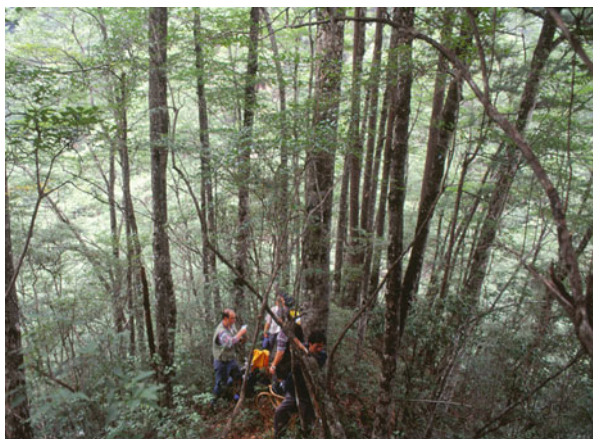


Fig. 2.28 The leaves of *Fagus hayatae* sub-species *pashanica* are quite small and slightly serrated. It looks very similar to *Fagus hayatae* in Taiwan



in Badagongshan, while it is somewhat lower in Sinarundinario bashersuto-Fagetum lucidae (Wang et al. 2005). In Sinarundinario chungii—Fagetum lucidae (Wang et al. 2005) distributed in Fanjingshan Natural Reserve and Kuankuoshui Natural Reserve in Guizhou Province, the ratio of evergreen broad-leaved trees is high in the sub-canopy and shrub layer, with the shrub layer often dominated by scrub bamboo such as *Sinarundinaria nitida* and *S. chungii*.

The associations belonging to this alliance are mostly distributed on quite rainy districts (annual rainfall 1,200–1,600 mm), with the exception of some aspects of Fagetum engleriano-lucidae, occurring in areas with lower rainfall.

9. Sinarundinario chungii—Fagetum lucidae (Wang et al. 2005) (Run. no. 31–33)

Character species: *Sinarundinaria chungii*, *Illicium simonsii*, *Rubus pacificus*, *Carex henryi*, *Carpinus pubescens*, *Celastrus rosthornianus* var. *loeseneri*, *Carex omeiensis*, *Rubus amphidasya*, *Aucuba obtusata*, *Athyrium strigillosum*, *Camellia rosthorniana*, *Selaginella labordei*.

Type relevé: Wang et al. (2005), Table 2, Relevé reference number 17, Fanjingshan Natural Reserve in Guizhou Province (Elevation 1,700 m).

This association (Figs. 2.29, 2.30, and 2.31) is defined in the data collected from the survey of *Fagus lucida* forests at 1,570–1,980 m in Fanjingshan Nature Reserve (27° 53'N, 108° 42'E) and at 1,460–1,710 m in Kuankuoshui Nature Reserve in Guizhou Province by Wang et al. (2005). According to Wang et al. (2005), this association develops on the steep hillsides in the northeast and on the middle to upper slopes, in the south of Fanjingshan Nature Reserve and Kuankuoshui Nature Reserve. The association table of the Sinarundinario chungii—Fagetum lucidae is composed of 27 relevés; of them, 10 relevés are the author's original data.

Under this association, there are three subassociations classified: typicum (Run. no. 31) that grows in the Fanjingshan Nature Reserve, whereas subass. actinodaphnetosum reticulatae (Run. no. 32), as well as subass. chimonobambusetosum (Run. no. 33) can be observed in the Kuankuoshui Nature Reserve.

The canopy layer in this association is dominated by the deciduous *Fagus lucida*. However, a mixture of evergreen trees such as *Quercus multinervis*, *Q. glauca* and *Rhododendron haofi* was often observed. As evergreen trees are observed in the canopy and sub-canopy layers, the association can be considered as a mixed forest of deciduous and evergreen broad-leaved species. The forest floor is densely covered by *Sinarundinaria chungii*.

10. Polypodium argutum—Fagetum longipetiolatae ass. nov. (Run. no. 34)

Character species: *Quercus engleriana*, *Castanopsis carlesii*, *Cymbidium sinense*, *Polypodium argutum*, *Lophatherum gracile*, *Leptogramma scallani*.

Type relevé: Relevé reference number FAN14, Fanjingshan Natural Reserve, Guizhou Province (Elevation 1,170 m).

This association (Figs. 2.32, 2.33, and 2.34), observed on the steep slopes between 900 and 1,300 m above sea level in Fanjingshan Nature Reserve in Guizhou Province, presents normally a structure, in which *Fagus longipetiolata* grows in the canopy layer together with evergreen broad-leaved species. In this association, a wide variety of species, mainly of evergreen flora, are observed in

Fig. 2.29 *Fagus lucida* forest (*Sinarundinario chungii*—*Fagetum lucidae*) at an elevation of 1,200 m in the Fanjingshan Nature Reserve in Guizhou Province, China. This association develops on the steep hillsides



Fig. 2.30 Internal view of *Fagus lucida* forests. The species usually has a single trunk. Sub-canopy layer is dominated by evergreen broad-leaved trees of *Quercus multinervis*, *Q. glauca* and *Rhododendron haofui*. Shrub layer is dominated by *Sinarundinaria chungii*



Fig. 2.31 *Fagus lucida* has serrate, thick and glossy leaves. Peduncles are short and seeds are small



Fig. 2.32 Landscape of *Fagus longipetiolata* forests of Fanjinshan Nature Reserve in Puizhou Province, China



Fig. 2.33 Internal view of *Fagus longipetiolata* forest of Fanjinshan Nature Reserve in Puizhou Province, China. Sub-canopy layer is dominated by evergreen broad-leaved trees. The shrub layer is dominated by *Symplocos botryantha* and the herb layer is dominated by *Elatostema stewardii*



Fig. 2.34 In *Fagus longipetiolata*, the leaves are large and peduncles are long



each layer: the shrub layer is dominated by *Symplocos botryanta* and the herb layer is dominated by *Elatostema stewardii*. As the elevation increases, *Fagus longipetiolata* in the canopy layer of this association is progressively replaced by *Fagus lucida*. The floristic composition of the association also changes, and the association is often occurring in aspects of transition to the Sinarundinario chungii—Fagetum lucidae (Wang et al. 2005). On the other hand, deciduous trees disappear at lower elevations, and evergreen flora such as *Castanopsis platyacantha* and *Lithocarpus cleistocarpus* var. *omeiensis*, expand as dominant species, with the transition to an evergreen broad-leaved forest.

11. Sinarundinario bashersuto-Fagetum lucidae (Wang et al. 2005) (Run. no. 35–36)

Character species: *Eurya loquaiana*, *Clethra fabri*, *Cinnamomum bodinieri*, *Callicarpa brevipes*, *Ardisia affinis*, *Erythroxylum kunthianum*, *Fordiophyton faberi*, *Indosasa shibataeoides*, *Dioscorea batatas*, *Sinarundinaria bashersuta*, *Rubus alceaefolius*, *Viburnum foetidum* var. *rectangulatum*, *Rhaphiolepis indica*, *Quercus bambusaefolia*, *Manglietia fordiana*, *Rhododendron haofui*, *Castanopsis eyrei*, *Disporum cantoniense*, *Oreocharis benthamii* var. *reticulata*, *Ternstroemia kwangtungensis*, *Phellodendron chinense*.

Type relevé: Wang et al. (2005), Table 2, Relevé reference number 7, Nanshan Nature Reserve, Hunan Province (Elevation 1,760 m)

This association was recorded from the data collected by Wang et al. (2005) in Nanshan (26° 7'N, 110° 8'E) in Hunan Province, located on the border of Guangxi Province. The authors designated the following species as character species: *Sinarundinaria bashersuta*, *Clethra fabri*, *Erythroxylum kunthianum*, *Indosasa shibataeoides*, *Manglietia fordiana*, *Dioscorea batatas*, *Fordiophyton faberi*, *Rubus alceaefolius* and *Callicarpa brevipes*. In our study, we classified all of these species as character species of the association except *Actinidia kolomikta*. In addition, we added a wide variety of species as character species, such as *Eurya loquaiana* and *Cinnamomum bodinieri*. In Nanshan, according to Wang et al. (2005), forests of *Fagus lucida* develop on the summit of the mountains and the upper parts of the northeastern slopes at elevations of around of 1,690–1,830 m. The association includes two subassociations: *symplocetosum lancifoliae* (Run. no. 35), and *torricellietosum tiliifoliae* (Run. no. 36).

In this association, also according to Wang et al. (2005), *Fagus lucida* dominates the canopy layer. Mixed with deciduous species such as *Liquidambar formosana*, *Acer sinense* and *Sorbus folgneri* and evergreen trees such as *Quercus multinervis*, *Q. bambusaefolia*, *Castanopsis eyrei*, *Manglietia fordiana* and *Rhododendron indica*, it forms a mixed evergreen-deciduous forest. Evergreen trees prevail in the sub-canopy layer, and the shrub layer is densely covered by *Sinarundinaria bashersuta* and *Indosasa shibataeoides*. Many *F. lucida* saplings are also observed. In the herb layer, many evergreen ferns such as *Athyrium strigillosum* and *Allantodia wichuriae* are present.

12. Fagetum engleriano-lucidiae (Wang et al. 2005) (Run. no. 37–38)

Character species: *Abelia macrotera*, *Euonymus alatus*, *Aster ageratoides*, *Carex capilliformis*, *Carex sendaica*, *Quercus aliena* var. *acutidentata*, *Quercus*

serrata var. *brevipetiolata*, *Platycarya strobilacea*, *Adenophora hunanensis*, *Philadelphus incanus*.

Type relevé: Wang et al. (2005), Table 2, Relevé reference number 40, Dalaoling Nature Reserve, Hubei Province (Elevation 1,758 m).

Wang et al. (2005) conducted a survey of the beech forests in this association at the following locations and recorded the association, *Fagetum engleriano-lucidae* (Wang et al. 2005): 1,310–1,780 m in Dalaoling Nature Reserve (31° 2'N, 110° 54'E), 1,620–1,800 m in Longmenhe Nature Reserve (31° 18'N, 110° 29'E), 1,640 m in Houhe Nature Reserve (30° 6'N, 110° 32'E), and 1,330–1,450 m in Baotianmann Nature Reserve (33° 30'N, 111° 55'E) in Henan Province. In this study, we were able to identify all of the associations by their floristic compositions and characteristics, except the data for the Houhe Nature Reserve.

Wang et al. (2005) designated the following species as character species of the association: *Viola selkirkii*, *Fagus engleriana*, *Euonymus alatus*, *Carex siderosticta*, *C. sendaica*, *Abelia macrotera* and *Aster ageratoides*. However, in our study *Viola selkirkii*, *Fagus engleriana*, *Euonymus alatus* and *Carex siderosticta* cannot be considered as character species. Instead, many other species have been added as character species of the association. Under this association, there are two subassociations: *carpinetosum cordatae* var. *chinensis* seen in Dalaoling Nature Reserve and Longmenhe Nature Reserve, and *carpinetosum turczaninowii*, which occurs in Baotianmann Nature Reserve.

In this association, *Fagus engleriana* and *F. luchida* are mixed in the canopy layer, and deciduous trees such as *Castanea henryi*, *Quercus aliena* var. *acutidentata*, *Carpinus cordata* var. *chinensis* and *Sorbus folgneri* often dominate. In the sub-canopy layer, many *Rhododendron* species grow, and in the shrub layer the degree of dominance by *Fagus engleriana*, and *Dendrobenthamia japonica*, as well as by evergreen species such as *Rhododendron hypoglauca* and *Quercus multinervis*, is high. The dominance of scrub bamboo is low.

13. *Elatostemo sessile*—*Fagetum lucidae* ass. nov. (Run. no. 39)

Character species: *Phoebe sheareri*, *Cercis chinensis*, *Elatostema sessile*, *Saxifraga stolonifera*, *Aesculus wilsonii*, *Bletilla striata*, *Disporopsis pernyi*, *Primula ovalifolia*, *Zingiber mioga*, *Toona ciliata*, *Trachelospermum jasminoides*, *Phoebe neurantha*.

Type relevé: Wang et al. (2005), Table 2, Relevé reference number 30, Dalaoling Nature Reserve, Hubei Province (Elevation 1,758 m).

Wang et al. (2005) recorded *Fagetum engleriano-lucidae* (Wang et al. 2005) in the widespread beech forests in the Dalaoling Nature Reserve, Longmenhe Nature Reserve and Houhe Nature Reserve in Hubei Province, and in the Baotianman Nature Reserve in Hunan Province. However, in the present study, the data for Houhe Nature Reserve contained compositional characteristics as well as a large number of distinctive species, so it was necessary to include it under another association. This association was not used for beech forests other than those described in the data for Houhe Nature Reserve, making this reserve newly independent.

Based on Wang et al. (2005), this association is distributed over a small area at the northern limit of the Chinese beech forests, forming a small island stretching from the northeast to the northwest slopes of the Houhe Nature Reserve. Together with *Fagus engleriana*, the tree canopy consists mainly of deciduous species *Quercus glandulifera* var. *brevipetiolata*, *Q. aliena* var. *acutidentata* and *Carpinus turczaninowii*, with occasional conifers *Pinus tabulaeformis* and *Tsuga chinensis*. The sub-canopy layer is not well developed. The development of the shrub layer varies, but *Lindera obtusiloba* and *Cercis chinensis* are conspicuous. The herb layer has high frequency of *Carex capilliformis*, *Maianthemum bifolium*, *Ophiorrhiza japonica*, *Elatostema sessile*, *Saxifraga stolonifera*, *Disporopsis pernyi* and *Zingiber mioga*.

14. Sinarundinario nitidae-Fagetum lucidae (Wang et al. 2005) (Run. no. 40–41)

Character species: *Hedera nepalensis*.

Type relevé: Wang et al. (2005), Table 2, Relevé reference number 32, Badagongshan Nature Reserve, Hunan Province (Elevation 1,460 m).

According to Wang et al. (2005), *Sinarundinaria nitida*, *Lithocarpus* sp. *Rubus buergeri* and *Sarcopyramis bodinieri* were proposed as the character species for this association in the northern region of Hunan province and Badagongshan Nature Reserve on the border of Hunan and Hubei Province (29° 46'N, 110° 4'E). Its distribution is centered on slopes of 30–48° at an elevation of 1,430–1,600 m. Of the species indicated by Wang et al. (2005), in this study we demonstrate that *Rubus buergeri* has to be considered as character species for the class, *Sinarundinaria nitida* is a character species for the order, and *Sarcopyramis bodinieri* is indicated as the differential species for the subassociation. In the present study, we found that the only character species, *Hedera nepalensis*, had low constancy. From this, it can be said that the association demonstrates the properties of a typical association, showing the characteristics of the *Abelio englerianae*—*Fagion* all. nov. alliance. We consider this association to be essentially a *symplocetosum crassifoliae* subassociation, and Wang et al. (2005) divided this association into two subassociations; *typicum* and *symplocetosum crassifoliae*.

Again according to Wang et al. (2005), the dominance of *F. lucida* in the canopy layer in this association is high, with a mixture of the deciduous *Sorbus folgeneri* and *Betula insignis*, and the evergreen *Quercus gracilis* and *Q. multinervis*. The sub-canopy layer, shows little dominance of the deciduous species, with the evergreen species *Q. multinervis*, *Symplocos anomala*, *Eurya muricata*, *Camellia caudata* and *C. pitardii* frequently appearing. *Sinarundinaria nitida* are scattered among the shrub layer with little dominance, while deciduous species are dominant in the herb layer.

C-c. Qiongzheo tumidinodae—Fagion all. nov. (Run. no. 42–44)

Character species: *Castanopsis platyacantha*, *Qiongzheo tumidinoda*, *Allantodia hirtipes*, *Camellia grijsii*, *Ilex intermedia* var. *fangli*, *Rubus chroosepalus*, *Rhododendron hypoglaucum*, *Acanthopanax evodiaefolius* var. *gracilis*, *Viburnum willeianum*, *Stranvaesia amphidoxa*.

This alliance consists of the three associations distributed in Sanjiangkou Nature Reserve in Dagan County, Yunnan Province, Xiaoqiao Nature Reserve in south-eastern Yunnan Province and on Mt. Daixue in Weixin County in northeastern Yunnan Province, between 1,600 and 2,400 m elevation. An important feature of the associations included in this alliance is the clear dominance of evergreen tree species over the deciduous ones (25–16 %, see in Table 3.9). Other characteristics are the elevated presence of climbers (15 %) and in the herb layer the presence of rhizome-geophytes (about 23 %). As to the climate, it has to be pointed out that the associations of this alliance occur on mountain ranges with relatively low rainfall, hardly reaching 1,000 mm in the year.

15. *Sinocalamus giganteus*—*Fagetum lucidae* ass. nov. (Run. no. 42)

Character species: *Galium asperuloides* var. *hoffmeisteris*, *Sinocalamus giganteus*, *Eurya semisenullata*, *Carpinus fangiana*, *Symplocos ramosissima*, *Allantodia squamigera*, *Microlepis marginata*, *Ligustrum delavayanum*, *Eurya graffi*, *Hydrangea xanthoneura*, *Arachniodes pseudo-aristata*, *Spatholirion longifolium*, *Acer proliferum*.

Type relevé: Relevé reference, page 159–167: number YUN2, Sanjiangkou Nature Reserve, Hunan Province (Elevation 1,780 m).

This association is known for the Sanjiangkou Nature Reserve in Dagan County, Yunnan Province (28° 10'N, 103° 58'E) at an elevation of between 1,800 and 2,400 m, and distribution is limited to the ridges and upper slopes. The vertical structure of this association is composed of mainly deciduous species in the upper layers, with a large increase in the proportion of evergreen species as moving down to the lower layers. *Fagus lucida* is dominant in the canopy layer, although a mixture of *Lithocarpus cleistocarpus*, *Acer proliferum*, *Castanopsis platyacantha*, *Acanthopanax evodiaefolius* and other species has also been observed. The sub-canopy layer is poorly developed. The shrub layer is dominated by *Sinocalamus giganteus*, although evergreen shrubs, such as *Symplocos botryantha*, *S. ramosissima* and *Eurya semisenullata*, grow in profusion. The herb layer is also poorly developed, although there are many evergreen pteridophytes including *Polystichum makinoi* and *Plagiogyria stenoptera*.

16. *Viburno flavescentis*—*Fagetum englerianae* ass. nov. (Run. no. 43)

Character species: *Sorbus sargentiana*, *Toxicodendron radicans* var. *hispidus*, *Lepisorus bicolor*, *Neolitsea chunii*, *Dichroa febrifuga*, *Athyrium delavayi*, *Polypodiastrium dielsianum*, *Davidia involucreata* var. *vilmoriniana*, *Dendrobenthamia melanotricha*, *Viburnum flavescentis*, *Phyllagathis longipes*, *Smilacina yunnanensis*, *Schizophragma hypoleuca*, *Smilax opaca*.

Type relevé: Wu et al. (1987), Table 8-15, Relevé reference, page 159–167: number 1, Mt. Daixue, Weixin County, Yunnan Province (Elevation 1,700 m).

This plant community, studied by Wu et al. (1987) at Mt. Daixue, Weixin County, in northwestern Hunan Province (27° 40'N, 104° 52'E) at an elevation of 1,600–1,800 m, is recorded to consist of *Castanopsis platyacantha*, *Fagus engleriana*, and *Litsea chunii* comm. The forest structure largely corresponds to an old growth condition. The canopy layer consists of a mixture of the evergreen *Castanopsis platyacantha* and *Machillus ichangensis*, and deciduous trees as *Fagus*

engleriana and *Acer oliverianum*, to give the appearance of a mixed forest of evergreen and deciduous species. The sub-canopy layer has extremely few deciduous trees, with evergreen species such as *Neolitsea chunii*, *Symplocos paniculata* and *Camellia grijsii* being dominant. The shrub layer is poorly developed, with the sometimes dominant scrub bamboo *Qiongzhusa tumidinoda* mixed with *Dichroa febrifuga* and *Viburnum flavescens*. Evergreen pteridophytes, including *Allantodia hirtipes*, *Athyrium delavayi* and *Plagiogyria stenopteria*, are dominant in the herb layer.

17. Tripterospermo cordifolium—Fagetum englerianae ass. nov. (Run. no. 44)

Character species: *Schima crenata*, *Lindera subcaudata* var. *hemsleyana*, *Neolitsea chinensis*, *Panicum brevifolium*, *Manglietia duclouxii*, *TripterospERMUM cordifolium*, *Sorbus coronata*, *Microsorium buergerianum*, *Ophiopogon bockianus*, *Elatostema lineolatum*, *Evodia rutaecarpa* var. *bodinierii*, *Hydrangea yunnanensis*, *Holboellia angustifolia*, *Betula albo-sinensis*, *Eurya handel-mazzettii*, *Symplocos discolor*, *Smilax lebrunii*, *Euonymus leclerei*, *Skimmia arborescens*, *Athyrium epirachis*, *Actinidia vitifolia*.

Type relevé: Wu et al. (1987), Table 8-14, Relevé reference, page 159–167: number 7, Sanjiankou Nature Reserve in Daguan County, Hunan Province (Elevation 1,640 m).

This association was reported as *Castanopsis platyacantha*, *Schima crenata* and *Eurya brevistyla* by Wu et al. (1987). It exists as moist alpine evergreen broad-leaved forests in Sanjiankou Nature Reserve in Daguan County, Hunan Province (28° 10'N, 103° 58'E) and Suijan County at elevations of 1,600–2,000 m. The location consists of steep slopes with a gradient of 30–40°. The uneven crowns in the canopy with a mixture of deciduous species, *Fagus engleriana* and *Acer oliverianum*, growing together with the dominant evergreens *Castanopsis platyacantha*, *Schima crenata* and *Machilus ichangensis*. Evergreen species, such as *Eurya brevistyla*, *Ilex intermedia* var. *fangii*, *Neolitsea chinensis* and *Symplocos caudata*, are common in the sub-canopy layer. The shrub layer is often dominated by the scrub bamboo species *Qiongzhusa humidinoda*. The herb layer is poorly developed, although evergreen pteridophytes, including *Allantodia hirtipes* and *Plagiogyria stenopteria*, are dominant.

C-d. Indocalamo latifolii—Fagion hayatae var. zhejiangensis all. nov. (Run. no. 45–46)

Character species: *Fagus hayatae* var. *zhejiangensis*, *Indocalamus latifolius*, *Toxicodendron trichocarpa*, *Quercus nubium*, *TripterospERMUM chinense*, *Ainsliaea macroclinidioides*, *Eurya rubiginosa* var. *attenuata*, *Magnolia cylindrica*, *Rhododendron ovatum*, *Dioscorea bulbifera*, *Albizia kalkora*, *Liriope graminifolia*, *Acer elegantulum*, *Photinia parvifolia*, *Smilax nervo-marginata*.

This alliance includes the beech forests of Zhejiang Province in China, characterized by *F. hayatae* Palib. ex Hayata var. *zhejiangensis* Liu M.C. et Wu M.H., which is endemic in this territory (the nominal variety *F. hayatae* Palib. ex Hayata var. *hayatae* occurs in Taiwan, cfr. ass. 20). This vegetation was described by Wang and Fujiwara (2003) as an *Indocalamus latifolius-Fagus hayatae* community, divided into *Pieris japonica* and *Lyonia ovalifolia* subunits. The authors have

not indicated the Latin association name or type relevé. Consequently, *Indocalamus latifolius-Fagus hayatae* community can not be considered a validly published association. As a matter of fact, the two subunits are described for different localities (Qingliangfeng Nature Reserve and Sihaishan Nature Reserve, respectively). In addition, they differ from one another in more than 20 differential species. In our opinion, considering the differences among beech associations in other areas of China, these two subunits should be considered different associations. As to the nomenclatural problems, we propose to save the original formulation by Wang and Fujiwara (2003) for one of these new associations (19), because this corresponds to the subunit, where *Indocalamus latifolius* occurs with higher frequency. For the other association (18) the name is derived from *Carex lanceolata* (which occurs only in this type of beech forest) instead of the widespread *Pieris japonica*.

The two associations included in this alliance are described for mountain ranges not far away from the coast of the Chinese Sea. The climate is relatively fresh (11–13 °C in 1,000 m elevation) and humid, with 1,700–1,800 mm rainfall (Table 3.5). In contrast with the previous alliances, here the deciduous species are prevailing (32 % and 23 %) over the evergreen (16 % and 17 %) in the tree layer as well as in the shrub layer (Table 3.9).

18. *Carici lanceolatae*—Fagetum *hayatae* var. *zhejiangensis* ass. nov. lim. (Hukusima et al. 2001) (Run. no. 45).

Character species: *Carex lanceolata*, *Schisandra henryi*, *Viola rossii*, *Callicarpa giraldii*, *Meliosma myriantha* var. *discolor*, *Viburnum hengshenicum*, *Aster procerus*, *Picrasma quassioides*, *Liquidambar acalycina*, *Eurya hebeclados*.

Type relevé: Wang and Fujiwara (2003), Table 2, Reference number 6. We were not able to indicate the type relevé, because in the literature only a synoptic table exists.

Wang and Fujiwara (2003) reported data for this plant community from three study districts on the steep upper slopes, between 970 and 1,040 m, of the Qingliangfeng Nature Reserve in Zhejiang Province (30° 6'N, 118° 53'E). The *Pieris japonica* subunit of the *Indocalamus latifolius-Fagus hayatae* community was recorded by Wang and Fujiwara (2003) in these districts. The results of the present study revealed that this community possessed the abovementioned character species as well as species peculiar to it, allowing it to be differentiated from other beech forests. However, we cannot indicate a type relevé as the original data provided in Wang and Fujiwara (2003) consist only of a synoptic table with frequency results, without the detailed cover values for the single relevés.

Many of the character species in this association are the differential species for the subassociation in Wang and Fujiwara (2003). They described the canopy layer to be dominated by the deciduous *Fagus hayatae* var. *zhejiangensis*, although *Schima superba* is sometimes observed in that layer. Development of the sub-canopy layer below the canopy is poor, with *Pieris japonica* dominant in the sub-canopy and shrub layers. The scrub bamboo *Indocalamus latifolius* grows in the shrub layer with low coverage. Many species are present in the herb layer, though none is clearly dominant. Unlike other beech forests, *Fagus hayatae* var.

zhejiangensis saplings and seedlings are often observed, indicating steady regeneration of the community.

19. *Indocalamus latifolii*-Fagetum *hayatae* var. *zhejiangensis* (Wang and Fujiwara 2003 lim. Hukusima et al. 2001) (Run. no. 46)

Character species: *Lyonia ovalifolia*, *Abelia dielsii*, *Carex chinensis*, *Polygonatum sibiricum*, *Smilax austro-zhejiangensis*, *Calamagrostis arundinacea* var. *ciliata*, *Photinia paniculata*, *Lithocarpus harlandii*, *Prunus serrulata*, *Indigofera nigrescens*, *Bredia amoena*, *Ilex ficoidea*, *Ilex triflora*, *Spiraea chinensis*, *Itea chinensis* var. *oblonga*, *Rubus corchorifolius*, *Quercus fabri*, *Diplazium pinfaense*.

Type relevé: Wang and Fujiwara (2003), Table 2, Reference number 7. Like in the previous association, we are not able to indicate the type relevé, because in the original description only a synoptic table is given.

This association was studied by Wang and Fujiwara (2003) in the Sihaisan nature reserve in Zhejiang Province (28° 30'N, 120° 43'E). They made four relevés at elevations between 900 and 960 m, and the *Lyonia ovalifolia* subunit of the *Indocalamus latifolius*-*Fagus hayatae* community was recorded. In the present study, we took the differential species of the lower units presented in Wang and Fujiwara (2003) as the abovementioned character species. Basing on the species composition, this unit appear quite independent from one another and consequently we concluded that the association level is more adequate for this plant communities so that we propose this one as a distinct association. However, we cannot indicate a type relevé as only frequency results and not the original data are provided in Wang and Fujiwara (2003).

A distinctive characteristic of this association is the large number of species, such as *Fagus hayatae* var. *zhejiangensis* and *Toxicodendron trichocarpa*, in the canopy layer, and dominated by deciduous species. Evergreen species are dominant in the shrub and herb layers. *Indocalamus latifolius* is dominant on the shrub layer. Unlike other plant communities, *Fagus hayatae* var. *zhejiangensis* saplings and seedlings are plentiful, indicating healthy regeneration of the community.

2.3.2 D. Fagetalia *hayatae* (Hukusima et al. 2005) (Run. No. 47–48)

Character species: *Fagus hayatae* var. *hayatae*, *Neolitsea acuminatissima*, *Yushania nitakayamensis*, *Stauntonia purpurea*, *Elatostema trilobulatum*, *Crypsinus echinosporus*, *Rubus shinkoensis*, *Schizophragma integrifolium* var. *formosana*, *Camellia tenuifolia*, *Dryopteris formosana*, *Acrophorus stipellatus*, *Plagiogyria formosana*, *Quercus sessilifolia*, *Illicium tashiroi*, *Smilax elongato-reticulata*, *Osmanthus heterophyllus*, *Pourthiaea villosa* var. *parvifolia*, *Viburnum luzonicum*, *Tripterospermum lanceolata*, *Coptis quinquefolia*, *Eurya leptophylla*, *Rhododendron formosanum*, *Smilax elongato-umbellata*, *Loxogramme remote-frondigera*, *Damnacanthus angustifolius*, *Ardisia brevicaulis*, *Trochodendron aralioides*, *Polypodium amoenum*, *Pieris taiwanensis*, *Selaginella remotifolia*, *Viola formosana* var. *formosana*, *Euonymus spraguei*, *Cremastra appendiculata*.

Fig. 2.35 Landscape of the *Fagus hayatae* forests in Tungshan, Taiwan. The beech forests are only distributed in the north-east part of the island, and usually grow above an elevation of 1,300 m



The distribution of *Fagus hayatae* in Taiwan is extremely limited, being restricted to the north-eastern part of the island (24° 30'N, 121° 37'E) (Hsieh 1989). Within this region, the species has been reported to grow in the Mt. Lala Nature Reserve, which extends from Mt. Lalashan (2,030 m) in the south to Mt. Chulushan (1,366 m) in the north, and the Mt. Tungshan area, a mountain 25 km southeast of Mt. Lalashan. On these mountains, beech forests are mainly located on the ridges at elevations between 1,300 and 2,000 m.

Fagus hayatae forests (Figs. 2.35, 2.36, 2.37, 2.38, and 2.39) are envisaged to have had a lower elevation limit and wider distribution at the time of the last glacial peak about 20,000 years ago. However, the following climatic warming has led to the shrinkage of their distribution to the current range. Therefore, *F. hayatae* forests in Taiwan are considered relict forests, and their conservation value is high.

The authors undertook a study in Taiwan and redesignated the Yushanio-Fagetum hayatae (Suz.-Tok.) ex Hukusima et al. (2005) association, which includes two subassociations, and the Fagion hayatae (Suz.-Tok.) ex Hukusima et al. (2005) alliance. We also newly reported the order Fagetalia hayatae (Hukusima et al. 2005).

This order includes only the following alliance.

D-a. Fagion hayatae Suz.-Tok. ex Hukusima et al. 2005 (Run. no. 47–48)

Character species: The character species are the same as the order character species.

In Taiwan, only one phytosociological study on *F. hayatae* forests has been performed until present: Suzuki (1954) described and reported the association Indocalameto-Fagetum hayatae (Suzuki 1954) and the alliance Fagion hayatae (Suzuki 1954) in Mt. Lala, northern Taiwan. However, the cited study is incomplete since Suzuki was unable to present vegetation tables, due to the loss of his original data set during World War II. Therefore, he described the association and alliance by referring to incomplete notes. An ecological study of vegetation in *F. hayatae* forests by Hsieh (1989) clarified the forest physiognomy, structure, and floristic composition. He classified the vegetation types into three subgroups using cluster analysis, and suggested that the differences in vegetation types are primarily related to elevation.

Fig. 2.36 Internal view of the *Fagus hayatae* forest in Tungshan. Evergreen broad-leaved trees are regularly dominant in the sub-canopy layer. The dwarf bamboo *Yushania nitakayamensis* is growing in the shrub layer



Fig. 2.37 The *F. hayatae* forest of Mt. Peichatienshan in Taiwan. The beech usually grow only on the ridge tops, and they are no more than 12 m in height, forming relatively stunted shape



Fig. 2.38 There are large beech trees growing in Tungshan. A single tree, with the trunk of 123 cm diameter. Many epiphytes are growing on the trees due to high humidity



Fig. 2.39 *Fagus hayatae* has very small leaves with clearly serrated margin. Their cupules are very small



This alliance includes only the following association.

20. Yushanio-Fagetum hayatae Suz.-Tok. ex Hukusima et al. 2005 (Run. no. 47–48)

Character species: The character species are the same as the order character species.

Type relevé: Hukusima et al. (2005), Table 3, Relevé reference number TU1, Mt. Tungshan (Elevation 1,790 m).

F. hayatae forests are all growing in the vicinity of evergreen-broadleaved forests. Floristic comparison with the evergreen-broad-leaved forests in Mt. Lopeishan (Oono et al. 1997) revealed that of the 160 total species recorded in the *F. hayatae* forests, there are 29 evergreen species (18 %) are commonly found in evergreen-broadleaved forests. This means that *F. hayatae* forests share a relatively small number of species in common with the adjacent evergreen broad-leaved forests.

The feature of the *F. hayatae* forests is that *F. hayatae* is always dominant in the canopy layer, and evergreen *Quercus* species rarely share the canopy. Evergreen trees are regularly dominant in the sub-canopy layer, and scrub bamboo, *Yushania niitakayamensis*, is dominant in the shrub layer. The herb layer is dominated by *Dryopteris formosana* or *Elatostema* species.

The climate in the Taiwanese beech forest is warm-humid of the subtropical type: in fact, these mountains are close to the Tropic of Cancer. Temperature in 1,000 m elevation is 17 °C, the highest one recorded for the associations included in the class Litseo elongatae-Fagetea; yearly rainfall reaches 2,663 mm.

2.4 III. Class of Evergreen-Broadleaved Forests (Class Name and Definition Are Still Undecided)

The plant communities below described occur in evergreen broad-leaved forests largely distributed over the mountainous areas of southeastern Hunan Province; our relevés were carried out in mountain areas of the southern Yunnan Province. These

forests consist primarily of populations of *Fagus longipetiolata* mixed with few deciduous species. In general composition indeed, evergreen flora is largely dominant in each forest layer (more than 47 % in the tree layer and 11 % in the shrub layer) (Table 3.1b). The studied forests develop at elevations of 1,440–1,800 m. Vegetation of this class has probably a large diffusion in the southern mountainous ranges of South China, outside of the area occupied by the *Fagus* species.

This class includes at least one order (still to be described).

2.4.1 E. Order of Evergreen-Broadleaved Forests (Order Name and Definition Are Still Undecided)

E-a. Ardisio hypargyreae—Castanopsis fabrii all. nov. (Run. no. 49–51)

Character species: *Polygala tricornis*, *Ardisia hypargyrea*, *Symplocos glandulifera*, *Smilax granulicaulis*, *Cinnamomum burmannii*, *Castanopsis fabrii*, *Lasianthus biermannii*, *Acer wilsonii*, *Euonymus mengtzeunus*, *Chimonobambusa utilis*, *Elatostema papillosum*, *Lithocarpus megalophyllus*.

This alliance is proposed as the syntaxon including evergreen broad-leaved forests with the presence of *Fagus* species, which were investigated in the Yunnan province, at subtropical latitudes (ca. 23°N). These *Fagus* forests fundamentally differ from the beech forests belonging to the class Litseo elongatae-Fagetalia sp. div. cl. nov., and to the order Sinarundinario nitidae—Fagetalia sp. div., which are widespread in several Chinese provinces at higher latitudes, as deciduous beech forests. In fact, the majority of the species composing the communities of the Ardisio hypargyreae—Castanopsis fabrii belong to the evergreen flora and these forests are interspersed with only a few species of the deciduous flora typically found in the more northern beech forests. Therefore, this vegetation should be clearly regarded as a different class, order and alliance. However, species of the genus *Fagus* are included in the canopy layer, occasionally with high dominance; therefore, we provisionally propose it as an association and alliance in this still undescribed different class and order characteristic of the South-Chinese evergreen broad-leaved forests. From compositional estimations, the physiognomy of this plant community mostly fits with that of evergreen broad-leaved forests. Structurally, *Lithocarpus naiadarum* is dominant in the canopy layer, growing together with a mixture of *Castanopsis* and *Cyclobalanopsis* species as well as *F. longipetiolata* in two different associations.

The associations belonging to this alliance develop in a subtropical mountain climate, warm and subhumid: temperatures in 1,000 m elevation are over 19 °C, with yearly rainfall of 1,200–1,300 mm. In the tree layer the evergreen species are strongly prevailing (45–47 % to 7–9 % of deciduous species); also in the shrub layer evergreen species are prevailing, but there the situation is more balanced. Between herbs, the highest frequency (19 %) is reached by rhizome-geophytes, mainly ferns.

21. Prismatomerio henryi—Lithocarpum naiadari ass. nov. (Run. no. 49–50)

Character species: *Lithocarpus naiadarum*, *Acanthopanax evodiaefolius* var. *pseudoevodiaefolius*, *Castanopsis calathiformis*, *Machilus kurzii*, *Nyssa javanica*, *Parakmeria yunnanensis*, *Lithocarpus truncatus*, *Quercus chapaensis*, *Elaeocarpus javanicus*, *Adinandra wangii*, *Castanopsis rufotomentosa*, *Rhododendron macrocarpum*, *Schima villosa*, *Manglietia rufibarbata*, *Albizia turgida*, *Prismatomeris henryi*, *Itea chinensis*, *Eriobotrya bengalensis*, *Lindera metcalfiana*, *Meliosma sichouensis*, *Beilschmiedia robusta*, *Osmanthus corymbosus*, *Eurya trichocarpa*, *Camellia forrestii*, *Lithocarpus dealbatus*, *Gomphandra tetrandra*, *Illicium yunnanensis*, *Sloanea elegans*, *Lasianthus longicaudus*, *Schefflera producta*, *Euonymus forbesianus*, *Parathelypteris hirsutipes*, *Asplenium normale*, *Ophiopogon clavatus*, *Athyrium malipoense*, *Sarcandra hainanensis*, *Kadsura heteroclita*, *Fissistigma acuminatissimum*, *Neolitsea levinei*, *Alpinia chinensis*, *Pyrrosia lingua*, *Piper* cfr. *flaviiflorum*, *Vittaria yunnanensis*.

Type relevé: Wu et al. (1987), Table 8-5, Relevé reference number 3, Mt. Caoguoshan in Xichou County, Wenshan Zhuang, in southern Yunnan Province (Elevation 1,800 m).

This plant community was reported by Wu et al. (1987) at Mt. Caoguoshan in Xichou County, Wenshan Zhuang, in southern Yunnan Province as *Lithocarpus naidarum*, *Acanthopanax evodiaefolius* var. *pseudoevodiaefolius*, and *Fagus longipetiolata* Comm. We selected the study districts that included *Fagus* species (Run. no. 1–3, 4–11) from Table 8-5 in Wu et al. (1987) for our study. These data consist in the principal species of constancy level III or above within a 400 m² area. Although this species list remains incomplete, the following two plant communities can be clearly defined, from the differences in species composition.

This plant community is distributed in a primeval condition over the hills around Mt. Caoguoshan in Xichou County, Wenshan Zhuang at an elevation of 1,500–1,850 m. Many taxa of the families Fagaceae and Lauraceae (at the species and variety levels) are most abundant, followed by those of Theaceae and Magnoliaceae. In addition, Araliaceae, Elaeocarpaceae, Symplocaceae and other subtropical evergreen broad-leaved forest species are recorded. The forests layers are structurally well developed, with three upper tree layers, a shrub layer and a herb layer.

The upper canopy layer is composed of *Lithocarpus naiadarum*, *Acanthopanax evodiaefolius* var. *pseudoevodiaefolius*, *Fagus longipetiolata*, *Castanopsis calathiformis*, *Machilus kurzii*, *Nyssa javanica*, and *Parakmeria yunnanensis*. The middle canopy layer consists of *Magnolia rufibarbata*, *Cinnamomum burmannii*, *Albizia turgida*, and *Itea chinensis*. The sub-canopy layer consists of *Lindera metcalfiana*, *Meliosma sichouensis*, *Neolitsea levinei* and *Camellia forrestii*, which grow at high densities. In the shrub layer, scrub bamboo (*Chinanobambusa* sp.) is extremely dominant. The herb layer is luxurious and heterogeneous in nature, with evergreen Liliaceae of *Ophiopogon* spp. and evergreen pteridophytes such as *Allantodia metterums* and *Parathelypteris hirsuta* growing in profusion.

This plant community is divided into two subassociations with different compositions: typicum (Run. no. 49) and *Plagiogyria maxima* subass. (Run. no. 50).

22. *Athyrio nardii*—*Michelietum balansae* ass. nov. (Run. no. 51)

Character species: *Allantodia petri*, *Cylindrokelupha balansae*, *Michelia balansae*, *Schefflera bodinieri*, *Acanthopanax giraldii*, *Athyrium nardii*, *Globba barthei*, *Michelia yunnanensis*, *Dryopteris livida*, *Machilus salicina*, *Parkmeria yunnanensis*, *Lithocarpus carolinae*, *Liparis japonica*, *Dendropanax macrocarpus*, *Carex perakensis*, *Canthium simile*, *Calamus oxycarpus*, *Asplenium unilaterale*, *Schima argentea*, *Symplocos adenophylla*.

Type relevé: Unpublished data.

This association is found at an elevation of 1,700 m in the area of the Xiaoqiao Nature Reserve in Xichou County in Yunnan province (23° 35'N, 105°E). The canopy layer is well developed, dominated by *Fagus longipetiolata*, and mixed with evergreen broad-leaved trees of *Michelia balansae*, *Schefflera bodinieri*, *Michelia yunnanensis*, *Machilus salicina*, *Parkmeria yunnanensis*, *Lithocarpus carolinae*, *Dendropanax macrocarpus* and *Schima argentea*. The sub-canopy layer is poorly developed. The shrub layer is also poorly developed, but evergreen shrubs of *Canthium simile* and *Symplocos adenophylla*, deciduous shrubs of *Acanthopanax giraldii* often grow. The herb layer is well developed and dominated by evergreen pteridophytes such as *Athyrium nardii*, *Dryopteris livida* and *Asplenium unilaterale*.

2.5 Final Comment

The comparative description of 21 forest communities with species of *Fagus* in the tree layer, from the cool insular habitats in Japan and Korea, to the subtropical continental mountains of South Yunnan, offers a rare example of the possibility to give a synthetic outlook on structure and ecology of a unitary vegetation type over his complete geographical range. The level of the investigation in the different areas was not uniform: very detailed in Japan, where it was necessary to synthesize a large literature, whereas for China only single spots are analyzed. With a complex elaboration, it was possible to reach a comparable level of information for all aspects of the *Fagus* forests of East Asia. The result is condensed in the description of the adaptations to the local conditions, a good example of unity in the diversity.

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