A preliminary vegetation study of Fagus forests in central China : species composition, structure and ecotypes

Journal of Phytogeography and Taxonomy **51** : 137-157, 2003

Zheng-Xiang Wang and Kazue Fujiwara: **A preliminary vegetation study of *Fagus* forests in central China : species composition, structure and ecotypes**

Graduate School of Environment and Information Sciences, Yokohama National University, Tokiwadai 79–7, Hodogaya-Ku, Yokohama 240–8501, Japan

Abstract

Beech (*Fagus*) forests were surveyed from eastern to western central China by phytosociological methods (Braun-Blanquet 1964) and were summarized into four communities. The main environmental factors affecting vegetation establishment were analyzed. Physiognomically, *Fagus* forests in central China can be classified into two types. Type 1 involves semi-evergreen forests of evergreen and deciduous broad-leaved trees. This type occurs at high altitude (1,140–1,980 m) in mountains with clouds and mist ; the climate is warm and moist. Low temperature and freezing damage are the main limiting factors. Type 2 is deciduous broad-leaved forests. These occur in low mountains (900–1,040 m) in coastal areas. Typhoons and rainstorms are the main limiting factors. Type 2 is similar to the Sapio japonici-Fagetum crenatae in southern Japan.

Keywords : Chinese *Fagus* forest, community structure, ecotype, phytosociological methods, species composition.

Introduction

Fagus forests occur extensively in temperate regions of the Northern Hemisphere. There are 11 species in the genus *Fagus*, five of which are endemic in southern China : *Fagus lucida*, *F. engleriana*, *F. longipetiolata*, *F. hayatae* and *F. chienii* (Wu 1980 ; Peters 1992, 1997). These occur mainly in the montane belts of the subtropics, from 450 to 2, 200 m (22–34°N, Chang and Huang 1988 ; Hong and 'An 1993 ; Cao 1995), and constitute special montane mixed evergreen-deciduous broad-leaved forests or deciduous broad-leaved forests (Wu 1980 ; Zhu and Yang 1985 ; Wang and Li 1996 ; Zhang 2000).

Chinese *Fagus* forests have complex stand composition and typology, due to topographic heterogeneity and the complex mountain climates. Cao (1995), Cao and Peters (1997) reported that glaze, snow and other disturbance by cold weather reduce the canopy dominance of evergreen broad-leaved trees but that deciduous broad-leaved trees can tolerate these stresses. In such cases the formation of mixed evergreen-deciduous broad-leaved forests may be beneficial. The definitive factor(s) governing the establishment of various types of Chinese *Fagus* forest, however, may vary. It is necessary to analyze ecotypes of these forests in detail and to clarify the species composition and forest structure.

Fagus forests in China have not been well studied, especially by the Braun-Blanquet method, and are still less known than *Fagus* forests in Europe and Japan. Recently a phytosociological classification system of *Fagus* forests has been produced (Hukusima et al. 1995), which pointed out similarities between the species composition of Chinese *Fagus* forests and the Sapio japonici–Fagetum crenatae in Japan. No data were presented, however. The Sapio japonici–Fagetum crenatae had been analyzed using a phytosociological approach by Sasaki (1970), Miyawaki (1981, 1982) and Hukusima et al. (1995). This provides a useful basis for comparison of the *Fagus* forests in China and southern Japan. Natural Chinese *Fagus* forests have recently been greatly reduced by human activities such as direct felling. Therefore it is an urgent issue to study species composition and structure of these *Fagus* forests, for their protection.

The purpose of this paper is to analyze the ecological characters of *Fagus* forests in central

China, based on phytosociological sampling data; to compare the species composition of *Fagus* forests in central China with those in southern Japan (Kyushu and Shikoku); and to discuss the main climatic factors affecting Chinese *Fagus* forest structure. Syntaxonomic work on Chinese *Fagus* forests will be continued.

Investigation areas and methods

The vegetation survey was carried out from eastern to western central China along about 30° N latitude. Study sites were located at Sihaishan and Qingliangfeng (Zhejiang Province), at Longmenhe, Dalaoling and Houhe (Hubei Province), and at Kuankuoshui and Fanjingshan (Guizhou Province) (Fig. 1). The altitude and main environmental factors of all investigation areas are shown in Table 1, with data from *Fagus* forest sites in Kyushu and Shikoku for comparison.

The altitude ranges of Chinese *Fagus* forests are significantly different, due to the three so-called "steps" of Chinese topography (see Fig. 1). The landform in China is roughly divisible into three elevational steps (Northwest Teacher's Col-

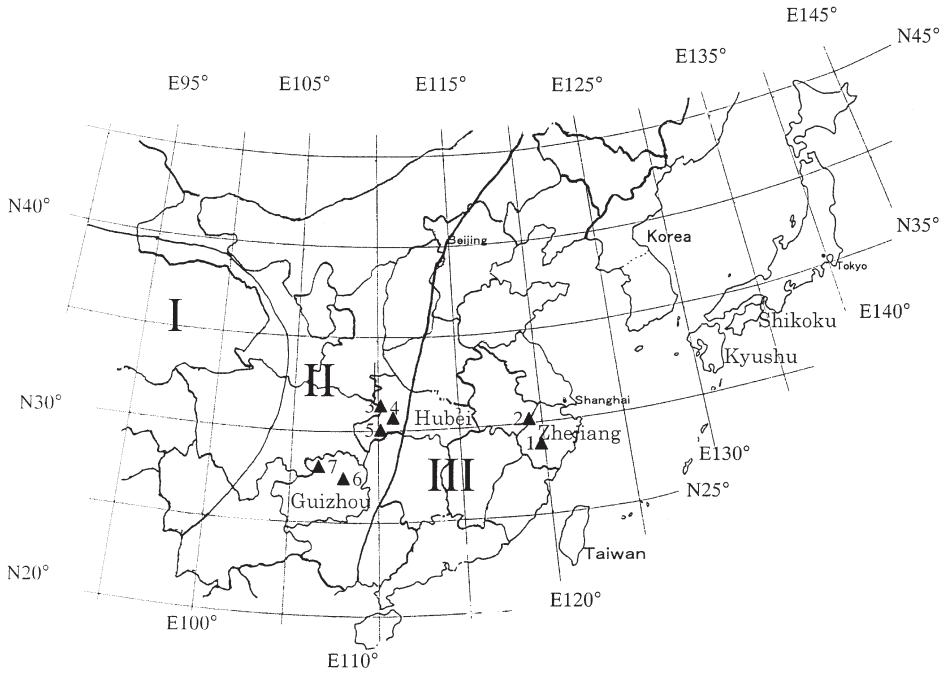

Fig. 1. Locations of study sites.
Ⅰ, Ⅱ, Ⅲ are the first, the second, the third step of Chinese topography, respectively. 1, 2, 3, 4, 5, 6, 7 are Sihaishan, Qingliangfeng, Longmenhe, Dalaoling, Houhe, Fanjingshan, Kuankuoshui, respectively.

Table 1. Background data for stands surveyed in the present study

Stand	Fanjingshan	Kuankuoshui	Dalaoling	Longmenhe
Location	27°53'N	28°12'N	31°2'N	31°18'N
	108°42'E	107°9'E	110°54'E	110°29'E
Elevation (m)	1,570–1,980	1,460–1,710	1,310–1,780	1,620–1,800
Mean Ann. temp.	9.8	10.6	7.8	8.7
Mean temp. of July	22	20.4	18.6	19.6
Mean temp. of January	0.4	−0.1	−3.2	−2.85
Rainfall (mm)	2,600	1,350	1,446	1,584
Relative humidity	>90	88	83.5	83
WI (℃・month)	72.5	79.9	71.2	76.4
CI (℃・month)	−14.8	−12.7	−14.6	−22.4
Parent substrate	Sandstone,Shale Quartz	Sandstone,Shale	Granite, Shale, Sandstone	Quartz, Shale

lege 1984) : the Qinghai-Tibet Plateau with a mean altitude of over 4,000 m (represented by I in Fig. 1), an intermediate mountainous region of 1,000–2,000 m altitude (Ⅱ in Fig. 1) and the eastern plain and hilly area with altitudes below 1,000 m (Ⅲ in Fig. 1). *Fagus hayatae* forests were found only near the east coast, from 900 to 1,040 m. *Fagus longipetiolata* forests were found from 1,270 to 1,380 m at Houhe (Hubei) and were occasionally observed in other low-altitude areas. *Fagus engleriana* forests were surveyed from 1,310 to 1,800 m in three areas of Hubei Province. *Fagus lucida* forests remained from 1,370 to 1,800 m at Longmenhe and Dalaoling (Hubei) and from 1,460 to 1,980 m at Kuankuoshui and Fanjingshan (Guizhou).

Temperature characteristics (mean annual, July and January temperatures) are shown in Table 1. Warmth and Coldness Indices (WI, CI) were calculated for the *Fagus* forest sites by the method of Kira (1945, 1977 ; cf. Fang and Yoda 1989). Sihaishan and Qingliangfeng (near the coast in Zhejiang Province) are warmer than the other study areas, due to their more maritime climate. Average annual precipitation and relative humidity showed that Fanjingshan was the wettest of all the study areas. In addition, typhoons and rainstorms are very important climatic factors for the *Fagus* forests in Sihaishan and Qingliangfeng. This will be discussed in the last part of this paper. . The main climate data were available from the literature (Zhu and Yang 1985 ; Song and Liu 1999 ; Zhang 2000) and from meteorological stations. The lapse rate for temperature was calculated at around 0.55℃ per 100 m.

Site environmental factors were recorded in the field, especially topography, bedrock, wind exposure, litter layer, and soil type. The soil of all study areas has developed mainly from shale, sandstone and granite, and has a pH of 4.5–6 (Wu 2000). According to the FAO (1988) soil classification these are Cambisols. Chinese *Fagus* forests are found mainly on sandy loam (Wu 1980 ; Peters 1997), or at Fanjingshan, on granular, medium loam (Zhou 1990). There are similarities in the soil profiles of the different *Fagus* forests (Zhu 1981). At Fanjingshan, the thickness of the soil layers is as follows : A_0-2–4 cm, A-20 cm, B-22 cm, C-35 cm (Zhou 1990). At Kuankuoshui, the layers are thicker is A_0-7–8 cm, A-28 cm, B-38 cm, C-30 cm (Zhou 1985). At Houhe, the thickness is A_0-5–9 cm, A-8 cm, B-25 cm, C-37 cm (Song and Liu 1999). At Qingliangfeng, the thickness is A_0-0–2 cm, A-25 cm, B-20 cm, C-25–30 cm (Song 1997). The soil profile data were available, from the same sites as in our study. Leaf litter (A_0) layers show marked difference. At Qingliangfeng and Sihaishan, the litter layer is very thin (0–2 cm), and rocks are commonly exposed at the surface. This is related to rainstorms, which scour off the leaf litter.

The species composition and structure of Chinese *Fagus* forests were studied by phytosociological methods described by Braun-Blanquet (1964) and Fujiwara (1987). All vascular plant species in these *Fagus* forests were divided into two life forms (habits), evergreen and deciduous. The cover-abundance value of these two life forms, in each layer of all communities, was calculated for comparison of forest structure. The formula used was :

Houhe	Qingliangfeng	Sihaishan	Kyushu	Shikoku
30°6'N	30°6'N	28°30'N	32°–33°N	33°–34°N
110°32'E	118°53'E	120°43'E	131°–132°E	132°–134°E
1,140–1,650	970–1,040	900–960	1,000–1,700	1,000–1,700
8.3	11.1	12.2	7–8	9.5
18.5	22.5	25.1	18	15–17
−2.3	−0.5	2.1	−3.5–−4	−4.2–−5
1,814	1,900	1,900	2,500–3,250	2,000–3,150
78	82	76	78–81	78–81
88.2	86.5	94.8	60–65	49–50
−10.2	−12.6	−8.4	−18–−25	−32–−34
Sandstone, Limestone	Sandstone,Shale	Sandstone,Shale	Granite,Tuff	Granite, Limestone

$$CAV = \Sigma\ pi/n \times 100$$

in which CAV is the cover-abundance value; n is the number of stands; and pi is the mean abundance percentage, calculated from the Braun-Blanquet cover codes (1–5) as follows: 5 = 87.5%, 4 = 62.5%, 3 = 37.5%, 2 = 15%, 1 = 2.5% and + = 0.1%.

In addition, the species common to *Fagus* forests in central China and *Fagus* forests in southern Japan were identified.

Results

1. Classification and characteristics of communities

Phytosociological data were gathered at 50 sites in seven study areas, along with relevant environmental data. From analytical tablework, the *Fagus* forests were classified into four main communities (Table 2) : 1) a *Sinarundinaria chungii–Fagus lucida* community; 2) a *Fagus engleriana–Fagus lucida* community; 3) a *Carex filicina–Fagus longipetiolata* community; and 4) an *Indocalamus latifolius–Fagus hayatae* community.

1) *Sinarundinaria chungii–Fagus lucida* community

This community occurs in the Fanjingshan Nature Reserve and Kuankuoshui Nature Reserve (Guizhou), on areas that belong to the Yunnan-Guizhou Plateau of the second step of Chinese topography (Fig. 1, Wu 1980). There is high relative humidity (Table 1) and a thick thermal inversion layer. The *Sinarundinaria chungii –Fagus lucida* community mainly occurred on a ridge and steep upper north and south-facing slopes. The differential species of this community are *Sinarundinaria chungii*, *Eurya brevistyla*, *Symplocos adenopus*, *Enkianthus serrulatus*, *Illicium simonsii* and *Mahonia japonica*. In this community, deciduous species in the canopy and herb layers have higher cover-abundance values than do evergreen species. On the other hand, evergreen species have higher cover-abundance values than do deciduous species in the tree-understory and shrub layers (Table 3, Fig. 2). Dense stands of bamboo, especially *Sinarundinaria chungii*, occupy the shrub or herb layer. The *Sinarundinaria chungii–Fagus lucida* community was divided into two subunit communities, an *Actinodaphne reticulata* subunit and a *Chimonobambusa utilis* subunit.

The *Actinodaphne reticulata* subunit can be differentiated by *A. reticulata*, *Viola schneideri*, *Carpinus pubescens*, *Liriope platyphylla*, *Holboellia coriacea*, *Ophiopogon mairei*, *Schima sinensis* and *Lepisorus thunbergiana*. It occurs at Fanjingshan from 1,570 to 1,980 m and at 1,460 m at Kuankuoshui (only one stand was surveyed). The canopy cover is 70–80%, the height is 23–28 m, the diameter at breast height (DBH) of *Fagus lucida* is 33–130 cm, and the mean number of species is 57 in this subunit. In the canopy tree layer of the *Actinodaphne reticulata* subunit, *Fagus lucida* is dominant, but other trees can arrive in the canopy layer as well. These include deciduous broad-leaved species such as *Acer davidii*, *Cornus controversa* and *Prunus brachyda*, and evergreen broad-leaved species such as *Quercus multinervis*, *Q. stewardiana*, *Q. glauca*, *Lithcarpus henryi* and *Schima sinensis*. This is a significant number of evergreen species and indicates that the habitats of this subunit community are moist and warm. The understory tree layer is poorly developed, with cover of only about 30%. The species composition is similar to the *Chimonobambusa utilis* subunit community, but there are more evergreen broad-leaved species. *Sinarundinaria chungii* occurs often and covers more than 85% in the shrub layer. *Indocalamus longiauritus* can grow where short *Sinarundinaria chungii* occurs, and a few juvenile trees of evergreen broad-leaved species such as *Actinodaphne reticulata*, *Camellia cuspidata* and *Illicium simonsii* are well developed on such places. Ferns and epiphytic mosses are unusually abundant in the *Actinodaphne reticulata* subunit. This seems to imply that the habitats are moist.

The *Chimonobambusa utilis* subunit is differentiated by a few herb species, e.g. *Carex omeiensis*, *C. henryi*, *Viola davidii*, *V. brunneostipulosa*, and two species of evergreen broad-leaved tree, *Litsea suberosa* and *Eurya nitada* var. *aureascens*. This subunit was recognized in Kuankuoshui only from 1,530 to 1,710 m. *Chimonobambusa utilis* is a unique differential species, with 50% cover in the shrub layer, but was not at Fanjingshan. This subunit community has

Table 2. Summarized table of Chinese *Fagus* forests

A : *Sinarundinaria chungii–Fagus lucida* community
a_1 : *Actinodaphone reticulata* subunit community
a_2 : *Chimonobambusa utilis* subunit community
B : *Fagus engleriana–Fagus lucida* community
b_1 : *Castanea henryi* subunit community
b_2 : *Acer griseum* subunit community
C : *Carex filicina–Fagus longipetiolata* community
D : *Indocalamus latifolius–Fagus hayatae* community
d_1 : *Pieris japonica* subunit community
d_2 : *Lyonia ovalifolia* subunit community

Reference number	1	2	3	4	5	6	7		
Community number	A		B		C	D			
Subunit community number	a_1	a_2	b_1	b_2		d_1	d_2	Growing	Life form
Number of stands	10	7	19	4	3	3	4	Layer	EG: evergreen
Average number of species	51		56		56	59			DE: deciduous
Differential species of *Sinarundinaria chungii* — *Fagus lucida* community									
Sinarundinaria chungii	IV	V	·	·	·	·	·	S,H	EG
Eurya brevistyla	III	III	r	·	·	·	·	T2,S,H	EG
Symplocos adenopus	III	III	·	·	·	·	·	T1,T2,S,H	DE
Enkianthus serrulatus	III	II	·	·	·	·	·	T2,S,H	DE
Mahonia japonica	II	III	·	·	·	·	·	S,H	EG
Illicium simonsii	III	II	·	·	·	·	·	T2,S,H	EG
Differential species of *Actinodaphne reticulata* subunit community									
Actinodaphne reticulata	V	·	·	·	·	·	·	T2,S,H	EG
Viola schneideri	III	·	r	·	·	·	·	H	DE
Holboellia coriacea	III	·	·	2	·	·	·	S,H	EG
Lepisorus thunbergiana (ep.)	III	I	·	·	·	·	·	T2,S,H	EG
Carpinus pubescens	III	·	·	·	·	·	·	T1,T2,S,H	DE
Ophiopogon mairei	III	·	·	·	·	·	·	H	DE
Liriope platyphylla (fl)	III	·	·	·	·	·	·	H	DE
Schima sinensis	III	·	·	·	·	·	·	T1,T2,S,H	EG
Differential species of *Chimonobambusa utilis* subunit community									
Chimonobambusa utilis	+	IV	·	·	·	·	·	S	EG
Carex omeiensis	+	III	·	·	·	·	·	H	DE
Viola davidii	·	III	r	1	·	·	·	H	DE
Carex henryi	·	III	·	·	·	·	·	H	DE
Litsea suberosa	·	III	·	·	·	·	·	S,H	EG
Eurya nitida var. *aureascens*	·	III	·	·	·	·	·	T2,H	EG
Viola brunneostipulosa	·	III	·	·	·	·	·	H	DE
Differential species of *Fagus engleriana* — *Fagus lucida* community									
Fagus engleriana	·	·	III	4	1	·	·	T1,T2,S,H	DE
Carex subpediformis	+	·	IV	3	·	·	·	H	DE
* *Viola selkirkii*	·	I	IV	3	·	·	·	H	DE
Carpinus cordata var. *chinensis*	·	·	IV	3	·	·	·	T1,T2,S,H	DE
Euonymus alatus	·	·	IV	2	·	·	·	S,H	DE
Polystichum neolobatum	·	II	III	4	·	·	·	H	EG
Rhododendron hypoglaucum	·	·	III	4	·	·	·	T2,S,H	EG
Viburnum betulifolium	·	I	III	2	·	·	·	S	DE
* *Carex sendaica*	·	·	III	4	·	·	·	H	DE
Aster ageratoides	+	·	III	2	·	·	·	H	DE
Carex siderosticta	·	·	III	2	·	·	·	H	DE
Parathelypteris nipponica	·	·	III	1	·	·	·	H	EG
Rhododendron augustinii	·	·	II	2	·	·	·	T2,S,H	EG
Luzula pulmosa	·	·	II	3	·	·	·	H	DE
Polygonum suffultum	·	·	II	3	·	·	·	H	DE
Abelia macrotera	·	·	III	1	·	·	·	S,H	DE
Quercus serrata var. *brevipetiolata*	·	·	II	3	·	·	·	T1,T2,S,H	DE
* *Lindera obtusiloba*	+	·	II	3	·	·	·	S,H	DE
Differential species of *Castanea henryi* subunit community									
Castanea henryi	·	·	IV	·	·	·	·	T1,T2,S,H	DE
Hamamelis mollis	·	·	III	·	·	·	2	T2,S	DE
Lindera floribunda	·	·	III	·	·	·	·	T2,S,H	EG
Pieris formosa	·	·	III	·	·	·	·	S	EG
Differential species of *Acer griseum* subunit community									
Acer griseum	·	·	·	3	·	·	·	T1,T2,S	DE
Abelia parvifolia	·	·	r	3	·	·	·	S	DE

Table 2. Continued

	Saxifraga sibirica	·	·	·	3	1	·	·	H	DE
*	*Helwingia japonica*	·	·	r	3	·	·	·	S,H	DE
	Holboellia fargesii	·	·	r	3	·	·	·	T1,S,H	EG
	Rubus bambusarum	·	·	·	3	·	·	·	S	EG
	Aucuba chinensis	+	·	r	2	·	·	·	S,H	EG
	Tetrastigma hypoglaucum	+	I	·	2	·	·	·	H	DE
	Cacalia ainsliaeflora	·	·	r	2	·	·	·	H	DE
	Rubia leiocaulis	·	·	r	2	·	·	·	H	DE
	Carex grandiligulata	·	I	·	2	·	·	·	H	DE
*	*Elaeagnus pungens*	·	·	r	2	·	·	·	S,H	DE
	Callicarpa japonica var. *angustata*	·	·	r	2	·	·	·	S	DE
	Galium asperuloides	·	I	·	2	·	·	·	H	DE
	Euonymus sanguineus	·	·	·	2	·	·	·	S	DE
	Actaea asiatica	·	·	·	2	·	·	·	H	DE
	Euptelea pleiosperma	·	·	·	2	·	·	·	T1,T2	DE
	Tiarella polyphylla	·	·	·	2	·	·	·	H	DE
	Galium aparine	·	·	·	2	·	·	·	H	DE
	Sinowilsonia henryi	·	·	·	2	·	·	·	T1	DE
	Ribes tenue	·	·	·	2	·	·	·	S	DE
	Gentiana rhodantha	·	·	·	2	·	·	·	H	DE
	Salvia chinensis	·	·	·	2	·	·	·	H	DE
	Tilia tuan	·	·	·	2	·	·	·	T1,S,H	DE
Differential species of higher units of *Sinarundinaria chungii* －*Fagus lucida* community and *Fagus engleriana* －*Fagus lucida* community										
	Fagus lucida	V	V	V	·	·	·	·	T1,T2,S	DE
	Quercus multinervis	V	V	II	4	·	·	·	T1,T2,S,H	EG
	Sorbus folgneri	II	IV	IV	1	·	·	·	T1,T2,S,H	DE
	Acer davidii	II	II	IV	4	·	·	·	T1,S,H	DE
	Hydrangea anomala	II	III	II	2	·	·	·	T2,S,H	DE
Differential species of *Carex filicina* －*Fagus longipetiolata* community										
	Fagus longipetiolata	II	·	·	·	3	·	1	T1,T2,S	DE
	Carex filicina	·	I	r	·	3	·	·	H	DE
	Phoebe sheareri	·	·	·	·	3	·	·	T1,T2,S	EG
	Cercis chinensis	·	·	·	·	2	·	·	T2,S	DE
	Rubus irenaeus	·	II	·	·	2	·	·	H	EG
	Elatostema sessile	·	·	r	·	2	·	·	H	DE
	Saxifraga stolonifera	·	·	·	1	2	·	·	H	DE
	Aesculus wilsonii	·	·	·	·	2	·	·	S	DE
	Bletilla striata	·	·	·	·	2	·	·	H	DE
	Disporopsis pernyi	·	·	·	·	2	·	·	H	DE
	Primula ovalifolia	·	·	·	·	2	·	·	H	DE
	Zingiber mioga	·	·	·	·	2	·	·	H	DE
	Toona ciliata	·	·	·	·	2	·	·	T1,S	DE
	Trachelospermum jasminoides	·	I	·	·	2	·	·	H	EG
	Phoebe neurantha	·	·	·	·	2	·	·	T2,S,H	EG
Endemic species in Hubei										
	Ilex pernyi	·	·	V	4	3	·	·	S,H	EG
	Pyrola decorata	+	·	III	2	2	1	·	H	EG
	Tupistra chinensis	·	·	III	2	1	·	·	H	DE
	Epimedium davidii	·	·	II	4	3	·	·	H	DE
	Lithocarpus cleistocarpus	·	·	II	3	2	·	·	T1,T2,S,H	EG
	Polygonatum cyrtonema	·	I	II	3	1	·	·	H	DE
*	*Celastrus orbiculatus*	·	·	II	3	1	·	·	T1,S,H	DE
	Platycarya strobilacea	·	·	II	2	3	·	·	T1,T2,S,H	DE
	Acer amplum	·	·	II	4	2	·	·	T1,T2,S,H	DE
	Asarum sieboldii	·	·	II	1	2	·	·	H	DE
	Padus wilsonii	·	·	II	1	2	·	·	T1,T2	DE
	Quercus oxyodon	·	·	I	1	3	·	·	T1,T2,S,H	EG
	Schizophragma integrifolia	·	·	II	·	1	·	·	T1,S,H	EG
	Hedera nepalensis var. *sinensis*	·	·	I	2	2	·	·	S,H	EG
	Viburnum rhytidophyllum	·	·	I	3	·	·	·	S,H	EG
	Lonicera acuminata	·	·	II	·	·	·	·	S,H	EG
	Ligularia veitchiana	·	·	II	·	·	·	·	H	DE
	Kerria japonica	·	·	I	2	1	·	·	S,H	DE
	Tricyrtis maculata	·	·	I	3	·	·	·	H	DE
	Chloranthus henryi	·	·	I	·	2	·	·	H	DE
Differential species of *Indocalamus latifolius* －*Fagus hayatae* community										
	Fagus hayatae	·	·	·	·	·	3	4	T1,T2,S,H	DE
	Indocalamus latifolius	·	·	·	·	·	1	3	H	EG

Table 2. Continued

	Schima superba	I	·	·	·	·	3	4	T1,T2,S,H	EG
	Toxicodendron trichocarpa	·	·	·	·	·	3	4	S,H	DE
*	*Sapium japonicum*	·	·	I	·	·	3	4	T2,S,H	DE
	Dioscorea bulbifera	·	I	·	·	·	3	3	S,H	DE
	Quercus nubium	·	·	·	·	·	2	4	T2,S	EG
	Ainsliaea macroclinidioides	·	·	I	1	·	2	4	H	DE
	Carpinus viminea	+	I	·	·	·	2	3	T1,T2,S,H	DE
	Rhododendron latoucheae	+	I	·	·	·	1	4	T2,S,H	EG
*	*Polygonatum odoratum*	·	·	I	·	·	2	3	H	DE
	Tripterospermum chinense	·	·	·	·	·	3	2	S,H	DE
*	*Clethra barbinervis*	·	·	·	·	·	1	4	T2,S,H	DE
	Eurya rubiginosa var. *attenuata*	·	·	·	·	·	1	4	S	EG
	Ilex wilsonii	·	·	·	·	·	1	4	S,H	EG
	Magnolia cylindrica	·	·	·	·	·	3	2	T2,S,H	DE
	Litsea coreana var. *sinensis*	·	·	·	·	·	2	3	S,H	EG
	Lindera glauca	+	·	r	1	·	2	2	S,H	DE
	Rhododendron ovatum	·	·	·	·	·	2	2	S,H	EG
	Albizia kalkora	·	·	·	·	·	1	3	S,H	DE
	Liriope graminifolia	·	·	·	·	·	1	3	H	DE
	Acer elegantulum	·	·	·	·	·	1	2	T2,S,H	DE
	Photinia parvifolia	·	·	·	·	·	1	2	S,H	DE
*	*Hydrangea paniculata*	·	·	·	·	·	1	2	S,H	DE
	Smilax nervo-marginata	·	·	·	·	·	1	2	H	DE
	Nyssa sinensis	·	·	·	·	·	1	2	T2,S	DE
Differential species of *Pieris japonica* sununit community										
*	*Pieris japonica*	·	·	·	·	·	3	·	T2,S,H	EG
	Carex lanceolata	·	I	·	·	·	3	·	H	DE
	Schisandra henryi	·	·	·	·	·	3	·	S,H	DE
	Viola rossii	·	·	·	·	·	3	·	H	DE
	Hydrangea davidii (fl)	·	I	·	·	·	2	·	S,H	DE
	Eurya hebeclados	·	I	·	·	·	2	·	S,H	EG
	Parathelypteris glanduligera	+	·	·	·	·	2	·	H	EG
	Callicarpa giraldii	·	·	·	·	·	2	·	H	DE
	Meliosma myriantha var. *discolor*	·	·	·	·	·	2	·	S,H	DE
	Viburnum hengshenicum	·	·	·	·	·	2	·	S,H	DE
	Aster procerus	·	·	·	·	·	2	·	H	DE
	Cymbidium faberi	·	·	·	·	·	2	·	H	DE
	Picrasma quassioides	·	·	·	·	·	2	·	H	DE
	Liquidambar acalycina	·	·	·	·	·	2	·	T2,H	DE
Differential species of *Lyonia ovalifolia* subunit community										
	Lyonia ovalifolia	+	·	·	·	·	·	4	T2,S	DE
	Abelia dielsii	·	·	·	·	·	·	4	S,H	DE
	Carex chinensis	·	·	·	·	·	·	4	H	DE
	Polygonatum sibiricum	·	·	·	·	·	·	4	H	DE
	Liriope muscari	·	·	·	·	·	·	4	H	DE
	Smilax austro-zhejiangensis	·	·	·	·	·	·	4	H	DE
	Prunus serrulata	+	·	·	·	·	·	3	T1,T2,S,H	DE
	Calamagrostis arundinacea var. *ciliata*	·	·	·	·	·	·	3	H	DE
	Ardisia japonica	·	·	·	·	·	·	3	H	EG
	Photinia paniculata	·	·	·	·	·	·	3	S,H	DE
	Lithocarpus harlandii	·	·	·	·	·	·	3	T2,S	EG
	Diplazium pinfaense	·	I	·	·	·	·	2	H	EG
	Thelypteris sp.	+	·	·	·	·	·	2	H	EG
	Indigofera nigrescens	·	·	·	·	·	·	2	H	DE
*	*Pertya glabrescens*	·	·	·	·	·	·	2	H	DE
	Bredia amoena	·	·	·	·	·	·	2	H	DE
	Leucobryum glaucum	·	·	·	·	·	·	2	M	DE
	Ilex ficoides	·	·	·	·	·	·	2	S	EG
	Ilex triflora	·	·	·	·	·	·	2	S	EG
	Spiraea chinensis	·	·	·	·	·	·	2	S,H	DE
	Itea chinensis var. *oblonga*	·	·	·	·	·	·	2	S	EG
	Rubus corchorifolius	·	·	r	·	·	·	2	S,H	DE
	Pertya scandens	·	·	·	·	·	·	2	S	DE
	Eurya nitida	+	·	·	·	·	·	2	H	EG
	Quercus fabri	·	·	·	·	·	·	2	T1,T2	DE
	Carex sp1.	·	·	·	·	·	·	2	H	DE
	Trachelospermum cathayanum	·	·	·	·	·	·	2	H	DE
	Viola sp.	·	·	·	·	·	·	2	H	DE

Table 2. Continued

Common species of *Fagus* forests in Hubei and *Fagus* forests in Zhejiang									
Quercus gracilis	·	·	II	1	2	3	4	T1,T2,S,H	EG
Acanthopanax evodiaefolius	·	·	II	·	·	3	4	T1,T2,S,H	DE
Rhododendron mariesii	·	·	III	·	·	3	3	T2,S,H	DE
Eurya muricata	·	·	II	1	·	2	4	T2,S,H	EG
Fraxinus chinensis	·	·	II	1	·	3	4	T2,S,H	DE
* *Ilex pedunculosa*	·	·	III	·	·	3	·	S,H	EG
Rhododendron stamineum	·	I	II	·	2	·	1	T2,S	EG
Liriope spicata	·	·	I	2	·	2	2	H	DE
Character and Differential species of higher units									
* *Cornus kousa*	·	III	V	3	1	2	·	T1,T2,S,H	DE
* *Smilax stans*	II	IV	III	3	3	·	·	S,H	DE
Viburnum sympodiale	I	III	IV	1	2	·	3	S,H	DE
* *Viburnum erosum*	+	I	IV	1	1	2	4	S,H	EG
Rhododendron simsii	·	I	IV	·	·	3	4	T2,S,H	DE
Camellia cuspidata	III	I	II	·	3	·	3	T2,S,H	EG
Dryopteris fuscipes	V	III	·	·	1	·	3	H	EG
Ophiorrhiza japonica	·	III	I	3	3	·	1	H	DE
Lindera reflexa	·	II	I	2	·	3	4	S,H	DE
Acer oliverianum	I	III	II	·	·	·	·	T2,S,H	DE
Acer flabellatum	III	·	r	2	1	·	·	T1,T2,S,H	DE
Magnolia sprengeri	+	I	II	·	1	·	·	T1,T2,H	DE
Actinidia chinensis	·	II	II	·	1	·	·	H	DE
Clethra fargesii	I	I	II	·	·	·	·	T1,T2,S,H	DE
Symplocos stellaris	I	I	·	·	·	·	3	T2,S,H	EG
Hydrangea umbellata	·	I	I	·	·	1	2	S,H	DE
Lindera fruticosa	I	·	I	·	1	·	·	T2,S,H	DE
Acer franchetii	+	·	I	1	·	·	·	T2,H	DE
Other species									
Euonymus fortunei	II	I	II	1	2	·	·	S,H	EG
Disporum sessile	II	·	II	3	·	·	2	H	DE
Reineckea carnea	III	·	r	3	1	·	·	H	DE
Symplocos paniculata	III	·	II	·	·	·	·	S,H	DE
Paederia scandens	I	I	r	2	·	3	1	S,H	DE
Elaeagnus lanceolata	II	I	I	1	2	·	·	S,H	EG
Ainsliaea henryi	II	I	II	·	·	·	·	H	DE
Viola principis	II	II	r	2	1	·	·	H	DE
Lithocarpus henryi	II	II	I	·	1	·	·	T1,T2	EG
Ardisia crenata	+	III	·	·	·	2	3	S,H	EG
Betula luminifera	·	I	II	·	·	·	·	T1,S,H	DE
* *Lindera umbellata*	I	·	II	·	·	·	·	T2,S,H	DE
Smilax glabra	I	II	·	·	·	3	1	S,H	DE
* *Cornus controversa*	II	II	I	1	·	·	·	T1,T2,S,H	DE
Smilax cocculoides	I	I	II	·	1	·	·	H	DE
Cerasus conradinae	·	·	II	·	·	·	·	S	DE
Lyonia ovalifolia var. *elliptica*	·	·	II	1	·	·	·	T2,S,H	DE
Quercus engleriana	I	·	II	1	·	·	·	T1,T2,S	EG
Quercus glauca	II	·	I	·	1	·	·	T1,T2,S,H	EG
Lonicera henryi	II	·	I	·	1	·	·	S,H	EG
Pterygocalyx volubilis	III	·	I	·	·	·	·	H	DE
Lindera fragrans	II	·	r	3	·	·	·	S,H	EG
Indocalamus longiauritus	II	·	r	3	·	·	·	S,H	EG
* *Daphniphyllum macropodum*	II	·	I	·	·	·	·	T1,T2,S,H	EG
* *Oxalis griffithii*	I	·	I	1	2	·	·	H	DE
Quercus myrsinaefolia	·	·	II	1	·	2	·	T1,T2,S,H	EG
Quercus stewardiana	+	III	·	·	·	3	·	T1,T2,S,H	EG
Carex capilliformis	·	·	II	·	·	·	·	H	DE
Schisandra sphenanthera	·	·	II	·	·	·	·	S,H	DE
Rhododendron sutchuenense	·	·	II	·	·	·	·	T2,S,H	EG
Calamagrostis sylvatia	·	·	II	·	·	·	·	H	DE
* *Sorbus alnifolia*	·	·	II	·	·	·	1	T2,S	DE
Ophiopogon bodinieri	·	I	II	1	·	·	·	H	DE
Dendropanax dentigerus	I	I	·	·	·	·	3	S,H	EG
Litsea cubeba	I	·	·	·	1	3	·	S,H	DE
Stewartia sinensis	·	·	II	·	·	·	2	T2,S	DE
Litsea pungens	·	II	I	1	·	·	·	S,H	DE
Rubia cordifolia	·	III	I	·	·	·	·	H	DE
Astilbe rubra	·	·	II	1	·	·	·	H	DE

Table 2. Continued

	Corylopsis sinensis	+	·	I	1	·	2	·	S, H	DE
	Ficus heteromorpha	+	II	I	·	1	·	·	T2,S,H	DE
	Pinus armandii	·	·	II	·	·	·	·	S,H	DE
	Quercus spinosa	·	·	II	·	·	·	·	T2,S	EG
*	*Lespedeza buergeri*	·	·	II	·	·	·	·	S,H	DE
	Anaphalis margaritacea	·	·	II	·	·	·	·	H	DE
	Eupatorium japonicum	·	I	I	1	·	·	·	H	DE
	Athyrium strigillosum	II	I	·	·	·	·	·	H	EG
	Viburnum corymbiflorum	II	I	·	·	·	·	·	S,H	DE
	Parthenocissus heterophylla	II	·	r	·	·	·	1	T2,S,H	DE
	Rubus pacificus	II	I	·	·	1	·	·	S,H	EG
	Symplocos caudata	II	I	r	·	·	·	·	S,H	EG
	Rhamnus hemsleyana	II	·	·	2	·	·	·	S,H	EG
	Celastrus rosthornianus var. *loeseneri*	II	II	·	·	·	·	·	T1,S,H	DE
	Rubus amphidasys	II	II	·	·	·	·	·	H	DE
	Kadsura longepedunculata	·	·	r	2	·	·	2	S,H	EG
*	*Cayratia japonica*	·	I	r	·	3	·	·	S,H	DE
	Dryopteris championii	I	I	·	·	2	·	·	H	EG
	Berchemia kulingensis	II	·	·	·	·	2	·	H	DE
	Sargentodoxa cuneata	·	·	I	·	·	2	·	H	DE
	Tetracentron sinense	I	I	r	·	1	·	·	T1,T2	DE
	Berberis julianae	·	I	II	·	·	·	·	S,H	EG
	Litsea elongata	+	I	I	·	·	·	·	T2,S,H	EG
	Rhus punjabensis	·	·	II	·	·	·	·	T2,S,H	DE
*	*Viola grypoceras*	·	·	II	·	·	·	·	H	DE
	Vaccinium japonicum	·	·	II	·	·	·	·	S,H	DE
	Quercus acutissima	·	·	I	·	2	·	·	S,H	DE
	Eurya alata	·	·	II	·	·	·	·	T2,S	EG
*	*Oplismenus undulatifolius*	I	II	·	·	·	·	·	H	DE
	Ardisia crispa	+	II	·	·	1	·	·	S,H	EG
	Sorbus xanthoneura	I	II	·	·	·	·	·	T1,S,H	DE
	Callicarpa cathayana	II	·	·	·	·	·	·	S,H	DE
	Leptorumohra miguliana	II	·	·	·	·	·	·	M	DE
	Rhododendron leishanicum	II	·	·	·	·	·	·	T1,T2,S,H	EG
	Rhododendron ririei	II	·	·	·	·	·	·	T1,S,H	EG
	Viburnum setigerum	II	·	·	·	·	·	·	S	DE
	Symplocos lancilimba	II	·	·	·	·	·	·	S,H	EG
	Daphne papyracea	II	·	·	·	·	·	·	S,H	EG
	Rubus malifolius	II	·	·	·	·	·	·	S,H	DE
	Aucuba obcordata	II	I	·	·	·	·	·	S	EG
	Machilus rehderi	II	I	·	·	·	·	·	T2,S,H	EG
	Goodyera repens	·	·	I	1	·	·	·	H	DE
	Goodyera velutina	I	·	I	·	·	·	·	H	DE
	Halenia elliptica	+	·	I	·	·	·	·	H	DE
	Stellaria palustris	·	·	I	2	·	·	·	H	DE
	Viola accuminata	·	·	II	·	·	·	·	H	DE
	Acer sinense	I	I	·	1	·	·	·	T1,T2	DE
	Alangium chinense	·	·	r	·	1	2	·	H	DE
	Quercus aliena var. *acuteserrata*	·	·	II	·	·	·	·	T1,T2,S	DE
	Cypripedium japonica	·	·	II	·	·	·	·	H	DE
	Arthraxon hispidus	·	·	·	·	2	2	·	H	DE
	Carex brunnea	·	·	II	·	·	·	·	H	DE
	Castanopsis eyrei	I	II	·	·	·	·	·	T1,T2,S,H	EG
	Chrysosplenium lanuginosum	+	I	r	1	·	·	·	H	DE
	Dioscorea althaeoides	+	I	r	1	·	·	·	H	DE
*	*Gynostemma pentaphyllum*	I	I	r	·	·	·	·	H	DE
	Ilex fargesii	I	·	r	·	1	·	·	S,H	EG
	Litsea coreana	+	I	·	·	·	1	1	S,H	EG
	Rubus trianthus	II	·	r	·	·	·	·	H	DE
	Selaginella labordei	II	I	·	·	·	·	·	M	EG
	Toxicodendron vernicifluum	·	·	r	1	·	1	1	T1,T2,H	DE
	Smilax polycorea	·	·	II	·	·	·	·	S,H	DE
	Carex sutchanensis	·	·	I	·	·	·	·	H	DE
	Synurus deltoides	·	·	I	·	·	·	·	H	DE
	Adenophora hunanensis	·	·	I	·	·	·	·	H	DE
	Euphorbia hylonoma	·	·	I	·	·	·	·	H	DE
	Fragaria orientalis	·	·	I	·	·	·	·	H	DE
	Lonicera gynochlamydea	·	·	I	·	·	·	·	H	DE
	Lysimachia clethroides	·	·	I	·	·	·	·	H	DE
	Scutellaria baicalensis	·	·	I	·	·	·	·	H	DE

Table 2. Continued

	Veratrum schindleri	·	·	I	·	·	·	·	H	DE
	Cymbidium goeringii	+	·	I	·	·	·	·	H	DE
	Pachysandra terminalis	·	·	I	·	·	·	·	H	EG
	Ainsliaea gracilis	·	II	r	·	·	·	·	H	DE
	Camellia pitardii	+	II	·	·	·	·	·	S,H	EG
	Lonicera japonica	·	II	·	1	·	·	·	H	EG
	Lithocarpus confinis	+	II	·	·	·	·	·	T1,S	EG
	Vaccinium carlesii	+	II	·	·	·	·	·	S,H	EG
	Arisaema consanguineum	II	·	·	·	·	·	·	H	DE
	Alpinia chinensis	II	·	·	·	·	·	·	H	DE
	Elatostema stewardii	II	·	·	·	·	·	·	H	DE
	Eurya obtusifolia	II	·	·	·	·	·	·	S,H	EG
	Ilex chinensis	II	·	·	·	·	·	·	S,H	EG
	Stellaria wushanensis	II	·	·	·	·	·	·	H	DE
	Ilex yunnanensis	II	·	·	·	·	·	·	S,H	DE
	Impatiens siculifer	I	I	·	·	·	·	·	H	DE
	Sorbus aronioides	I	I	·	·	·	·	·	T1,T2,S	DE
	Carex pachyrrhiza	II	·	·	·	·	·	·	H	DE
	Rhododendron haohui	II	·	·	·	·	·	·	T2,S,H	EG
	Eurya loquiana	II	·	·	·	·	·	·	S	EG
	Lindera cercidifolia	II	·	·	·	·	·	·	S,H	DE
	Symplocos anomala	II	·	·	·	·	·	·	T2,S	EG
	Dryopteris erythrosora	+	II	·	·	·	·	·	H	EG
	Aralia chinensis	·	·	I	·	·	·	·	S,H	DE
	Betula chinensis	·	·	I	·	·	·	·	T2,S	DE
	Smilax discotis	·	·	I	·	·	·	·	S,H	DE
	Clematis otophora	·	·	I	·	·	·	·	S,H	DE
	Asarum chinensis	·	·	I	·	1	·	·	H	DE
*	*Akebia trifoliata*	+	·	r	·	·	1	·	S,H	DE
	Allantodia wichurae	I	I	·	·	·	·	·	H	EG
	Arachniodes chinensis	+	I	r	·	·	·	·	H	EG
*	*Athyrium otophorum*	·	·	I	·	·	·	·	H	EG
	Camellia rosthorniana	I	I	·	·	·	·	·	S	EG
	Cinnamomum burmanii	·	·	r	1	1	·	·	S,H	EG
	Cinnamomum wilsonii	I	I	·	·	·	·	·	S,H	EG
	Diospyros lotus	·	I	r	·	1	·	·	T2,S	DE
	Enkianthus chinensis	+	I	r	·	·	·	·	T2,S	DE
	Eragrostis ferruginea	·	·	I	·	·	·	·	H	DE
	Euonymus cornutus	I	I	·	·	·	·	·	S,H	DE
	Euscaphis japonica	·	I	r	·	·	·	1	T2,S	DE
	Ilex ciliospinosa	I	I	·	·	·	·	·	S,H	EG
*	*Ilex macropoda*	+	·	r	·	·	·	1	T2,S	EG
	Ilex szechwanensis	II	·	·	·	·	·	·	S,H	EG
	Kalopanax septemlobus	·	I	r	1	·	·	·	T1,S	DE
	Lindera communis	I	I	·	·	·	·	·	S	EG
	Philadelphus incanus	·	·	I	1	·	·	·	T2,S	DE
	Pittosporum glabratum var. *neriifolium*	I	I	·	·	·	·	·	S	EG
	Polystichum makinoi	+	·	r	·	1	·	·	H	EG
	Prunus brachypoda	II	·	·	·	·	·	·	T1,H	DE
*	*Prunus grayana*	II	·	·	·	·	·	·	T2,S,H	DE
	Saxifraga flabellifolia	·	·	r	1	1	·	·	H	DE
	Schisandra incarnata	·	·	r	1	1	·	·	H	DE
	Scutellaria franchetiana	·	·	I	1	·	·	·	S,H	DE
	Sinarundinaria nitida	·	·	r	1	1	·	·	S,H	EG
	Tripterospermum cordatum	I	I	·	·	·	·	·	H	DE
	Woodwardia japonica	+	II	·	·	·	·	·	H	EG
	Parthenocissus himalayana	I	I	·	·	·	·	·	T2,H	DE

* Species in *Fagus* forests common to central China and southern Japan. T 1 : canopy tree layer. T 2 : understory tree layer. S : shrub layer. H : herb layer. M : moss layer.

Additional species occurring twice : *Dioscorea tokoro* in reference No.1 (+ - H), in No.4 (1 - H), DE, *Celastrus hypoleucus* No.1 (+ - H), No.6 (1 - H) DE, *Elaeagnus glabra* No.1 (+ - S), No.6 (1 - H), EG, *Rubus oblongus* No.1 (+ - S,H), No.2 (I - S,H), DE, *Acer mono* No.1 (+ - T 1, S), No.3 (r - T 1, S), DE, *Cotoneaster apiculatus* No.1 (+ - S), No.3 (r - S), DE, *Lithocarpus corneus* No.1 (+ - S, H), No.2 (I - S, H), EG, *Neolitsea levinei* No.1 (+ - S, H), No.2 (I - H), EG, *Ilex franchetiana* No.1 (+ - S, H), No.2 (I - S), EG, *Ilex subodorata* No.1 (+ - S, H), No.2 (I - S), EG, *Neolitsea aurata* No.1 (+ - S), No.5 (1 - S), EG, *Plagiogyria japonica* No.1 (+ - H), No.7 (1 - H), DE, *Malus yunnanensis* No.1 (+ - T 2, S), No.2 (I - T 2), DE, *Rhus sylvestris* No.1 (+ - S, H), No.6 (1 - S,H), DE, *Viburnum sempervirens* var. *trichophorum* No.1 (+ - S), No.2 (I - S), DE, *Carpinus fargesii* No.2 (I - T 1, S), No.4 (1 - T 1, S), DE, *Dioscorea japonica* No.2 (I - H), No.6 (1 - H), DE, *Galium bungei* No.2 (I - H), No.4 (1 - H), DE, *Lophatherum gracile* No.2 (I - H), No.3 (r - H),

DE, *Styrax odoratissima* No.2 (I - T 2), No.6 (1 - S, H), DE, *Toxicodendron succedaneum* No.2 (I - T 1), No.3 (r - S), DE, *Rosa banksiopsis* No.3 (r - S, H), No.5 (1 - S,H), DE, *Sorbus caloneura* No.3 (r - S, H), No.4 (1 - S,H), DE, *Padus grayana* No.3 (r - S), No.5 (1 - S), DE, *Panax transitorius* No.3 (r - H), No.5 (1 - H), DE, *Acanthopanax gracilistylus* No.3 (r - S,H), No.4 (1 - S,H), DE, *Allium victorialis* No.3 (r - H), No.4 (1 - H), DE, *Aristolochia heterophylla* No.3 (r - H), No.5 (1 - H), DE, *Indigofera amblyantha* No.6 (1 - H), No.7 (1 - H), DE, *Cephalanthera erect* No.3 (r - H), No.4 (1 - H), DE, *Chrysosplenium macrophyllum* No.3 (r - H), No.4 (1 - H), DE, *Clerodendrum trichotomum* No.3 (r - S), No.5 (1 - S), DE, *Euonymus myrianthus* No.3 (r - S, H), No.5 (1 - S, H), EG, *Euonymus oblongifolium* No.3 (r - S, H), No.5 (1 - S, H), EG, *Galium trifidum* No.3 (r - H), No.4 (1 - H), DE, *Gentiana rubicunda* No.3 (r - H), No.4 (1 - H), DE, *Heterosmilax japonica* No.3 (r - S), No.4 (1 - S, H), DE, *Hydrangea longipes* var. *rosthornii* No.3 (r - S), No.4 (1 - S), DE, *Ilex purpurea* No.3 (r - T 2, S), No.5 (1 - S,), EG, *Lindera nessiana* No.3 (r - S), No.5 (1 - S), DE, *Lonicera maackii* No.3 (r - H), No.6 (1 - H), DE, *Melia azedarach* No.3 (r - T 2), No.5 (1 - T 2), DE, *Tripterospermum affine* No.3 (r - H), No.4 (1 - H), DE, *Neolitsea confertifolia* No.3 (r - S), No.5 (1 - S), EG, *Osmanthus armatus* No.3 (r - S), No.4 (1 - S), EG, *Paris thibetica* No.3 (r - H), No.4 (1 - H), DE, *Vitis davidii* No.3 (r - S, H), No.4 (1 - S, H), DE, *Desmodium racemosum* No.4 (1 - S), No.5 (1 - S), DE, *Lindera angustifolia* No.4 (1 - S), No.5 (1 - S), EG, *Paris polyphylla* No.4 (1 - H), No.5 (1 - H), DE, *Stachyurus chinensis* No.4 (1 - S), No.7 (1 - S), DE, *Camellia fraterna* No.6 (1 - S), No.7 (1 - S), EG.

Additional species occurring once in reference No.1 : *Torricellia angulata* var. *intermedia* I - T 1, T 2, DE, *Polystichum discretum* I - H, EG, *Prunus dielsiana* I - T 1, H, DE, *Pteretis struthioptris* I - H, DE, *Pyrrosia lingua* I - H, EG, *Lindera megaphylla* I - T 1, S, EG, *Pellionia radicana* I - H, DE, *Neolitsea ovatifolia* I - S, H, EG, *Oplismenus compositus* I - H, DE, *Eurya semiserrulata* I - S, EG, *Carex heudesii* I - H, DE, *Cornus kousa* var. *chinensis* I - T 1, T 2, DE, *Dryopteris rosthornii* I - H, EG, *Paris polyphylla* I - H, DE, *Rhamnus nepalensis* I - S, H, DE, *Castanopsis fabri* I - T 2, S, EG, *Tutcheria hirta* I - T 2, S, DE, *Aristolochia moupinensis* I - H, DE, *Ficus erecta* var. *beecheyana* I - S,H, DE, *Skimmia reevesiana* I - H, EG, *Acer palmatum* + - H, DE, *Actinidia arguta* + - S, H, DE, *Actinidia melanandra* - + - S, DE, *Calanthe discolor* + - H, DE, *Carex cryptostachys* + - H, DE, *Carex rhynchophora* + - H, DE, *Carex stipitinux* + - H, DE, *Carpinus kweichowensis* + - T 1, S, DE, *Celastrus glaucophyllus* var. *rugosus* + - H, DE, *Clethra pinfaensis* + - S, DE, *Corylus ferox* var. *thibetica* + - T 2, DE, *Dendrobium nobile* + - H, DE, *Dianthus* sp. + - H, DE, *Dioscorea opposita* + - H, DE, *Diospyros kaki* var. *sylvestris* + - T 2, DE, *Elatostema obtusum* + - H, DE, *Euphorbiaceae* sp. + - S, DE, *Fraxinus longicuspis* + - S, H, DE, *Fraxinus malacophylla* + - S, H, DE, *Heterosmilax yunnanensis* + - H, DE, *Hymenophyllum barbatum* + - M, DE, *Ilex rotunda* + - S, DE, *Ilex tsoii* + - S, DE, *Latouchea fokiensis* + - H, DE, *Litsea ichangensis* + - S, DE, *Lysionotus pauciflorus* + - S, DE, *Matteuccia struthiopteris* + - H, DE, *Melampyrum roseum* + - H, DE, *Ophiopogon heterandrus* + - H, DE, *Ophiopogon spicatum* (fl) + - H, DE, *Ophiopogon tonkinensis* + - H, DE, *Oreocharis henryana* (fr) + - S, DE, *Panax pseudo-ginseng* + - H, DE, *Pilea peploides* + - H, DE, *Polygonum runcinatum* + - H, DE, *Primula serratifolia* + - H, DE, *Primula stenodonta* + - H, DE, *Prunus glandulosa* + - S, DE, *Prunus polytricha* + - T 1, DE, *Prunus spinulosa* + - S, DE, *Prunus ssiori* + - T 1, DE, *Ribes acuminatum* + - H, DE, *Rubus caudifolius* + - H, DE, *Rubus pungens* var. *indefensus* + - S, DE, *Silene fortunei* + - H, DE, *Siphocranion macranthum* + - H, DE, *Smilax microphylla* + - H, DE, *Sorbus globosa* + - H, DE, *Sorbus zahlbruckneri* + - H, DE, *Spodiopogon sibiricus* + - H, DE, *Stephania cepharantha* + - H, DE, *Styrax dasyanthus* + - H, DE, *Toxicodendron radicans* ssp. *hispidum* + - H, DE, *Turpinia pomifera* var. *minor* + - S, DE, *Viola diffusa* + - H, DE, *Allantodia metteniana* + - H, EG, *Asplenium wrightii* + - H, EG, *Aucuba chlorascens* + - S, EG, *Berberis aemulans* + - H, EG, *Cephalotaxus sinensis* + - T 2, S, EG, *Cinnamomum* sp. + - H, EG, *Cleyera incornata* + - S, EG, *Cleyera japonica* + - S, EG, *Diplazium donianum* (ep.) + - S, EG, *Dryopteris decipiens* + - H, EG, *Dryopteris* sp 1. + - H, EG, *Dryopteris* sp 2. + - H, EG, *Dryopteris* sp 3. + - H, EG, *Eriobotrya japonica* + - S, EG, *Euonymus fortunei* var. *radicans* + - H, EG, *Eurya aurea* + - S, EG, *Eurya distichophylla* + - S, EG, *Ilex cyrtura* + - H, EG, *Ilex viridis* + - H, EG, *Indocalamus nubigenus* + - H, EG, *Jasminum nervosum* + - S, EG, *Ligustrum delavayanum* + - S, EG, *Loxogramme duclouxii* + - M, EG, *Loxogramme grammitoides* + - M, EG, *Lycopodium clavatum* + - M, EG, *Microtropis triflora* + - S, EG, *Myrsine stolonifera* + - H, EG, *Osmanthus delavayi* + - H, EG, *Phoebe crassipedicella* + - H, EG, *Pyrrosia drakeana* (ep.) + - S, H, EG, *Pyrrosia mollis* + - M, EG, *Quercus setolosa* + - S, EG, *Rhododendron argyrophyllum* + - T 2, S, H, EG, *Rhododendron brevinerve* + - S, EG, *Symplocos botryantha* + - S, EG, *Symplocos decora* + - S, EG, *Vaccinium pubicalyx* + - H, EG, *Viburnum atrocyaneum* + - S, EG, *Viburnum oliganthum* + - T 2, S, EG, *Hypnum plumaeforme* + - M, *Philonotis turneriana* + - M, *Rhodobryum giganteum* + - M ; No.2 : *Rhododendron aberconwayi* II - S, EG, *Sedum aizoon* I - H, DE, *Cacalia subglalora* II - H, DE, *Alium asperuloides* var. *hoffmeisteri* II - H, DE, *Disporum cantoniense* II - H, DE, *Ilex formosana* II - S, H, EG, *Ophiopogon chingii* II - H, DE, *Thalictrum aquilegifolium* II - H, DE, *Lithcarpus spicatus* II - S, H, EG, *Rhododendron auriculatum* II - S, H, EG, *Symplocos sumuntia* II - S, H, EG, *Acanthopanax evodiaefolius* var. *ferrugineus* II - T 1, T 2, DE, *Allium ovalifolium* I - H, DE, *Aruncus Sylvester* I - H, DE, *Astilbe chinensis* I - H, DE, *Athyrium vidalii* I - H, DE, *Carex thomsonii* I - H, DE, *Cimicifuga acerina* (fr) I - H, DE, *Cyclosorus acuminatus* I - H, DE, *Davidia involucrata* var. *vilmoriniana* I - T 1, DE, *Dendrobenthamia capitata* I - S, DE, *Dendrobenthamia japonica* var. *chinensis* I - H, DE, *Elaeocarpus glabripetalus* I - S, H, DE, *Elatostema cuspidatum* I - H, DE, *Ficus tikoua* I - S, DE, *Hosta ventricosa* I - H, DE, *Impatiens* sp. I - H, DE, *Iris japonica* I - H, DE, *Ligustrum sinense* var.

stauntonii I - H, DE, *Lyonia ovalifolia* var. *lancedata* I - S, H, DE, *Monomelangium pullingeri* I - H, DE, *Ophiopogon stenophyllus* I - H, DE, *Paulownia fortunei* I - S, DE, *Phryma leptostachya* I - H, DE, *Polygonatum punctatum* I - H, DE, *Rubus biflorus* I - S, H, DE, *Rubus chroosepalus* I - H, DE, *Rubus eustephanus* (fr) I - S, DE, *Rubus ichangensis* I - H, DE, *Rubus palamatus* I - H, DE, *Rubus tephrodes* I - H, DE, *Sagenia coadunate* I - H, DE, *Sambucus chinensis* I - H, DE, *Sassafras tzumu* I - T 1, DE, *Senecio scandens* I - H, DE, *Toona sinensis* I - T 2, DE, *Tricyrtis macropoda* I - H, DE, *Camellia elongata* I - S, EG, *Castanopsis platycantha* I - T 1, EG, *Dryopteris chinensis* I - H, EG, *Dryopteris laeta* I - H, EG, *Dryopteris peninsulae* I - H, EG, *Dryopteris varia* I - H, EG, *Euonymus lecleri* (fl) I - S, EG, *Ilex corallina* var. *aberrans* I - S, EG, *Ligustrum japonicum* I - S, EG, *Lindera pulcherrima* var. *hemsleyana* I - S, EG, *Lonicera crassifolia* I - H, EG, *Lonicera pampaninii* I - H, EG, *Osmanthus reticulata* I - S, EG, *Osmunda japonica* I - H, EG, *Pyrrosia shearei* I - H, EG, *Rhododendron calophytum* I - T 2, EG, *Schima wallichii* I - S, EG ; No.3 : *Paris fargesii* I - H, DE, *Pteridium revolutum* I - H, EG, *Mahonia bealei* I - S, H, EG, *Ilex centrochinensis* I - S, EG, *Euonymus bungeanus* I - H, DE, *Keteleeria davidiana* I - T 2, S, EG, *Carex rochebrunii* I - H, DE, *Castanea seguinii r* - T 1, S, DE, *Saussurea cordifolia* I - H, DE, *Weigela florida* I - S, H, DE, *Scutellaria indica* I - H, DE, *Smilax ferox* I - S,H, DE, *Cynanchum auriculatum* I - H, DE, *Lepisorus contortus* I - H, EG, *Woodsia polystichoides* I - H, EG, *Photinia villosa* I - S, H, DE, *Aconitum canabifolium* I - H, DE, *Dioscorea nipponica* I - H, DE, *Imperata cylindrica* var. *major* I - H, DE, *Pinus massoniana* I - T 2, EG, *Smilax arisanensis* I - H, DE, *Salvia cavaleriei* var. *simplicafolia* I - H, DE, *Saussurea pinetorum* I - H, DE, *Rhus vernicifluum* I - T 1,T 2, DE, *Pinus henryi* I - T 1, EG, *Patrinia heterophylla* ssp. *angustifolia* I - H, DE, *Achyranthes aspera* r - H, DE, *Aconitum carmichaeli* r - H, DE, *Aconitum sinomontanum* r - H, DE, *Actinidia polygama* r - S, DE, *Angelica bisserata* r - H, DE, *Arisaema lobatum* r - H, DE, *Artemisia argyi* r - H, DE, *Artemisia lactiflora* r - H, DE, *Asparagus cochinchinensis* r - H, DE, *Cacalia profundorum* r - H, DE, *Cardiandra moellendorffii* r - H, DE, *Carpinus hupeana* r - S, DE, *Castanea mollissima* r - T 1, DE, *Cerasus darafolia* r - S, DE, *Cerasus dielsiana* r - S, DE, *Circaea cordata* r - H, DE, *Clematis montana* r - H, DE, *Clematis quinquefoliolata* r - H, DE, *Cocculus orbiculatus* r - H, DE, *Cornus walteri* r - T 2, DE, *Cynanchum officinale* r - H, DE, *Delphinium anthriscifolium* r - H, DE, *Dendranthema indicum* r - H, DE, *Desmodium heterocarpum* r - H, DE, *Deutzia discolor* r - S, DE, *Deutzia schneideriana* r - S, DE, *Elaeagnus multiflora* r - S, DE, *Forsythia giraldiana* r - S, DE, *Forsythia viridissima* r - S, DE, *Fragaria nilgerrensis* r - H, DE, *Halenia elliptica* var. *grandiflora* r - H, DE, *Kinostemon ornatum* r - H, DE, *Koelreuteria puniculata* r - H, DE, *Leontopodium japonicum* r - H, DE, *Lespedeza bicolor* r - S, DE, *Lespedeza formosa* r - H, DE, *Lysimachia stenosepala* r - H, DE, *Marsdenia sinensis* r - S, DE, *Miscanthus sinensis* r - H, DE, *Phegopteris polypodioides* r - H, DE, *Phymatopsis sinensis* r - H, DE, *Pilea angulata* r - H, DE, *Pilea cavaleri* r - H, DE, *Pilea mongolica* r - H, DE, *Pilea pinofasiata* r - H, DE, *Pilea sinofasiata* r - H, DE, *Pterocarya strobilacea* r - S, DE, *Pterostyrax psilophylla* r - T 1, DE, *Rhamnus crenata* r - S, DE, *Rhamnus vtilis* r - S, DE, *Rhus potaninii* r - S, DE, *Rosa roxburghii* r - S, DE, *Rubus adenophorus* r - H, DE, *Rubus innominatus* r - H, DE, *Rubus mesogaeus* r - H, DE, *Sabia campanulata* r - S, DE, *Saposhnikovia divaricata* r - H, DE, *Scirpus subcapitatus* r - H, DE, *Sedum major* r - H, DE, *Smilax china* r - S, DE, *Smilax scobinicaulis* r - S, DE, *Solanam pittosporifolia* r - H, DE, *Spiraea japonica* var. *fortunei* r - S, DE, *Stephania japonica* r - H, DE, *Tapiscia sinensis* r - T 1, DE, *Tripterospermum filicaule* r - H, DE, *Viola inconspicua* r - H, DE, *Vitis flexuosa* r - T 2, DE, *Arachniodes festina* r - H, EG, *Athyrium amplissima* r - H, EG, *Athyrium nipponica* r - H, EG, *Athyrium wardii* r - H, EG, *Berberis silvicola* r - S, EG, *Berberis triacanthophora* r - S, EG, *Camellia caudata* r - T 2, EG, *Cyrtomium fortunei* r - H, EG, *Daphniphyllum angustifolium* r - S, EG, *Dryopteris cycadine* r - H, EG, *Ilex intermedia* r - S, EG, *Lepisorus angustus* r - H, EG, *Lonicera fragrantissma* r - S, EG, *Lonicera pileata* r - H, EG, *Loropetalum chinense* r - S, EG, *Neolitsea gracilipes* r - S, EG, *Polystichum hecatopteron* r - H, EG, *Polystichum tripteron* r - H, EG, *Pteris deltodon* r - H, EG, *Rosa cymosa* r - S, EG, *Rubus henryi* r - S, EG, *Serissa serissoides* r - H, EG, *Stranvaesia davidiana* var. *undupata* r - S, EG ; No.4 : *Veratrum nigrum* 2 - H, DE, *Abelia forrestifolia* 1 - S, DE, *Acanthopanax henryi* 1 - S, DE, *Acanthopanax senticosus* 1 - S, DE, *Acer cappadocicum* 1 - T 1, DE, *Acer maximowiczii* 1 - T 2, DE, *Angelica pubescens* 1 - H, DE, *Astilbe grandis* 1 - H, DE, *Cacalia otopteryx* 1 - H, DE, *Carex leucochlora* 1 - H, DE, *Cayratia oligocarpa* 1 - H, DE, *Cimicifuga foetida* 1 - H, DE, *Delphinium trisectum* 1 - H, DE, *Galium tricorne* 1 - H, DE, *Hemiboea subcapitata* 1 - H, DE, *Hydrangea fulvescens* 1 - S, DE, *Meliosma cuneifolia* 1 - S, DE, *Neillia ribesioides* 1 - S, DE, *Padus buergeriana* 1 - T 2, DE, *Panax pseudoginseng* var. *japonicus* 1 - H, DE, *Rhamnella martini* 1 - H, DE, *Rodgersia aesculifolia* 1 - H, DE, *Rubus chiliadenus* 1 - S, DE, *Rubus lasiostylus* 1 - S, DE, *Salvia scapiformis* 1 - H, DE, *Sanicula chinensis* 1 - H, DE, *Sedum verticillatum* 1 - H, DE, *Stachyurus himalicus* 1 - S, DE, *Staphylea holocarpa* 1 - S, DE, *Swertia bimaculata* 1 - H, DE, *Tilia intonsa* 1 - S, DE, *Tilia oliveri* 1 - T 1, DE, *Vitis quinquangularis* 1 - T 1, DE, *Youngia heterophylla* 1 - H, DE, *Dryoathyrium viridifrons* 1 - H, EG, *Lindera pulcherrima* 1 - S, H, EG, *Meliosma beaniana* 1 - T 2, EG, *Nothopanax davidii* 1 - S, EG, *Polypodium amoenum* 1 - H, EG, *Pyrrosia petiolosa* 1 - H, EG, *Viburnum henryi* 1 - S, EG ; No.5 : *Acanthopanax giraldii* 1 - H, DE, *Adiantum capillus* 1 - H, DE, *Asarum debile* 1 - H, DE, *Bretschneidera sinensis* 1 - T 2, DE, *Cacalia tangutica* 1 - H, DE, *Desmodium sambuense* 1 - H, DE, *Dicliptera chinensis* 1 - H, DE, *Disporopsis aspera* 1 - H, DE, *Dysosma difformis* 1 - H, DE, *Emmenopterys henryi* 1 - S, DE, *Epipactis helloborine* 1 - H, DE, *Hovenia dulcis* 1 - T 1, DE, *Lactuca sororia* 1 - H, DE, *Ophiopogon intermedius* 1 - H, DE, *Polygonatum nodosum* 1 - H, DE, *Premna microphylla* 1 - S, DE, *Ranunculus japonicus* 1 - H, DE, *Salvia hupehensis* 1

- H, DE, *Viburnum thytidophyllum* 1 - S, DE, *Zanthoxylum bungeanum* 1 - S, DE, *Zanthoxylum dissitum* 1 - S, DE, *Zanthoxylum echinocarpum* 1 - S, DE, *Zanthoxylum stenophyllum* 1 - S, DE, *Arachniodes exilis* 1 - H, EG, *Coniogramme japonica* 1 - H, EG, *Dryopteris labordei* 1 - H, EG, *Holboellia grandiflora* 1 - H, EG, *Kadsura heteroclite* 1 - T 1, EG, *Ligustrum sinense* 1 - S, EG, *Litsea sericea* 1 - S, EG, *Machilus ichangensis* 1 - S, EG ; No.6 : *Acer pibupalmatum* 1 - H, DE, *Ampelopsis brevipedunc* var. *kulingensis* 1 - H, DE, *Aristolochia kaepferi* 1 - H, DE, *Corylopsis glandulifera* 1 - S, DE, *Corylus kweichouensis* 1 - H, DE, *Dalbergia hubeiana* 1 - H, DE, *Gramineae* sp.1 - H, DE, *Hovenia trichocarpa* 1 - H, DE, *Hydrangea strigosa* 1 - S, H, DE, *Ligularia fischeri* 1 - H, DE, *Mallotus japonicus* var. *floccosus* 1 - H, DE, *Polygonatum filipes* 1 - H, DE, *Prunus discoidea* 1 - T 2, DE, *Pueraria lobata* 1 - H, DE, *Rubus hirsutus* 1 - H, DE, *Solidago decurrens* 1 - H, DE, *Stewartia rostrata* 1 - T 2, DE, *Syneilesis aconitifolia* 1 - H, DE, fern sp. 1 - H, EG ; No.7 : *Alangium platanifolia* 1 - S, DE, *Amelanchier sinica* 1 - H, DE, *Dalbergia millettii* 1 - S, DE, *Millettia dielsiana* 1 - S, H, DE, *Stewartia acutisepala* 1 - T 2, S, DE, *Arachnioides rhomboidea* 1 - H, EG, *Ardisia chinensis* 1 - H, EG, *Cornus hongkongensis* ssp. *elegans* 1 - S, EG, *Daphne odora* var. *atrocaulis* 1 - H, EG, *Dennstaedia* sp. 1 - H, EG, *Ilex micrococca* 1 - S, EG, *Ilex suaveolens* 1 - S, EG, *Lithocarpus oldhamii* 1 - T 2, S, EG, *Lithocarpus ovatum* 1 - S, EG, *Rhododendron fortunei* 1 - S, EG, *Stauntonia leucanthe* 1 - S, H, EG, *Viburnum propinquum* 1 - S, EG, moss sp.1 - M, *Orthomniopsis japonica* 1 - M.

fewer evergreen species in the tree layer than does the *Actinodaphne reticulata* subunit, namely only occasional individuals of *Quercus multinervis* and *Castanopsis platycantha*. The ferns and epiphytic mosses are fewer than in the *Actinodaphne reticulata* subunit. This subunit community has 75–85% canopy cover, and the height of tree layer is about 16–24 m. The mean number of species is 42.

In study areas of the *Sinarundinaria chungii*-*Fagus lucida* community, we did not find seedlings of *Fagus lucida* in the herb layer (Table 4), suggesting that regeneration of *Fagus lucida* is bad under dense bamboo.

2) *Fagus engleriana*–*Fagus lucida* community

This community mainly occurs at the Dalaoling and Longmenhe forest stations and was surveyed at only one site, in the Houhe Nature Reserve. The sites are in the transition between the second and third steps of the Chinese topography (Fig. 1, Wu 1980). Mean annual, July, and January temperatures and relative humidity are lower than in the *Sinarundinaria chungii*–*Fagus lucida* community (Table 1). The differential species of this community are *Fagus engleriana*, *Quercus serrata* var. *brevipetiolata*, *Carpinus cordata* var. *chinensis*, *Rhododendron hypoglaucum*, *R. augustinii*, *Euonymus alatus*, *Viburnum betulifolium*, *Lindera obtusiloba*, *Abelia macrotera*, *Carex subpediformis*, *C. sendaica*, *C. siderosticta*, *Viola selkirkii*, *Aster ageratoides*, *Parathelypteris nipponica*, *Luzula plumosa*, *Polystichum neolobatum* and *Polygonum suffultum*. This community involves a mixture of evergreen and deciduous broad-leaved forest trees, as in the *Sinarundinaria chungii*–*Fagus lucida* community. Deciduous species are dominant in the canopy and herb layer. Evergreen species are dominant in the tree understory and in the shrub layer (Table 3, Fig. 2). Two subunit communities were classified, a *Castanea henryi* subunit and an *Acer griseum* subunit.

The differential species of the *Castanea henryi* subunit are *C. henryi*, *Lindera floribunda*, *Pieris formosa* and *Hamamelis mollis*. The *Castanea henryi* subunit can be found on steep upper slopes of the mountains at Dalaoling, Longmenhe and Houhe, from 1,310 to 1,780 m. It mainly occurs on shady slopes, with occasional rock outcrops. The litter layer is adventitious in the study areas and may or may not reach 10 cm. This subunit is often a mixture with both *Fagus lucida* and *F. engleriana*. The canopy cover is 45–85%, and the height varies significantly, from 13 to 22 m. The mean number of species is 53. The regeneration of *Fagus engleriana* mainly depends on sprouting, mostly 4–5 shoots per tree but occasionally as many as 22. In the *Castanea henryi* subunit, the canopy was composed entirely by a few deciduous broad-leaved trees (other than beech) : e.g. *Castanea henryi*, *Betula luminifera*, *Carpinus cordata* var. *chinensis*. Evergreen broad-leaved species include *Rhododendron* (*R. hypoglaucum*, *R. stamineum*) and *Quercus* (*Q. multinervis*, *Q. gracilis*, *Q. glauca*, *Q. myrsinaefolia*). Coniferous trees, such as *Cephalotaxus sinensis*, *Keteleeria davidiana* and *Pinus henryi*, were found occasionally in the tree and

Table 3. Cover-abundance values (CAV) of evergreen and deciduous species in the layers of *Fagus* forests in

	Sinarundinaria chungii–Fagus lucida comm.				*Fagus engerleriana–Fagus lucida* comm.				*Carex filicina–Fagus longipetiolata* comm.			
	CE	CE%	CD	CD%	CE	CE%	CD	CD%	CE	CE%	CD	CD%
T 1	15.9	17.5	75.0	82.5	1.5	2.4	61.5	97.6	11.0	15.6	59.4	88.4
T 2	22.7	68.4	10.5	31.6	26.2	67.9	12.4	32.1	22.7	98.6	0.3	1.4
S	31.1	55.2	25.2	44.8	23.4	69.0	9.9	31.0	62.3	97.5	1.6	2.5
H	11.3	17.0	55.3	83.0	5.2	19.6	21.2	80.4	10.6	18.7	46.2	81.3

shrub layers. This seems to imply that the habitats of this subunit have a cooler climate than in the other communities. The shrub layer of the *Castanea henryi* subunit community is short of bamboo, especially in Dalaoling. Therefore, more species can live in the shrub and herb layers, due to better living space, and a few seedlings and juveniles of *Fagus lucida* or *F. englerana* can grow in these layers. The regeneration of beech seems better than in the *Sinarundinaria chungii–Fagus lucida* community.

The *Acer griseum* subunit can be differentiated by *Acer griseum*, *Abelia parvifolia*, *Saxifraga sibirica*, *Helwingia japonica*, *Holboellia fargesii*, *Rubus bambusarum*, *Aucuba chinensis*, *Tetrastigma hypoglaucum*, *Cacalia ainsliaeflora*, *Rubia leiocaulis*, *Carex grandiligulata*, *Elaeagnus pungens*, *Callicarpa japonica* var. *angustata*, *Galium asperuloides*, *Euonymus sanguineus*, *Actaea asiatica*, *Euptelea pleiosperma*, *Tiarella polyphylla*, *Galium aparine*, *Sinowilsonia henryi*, *Ribes tenue*, *Gentiana rhodantha*, *Salvia chinensis* and *Tilia tuan*. This subunit grows only at the Longmenhe forest station from 1,760 to 1,800 m. The environment of this community is similar to that of the *Castanea henryi* subunit. The mean number of species reaches 73, and the species composition and structure are obviously

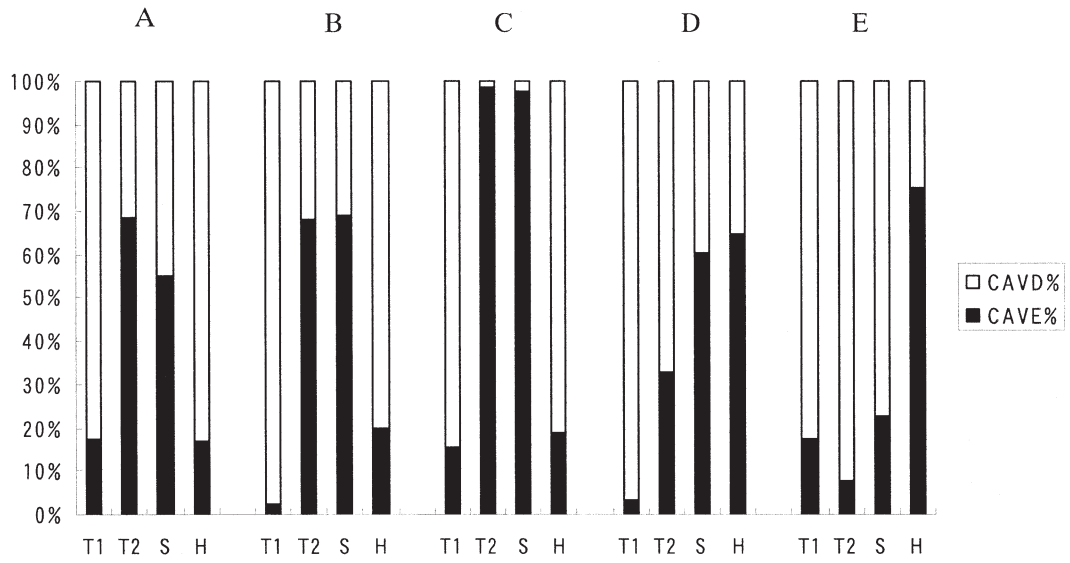

Fig. 2. Cover-abundance percentage of evergreen and deciduous species in the layers of *Fagus* forests in central China and southern Japan.
A: *Sinarundinaria chungii–Fagus lucida* community. B: *Fagus engleriana–Fagus lucida* community. C: *Carex filicina–Fagus longipetiolata* community. D: *Indocalamus latifolius–Fagus hayatae* community. E: Sapio japonici–Fagetum crenatae. CAVD: cover-abundance percentage of deciduous species. CADE: cover-abundance percentage of evergreen species. T 1: canopy tree layer. T 2: understory tree layer. S: shrub layer. H: herb layer.

central China and southern Japan

Indocalamus latifolius–Fagus hayatae comm.				Sapio japonici–Fagetum crenatae			
CE	CE%	CD	CD%	CE	CE%	CD	CD%
2.2	3.5	60.3	96.5	15.3	17.4	72.6	82.6
11.2	32.7	23.0	67.3	2.2	7.5	23.3	92.5
28.3	60.3	18.6	39.7	10.2	22.9	34.3	77.1
16.1	64.9	8.7	35.1	67.1	75.3	22.0	24.7

CE : cover-abundance value of evergreen species. CE% : cover-abundance percentage of evergreen species. CD : cover-abundance value of deciduous species. CD% : cover-abundance percentage of deciduous species. T 1 : canopy tree layer. T 2 : understory tree layer. S : shrub layer. H : herb layer.

different from the *Castanea henryi* subunit. *Quercus multinervis* has a higher cover in the tree layer and more than *Fagus engleriana* now and then. The canopy cover reaches 80–85%. In the shrub layer, *Indocalamus longiauritus* has a higher cover than the others species, though gaps are extensive. The cover of the herb layer is 10–55% and is restricted by bamboo. In the herb layer, the main species are *Tupistra chinensis*, *Reineckea carnea*, *Epimedium davidii* and species of *Carex*.

3) *Carex filicina–Fagus longipetiolata* community

The *Carex filicina–Fagus longipetiolata* community occurs in the Houhe Nature Reserve (Hubei), on middle slopes of 33–45° . There are many tree falls, and twining plants are abundant. The height of the canopy is 18–19 m, the canopy cover is 70–80%, and each site has 52–62 species. This community can be differentiated by *Fagus longipetiolata*, *Carex filicina*, *Cercis chinensis*, *Rubus irenaeus*, *Elatostema sessile*, *Saxifraga stolonifera*, *Aesculus wilsonii*, *Bletilla striata*, *Disporopsis pernyi*, *Primula ovalifolia*, *Zingiber mioga*, *Phoebe sheareri*, *Toona ciliata*, *Trachelospermum jasminoides* and *Phoebe neurantha*. *Fagus longipetiolata* is dominant in the tree layer, though it is mixed with a few evergreen species such as *Lithocarpus cleistocarpus* and *Quercus glauca*. In the tree understory and shrub layer evergreen broad-leaved species are dominant, both in number of species and in cover (Table 3, Fig. 2). The main evergreen species are *Phoebe sheareri*, *Quercus gracilis*, *Rhododendron stamineum*, *Camellia cuspidata* and *Ilex pernyi*. *Sinarundinaria nitida* occurred at only one site. *Carex filicina* has a higher cover than the other herb-layer species. Seedlings of woody plants were found frequently. The regeneration of *Fagus longipetiolata* is bad in this community. We did not find seedlings in the herb layer, and juveniles were rare as well (Table 4).

4) *Indocalamus latifolius–Fagus hayatae* community

This community grows in the Sihaishan Nature Reserve and Qingliangfeng Nature Reaerve (Zhejiang), on the third step of Chinese topography, near the coast (Fig. 1, Wu 1980). The climate is warmer than the other study areas (Table 1). It occurs on a steep upper slope of 20–58°. The differential species of this community are *Fagus hayatae*, *Toxicodendron trichocarpa*, *Sapium japonicum*, *Schima superba*, *Dioscorea bul-*

Table 4. Cover-abundance values of *Fagus* species in the layers of all communities in central China

	Sinarundinaria chungii–Fagus lucida comm.	*Fagus engleriana–Fagus lucida* comm.		*Carex filicina–Fagus longipetiolata* comm.	*Indocalamus latifolius–Fagus hayatae* comm.	
	F. lucida	*F. lucida*	*F. engleriana*	*F. longipetiolata*	*F. longipetiolata*	*F. hayatae*
T 1	59.1	19.35	22.7	37.5	0.36	55.35
T 2	0.01	1.3	2.94	0	0.39	2.87
S	0.9	0.46	0.33	0.03	0	4.67
H	0	0.11	0.01	0	0	0.03

T 1 : canopy tree layer. T 2 : understory tree layer. S : shrub layer. H : herb layer.

bifera, *Quercus nubium*, *Carpinus viminea*, *Ainsliaea macroclinidioides*, *Rhododendron latoucheae*, *Polygonatum odoratum*, *R. ovatum*, *Tripterospermum chinense*, *Clethra barbinervis*, *Eurya rubiginosa* var. *attenuata*, *Ilex wilsonii*, *Magnolia cylindrica*, *Litsea coreana* var. *sinensis*, *Albizia kalkora*, *Lindera glauca*, *Liriope graminifolia*, *Indocalamus latifolius*, *Acer elegantulum*, *Photinia parvifolia*, *Hydrange paniculata*, *Smilax nervo-marginata* and *Nyssa sinensis*. The structure of this community is different from the other communities in that deciduous species are dominant in the tree layers and evergreen species are dominant in the shrub and herb layers (Table 3, Fig. 2). Seedlings and juveniles of *Fagus hayatae* were often found at each site, showing that regeneration of *Fagus hayatae* in this community is better than in the other communities. This community was classified into two subnunit communities, a *Pieris japonica* subunit and a *Lyonia ovalifolia* subunit.

The differential species of the *Pieris japonica* subunit are *Carex lanceolata*, *Pieris japonica*, *Schisandra henryi*, *Viola rossii*, *Hydrangea davidii*, *Callicarpa giraldii*, *Meliosma myriantha* var. *discolor*, *Viburnum hengshenium*, *Aster procerus*, *Cymbidium faberi*, *Picrasma quassioides*, *Eurya hebeclados*, *Liquidambar acalycina* and *Parathelypteris glanduligera*. This subunit occurs at Qinglingfang, at 970 to 1,040 m. The canopy cover is 40–80%, and its height is 16–20 m. There were 41–54 species at each site. *Fagus hayatae* is mono-dominant in this subunit, but *Schima superba* occasionally also occurs in the canopy. The tree understory is poorly developed, with only 15–30% cover, and *Pieris japonica* is the common species in this layer and the shrub layer. There are sparse bamboos (*Indocalamus latifolius*) in the herb layer. Although the species are abundant in the herb layer, dominant species are not clearly discernable.

In contrast, the *Lyonia ovalifolia* subunit can be differentiated by *Abelia dielsii*, *Lyonia ovalifolia*, *Carex chinensis*, *Polygonatum sibiricum*, *Liriope muscari*, *Smilax austro-zhejiangensis*, *Calamagrostis arundinacea* var. *ciliate*, *Ardisia japonica*, *Prunus serrulata*, *Photinia paniculata*, *Lithocarpus harlandii*, *Indigofera nigrescens*, *Pertya glabrescens*, *Bredia amoena*, *Ilex ficoides*, *Ilex triflora*, *Itea chinensis* var. *oblonga*, *Spiraea chinensis*, *Rubus corchorifolius*, *Pertya scandens*, *Eurya nitida*, *Quercus fabri*, *E. nitida*, *Trachelospermum cathayanum*, *Leucobryum glaucum*, *Diplazium pinfaense*, *Thelypteris* sp., *Carex* sp. and *Viola* sp. This subunit community grows in a long, narrow plot in the Sihaishan Nature Reserve, from 900 to 960 m. In this subunit, the canopy height is only 12–15 m, but there are 52–75 species per site. A few deciduous broad-leaved species grow in the canopy apart from *Fagus hayatae*, such as *Carpinus viminea* and *Quercus fabri*. The tree understory of this subunit has a higher cover (25–50%) than in the *Pieris japonica* subunit. *Indocalamus latifolius* is dominant in the herb layer but is sparse.

2. Comparative study of *Fagus* forests in central China and *Fagus* forests in southern Japan

Based on data from 50 sites, *Fagus* forests in central China are composed of 827 species from 328 genera and 118 families. The geographic range is from eastern to western central China at 27–31° N latitude. The forest climates vary from continental to maritime. Kyushu and Shiko-ku (southern Japan, at 31–34° N) mainly have a maritime forest climate, so there are a few general similarities between *Fagus* forests in central China and in southern Japan. At first, many common species occur in the *Fagus* forests of the two areas (Table 5), especially between *Fagus* forests in central China and the Sapio japonici–Fagetum crenatae in Kyushu and Shikoku. This seems to imply that the Sapio japonici–Fagetum crenatae is most closely related to the *Fagus* forests of central China. The main common species are *Cornus kousa*, *Cornus controversa*, *Lindera umbellata*, *Sorbus alnifolia*, *Viburnum erosum*, *Viola selkikii*, *Sapium japonica*, *Clethra barbinervis*, *Hydrangea paniculata*, *Ilex pedunculosa* and *Pieris japonica*. Moreover, not only the *Indocalamus latifolius*－*Fagus hayatae* community near the eastern coast but also the *Sinarundinaria chungii*－*Fagus lucida* and *Fagus engleriana*－*Fagus lucida* communities in west-central China have many species common with the Sapio japonici－Fagetum crenatae of southern Japan. So *Fagus* forests in southern Japan have a close relationship with *Fagus* for-

Table 5. The number of species common to *Fagus* forests in China and *Fagus* forests in southern Japan

		Guizhou Sc-Flu	Hubei Fe-Flu	Hubei C-Flo	Zhejiang I-Fh	Total of common species
Kyushu	Sa-Fc	5 (16)	9 (10)	2 (2)	8 (5)	34
	L-Fc	2 (9)	2 (18)	1 (4)	2 (5)	24
	St-Fj	2 (2)	2 (1)	0	4 (1)	8
Shikoku	Sa-Fc	3 (15)	9 (14)	2 (3)	8 (5)	40
	St-Fj	3 (4)	3 (6)	1 (1)	5 (4)	15

( ) : the number of common species of appearing only once. Sc-Flu : *Sinarundinaria chungii–Fagus lucida* community. Fe-Flu : *Fagus engleriana–Fagus lucida* community. C-Flo : *Carex filicina–Fagus longipetiolata* community. I-Fh : *Indocalamus latifolius–Fagus hayatae* community. Sa-Fc : Sapio japonici–Fagetum crenatae. L-Fc : *Leucosceptrum stellipilum* var. *tosaense–Fagus crenata* community. St-Fj : Styraco shiraianae–Fagetum japonicae.

ests not only in eastern but also in western (central) China.

In addition, there is a dense bamboo growth in the shrub or herb layer of *Fagus* forests in both China and Japan. In lower mountains of central China, the main bamboo species are *Indocarlamus latifolius*, *I. longiauritus* and *Chimonobambusa utilis*. The species of *Sinarundinaria*, such as *Sinarundinaria nitida* and *S. chungii*, mainly occur in higher mountains of China. In Japan, *Sasa* occurs widely under the canopy of *Fagus* forests, especially *Sasa borealis* on the Pacific side of the central mountains and *S. kurilensis* on the Japan Sea side (Hara 1983; Hukusima et al.1995; Ohno 1998; Shimano 1999). In both China and Japan, the regeneration of beech is hindered by this bamboo, and the existence of forest gaps and lack of bamboo is advantageous to beech regeneration (Nakashizuka and Numata 1982; Cao 1995; Shimano 1999). Our vegetation survey confirmed this, namely that the regeneration of beech is better in the *Fagus engleriana*－*Fagus lucida* and *Schima superba*－*Fagus hayatae* communities, due to the lack of bamboo or presence of bamboo gaps.

There is one obvious difference in species composition and structure between the *Fagus* forests of southern Japan and central China, especially western central China. In these *Fagus* forests, evergreen broad-leaved species, especially *Quercus*, *Rhododendron*, *Eurya*, *Ilex* and *Camellia*, have a higher cover-abundance value and more species in the canopy tree layer and shrub layer than deciduous broad-leaved species. For instance, 10 of the 14 species of *Quercus* are evergreen and 15 of 17 species of *Rhododendron* are evergreen. Therefore, a typical semi-evergreen (evergreen plus and deciduous broad-leaved) beech forest can be formed, such as the *Sinarundinaria chungii–Fagus lucida*, *Fagus engleriana*－*Fagus lucida* and *Carex filicina*－*Fagus longipetiolata* communities. In contrast, few evergreen broad-leaved species occur in the tree layer of the Japanese Sapio japonici－Fagetum crenatae (Miyawaki 1981, 1982). The Sapio japonici－Fagetum crenatae is a type of deciduous beech forest, and the community structure is similar to that of the *Indocalamus latifolius–Fagus hayatae* community near the Chinese east coast (Fig. 2). In addition, cold-temperate coniferous trees are well developed in the Sapio japonici－Fagetum crenatae, such as *Abies firma*, *Tsuga sieboldii* and *Abies homolepis* (Miyawaki 1981, 1982). Few cold-temperate coniferous trees occur in *Fagus* forests of central China, and the few warm-climate coniferous trees, in particular *Keteleeria davidiana*, *Cephalotaxus sinensis* and *Pinus henryi*, occur only in the *Fagus engleriana –Fagus lucida* community. Moreover, the *Fagus* forests of central China have a mean richness of more than 50 species, far higher than in the Sapio japonici－Fagetum crenatae in Kyushu and Shikoku (only 25 species in Kyushu and 28 species in Shikoku). This indicates higher species diversity in general in the *Fagus* forests of central China than in southern Japan.

Discussion

Fagus forests occur mainly in humid, cool-

temperate regions in the Northern Hemisphere (Peters 1992) but are absent from cool-temperate northern China due to its continental climate (Cao 1995). In China *Fagus* forests mainly occur in mountains of the warm-temperate and subtropical evergreen broad-leaved forest zones. By physiognomy, these *Fagus* forests can be classified into two types: semi-evergreen broad-leaved forests (mixtures of evergreen and deciduous broad-leaved trees) (Type 1) and deciduous broad-leaved forests (Type 2).

The *Sinarundinaria chungii*－*Fagus lucida*, *Fagus engleriana*－*Fagus lucida* and *Carex filicina*－*Fagus longipetiolata* communities belong to Type 1. Evergreen species are dominant in the tree understory and shrub layer, especially evergreen species of *Quercus*, *Rhododendron*, *Eurya*, *Ilex* and *Camellia*. Beech trees dominate in the canopy but are associated with other deciduous and evergreen broad-leaved trees. Herbaceous species are few in the herb layer, and there are few ferns with low coverage. Type 1 occurs mainly in mountains of western and central China, which belong to the second step of Chinese topography (1,000–2,000 m altitude). In this region there is complex and varied topography, and a warm, moist monsoon climate. Even in the Quaternary glacial period, climate changed little in these mountains (Li 1998), providing refugia for Tertiary relic plants. There are many Tertiary relic, endemic species in *Fagus* forests of Type 1, including *Davidia involucrata* var. *vilmoriniana*, *Bretschneidera sinensis*, *Tapiscia sinensis*, *Emmenopterys henryi*, *Tetracentron sinensis*, *Keteleeria davidiana*, *Pterostyrax psilophylla* and *Euptelea pleiosperma*.

Low temperature in winter is the main factor controlling the distribution of evergreen broad-leaved trees (Sakai and Larcher 1987). In mountains of western and central China, the mean January temperature (−3.2～0.4℃), WI (71.2～88.2) and CI (−22.4～−10.2) are clearly higher than in the mountains of southern Japan (−5～−3.5℃ in January; WI, 49～65; CI, −34～−18). These Chinese mountains are often covered with clouds and mist, and have a thick thermal inversion layer. This results in more evergreen broad-leaved trees in Chinese *Fagus* forests and higher species diversity. This type is a permanent vegetation type. It is impossible for evergreen broad-leaved forests to replace these Type 1 forests. Most Chinese *Fagus* forests receive freezing rain, freezing fog and heavy snow in winter and early spring, due to the continental climate and high altitude (Cao 1995; Cao and Pters 1997). Evergreen broad-leaved trees receive more serious damage than beech trees because of their dense crowns and permanent foliage. Most *Fagus* forests in China belong to this type.

The *Indocalamus latifolius*－*Fagus hayatae* community (Type 2) is an overwhelmingly deciduous broad-leaved forest type. It occurs mainly in the hilly land of east-central China near the coast, which belongs to the lowest step of Chinese topography (less than 1,000 m altitude). Although these areas have a warmer climate, and the frequency and intensity of freezing damage are far less than for Type 1, evergreen broad-leaved trees are few and *Fagus hayatae* dominates absolutely in the tree layer. We considered that typhoons and rainstorms are the principal factor affecting the growth of evergreen broad-leaved trees in these areas. The climate of these areas has two rainfall peaks, the "plum rains" in June and rainstorms in August or September. Typhoons occur during the growing season of evergreen broad-leaved trees (July–September), 1–2 times every year. Rainstorms with a daily mean rainfall of over 50 mm occur on 7–9 days. In the Chinese *Fagus* range, rainstorm frequency increases towards the eastern coast (Cao and Pters 1997). Freezing, typhoons and rainstorms damage the branches and leaves of trees and bring more serious damage for evergreen broad-leaved trees on steep slopes, because evergreen broad-leaved trees have a dense crown. As a result, restoration of evergreen broad-leaved trees is more difficult than for deciduous broad-leaved trees. In study areas of Type 2, we found the A_0 layer of the soil profile to be thin (0–2 cm) and the roots of trees are commonly exposed at the surface. In addition, the evergreen broad-leaved trees of the adjacent vegetation are dwarfed and clumped at Qingliangfeng (Song 1997). At Sihaishan, the canopy height of *Fagus* forests is only 12–15 m. This is related to frequent disturbance by typhoons and rainstorms.

The site environment of the *Indocalamus latifolius–Fagus hayatae* community (Type 2) is obviously different from those of other *Fagus* communities in Tape 1. The *Indocalamus latifolius – Fagus hayatae* community grows in the warm, low-altitude zone, on steep upper slopes. It is easily disturbed by wind. So, the soil of Type 2 may be drier than that of Type 1. It seems to be a disadvantage for evergreen broad-leaved trees, but we must get more data to confirm it.

The species composition and structure of the *Indocalamus latifolius – Fagus hayatae* community in eastern China are similar to the composition and structure of the Sapio japonici–Fagetum crenatae in southern Japan, because both are affected by the maritime climate. In addition, southern Japan separated from the Asian mainland only at the end of the Miocene, after which the vegetation of Japan and China diverged somewhat (Hotta 1974). Of course, the vegetation in eastern China has a close relationship with that of southern Japan, but *Fagus* forests in Zhejiang (*Indocalamus latifolius – Fagus hayatae* community) do occur further south (28～30° N) and at lower elevation (900～1,040 m). Thus, the climate of the Zhejiang forests is warmer than that of the *Fagus crenata* forests in Kyushu and Shikoku. The *Indocalamus latifolius – Fagus hayatae* community contains more evergreen broad-leaved species in the shrub and herb layers than does the Sapio japonici – Fagetum crenatae, but coniferous trees are rare.

Acknowledgements

We would like to express our appreciation to Prof. Dr. Cao Kun-Fang of the Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, for his invaluable suggestions and present literature. We are also very grateful to Prof. Dr. K. Ohno, and Prof. Dr. T. Kikuchi and Dr. You Hai-Mei, of the Graduate School of Environment and Information Sciences of Yokohama National University, for their useful advice on data analysis and literature. We would like to thank Prof. Liu Sheng-Xiang of Central China Normal University, Prof. Zhang Fang-Gang of Zhejiang Museum of Natural History and Zhao Zi-En of Wuhan Botanical Institute, Chinese Academy of Sciences for their help in the field study and identification of species. We also thank Prof. Dr. E. O. Box, University of Georgia (USA) not only for help in the fieldwork but also for discussions and English editing.

References

Braun-Blanquet, J. 1964. Pflanzensoziologie, Grundzuge der Vegetationskunde, 3 Aufl. 631 pp. Springer-Verlag, Wien.

Cao, K.-F. 1995. *Fagus* dominance in Chinese montane forests: natural regeneration of *Fagus lucida* and *Fagus hayatae* var. *pashanica*. 116 pp. Doctoral thesis, Wageningen Agricultural University, Wageningen.

Cao, K.-F. and Peters, R. 1997. Species diversity of Chinese beech forests in relation to warmth and climatic disturbance. Ecol. Res. **12** : 175–189.

Chang, Y.-T. and Huang, C.-C. 1988. Notes on Fagaceae (2). Acta Phytotaxonomica Sinica **26** (2) : 111–119. (in Chinese with English abstract)

Fang, J.-Y. and Yoda, K. 1989. Climate and vegetation in China 2: distribution of main vegetation types and thermal climate. Ecol. Res. **4** : 71–83.

FAO. 1988. FAO-UNESCO soil map of the world. World Resources Rep. 60 pp. FAO, Rome.

Fujiwara, K. 1987. Aims and methods of phytosociology or "vegetation science". Plant ecology and taxonomy to the memory of Dr. Satoshi Nakanishi, pp. 607–628. Kobe Geobotanical Society, Kobe.

Hara, M. 1983. A study of the regeneration process of a Japanese beech forest. Ecol. Res. **20** : 115–129.

Hong, B.-G. and 'An, S.-Q. 1993. A preliminary study on the geographical distribution of *Fagus* in China. Acta Botanica Sinica **35** (3) : 229–233. (in Chinese with English abstract)

Hotta, M. 1974. History and geography of plants. pp. 233–346. Sanseido, Tokyo. (in Japanese)

Hukusima, T., Takasuna, H., Matsui, T., Nishio, T., Kyan, Y. and Tsunetomi, Y. 1995. New phytosociological classification of beech forests in Japan. Jap. J. Ecol. **45** : 79–98. (in Japanese with English abstract)

Kira, T. 1945. A new classification of climate in eastern Asia as the basis for agricultural geog-

raphy. 23 pp. Hort. Inst. Kyoto Univ., Kyoto. (in Japanese)
Kira, T. 1977. A climatological interpretation of Japanese vegetation zones. Miyawaki, A. and Tuxen, R. (eds.). Vegetation science and environmental protection, pp.21–30. Maruzen, Tokyo.
Li, W.-Y. 1998. Quaternary vegetation and environment in China. 253 pp. Science Press, Beijing. (in Chinese)
Miyawaki, A. (ed.). 1981. Vegetation of Japan. Part 2: Kyushu. 484 pp. Shibundo, Tokyo. (in Japanese with German abstract)
Miyawaki, A. (ed.). 1982. Vegetation of Japan. Part 3: Shikoku. 539 pp. Shibundo, Tokyo. (in Japanese with German abstract)
Nakashizuka, T. and Numata, M. 1982. Regeneration process of climax beech forests. 1. Structure of a beech forest with the undergrowth of Sasa. Jap. J. Ecol. **32** : 57–67.
Northwest Teacher's College. 1984. Physical geography atlas of China. 200 pp. Map Publishing House, Beijing. (in Chinese)
Ohno, K. 1998. Phytosociological classification of beech forests on the Japan Sea Coast (Saseto kurilensae–Fagion crenatae). Abstracts of 3rd Congress of Vegetation Science, Japan, p. 45. Yokohama. (in Japanese)
Peters, R. 1992. Ecology of beech forests in the northern hemisphere. 122 pp. Doctoral thesis, Landbouwuniversiteit, Wageningen.
Peters, R. 1997. Beech forests. 169 pp. Kluwer Academic Publishers, Dordrecht.
Sakai, A. and Larcher, W. 1987. Forest survival of plants, responses and adaptation to freezing stress. 321 pp. Springer-Verlag, Berlin.
Sasaki, Y. 1970. Versuch zur systematischen und geographischen Gliederung der Japanischen Buchenwaldgesellschafte. Vegetatio **20** : 214–249.
Shimano, K. 1999. The effects of snow upon Japan Sea type beech forests. J. Phytogeogr. Taxon. **47** : 97–106. (in Japanese with English abstract)
Song, C.-S. (ed.). 1997. Scientific survey of Qingliangfeng Nature Reserve. 180 pp. Forest Press, Beijing. (in Chinese with English abstract)
Song, C.-S. and Liu, S.-X. 1999. Scientific survey of the Hubei Houhe Nature Reserve. 197 pp. Forest Press, Beijing. (in Chinese with English abstract)
Wang, X.-P. and Li, J.-Q. 1996. The study of beech forest classification in Guangxi. Bulletin of Botanical Research **16** (4) : 369–404. (in Chinese with English abstract)
Wu. Z.-L. (ed.). 2000. Forest in China. Ⅲ. 1838 pp. China Forestry Publishing House, Beijing. (in Chinese)
Wu, Z.-Y. (ed.). 1980. Vegetation of China. 1375 pp. Science Press, Beijing. (in Chinese)
Zhang, F.-G. 2000. Community characteristics of the Taiwan beech forest of Qingliangfeng Mountain in Zhejiang. Journal of Zhejiang University (Agric. & Life Sci.) **27** (4) : 403–406. (in Chinese with English abstract)
Zhou, Z.-X. (ed.). 1985. Scientific survey of the Kuankuoshui Forest Area. 236 pp. Guizhou People's Publishing House, Guizhou. (in Chinese)
Zhou, Z.-X. (ed.). 1990. Research on the Fanjing Mountain. 525 pp. Guizhou People's Publishing House, Guizhou. (in Chinese)
Zhu, K.-Z. (ed.). 1981. Physical geography of China. (Soil). 194 pp. Science Press, Beijing. (in Chinese)
Zhu, S.-Q. and Yang, Y.-Q. 1985. Structure and dynamics of *Fagus lucida* forest of Guizhou Province. Acta Phytoecologia et Geobotanica Sinica **9** (3) : 183–191. (in Chinese with English abstract)

(Received May 5, 2003; accepted October 25, 2003)

汪　正祥・藤原一繪：中国華中区域におけるブナ林の植生生態学的研究：種組成，植生構造及び生態類型

中国華中区域の東部から西部まで植物社会学的方法でブナ林を調査し，4 群落が区分された。これらの群落の種組成や構造及び制限環境要因を解析した。種組成，生活形，林分構造，及び分布を比較した結果，中国のブナ林は 2 タイプに類型化された。タイプ 1 のブナ林は常緑・落葉広葉樹混生林，温暖・湿潤気候を有する高海抜地域（1,140–1,980 m）において発達している。冬季と春季の低温及び凍害が混生林構造を形成している。タイプ 2 のブナ林は落葉広葉林の特徴を持ち，中国西部ブナ林立地より東部海岸の低海抜地（900–1,040 m）に発達し

ている。台風と暴風雨により成立しているものと考えられる。中国のブナ林と日本の九州，四国のブナ林を種組成的に比較してみると，タイプ2のブナ林（*Indocalamus latifolius*－*Fagus hayatae* community）が日本のシラキ–ブナ群集に対応していた。

（〒240–8501　横浜市保土ヶ谷区常盤台 79–7　横浜国立大学大学院環境情報学府・研究院）