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＜**Data**＞

Forest structure in a beech (*Fagus crenata* Blume) stand on a 1-ha permanent plot for the Monitoring Sites 1000 Project in Kayanodaira, central Japanese snowbelt

Hideyuki IDA

Forest structure in a beech (*Fagus crenata* Blume) stand on a 1-ha permanent plot for the Monitoring Sites 1000 Project in Kayanodaira, central Japanese snowbelt. Hideyuki IDA (Institute of Nature Education in Shiga Heights, Faculty of Education, Shinshu University, Shigakogen, Yamanouchi-machi, Nagano 381-0401, Japan. E-mail : pida@shinshu-u.ac.jp). *Bulletin of the Institute of Nature Education in Shiga Heights, Shinshu University* **50** : 33-40 (2013).

Nomenclature : Yonekura (supervised by Murata) (2012)

Introduction

Beech (*Fagus crenata* Blume) forests are the most common type of forest vegetation in the cool-temperate zone of Japan. However, in the middle of the 20th century, many beech stands were cut for fuel and pulp production and replaced by coniferous plantations. As a result, the proportion of Japan's forest area covered by natural beech forests has decreased substantially.

Two ecotypes of Japanese beech occur in the country : the Japan Sea type and the Pacific Ocean type. The Japan Sea type occurs in areas with abundant winter snowfall ; it is usually dominated by *F. crenata* in the canopy layer and often forms pure forests. The Pacific Ocean type occurs in areas that do not experience heavy snowfall and is distinguished by the formation of mixed forests with a relatively lower dominance of *F. crenata* (Shimano 2006). The beech forests of Kayanodaira, which was the location for this study, belong to the Japan Sea type.

This paper presents 2012 tree census data and stand structure for a 1-ha permanent plot of beech forest for the Monitoring Sites 1000 Project launched by the Ministry of the Environment of Japan (Ishihara et al. 2011). The 2005-2009 tree census data from the project have already been published as a Data Paper (Ishihara et al. 2011).

Site description

1) Natural environment

The Kayanodaira Heights (at 36°50′N, 138°30′E, and approximately 1400-1700m a.s.l.), belongs to Joshin'etsu-kogen National Park, located near Kijimadaira Village in the northeastern part of Nagano Prefecture. This area is a plateau originating from lava flows. At the study site, the mean annual temperature was 4.9°C and annual precipitation was 1677.5mm (1981-2010) according to Mesh Climate Data 2010 (Japan Meteorological Agency 2012). This region near the Japan Sea is characterized by abundant winter snowfall in which the snow cover usually lasts from November to the following May. The maximum snow depth reaches 3-4m annually.

2) Vegetation history

In most of Kijimadaira Village (350m a.s.l.) up to the Kayanodaira Heights, the natural vegetation is mainly forest dominated by beech. However, the area is currently also covered by various other types of forest such as larch (*Larix kaempferi*) and Japanese cedar (*Cryptomeria japonica*) plantations. Some secondary oak forests dominated by *Quercus serrata* and *Q. crispula*, and secondary birch forests typically dominated by *Betula platyphylla* var. *japonica* and *B. ermanii* also exist. Primary and secondary beech forests are confined

to a limited area above 1400m a.s.l. in the Kayanodaira Heights.

The beech stands surrounding the study plot had previously been utilized for fuelwood production. Many disused coalpits (charcoal kilns) remain within the stands. While the stands are technically secondary forests, they are considered to be old-growth beech stands. The beech-dominated forest is mostly national forest at present and is conserved as the Kayanodaira Natural Recreation Forest.

Fagus crenata-dominated forests in this region belong to the Aucubo-Fagetum crenatae, which is an association attached to the larger Saso kurilensis-Fagion crenatae association (Miyawaki et al. 1994). This association usually grows on thick fertile soils under the mesic conditions of the Japan Sea climate, with its heavy winter snowfall. An undergrowth of dwarf bamboo, including *Sasa kurilensis* and *S. senanensis*, is present. *Sasa*, a monocarpic plant genus, is a typical undergrowth vegetation type in Japanese beech forests and may have a large impact on the regeneration of the forests (Ida and Nakagoshi 1996). The simultaneous death of *Sasa* improves the survival rate of seedlings and a large seedling bank can be produced (Nakashizuka 1988 ; Abe et al. 2001).

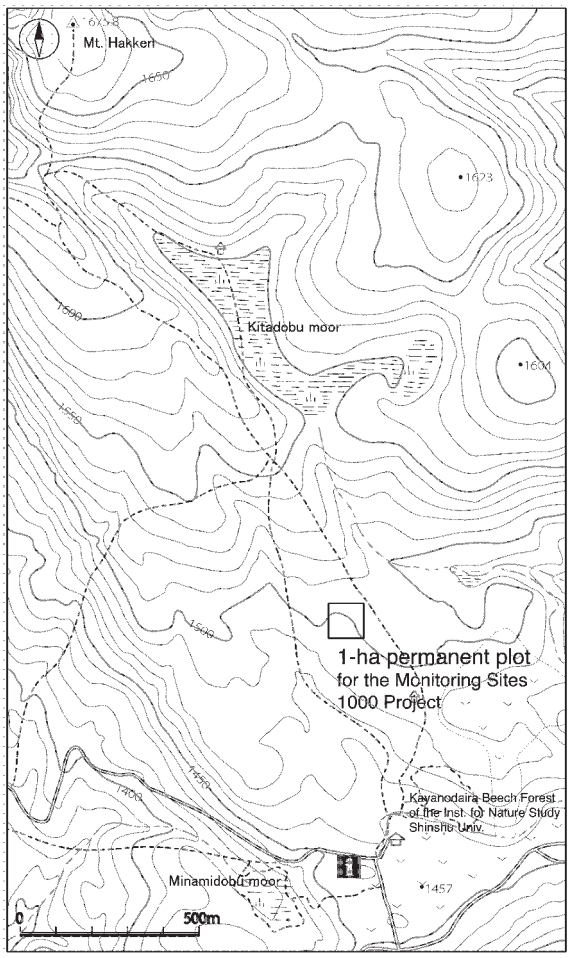

Fig. 1. Map of the study site showing the location of a 1-ha permanent plot for the Monitoring Sites 1000 Project in Kayanodaira. Dashed line shows nature trails.

Outline of the permanent plot

1) Research history of the plot (Figs. 1, 2)

A permanent plot (named KYD ; 36°50′18″N, 138°30′00″E, 1500m a.s.l. ; Figs. 1, 2) of 1 ha (100m×100m) in area, horizontally projected on a gentle slope in an old-growth stand dominated by beech (*Fagus crenata*) was originally established in 1998. The plot was enrolled in 2005 as one of the core sites for the Monitoring Sites 1000 Project (Ishihara et al. 2011). The forest floor is characterized by dense dwarf bamboo, *Sasa senanensis*, dominates the plot. Within the plot each year as part of the monitoring project, a tree census is conducted, reproductive organs for beech and fallen litter are observed using litter traps, and ground insects are collected using pitfall traps. In and around the plot, the bird community is also surveyed every year.

Fig. 2. The *Fagus crenata* stand in a 1-ha permanent plot for the Monitoring Sites 1000 Project in Kayanodaira in 2012.

In and around the plot, ecological studies have been undertaken since 1995. For example, an approximately 10-ha permanent stand was established to investigate the bird community. Sixty-six bird species have been recorded in the breeding season, with a strong presence of hole-nesting birds (Hotta et al. 2000). Ida et al. (2004) reported the predispersal predation of beech seeds by rodents, as observed using a tree tower set near the plot (Hotta et al. 2001). In 2011 and 2012, the monitoring of carbon dynamics (Hirota et al. 2011) and an investigation of the chemical characteristics of soil organic matter (Iimura et al. 2012, 2013) were conducted in the plot.

2) Vegetation

Fagus crenata is the dominant canopy tree species in the plot, but other arboreal species such as *B. ermanii* and *Aesculus turbinata* sometimes occur in the canopy. *Acer nipponicum*, *A. japonicum*, *A. rufinerve*, *Sorbus commixta*, *Padus grayana*, *Tilia japonica*, *Euonymus macropterus*, *Hydrangea paniculata*, and *Viburnum furcatum* are abundant in the shrub layer. *Dryopteris expansa*, *Thelypteris quelpaertensis*, *Carex multifolia*, *Maianthemum dilatatum*, and *M. japonicum* appear frequently in the herb layer. An undergrowth of *S. senanensis* exists in the stands.

3) Tree census data (Table 1, Figs. 3-6, Supplement)

All living trunks in the plot with a trunk girth at breast height 130cm (GBH) ≥15cm have been tagged with an aluminum plate (Fig. 3a) holding an ID number (A0001-A1164 in 2012 ; shown in the attached supplement) and identified, and the coordinates (N[x]-W[y] axis ; Fig. 3b) for the position of trunk roots have been recorded since 2005. Measurements of GBH (Fig. 4), confirmation of the survival of all tagged trunks, and an investigation of newly recruited trunks have been conducted every autumn (September-November) since 2006. Additionally in 2012, the forest layer to which each tagged trunk belonged was classified as having either a vertically unshaded trunk crown (unshaded area ≥30%, i.e., shaded area < 70%) or a shaded trunk crown (unshaded area < 30%, i.e., shaded area ≥70% ; Fig. 5). The layers were distinguished by their vertical physiognomy as I) the trunk reached the canopy ; II) trunk height ≥5m under the canopy or trunk height < 10m in the fully opened canopy gap ; or III) shrub (trunk height <5m).

Fig. 3. (a) An aluminum plate holding the trunk ID number (Racetrack Aluminum Tags, Forestry Supplies Inc.) with a stainless steel nail (#12×50mm) and (b) a red plastic pile (Etapron K-50, Juzen Corp.), driven into the ground at intervals of 10m, showing the coordinates (N[x]-W[y] axis written with the oil-based marker ; Magic Ink, Teranishi Chemical Industry Co., Ltd.) for the position in a 1-ha permanent plot for the Monitoring Sites 1000 Project in Kayanodaira.

The 2012 measurements of species composition, basal area, density, and characteristics of diameter at breast height 130cm (DBH ; GBH/π) of all living trunks (≥5cm DBH) in the 1-ha plot are shown in Table 1. Trunks <5cm DBH were omitted in Table 1. In total, 20 woody species were recorded in the plot. A frequency distribution for the DBH of the beech population is shown in Fig. 6. Based on the shape of the distribution, the beech population appears to constantly regenerate.

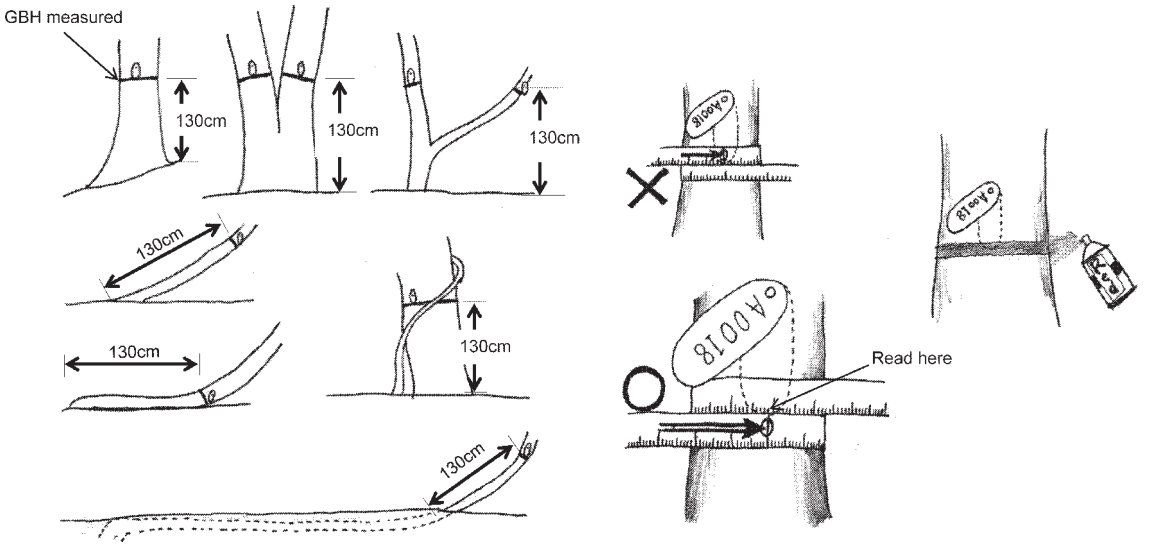

Fig. 4. Procedure for measuring the girth at breast height 1.3m (GBH) using a steel tape measure (Engineer -pocket 10m : EPK-10, TJM Design Corp.).

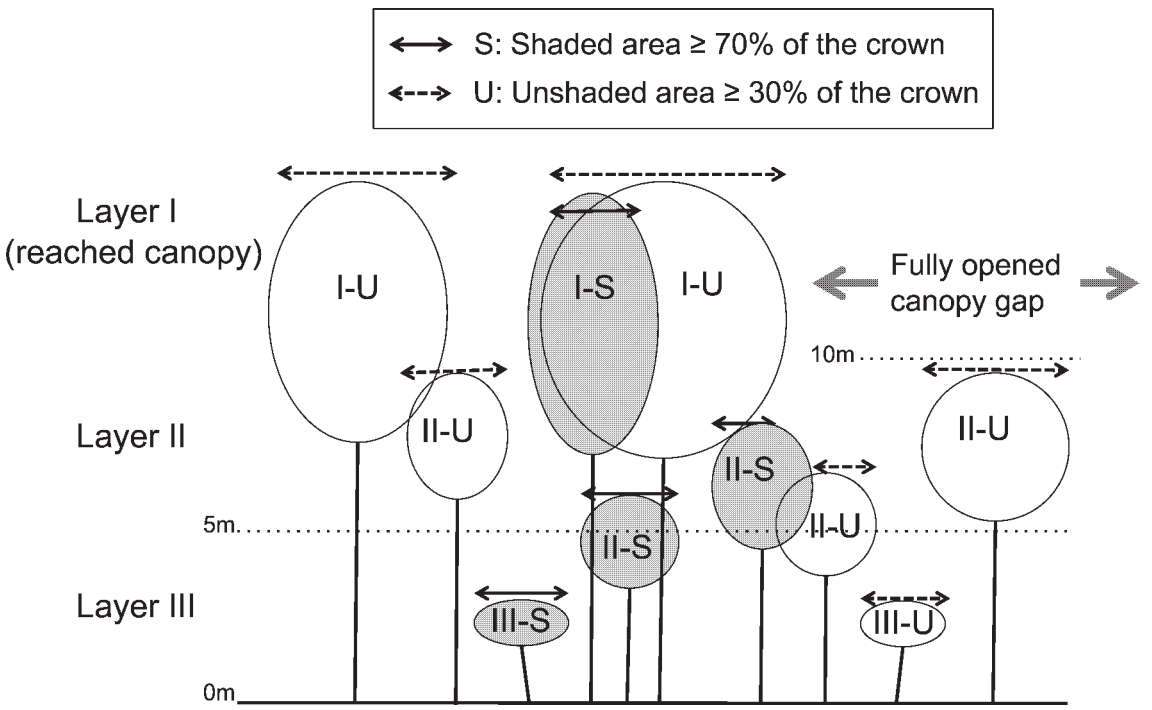

Fig. 5. Definitions of the forest layer to which the trunk belonged (I : trunk reached canopy ; II : trunk height ≥5m under the canopy or trunk height <10m in the fully opened canopy gap ; III : trunk height <5m) and whether the trunk crown was vertically shaded (S : shaded area ≥70% of the crown, i.e., unshaded area < 30%) or unshaded (U : unshaded area ≥30%, i.e., shaded area <70%) in a 1-ha permanent plot for the Monitoring Sites 1000 Project in Kayanodaira.

Table 1. Species composition, basal area, density, and characteristics of diameter at breast height 130cm (DBH) for all living trunks (≥5cm DBH) in a 1-ha permanent plot for the Monitoring Sites 1000 Project in Kayanodaira in 2012.

						Density (No./ha) for each layer*1 and crown status*2										
		Basal area (BA)		Density		I		II		III		Diameter at breast height (DBH : cm)				
Species	Family	m²/ha	%	No./ha	%	Unshaded	Shaded	Unshaded	Shaded	Unshaded	Shaded	mean ± SD	Max.	Min.	和名	科名
Fagus crenata	Fagaceae	27.89	83.6	251	25.5	83	3	6	31	18	110	27.4 ± 25.7	106.7	5.0	ブナ	ブナ
Betula ermanii	Betulaceae	1.12	3.4	5	0.5	4	–	–	–	–	1	46.7 ± 25.8	75.7	5.2	ダケカンバ	カバノキ
Aesculus turbinata	Sapindaceae	0.91	2.7	21	2.1	4	–	2	–	6	9	19.4 ± 13.4	48.8	5.1	トチノキ	ムクロジ
Acer nipponicum	Sapindaceae	0.88	2.6	185	18.8	–	–	1	1	101	82	7.4 ± 2.3	18.8	5.0	テツカエデ	ムクロジ
Chengiopanax sciadophylloides	Araliaceae	0.44	1.3	24	2.4	–	1	3	2	6	12	13.7 ± 7.0	36.2	6.7	コシアブラ	ウコギ
Acer japonicum	Sapindaceae	0.44	1.3	80	8.1	–	–	1	2	34	43	7.9 ± 2.8	18.4	5.0	ハウチワカエデ	ムクロジ
Hydrangea paniculata	Hydrangeaceae	0.44	1.3	129	13.1	–	–	–	–	60	69	6.5 ± 1.2	10.6	5.0	ノリウツギ	アジサイ
Viburnum furcatum	Adoxaceae	0.24	0.7	81	8.2	–	–	–	–	24	57	6.0 ± 0.9	8.8	5.0	オオカメノキ	レンプクソウ
Sorbus commixta	Rosaceae	0.18	0.5	36	3.7	–	–	–	–	13	23	7.6 ± 2.2	13.3	5.1	ナナカマド	バラ
Phellodendron amurense	Rutaceae	0.16	0.5	10	1.0	1	–	2	–	7	–	12.8 ± 6.6	24.0	6.4	キハダ	ミカン
Cornus controversa	Cornaceae	0.15	0.5	53	5.4	–	–	–	–	30	23	6.0 ± 0.8	8.6	5.0	ミズキ	ミズキ
Acer pictum subsp. *mayrii*	Sapindaceae	0.09	0.3	1	0.1	–	–	1	–	–	–	34.6	34.6	34.6	アカイタヤ	ムクロジ
Padus grayana	Rosaceae	0.09	0.3	21	2.1	–	–	–	–	4	17	7.2 ± 1.7	10.8	5.1	ウワミズザクラ	バラ
Acer rufinerve	Sapindaceae	0.08	0.2	14	1.4	–	–	–	1	3	10	8.4 ± 2.2	13.2	5.7	ウリハダカエデ	ムクロジ
Euonymus macropterus	Celastraceae	0.07	0.2	19	1.9	–	–	–	–	5	14	6.8 ± 1.3	9.2	5.0	ヒロハノツリバナ	ニシキギ
Tilia japonica	Malvaceae	0.07	0.2	9	0.9	–	–	–	–	4	5	9.4 ± 3.3	15.5	5.3	シナノキ	アオイ
Corylus sieboldiana	Betulaceae	0.06	0.2	23	2.3	–	–	–	–	10	13	5.6 ± 0.6	7.8	5.0	ツノハシバミ	カバノキ
Symplocos sawafutagi	Symplocaceae	0.04	0.1	16	1.6	–	–	–	–	2	14	5.5 ± 0.6	6.9	5.0	サワフタギ	ハイノキ
Acer tschonoskii	Sapindaceae	0.01	<0.1	3	0.3	–	–	–	–	1	2	6.7 ± 0.5	7.3	6.2	ミネカエデ	ムクロジ
Toxicodendron trichocarpum	Anacardiaceae	0.01	<0.1	3	0.3	–	–	–	–	3	–	5.6 ± 0.1	5.7	5.5	ヤマウルシ	ウルシ
Total		33.37	100.0	984	100.0	92	4	16	37	331	504	12.9 ± 16.3	106.7	5.0		

*1 I : trunk reached canopy ; II : trunk height ≥5m under the canopy or trunk height <10m in the fully opened canopy gap ; III : trunk height <5m.

*2 Unshaded (unshaded area ≥30%, i.e., shaded area <70%) ; Shaded (shaded area ≥70% of the crown, i.e., unshaded area <30%).

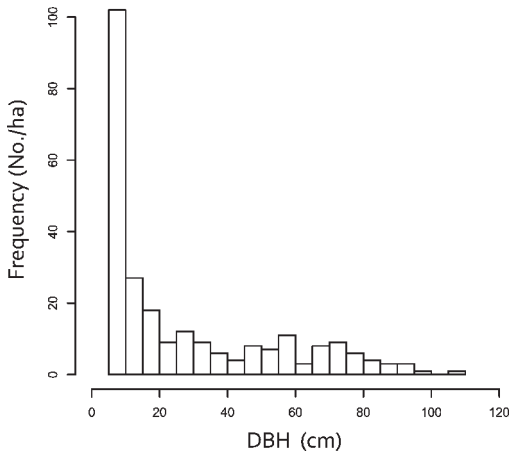

Fig. 6. Frequency distribution of *Fagus crenata* living trunks (≥5cm diameter at breast height : DBH, n=251) as the most dominant tree in a 1-ha permanent plot for the Monitoring Sites 1000 Project in Kayanodaira in 2012.

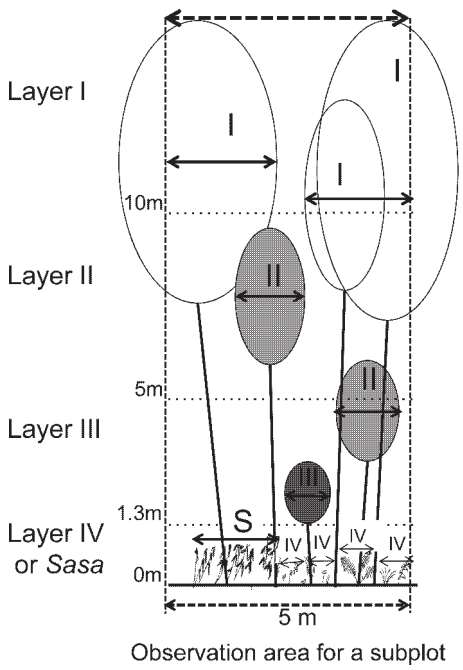

Fig. 7. Definition of the five layers by vertical physiognomy in 400 subplots of 5m×5m in a 1-ha permanent plot for the Monitoring Sites 1000 Project in Kayanodaira. I) canopy (height≥10m) ; II) subcanopy (≥5m) ; III) shrub (<5m) ; IV) undergrowth, including woody and herbaceous plants and lianas lower than *Sasa* cover or 1.3m in height without *Sasa* cover ; S) *Sasa* cover.

4) Layer structure of the stand (Figs. 7, 8)

The plot was divided into 400 subplots of 5m× 5m. Each subplot was divided into five layers by vertical physiognomy (Figs. 7, 8) : I) canopy (height ≥10m) ; II) subcanopy (height <10m, ≥ 5m) ; III) shrub (height <5m) ; IV) undergrowth ; or S) *Sasa* cover. The "undergrowth" category included woody and herbaceous plants and lianas lower than *Sasa* cover or 1.3m in height without *Sasa* cover. For each layer, percent coverage was determined by a visual inspection. The field survey was conducted in October 2012, before leaves began to fall.

Acknowledgments

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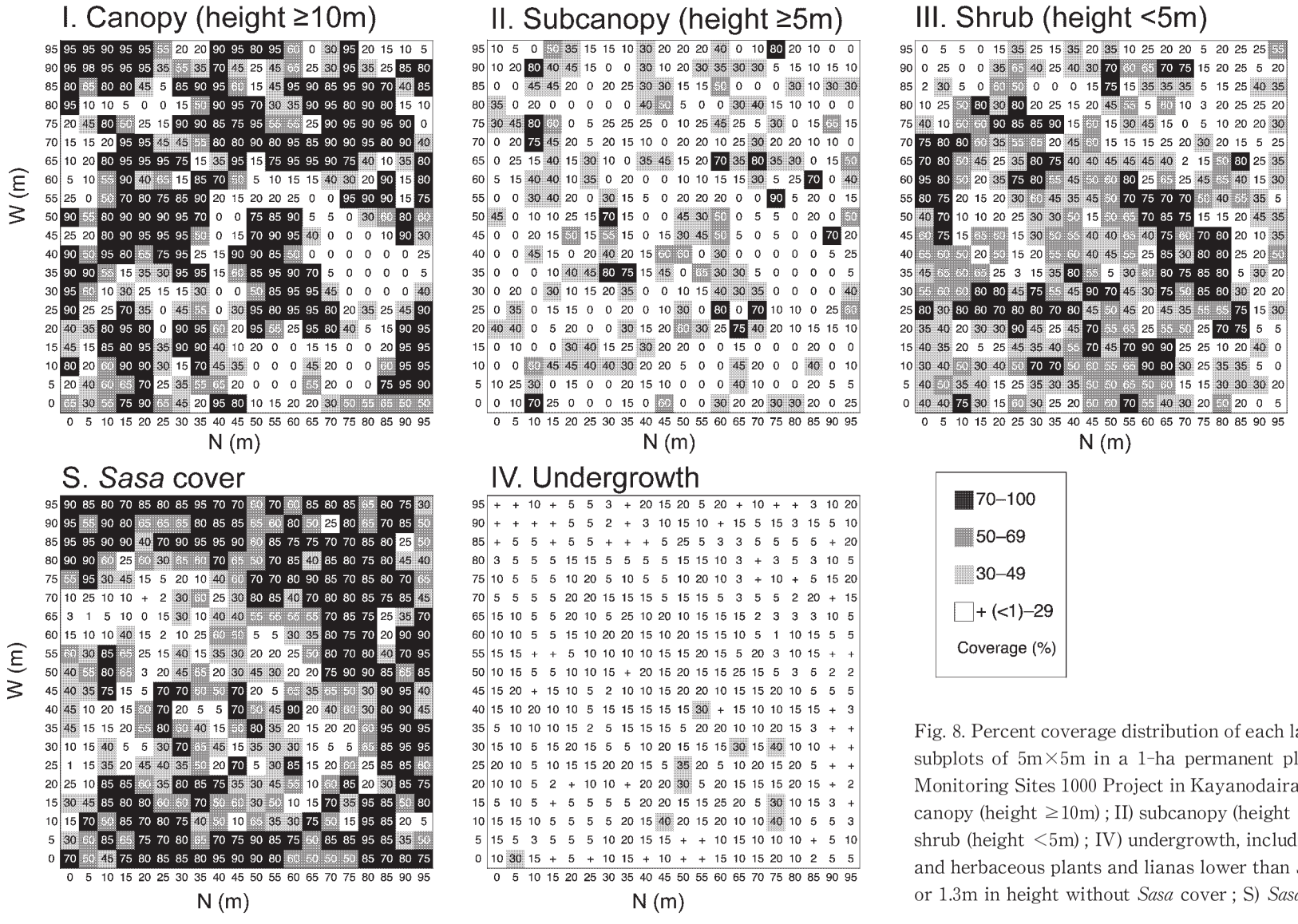
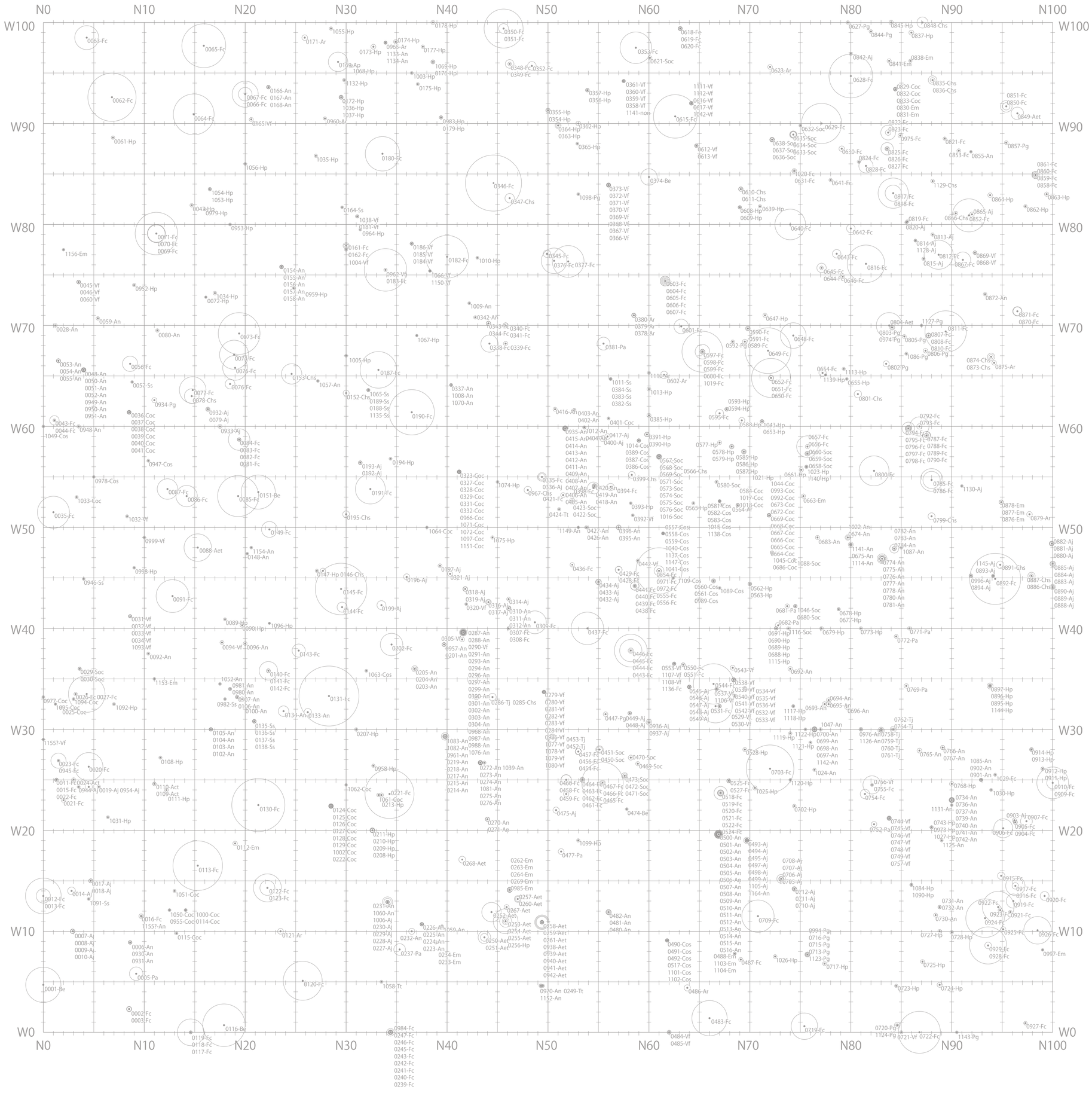


Fig. 8. Percent coverage distribution of each layer in 400 subplots of 5m×5m in a 1-ha permanent plot for the Monitoring Sites 1000 Project in Kayanodaira in 2012. I) canopy (height ≥10m) ; II) subcanopy (height ≥5m) ; III) shrub (height <5m) ; IV) undergrowth, including woody and herbaceous plants and lianas lower than *Sasa* cover or 1.3m in height without *Sasa* cover ; S) *Sasa* cover.



List of woody species

Abbreviations	Scientific name	Japanese name
Fc	Fagus crenata	BUNA
Be	Betula ermanii	DAKE-KAMBA
Aet	Aesculus turbinata	TOCHI-NOKI
An	Acer nipponicum	TETSU-KAEDE
Chs	Chengiopanax sciadophylloides	KOSHIABURA
Aj	Acer japonicum	HAUTCHIWA-KAEDE
Hp	Hydrangea paniculata	NORI-UTSUGI
Vf	Viburnum furcatum	OHKAMENOKI
Soc	Sorbus commixta	NANAKAMADO
Pa	Phellodendron amurense	KIHADA
Coc	Cornus controversa	MIZUKI
Ap	Acer pictum subsp.mayrii	AKA-ITAYA
Pg	Padus grayana	UWAMIZU-ZAKURA
Ar	Acer rufinerve	URIHADA-KAEDE
Em	Euonymus macropterus	HIROHANO-TSURIBANA
Cos	Tilia japonica	SHINANOKI
Tj	Corylus sieboldiana	TSUNO-HASHIBAMI
Ss	Symplocos sawafutagi	SAWAHUTAGI
Act	Acer tschonoskii	MINE-KAEDE
Tt	Toxicodendron trichocarpum	YAMA-URUSHI

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Author for correspondence: IDA, Hideyuki (Institute of Nature Education in Shiga Heights, Faculty of Education, Shinshu University, Shigakogen, Yamanouchi-machi, Nagano 381-0401, Japan. E-mail: pida@shinshu-u.ac.jp).

Map of the 1-ha permanent plot for the Monitoring Sites 1000 Project in Kayanodaira in 2012, showing the position of the root ("•" labeled trunk ID) for all living individuals with a trunk diameter at breast height 130 cm (DBH) ≥5 cm. Size of circles (○) indicates the relative DBH size. Supplement for IDA,H. (2013).