

東京大学日光植物園四阿屋根の植物相

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**Flora on the Shingled Roof of an Arbor in the Botanical
 Gardens, Nikko(Tochigi Pref.), Honshu, Japan**

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東京大学日光植物園四阿屋根の植物相

The Botanical Gardens, Nikko, Faculty of Science, University of Tokyo is located near the northern boundary of the Kanto District (139°36'E, 36°45'N) with the highest point of 647m above sea level and the temperate climate with the mean annual temperature (at 9 o'clock in a. m.) of 12.1°C, the mean annual precipitation of 2168mm and the mean annual humidity of 69%. The area of the Gardens, extending

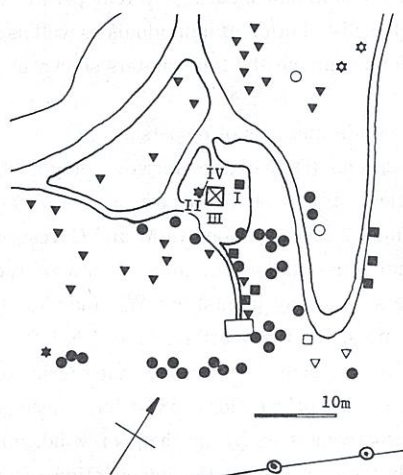


Fig. 1. Map showing the arbor investigated and distribution of trees. Roman numerals showing the four quarters of the roof. *Cryptomeria japonica* (●), *Chamaecyparis obtusa* (▼), *Pinus densiflora* (■), *Alnus hirsuta* var. *sibirica* (★), *Ulmus Davidiana* var. *japonica* (▽), *Zelkova serrata* (⊗), *Acer cissifolium* (○), *A. Mono* (□).

up to 10 hectares, is mostly occupied by woody plants. About 2000 species of higher plants are now cultivated wildly.

There is an arbor in the Gardens surrounded with tall trees belonging to 8 species (Fig. 1). The wooden, lowly pyramidal roof, 25.92m² in size, is covered with a shingle made of *Cryptomeria japonica* bark. The arbor was repaired in 1957, and then the shingle was made a complete exchange (Fig. 2A). The bark used was gathered at Nikko. Several years after, it was

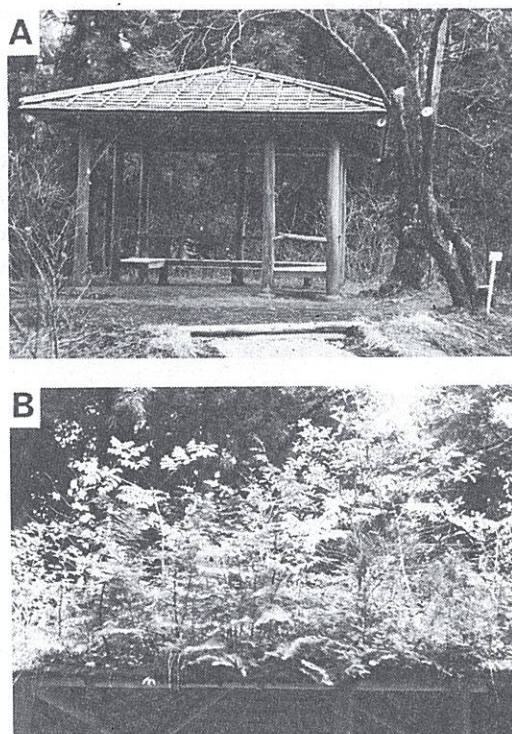


Fig. 2. A. The arbor with shingle roof. The picture taken at the repaired year (1957). B. The roof of the same arbor in 1980.

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noted that many species of higher plants were naturally grown on the shingle roof. High precipitation and humidity seem to be favourable for their germinating and survival. In 1980, the arbor, then it looked like a sapling nursery, became exposed to serious danger (Fig. 2B). On September 3 of this year, the aerial parts of the plant grown on the roof were entirely cut down for the maintenance of the arbor. At that time, the floristic composition, the methods of dispersal of each species, the number of individuals of each species of woody plants, the fresh weight of woody plants, and the height of woody plants exceeding 40cm high are investigated. The methods of dispersal here adopted are expressed with the combination of three characters. The methods are summarized as follows :

Method	Disseminules	State
W Wind	F Fruit	a dust
A Animals	S Seed	b winged, plum-
M Mechanical	P Having ap-	ed or wolly
G Gravity	pendages as aril	c fleshy or juicy
	or bract scale	d others

The floristic composition and measuring were undertaken on all the four quarters of the roof. The main aims of this investigation are to be confirmed the flora of such peculiar situation and the main methods of dispersal of species found.

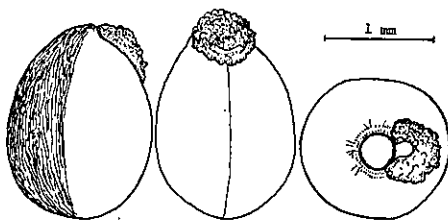


Fig. 3. Seed of *Viola mandshurica* collected at Nikko (J. MATSUMURA in 1885 (T1))

RESULTS AND DISCUSSION

1. The floristic composition

The number of species found on the shingle roof is 50, of which 3 are Pteridophyta, 6 are Gymnosperms and 41 are Angiosperms (monocotyledonous species 3, dicotyledonous 38). These species are enumerated in Tab. 1. 37 species (74% of the floristic composition) are woody, and others (13%) are perennial herb.

2. The number of woody plants and the fresh weight and height

The total number of individuals of woody plants is 534 (Tab. 1). The dominants are *Chamaecyparis obtusa* (249 numbers, the fresh weight of the aerial part is 12.3kg), *Cryptomeria japonica* (69, 0.85kg), *Hydrangea paniculata*(31), *Ilex serrata*(24), *Clethra barbinervis*(24), *Pinus densiflora*(21), and *Acer cissifolium*(19). Among these species three conifers and *Acer cissifolium* are planted around the arbor (Fig. 1). These trees might be affected to the specific dominance of themselves.

Trees exceeding 1m are *Hydrangea paniculata* (2.3m ; 1.8m), *Prunus Jamasakura* (2.2m), *Betula Maximowicziana* (2.1m ; 1.2m), *Cercidiphyllum japonicum* (2m), *Salix Bakko* (2m), *Aralia elata* (1.9m ; 1.2m), *Betula grossa* (1.6m) and *Chamaecyparis obtusa* (1.5m). All these except *Chamaecyparis obtusa* are sun tree and known as pioneers to such exposed situations of bare lands and new clearings in temeperate region.

The distribution of individuals as well as species is different among the four quaters shown in Tab. 2.

3. The main methods of dispersal

34 species (68% of the floristic composition) are classified in W, 14 (28%) are done A, and the remaining 2 species belong to M and G, respectively. 467 individuals (approximately 87.5% of the total numbers of woody plants) are W. Individuals of A are dominant in the quarter IV faced NNW.

As the result it is confirmed that species of more than the half of the flora (68%) have been able to establish themselves by the help of wind, and 28% have become spread by the introduction of animals (all by fruit- or seed-eating birds). Both wind and animal (bird) dispersal methods are certainly most effective to establish plants in such exposed bare situation. Almost members of the flora on the roof are cultivated or grow naturally in the Gardens. But no fruiting plants of *Betula Maximowicziana*, *Sorbus alnifolia* and *S. japonica* are known to occur in and around the Gardens. Good fruit-bearers of these grow in Oku Nikko area belonging to cool-temperate climatic zone more than 10km far from here. Their disseminules might be carried to here from farther area by wind or animals (birds).

There are two cases of special interest. *Quercus serrata* produces heavy seeds which have no special

Table 1. The list of species found on the shingle roof, and the methods of dispersal, the distribution in each quarter of the roof, the number of, individuals the height and fresh weight of the aerial part of each species.

Species ¹⁾	Main method of dispersal ²⁾	I (ENE)		II (WSW)		III (SSE)		IV (NNW)		Total n. of individuals	Total weight
		N. of individuals	Max. height	N. of individuals	Max. height	N. of individuals	Max. height	N. of individuals	Max. height		
<i>Abies firma</i> Sieb. et Zucc.	WPb	—	cm	—	—	1	—	—	—	1	kg
<i>Pinus densiflora</i> Sieb. et Zucc.	WPb	9	70	6	—	2	—	4	90	21	1.25
<i>Cryptomeria japonica</i> (L.f.) D. Don	WSb	44	40	11	—	4	—	10	90	69	0.85
<i>Chamaecyparis obtusa</i> (Sieb. et Zucc.) Sieb. et Zucc.	WSb	67	70	61	—	38	—	83	150	249	12.3
<i>C. pisifera</i> (Sieb. et Zucc.) Sieb. et Zucc.	WSb	1	—	—	—	1	—	—	—	2	—
<i>Taxus cuspidata</i> Sieb. et Zucc.	APc	—	—	1	—	—	—	—	—	1	—
<i>Salix Bakko</i> Kimura	WFB	1	—	—	—	1	200	—	—	2	—
<i>Alnus hirsuta</i> Turcz. var. <i>sibirica</i> (Fisch.) C. K. Schn.	WFB	2	—	—	—	—	—	—	—	2	—
<i>Betula Ermanii</i> Cham.	WFB	1	70	1	—	—	—	—	—	2	—
<i>B. grossa</i> Sieb. et Zucc.	WFB	1	160	—	—	—	—	—	—	1	—
<i>B. Maximowicziana</i> Regel	WFB	1	120	1	210	—	—	—	—	2	—
<i>B. platyphylla</i> Sukat. var. <i>japonica</i> (Miq.) Hara	WFB	1	60	—	—	—	—	—	—	1	—
<i>Quercus serrata</i> Thunb.	GSd	1	—	3	—	1	—	1	—	6	—
<i>Zelkova serrata</i> (Thunb.) Makino	AFd	—	—	1	—	—	—	—	—	1	—
<i>Morus bombycis</i> Koidz.	AFc	—	—	2	—	—	—	1	—	3	—
<i>Cercidiphyllum japonicum</i> Sieb. et Zucc.	WFB	7	40	2	200	—	—	2	—	11	—
<i>Hydrangea involucrata</i> Sieb.	WSa	—	—	1	—	—	—	—	—	1	—
<i>H. paniculata</i> Sieb.	WSa	12	100	6	—	7	180	6	230	31	—
<i>Schizophragma hydrangeoides</i> Sieb. et Zucc.	WSa	—	—	—	—	—	—	—	—	1	—
<i>Deutzia gracilis</i> Sieb. et Zucc.	WSa	—	—	—	—	—	—	1	—	1	—
<i>Spiraea japonica</i> L. f.	WSa	—	—	—	—	1	—	—	—	1	—
<i>Prunus Jamasakura</i> Sieb. ex Koidz.	AFc	—	—	—	—	1	220	13	—	14	12.7
<i>P. verecunda</i> (Koidz.) Koehne	AFc	—	—	—	—	—	—	—	—	1	—
<i>Rubus palmatus</i> Thunb. var. <i>coptophyllus</i> (A. Gray) Koidz.	AFc	—	—	—	—	—	—	—	—	1	—
<i>Sorbus alnifolia</i> (Sieb. et Zucc.) K. Koch	AFc	—	—	—	—	—	—	1	—	1	—
<i>S. japonica</i> (Decne.) Hedl.	AFc	—	—	—	—	—	—	—	—	1	—
<i>Rhus ambiguus</i> Lavallée ex Dipp.	AFc	—	—	1	—	1	—	—	—	2	—
<i>Acer cissifolium</i> (Sieb. et Zucc.) K. Koch	WFB	4	—	2	—	2	—	11	—	19	—
<i>A. mono</i> Maxim.	WFB	7	—	2	—	1	—	6	—	16	—
<i>A. palmatum</i> Thunb. subsp. <i>amoenum</i> (Carr.) Hara	WFB	—	—	1	—	—	—	2	—	3	—
<i>A. rufinerve</i> Sieb. et Zucc.	WFB	—	—	1	—	—	—	2	—	1	—
<i>Ilex serrata</i> Thunb.	AFc	1	—	4	—	3	—	16	—	24	—
<i>Aralia elata</i> (Miq.) Seemann	AFc	—	—	2	190	—	—	7	120	9	—
<i>Clethra barbinervis</i> Sieb. et Zucc.	WSa	13	100	4	—	—	—	7	—	24	—
<i>Rhododendron japonicum</i> (A. Gray) Suringer	WSa	1	—	—	—	—	—	—	—	1	—
<i>Lonicera tenuipes</i> Nakai var. <i>glandulosa</i> (Maxim.) Nakai	AFc	—	—	—	—	—	—	2	—	2	—
<i>Weigela decora</i> (Nakai) Nakai	WSa	2	—	—	—	2	—	2	—	6	—
<i>Davallia Mariesii</i> Moore	WSa	—	—	+	—	—	—	—	—	534	27.1
<i>Athyrium yokoscense</i> (Franch. et Sav.) Christ	WSa	++	—	++	—	—	—	—	—	—	—
<i>Pleopeltis Onoei</i> (Franch. et Sav.) Okuyama ex Ohwi	WSa	—	—	+	—	—	—	—	—	—	—
<i>Boehmeria tricuspis</i> Makino	WFn	—	—	+	—	—	—	+	—	—	—
<i>Ampelopsis glandulosa</i> (Wall.) Momiyama var. <i>heterophylla</i> (Thunb.) Momiyama	AFc	—	—	+	—	—	—	—	—	—	—
<i>Viola mandshurica</i> W. Becker	MSd	—	—	+	—	—	—	—	—	—	—
<i>Aralia cordata</i> Thunb.	AFc	+	—	—	—	—	—	+	—	—	—
<i>Artemisia indica</i> Willd. var. <i>Maximowiczii</i> (Nakai) Hara	WFB	+	—	—	—	—	—	+	—	—	—
<i>Aster leiophyllus</i> Franch. et Sav.	WFB	—	—	—	—	—	—	+	—	—	—
<i>Solidago Virga-aurea</i> subsp. <i>asiatica</i> (Nakai) Kitamura	WFB	+	—	+	—	+	—	+	—	—	—
<i>Hosta laocifolia</i> (Thunb.) Engler	WSb	—	—	—	—	—	—	—	—	—	—
<i>Calamagrostis arundinacea</i> Roth var. <i>brachytricha</i> Hack.	WFB	+	—	—	—	—	—	—	—	—	—
<i>Miscanthus sinensis</i> Anderss.	WFB	+	—	—	—	—	—	—	—	—	—

1. The sequence of families is that of 12th ed. of Engler's Syllabus der Pflanzenfamilien (Melchior & Werdermann, 1954; Melchior 1964).

2. W: Wind. A: Animals. M: Mechanical. G: Gravity. F: Fruit. S: Seed or spore. P: Aril or bract scale. a: dust. b: winged, plumed or woolly. c: fleshy or juicy. d: others.

mechanism to disperse. The seeds of such oaks as *Quercus serrata* are considered to be clithochory (e. g. Hotta 1974). Recently Nakao (1978) suggested the possibility of dispersion by some kind of birds. However, it is difficult to decide whether this *Quercus* on the roof might be carried here by birds or monkey or by children's trifling.

The dispersal method of *Viola* is principally mechanical, but seeds of *Viola* have a caruncle and are known to be palatable to ants as their food (Sernander 1906, Makino 1943, Hotta 1974). The seed of *V. mandshurica* apparently has a caruncle and is somewhat sweet (Fig. 3). Thus, the seed of this *Viola* might have been carried on the roof from a ground level habitat by ants. But, there is no denying the possibility that in sticking the shingle bark the seeds might be present here from the beginning.

Table. 2. Distribution of the species and the individuals of woody plants among the four quarters

Quarter	I	II	III	IV
N. of species	19	20	15	18
N. of individuals of woody plants ¹⁾	176	113	66	175

1) By the lack of data, four species, *Schizophragma hydrangeoides*, *Prunus verecunda*, *Rubus palmatus* var. *coptophyllus* and *Sorbus japonica* could not distribute to any quarter.

It may be supposed that differences of the floristic composition and the total number of individuals of woody plants among the four quarters of the roof are affected by their location. In the quarter III the wind flow is obstructed by the less interrupted trunks of ever green conifers (Fig. 1). The front of the quarter I and IV is rather open. The great increase of the individuals of wind dispersing woody plants in the quarter I and IV is thought to be directly related to the exposed situation to wind flow towards these two quarters. Especially the front of the quarter IV is a pond. Birds are resting in the quarter IV much more than in the other three quarters. The predominancy

of animal dispersing woody plants in the quarter IV is thought to be apparently related to this circumstance.

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東京大学理学部附属植物園日光分園内にある四阿の杉の柿葺き屋根 (面積 25.92 m²) に自然に生えた植物の種類とそのうちの木本性植物の個体数, 高さ, 地上部の生重量を調べた。この屋根は 1957 年に葺直したもので, 調査したのはそれから 23 年経過した 1980 年 9 月である。その結果 50 種の高等植物が生育していることが判明した (表-1)。木本性植物の総本数は 534 本, 地上部の生重量は 27.1 kg であった。個体数の多い種はヒノキ, スギ, ノリウツギ, ウメモドキ, リョウブ, アカマツ, ミツデカエデであった。ノリウツギ, ヤマザクラ, ウダイカンバ, カツラなど 8 種 11 個体が高さ 1 m を超していた。最高はノリウツギの 2.30 m であった。50 種のうち, 34 種が風散布, 14 種が動物散布 (すべて鳥による), 2 種 (コナラ, スミレ) がその他の散布方法によって, 散布体がこの屋根に運ばれ定着したとみられる。50 種のうち, ウダイカンバ, ウラジロノキ, アズキナシの 3 種は植物園やその周辺に結実する個体が見当らないから, 日光地方における本来の生育地である奥日光から散布体が運ばれてきたと推測される。コナラとスミレの存在は散布方法と関連して興味深い, 結局のところどのようにして屋根に散布体もたらされたか断定はできない。コナラについては鳥類やサル, スミレについてはアリによる散布が十分考えられるが, 前者では子供のいたずら, 後者では工事時に杉皮に附着してきた可能性を否定できない。四阿の四角錐状の屋根を形作る 4 面の間には種類, 個体数に差があった (表-2)。これらの差は四阿をかこむ周囲の環境に密接な関係があると思われる。

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○ 井上幸三著: マクシモービチと須川長之助 岩手植物の会 1981.6.10 発行。B 6 版, 302 頁, 2,000 円。

須川長之助はマクシモービチの命に従い, 日本国内を踏査して, 植物採集に従事した人物として知られる。著者は, 長之助と同郷の関係から, 彼の生涯に興味を持たれるまゝ, 長年にわたって研究をつづけて来られたが, その成果がみられる本著が生れた。当時の世相も知れることができ, 興味深い。 (里見信生)