THE ALPINE VEGETATION OF MT. FUJI

Mikio TOHYAMA

Department of Botany, Faculty of Agriculture
Hokkaido University, Sapporo, Japan

Received December 11, 1967

Introduction

Fuji, one of the most beautiful mountains facing the Pacific Ocean in central Japan, is a dormant volcano. The first eruption occurred in 781 A.D., followed by series of eruptions in 800, 826, 864, 870, 937, 999, 1033, 1083, 1511, 1560, 1700 and 1707[1]. Owing to the repeated eruptions, the vegetation of the upper part of Mt. Fuji at the present time is unstable and occupies bare land over 2600m~2800m elevation. The barren area is mainly composed of new basaltic lava-flows and in the upper part, of pyroclastic ejecta[2,3]. The latter consist of volcanic bombs, scoria, lapilli and coarse ash. The tree-line is estimated to lie from 2300 m to 2750 m elevation. The tree-line as here defined, means the upper limit of the distribution of the Japanese larch (*Larix leptolepis*). Between the upper barren area and the tree-line, the zone of alpine vegetation is developed. In 1911 Prof. B. HAYATA[4] called this zone "the *Salix-Alnus* region and the higher grass region". But the present author treats this zone in this paper as that of "the alpine vegetation". The most striking fact is that there is no dwarf Siberian pine, *Pinus pumila*, on Mt. Fuji. This species is commonly distributed and often forms impenetrable thicket in the alpine zone elsewhere in Japan. In addition, alpine plants are very poor in number of species. The vegetation on the upper part of Mt. Fuji presents a remarkable simplicity, but the plant-communities are not uniform, as they show different constructions in species depending upon such conditions as the volcanic construction, the topography, etc. Among the higher plants in the alpine vegetation, *Alnus maximowiczii*, *Salix reinii* and *Polygonum weyrichii* var. *alpinum* are commonly found. In general, these species

1) TSUYA, H. (1955): Geological and Petrological Study of Volcano Fuji, V. Bull. Earthq. Res. Inst. **33**-3. 341~382.
2) MACHIDA, H. (1964): History of the Volcano Fuji and its outskirts by Tephrochronology. Chigaku-zasshi. **73**-6. 337~350. (in Japanese)
3) ———— (1965): Geomorphological map of Volcano Fuji.
4) HAYATA, B. (1911): The Vegetation of Mt. Fuji. 95~101.

[Jour. Facul. Agr. Hokkaido Univ., Sapporo, Vol. 55, Pt. 4, 1968]

are often found on new volcanoes in Japan.

This paper consists of two parts:—I. the first part is a phytosociological study and, II. the second part deals with the geographical distribution of the higher plants on the upper part of Mt. Fuji.

The writer expresses his sincere appreciation to Emeritus Prof. Dr. M. TATEWAKI for his kind direction and ever-willing advice.

I. Phytosociological Study

The alpine vegetation, occupying a zone averaging 200 m~300 m wide, is poorly developed and lies between the tree-line and the upper barren area. The alpine vegetation is mainly divided into two associations based on the edaphic conditions:—one association is represented by the herb, *Polygonum weyrichii* var. *alpinum*, and the other, the shrub, *Alnus maximowiczii*.

1. The association of *Polygonum weyrichii* var. *alpinum*

This association is widely distributed as a part of the alpine vegetation of Mt. Fuji. Beside *Polygonum weyrichii* var. *alpinum*, *Salix reinii*, *Arabis serrata* var. *serrata*, *Stellaria nipponica* and *Artemisia pedunculosa* are often found, but they occur in scattered fashion. The present association is composed of the following four sociations:- a) *Polygonum weyrichii* var. *alpinum*-, b) *Astragalus adsurgens*-, c) *Salix reinii*-, and d) *Polygonum cuspidatum* form. *compactum* sociations.

a) The *Polygonum weyrichii* var. *alpinum* sociation

This sociation is the commonest and most representative one in the alpine vegetation of Mt. Fuji. It is developed from 2300 m to 2800 m elevation, and shows some differences in sociological composition. In the highest part, *Polygonum weyrichii* var. *alpinum* is dominant and accompanied by a few individuals of *Stellaria nipponica*. At lower elevation, *Salix reinii*, *Arabis serrata* var. *serrata* and *Artemisia pedunculosa* occur, and generally the degree of plant-cover increases.

[1. a] belt-transect $(20 \times 1)m^2$ *Polygonum weyrichii* var. *alpinum* sociation

The result of the phytosociological analysis of the [1. a] belt-transect at 2500 m elevation on Fuji's northern slope is shown in Table 1.

b) The *Astragalus adsurgens* sociation

This sociation belongs to the *Polygonum weyrichii* var. *alpinum* association. It is composed of almost the same species as the *Polygonum weyrichii* var. *alpinum* sociation, but *Astragalus adsurgens* plays an important role. It is developed at about 2400 m elevation, where gravels prevail and where the

TABLE 1. [1. a] belt-transect (20×1) m² Cover degree and frequency of the plants in the *Polygonum weyrichii* var. *alpinum* sociation

Distance (m) / Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Freq. (%)	C.V.
Polygonum weyrichii var. *alpinum*	1	1	1		1	1		1	2	2		1		1	+	2	1	1		1	75	538
Salix reinii	1						+	1		1	1		1		1	+			1		45	175
Artemisia peduncalosa	+													+							10	
Arabis serrata var. *serrata*				+									+								10	
Stellaria nipponica				+															+		10	

substratum of this soiation is not in such an unstable condition as in that of the former sociation.

[1. b] belt-transect (20×1) m² *Astragalus adsurgens* sociation

The result of the phytosociological analysis of the [1.b] belt-transect at 2400 m elevation on the northern slope is shown in Table 2.

TABLE 2. [1. b] belt-transect (20×1) m² Cover degree and frequency of the plants in the *Astragalus adsurgens* sociation

Distance (m) / Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Freq. (%)	C.V.
Astragalus adsurgens		1	1	1	1	+		1		3	+	1		1		1	+	1	3	1	75	625
Arabis serrata var. *serrata*	+	1	1	+		+		+	+	+			+				+	+	1		60	75
Polygonum weyrichii var. *alpinum*	1									1	+		1								20	75
Artemisia peduncalosa		1	+																		10	25
Salix reinii	1																				5	25

c) The *Salix reinii* sociation

In general, *Salix reinii* is scattered in the upper fringing zone of *Betula ermanii*— and *Larix leptolepis* forests, often forming the present sociation. The willow in question shows the creeping form and attains a height of 20 cm. The elements of this sociation are almost the same species as enumerated in the former sociations.

[1. c] belt-transect (20×1) m² *Salix reinii* sociation

The result of the phytosociological analysis of the [1. c] belt-transect at

TABLE 3. [1. c] belt-transect $(20\times1)\,m^2$ Cover degree and frequency of the plants in the *Salix reinii* sociation

Distance (m) / Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Freq. (%)	C.V.
Salix reinii		3	2				+	1	3	1	1		1			1	2			1	50	675
Polygonum cuspidatum form. *compactum*					3								1	1				1			20	263
Alnus maximowiczii	1														2					+	15	113
Polygonum weyrichii var. *alpinum*												1		1					1		15	75
Larix leptolepis																1					5	25
Arabis serrata var. *serrata*												+									5	

2450 m elevation on the northern slope is shown in Table 3.

[1. c'] belt-transect $(20\times1)\,m^2$ *Salix reinii* sociation

The result of the phytosociological analysis of the [1. c'] belt-transect at 2500 m elevation on the northeastern slope is shown in Table 4.

TABLE 4. [1. c'] belt-transect $(20\times1)\,m^2$ Cover degree and frequency of the plants in the *Salix reinii* sociation

Distance (m) / Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Freq. (%)	C.V.
Salix reinii	1	1	2	1	2	+		1		1		1	1	1			2	1		1	70	513
Polygonum weyrichii var. *alpinum*						1	+	1	1										1		25	100
Artemisia pedunculosa		1		1					+				1								20	75
Arabis serrata var. *serrata*																		+			5	

d) The *Polygonum cuspidatum* forma *compactum* sociation

In general, this sociation is distributed on wastelands of the montane district in central Japan. However, it is sometimes found in special sites such as on the upper part of recent volcanoes like Mt. Fuji and others. On Mt. Fuji the sociation, in which *Polygonum cuspidatum* form. *compactum* is dominant occurs in two associations. One is developed in the alpine vegetation as mentioned above. It is distributed from (2000 m~) 2300 m to 2500 m on the northern slope and the sociological construction is similar to that of the *Polygonum weyrichii* var. *alpinum* sociation. That is the *Polygonum cuspidatum* form. *compactum* sociation in the alpine vegetation. The other is found

in the *Cirsium purpuratum* association, developed at 1200 m to 2000 m on the southeastern slope. This slope was severely influenced by fall of ejecta from the great eruption in 1707. Due to that eruption, no forest has developed even at present, and the vegetation superficially resembles the alpine one. However the components of the latter sociation are quite different, the important elements being represented by *Cirsium purpuratum* and *Campanula punctata* var. *hondoensis* and accompanied by lower montane plants.

[1. d] belt-transect $(20\times1)\,m^2$ *Polygonum cuspidatum* forma *compactum* sociation

The result of the phytosociological analysis of the [1. d] belt-transect at 2450 m elevation on the northern slope is shown in Table 5.

TABLE 5. [1. d] belt-transect $(20\times1)\,m^2$ Cover degree and frequency of the plants in the *Polygonum cuspidatum* form. *compactum* sociation

Distance (m) / Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Freq. (%)	C.V.
Polygonum cuspidatum form. *compactum*	2	+	1		1	2	1			2	1			1	1		2		2	1	65	613
Polygonum weyrichii var. *alpinum*		1	+	1					1				1	1		1			1		40	175
Salix reinii		1			1			1	1				1	1							30	150
Arabis serrata var. *serrata*				+						+		1									15	25

2. The association of *Alnus maximowiczii*

One of the remarkable plant-communities of the alpine vegetation developed on the lava-flow is mainly represented by the *Alnus maximowiczii* association from 2400 m to 2700 m on the eastern slope. The height of the shrubby alder is about 50 cm. Although the alder is the principal species, *Larix leptolepis* and *Salix reinii* sometimes occur in the association. A ground flora occurs which differs both in the degree of plant-cover and in the kinds of species when compared with the *Polygonum weyrichii* var. *alpinum* association. It is to be noted that Mt. Fuji is the southern limit of the distribution of *Alnus maximowiczii*. The present alder community in the needle-leaved forest zone on Fuji was reported by the present author[1] in 1966.

[2. a] belt-transect $(10\times1)\,m^2$ *Alnus maximowiczii* sociation

The result of the phytosociological analysis of the [2. a] belt-transect at 2500 m elevation on the eastern slope is shown in Table 6.

1) TOHYAMA, M. (1966): Upper deciduous broad-leaved forests of Mt. Fuji. Mem. Fac. Agr. Hokkaido Univ. **6**-1, 42~44. (in Japanese)

TABLE 6. [2.a] belt-transect (10×1) m² Cover degree and frequency of the plants in the *Alnus maximowiczii* sociation

Species \ Distance (m)	1	2	3	4	5	6	7	8	9	10	Freq. (%)	C.V.
Alnus maximowiczii	3	1	5	4	4	3	4	3	2	4	100	4725
Salix reinii	1	3				1	+	1	1		60	575
Cassiope lycopodioides	2	1			+		+		1		50	275
Larix leptolepis						1		1	1		30	150
Artemisia pedunculosa	1	+		1							30	100
Saussurea triptera	+	1	1								30	100
Solidago virga-aurea var. *leiocarpa*					+			1		1	30	100
Phyllodoce nipponica				+				1			20	50
Deschampsia flexuosa				+					+		20	50
Festuca ovina							1		+		20	50
Carex oxyandra						1					10	50

II. Geographical Distribution

The geographical distribution of the plants growing in the alpine vegetation is here treated from the view-point of the distribution-types according to the HULTÉN[1] and TATEWAKI[2] systems. The unit of the discussion is based on the species. The following table enumerates the species found in the alpine vegetation and their distribution-type followed by the arrangement using OHWI's classification[3,4].

TABLE 7. Families, species and distribution-types of the alpine elements

Family	Species	Distribution-type
Lycopodiaceae	*Lycopodium selago* LINN. var. *appressum* DESV.	sp. Circumpolar
Ophioglossaceae	*Botrychium lanceolatum* ANGSTR.	Circumpolar
	Botrychium lunaria SWARTZ	Cosmopolite
Salicaceae	*Salix reinii* FRANCH. et SAVAT.	Japanese
Betulaceae	*Alnus maximowiczii* CALL.	Eastern Asiatic

1) HULTÉN, E. (1927~1930): Flora of Kamtchatka and the Adjascent Islands. I~IV.
2) TATEWAKI, M. (1963): Hultenia. Jour. Fac. Agr. Hokkaido Univ. **53** pt. 2. 131~199.
3) OHWI, J. (1957): Flora of Japan, Pteridophyta.
4) —— —— (1965): Flora of Japan, rev. ed.

Polygonaceae	*Polygonum weyrichii* FR. SCHM. var. *alpinum* MAXIM.	sp. Japanese
Caryophyllaceae	*Stellaria nipponica* OHWI	Japanese
Cruciferae	*Arabis serrata* FRANCH. et SAVAT. var. *serrata*	sp. Japanese
Leguminosae	*Astragalus adsurgens* PALL.	Eastern Asiatic
	Astragalus membranaceus BUNGE var. *obtusus* MAKINO	sp. Eastern Asiatic
	Hedysarum vicioides TURCZ.	Eastern Asiatic
Ericaceae	*Cassiope lycopodioides* D. DON	Northern Pacific
	Phyllodoce nipponica MAKINO	Japanese
	Vaccinium vitis-idaea LINN.	Circumpolar
Orobanchaceae	*Boschniakia rossica* FEDTSCH. et FLEROV	Asiatic–Western American
Compositae	*Artemisia pedunculosa* MIQ.	Japanese
Cyperaceae	*Carex oxyandra* KUDO	Asiatic Pacific
	Carex stenantha FRANCH. et SAVAT.	Northern Asiatic Pacific
Gramineae	*Agrostis flaccida* HACK.	Japanese
	Deschampsia flexuosa TRIN.	Cosmopolite
Juncaceae	*Luzula oligantha* G. SAM.	Northern Asiatic Pacific

As shown in the above table, the total number of species of higher plants is only 21 representing 14 families. Among them, *Botrychium lanceolatum* is very rare in Japan. *Astragalus adsurgens* is found in a rather limited

TABLE 8. Distribution-types and the alpine species

Distribution-type	Species
Japanese	*Salix reinii*, *Polygonum weyrichii* var. *alpinum*, *Stellaria nipponica*, *Arabis serrata* var. *serrata*, *Phyllodoce nipponica*, *Artemisia pedunculosa*, *Agrostis flaccida*
Eastern Asiatic	*Alnus maximowiczii*, *Astragalus adsurgens*, *Astragalus membranaceus* var. *obtusus*, *Hedysarum vicioides*
Circumpolar	*Lycopodium selago* var. *appressum*, *Botrychium lanceolatum*, *Vaccinium vitis-idaea*
Cosmopolite	*Botrychium lunaria*, *Deschampsia flexuosa*
Northern Asiatic Pacific	*Carex stenantha*, *Luzula oligantha*
Asiatic-Western American	*Boschniakia rossica*
Northern Pacific	*Cassiope lycopodioides*
Asiatic Pacific	*Carex oxyandra*

number of localities in Japan. It is very curious that *Empetrum nigrum* var. *japonicum* is not found on Mt. Fuji, for it grows commonly on other volcanic mountains in Japan.

The following table shows the number of geographical distribution-types and the species.

There are no endemic plants, except for one variety—*Arabis serrata* var. *serrata*. From the view-point of plant distribution, the Japanese element holds first rank. Of this only *Artemisia pedunculosa* is limited to central Honshū. The Eastern Asiatic element is represented by 4 species. However, if the Northern Asiatic Pacific and the Asiatic Pacific elements are taken into consideration, the number of species in this category is 7. In addition, if the Northern Pacific and Asiatic-Western American elements are added, the number becomes 9. Quite unexpectedly, the Circumpolar element has only 3 species and the Cosmopolite element only 2 species.

Résumé

1. In the alpine vegetation of Mt. Fuji, there are the *Polygonum weyrichii* var. *alpinum*— and the *Alnus maximowiczii* associations. The former is mainly developed on the ejecta and the latter on the lava-flows.

2. The *Polygonum weyrichii* var. *alpinum* association is composed of the *Polygonum weyrichii* var. *alpinum*—, the *Astragalus adsurgens*—, the *Salix reinii*— and the *Polygonum cuspidatum* form. *compactum* sociations. The common elements found in the four sociations mentioned above are *Polygonum weyrichii* var. *alpinum*, *Salix reinii* and *Arabis serrata* var. *serrata*.

3. The *Alnus maximowiczii* association is typified by *Salix reinii* and *Larix leptolepis* beside the dominant alder. All show a shrubby form. Scattered among them on the ground are *Cassiope lycopodioides*, *Phyllodoce nipponica*, etc.

4. Alpine plants of the alpine vegetation of Mt. Fuji are few in number and have no endemic plants at the species level. From the view-point of plant distribution, the Japanese element maintains first rank.

Literature

HAYATA, B. (1911): The vegetation of Mt. Fuji.

(1929): Succession in the vegetation of Mt. Fuji. Act. For. Fenn. **34**. 1~28. pl. 12. map 1.

HULTÉN, E. (1927~1930): Flora Kamtchatka and the Adjascent Islands. I~IV.

MACHIDA, H. (1964): History of the volcano Fuji and its outskirts by Tephrochronology. Chigaku-zasshi. **73**-6. 337~350. (in Japanese)

MACHIDA, H. (1965): Geomorphological map of volcano Fuji.
OHWI, J. (1957): Flora of Japan, Pteridophyta.
——— (1965): Flora of Japan. rev. ed.
SUGIMOTO, J. (1935): Flora of Mt. Fuji. (in Japanese).
TAKEDA, H. (1924): Plants of Mt. Fuji. (in Japanese).
——— (1931): Mt. Fuji. (in Japanese).
TATEWAKI, M. (1963): Hultenia. Jour. Fac. Agr. Hokkaido Univ. **53**-2. 139～199.
———, ITO, K. & TOHYAMA, M. (1965): Phytosociological study on the forests of Japanese larch. Res. Bull. Coll. Exp. For. Hokkaido Univ. **23**-1. 83～146. (in Japanese).
TOHYAMA, M. (1966): Subalpine needle-leaved forests of Mt. Fuji. Mem. Fac. Agr. Hokkaido Univ. **6**-1. 1～34. (in Japanese).
——— (1966): Upper deciduous broad-leaved forests of Mt. Fuji. Mem. Fac. Agr. Hokkaido Univ. **6**-1. 35～46. (in Japanese).
TSUYA, H. (1955): Geological and petrological studies of Volcano Fuji, V.—5. On the 1707 eruption of Volcano Fuji. Bull. Earthq. Res. Inst. **33**-3. 341～382.
UMEMURA, J. (1902): Flora of Mt. Fuji. (in Japanese).

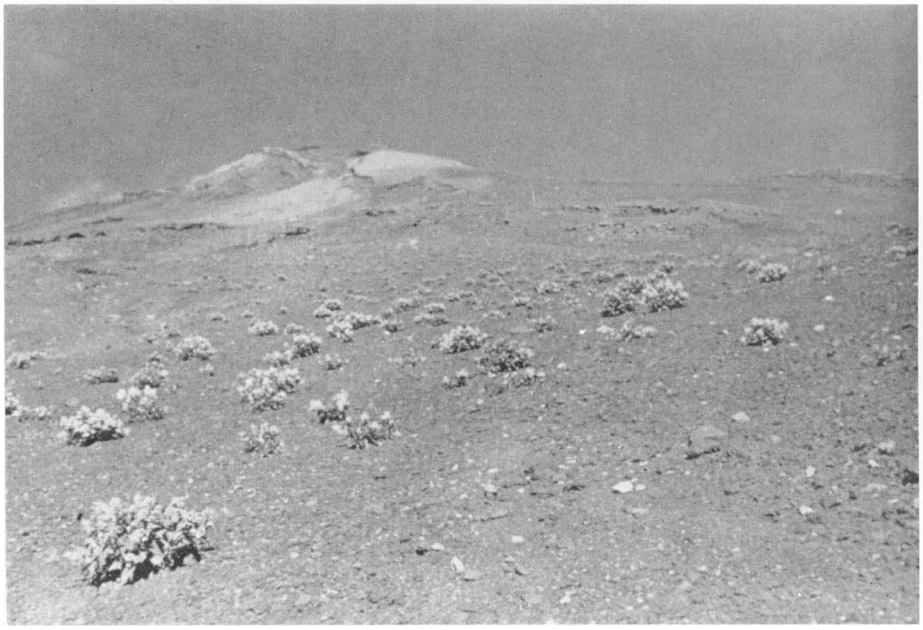

Photo 1. *Polygonum weyrichii* var. *alpinum* sociation on the northern slope (2600 m)

Photo 2. *Polygonum weyrichii* var. *alpinum* on the northern slope (2450 m)

Photo 3. *Astragalus adsurgens* on the northern slope (2400 m)

Photo 4. *Arabis serrata* var. *serrata* on the northern slope (2450 m)

Photo 5. *Salix reinii* on the northern slope (2450 m)

Photo 6. *Salix reinii* sociation on the northern slope (2450 m)