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An Introduction to Vegetation of the Daisetsuzan Mountains*

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A Landscape and climate

1 Geography and landscape

“Daisetsuzan” or “Taisetsuzan” (the Daisetsuzan Mountains) is a general term for the central highland of Hokkaido, which includes about 60 summits above 1600 m, about 20 summits above 2000 m, and the highest summit in Hokkaido (Mt. Asahidake: 2290 m). The Daisetsuzan Mountains are well known as the largest national park in Japan, whose total area reaches to ca. 230,000 ha, extending from the lower altitudes of ca. 400-500 m. The area above the forest limit at the altitudes of 1400-1600 m is also largest in Japan.

The Daisetsuzan Mountains are divided into the following four districts (Fig. 1): (A) northern Daisetsuzan, (B) central Daisetsuzan, (C) southern Daisetsuzan (Tokachi-Renpo) and (D) eastern Daisetsuzan, based on the geological and topographical characteristics described in the next paragraph.

2 Geology and topography

2.1 Northern and central Daisetsuzan

(Fig. 1. A & B: after Konoya et al. 1966, 1968; Takahashi 1990, 2000)

Both northern and central Daisetsuzan are mainly composed of an andesitic lava plateau and a number of dome-shaped volcanic cones on the lava plateau. The volcanic landforms of these districts consist of the following five elements: (1) a wide, gentle lava plateau ranging from 1400 to 1800 m, (2) dome-shaped volcanic cones whose summits are around

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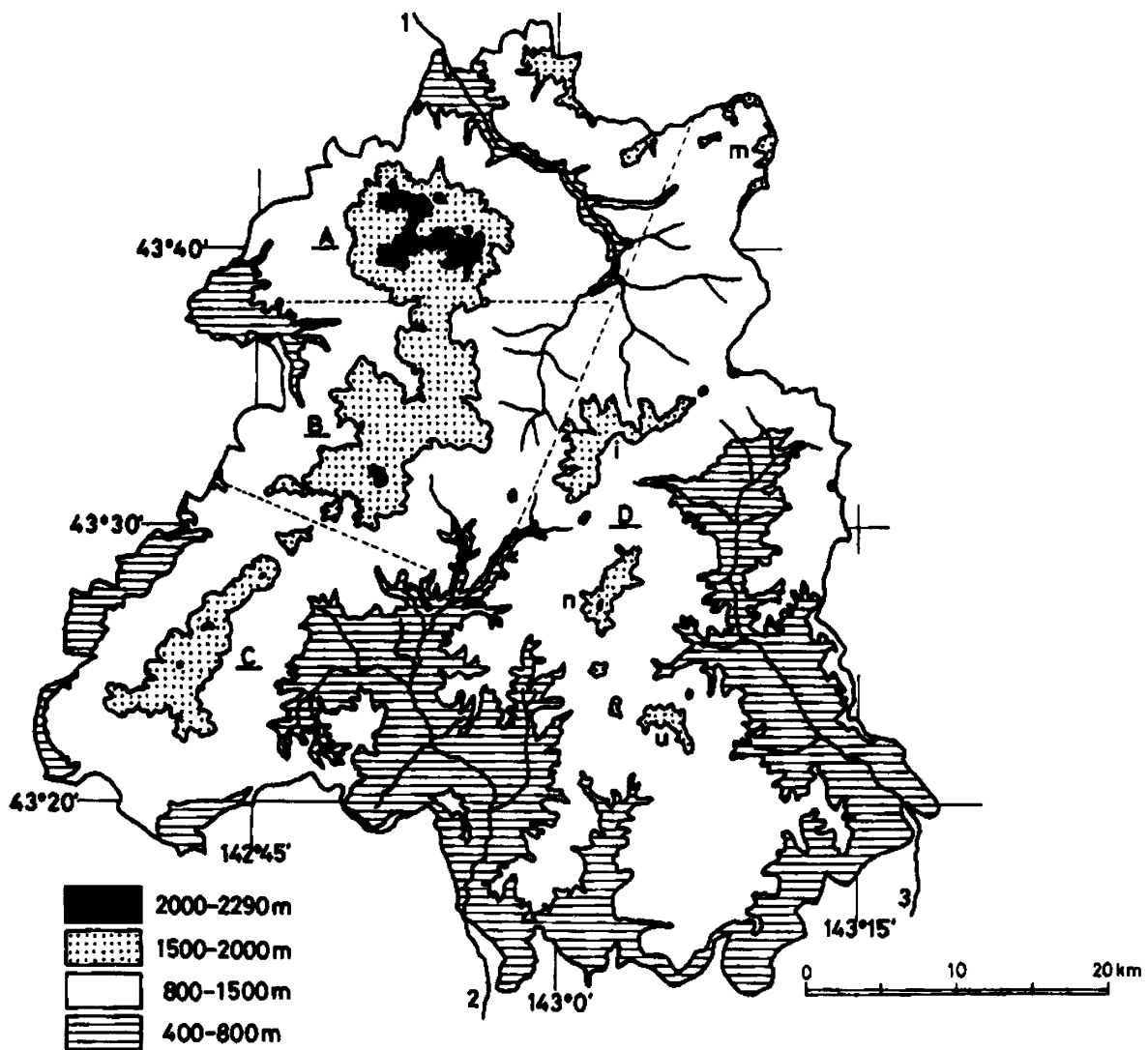


Fig. 1. Division of district in the Daisetsuzan Mountains.

- | | |
|---|------------------------|
| A. Northern Daisetsuzan | B. Central Daisetsuzan |
| C. Southern Daisetsuzan (Tokachi-Renpo) | D. Eastern Daisetsuzan |
| (m. Mt. Muridake, i. The Ishikaridake Mountains, | |
| n. Mt. Nipesotsuyama, u. Mt. Upepesankeyama) | |
| 1. Ishikarigawa River, 2. Tokachigawa River, 3. Otofukegawa River | |

2000 m, (3) Ohachidaira crater about 2 km in diameter, (4) Asahidake strato-volcano and (5) large-scale landslides (Holocene). The formation of these two districts occurred in the following four stages: (I) formation of the base of the Daisetsu volcanic group (Plio-Pleistocene), (II) formation of the Older Daisetsu Volcano (detailed age is not known), (III) formation of the Younger Daisetsu Volcano, including the formation of Ohachidaira crater (detailed age not known) and (IV) formation of the Asahidake volcano (Holocene).

Northern Daisetsuzan includes the following three kinds of summits, the former two forming a double crater: (2, II) dome-shaped volcanic cones (Mt. Kurodake, 1984 m; Mt.

Hokuchindake, 2244 m; Mt. Hakuundake, 2230 m; Mt. Koizumidake, 2158 m; etc.), (3, III) summits on Ohachidaira crater (Mt. Mamiyadake, 2185 m; Mt. Hokkaidake, 2149 m; etc), and (4, IV) Mt. Asahidake (2290 m) on the outside of the double crater. On the other hand, central Daisetsuzan is characterized by development of (1, I) gentle lava plateaus (Takanegahara, 1700-1860 m; Goshikigahara, 1560-1860 m; Koganegahara, 1500-1750 m; Numanohara, 1420-1450 m; etc), and the only known (2, II) dome-shaped cone (Mt. Tomuraushiyama, 2141 m: highest in the district).

The area above the forest limit is much larger in northern and central Daisetsuzan than those of the other districts, extending ca. 12 km in N-S direction and ca. 9 km in W-E direction in the former and ca. 15 km in both N-S and W-E directions in the latter, respectively.

2.2 Southern Daisetsuzan

(Tokachi-Renpo; Fig. 1. C: after Katsui et al. 1963; Sako & Hasegawa 1957)

Southern Daisetsuzan is a volcanic row, elongating straightly in NE-SW direction. The area above the forest limit in this district extends ca. 25 km in length with width of ca. 1-4 km. The formation of the volcanic row occurred in the following stages (Fig. 3): (I) formation of the Older Tokachidake Volcanoes (Mt. Furanodake, 1912 m; Genshigahara, 1000-1300 m; etc.: middle Pleistocene), (II) formation of the Middle Tokachidake Volcanoes (Mt. Bieidake, 2052 m; Mt. Oputateshikeyama, 2013 m; Mt. Kamihorokametokkuyama, 1920 m: late Pleistocene), and (III) formation of the Younger Tokachidake Volcanoes (Mt. Bieifuji, 1888 m; Mt. Tokachidake, 2077 m: Holocene). These mountains are composed of various basaltic and andesitic ejecta.

Briefly speaking, the central volcanic row around Mt. Tokachidake is younger. By contrast, the northeastern and southwestern ends of the volcanic row, i.e. Mt. Oputateshikeyama and Mt. Furanodake are much older, both of which are characterized by the dissected, steep landforms.

2.3 Eastern Daisetsuzan

(Fig. 1. D: after Hasegawa et al. 1961; Saito et al. 1960; Yamagishi & Matsunami 1976)

Eastern Daisetsuzan is a general term for the highland composed of some scattered mountains, with length of 2-12 km and width of 0.5-2 km above the forest limits. Both Mt. Muridake (Fig. 1. m: 1876 m) and the Ishikari Mountains (Fig. 1. i: Mt. Yuniishikaridake, 1745 m; Mt. Otofukekeyama, 1932 m; Mt. Ishikaridake, 1966 m) are mainly composed of Hidaka Super Group (slates and sandstones, Pre-Tertiary) and overlaid by diorite and

diabase (Miocene). These landforms are fairly steep.

The other mountains which are the older volcanoes, are also characterized by the dissected, rather steep landforms: Mt. Upepesankeyama (Fig. 1. u: 1836 m) is composed of welded tuff (Miocene); Mt. Nishikumaneshiriyama (1638 m) formed as a dissected lava plateau consists of augite andesite (Pliocene); Mt. Nipesotsuyama (Fig. 1. n: 2013 m), Mt. Maruyama (1692 m) and Mt. Mukayama (1759 m) are composed of hyperstene hornblende andesite or hornblende augite andesite (early Pleistocene).

3 Climate and periglacial phenomena above the forest limit

(after Sone 1999; Sone & Takahashi 1988; Takahashi 1990, 2000)

Climatic conditions actually measured above the forest limit in northern and central Daisetsuzan are as follows: the mean annual air temperature ranges from -3.8°C to -5.2°C ; the coldest month is January with a monthly mean from -22.0°C to -15.9°C ; the warmest month is August or July, with a monthly mean from 10.2°C to 13.9°C . The air temperature above the forest limit corresponds to that of a discontinuous permafrost zone.

The total amount of precipitation in summer, measured above the forest limit in northern Daisetsuzan, is as follows: 939.5 mm from June to September in 1995, and 976 mm from the middle of June to September in 1996. These amounts of precipitation show that the climate of the highland is more humid than that of the lowlands, where annual precipitation varies from ca. 900 to 1200 mm (952 mm in Obihiro, 1158 mm in Asahikawa).

Wind speed and direction at the altitude of ca. 2000 m. in northern Daisetsuzan, which were observed in winter of 1985, 1997 and 1998, are as follows: the monthly mean wind speed from October to April exceeded 10 m/s, and especially in January the speed was close to 15 m/s; the instantaneous wind speed exceeded 30 m/s, and the maximum wind speed sometimes was 45.1 m/s; the main wind direction was WNW or WSW. These results show that strong westerly wind prevails in winter above the forest limit in the Daisetsuzan Mountains.

The area above the forest limit in the Daisetsuzan Mountains is the most typical periglacial region in Japan, with many kinds of periglacial phenomena, particularly on wind-blown ground. Patterned ground includes numerous forms such as polygons, terraces, etc. Permafrost also occurs under present climatic conditions. The only known palsa bog in Japan is formed on the lava plateau at the altitude of ca. 1700 m in central Daisetsuzan.

B Actual vegetation

1 Overview

(after Igarashi et al. 1981; Ito & Sato 1981; Kira 1948, 1949; Miyawaki ed. 1988; Okitsu 1984; Okitsu & Ito 1984; Sato 1988, 2000; Tatewaki 1958, 1963; Watanabe 1979)

As shown in Fig. 2, the altitudinal vegetational zones in the Daisetsuzan Mountains are divided into three zones: (1) montane mixed forest zone (below ca. 800 m), (2) subalpine evergreen needle-leaved forest zone (from ca. 800 m to the forest limit at 1400-1600 m), and (3) *Pinus pumila* zone (above the forest limit).

The mixed forest zone is composed of not only cool-temperate hardwoods such as *Acer mayrii*, *Acer mono*, *Cercidiphyllum japonicum* (Katsura tree), *Fraxinus mandshurica* var. *japonica*, *Quercus mongolica* var. *grosseserrata*, *Tilia japonica*, *Tilia maximowicziana*, *Ulmus davidiana* var. *japonica*, *Ulmus laciniata*, etc, but also subarctic conifers such as *Abies sachalinensis*, *Picea Glehnii* and *Picea jezoensis*, although the latter conifers dominate in the subalpine zone. The mixed forest zone is characterized physiognomically by the intermixing of deciduous broad-leaved forests, mixed forests of hardwoods and conifers, and

2290m	(3) The <i>Pinus pumila</i> zone Alpine chinophobus communities (Fig. 4); Subalpine and alpine chinophilous communities (Fig. 5); Subalpine <i>Pinus pumila</i> scrub community (Figs. 4-6)
1400-1600m (forest limit)	(2) Subalpine evergreen needle-leaved forest zone Subalpine tall-herb communities, the <i>Weigela middendorffiana</i> thicket and the <i>Sorbus matsumurana</i> thicket (Fig. 6); The <i>Betula ermanii</i> forest (Weigelo-Betuletum ermanii, in part); Mixed forest of <i>Betula ermanii</i> and conifers, and evergreen needle-leaved forests (Piceo-Abietum sachalinensis, Piceetum glehnii) Secondary forests (the <i>Abies sachalinensis</i> - <i>Betula ermanii</i> forest) Riverside forest (Toisuso-Populetum maximowiczii)
ca. 800m	(1) Montane mixed forest zone Evergreen needle-leaved forests and mixed forests of conifers and hardwoods (Abieti sachalinensis-Quercetum grosseserratae, Driopterido-Abietum sachalinensis); Deciduous broad-leaved forest (various <i>Quercus mongolica</i> var. <i>grosseserrata</i> dominated forests, Ulmo laciniatae-Cercidiphyllatum japonici), composed of hardwoods such as <i>Acer mayrii</i> , <i>Acer mono</i> , <i>Fraxinus mandshurica</i> var. <i>japonica</i> , <i>Quercus mongolica</i> var. <i>grosseserrata</i> , <i>Tilia japonica</i> , <i>Tilia maximowicziana</i> , <i>Ulmus davidia</i> var. <i>japonica</i> , <i>Ulmus laciniata</i> , etc; Secondary forests composed mainly of <i>Betula platyphylla</i> var. <i>japonica</i>
400-500m	Riverside willow thicket (Salicetum petsusu-sachalinensis)

Fig. 2. Altitudinal vegetational zones in the Daisetsuzan Mountains, central Hokkaido, Japan.

evergreen needle-leaved forests in part. The above montane vegetation, lacking the *Fagus crenata* forest, extends throughout the lowlands of Hokkaido, with the exception of southern Hokkaido south of the Kuromatsunai Depression, to Shimid's Line of Sakhalin and Miyabe's Line of the Kuril Islands, as well as to the Amur Basin including eastern Manchuria. This area has been considered an ecotone between temperate East Asia and subarctic Siberia, i.e. a northern ecotone between the cool-temperate and subarctic zones ("Mixed forest zone of the Far East", or "Pan-mixed forest zone": Tatewaki 1958).

The main factor controlling the boundary of the montane and subalpine zones is considered to be a thermal condition, i.e. Warmth Index (WI) of 45 month-degrees (Kira 1948, 1949). In the Daisetsuzan Mountains, many montane/cool-temperate hardwoods reach their upper limits at ca. 800 m, where WI 45 are also estimated, based on the climatic observations in the lowlands and using a temperature lapse rate (0.55°C/100 m).

On the other hand, the forest limit normally at 1400-1600 m does not clearly correspond to the thermal condition (Kira's WI 15) in the Daisetsuzan Mountains. Okitsu & Ito (1984) considered the prevailing northwesterly wind in winter as the most influential factor controlling the forest limit in Hokkaido. Okitsu (1984) also pointed out that the forest limit on the boulder fields in northern and central Daisetsuzan descended lower than the level expected when a soil layer is present, and that the development of soil layer is an important factor.

The subalpine needle-leaved forest zone sometimes includes the pure stands of *Betula ermanii*, which dominates commonly above 1300-1400 m in the Daisetsuzan Mountains. In classical studies "the *Betula ermanii* zone" has been recognized between the needle-leaved forest zone and *Pinus pumila* zone. However, current studies do not recognize this zone because of the following facts. The *Betula ermanii* forest occurs on the steep leeward slopes, covering the altitudinal range of 400-500 m, especially in eastern Daisetsuzan. On the other side, it seldom occurs on the windward slopes or on volcanic boulder slopes, especially around Mt. Tokachidake in southern Daisetsuzan. The *Betula ermanii* forest is considered to supplement the subalpine zone where conifers do not occur, mainly due to strong avalanche influences (Watanabe 1979).

As shown in Fig. 3, both the altitude of the forest limit and the development of *Betula ermanii* forest vary conspicuously in southern Daisetsuzan, mainly due to the difference of time after the eruptions of volcanoes. Around Mt. Tokachidake which is the latest volcano located in the central volcanic row, its forest limit is found at 900-1000 m, and the *Betula ermanii* forest never occur. On the volcanic boulder fields around Mt. Tokachidake, both needle-leaved forest (especially the *Picea Glehnii* forest) and *Pinus pumila* scrub

community have been establishing and forming the forest limit. On the contrary, around Mt. Oputateshikeyama and Mt. Furanodake, which are situated at each end of the volcanic row and the older dormant volcanoes, their forest limits formed by *Betula ermanii* forest lie at ca. 1400 m.

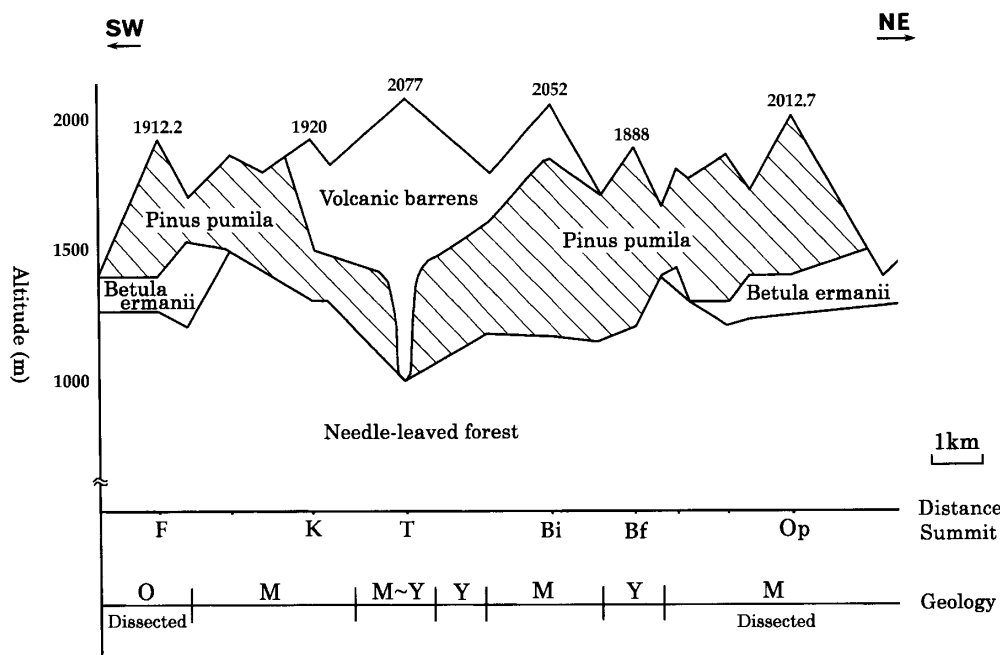


Fig. 3. Altitudinal vegetational zones in the southern Daisetsuzan (Tokachi-Renpo, northwestern side), central Hokkaido, Japan
 F: Mt. Furanodake, K: Mt. Kamihorokametokkuyama, Mt. Tokachidake,
 Bi: Mt. Bieidake, Bf: Mt. Bieifuji, Op: Mt. Oputateshikeyama
 O, M, and Y: the Older, the Middle, and the Younger Tokachi Volcanoes

2 Altitudinal vegetational zones in the Daisetsuzan Mountains

2.1 Montane mixed forest zone (Fageetea crenatae-region): below ca. 800 m

In this zone, the deciduous broad-leaved forests (*Quercus mongolica* var. *grosseserrata* forests) and the mixed forests (*Abieti sachalinensis*-*Quercetum grosseserratae* and *Driopterido- Abietum mayrianae*) are developed widely on mesic smooth slopes and rather dry convex slopes. In humid habitats such as concave slopes or the foot of mountains, other broad-leaved forest (*Ulmo laciniatae*-*Cercidophylletum japonici*) occurs. In the montane zone, the secondary forests including mainly *Betula platyphylla* var. *japonica* forest and various man-made forests (*Abies sachalinensis*, *Fraxinus mandshurica* var. *japonica* and *Larix kaempferi* in the lower altitudes, and *Picea glehnii* in the higher altitudes) are found.

Along the streams in the montane zone, the *Salicetum petsusu-sachalinensis* is very

common, occurring on the riversides. The Toisuso-Populetum maximowiczii, consisting of *Populus maximowiczii* and *Toisusu urbaniana* (Salicaceae), is also common along the larger rivers in the Daisetsuzan Mountains. This forest occurs on the riverbeds and river terraces, but usually mingles with conifers on the older terraces. The Toisuso-Populetum maximowiczii, which is distributed from the upper part of the montane zone to the lower part of the subalpine zone (400-1000 m), is divided into the two subassociations corresponding to two altitudinal zones.

2.2 Subalpine evergreen needle-leaved forest zone (Vaccinio-Piceetea region): ca. 800 m - ca. 1400-1600 m (forest limit)

The Piceo-Abietum sachalinensis, which is mainly composed of *Abies sachalinensis* and *Picea jezoensis* and sometimes mingles with *Betula ermanii* and *Picea glehnii*, is most common in the subalpine zone. The *Picea glehnii* dominated forest (Piceetum glehnii) occurs exclusively on such specific habitats as the peripheries of mires and volcanic boulder slopes. The mixed forest of conifers and *Betula ermanii* and the pure forest stands of the latter (incl. Weigelo-Betuletum ermanii) occur frequently in the upper part of the subalpine zone.

The mixed forest of conifers and *Betula ermanii* occurs also on the destroyed sites by woodcutting as a secondary forest (*Abies sachalinensis*-*Betula ermanii* forest). However, natural landscape can still be found in the subalpine zone of the Daisetsuzan Mountains.

In the upper part of the subalpine zone, both the *Sorbus matsumurana* thicket and the *Weigela middendorffiana* thicket (Aconito-Weigeletum middendorffianae; Athyrio brevifrons-Weigelion middendorffianae) occur on the margins and the intermediate sites on avalanche slopes, respectively, and are adjacent to the tall-herb community (Saussureo yezoensis-Caricetum riishirensis) on the center of avalanche slopes (Fig. 6).

The Hyperico yojiroanae-Fimbristylidetum dichotomae annuae is limited to Kogen Spa in northern Daisetsuzan and occurs on the vapor fumaroles with high soil temperature and without snow cover in winter, although the fumaroles are located at 1260 m in the subalpine zone. Among the character species, *Hypericum yojiroanum* is endemic to this fumaroles and *Fimbristylis dichotoma*, which is distributed from subtropical to subarctic zones, is limited to the fumaroles in central and eastern Hokkaido.

2.3 Mire vegetation in the subalpine needle-leaved forest zone

(after Tachibana & Sato 1981, 1982, 1983, 1985; Tachibana et al. 1984)

In the subalpine zone of the Daisetsuzan Mountains, there are several mires established

on lava plateaus (Tenninkyo-Hisagonuma, 940 m; Tennyogahara, 1210 m; and Numanotaira, 1420-1450 m in northern Daisetsuzan; Numanohara, 1420-1450 m in central Daisetsuzan; and Genshigahara, 1000-1300 m in southern Daisetsuzan).

The mire vegetation is mainly composed of the following plant communities: (1) hydrophytic communities: a) submerged communities consisting of *Isoetes asiatica*, *Potamogeton fryeri*, *Sparganium hyperboreum*; b) emerged communities consisting of *Eleocharis intersita*, *Menyanthes trifoliata*; (2) bog communities: a) hollow communities (*Scheuchzerieta palustris*) consisting of *Carex limosa*, *Drosera anglica*, *Rhynchospora alba*, *Scheuchzeria palustris*, etc; b) lawn communities dominated by *Sphagnum lindbergii* or *Sphagnum pulchrum*; c) hummock communities (*Oxycocco-Sphagnetia*) dominated by *Carex middendorffii*, *Eriophorum vaginatum* and various *Sphagnum* species (*Sph. apiculatum*, *Sph. fuscum*, *Sph. magellanicum*, *Sph. nemoreum*, *Sph. papillosum*, *Sph. robustum*); (3) primary oligotrophic mire communities consisting mainly of *Sphagnum* species (*Sph. apiculatum*, *Sph. compactum*, *Sph. tenellum*), including *Carex ominana* var. *monticola*, *Rhynchospora alba*, *Rhynchospora yasudana* and *Scirpus caespitosus*; (4) fen communities consisting of *Carex rhynchophysa*, *Carex thunbergii* var. *appendiculata*, *Carex traiziscana*, *Carex vesicaria* and *Juncus filiformis*; (5) substitute communities composed of *Carex michauxiana* var. *asiatica*, *Carex omiana* (incl. var. *monticola*) and *Scirpus caespitosus*, lacking *Sphagnum* species due to influence of trampling; and (6) surrounding shrub or forest communities including the *Piceetum glehnii* and local stands of *Pinus pumila* community (*Vaccinio-Pinetum pumilae*).

Mires at Tennyogahara and Genshigahara are characterized by development of primary oligotrophic mire communities, which has been established directly on lava plateaus, but mires of Numanotaira and Numanohara established at the higher altitudes by development of various bog communities and hydrophytic communities. Tenninkyo-Hisagonuma mire is characterized mainly by development of fen communities.

2.4 The *Pinus pumila* zone

(after Igarashi et al. 1981; Ito et al. 1973; Ito & Sato 1981; Miyawaki ed. 1988; Nakamura 1988; Ohba 1969, 1973, 1974; Okitsu 1984; Okitsu & Ito 1984; Sato 1976, 1988, 2000)

The *Pinus pumila* scrub community (*Vaccinio-Pinetum pumilae*; *Vaccinio-Piceetea*), which dominates above the forest limit, is composed of subalpine species such as *Ledum palustre* var. *diversipilosum*, *Rhododendron aureum*, *Sorbus sambucifolia*, *Vaccinium vitis-idaea*, etc. Focusing on the species composition as well as productivity of this community showing the subalpine characters, the *Pinus pumila* zone has been treated as a subalpine zone.

However, the *Pinus pumila* zone includes not only subalpine communities but also considerable alpine communities belonging to the Cetrario-Loiseleurietea, Dicro- Stellarietea, Carici rupestris-Kobresietea bellardii, etc. The *Pinus pumila* zone is obviously characterized by both subalpine and alpine communities, occurring on the closely situated but extremely different habitats of snow accumulation, mainly due to westerly prevailing winds in winter and the topography, as shown in Figs. 4-6.

The following combination of community-habitat is common throughout the *Pinus pumila* zone in the Daisetsuzan Mountains: (1) alpine chinophobus (snow-hostile) dwarf-shrub communities (Arcterico-Loiseleurietum procumbentis & Arctoo-Vaccinietum uliginosi; Cetrario-Loiseleurietea) on the stable wind-blown sites composed of coarse materials in the fronts of terraces or margins of polygons; (2) alpine chinophobus desert communities (Dicro-Violetum crassae; Dicro-Stellarietea nipponicae) on the unstable wind-blown barrens composed of fine materials; (3) subalpine and alpine chinophilous (snow-loving) dwarf-shrub communities (*Phyllodoce caerulea* community & *Phyllodoce aleutica* community; Harimanetalia; Phyllodoco-Harrimanetea) on the seasonally moist snowbed; (4) subalpine and alpine chinophilous short-herb communities (*Carex pyrenaica-Primula cuneifolia* community; Geetalia pentapetali; Phyllodoco-Harrimanetea) on the permanently moist snowbed; (5) subalpine and alpine chinophilous desert communities (Carici-Saxifragetum merckii; Saxifrago-Cardaminetalia nipponicae) on the bottom of the snowbed.

However, the vegetation above the forest limit shows some regional differences among

	← Snow accumulation →	
	Thin	Intermediate
Stable, Coarse materials ↑	Alpine dwarf-shrub communities (Arctoo-Vaccinietum uliginosi) (Arcterico-Loiseleurietum procumbentis)	Subalpine scrub community (Vaccinio-Pinetum pumilae)
	Alpine herbaceous communities on the permafrost sites (Salici-Oxtropidetum yezoensis) (Junco-Saxifragetum laciniatae)	
↓ Unstable, Volcanic barrens	Alpine desert communities (Dicro-Violetum crassae) (Stellario-Polygonetum ajanensis on volcanic barrens) (<i>Carex flavocuspis</i> community on volcanic barrens)	(<i>Carex oxyandra-Polygonum weyrichii</i> community on volcanic barrens)

Fig. 4. Chinophobus (snow-hostile) communities on the wind-blown sites in the *Pinus pumila* zone in the Daisetsuzan Mountains, central Hokkaido, Japan.

	← Snow accumulation →
	Intermediate Thick
Long ↑	Subalpine scrub community (<i>Vaccinio-Pinetum pumilae</i>)
G l o w i n g s e a s o n	Subalpine and alpine tall-herb communities around snowbeds (<i>Saussureo yezoensis-Caricetum riishirensis</i> : snowbed type) (<i>Glycerio alnastreti-Athyrietum alpestris</i>) Subalpine and alpine short-herb communities on the permanently moist snowbeds and dwarf-shrub communities on the seasonally moist snowbeds (<i>Lagotis stelleri</i> var. <i>yezoensis-Primula cuneifolia</i> comm.) (<i>Scirpus caespitosus-Scirpus maximowiczii</i> comm.) (<i>Phyllodoce caerulea</i> comm.) (<i>Fauria crista-galli-Primula cuneifolia</i> comm.) (<i>Phyllodoce aleutica</i> comm.) (<i>Carex pyrenaica-Primula cuneifolia</i> comm.) (<i>Carex pyrenaica-Pogonatum sphaerotheresium</i> comm.)
↓ Short	Subalpine and alpine chinophilous desert community on the bottom of snowbed (<i>Carici-Saxifragetum merckii</i>)

Fig. 5. Chinophilous (snow-loving) communities in the snowbeds in the high-subalpine zone and the *Pinus pumila* zone in the Daisetsuzan Mountains, central Hokkaido, Japan.

	← Snow accumulation →
	Intermediate Thick
Stable ↑	Subalpine scrub communities (<i>Vaccinio-Pinetum pumilae</i>) (<i>Sorbus matsumurana</i> thicket) (<i>Weigela middendorffiana</i> thicket)
↓ Unstable	Subalpine tall-herb communities (<i>Saussureo yezoensis-Caricetum riishirensis</i>)

Fig. 6. Chinophilous (snow-loving) communities on the avalanche slopes in the high-subalpine zone in the Daisetsuzan Mountains, central Hokkaido, Japan.

the four districts. The following three desert communities limited to the volcanic barrens of active volcanoes, are considered to be in an initial stage of vegetational succession: the *Stellario- Polygonetum ajanensis* of Ohachidaira crater in the northern Daisetsuzan, the *Carex flavocuspis* community of Mt. Asahidake in northern Daisetsuzan and Mt. Tokachidake in southern Daisetsuzan, and the *Carex oxysandra-Polygonum weyrichii* community of Mt. Tokachidake. Among them, the former two communities occurring on wind-blown sites at higher altitudes, but the latter on the lower part of volcanic barrens at

ca. 900-1500 m.

Alpine chinophobus herbaceous community (Salici-Oxtropidetum yezoensis; Carici rupestris-Kobresietea bellardii) limited to the wind-blown sites around Mt. Koizumidake in northern Daisetsuzan is very noteworthy. Its habitat is considered to be under the real alpine condition because permafrost was discovered under the ground, and its species composition includes considerable circumpolar elements (*Dryas octopetala* var. *asiatica*, *Lloydia serotina*, etc). The Junceto-Saxifragetum laciniatae, occurring on the smaller wet barrens where melting water from frozen ground is supplied in summer, is also limited to the wind-blown sites of Mt. Koizumidake as well as Takanegahara in central Daisetsuzan. The Glycerio alnastreti-Athyrietum alpestris belonging to the subalpine Trollio-Ranunculetea acris nipponici is found rather rarely along snowbed streams above the forest limit in northern and central Daisetsuzan.

In central Daisetsuzan, subalpine and alpine chinophilous short-herb communities on the permanently moist snowbed are developed widely. Especially, the *Lagotis stelleri* var. *yezoensis*-*Primula cuneifolia* community, the *Fauria crista-galli*-*Primula cuneifolia* community and the *Scirpus caespitosus*-*Scirpus maximowiczii* community are limited to this district. Eastern Daisetsuzan is characterized especially by development of both alpine chinophobus dwarf-shrub community (Arctoo-Vaccinietum uliginosi) on wind-blown sites and subalpine tall-herb community (Saussureo yezoensis-Caricetum riishirensis; Trollio-Ranunculetea acris nipponici) on avalanche slopes.

C Land use

1 National Park, Natural Monument, and Wilderness Area

The Daisetsuzan Mountains was designated in 1954 as a national park, and its area of ca. 230,000 ha is the largest among Japanese national parks. The main part above the forest limit in northern and central Daisetsuzan was designated in 1977 as a Special Natural Monument. Along the upper streams of Tokachigawa River, the area of 1,035 ha composed of the subalpine virgin forests has been protected since 1977 as a Wilderness Area.

2 Agriculture and Forestry

Daisetsuzan National Park (the Daisetsuzan Mountains) consists of state lands (214,812 ha: 94.7 %), public lands (9,853 ha: 4.3 %) and private lands (2,099 ha: 0.9 %). Among

Japanese national parks, the proportion of state land is the second highest, and that of private lands is the second lowest in Daisetsuzan National Park. In this national park, traditional agriculture has been carried out only on the lowermost private lands, and never includes the stock farming (grazing) in the forest area and above the forest limit.

On the other hand, state lands are owned by the Forestry Agency of Japan, and public lands by the Forestry Office of Hokkaido Government. At the same time, Environment Agency of Japan divided Daisetsuzan National Park into the following three categories from the viewpoint of the preservation planning: special protection areas (36,807 ha: 16.2 %), special areas (183,492 ha: 80.9 %) and ordinary areas (43,272 ha: 19.1 %). Among them, the special protection area corresponds mostly to the area above the forest limit and several mires in the subalpine zone, in which forestry is impossible. The special area includes the first, second, and third classes. The first class-special area (29,566 ha: 13.0 %) is restricted in forestry for the purposes of protection of sources of water supply, prevention of landslide, etc. In the third class-special area (94,848 ha: 41.9 %) and the ordinary area (19.1 %), forestry frequently occurs. Therefore, forestry has been carried out for a long time even in the national park. This is a great problem in Japanese national parks.

Nevertheless, Daisetsuzan National Park has still a vast natural landscape. Furthermore, recently, the forestry policy has just changed and attached importance of forests working for public good, because of not only its economy but also nature conservation. We are waiting the progressing of vegetational succession in the forest area of the Daisetsuzan Mountains.

3 Tourism

The number of visitors to Daisetsuzan National Park was calculated to be ca. 6,140,000 of people in 1996. Many of them crowded into several famous hot springs on the foot of the mountains, especially at Sounkyo Spa, Tenninkyō Spa, Asahidake Spa, and Kogen Spa in descending order of visitors. In northern Daisetsuzan, it is easy in summer to make a day's trip for hiking to the summits of Mt. Kurodake and Mt. Asahidake, where cable cars or ski lifts carries us to the higher altitudes. A day's trip from the higher gateway such as Ginsendai to Mt. Akadake is also common. Most mountains of central and southern Daisetsuzan, excluding Mt. Tomuraushi-yama and Mt. Tokachidake which are easy to approach from the higher gateways, need the mountaineering with a burden on our back and staying at mountain huts. Mountains of eastern Daisetsuzan where there is not any mountain hut need the hard mountaineering. However, the last decade was booming for

mountaineering or hiking in the mountains in Japan. In the Daisetsuzan National Park, people have crowded to northern Daisetsuzan and some other approachable mountains. Therefore, local destruction of vegetation by trampling along the trails and around the mountain huts has become considerable. Visitors to the area above the forest limit in winter crowded for skiing upon Mt. Kurodake, Mt. Asahidake and Mt. Tokachidake. Mountaineering in winter is not popular, except for the trained alpinists. Recently, increasing number of snowmobile-lovers has frequently entered the area of national park, in spite of legally prohibited snowmobiles in Daisetsuzan National Park. Now, it is necessary to make an adequate program for sustainable utilization and nature protection, especially in the approachable districts and mountains.

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J: in Japanese; E: in English; G: in German; JE: in Japanese with English summary; JG: in Japanese with German summary; JGE: in Japanese with German and English summaries.