

The Subarctic Summer Green Forest Zone in the Northeastern Asia

by

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I. An oceanic tree species with unique characteristics, *Betula ermani*

Betula ermani CHAM. is distributed in the subalpine or subarctic forests in the Pacific coast region of the northeastern part of Eurasian continent, Japan, the Kuriles, Kamchatka, Sakhalin, as well as in the continent, North Korea, Sikhota-Alin Range of Ussuri, east Manchuria, the Amur Basin, the Stanovoi Range and Transbaikal District.

The genus *Betula* are an interesting group of plants in speciation and adaptation. The genus is distributed in the temperate zone, the subarctic zone, and the arctic zone in the northern hemisphere. In the semi-arctic zone, the genus belong to the group of plants forming the timber line. For example, shrubs in the tundra, as "Jernik" are composed of *Betula nana*, *B. humilis* and *B. exilis*. These species as well as arctic willows can be considered to be one of the most adopted arbor species of angiosperms in the coldest climate on the earth. The birch has the center of distribution range in subarctic or subalpine zones where coniferous forests are most developed. Species in the genus such as *Betula verrucosa* distributed from Europe to Siberia and *B. platyphylla* growing from the east Siberia to Japan are members of secondary forest community occurring after the fire and clear felling. Some birch species, for example, *Betula utilis* (Schewe infurth, 1957) in the eastern Himalaya, *B. alajica* in Pamir and Alai, and *B. litwinowii* in Caucasus grow in the subalpine zone as a poorly formed forest belt, aggregates or sporadic occurrence (Isachenko et al. 1956). These species appear to grow in a site unsuitable for conifers though the site is included in the boreal or subalpine forest zones, and also the species are adopted in the early stages of succession.

Birches in the temperate zone can be found in northeastern Asia as well as in North America. Most of the temperate zone birches grow sporadically, singly as well as in an aggregate in the deciduous forest and mixed forest. In addition to the occurrence of the birches in the forest belt, some species show specific adaptations. For example, *Betula nigra* in North America grows along river sides in the temperate or warm temperate zone, and *B. chichibuensis* in Japan occurs in the lime-stone area. Also there are a few species to form forest belt such as *B. davurica* distributed widely from the dry temperate zone of the Northeastern Asia to the subarctic zone (Yang, 1937).

Among birch species, *Betula ermani* is considered to be a species of potential ecological niche for wide adaptations. In Japan, *Betula ermani* appears at first in the primary succession of the Tokachi Volcanic Mountains and also the species is one of the most important species in the secondary succession of subalpine and subarctic zones. Also, the species spreads its habitat to the

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temperate zone as seen in a secondary forest resulted from the forest fire in the eastern Hokkaido. *Betula ermani* is commonly mixed at a rate of 5 to 10% in the coniferous forest of the subalpine zone in Hokkaido (Watanabe, 1967, 1970). A similar trend can be noted in the forest in Honshu. *Betula ermani* is a member of climax species in the boreal coniferous forest of Far East or and in the subalpine zone of the same region.

In the heavy snow area along the Japan Sea (Tatewaki, 1958b; Suzuki, 1963) and in timber line of high mountains, *B. ermani* forms edaphic climax, whereas from the Kuriles to Kamchatka it forms climax forest under the extreme climate with humid and strong wind (Hulten, 1927-30, Tatewaki, 1958a). Judging from these adaptations, *Betula ermani* is a unique species with all the characteristics of the birches.

II. Life span of *Betula ermani*, intolerant tree species forming climax forest

The previous theory can be described as follows: when a bare land is formed after the forest is destroyed, intolerant species at first come in and then tolerant species take over to form climax forest. It was assumed that in the subalpine zone of Japan *Tsuga diversifolia*, or *Abies mariesii* in Honshu and *Picea jezoensis* (*Picea glehni*)-*Abies sachalinensis* (include *A. sachalinensis* var. *mayriana*) in Hokkaido form climatic climax. Contrary to such general idea for the succession *Betula ermani* is not only an intolerant species to form the secondary forest, but also the one to form the climax forest. Therefore, *Betula ermani* possesses two diverse characteristics, intolerant species as a member of the secondary forest, and the special characteristic one in climax formation.

Such diverse characters of *Betula ermani* may be attributable to the life span of the species. In order to verify the hypothesis, age structures of undisturbed forests have been analysed (Watanabe, 1970). It was ecological niche among member species of the forests to be considered. It was found out in the study that ecological niche among member species of the forest should be evaluated not only by mixture rate but also relationship of ages among the member species. It will be a great mistake to make conclusion on forest succession only by apparent stand composition. For example, the average age of dominant trees in the undisturbed *Abies sachalinensis* forest ranges from 90 to 130 years, with some individual reaching 250 years of age, although the age varies depending on sites. These ages are not surprisingly high, compared with those of intolerant *Betula platyphylla* of 70 to 100 years. *Betula ermani* in Hidaka Range reaches 120 to 200 years. *Picea jezoensis* trees mixed with *Abies sachalinensis* reach the age between 170 and 250 years twice as old as that of *Abies sachalinensis*. Therefore, the average age of *Betula ermani* is not low compared with that of *Abies* and *Picea*, suggesting that the birch has the potential to make a stable forest type. It can not be concluded that the birch is replaced by the fir in the end only because the birch is an intolerant species, or simply because the fir is present in the low strata. Oftentimes in a secondary forest, those fir seedlings show the same age as that of *Betula ermani* forest. To analyse forest succession, it is important to understand species characteristics or growth patterns of the trees in the upper story as well as the lower story. *Abies*

sachalinensis the tolerant species with a relatively short life span, often grow in the lower story in the mixed forest of *Abies-Picea* or in the *Betula ermani* forest. Although the fir appears to be the succeeding species, the fir trees suppressed for more than 60 years lose their potential to be dominant trees. Instead, younger trees of the same species take over the position of the dominant (Watanabe, 1970). Very few dominant *Abies sachalinensis* trees show the evidence of suppression in the annual rings. Therefore, the regeneration pattern of *Abies sachalinensis* is discontinuous in relation to ages. For this reason, the fir trees under the *Picea* and *Betula* forests are not always the dominant ones in the next generation. Filling the gap created by the death of the dominant trees in the birch forest, the regeneration of the birch is more advantageous than that of the fir suppressed for tens of years. In the central part of Hoakaido, mixed forests of spruce and fir in the upper streams of Tokachi River contain 5 to 10% of the birch. In these forests, the birch shows a regeneration pattern as described above. *Betula ermani* occupies the gap because of its intolerant nature, and maintains the position for a long period because of its long life span. This is the reason why the species forms stable forest type in the subarctic or subalpine zones.

III. *Betula ermani* forming forest belts replacing conifers in the Hidaka Range in Hokkaido

It is Hidaka Range that *Betula ermani* forest develops most in Hokkaido (Watanabe, 1967, 1971, Ohsawa et al. 1973). Hidaka Range extends its main ridge in the north an south direction and rises very sharply. In the main ridges, the vertical drop from the peak to the valley is exceedingly steep, with 700 to 1000 meters. Below the peak, except cirques, alpine meadows, and siberian dwarf pine fields, the birch forests mixed with a small number of *Picea jezoensis* and *Abies sachalinensis* are present in the 700 meters steep drops. The birch forest develops particularly well in Mt. Satsunai and the peak 1823 M.



Photo 1. *Betula ermani* forest in the Hidaka Range (Mt. Satsunai and Mt. Esaomantotsutabetsu at left: July 1953)



Photo 2. Ibid. (near Mt. 1823 M. peak: July 1957)

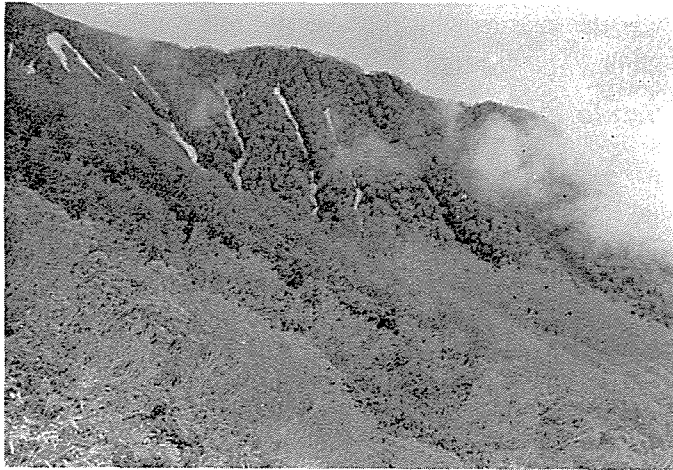


Photo 3. Ibid. (near Mt. Memuro: May 1958)

In the south of Mt. Koikakushu Satsunai the birch establishes even on the saddle part of the ridges (Photo 1, 2). The birch forest belts in the main ridges of Hidaka Range do not consist only of the birch, but sometimes in patches, *Alnus maximowiczii*, *Acer tschonoskii*, *Acer ukurunduense*, *Sorbus matsumurana* and *Sasa kurilensis* (Photo 3). In the branch ridges or the gentle slopes in the lower subalpine zone, *Picea jezoensis* and *Abies sachalinensis* are mixed in a high rate, and sometimes the forest turns the pure conifer forest of *Abies* and *Picea*.

Generally *Betula ermani* is dominant in this area of the subalpine zone and there is no transition zone of conifers between the temperate zone forest and timber line. No plausible explanation is available for the lack of conifer belt in the main ridges of the Hidaka Range in Hokkaido. However, one of the reasons is probably attributable to the steepness of slopes. In the subalpine zone of Mt. Penkenushi the northernmost peak of the Range, flat plains form magnificent conifer forests. No other flat areas are present in the subalpine zone of the



Photo 4. *Betula ermani*-*Acer tschonoskii* community in the slope of Mt. Memuro (July, 1958)



Photo 5. *Alnus maximowiczii* forest along the streams in the subalpine zone on Mt. Totsutabetsu in the Hidaka Range. (June, 1957)

Range. The steep topography in the Hidaka Range may produce climax in the subalpine zone, which is not suitable for the growth of conifers. Probably, *Betula ermani* growing in the timber line descends down to the zone of conifers, resulting in total coverage of the birch in the area. Similarly the Ishikari Range with topographic and geologic conditions same as those in Hidaka develops *Betula ermani* forests (Tatewaki, 1950, Takaya, 1955, Watanabe, 1966b).

Reasons why *Betula ermani* maintains the position of edaphic climax forest type may be attributable to its intolerance and long life span. After elimination of coniferous forests by forest fires, the birch can establish a subclimax at least

for over one hundred years. One of good example can be illustrated in the forests near Lake Mashu in the eastern Hokkaido. A great difference in composition is shown between the conifer forest escaped from the fire and the birch forest established after the fire.

IV. Oceanic subarctic birch forest in Japan

It is interesting to note that *Betula ermani* forest develops along the seashore line in Kiri-tatpu, Siriba Cape in Atsukeshi in Kushiro region of Hokkaido. The warmth index (Kira, 1948) in the area with below 45°C suggests that the area climaticall belongs to the subarctic zone (Watanabe, 1958). However, such a low index is limited only within a narrow coastal line, and the warmth index rises to near 50°C in the inner areas, resulting in the temperate zone compositions of pan-mixed forest zone (Tatewaki, 1955). It is the cold current of the Kuriles that the subarctic zone develops locally in the coastal line. Various ocean

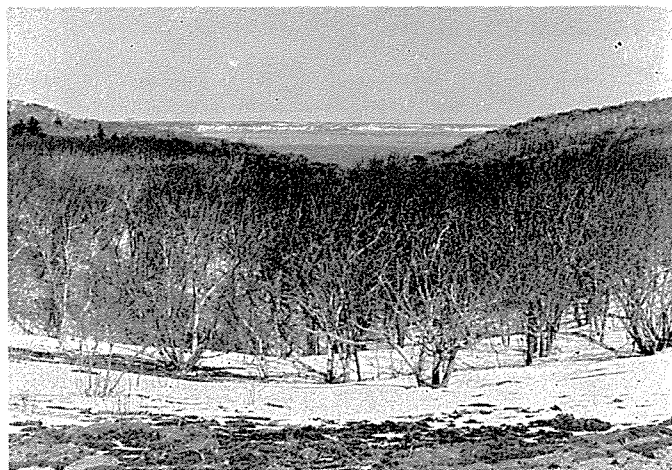


Photo 6 and 7. *Betula ermani* forest at Shiriba Cape in Kushiro (*Alnus maximowiczii* is mixed at the edges of the forest. (*Abies sachalinensis* is also sporadically found: March, 1961).

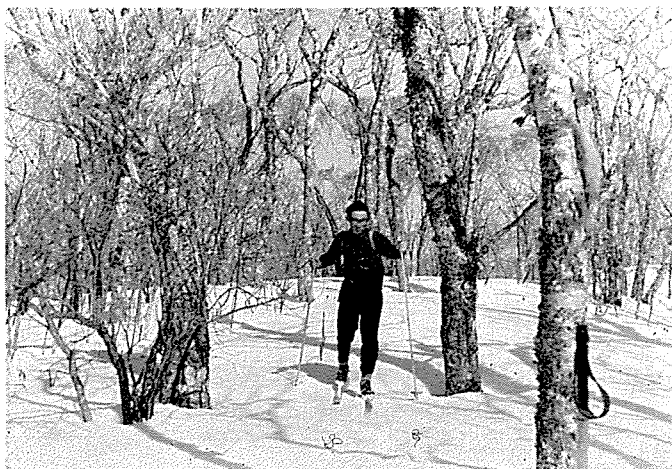


Photo 8. The inside of the forest shown in Photo 7 (March, 1961).

currents affect the distribution of plants. The warm current (Japan current) and the cold current (the Kurile current) meet at Erimo Cape in the Hidaka district, where the subarctic species form the southern limit as well as the temperate species form the northern limit. In contrast, the coastal line of Kushiro is influenced by the Kurile current and low in temperature in the summer often forming fogs, so that the climate is suitable for the growth of *Betula ermani* (Photo 6, 7, 8).

Suzuki (1972) suggested that no oceanic subarctic birch zone exists in Japan, but this is not totally acceptable. Under the climate of Japan, the subarctic zone in the coastal areas is limited only in Kushiro, Nemuro, and Kitami. Only in a small subarctic coastal area in Kushiro, the subarctic oceanic birch zone is formed.

In a sense, the macroclimate of Japan should be considered as an oceanic climate. Therefore, the birch forest is more or less influenced by the oceanic climate. In addition, *Picea jezoensis* and *Abies sachalinensis* are species of oceanic spruce and fir. These species including siberian dwarf pine are characteristic in the subarctic oceanic forest zone in the North, eastern Asia, and also form the area of *Vaccinio-Piceetea japonica* of Braun-Blanquet (1959).

V. The subarctic summer green forest zone in Far East

Discussion will be centered on significance of the subarctic summer green forests in formation of forest belts, as the subarctic summer green forests is established under extremely severe conditions for plant growth in the extreme oceanic climate with humidity and constantly strong cold wind. Depressions originated in mid-China, generally develop in Japan and reaches its maximum strengths in the Kuriles and the Aleutian Islands. Therefore, the Kuriles and Kamchatka are always raided by depressions with the rains and strong winds. Also, the cold current originated from the Sea of Okhotsk and the Arctic Ocean brings the cold and humid climate to the Kuriles and Kamchatka. Typical summer green forests in Far East exist in an area occupied by *Betula ermani*

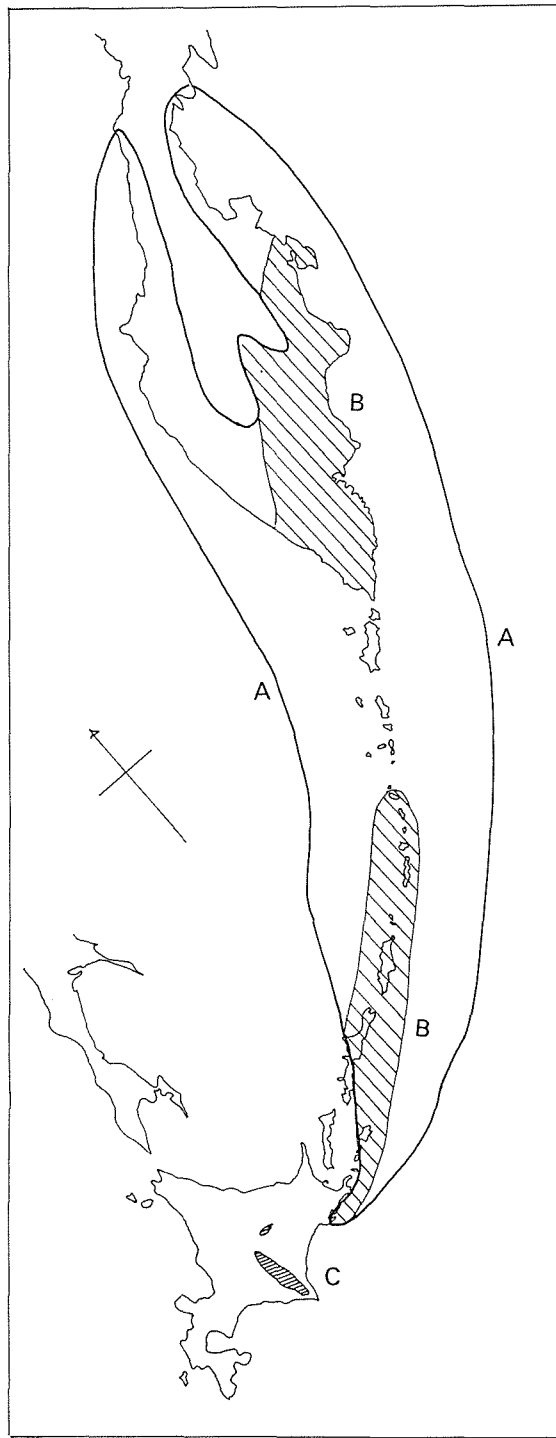


Fig. 1. The subarctic summer green forest zone in the Northeastern Asia (A), With abundant *Betula ermani* (B), and other areas with abundant *Alnus maximowiczii*. *Betula ermani* area of the Hidaka Range in Hokkaido, Japan (C).

and *Alnus maximowiczii* adopted to the cold, humid, and windy climate (Fig. 1). *Alnus maximowiczii* is a species adopted in the subarctic and subalpine zones under the oceanic climate of northeastern Asia, and generally grows in intermediate zones between the birch and the siberian dwarf pine. At the timber line, the alder exists as shrubs but in the subalpine zone in Hidaka, it forms a beautiful forest along the streams. Therefore, the alder is a symbolic species as well as the birch is (Tatewaki 1958a, Watanabe, 1966b). In the coastal line of Kushiro, the alder forms aggregates in patches. Also, Etorofu Island in Hokkaido, and the chain of islands from the Kuriles to Kamchaka represent a territory for the alder (Hulten, 1927-1930, Tatewaki, 1958). As shown in Fig. 1, the subarctic summer green forests can be divided into two different territories, one dominated by *Betula ermani* and the other by *Alnus maximowiczii*. The latter appears to have the severe climate for the survival of the birch. *Abies sachaliensis* and *Picea jezoensis* of oceanic nature can not grow in the subarctic summer green forest because of its severe climate. However, the zone can be recognized as a tall tree zone, although windy areas are covered with subtrees or small shrubs. It is noteworthy that the birch and alder establish ecological niche under the severe climatic conditions.

The subarctic summer green forest is formed under the severe conditions and similar formations of birches are established in Greenland, Iceland, and Fennoscandia (Hämäläinen, 1963) as well as *Nothofagus antctica* and *N. pumilis* in Patagonia in South America (Pisano, 1966). These evidences suggest that the deciduous forest is formed under the oceanic climate of the subarctic zone with extremely humid and windy conditions.

VI. The vegetation units of *Betula ermani* forests and *Alnus maximowiczii* forests

Nakano (1941) recognized that the typical alliance in the subarctic zone in Japan was *Betulion Ermani* and that association consisted of *Betuleto Ermani-Abietum Mayrianae* (Hokkaido, Sakhalin) and *Betuleto Ermani-Abietum Veitchii* (Honshu subalpine zone). It was his excellent observations that a unit in alliance was named after *Betula ermani* because the species existed always in the subalpine or subarctic zones in Japan. Most of Japanese researchers ever since have not taken attention to the birch. After 20 years, *Betulion Ermani* were upgraded to order, *Betuletalia ermani* (Nakano) Suz.-Tok., Okamoto et Honda (1963), although alliance was designated as *Betulion ermani* (non Nakano) emend. Suz. Tok., Okamoto, K Honda (1963). At least this suggests that *Betula ermani* is an important species and represents the subarctic and subalpine zones in Japan. *Betula ermani* forests in Hidaka, Kushiro, Kuriles and Kamchatka may be included in *Betulion ermani* as suggested by Suzuki et al.

There are two different opinions concerning whether *Alnus maximowiczii* forests belong to *Betuletalia ermani* or the other order with hygrophytes in the subarctic zone. Preferably, the alder forests (*Alnetalia maximowiczii*, prov.) should be separated from *Betuletalia ermani*, because the alder can grow in a great aggregate in North Kuriles and west Kamchatka under the climate much more severe than the birch can stand.

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