FOREST ECOLOGY OF THE ISLANDS OF THE NORTH PACIFIC OCEAN

By

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Preface

The area of the present study includes Hokkaido, Sakhalin, the Kurile Islands, the Commander and Aleutian Islands. They extend from the northwestern to the northern part of the Pacific Ocean. Hokkaido and Sakhalin are the northernmost islands of the Japanese Archipelago; Hokkaido is the northernmost island of the present Japan, from which Sakhalin is separated on the north by the Soya Strait 24 miles wide. The Kurile Islands form a long chain of the islands between the southern tip of Kamtchatka and the northeastern coast of Hokkaido, separated by the Sea of Okhotsk from the Pacific Ocean. They possess a flora between that of Hokkaido, rich in species and especially characterised by the presence of the Temperate Eastern Asiatic elements including the Japanese and Chinese elements, and that of Kamtchatka poor in species and in the phytogeographical respect as if it were an outlying island of the boreal Siberia as Prof. HULTEN[1] described. The Commander Islands and the Aleutian Islands from a beautiful arc between the Bering Sea and the North Pacific Ocean, showing many interesting floristic relationships between Asia and America.

During the last 40 years or so, while working in the Hokkaido University at Sapporo, the writer has mainly studied the forest ecology of Hokkaido, Sakhalin and the Kurile Islands. In 1929 the writer was privileged to make a botanical exploration of the Aleutian Islands. For a comparative study of the forest ecology, he has on several occasions explored Manchuria, Inner Mongolia and also North China.

In this report, the species were treated in the narrow sense so as to stress geographical distribution.

1) HULTEN, E.: Studies on the origin and distribution of the flora in the Kurile Islands. Bot. Notis. 325~343. (1933)

[Journ. Facul. Agr., Hokkaido Univ., Sapporo, Vol. L, Pt. 4, 1958]

From the point of view of floristic phytogeography, the area of the present study ranges from the Temperate Eastern Asiatic to the Subarctic region, and the physiognomy of the forests is very interesting and rather complex. Therefore it is worth while to explain here their importance and characteristics.

The writer wishes to express his sincere gratitude to late Prof. K. MIYABE for his kind direction, to Prof. S. ITO and Dr. H. TAKEDA for their kind encouragement, to Prof. E. HULTEN at Stockholm, Prof. DU RIETZ at Uppsala, Prof. B. LINDQUIST at Goeteborg, Prof. R. NORDHAGEN at Oslo, Prof. K. FAEGRI at Bergen, Prof. W. LUEDI at Zuerich, Prof. R. HEIM at Paris, and Profs. L. EMBERGER and BRAUN-BLANQUET at Montpellier for their valuable advice and assistance, and also to the members of the Forest Offices of the national forest and the Forest Section of Hokkaido Government for their kind patronage.

PART I. FOREST COMMUNITIES OF THE ISLANDS OF THE NORTH PACIFIC OCEAN

I. The Important Phytogeographical Lines of Demarcation in the Islands of the North Pacific Ocean (Fig. 1)

In the Islands of the North Pacific Ocean, there are important phytogeographical lines of demarcation as follows:

1) SCHMIDT's Line in Sakhalin.
2) MIYABE's Line in the Kurile Islands.
3) Kuromatsunai Depression in Hokkaido.

1. SCHMIDT's Line

In his Flora Sachalinensis (1868), FRIEDRICH SCHMIDT[2] divided the island of Sakhalin into two natural botanical districts by a line extending from the north of Dui on the coast of the Sea of Japan. After botanical exploration, SCHMIDT and P. GLEHN arrived at the conclusion that the floral character of the southwestern part of Sakhalin is essentially that of a northern extention of the flora of Japan. On the other hand, they found an extensive area of tundra, so-called Sakhalin tundra by Prof. Y. OKADA[3] and hills covered mostly with the larch (*Larix kam-*

2) SCHMIDT, FR.: Reisen im Amur-Lande und auf der Insel Sachalin. Mem. Acad. Imp. Sc. St. Petersb. Ser. 7. **12**-2. 1~227. (1868); Russ. ed. (1874)

3) OKADA, Y.: On the so-called tundra formation of North Saghalien. Bot. Mag. Tokyo. **38**. 76~83. (1924)

4) KUDO, Y.: Ueber die Pflanzen-geographie Nordjapans und der Insel Sachalin. Oesterr. Bot. Zeits. **76**-5. 307~311. (1927)

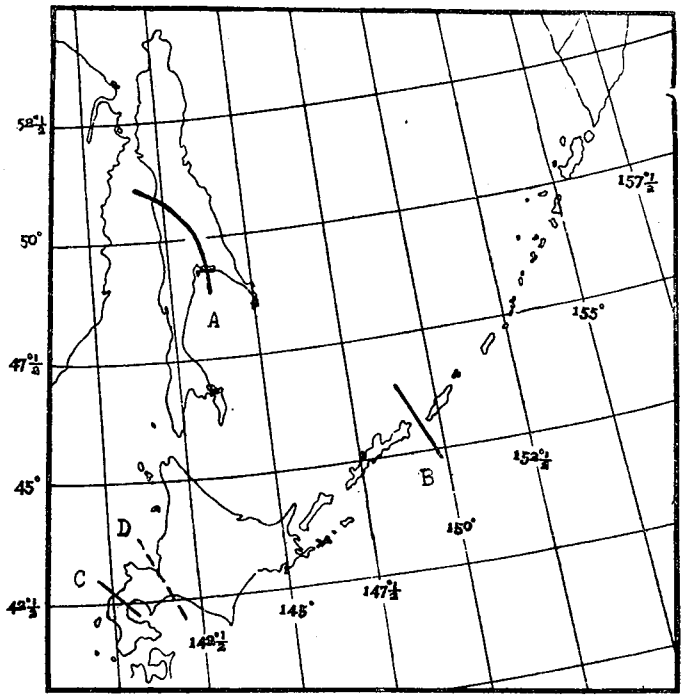

Fig. 1. Important demarcation lines.
A. SCHMIDT's Line; B. MIYABE's Line;
C. Kuromatsunai Depression; D. Ishikari Depression

tschatica) in the north-eastern part. In 1927, Prof. Y. KUDO[4] as result of his two years of field experience in Northern Sakhalin during 1922~1923, came to indorse SCHMIDT's view, and proposed to call this line of demarcation SCHMIDT's Line. In 1937, Prof. K. MIYABE and TATEWAKI[5] discussed the significance of SCHMIDT's Line after a detailed study of striking examples of the eastern part of the alpine zone of the pre-Tertiary rocks, and strengthend the significance of SCHMIDT's Line in the plant distribution in Sakhalin. According to our studies up to the present, the characteristics of the area northwards from the line of demarcation are summarized as follows:—

i) Extensive development of the forest of *Larix kamtschatica.*
ii) Predominance of *Picea jezoensis* in the *Picea jezoensis-Abies sachalinensis* forest of which the percentage relationship between the Yezo spruce and Sakhalin fir is usually larger

5) MIYABE, K. and TATEWAKI, M.: On the significance of SCHMIDT's line in the plant distribution in Saghalien. Proc. Imp. Acad. Tokyo. 13. 24~26. (1937)
6) YAMAZAKI, T.: Study on the ratio of the mixture between *Picea jezoensis* and *Abies sachalinensis* in the virgin forest, Saghalien. Bull. Kyoto Univ. For. 9. (1939) (in Japanese).

than 60 : 40.[6]

iii) The sudden decrease in the species of the temperate broad-leaved trees.

iv) The absence of the strata of *Sasa* spp.

v) The lack of the climbing plants except *Clematis ochotensis*.

vi) The presence of some characteristic plants distributed in the districts of Ajan and Okhotsk, or more widely distributed in the subarctic or arctic regions.

2. MIYABE's Line

For the geobotanist, the most interesting problem in the islands of the North Pacific Ocean is surely the plant-distribution of the Kurile Islands. References have already been made to the phytogeography, especially to the migration of the plants in this area. In the important classic papers on the phytogeography, Prof. K. MIYABE and A. ENGLER first discussed the question of distribution. The former[7] in 1892, stated that Sakhalin had a more important role than the Kuriles for the migration of the rich flora of Japan proper. The latter[8] put forward his opinion in 1899 that the Kuriles form an important archipelago as the migratory route of plants in the Neozoic Era. The study by Dr. H. TAKEDA[7] in 1913 led him to agree with ENGLER's opinion that the Kurile Archipelago was an important route for the migration of plants. He called attention to the presence of widespread arctic-alpine elements in the Kuriles which are common to those of the alpine regions of the main island of Japan. After TAKEDA's paper, Prof. Y. KUDO[10] in 1922 demonstrated with respect to the remarkable difference in the flora and plant-communities between the Southern and the Northern Kuriles that the Southern Kuriles belong to ENGLER's[11] "Temperate East Asiatic Region" and should form the northern limit of his "Provinz des mittleren und noerdlichen Japan", while the Northern Kuriles should be placed in ENGLER's "Subarctic Region" next to the

7) MIYABE, K.: The Flora of the Kurile Islands. Mem. Boston Soc. Nat. Hist. **6-7**. 203~275. (1890)

8) ENGLER, A.: Die Entwicklung der Pflanzengeographie. (1899)

9) TAKEDA, H.: The flora of the Island of Shikotan. Journ. Linn. Soc. Bot. **42**. 435~510. (1913)

10) KUDO, Y.: Flora of the Island of Paramushir. Journ Coll. Agr. Hokkaido Imp. Univ. **11**-2. 209~292. (1925)

11) ENGLER, A.: Uebersichit ueber die Florenreiche und Florengebiete der Erde. ENGL. u. GILG, Syl. Pfl.-fam. 374~388. (1924)

Subprovince of "Nordostsibirien mit Kamtschatka". KUDO[4,10] rendered great service to the establishment of definite criteria for the phytogeography of the Kuriles. In 1933, Prof. E. HULTEN[1] presented a discussion on the origin and distribution of the flora in the Kurile Islands. He stated that a gradual transition takes place and that the line of demarcation can not be a sharp one. He came to the conclusion that the line of demarcation between Japanese and Kamtchatkan floral regions can be drawn between the Islands of Ketoi and Ushishir as a very important physiognomical change takes place, especially citing the example of community of *Sasa kurilensis*.

After a detailed study of the flora and the plant-communities in the Central Kuriles in 1927~1930, the writer[12] proposed the name "MIYABE's Line" in 1933 for the Etorof Strait as the most important boundary line between the Temperate Eastern Asiatic Region of ENGLER and the Subarctic Region. The elements of the flora of the Central Kuriles are represented by those of which are the prevailing ones with some range into the circumpolar, subarctic or arctic-alpine ranges. There is a conspicuous absence of *Abies, Picea, Populus, Ulmus, Quercus* etc. which are widely distributed in the forests of Hokkaido and the Southern Kuriles. On the other hand, such genera as *Taxus, Acer, Sasa,* etc. having an undisrupted range in Japan, exhibit some northward extension to the Central Kuriles, disappearing gradually towards the north. It indicates that the chain of the islands may be considered to play the present role of a floral bridge introducing the northern elements to the south and the southern to the north. He[13] had a chance again to discuss MIYABE's Line in 1947 when the 88th birthday of Prof. K. MIYABE was celebrated. In that paper, a detailed statistical analysis of the floral elements was presented and the plant-communities were also taken into considertion. According to the studies up to the present, the characteristics of the north from this line of demarcation are briefly summarized as follows:

i) The lack of the fir-spruce- and the larch forest.
ii) The lack of the broad-leaved forests belonging to the Temperate Eastern Asia.
iii) The lack of climbing plants.

12) TATEWAKI, M.: The phytogeography of the Middle Kuriles. Journ. Fac. Agr. Hokkaido Imp. Univ. **14**. 191~363. (1933)

13) TATEWAKI, M.: On the MIYABE line. Agr. Soc. Nor. Temp. Reg. Sapporo **1-4**. 377~416. (1947)

iv) The sudden decrease of the number of the Japanese, Japanese-Chinese and Temperate Eastern Asiatic elements.
v) The dominance of the subarctic elements.

3. Kuromatsunai Depression (Fig. 2)

From the geobotanical point of view, the demarcation line in Hokkaido is represented by a depression, namely the Kuromatsunai Depression. It is situated in the southwestern part of Hokkaido, extending between Oshamanbe on the Pacific side to near Suttsu on the side of the Sea of Japan through Kuromatsunai. It is the most important depression in Hokkaido for the plant distribution of the

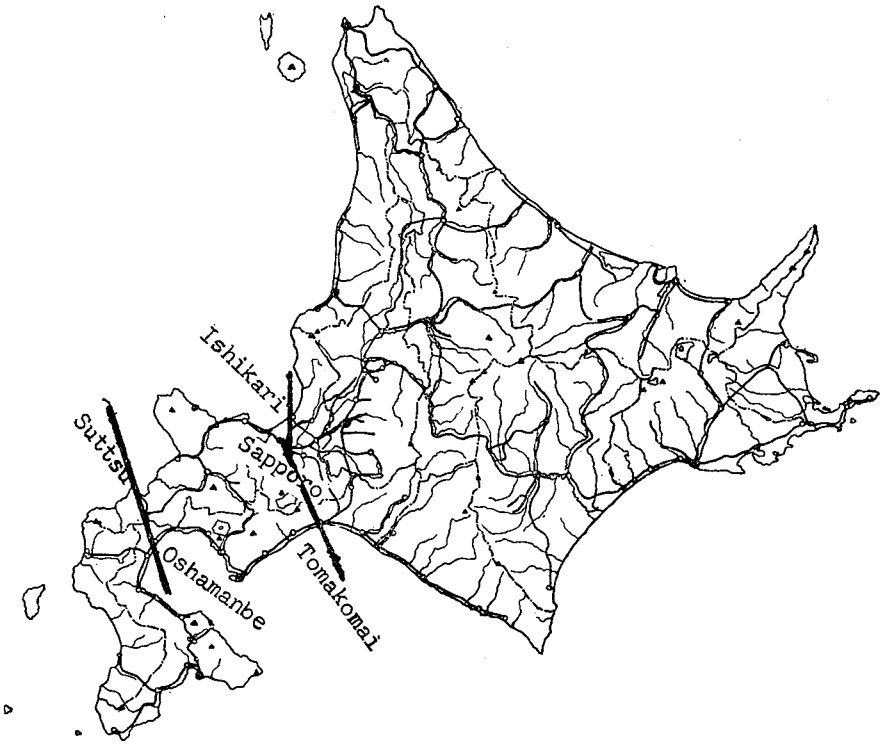

Fig. 2. Kuromatsunai- and Ishikari Depressions

present age. The importance of this depression from the geobotanical side was pointed out for the first time in 1935 by Prof. K. MIYABE[14] in a preliminary report.

The phytogeographical characteristics of this depression are summarized as follows:

14) MIYABE, K.: On the flora of Hokkaido. Nippon Gakujutsu-kyôkai Hôkoku **10**-4. 897~906. (1935)

i) It forms the northern limit of many important Japanese or Japanese-Chinese elements of the typical temperate zone restricted in the parts to the south of this depression including the Island of Okushiri. Some of these elements show interesting disjunctive distribution.

ii) The representative forests of temperate Japan, are also restricted to the parts southward of this depression. For example there are the *Fagus crenata-* (Pl. XXII), *Thujopsis dolabrata* var. *Hondai-*, *Pinus parviflora* var. *pentaphylla-* and *Pterocarya rhoifolia- Aesculus turbinata* forests.

iii) *Picea jezoensis,* the important element of the needle-leaved forest in Hokkaido and Sakhalin, does not reach as far as this depression; *Picea Glehni* has a similar distribution, but two restricted localities beyond this depression somewhat southward are known.

Ishikari Depression (Fig. 2): Another depression of the demarcation line is known as the Ishikari Depression, a broad depression of post-Tertiary date, extending between Tomakomai on the Pacific side to Ishikari on the side of the Sea of Japan through Sapporo. By this depression in Hokkaido is geologically divided into two distinct parts, viz. southwestern Hokkaido and eastern Hokkaido. The former is only an extension of northern Honshu, the main island of Japan, while the latter occupies the main part of Hokkaido and is itself divided into two parts, viz. the central and the eastern (in narrow sense). In central Hokkaido, a complete succession of rocks ranging from Paleozoic to recent is found. In the eastern part of Hokkaido, the Chishima (Kuriles) Range, a volcanic group, is situated from the north-eastern end to the westward. On the phytogeographical side the significance of these three parts is as follows:—

i) In the south-western part, lying to the south of this depression, some of direct continuations of northern Honshu. There are prominent Japanese and Japanese-Chinese elements distributed in the Temperate Eastern Asia.

ii) In the central part are found the Japanese-Chinese elements of Temperate Eastern Asia especially in its southern province. Some Japanese elements of the alpine plants occur in the mountains of the backbone of Hokkaido. It is worth while to note the presence of the disjunctive distribution of the alpine plants belonging to the Circumpolar, the Eurasiatic and the Northern Pacific elements, most of which occur in the middle part. These plants are found in the pre-Tertiary districts.

iii) In the eastern part of this depression are found relics of the

continental elements of Eastern Asia. *Chosenia bracteosa, Betula davurica* and *Rhododendron parvifolium* are enumerated as remarkable examples.

iv) The flora of the low land of the eastern district of the eastern part was influenced by the volcanic activity of the Mashu group, forests of the oaks (*Quercus crispula* and *Quercus dentata*) and the birches (*Betula Ermani* and *Betula platyphylla*) are well developed.

4. Intermediate Zone between the Temperate Eastern Asiatic and the Subarctic Siberian Regions

From the Kuromatsunai Depression in Hokkaido to SCHMIDT's Line in Sakhalin and MIYABE's Line in the Kurile Islands, the forest shows an intermediate character between the Temperate Eastern Asiatic and the Subarctic Siberian regions, not only based on the floristic composition but also the sociological construction. The same condition is found in northern Korea, eastern Manchuria and the south-eastern part of the Far East of the USSR including Ussuri, the lower Amur and southern Maritime province. In other words the area under consideration is around the northern part of the Sea of Japan. The important characters of the forest in the present area are briefly explained as follows:

The spruce-fir-forests (in wide sense) composed of the subarctic elements and the broad-leaved forests composed of the Temperate Eastern Asiatic elements stand side by side, and the mixed forest composed of those elements above mentioned are often found in the low land. In any case, all those forests show the mosaic arrangement of the intermixture in the Temperate Eastern Asiatic and the Subarctic phytogeographic character. The precise direction of the intermediate zone is shown in the later part "Pan Mixed Forest Zone".

5. Subdivisions of the Subarctic Zone (Fig. 3)

It is noticeable that the forests of the Central and the Northern Kuriles and the Aleutian Islands including the Commander Islands have quite different vegetation in spite of belonging to the needle-leaved forest zone. They are characterized by the absence of the forest composed of the needle-leaved trees. Among them, the forest vegetation of the Central and the Northern Kuriles is only represented by the shrubby thickets influenced by the strong wind in winter and the cool summer. The former are mainly composed of *Pinus pumila, Alnus Maximowiczii* and *Betula Ermani* while the latter *Pinus pumila* and *Alnus Maximowiczii.* The Aleutian and the Commander Islands show the

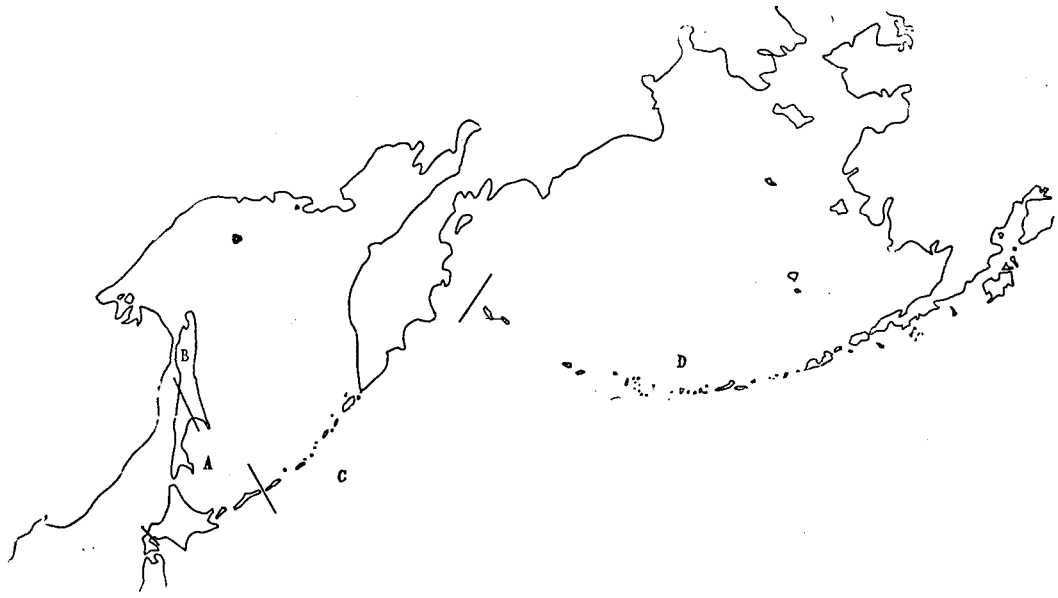

Fig. 3. Climax communities of the needle forest-zone

A. *Picea jezoensis-Abies sachalinensis* forest (mountain); B. *Larix kamtschatica* forest; C. *Pinus pumila* thicket; D. Heath.

arctic-like vegetation with no forest nor thicket. (Pl. I. a, b) According to Prof. HULTEN*), the *Vaccinium uliginosum-Empetrum nigrum*-moss association or the *Empetrum nigrum*-lichen association are well developed, owing to a large extent regulated by the wind. But the analysis of the floristic composition of the whole chain prove that they must belong to the subarctic zone.

On the other hand, the needle-leaved forest of Northern Sakhalin is characterized by the dominant presence of *Larix kamtschatica* forest, while that of the intermediate zone in vertical distribution by the *Picea jezoensis-Abies sachalinensis* forest.

The differences of the vegetation between the horizontal and the vertical needle-leaved forests are characterized in the latter by the presence of *Sasa* strata as well as that of the small trees and shrubs such as *Acer Tschonoskii, Acer ukurunduense, Ilex Sugeroki, Ilex rugosa, Euonymus macropterus, Euonymus sachalinensis* var. *tricarpus* and *Menziesia pentandra*, etc. and also sometimes by that of the climbers such as *Rhus ambigua* and *Actinidia Kolomikta*. These genera never belong to the subarctic elements.

From the geobotanical distribution of the forest vegetation of the

subarctic zone of the islands of the Northern Pacific Ocean are divided into the following table.

Forest Vegetation	Climax forest		District
	Deciduous needle-leaved forest	*Larix kamtschatica* forest	Northern Sakhalien
Needle-leaved forest	Evergreen needle-leaved forest	*Picea jezoensis-Abies sachalinensis* forest	Hokkaido Proper, Southern Sakhalien and the Southern Kuriles (mountain distribution)
Shrubby thicket		*Pinus pumila* thicket	the Central and the Northern Kuriles
None		Heath	the Commander Islands and the Aleutian Islands

II. Forest Communities

1. Shrubby Thickets

i. Thicket of *Pinus pumila*

The dwarf Siberian pine (*Pinus pumila*) is widely distributed in arctic-alpine zone in the northern part of Eastern Asia, but not yet found in the Commander Islands and the Aleutian Islands. This pine is characterised by the following features:

i) It forms a dense and entirely pure community in general, forming often impenetrable thickets.

ii) The under-growth is not well developed and sometimes entirely absent.

iii) It is usually dwarf and has no distinct main trunk; the branches, which exceed a length of 10 m, are prostrate and creeping.

In the alpine belt of Japan, dense thickets of this pine are very commonly found, except on easily disintegrated slopes, steep cliffs and excessively damp places. In the middle part of central Hokkaido it occurs above 1400–1500 m (Pl. II. a), and in the southern part of the Hidaka Range over 1600–1800 m. But if one goes to the Kurile Islands, north of the Island of Urup, one will find it coming down to the level of the sea (Pl. II. b). It shows the climate climax. It is likely to be

* HULTEN, E.: Flora of the Aleutian Islands. 37~39. (1937)
BANK, T. P.: Botanical and ethnobotanical studies in the Aleutian Islands. Michigan Acad. Sci. Arts & Letters 37. 26~28. (1952)

influenced by the special insular climate, especially by the frequently dense fog in summer and severe wind in winter. The same physiognomy will be seen in the SCHMIDT Peninsula of the northernmost part of Sakhalin. The main associations of this thicket are as follows:

a) *Pinus pumila-Rhododendron aureum-Empetrum nigrum* association
b) *Pinus pumila-Arctous japonica-Vaccinium uliginosum* association
c) *Pinus pumila-Ledum palustre* association
d) *Pinus pumila-Sorbus Matsumurana* association
e) *Pinus pumila-Sasa kurilensis* association
f) *Piuus pumila*-non plant cover association

KUDO, Y.: Flora of the Island of Paramushir. Journ. Coll. Agr. Hokkaido Imp. Univ. **9**-2. 33~35. (1922)

TATEWAKI, M.: The distribution of *Pinus pumila* in Northern Japan. Ecol. Rev. Jap. **1**-1. 23~36. (1935) (in Japanese)

" : The vegetation of Daisetsu Mountain-range. (1949) (in Japanese)

ii. Thicket of *Sabina Sargentii*

In only one locality, the north-western corner of the Island of Shikotan, Southern Kuriles, is the pure thicket of *Sabina Sargentii* found, developed on the upper parts of hilly mountains (160–200 m). It has no under-growth and the prostrate aspect like the physiognomy of the low thicket of *Pinus pumila* developed in the high mountain. (Pl. III. b)

iii. Thicket of *Alnus Maximowiczii*

Alnus Maximowiczii, the Eastern Asiatic species related to *Alnus fruticosa*, shows an interesting ecological distribution. In the Kurile Islands, the thickets of *Pinus pumila* are well developed throughout the Islands. But it is worthy of notice that on a few of the islands there is a complete absence of this pine. Alaid, the northernmost island of the Kuriles and the Island of Matua in the Central part afford good examples. They are of recent volcanic eruption and of a graceful conical form. On Mt. Alaid (2339 m), only the alder thickets are found as high as 500–700 m above sea-level (Pl. IV. a) while on Mt. Matua they are found as high as 400 m. (Pl. IV. b) They clothe the ranges from the bottom of the gullies to the ridge of the mountain, showing the physiognomy of an edaphic climax. The developement of the alder thickets depends upon the volcanic conditions. The height of the tree varies with the localities. In the upland exposed to the wind, the alder is merely small-shrubs lying flat on the ground, but in the sheltered

gully it attains a height of 3–5 m.

A similar edaphic aspect is found on such mountains in Hokkaido as Mt. Komagatake and Mt. Tarumai, both of which are still active. Mt. Tarumai is a famous triple volcano of which the dome was formed in the central cone in 1909. Traceable patch of *Pinus pumila* is found very locally on Mt. Tarumai. Generally speaking the alder thickets are found along the valley of the mountains of Hokkaido, often forming a narrow pure belt. Such thickets are developed from the upper part of the mountain and come as far down as the zone of the needle forest. (Pl. V. a) Sometimes they appear along the coast of the Pacific side in eastern Hokkaido where sea-fogs are frequent in summer.

The under-layer of the forest under consideration seems very considerable in different places but sometimes it is completely absent. The communities of this forest are as follows:

a) *Alnus Maximowiczii-Calamagrostis Langsdorffii* association
b) *Alnus Maximowiczii-Dryopteris austriaca* association (Pl. V b)
c) *Alnus Maximowiczii-Filipendula kamtschatica* association
d) *Alnus Maximowiczii-Sasa kurilensis* association
e) *Alnus Maximowiczii*-non plant cover association

TATEWAKI, M.: On the plants collected in the Island of Alaid by HIDEGORO ITO and GOSAKU KOMORI. Trans. Sapporo Nat. Hist. Soc. **9**–2. 152~153. (1927)

" : The primary survey of the vegetation of the Middle Kuriles. Journ. Fac. Agr. Hokkaido Imp. Univ. **29**–4. (1931)

" : Forest botany of Mt. Tarumai. Goryorin, No. **165**. 18~19. (1942) (in Japanese)

TATEWAKI, M. & AKAGI, K.: Vegetation of the district around the Paramushir Strait. Report of the Scientific Investigetian in the N. Kuriles. 33~34. (1944) (in Japanese)

TATEWAKI, M., NAKANO, M. & YAMAMOTO, H.: Phytosociological study on forests in the district influenced by sea-fog. Studies on fog-prevention forest. **3**. 194~196. 208~212. (1953) (in Japanese)

iv. Forest of *Betula Ermani*

In Hokkaido, the forest of *Betula Ermani* forms often in the intermediate zone (Pl. VI. a, b) making rather a narrow belt between the thicket of the dwarf Siberian pine (*Pinus pumila*) in the alpine zone and the needle-leaved forest composed of *Picea jezoensis* and *Abies sachalinensis* in the subalpine zone. (Pl. VI.) The analysis of the elements composing its flora shows an over-all character of the needle-leaved

forest in spite of there being some intermixture of arctic-alpine or alpine elements. The height and form of the birch tree vary with the localities. In central Hokkaido, it is developed at the altitudes between 1300 m and 1800 m. The mixed shrubs in this forest are *Acer Tschonoskii, Acer ukurunduense, Weigela Middendorffiana, Sorbus Matsumurana,* etc. In the Kurile Islands such forest is found at sea-level and it is distributed as far north as the Island of Rashua, showing an uninterrupted range of distribution. It is very interesting that it is entirely absent between the Island of Matua and of Alaid, the northernmost of the Kuriles, but that it again appears in Kamtchatka. The typical community is the *Betula Ermani-Sasa kurilensis* association. Besides this there are the following associations.

a) *Betula Ermani-Calamagrostis Langsdorffii* association
b) *Betula Ermani-Sorbus Matsumurana* association
c) *Betula Ermani-Vaccinium axillare* association
d) *Betula Ermani-Acer ukurunduense* association

TATEWAKI, M.: The vegetation of Daisetsu Mountain-range. (1949) (in Japanese)
" : The vegetation of the Upper Otofuke River, Prov. Tokachi. "Midori-no-me" (Obihiro Forest Office) 2–2. 131. (1950) (in Japanese)

2. Needle-Leaved Forest

i. Forest of *Picea jezoensis-Abies sachalinensis*

The subarctic or needle-leaved forests in the islands of the Far East are represented by the forests of the spruces and the firs except Northern Sakhalin. They are often codominated by *Picea jezensis-Abies sachalinensis,* and sometimes dominated respectively by *Picea jezoensis, Abies sachalinensis* or *Abies Mayriana.* The percentage respectively between *Picea jezoensis* and *Abies sachalinensis* are not constant as already stated. If one goes up to the mountain or to the north, *Picea jezoensis* increases. At the present day, spruce-fir forests are still in existence in Hokkaido, Sakhalin and also the Southern Kuriles as far as the middle part of the Island of Etorofu (the fir forest). (Fig. 4) In the area of the distribution of this needle-levaed forest, they are frequently seen and gradually increase towards the north and the east, but are scarce in the southwestern part.

In the southwestern part of Hokkaido, the forest of *Abies Mayriana,* a species closely related to *Abies sachalinensis,* is scattered among the forests of the Japanese beech, while in its central part, the forest

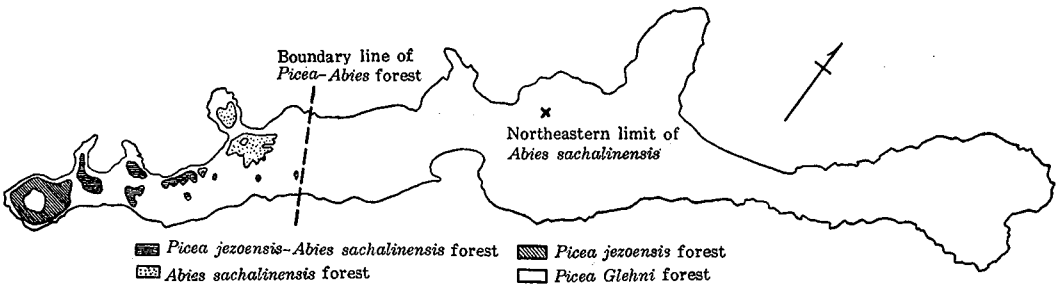

Fig. 4. Distribution of *Picea* and *Abies* in Etorofu Island

dominated by *Picea jezoensis* and *Abies sachalinensis* is well developed at altitudes from 800 m to 1200 m. Along the upper Ishikari, very fine forests of the spruce and fir called "Japanese Taiga" were developed. (Pl VII. a) But it is very regretable that they were destroyed by the terrible storm in the autumn of 1949. (Pl. VII. b) As shown by the results of the studies up to the present, the spruce-fir forests under consideration were researched most precisely by the Japanese botanists. The forest types and the associations are as follows:

1) *Sasa* Type
   Picea jezoensis-Abies sachalinensis-Sasa association (Pl. VIII. a)
2) Fern Type
   Picea jezoensis-Abies sachalinensis-Dryopteris austriaca association
   Picea jezoensis-Abies sachalinensis-Dryopteris austriaca sociation
   Picea jezoensis-Abies sachalinensis-Dryopteris amurensis sociation (Pl. IX. a)
   Picea jezoensis-Abies sachalinensis-Dryopteris crassirhizoma association
3) Shrub Type
   Picea jezoensis-Abies sachalinensis-Rhododendron Fauriae association
   Picea jezoensis-Abies sachalinensis-Menziesia pentandra association
   Picea jezoensis-Abies sachalinensis-Vaccinium axillare association
4) *Carex* Type
   Picea jezoensis-Abies sachalinensis-Carex sachalinensis association (Pl. IX. b)
5) Moss Type
   Picea jezoensis-Abies sachalinensis-moss association
6) Non plant-cover Type (Pl. VIII. b)

The *Sasa* type is the climax while the *Carex* type occurs in rather

an initial stage. The latter is mostly found in Sakhalin and also locally in central and eastern Hokkaido. The area of the fern type is not large; it oocurs in humid climate. The dominance of *Dryopteris amurensis* in the forest floor occurs in Sakhalin and very locally in central Hokkaido. Among the shrub types, *Picea jezoensis-Abies sachalinensis-Rhododendron Fauriae* association (sometimes codominated or dominated by *Rhododendron Albrechtii*) found on the rocky slopes is common. The moss type is rarely found on only rocky slopes, covering not so large area. It occurs mainly in the eastern part of Hokkaido and also in Sakhalin. In the ground flora, *Lycopodium* and *Cornus canadensis* are characteristic.

KIKKAWA, Y.: Investigations on the stand-types of the spruce-fir natural forest in Southern Saghalien. Rep. Saghal. Cent. Exp. Stat. Ser. 2. **1**. (1932) (in Japanese)

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ii. Forest of *Abies sachalinensis*

Abies sachalinensis is distributed in Sakhalin, Southern Kuriles and Hokkaido except the southwestern part where it is substituted by *Abies Mayriana*. In the Southern Kuriles it reaches as far as the middle part of Etorof Island. (Fig. 4) The pure Sakhalin fir forest is commonly found on the low land in the area under consideration, but sometimes in the mountain district as seen on Mt. Meakan. The *Abies Mayriana* (including *Abies sachalinensis*)-*Cephalotaxus nana* sociation is developed in the southwestern part of Hokkaido. The following associations and sociations are found:

a) *Abies sachalinensis* (*Mayriana*)-*Sasa* association
   Abies sachalinensis-Sasa amphitricha sociation
   Abies sachalinensis-Sasa apoiensis sociation
   Abies sachalinensis (*Mayriana*)-*Sasa kurilensis* sociation
   Abies sachalinensis (*Mayriana*)-*Sasa paniculata* sociation (Pl. X. a)
   Abies sachalinensis-Sasamorpha purpurascens sociation

b) *Abies sachalinensis* (*Mayriana*)-fern association

Abies sachalinensis (*Mayriana*)-*Dryopteris crassirhizoma* sociation (Pl. X. b)

Abies sachalinensis-Dryopteris austriaca sociation

c) *Abies sachalinensis-Carex sachalinensis* association

Abies sachalinensis-Carex sachalinensis sociation

d) *Abies sachalinensis-Daphniphyllum humile* association

Abies Mayriana-Cephalotaxus nana sociation

Abies Mayriana-Cephalotaxus nana-Daphniphyllum humile sociation

Abies sachalinensis (*Mayriana*)-*Daphniphyllum humile* sociation

e) *Abies sachalinensis-Rhododendron Fauriae* association

Abies sachalinensis-Rhododendron Fauriae sociation

f) *Abies sachalinensis-Ribes sachalinensis* association

Abies sachalinensis-Ribes sachalinensis sociation

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TATEWAKI, M. & TAKAHASHI, K.: Plant communities. A memoir of the scientific investigations of the primaeval forests in the head waters of the River Ishikari, Hokkaido, Japan. (1955) (in Japanese)

TATEWAKI, M. & SUGAWARA, F.: Geobotanical study on the forests in the district of the southern distribution-limit of *Abies Mayriana* MIYABE et KUDO. Hakodate Forest Office. (1955)

iii. Forest of *Picea jezoensis* (Pl. XI. a)

Picea jezoensis is distributed in north-eastern Asia, especially influenced by the oceanic climate. It shows an interesting interrupted distribution in Japan occuring in the mountain district of central Honshu and also in the area northwards from the Kuromatsunai Depression in Hokkaido. In Sakhalin it commonly grows throughout the island except in the northernmost part of the SCHMIDT Peninsula. In the Kurile Islands it reaches only as far as the Southern Kuriles, where the eastern extreme is the southwestern part of the Island of Etorofu.

The pure forests of *Picea jezoensis* occur rather rarely in the area under consideration. Such as found in the cool and moist climate in summer. In keeping with this character, stands are restricted to the

basins or to the flat areas at the heads of valleys influenced by the frequent fogs in summer. The upper valley of the River Ishikari affords an excellent example. The *Picea jezoensis-Sasa* association is representative of its community. (Pl. XI. b) It is composed of over-matured uniform forest of which the undergrowth is exclusively dominated by *Sasa*.

There is another remarkable forest of *Picea jezoensis* on Mt. Tarumai, a triple volcano situated on the Pacific-side already mentioned in the paragraph on the forest of *Alnus Maximowiczii*. Its prominent physiognomy is characterised by the complete absence of the *Sasa* stratum. The forest of the Yezo spruce on Mt. Tarumai is a result of the volcanic activity and the frequent fogs in summer. The communities of the edaphic climax are represented by the *Picea jezoensis*-moss associations. Among the mosses of this association are found *Lycopodium annotinum*, *Lycopodium obscurum*, *Chimaphila umbellata*, *Pyrola renifolia*, etc. It is great pity that most of these excellent forests were cut during the last period of the 2nd World War for the paper industry of the newspapers of Japan and also influenced by the terrible storm in 1954. The following associations and sociations we found on Mt. Tarumai.

a) *Picea jezoensis*-moss association
   Picea jezoensis-Lycopodium annotinum sociation
   Picea jezoensis-Pyyrola sociation
b) *Picea jezoensis-Dryopteris* association
   Picea jezoensis-Dryopteris austriaca sociation
   Picea jezoensis-Dryopteris crassirhizoma sociation
c) *Picea jezoensis-Ledum palustre* association
   Picea jezoensis-Ledum palustre sociation
   Picea jezoensis-Leucothoe Grayana sociation

TATEWAKI, M.: Forest botany of Mt. Tarumai. Goryorin No. **165**. 13.~15. (1942) (in Japanese)

" : HATTORI's an investigation on the primaeval forest in the northern mountain regions, Hokkaido. Bull. Sapporo Br. For. Exp. St. **19**. 18~19. (1950) (in Japanese)

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TATEWAKI, M.: The primaeval needle-leaved forests along the road-side, Akan, Akan National Park, Prov. Kushiro, Hokkaido. Hoppo Ringyo (Northern Forestry) No. **48**. 1~4. (1953) (in Japanese)

TATEWAKI, M. & TAKAHASHI, K.: Plant communities. A memoir of the scien-

tific investigations of the primaeval forests in the head waters of the River Ishikari, Hokkaido, Japan. 16~21, 31~153. (1955) (in Japanese)

iv. Forest of *Picea Glehni* (Fig. 5)

Picea Glehni is one of the most important needle-leaved trees of Hokkaido. It is mainly distributed in Hokkaido, especially in its eastern as well as northern part. Very locally it is found along the Aniwa Bay in Sakhalin (Pl. XII. a) and also in some limited localities of the Southern Kuriles. (Pl. XII. b) It often forms a fine, pure, uniform forest ranging from the wet bogs to such dry soils as sand dunes. Even from a glimpse of the forests of *Picea Glehni*, it is immediately seen that they are entirely different from any of other forests. These spruce forests afford an excellent subject for the study of phytosociology, supporting a definite vegetation. In them there are, therefore, represented remarkable forest-communities which must be considered as the edaphic climax.

TATEWAKI, M. & YAMANAKA, T.: Northern limit of *Picea Glehni*. Hokkaido-Ringyo-Kaiho **36**–11. 1~6. (1938) (in Japanese)

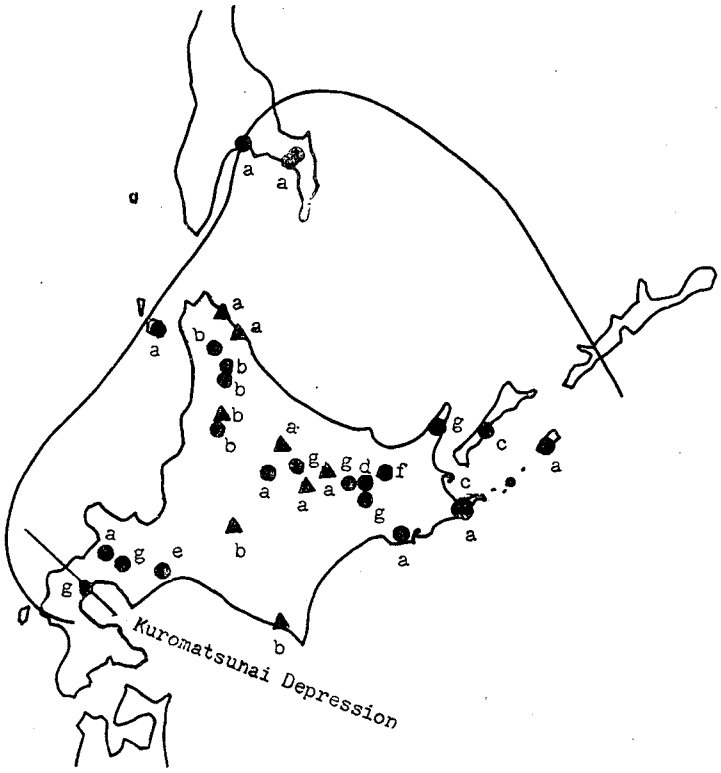

Fig. 5. Geographical area of *Picea Glehni*.
●: Experimental plot; ▲: Researched plot

The author has continued his researches about the associations of the forests under consideration for about the past 25 years. After the result of the investigations, the following seven series of the edaphic categories are distinguished.

a. Swamp and bog; b. Serpentine district; c. Sand dune;
d. Area burned-over by forest fires; e. Volcanic sand and gravel;
f. The neighbourhood of the hot-springs; g. Rocky slope.

a. Bog and Swamp

In the northern part along the Ochotsk Sea as well as the eastern part along the Pacific coast of Hokkaido, the forest of GLEHN's spruce prevails on the bog and swamp. It is interesting that, in respect to average heights of the trees, there are three types correlated with the development of the bogs. In the center of the bog composed of the *Sphagnum* stratum, occurs the dwarf forest of 0.5–1 m in height. The communities existing there, are represented by the *Picea Glehni-Carex Middendorffii* sociation. Around it, there is an intermediate forest 2–5 m in height on the intermedate bogs of which the strata are dominated by *Ledum palustre* or *Osmunda cinnamomea*. The dwarf and intermediate forests occur on very wet lands. On the margin of the bog, the tall forest over 10 m in height is found in which the undergrowth is often dominated by *Menziesia pentandra* and by *Vaccinium axillare* in the alpine belt. In the swamps, the GLEHN's spruce attains a considerable height; there the undergrowth is dominated by *Phragmites communis* or *Lysichiton camtschatcense*. The main associations of the GLEHN's spruce forest on the bogs and swamps are as follows:

a) *Picea Glehni-Sphagnum* association
  Picea Glehni-Carex Middendorffii sociation (Pl. XIII. a)
  Picea Glehni-Phragmits communis-Oxycoccus quadripetalus sociation
b) *Picea Glehni-Ledum palustre* association
  Picea Glehni-Ledum palustre sociation
  Picea Glehni-Eriophorum vaginatum sociation
  Picea Glehni-Moliniopsis japonica sociation
  Picea Glehni-Osmunda cinnamomea sociation (Pl. XV. a)
  Picea Glehni-Carex caespitosa sociation (Pl. XIII. b)
c) *Picea Glehni-Phragmites communis* association
  Picea Glehni-Phragmites communis sociation (Pl. XIV. a)
  Picea Glehni-Lysichiton camtschatcense sociation

Picea Glehni-Equisetum palustre sociation (Pl. XIV. b)

b. Serpentine District

The characteristic forests of *Picea Glehni* are found in the serpentine district of the central and the northern part of Hokkaido. (Pl. XVII. a) One of the largest forests is found in the Teshio Experiment Forest of Hokkaido University situated in the northwestern part of central Hokkaido. The edaphic climax is represented by *Picea Glehni-Sasa* association.

c. Sand Dune

Forests of this spruce developed on the sand dunes are very rarely found. Only two localities were investigated. One of them is located on the sand bar along Lake Fûren, situated in eastern Hokkaido, and the other in the central part of Kunashiri Island of the Southern Kuriles on the Pacific side. These localities are influenced by the frequent sea-fog in summer. The *Picea Glehni-Majanthemum dilatatum* association is the representative.

d. Areas burned over by Forest Fires

As secondary vegetation following forest fires, the forest of *Picea Glehni* can be found in Hokkaido only in the mountain district in eastern Hokkaido. The representative of this series is developed on Mt. Kikin in the eastern part of Prov. Kitami. There one finds *Picea Glehni-Sasa* association. Another example can be seen in the national forest at Oketo, Prov. Kitami. (Pl. XVI. b) The GLEHN's spruce is associated with *Betula platyphylla.*

e. Volcanic Sand and Gravel

One of the characteristic communities of GLEHN's spruce is found in the forest developed on volcanic sand and gravel. Such occurs on recent volcanoes, for example, on Mt. Meakan, Mt. Tarumai, etc. Sometimes the moss-layer is well developed and sometimes *Ledum palustre* var. *yesoense* covers the ground forming a continuous mat. There are found the associations and sociations as follows:—

a) *Picea Glehni*-moss association
Picea Glehni-moss sociation
Picea Glehni-Lycopodium sociation
Picea Glehni-Coruns canadensis sociation (Pl. XV. b)

b) *Picea Glehni-Ledum palustre* association
Picea Glehni-Ledum palustre sociation
Picea Glehni-Leucothoe Grayana sociation

f. Neighbourhood of Hot-springs

In the eastern part of Hokkaido, GLEHN's spruce stands are often found in the neighbourhood of hot springs. They occur on soil of strong acidity. Remarkable examples are found in the Akan National Park, among which the representative is that of Kawayu hot-spring. The spruce at Kawayu attains a height of 5–7 m, occasionally attaining 10 m or slightly more. The forest floor is partly dominated by *Cornus canadensis* and partly by *Osmunda cinnamomea*. (Pl. XVII. b) The *Picea Glehni-Sasa amphitricha* sociation is developed along the borders of this forest.

g. Rocky Slope

Stands of *Picea Glehni* are commonly found on rocky slopes of the mountain district in Hokkaido and the southern Kuriles. In this case, the kind of the rocks is not so important, but the layers of soil are always thin. The communities of the forest are characterised by the good development of the moss layers (Pl. XVI. b), the shrub layers often associated with predominant moss on the ground floor. Representative shrubs are *Rhododendron Albrechtii* in the southern part associated often with *Viburnum furcatum*, *Rhododendron Fauriae* (Pl. XVIII. a) in the northern and eastern parts, sometimes *Rhododendron dauricum* in the eastern part (Pl. XVIII. b) and *Ilex Sugeroki* in the upper zone of the needle-leaved forest.

TATEWAKI, M.: Phytosociological study on the *Picea Glehni* forest. Res. Bull. Coll. Exp. For. Coll. Agr. Hokkaido Univ. **13**–2. (1944) (in Japanese)

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" : Vegetation at the points of the meteorological observation at Ochiishi, Prov. Nemuro, Hokkaido. ibid. **2**. 275~291. (1952) (in Japanese)

" : The vegetation of Mt. Meakan of the Tokachi-side, Akan National Park, Hokkaido, Japan. (Obihiro Forest Office) (1954) (in Japanese)

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v. Forest of *Larix kamtschatica* (Fig. 6)

Larix kamtschatica is distributed in the northeastern part of Eastern Asia. In the islands of the North Pacific Ocean, Sakhalin and the Southern Kuriles only are known to have this forest.

In the Southern Kuriles, the distribution is limited to the Islands of Shikotan (Pl. XXIX. a, b) and Etorof showing a distinct disjunctive distribution. In the Islands of Shikotan it is found only along the southern coast on the Pacific side. There may be seen the *Larix kamtschatica-Sphagnum* and the *Larix kamtschatica-Sasa* (*depauperata*) association. If comparison is made to that of the Island of Etorof, the distribution of the latter is wider. Its forest ranges from R. Saruya in the east to Guya in the west while its individuals are distributed from Moyoro in the east to Nokka in the west. As the communities, there are the *Larix kamtschatica-Sphagnum-*, *Larix kamtschatica- Ledum*

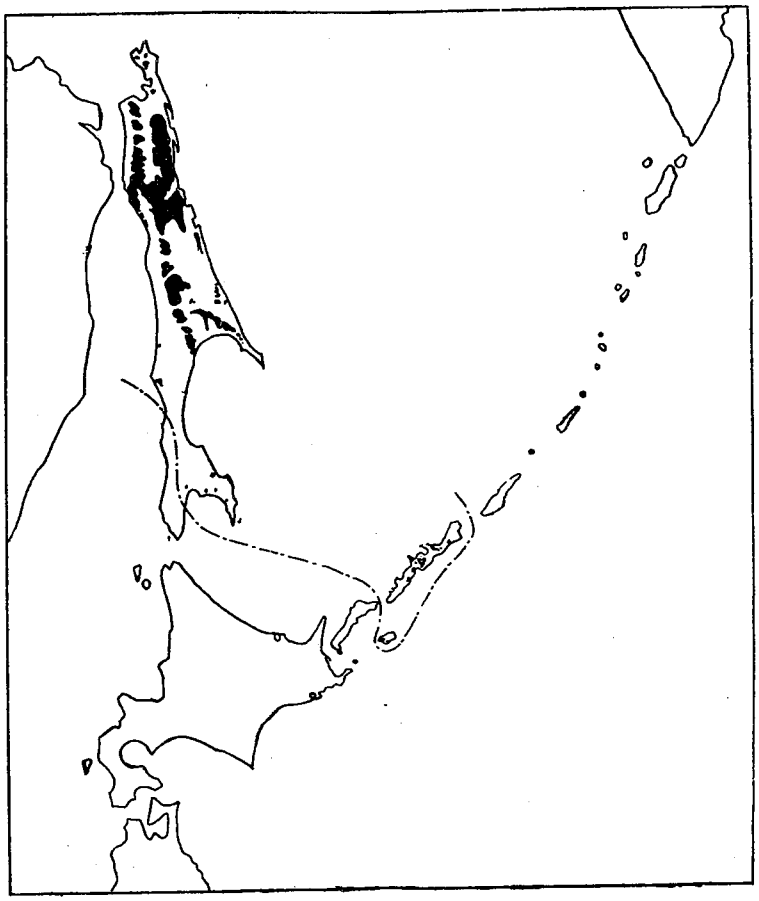

Fig. 6. Distribution of the *Larix kamtschatica* forest on the islands of the North Pacific Ocean

palustre-, and *Larix kamtschatica-Sasa* (*kurilensis*) associations.

Forests of this larch are well developed in Sakhalin. Towards the north beyond SCHMIDT's Line, it increases especially in number of separate forest, and the forests occur commonly on hills as well as on bogs. Among them larch forests developed along the R. Poronai were studied in most detail. The communities of the larch under consideration are found as follows:—

a) *Larix kamtschatica-Sphagnum* association
   Larix kamtschati a-Carex Middendorffii sociation (Pl. XX. a)
   Larix kamtschatica-Vaccinium axillare sociation
b) *Larix kamtschatica-Ledum palustre* association
   Larix kamtschatica-Ledum palustre sociation (Pl. XX. b)
   Larix kamtschatica-Eriophorum vaginatum sociation
   Larix kamtschatica-Osmunda cinnamomea sociation
c) *Larix kamtschatica-Calamagrostis Langsdorffii* association
d) *Larix kamtschatica-Sasa* association
   Larix kamtschatica-Sasa kurilensis sociation
   Larix kamtschatica-Sasa depauperata sociation

KUDO, Y.: Report of the vegetation of N. Saghalien. 21~22. (1924) (in Japanese)

YAMAZAKI, T.: Distribution and associations of *Larix dahurica* var. *japonica*. Bull. Kyoto Univ. For. **7**. (1934) (in Japanese)

TATEWAKI, M.: Report of the vegetation of Shikotan Island. (Hokkaido Government) 11. (1940) (in Japanese)

" : Plant communities in the middle part of Etorof Island. I. Hokkaido Ringyo-Kaiho **39**. 10~14. (1941) (in Japanese)

vi. Forest of *Thujopsis dolabrata* var. *Hondai* (Fig. 7)

Thujopsis dolabrata var. *Hondai* ("*Hiba*" in Japanese), one of the finest conifers occurs in the northern mountain district of the temperate Japan. It is found on the side of the Sea of Japan of the southwestern part of Hokkaido. The tree in this district grows to a great size attaining a height of 25 m and 70 cm in breast-high diameter. It forms a pure forest or a mixed forest with many other broad-leaved trees. In Hokkaido, the distribution of this tree is mostly limited to the Paleozoic district. Taking the distribution of the present species in northernmost Honshu (the main island of Japan) into consideration, it shows a remarkable example of the continous distribution though the Tsugaru Strait divides them at present. The presence of this forest

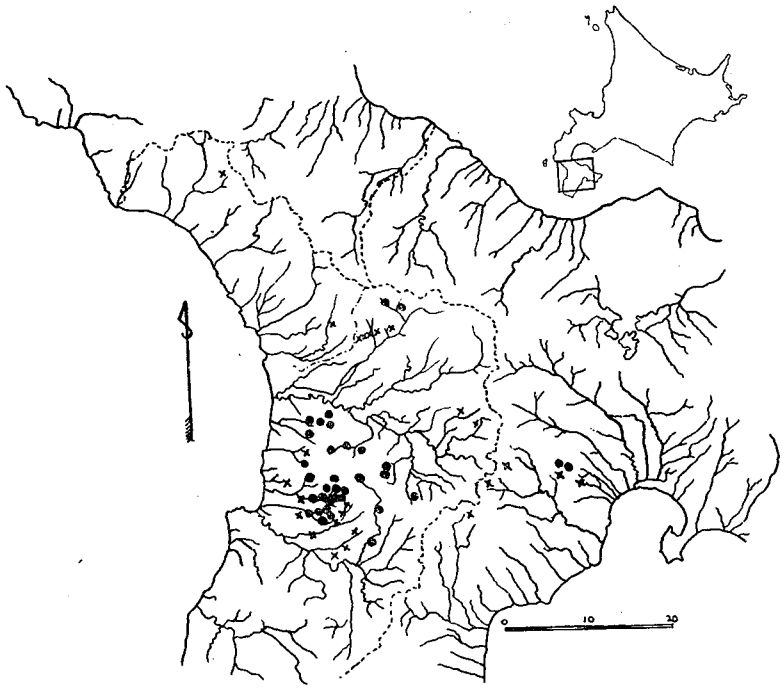

Fig. 7. Distribution of *Thujopsis dollabrata* var. *Hondai*
● : forest ; × : scattered distribution

in Hokkaido is considered to have been composed before the separation of the Tsugaru Strait. The forest floor is characterized by sparse vegetation or sometimes it is entirely absent owing to the insufficient light. The main associations of this forest are as follows:

a) *Thujopsis dolabrata* var. *Hondai-Spicanthopsis nipponica-Plagiogyria Matsumuraeana* association
b) *Thujopsis dolabrata* var. *Hondai-Carex conica* association
c) *Thujopsis dolabrata* var. *Hondai-Dryopteris crassirhizoma* association
d) *Thujopsis dolabrata* var. *Hondai*-non plant cover association.

TATEWAKI, M. & FUKIAGE, Y.: Vegetation of *Thujopsis dolabrata* var. *Hondai* forest in the district of its northern limit zone. Hakodate Forest Office. (1951) (in Japanese)

vii. Grove of *Pinus parviflora* var. *pentaphylla*

Pinus parviflora var. *pentaphylla* shows an interesting distribution in Hokkaido, forming two groups:— one of them is restricted in the southwestern part including Okushiri Island, and the other in the Hidaka Range. (Fig. 8) The largest forest existed in Samani District

Fig. 8. Distribution of *Pinus parviflora* var. *pentaphylla* in Hokkaido

in Prov. Hidaka, (Pl. XXVII. a) but it was cut during the War. At present, the groves of this pine were found only in scattered places. The main sociations of this forest are as follows:

Pinus parviflora var. *pentaphylla-Rhododendron Fauriae* sociation
Pinus parviflora var. *pentaphylla-Ilex Sugeroki* sociation
Pinus parviflora var. *pentaphylla-Menziesia pentandra* sociation
Pinus parviflora var. *pentaphylla-Carex blepharicarpa* sociation

TATEWAKI, M.: Report on the vegetation of the forests of Urakawa local forest office of Hokkaido Government. "Hayashi" (1952)-10. 44~47. (1952) (in Japanese)

" : Vegetation of the forest zone of *Fagus crenata*. "Ginyo" (Hakodate Forest Office) (1956)-3. 5~13. (1956) (in Japanese)

viii. Grove of *Taxus cuspidata*

The Japanese yew (*Taxus cuspidata*), the Eastern Asiatic element, has close relation to the European yew (*Taxus baccata*). Groves of Japanese yew in the area under consideration have been hitherto known very rarely in Honshu and Hokkaido. As the representative of the

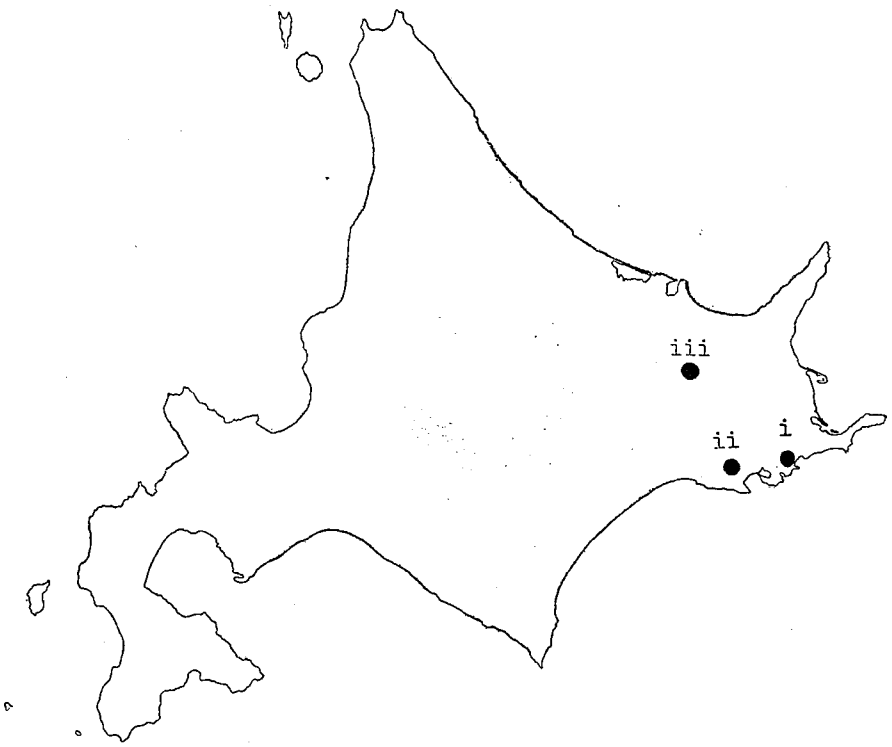

Fig. 9. ●: Pure Japanese yew forests

former, the only one grove in the province of Hida of central Honshu was famous. It had been protected as a national monument, but it was destroyed before 1945 during the recent war. Groves in Hokkaido have fortunately survived up to the present. They are found in only three localities of the eastern part of Hokkaido as follows (Fig. 9):

i) Chanai, Prov. Kushiro (Prefectural forest) (Pl. XXI. a)
ii) Kamioboro, Prov. Kushiro (National forest) (Pl. XXI. b)
iii) Near the lake-side of Kutcharo, Prov. Kushiro (National forest)

The areas of these groves are about 1–5 hectares, forming the secondary layer of 5–12 m in height. However the yew trees near the lake-side of Kutcharo are higher, being 11–17 m in height. *Abies sachalinensis, Picea jezoensis, Acer Mono, Magnolia obovata, Kalopanax pictus,* etc. are scattered in the first layer of 20–26 m in height. They are distributed in the environment of rather cool and frequently foggy summer, not very cold winter and the stand on the comparatively level land near the head of a valley.

The ground flora is characterised by the absence of *Sasa* spp. *Dryopteris crassirhizoma* and *Dryopteris austriaca* (both cover-degree about

3) are predominant associated with several shade- and humous-plants such as *Lycopodium serratum* var. *Thunbergii*, *Tiarella polyphylla*, *Oxalis Acetosella*, *Viola Selkirkii*, *Circaea alpina*, *Pyrola renifolia*, *Galium kamtschaticum*, *Clintonia udensis*, *Listera nipponica*, etc.

The climax community of these forests is represented by "the *Taxus cuspidata-Dryopteris* association", having few or no seedlings and young trees of the yew. It is a very remarkable forest type in our district.

TATEWAKI, M. & TASHIMO, Y.: The vegetation of the Japanese yew at Chanai, Prov. Kushiro. Ecol. Rev. Jap. 3-4. 279~294. (1937) (in Japanese)

TATEWAKI, M.: On the grove of *Taxus cuspidata* var. *latifolia*, Kutcharo, Prov. Kushiro, Hokkaido, Japan. Bull. Soc. Pl. Ecol. 2-4. 97~103. (1952) (in Japanese)

" : The vegetation of the prefectural forest at Chanai, Prov. Kushiro, Hokkaido, Japan. Northern Forestry, No. 7. 1~7. (1953) (in Japanese)

3. Summer Green Forest

i. Forest of *Fagus crenata*

The forest of the cold temperate zone in Japan is well represented by the Japanese-beech (*Fagus crenata*) one. It is well known as the climax forest. It is distributed from the mountains of Kyushu in the south to as far as near the Kuromatsunai Depression (42°47′44″ N.L.; 140°23′47″ E.L.) of Hokkaido in the north. (Fig. 10) In the southwestern part of Hokkaido, the present foresent is well developed from the sea-level to the limit of the timber-line (Pl. XXII. a) and the tree attains a height of 28 m and breast-high diameter of 1.5 m. The climax of the beech forest shows the *Fagus crenata-Sasa* association, the aspect of which is monotonous. Sometimes it is associated with *Acer japonicum* or *Acer Tschonoskii* in the shrub layer. In dampy lower slopes, the *Fagus crenata-Viburnum Wrightii* association is found, while on upper slopes of the rather dry ridges is found the *Fagus crenata*-ericaceous shrubs association, in which sometimes *Vaccinium Smallii* and *Hugeria japonica* are codominate, sometimes *Rhododendron Kaempferi* as dominant or *Leucothoe Grayana* is abundant. After the selective cutting or the partly clear cutting, *Lindera membranacea* usually occurs, and in such places, the *Fagus crenata-Lindera membranacea* association is often found.

The main associations and sociations of the beech forests are as follows:

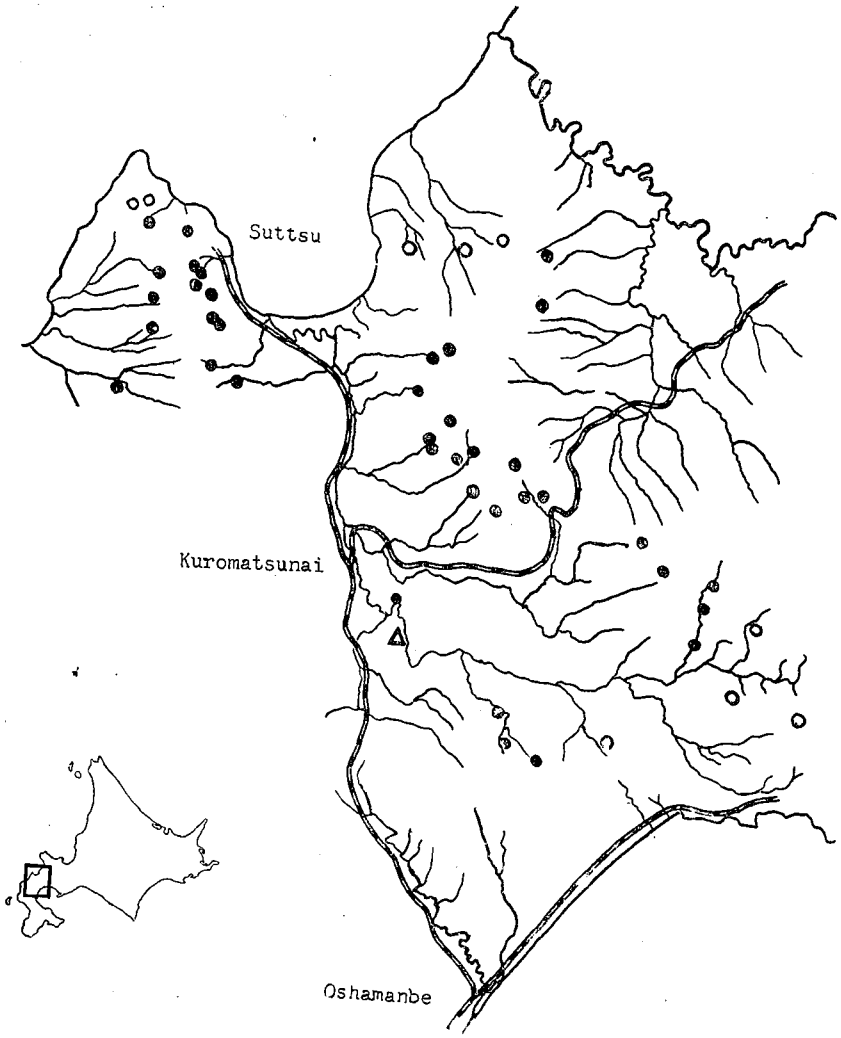

Fig. 10. Northern limit of *Fagus crenata*

● : forest; ○ : sparse distribution; △ : natural conservation

Fagus crenata-Sasa association
- *Fagus crenata-Sasa cernua* sociation (Pl. XXII. b)
- *Fagus crenata-Sasa paniculata* sociation

Fagus crenata-Acer association
- *Fagus crenata-Acer japonicum-Sasa* sociation
- *Fagus crenata-Acer Tschonoskii-Sasa* sociation

Fagus crenata-Viburnum Wrightii association
- *Fagus crenata-Viburnum Wrightii* sociation
- *Fagus crenata-Carex folisissima* sociation
- *Fagus crenata-Cephalotaxus nana* sociation

TATEWAKI, M.: Northern limit of *Fagus crenata*. Ecol. Rev. Jap. **11**-1~2. 46~51. (1948) (in Japanese)

INOKUMA, T., SUZUKI, T. & OKAMOTO, S.: Report of the vegetation of the Japanese beech forest in Hokkaido. Hakodate Forest Office. (1952) (in Japanese)

TATEWAKI, M., etc.: The forest vegetation in the district of the northern limit of the Japanese beech forest. TATEWAKI's Iconography of the vegetation of the natural forest in Japan. IV. Hakodate Forest Office. (1958) (in Japanese)

ii. Forest of *Pterocarya rhoifolia-Aesculus turbinata*

The communities mentioned above are to be found in the southwestern part of Hokkaido in the area under consideration. Along the valleys of this forest zone are found the *Pterocarya rhoifolia-Aesculus turbinata-*, *Pterocarya rhoifolia-Cercidiphyllum japonicum-*, *Pterocarya rhoifolia-* (Pl. XXIII. a) or *Aesculus* (Pl. XXIII. b) forests on rich soils. Such forests in their primaeval condition can hardly be found at present, owing to the development of the agriculture and forestry. Only a few localities situated near Hakodate, namely Nanae and Ohnuma, were used for the ecological analysis. The under growth of these forests is generally dominated by the tall herbage and often by the ferns. They are represented by the associations and the sociations as follows:

Pterocarya rhoifolia-Aesculus turbinata-fern association
- *Pterocarya rhoifolia-Aesculus turbinata*-fern sociation
- *Pterocarya rhoifolia-Mattenccia Struthiopteris* socciation

Pterocarya rhoifolia-Aesculus turibinata-tall herbage association
- *Pterocarya rhoifolia*-tall herbage sociation

Pterocarya rhoifolia-Aesculus turbinata-Sasa association
- *Pterocarya rhoifolia-Aesculus turbinata-Sasa cernua* sociation
- *Pterocarya rhoifolia-Sasa cernua* sociation
- *Pterocarpa rhoifolia-Sasa paniculata* sociation
- *Aesculus turbinata-Sasa paniculata* sociation

TATEWAKI, M.: Vegetation of the forest zone of *Fagus crenata*. "Ginyo" (Hakodate Forest Office) (1956)-3. 14~18. (1956) (in Japanese)

iii. Forest of *Ulmus propinqua-Acer Mono*

On rich alluvial soils in the plain or flat moist places along the valley were found the *Ulmus propinqua-Acer Mono* forest in the intermediate zone of northern temperate Eastern Asia. *Ulmus propinqua* is

an outstanding tree attaining a height of 30 m and breast-high diameter of over 1 m, and sometimes only this tree becomes dominant. It affords a prominent feature of the landscape with its broad heads of graceful pendant branches. But such a forest as this one under consideration having the primaeval aspect can be hardly found owing to the developments of cultivation. *Alnus hirsuta, Cercidiphyllum japonicum, Kalopanax pictus* and *Fraxinus mandshurica* are mixed. The undergrowth is dominated by *Sasa* or herbs such as *Cacalia hastata* subsp. *orientalis, Cirsium kamtschaticum*, and *Petasites japonicus* subsp. *giganteus. Anemone flaccida, Corydalis ambigua, Trillium Smallii, Trillium kamtschaticum*, etc. are also found. The associations of this forest are as follows:

Ulmus propinqua-Acer Mono-herbage association

Ulmus propinqua-Acer Mono-Sasa paniculata association

TATEWAKI, M. & MATSUE, K.: Report on the vegetation, Nopporo national forest, Hokkaido Forest Experiment Station. 95~97. (1934) (in Japanese)

iv. Forest of *Acer Mono-Tilia japonica*

The forest of *Acer Mono-Tilia japonica* is developed on the hill-slope in the intermediate zone. *Tilia japonica* (Pl. XXIX. a) is often associated with *Tilia Maximowicziana.* The present forest is rich in the species of trees; they are *Ostrya japonica Quercus crispula, Ulmus laciniata, Prunus Sargentii, Prunus Ssiori, Phellodendron amurense* var. *sachalinense, Acer Mayri, Acer ornatum,* ssp., *Acanthopanax sciadophylloides, Kalopanax pictus,* etc. The undergrowth is often dominated by *Sasa* or the tall herbage. Maruyama, a hill attaining a height of 226 m, is situated in the western part of Sapporo City, the capital of Hokkaido. The forest of this hill has been kept under the law of the state natural conservation. According to the analysis of the forest composition in 1949, it was well represented by the forest of *Acer Mono-Tilia japonica.*

TATEWAKI, M.: Forest vegetation. Scientific investigation, Maruyama Hill, Sapporo, Hokkaido. (1958) (in Japanese)

v. Forest of *Quercus crispula*

Quercus crispula is one of the most essential forest trees in northern Japan. It is a very difficult species, especially in its relation to *Quercus mongolica.* In Japan at present, some taxonomists treat it as an entirely separate species, and others as a variety of *Quercus mongolica.* The writer will treat it here as an autonomous species. This oak is tall

and can attain a height of 20–24 m and 50–80 cm in diameter at breast height. The forest of *Quercus crispula* found on rather dry soil is developed in Hokkaido and Southern Sakhalin and also in the Southern Kuriles as far as the Island of Etorof. The trees mixed in this oak forest are *Betula Ermani, Ostrya japonica, Ulmus propinqua, Acer Mono, Acer ornatum*, ssp., *Tilia japonica, Kalopanax pictus*, etc. The felling of this oak was suddenly increased from 1935. Up to that time, the pure forests composed of excellent trees over 20 m high and 70 cm in diameter at breast height were seen here and there, especially in the low-land of the eastern part of Hokkaido. Owing to the over-felling toward the close and after the World War II, the fine primaeval forest of this oak have almost disappeared. The communities of this oak forest are represented by the *Quercus crispula-Sasa* association, of which the undergrowth is exclusively dominated by *Sasa*. The culms of *Sasa* attain a height of 60–80 cm. The characteristics of this association are *Thalictrum Thunbergii, Angelica anomala, Calamagrostis Langsdorffii, Carex siderosticta, Polygonatum Maximowiczii*. The cover-dagree of these species is not over 1. The *Quercus crispula- Sasa* association has been used very commonly as the fine natural meadow for horse-grazing. If over-grazing occurs *Sasa* is often replaced by such ferns as *Osmunda cinnamomea, Pteridium aquilinum, Dryopteris crassirhizoma*, etc.

A characteristic association of this oak forest was found in the experiment forest of Kyushu University in the province of Tokachi. It is the *Quercus crispula-Rhododendron dauricum* association developed on a rocky slope. The oak trees are about 20 m in height, 40 cm at breast-high diameter and *Rhododendron dauricum* is 1.5~2(~4) m high, having the cover degree 3.

Along the coastal district of the province of Hidaka, *Quercus crispula* is sometimes replaced by *Quercus serrata*.

TATEWAKI, M.: The primary survey of the vegetation of fhe Hokkaido Experiment Forest, Kyushu University. Bull. Kyushu Univ. For. **21**. 1~60. (1953) (in Japanese)

TATEWAKI, M., NAKANO, M. & YAMAMOTO, H.: Phytosociological study on forests in the district influenced by sea-fog. Studies on fog-prevention forest. **3**. 218~224. (1953) (in Japanese)

" " " : Phytosociological study on forests in districts influenced by sea-fog. ibid. **4**. 183~184. (1954) (in Japanese)

vi. Forest of *Quercus dentata*

As the edaphic climax, the forest of *Quercus dentata* occurs on restricted soils such as the sandy soils along the coastal line or the terraces covered by volcanic ashes in Prov. Tokachi. The former is commonly found on the sand dune or the sandy hill-side along the coast in Hokkaido (Pl. XXIV. a) and extends to the Okhotsk-side of Kunashiri, the southernmost island of the Kuriles. The pure stands is developed in the distance of 100–150 m from the shore along the beach. The height of the tree is 1–1.5 m in the front belt, characterized often by the shrubby form or small tree with crooked gnarled stems. The tree-crown in such places seems to be evenly cut by a hair-clipper. As going inward, the height of tree increases, and is sparsely mixed with such trees as *Acer Mono, Kalopanax pictus, Salix Bakko* or *Salix Hultenii* var. *angustifolia,* and then *Quercus dentata* is often replaced by *Quercus crispula.* The representative communities is represented by *Quercus dentata-Sasa paniculata* sociation.

Along the Sea of Okhotsk the small groves of *Malus baccata* var. *mandshurica* occur here and there on the sand dune in the eastern part of Hokkaido.

In the flatty places on the terraces in Prov. Tokachi, were found the very fine forests *Quercus dentata* which had heen almost cut by the reclamation. The tree often attained a height of over 25 m, and the breast-high diameter of over 90 cm. (Pl. XXIV. b) The *Quercus dentata-Sasa* association is the representative community and sometimes associated with the shrubby stratum of *Lespedeza bicolor* in forest floor.

TATEWAKI, M.: NIIJIMA'S Waldbauliche Untersuchung von Kashiwa-Eichen (*Quercus dentata* THUNB.) Bull. Hokkaido For. Exper. St. **13**. 66~77. (in Japanese)

MATSUI, Y.: Research of the forest on the sand dune in the northern part of Hokkaido and the consideration for its treatment. (Asahigawa Forest Office) (1952) (in Japanese)

vii. Forest of *Betula platyphylla*

One of the remarkable forests of the birches will be represented by the *Betula platyphylla* (Pl. XXVIII. a) one which corresponds to that of *Betula verrucosa* in Europe. At present there is hardly found the pure forest composed of the big trees. But the young or moderate-aged forests accompanied by the underlayer of *Sasa* found in the low

land or lower place of the mountain. They are characterised by the beautiful white birk. In general they are developed after forest fires forming the pure stands. They are replaced by *Betula Ermani* forest in the mountain district in Hokkaido. Rarely the forests of the giant *Betula Maximowicziana* were found in the same district (commonly lower), but at the present, the younger forests are locally found. In the eastern part of Tokachi Province and very rarely in Kitami Province (Pl. XXVIII. b) in Eastern Hokkaido, the interesting forests of *Betula davurica* are found.

viii. Forest of *Acer Mono*

An another forest developed along the sea-coast is the forest of *Acer Mono*. It is usually found on hill-slopes. According to the population, it has been mostly lost the primaeval physiognomy, except rather low forests on windy slopes. The representatives of them are found in the Island of Kojima and Esashi, Prov. Oshima. Sometimes it occurs in the inland district. The remarkable example shall be seen in Wakoto Peninsula, Lake Kutcharo, Prov. Kushiro. The associations of this maple forest is represented by the *Acer Mono-Sasa* (*S. paniculata*) association, but occasionally by the *Acer Mono*-tall herbage association.

ix. Forest of *Alnus japonica* var. *arguta*

The pure forest of *Alnus japonica* var. *arguta* reaches its development in swampy places. It is considered to be the edaphic climax of the low moor. It was well developed in the plains of Hokkaido forming extensive woods. But these forests have gradually disappeared according to the advancement of reclamation. The associations of this alder forest are as follows:

Alnus japonica var. *arguta-Phragmites communis* association
- *Alnus japonica* var. *arguta-Phragmites communis* sociation
- *Alnus japonica* var. *arguta-Carex Augustinowiczii* sociation
- *Alnus japonica* var. *arguta-Lysichton camtschatcense* sociation (Pl. XXVI. a)
- *Alnus japonica* var. *arguta-Calamagrostis Langsdorffii* sociation

Only one locality along the railway is fortunately preserved near Lake Abashiri, Prov. Kitami in Hokkaido. The prominent *Alnus japonica* var. *arguta-Lysichton camtschatcense* sociation is there well developed.

Another very characteristic association is locally found in the eastern part of Hokkaido. It is the *Alnus japonica* var. *arguta-Sasa* (*amphitricha*) association.

x. Forest of *Alnus hirsuta*

This forest is often found on wet ground along the valley of the mountain districts in rather small area. It shows the physiognomy of the edaphic forest in the mixed zone as well as the subarctic zone of the vertical distribution. The undergrowth is dominated by *Cacalia hastata* subsp. *orientalis* or *Urtica platyphylla* or both codominated by them. The community is represented by the *Alnus hirsuta-Cacalia hastata* subsp. *orientalis* association. Another special association is locally found in the eastern part on the Pacific side of Hokkaido, namely in Prov. Nemuro. It is the *Alnus hirsuta-Sasa* (often by *S. amphitricha*) association found on the flatty land on the terraces and gives the best meadow for horse grazing in winter.

xi. Forest of *Fraxinus mandshurica*

The ash forests are found on three different habitats: the first on rich soils along the valley, the second also on rich soils on flatty places on the mountain district and the third on the intermediate place from the swampy forest to the mesophytic one, for an example from the *Alnus japonica* forest to the *Ulmus propinqua* forest. But the former two forests represented by *Fraxinus mandshurica-Sasa* association have been mostly cut by the development of the forestry and most of the last one had been cut by the development of the agriculture. At present, they are hardly found in the primaeval condition. But in only one locality in Hokkaido the natural forest is well preserved along the eastern side of Lake Abashiri. On wet grounds, *Fraxinus mandshurica-Lysichiton camtschatcense* association is found forming the monotonous physiognomy.

Along the lake-sides of Chimikeppu and Abashiri Prov. Kitami, the *Fraxinus mandshurica*-tall herbage association were enumerated, including the *Fraxinus mandshurica-Urtica platyphylla* sociation (Pl. XXVI. b) and *Fraxinus mandshurica-Petasites japonicus* subsp. *giganteus* sociations.

TATEWAKI, M.: Forest vegetation of the lake-side Chimikeppu, Prov. Kitami, 26~30. Kitami Forest Office. (1954) (in Japanese)

xii. Forest of *Cercidiphyllum japonicum*

"Katsura" *Cercidiphyllum japonicum* is one of the most important and the largest broad-leaved trees in Hokkaido. Usually it forms the elegant forest along the valley or the gentle slope of the hill.

It attains a height of 30 m and a breast-height of diameter over 1.8 m. The Katsura forests have been mostly cut for the development of the agriculture owing to its rich stand. The undergrowth was often dominated by *Sasa*, or partly by the ferns such as *Dryopteris crassirhizoma*, *Rumohra Standishii*, etc. or the tall herbage such as *Cacalia hastata* subsp. *orientalis*, *Urtica platyphylla*, etc. Fortunately, the Katsura forest has been preserved on Maruyama Hill, Sapporo, under the special protection of the national conservation. (Pl. XXVII. b)

TATEWAKI, M.: Study on the forest botany. Scientific investigation, Maruyama Hill at Sapporo. 3~15. (1958) (in Japanese)

xiii. Forest of *Salix*

The forests of *Salix* are well developed along the rivers. On the wet and muddy alluvial soils, are most commonly found the *Salix sachalinensis-Salix Petsusu* forests forming an almost exclusive community. The forest-floors are mainly composed of *Artemisia montana*, *Petasites japonicus* subsp. *giganteus*, *Senecio cannabifolius*, etc. The association is represented by the *Salix sachalinensis-Salix Petsusu*-tall herbage association. If the river-bed becomes more sandy or gravelly, *Salix rorida* often occurs. It is a handsome tree and sometimes becomes the dominant species from the mid-course to the upper part of the rivers.

xiv. Forest of *Populus Maximowiczii-Toisusu Urbaniana*

Along the upper part of the rivers, there is the *Populus Maximowiczii-Toisusu Urbaniana* forest in rich alluvial soil along the banks of rivers or in the vicinity of the stream. They are the giant trees attaining a height of 30 m and over 1 m breast-high diameter and sometimes form respectively each forest. (Pl. XXIX. b. Pl. XXX. a.) The underlayer are often dominated by the tall herbage such as *Cacalia hastata* subsp. *orientalis*, *Urtica platyphylla* or *Petasites japonicus* subsp. *giganteus* and sometimes by *Sasa paniculata*.

xv. Forest of *Chosenia bracteosa* (Fig. 11)

Chosenia, a monotypic genus of *Salicaceae*, is placed between *Populus* and *Salix*. It is distributed to the eastward from Baikal and extends as far as Kamtchatka, Sakhalin (Pl. XXX. b) and Japan. In Japan it shows a distinctly disjunctive distribution known at present only from two localities. One of them is found along the upper reaches of the R. Azusa, Kamikochi, Prov. Shinano in the mountainous district of central Japan, and the other along the certain rivers in the province

Fig. 11. Distribution of *Chosenia bracteosa* in Hokkaido

of Tokachi in central Hokkaido which originate from the mountains of pre-Tertiary rocks. The origin of these forests seems to be ancient, and *Chosenia* is considered to be a relic. *Chosenia* occurs only along the river-side especially on wide and dry river-bed. Sometimes it forms a pure forest but it is often associated with *Toisusu Urbaniana* and *Populus Maximowiczii*. It reaches as much as 30 m in height and 1 m diameter at breast height. The young trees are found on gravelly places of the sunny river-side, not on muddy nor shady places. When a young tree is established, it grows steadily, owing to the character of its deeper root. So the forests are often found on the old river-bed, been after the river has changed its course. Depending upon the environment, there is no definite dominant species of the under-growth. Sometimes *Petasites japonicus* subsp. *giganteus* is abundant, and sometimes *Carex pilosa*, or *Matteucia Struthiopteris* and *Pachysandra terminalis* are respectively abundant.

TATEWAKI, M.: Sociological study on *Chosenia bracteosa* NAKAI. Ecol. Rev. Jap. **11**-3~4. 77~86. (1948) (in Japanese)

4. *Sasa* Communities

In addition to what has been above explained, the *Sasa* community

must be here explained. In the wood lands, on the hillsides, and even on the fairly high mountains, *Sasa*, is frequently found, which adds a special feature to the vegetation of Hokkaido and Southern Sakhalin and also to that of the Southern and Central Kuriles as far as the Island of Ketoi. The different kinds of *Sasa* are now confused, for they have not yet been perfectly arranged from the systematical side. Most of them, however, are represented by the *Sasamorpha-*, the *Sasa kurilensis-*, the *Sasa paniculata-* and the *Sasa nipponica* groups. The first and the last groups are mostly limited to the Pacific side of Hokkaido, the latter of which is mostly restricted to the land of volcanic ash and small amount of snow through the year. *Sasa* are very numerous and vary in height and density according to local conditions. The largest species of *Sasa* is represented by *Sasa kurilensis* which attains a height over 2.5 m. They often form continuous and almost impenetrable thickets, extending for several miles and giving very monotonous aspect to the vegetation. Sometimes it is almost exclusively dominant on the forest floor which shows the climax as already explained.

NAKAI, T.: *Bambuseae.* MIYABE & KUDO, Flora of Hokkaido & Saghalien, II. 180–195. (1930)

TATEWAKI, M.: Studies on *Sasa.* Hokkaido Ringyo-Kaiho 38-1~8. (1940) (in Japanese)

TATEWAKI, M. & TSUJII, T.: Botanical study on the meadow and pasture in Hokkaido. 18~39. (1956) (in Japanese)

5. Woddy Climbers

From the phytogeographical and phytosociological point of view, it is a very interesting fact that there are climbers giving, especially in Hokkaido, warmer aspect to the forest.

The climbers occurring in the area under consideration number 25 species belonging to 11 families as follows; the table shows also the geographical distribution.

* occur mainly in the forests.

Species	Hokkaido				Sakhalin		Kuriles	
	SW		E					
	S	N	W	E	S	N	S	N
Clematis fusca	+	·	+	+	·	·	+	+
Clematis Maximowicziana	+	+	·	·	·	·	·	·
**Clematis ochotensis*	·	+	+	+	+	+	+	·
Clematis serratifolia	·	·	·	+	·	·	·	·

Species	Hokkaido				Sakhalin		Kuriles	
	SW		E					
	S	N	W	E	S	N	S	N
**Akebia trifolia*	+	+	·	·	·	·	·	·
**Menispermum dauricum*	+	+	+	·	·	·	·	·
Cocculus trilobus	+	·	·	·	·	·	·	·
**Schisandra chinensis*	+	+	+	+	+	·	+	·
**Schisandra nigra*	+	·	·	·	·	·	·	·
**Hydrangea petiolaris*	+	+	+	+	+	·	+	·
**Schizophragma hydrangeoides*	+	+	+	+	·	·	+	·
Pueraria lobata	+	+	+	·	·	·	·	·
**Rhus ambigua*	+	+	+	+	+	·	+	·
**Celastrus orbiculatus*	+	+	+	+	+	·	+	·
**Euonymus japonicus*	+	+	+	·	·	·	·	·
Ampelopsis brevipedunculata	+	+	+	+	+	·	+	·
Palthenocissus tricuspidata	+	+	·	·	·	·	·	·
**Vitis flexuosa*	+	·	·	·	·	·	·	·
**Vitis Coignetiae*	+	+	+	+	+	·	+	·
Vitis ficifolia var. *lobata*	+	·	·	·	·	·	·	·
**Actinidia arguta*	+	+	+	+	+	·	+	·
**Actinidia Kolomikta*	+	+	+	+	+	·	+	·
**Actinidia polygama*	+	+	+	+	·	·	·	·
**Hedera rhombea*	+	·	·	·	·	·	·	·
Smilax China	+	·	·	·	·	·	·	·

A perusal of the above list show that the number of different species of climbing plants decreases gradually from south to north and suddenly disappears from the north of the MIYABE and the SCHMIDT lines except *Clematis ochotensis* in the latter area. In the forest, *Hydrangea petiolaris, Rhus ambigua* and *Actinidia Kolomikta* are common in general.

Fourteen species are restricted to Hokkaido among which 9 species are distributed to the southwestern Hokkaido and 6 species of them are limited to the area southward from the Kuromatsunai Depression including Okushiri Island. *Clematis fusca* and *Schizophragma hydrangeoides* occur in the Southern Kuriles. From the distribution of the climbers, the Southern Kuriles would seen to have closer relation than Sakhalin to Hokkaido.

PART II. DISTRIBUTION OF THE LIGNEOUS PLANTS

The zone of the mixed forest lying between the temperate and the subarctic zones includes the very interesting problem of plant distribution. Here, the writer will try to mainly analyse the distributional character of the ligneous plants indigenous to the mixed forest zone of Eurasia.

1. Ligneous Plants Distributed as Far as the Beech Forest Zone

Special attention must be paid to be restricted distribution of ligneous plants in the northern part of the forest zone of *Fagus*. The climax forest of the cold temperate zone is represented by the *Fagus crenata* forest in Japan while in Scandinavia it is represented by the *Fagus sylvatica* forest. It is worth to note that *Fagus* forest is completely absent from continental Eastern Asia. The comparison of the construction of the ligneous flora between the *Fagus crenata* forest in Hokkaido (Fig. 12) and the *Fagus sylvatica* forest in Sweden (Fig. 14) will be discussed as follows.

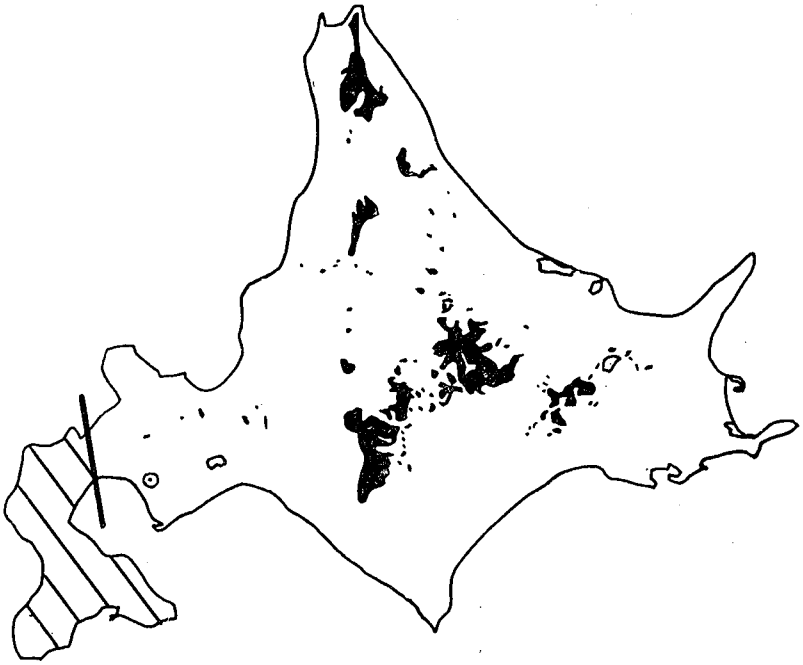

Fig. 12. Forest zones of Hokkaido
: Subarctic zone;
: Japanese beech zone
: Intermediate zone

i. Hokkaido

The ligenous plants not found northward from the Kuromatsunai Depression are as follows:

a. Families:

Cupressaceae (narrow sense), *Hamamelidaceae, Stachyuraceae, Clethraceae, Myrsinaceae.*

b. Genera:

Thujopsis, Pterocarya, Fagus, Coculus, Deutzia, Hamamelis, Hovenia, Stachyurus, Hedera, Aucuba, Helwingia, Tritomodon, Clethra, Bladhia.

c. Species:

The species are enumerated in the following list with the distribution of the neighbourhood.

× Variety, * HARA, H.: Enumeratio Spermatophytarum Japonicarum III

	Japan				
	Honshu	Shikoku	Kyushu	Korea	China
Cupressaceae					
Thujopsis dolabrata SIEB. et ZUCC. var. *Hondai* MAKINO	+	×	×	·	·
Salicaceae					
Salix Gilgiana SEEMEN	+	+	·	+	·
Juglandaceae					
Pterocarya rhoifolia SIEB. et ZUCC.	+	+	+	·	·
Fagaceae					
Fagus crenata BLUME	+	+	+	·	·
Menispermaceae					
Coculus trilobus DC.	+	+	+	+	+
Magnoliaceae					
Schisandra nigra MAXIM.	+	+	+	+	·
Saxifragaceae					
Deutzia scabra THUNB.	+	+	+	·	+
Hamamelidaceae					
Hamamelis japonica SIEB. et ZUCC.	+	+	+	·	·
Aceraceae					
* *Acer carpinifolium* SIEB. et ZUCC.	+	+	+	·	·
* *A. diabolicum* BLUME	+	+	+	·	·

	Japan				
	Honshu	Shikoku	Kyushu	Korea	China
Rhamnaceae					
Hovenia dulcis THUNB.	+	+	+	+	+
Vitaceae					
Vitis ficifolia BUNGE var. *lobata* NAKAI	+	+	+	+	+
V. flexuosa THUNB.	+	+	+	+	+
Stachyuraceae					
Stachyurus praecox SIEB. et ZUCC.	+	+	+	•	•
Elaeagnaceae					
Elaeagnus multiflora THUNB.	+	•	•	•	•
Araliaceae					
Acanthopanax innovans FR. et SAV.	+	+	+	•	•
A. spinosus MIQ.	+	•	•	•	•
Hedera rhombea BEAN.	+	+	+	+	•
Cornaceae					
Aucuba japonica THUNB. var. *borealis* MIYABE et KUDO	+	×	×	•	•
Helwingia japonica F. G. DIETR.	+	+	+	•	•
Ericaceae					
Menziesia ciliicalyx MAXIM.	+	+	•	•	•
* *Rhododendron japonicum* SURINGER	+	+	+	•	•
R. semibarbatum MAXIM.	+	+	+	•	•
Tritomodon campanulatus F. MAEKAWA	+	•	•	•	•
Clethraceae					
Clethra barbinervis SIEB. et ZUCC.	+	+	+	+	•
Myrsinaceae					
Bladhia japonica THUNB.	+	+	+	+	+
Styracaceae					
Styrax japonica SIEB. et ZUCC.	+	+	+	+	+
Oleaceae					
Ligustrum obtusifolium SIEB. et ZUCC.	+	+	+	+	•
L. Yukkianum KOIDZ. var. *glabrescens* TATEWAKI	×	•	•	•	•
Caprifoliaceae					
Lonicera gracilipes MIQ.	+	+	•	•	•
L. japonica THUNB.	+	+	+	+	+
L. strophiophora FRANCH.	+	•	•	•	•
Weigela coraeensis THUNB.	+	+	+	•	•
Total	32+(1)	26+(2)	23+(2)	12	8
%	100	84.8	75.8	36.4	24.2

All the species found in this category occur in Honshu. Shikoku and Kyushu maintain the subordinate rank from the phytogeographical relationship. The Japanese element plays the important role as shown in the above table.

ii. Scandinavia[1)]

In northwestern Europe, mainly Scandinavia, the ligneous plants not found north of the forest zone of *Fagus sylvatica* are enumerated in the following entries. The poverty in genera and species as compared with those of Japan are attributed to the influence of the ice age.

a. Family

Aquifoliaceae.

b. Genera

Fagus, Genista, Ulex, Euonymus, Ligustrum.

c. Species

* found as far as a little north of the forest zone of *Fagus sylvatica*

Fagaceae: *Fagus sylvatica, Quercus petraea.*
Ulmaceae: **Ulmus carpinifolia.* * *U. laevis.*
Malaceae: *Sorbus Meinichii, S. obtusifolia, S. subpinnata.*
Rosaceae: *Rosa pimpinellifolia, Rubus dissimulans, R. fissus, R. insularis, R. radula.*
Leguminosae: *Genista pilosa, Ulex europaeus.*
Aquifoliaceae: **Ilex Aquifolium.*
Celastraceae: **Euonymus europaeus.*
Aceraceae: *Acer campestre.*
Tiliaceae: *Tilia platyphylla.*
Oleaceae: *Ligustrum vulgare.*
Caprifoliaceae: **Lonicera Periclymenum.*

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1) The geographical distributions are mostly followed the maps of HULTEN, Atlas över växternas utbredning i Norden. (1950)

2. The Ligneous Plants not Found North of the Mixed Forest Zone

i. Japanese Archipelago including the Southern Kuriles

The area among the Kuromatsunai Depression and SCHMIDT's Line and Southern Kuriles lying the southwest of MIYABE's Line has mainly the floristic character of Japan. The following families, genera and species are not found north of the mixed forest zone.

a. Families

a) Not north of the Ishikari Depression.
Lardizabalaceae, Lauraceae, Hippocastaneaceae, Elaeagnaceae.

b) Not east of the west coast of Hokkaido.
Cephalotaxaceae, Menispermaceae, Coriariaceae, Symplocaceae.

c) Not east of the Hidaka Range.
Verbenaceae.

d) Not in Southern Sakhalin.
Cercidiphyllaceae, Daphniphyllaceae.

e) Not in the Southern Kuries.
Juglandaceae, Buxaceae.

f) Widely distributed in Hokkaido, but not in S. Sakhalin nor the Southern Kuriles.
Loranthaceae, Simaroubaceae, Staphyleaceae, Rhamnaceae, Alangiaceae.

If one of the above-mentioned families found in Southern Sakhalin and the Southern Kuriles, it is also found in Hokkaido.

In the mixed forest zone of the northern Japanese Archipelago including the Southern Kuriles, the following families are widely distributed and not found of the subarctic forest zone.

* Rarely found in the subarctic zone.

*Fagaceae, Ulmaceae, Moraceae, Magnoliaceae, Rutaceae, Anacardiaceae, Aquifoliaceae, Celastraceae, * Aceraceae, Vitaceae, Tiliaceae, Actinidiaceae, Araliaceae, Oleaceae.*

b. Genera

a) Not north of the Ishikari Depression.
Celtis, Akebia, Lindera, Aesculus, Berchemia, Parthenocissus, Elaeagnus, Oplopanax, Hugeria, Smilax.

b) Not east of the west coast of Hokkaido.
Cephalotaxus, Corylus, Menispermum, Coriaria, Symplocos, Weigela.

c) Not east of the Hidaka Range.
Castanea, Berberis, Pourthiaea, Zanthoxyllum, Callicarpa, Clerodendron.

d) Not found in Southern Sakhalin.
Cercidiphyllum, Magnolia, Schizophragma, Maackia, Daphniphyllum, Leucothoe.

e) Not found in the Southern Kuriles.
Juglans, Pachysandra, Acanthopanax.

f) Widely distributed in Hokkaido, but not found in Southern Sakhalin nor the Southern Kuriles.
Carpinus, Ostrya, Viscum, Picrasma, Staphylea, Rhamnus, Marlea, Styrax, Sasamorpha.

If one of the above-mentioned genera is found in Southern Sakhalin and the Southern Kuriles, it is also found in Hokkaido. The southern genera widely distributed in the mixed forest zone in the area under consideration are as follows:

* Sometimes found in the subartic zone (mountain distrit).

**Taxus, Quercus, Ulmus, Morus, Schisandra, Hydrangea, *Prunus, Lespedeza, Phellodendron, *Skimmia, Rhus, *Ilex, Celastrus, Euonymus, *Acer, Ampelopsis, Vitis, Tilia, Actinidia, Aralia, Kalopanax, Fraxinus, Ligustrum, Syringa, Viburnum, *Sasa.*

Taxus is distributed as far as Rashua Island and *Prunus* and *Acer* as far as Urup Island in the Central Kuriles. *Tilia* has been reported from Hokkaido, but rarely in Kunashiri Island, the Southern Kuriles and Southern Sakhalin. *Sasa* is distributed as far as Ketoi Island in the Central Kuriles forming an unbroken distributional chain.

c. Species

The species of the ligneous plants distributed as far as the mixed forest zone of the area under consideration are as follows:

a) Not east of the Hidaka Ranges.
Pinus parviflora var. *pentaphylla, Castanea crenata, Berberis amurensis* var. *japonica, Pourthiaea villosa, Zanthoxylum piperitum, Ilex macropoda, Callicarpa japonica, Clerodendron trichotomum, Viburnum dilatatum.*

b) Not north of the Ishikari Depression

Salix jessoensis, S. Miyabeana, Corylus heterophylla var. *Thunbergii, Celtis jessoensis, Clematis Maximowicziana, Akebia trifoliata, Lindera membranacea, Ribes japonicum, Rosa multiflora, Rubus vernus, Prunus Grayana, Ilex leucoclada, Euonymus Fortunei, Acer Sieboldianum* var. *yezoense, Aesculus turbinata, Berchemia racemosa, Parthenocissus tricuspidata, Elaeagnus umbellata, Oplopanax japonicus, Hugeria japonica, Smilax China.*

c) Only along the west coast of Hokkaido.
Cephalotaxus nana, Alnus pendula, Corylus Sieboldiana var. *brevirostris, Menispermum dauricum, Coriaria japonica, Symplocos chinensis, Weigela hortensis.*

d) Only along the Pacific coast of Hokkaido.
Quercus serrata, Prunus verecunda, Acer cissifolium, A. Miyabei.

e) Not found in the Southern Kuriles.
Juniperus conferta, Salix subfragilis, Juglans ailanthifolia, Crataegus jozana, C. Maximowiczii, Pachysandra terminalis, Tilia japonica, Acanthopanax senticosus.

f) Not found in Southern Sakhalin.
Salix integra, Toisusu Urbaniana, Alnus japonica, Betula Maximowicziana, Quercus dentata, Cercidiphyllum japonicum, Magnolia obovata, Schizophragma hydrangeoides, Sorbus alnifolia, Rubus mesogaeus, R. parvifolius, Maackia amurensis var. *Buergeri, Daphniphyllum humile, Rhus trichocarpa, Euonymns oxyphyllus, E. planipes, Acer japonicum, A. Mayrii, Tilia Maximowicziana, Cornus controversa, Leucothoe Grayana, Rhododendron Tschonoskii, Fraxinus lanuginosa* var. *serrata.*

g) Widely distributed in Hokkaido, but not found in Sakhalin nor the Kurile Islands.
Populus Sieboldi, Salix Bakko, S. gracilistyla, Alnus Mayri, Carpinus cordata, Ostrya japonica, Viscum coloratum, Magnolia Kobus var. *borealis, Hydrangea macrophylla* var. *acuminata, Rubus crataegifolius, R. phoenicolasius, Picrasma quassioides, Staphylea Bumalda, Acer aizuense, A. palmatum* subsp. *amoenum, A. ornatum* subsp. *Matsumurae, Rhamnus japonica, Daphne jezoensis, D. Miyabeana, Marlea platanifolia* var. *triloba, Acanthopanax divaricatus, A. sciadophylloides, Rhododendron Albrechti, Tripetaleia paniculata* var. *latifolia, Vaccinium hirtum, V. Oldhami, Lonicera Morrowii, Styrax Obassia, Sasamorpha purpurascens.*

h) Not found in Honshu.

Populus jesoensis, Ribes latifolium, Crataegus jozana, C. Maximowiczii, Acanthopanax senticosus, Lonicera chrysantha, L. sachalinensis.

i) Disjunctive distribution

* Hokkaido

Pinus densiflora (seminatural), Mt. Tarumai, Prov. Iburi.
Clematis serratifolia at Wakkanai, Prov. Kitami.
Stephanandra incisa in Southern Hidaka.
Epigaea asiatica in Oshima and Teshio.

** Sakhalin

Salix subfragilis near Amiba along the Horonai.
Tilia japonica along the Naibuchi.

Exception: In the Central Kuriles, *Taxus cuspidata* is distributed as far as Rashua Island, *Prunus nipponica* var. *kurilensis* as far as Urup Island and *Sasa kurilensis* as far as Ketoi Island.

The ligneous plants found as far as the mixed forest zone of the Japanese Archipelago including the Southern Kuriles, are shown in the following table with their distribution in the neighbouring regions. (× variety or subspecies)

Name of Plants	S. Sakhalin	S. Kuriles	Japan: Hokkaido	Japan: Honshu	Japan: Shikoku	Japan: Kyushu	Korea	Manchuria: S	Manchuria: E	N. China	Far East U.S.S.R.
Taxaceae											
Taxus cuspidata SIEB. et ZUCC.	+	+	+	+	+	·	+	·	+	×	+
Cephalotaxaceae											
Cephalotaxus nana NAKAI	·	·	+	+	·	·	·	·	·	·	·
Pinaceae											
Pinus densiflora SIEB. et ZUCC.	·	·	+	+	+	+	+	·	+	·	+
P. parviflora SIEB. et ZUCC. var. *pentaphylla* HENRY	·	·	+	+	×	×	·	·	·	·	·
Juniperaceae											
Juniperus conferta PARLAT.	+	·	+	+	·	+	·	·	·	·	·
Sabina Sargentii MIYABE et TATEWAKI	+	+	+	+	+	+	+	·	·	·	·
Salicaceae											
Populus jesoensis NAKAI	+	+	+	·	·	·	+	·	·	·	·

Name of Plants	S. Sakhalin	S. Kuriles	Japan: Hokkaido	Japan: Honshu	Japan: Shikoku	Japan: Kyushu	Korea	Manchuria: S	Manchuria: E	N. China	Far East U.S.S.R.
P. Sieboldi MIQ.	·	·	+	+	+	+	·	·	·	·	·
Salix Bakko KUMURA	·	·	+	+	·	·	·	·	·	·	·
S. gracilistyla MIQ.	·	·	+	+	+	+	+	·	+	+	+
S. integra THUNB.	·	+	+	+	·	+	+	·	+	·	+
S. jesoensis SEEMEN	·	·	+	+	·	·	·	·	·	·	·
S. Miyabeana SEEMEN	·	·	+	+	·	·	·	·	·	·	·
S. subfragilis ANDERS.	+	·	+	+	+	+	+	+	+	+	+
Toisusu Urbaniana KIMURA	·	+	+	+	·	·	·	·	·	·	·
Juglandaceae											
Juglus ailanthifolia CARR.	+	·	+	+	+	+	·	·	·	·	·
Betulaceae											
Alnus japonica STEUD.	·	+	+	+	+	+	+	+	+	+	+
A. Mayrii CARR.	·	·	+	+	·	·	+	·	·	·	·
A. pendula MATSUM.	·	·	+	+	·	·	·	·	·	·	·
Betula Maximowicziana REGEL	+	+	+	·	·	·	·	·	·	·	·
Carpinus cordata BLUME	·	·	+	+	+	+	+	+	+	+	+
C. laxiflora BLUME	·	·	+	+	+	+	+	·	·	·	·
Corylus heterophylla FISCHER var. *Thunbergii* BL.	·	·	+	+	·	·	×	×	×	·	·
C. Sieboldiana BLUME var. *brevirostris* C. K. SCHN.	·	·	+	+	+	+	+	×	×	×	+
Ostrya japonica SARG.	·	·	+	+	+	+	+	·	·	+	·
Fagaceae											
Castanea crenata SIEB. et ZUCC.	·	·	+	+	+	+	·	·	·	·	·
Quercus dentata THUNB.	·	+	+	+	+	+	+	+	+	+	+
Q. crispula BL.	+	+	+	+	+	+	+	·	·	·	·
Q. serrata THUNB.	·	·	+	+	+	+	+	·	·	+	·
Ulmaceae											
Celtis jessoensis KOIDZ.	·	·	+	+	+	+	+	·	·	·	·
Ulmus laciniata MAYR	+	+	+	+	·	+	+	+	+	+	+
U. propinqua KOIDZ.	+	+	+	+	+	+	+	+	+	+	+
Moraceae											
Morus bombycis KOIDZ.	+	+	+	+	+	+	+	+	+	+	·
Loranthaceae											
Viscum coloratum NAKAI	·	·	+	+	+	+	+	+	+	+	+

Name of Plants	S. Sakhalin	S. Kuriles	Japan: Hokkaido	Japan: Honshu	Japan: Shikoku	Japan: Kyushu	Korea	Manchuria: S	Manchuria: E	N. China	Far East U.S.S.R.
Cercidiphyllaceae											
Cercidiphyllum japonicum SIEB. et ZUCC.	·	+	+	+	+	+	·	·	·	+	·
Ranunculaceae											
Clematis Maximowicziana FR. et SAV.	·	·	+	+	+	+	+	·	·	+	·
C. serratiflolia REHD.	·	·	+	·	·	·	+	·	+	·	+
Lardizabalaceae											
Akebia trifoliata KOIDZ.	·	·	+	+	+	+	·	·	·	+	·
Berberidaceae											
Berberis amurensis RUPR. var. *japonica* REHD.	·	·	+	+	·	·	×	×	×	×	×
Menispermaceae											
Menispermum dauricum DC.	·	·	+	+	+	+	+	+	+	+	+
Magnoliaceae											
Magnolia Kobus DC. var. *borealis* SARG.	·	·	+	+	×	×	×	·	·	·	·
M. obovata THUNBERG	·	+	+	+	+	+	·	·	·	+	·
Schisandra chinensis BAILL.	+	+	+	+	·	·	+	+	+	+	+
Lauraceae											
Lindera membranacea MAXIM.	·	·	+	+	·	·	·	·	·	·	·
Saxifragaceae											
Hydrangea macrophylla SERINGE var. *acuminata* MAKINO	·	·	+	+	+	+	+	·	·	·	·
H. paniculata SIEBOLD	+	+	+	+	+	+	·	·	·	+	·
H. petiolaris SIEB. et ZUCC.	+	+	+	+	+	+	+	·	·	·	·
Ribes latifolium JANCZ.	+	+	+	·	·	·	·	·	·	·	·
R. japonicum MAXIM.	·	·	+	+	+	·	·	·	·	·	·
Schizophragma hydrangeoides SIEB. et ZUCC.	·	+	+	+	+	+	+	·	·	·	·
Spiraeaceae											
Spiraea media SCHMIDT	+	+	+	+	·	·	+	·	+	·	+
Stephanandra incisa ZABEL	·	·	+	+	+	+	+	·	·	·	·
Malaceae											
Crataegus jozana C. K. SCHN.	+	·	+	·	·	·	·	·	·	·	·
C. Maximowiczii SCHN.	+	·	+	·	·	·	+	·	+	·	+
Pourthiaea villosa DECNE.	·	·	+	+	+	+	+	·	·	+	·
Sorbus alnifolia K. KOCH.	·	+	+	+	+	+	+	+	+	+	+

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Rosaceae											
Rosa multiflora THUNB.	·	·	+	+	+	+	·	·	·	·	·
Rubus crataegifolius BUNGE	·	·	+	+	+	+	+	+	+	+	+
R. mesogaeus FOCKE	·	+	+	+	+	+	·	·	·	+	·
R. parvifolius LINN.	·	+	+	+	+	+	+	+	+	+	·
R. phoenicolasius MAXIM.	·	·	+	+	+	+	+	·	·	+	·
R. vernus FOCKE	·	·	+	+	·	·	·	·	·	·	·
Amygdalaceae											
Prunus Grayana MAXIM.	·	·	+	+	+	+	·	·	·	·	·
P. Maximowiczii RUPR.	+	+	+	+	·	+	+	+	+	·	+
P. nipponica MATSUM.	+	+	+	+	·	·	·	·	·	·	·
P. Sargentii REHDER	+	+	+	+	·	·	+	·	·	·	·
P. Ssiori FR. SCHN.	+	+	+	+	·	·	·	·	·	·	·
P. verecunda KOEHNE	·	·	+	+	+	·	+	·	·	·	·
Leguminosae											
Lespedeza bicolor TURCZ.	+	+	+	+	+	+	+	+	+	+	+
Maackia amurensis RUPR. et MAXIM. var. *Buergeri* C. K. SCHN.	·	+	+	+	·	·	×	×	×	×	×
Pueraria lobata OHWI	·	·	+	+	+	+	+	+	+	+	·
Rutaceae											
Phellodendron amurense RUPR. var. *sachalinense* FR. SCHN.	+	+	+	+	×	×	×	×	×	×	×
Skimmia japonica THUNB. var. *repens* OHWI	+	+	+	+	+	+	·	·	·	·	·
Zanthoxylum piperitun DC.	·	·	+	+	+	+	+	+	·	+	·
Simaroubaceae											
Picrasma quassioides BENN.	·	·	+	+	+	+	+	×	+	+	·
Daphniphyllaceae											
Daphniphyllum humile MAXIM.	·	+	+	+	·	·	·	·	·	·	·
Buxaceae											
Pachysandra terminalis SIEB. et ZUCC.	+	·	+	+	+	+	·	·	·	+	·
Coriariaceae											
Coriaria japonica A. GRAY	·	·	+	+	·	·	·	·	·	·	·
Anacardiaceae											
Rhus ambigua LAVALLÉE	+	+	+	+	+	+	·	·	·	+	·

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R. javanica LINN.	·	·	+	+	+	+	+	+	·	+	·
R. trichocarpa MIQ.	·	+	+	+	+	+	+	·	·	+	·
Aquifoliaceae											
Ilex radicans NAKAI	+	+	+	+	·	·	·	·	·	·	·
I. leucoclada MAKINO	·	·	+	+	·	·	·	·	·	·	·
I. Makinoi HARA	·	·	+	+	·	·	·	·	·	·	·
I. macropoda MIQ.	·	·	+	+	+	+	+	·	·	×	·
I. rugosa FR. SCHM.	+	+	+	+	×	×	·	·	·	·	·
Celastraceae											
Celastrus orbiculatus THUNB. var. *strigllosus* NAKAI	+	+	+	+	×	×	+	×	×	×	×
Euonymus alatus SIEB.	+	+	+	+	+	+	+	+	+	+	+
E. Fortunei HAND.	·	·	+	+	+	+	+	·	·	+	·
E. japonicus THUNB.	·	·	+	+	+	+	+	·	·	+	·
E. macropterus RUPR.	+	+	+	+	+	·	+	+	+	·	+
E. oxyphyllus MIQ.	·	+	+	+	+	+	+	·	·	+	·
E. planipes KOEHNE	·	+	+	+	·	·	+	+	+	·	+
E. sachalinensis FR. SCHM. var. *tricarpus* KUDO	×	×	+	+	·	·	·	·	·	·	·
E. Sieboldianus BLUME var. *sanguineus* NAKAI	+	+	+	+	×	×	+	×	·	×	·
Staphyleaceae											
Staphylea Bumalda DC.	·	·	+	+	+	+	+	·	+	+	·
Aceraceae											
Acer aizuense NAKAI	·	·	+	+	+	+	·	·	·	·	·
A. cissifolium K. KOCH	·	·	+	+	+	+	·	·	·	·	·
A. japonicum THUNB.	·	+	+	+	·	·	·	·	·	·	·
A. Mayrii G. V. SCHW.	·	+	+	+	·	·	·	·	·	·	·
A. Miyabei MAXIM.	·	·	+	+	·	·	·	·	·	·	·
A. Mono MAXIM.	+	+	+	+	+	+	+	+	+	+	+
A. palmatum THUNB. subsp. *amoenum* HARA	·	·	+	+	+	+	+	·	·	·	·
A. ornatum CARRIEER subsp. *Matsumurae* KOIDZ.	·	·	+	+	+	+	·	·	·	·	·
A. Sieboldianum MIQUEL var. *yezoense* MIYABE et TATEWAKI	·	·	+	×	×	×	·	·	·	·	·
A. ukurunduense TRAUTV. et MEY.	+	+	+	+	+	·	+	·	+	+	+

Name of Plants	S. Sakhalin	S. Kuriles	Japan: Hokkaido	Japan: Honshu	Japan: Shikoku	Japan: Kyushu	Korea	Manchuria: S	Manchuria: E	N. China	Far East U.S.S.R.
Hippocastanaceae											
Aesculus turbinata BLUME	·	·	+	+	+	+	·	·	·	·	·
Rhamnaceae											
Berchemia racemosa SIEB. et ZUCC.	·	·	+	+	+	+	+	·	·	+	·
Rhamnus japonica MAXIM.	·	·	+	+	×	×	·	·	·	·	·
Vitaceae											
Ampelopsis brevipedunculata TRAUTV.	+	+	+	+	+	+	+	+	+	+	+
Parthenocissus tricuspidata PLANCH.	·	·	+	+	+	+	+	+	+	+	+
Vitis Coignetiae PULL.	+	+	+	+	+	+	+	·	·	·	·
Tiliaceae											
Tilia japonica SIMONKAI	+	·	+	+	+	+	·	·	·	+	·
T. Maximowicziana SHIRASAWA	·	+	+	+	·	·	·	·	·	·	·
Actinidiaceae											
Actinidia arguta PLANCH.	+	+	+	+	+	+	+	+	+	+	+
A. Kolomikta MAXIM.	+	+	+	+	·	·	+	+	+	+	+
A. polygama PLANCH.	+	+	+	+	+	+	+	+	+	+	+
Thymeleaceae											
Daphne jezoensis MAXIM.	·	·	+	+	·	·	·	·	·	·	·
D. Miyabeana MAKINO	·	·	+	+	·	·	·	·	·	·	·
Elaeagnaceae											
Elaeagnus umbellata THUNB.	·	·	+	+	+	+	×	+	·	×	·
Alangiaceae											
Marlea platanifolia SIEB. et ZUCC. var. *triloba* MIQUEL	·	·	+	+	+	+	+	+	+	×	·
Araliaceae											
Acanthopanax divaricatus SEEMANN	·	·	+	+	+	+	·	·	·	+	·
A. sciadophylloides FRANCH. et SAVAT.	·	·	+	+	+	+	·	·	·	·	·
A. senticosus HARMS	+	·	+	·	·	·	+	+	+	+	+
Aralia elata SEEMANN	+	+	+	+	+	+	+	+	+	+	+
Kalopanax pictus NAKAI	+	+	+	+	+	+	+	+	+	+	+
Oplopanax japonicus NAKAI	·	·	+	+	+	·	·	·	·	·	·
Cornaceae											
Cornus controversa HEMSL.	·	+	+	+	+	+	+	+	+	+	·

Name of Plants	S. Sakhalin	S. Kuriles	Japan: Hokkaido	Japan: Honshu	Japan: Shikoku	Japan: Kyushu	Korea	Manchuria: S	Manchuria: E	N. China	Far East U.S.S.R.
Ericaceae											
Epigaea asiatica MAXIM.	·	·	+	+	·	·	·	·	·	·	·
Hugeria japonica NAKAI	·	·	+	+	+	·	+	·	·	·	·
Leucothoe Grayana MAXIM.	·	+	+	+	·	·	·	·	·	·	·
Rhododendron Albrechti MAXIM.	·	·	+	+	·	·	·	·	·	·	·
R. japanicum SUINGER	·	·	+	+	+	+	·	·	·	·	·
R. Tschonoskii MAXIM.	·	+	+	+	+	+	+	·	·	·	·
Tripetaleia paniculata SIEB. et ZUCC. var. *latifolia* MAXIM.	·	·	+	+	+	+	·	·	·	·	·
Vaccinium hirtum THUNB.	·	·	+	+	+	·	·	·	·	·	·
V. Oldhami MIQUEL	·	·	+	+	+	+	+	·	·	+	·
V. Smallii A. GRAY	+	+	+	+	·	·	·	·	·	·	·
Symplocaceae											
Symplocos chinensis DRUCE	·	·	+	+	+	+	+	+	+	+	·
Styracaceae											
Styrax Obassia SIEB. et ZUCC.	·	·	+	+	+	+	+	·	+	+	·
Oleaceae											
Fraxinus mandshuria RUPR.	+	+	+	+	·	·	+	+	+	+	+
F. lanuginosa KOIDZ. var. *serrata* HARA	·	+	+	+	+	+	+	·	·	·	·
Lingustrum Tschonoskii DEC.	+	+	+	+	+	+	·	·	·	·	·
Syringa reticulata HARA	+	+	+	+	+	+	+	+	+	+	+
Verbenaceae											
Callicarpa japonica THUNB.	·	·	+	+	+	+	+	+	·	+	·
Clerodendron trichotomum THUNB.	·	·	+	+	+	+	+	·	+	+	·
Labiatae											
Thymus japonicus KITAGAWA	+	+	+	+	·	+	+	·	·	·	·
Caprifoliaceae											
Lonicera chrysantha THRCZ.	+	+	+	·	·	·	+	+	+	+	+
L. Glehni FR. SCHM.	+	+	+	+	·	·	·	·	·	·	·
L. Morrowii A. GRAY	·	·	+	+	+	·	·	·	·	·	·
L. sachalinensis NAKAI	+	+	+	·	·	·	+	·	·	·	·
Sambucus Sieboldiana BLUME var. *Miquelii* HARA	+	+	+	+	×	×	+	·	+	×	+
Viburnum dilatatum THUNB.	·	·	+	+	+	+	+	·	·	+	·

Name of Plants	S. Sakhalin	S. Kuriles	Japan: Hokkaido	Japan: Honshu	Japan: Shikoku	Japan: Kyushu	Korea	Manchuria: S	Manchuria: E	N. China	Far East U.S.S.R.
V. furcatum BLUME	+	+	+	+	+	+	+	·	·	·	·
V. Sargenti KOEHNE	+	+	+	+	+	+	+	+	+	+	+
V. Wrightii MIQ.	+	+	+	+	+	+	+	·	·	+	·
Weigela hortensis K. KOCH	·	·	+	+	·	·	·	·	·	·	·
Gramineae											
Sasa spp.	+	+	+	+	+	+	+	·	·	·	·
Sasamorpha purpurascens NAKAI	·	·	+	+	+	+	+	·	·	·	·
Liliaceae											
Smilax China LINN.	·	·	+	+	+	+	+	·	·	+	·

I) Not common to the Far Eastern Asiatic Continent.

i) Common to Japan, Southern Sakhalin and the Southern Kuriles.

a) Only Hokkaido in Japan.

Ribes latifolium.

b) Common to Hokkaido and Honshu.

Prunus nipponica, P. Ssiori, Ilex radicans, Euonymus sachalinensis var. *tricarpus, Vaccinium Smallii, Lonicera Glehni.*

c) Common to Hokkaido, Honshu, Shikoku and Kyushu.

Skimia japonica var. *repens, Ilex rugosa, Ligustrum Tshonoskii.*

ii) Common to Japan and Southern Sakhalin.

a) Only Hokkaido in Japan.

Crataegus jozana.

b) Common to Hokkaido, Honshu and Kyushu.

Juniperus conferta.

iii) Common to Japan and the Southern Kuriles.

a) Common to Hokkaido and Honshu.

Toisusu Urbaniana, Betula Maximowicziana, Daphniphyllum humile, Acer japonicum, A. Mayrii, Tilia Maximowicziana, Leucothoe Grayana.

iv) Only Japan.

a) Hokkaido and Honshu.

Cephalotaxus nana, Pinus parviflora var. *pentaphylla, Salix Bakko, S. jessoensis, S. Miyabeana, Alnus pendula, Lindera*

membranacea, Rubus vernus, Coriaria japonica, Ilex leucoclada, I. Makinoi, Acer Miyabei, Daphne jezoensis, D. Miyabeana, Epigaea asiatica, Rhododendron Albrechti, Weigela hortensis.

b) Common to Hokkaidò, Honshu and Shikoku.
Ribes japonicum, Oplopanax japonicus, Vaccinium hirtum, Lonicera Morrowii.

c) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Populus Sieboldi, Castanea crenata, Rosa multiflora, Prunus Grayana, Acer aizuense, A. cissifolium, A. ornatum subsp. *Matsumurae, A. Sieboldiana* var. *yezoense. Aesculus turbinata, Rhamnus japonica, Acanthopanax sciadophylloides, Rhododendron japonicum, Tripetaleia paniculata* var. *latifolia.*

II) Common to Japanese Archipelago including Southern Sakhalin and the Southern Kuriles, Korea, Manchuria, China and the Far Eastern region of the U.S.S.R.

1) Common to Japanese Archipelago, Korea, Manchuria, China and the Far Eastern region of the U.S.S.R.

i) Common to Japan, Southern Sakhalin and the Southern Kuriles.

a) Only Hokkaido in Japan.
Lonicera chrysantha.

b) Common to Hokkaido and Honshu.
Schisandra chinensis, Actinidia Kolomikta, Fraxinus mandshurica.

c) Common to Hokkaido, Honshu and Shikoku.
Taxus cuspidata, Acer ukurunduense.

d) Common to Hokkaido, Honshu and Kyushu.
Ulmus laciniata.

e) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Ulmus propinqua, Lespedeza bicolor, Phellodendron amurense, Celastrus orbiculatus var. *strigillosus, Euonymus alatus, Acer mono, Ampelopsis brevipedunculata, Actinidia arguta, A. polygama, Aralia elata, Kalopanax pictus, Syringa reticulata, Sambucus Sieboldiana* var. *Miquelii, Viburnum Sargenti.*

ii) Common to Japan and Southern Sakhalin.

a) Only Hokkaido in Japan.
Acanthopanax senticosus.

b) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Salix subfragilis.

iii) Common to Japan and the Southern Kuriles.

a) Common to Hokkaido and Honshu.

Maackia amurensis var. *Buergeri*.

b) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Alnus japonica, Quercus dentata, Sorbus alnifolia.

iv) Only Japan.

a) Common to Hakkaido and Honshu.
Berberis amurensis var. *japonica.*

b) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Salix gracilistyla, Carpinus cordata, Corylus Sieboldiana var. *brevirostris, Viscum colonatum, Menispermum dauricum, Rubus crataegifolius, Parthenocissus tricuspidata.*

2) Common to Japanese Archipelago, Korea, Manchuria and the Far Eastern region of the U.S.S.R.

i) Common to Japan, Southern Sakhalin and the Southern Kuriles.

a) Common to Hokkaido and Honshu.
Spiraea media.

b) Common to Hokkaido, Honshu and Shikoku.
Euonymus macropterus.

c) Common to Hokkaido, Honshu and Kyushu.
Prunus Maximowiczii.

ii) Common to Hokkaido and Southern Sakhalin.

a) Only Hokkaido in Japan.
Crataegus Maximowiczii.

iii) Common to Hokkaido and the Southern Kuriles.

a) Common to Hokkaido and Honshu.
Euonymus planipes.

b) Common to Hokkaido, Honshu and Kyushu.
Salix integra.

iv) Only Japan.

a) Only Hokkaido in Japan.
Clematis serratiflolia.

b) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Pinus densiflora.

3) Common to Japanese Archipelago, Korea, Manchuria and China.

i) Common to Japan, Southern Sakhalin and the Southern Kuriles.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Morus bombycis, Euonymus Sieboldianus var. *sanguineus.*

ii) Common to Japan and the Southern Kuriles.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Rubus parvifolius, Cornus controversa.

iii) Only Japan.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.

Pueraria lobata, Zanthoxylum piperitum, Picrasma quassioides, Rhus javanica, Staphylea Bumalda, Elaegnus umbellata, Marlea platanifolia var. *triloba, Symplocos chinensis, Styrax Obassia, Callicarpa japonica, Clerodendron trichotomum.*

4) Common to Japanese Archipelago, Korea and China.

i) Common to Japan, Southern Sakhalin and the Southern Kuriles.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.

Viburnum Wrightii.

ii) Common to Japan and the Southern Kuriles.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.

Rhus tricocarpa, Euonymus oxyphyllus.

iii) Only Japan.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.

Ostrya japonica, Quercus serrata, Clematis Maximowicziana, Poulthiaea villosa, Rubus phoenicolosius, Ilex macropoda, Euonymus Fortunei, E. japonicus, Berchemia racemosa, Vaccinium Oldhami, Viburnum dilatatum, Smilax China.

5) Common to Japanese Archipelago, Korea and Manchuria.

i) Japan.

a) Common to Hokkaido and Honshu.

Corylus heterophylla var. *Thunbergi.*

6) Common to Japanese Archipelago and Korea.

i) Common to Japan, Southern Sakhalin and the Southern Kuriles.

a) Only Hokkaido in Japan.

Populus jesoensis, Lonicera sachalinensis.

b) Common to Hokkaido and Honshu.

Prunus Sargentii.

c) Common to Hokkaido, Honshu and Kyushu.

Thymus japonicus.

d) Common to Hokkaido, Honshu, Shikoku and Kyushu.

Sabina Sargentii, Quercus crispula, Hydrangea petiolaris, Vitis Coignetiae, Viburnum furcatum, Sasa spp.

ii) Common to Japan and the Southern Kuriles.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.

Schizophragma hydrangeoides, Rhododendron Tschonoskii, Fraxinus lanuginosa var. *serrata.*

iii) Only Japan.

a) Common to Hokkaido and Honshu.
Alnus Mayrii.

b) Common to Hokkaido, Honshu and Shikoku.
Prunus verecunda, Hugeria japonica.

c) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Carpinus laxiflora, Celtis jessoensis, Magnolia Kobus var. *borealis, Hydrangea macrophylla* var. *acuminata, Stephanandra incisa, Acer palmatum* var. *amoenum, Sasamorpha purpurascens.*

7) Common to Japanese Archipelago and China.

i) Common to Japan, Southern Sakhalin and the Southern Kuriles.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Hydrangea paniculata, Rhus ambigua.

ii) Common to Japan and Southern Sakhalin.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Pachysandra terminalis, Tilia japonica.

iii) Common to Japan and the Southern Kuriles.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Cercidiphyllum japonicum, Magnolia obovata, Rubus mesogaeus.

iv) Only Japan.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Akebia trifoliata, Acanthopanax divaricatus.

The Japanese element here enumerated attains a number of 54 species, while that of the temperate asiatic element 106. From the distributional point of view of the former, Hokkaido occupies the most important situation among Hokkaido, Southern Kuriles and Southern Sakhalin. The species found in the Southern Kuriles and in Southern Sakhalin are all found in Hokkaido.

Among the main islands of Japan, Honshu maintains the closest relationship enumerating 52 species except only to 2 species, namely *Ribes latifolia* and *Crataegus jozana.* The common species to Shikoku and Kyushu are all found in Honshu.

The common species to the Japanese Archipelago including the Southern Kuriles and the temperate eastern asiatic continent attain a number of 106. Among them over 1/3 are widely distributed in the Northern Japanese Archipelago, Korea, Manchuria, China and the Far Eastern region of the U.S.S.R. These facts show that these districts should be grouped into one floristic region.

Among the regions of Far Eastern Asia, Korea has the strongest

affinity and the Eastern Manchuria maintains a subordinate rank. The common species to China and the Far Eastern region of the U.S.S.R. respectively gradually decrease the number.

As stated above, the mixed forest zone in the Japanese Archipelago displays the characteristics of the Pan-mixed forest zone and has a close relation to that of the Far East Continent. Hokkaido, with the exception of the *Fagus crenata* forest zone, is the representative of the mixed forest zone from the view-point of both forest-type and geographical character of the ligneous species. According to the analysis of the distribution, the species of the ligneous flora, and the presence of the dominance of the Temperate Eastern Asiatic elements, especially the Temperate Japanese elements are very noticeable. Moreover, the dominant physiognomy of *Sasa* in the undergrowth, and large number and many species of climbing plants are also characteristic of the mixed forest zone of Hokkaido, extending to the Southern Kuriles and Southern Sakhalin.

ii. Eastern Manchuria*)

The following families, genera and species are not found north of the mixed forest zone in Far Eastern Asia. The materials are mainly based on those of Eastern Manchuria owing to the research of the writer.

* Only found as far north as Eastern Manchuria.

a. Families

*Taxaceae, Juglandaceae, Fagaceae, Ulmaceae, *Moraceae, Loranthaceae, Berberidaceae, Menispermaceae, Magnoliaceae, Rutaceae, *Simaroubaceae, Euphorbiaceae, Celastraceae, *Staphyleaceae, Aceraceae, Rhamnaceae, Vitaceae, Tiliaceae, Actinidiaceae, *Alangiaceae, Araliaceae, *Symplocaceae, *Styracaceae, Oleaceae, *Verbenaceae.*

b. Genera

*Taxus, Juglans, Carpinus, Corylus, Quercus, *Celtis, *Hemiptera, Ulmus, *Morus, Viscum, Berberis, Menispermum, Schisandra, Deutzia, Philadelphus, Physocarpus, Pyrus, Lespedeza, Maackia, *Pueraria, Phellodendron, Securinega, Celastrus, Euonymus, *Tripterygium, *Staphylea, Acer, Rhamnus, Ampelopsis, Vitis, Tilia, Actinidia, *Marlea, Acanthopanax,*

*) Prof. LIOU treated this area as the Changpei (Chohaku) District in his Illustrated Flora of Ligneous Plants of N.-E. China. (1955)

*Aralia, Kalopanax, *Symplocos, *Styrax, Fraxinus, Syringa, *Clerodendron, Abelia, Sambucus, Viburnum, Weigela.*

c. Species

The ligneous plants found as far as the mixed forest zone of the continent of the northeastern Far East, are shown in the following table with the distribution in the neighbouring regions. (× variety or subspecies)

Name of Plants	Korea	N. China	Far East U.S.S.R.	Japan				S. Sakhalin	S. Kuriles
				Hokkaido	Honshu	Shikoku	Kyushu		
Taxaceae									
Taxus cuspidata SIEB. et ZUCC.	+	×	+	+	+	+	·	+	+
Pinaceae									
Pinus densiflora SIEB. et ZUCC.	+	·	+	+	+	+	+	·	·
P. koraiensis SIEB. et ZUCC.	+	·	+	·	+	·	·	·	·
P. tabulaeformis CARR.	·	+	·	·	·	·	·	·	·
Salicaceae									
Populus koreana REHD.	+	·	+	·	·	·	·	·	·
Salix Gilgiana SEEMEN	+	·	·	+	+	+	·	·	·
S. gracilistyla MIQUEL	+	+	+	+	+	+	+	·	·
S. integra THUNB.	+	·	+	+	+	·	+	·	+
S. koreensis ANDERS.	+	·	·	·	+	·	+	·	·
S. subfragilis ANDERS.	+	+	+	+	+	+	+	+	·
Toisusu cardiophylla KIMURA var. *Maximowiczii* KIMURA	+	·	+	·	·	·	·	·	·
Juglandaceae									
Juglans mandshurica MAXIM.	+	·	+	·	·	·	·	·	·
Betulaceae									
Alnus japonica STEUD.	+	+	+	+	+	+	+	·	+
Betula chinensis MAXIM.	+	+	·	·	·	·	·	·	·
B. costata TRAUTV.	+	·	+	·	·	·	·	·	·
B. Schimidtii REGEL	+	·	+	·	+	·	·	·	·
Carpinus cordata BLUME	+	+	+	+	+	+	+	·	·
Corylus mandshurica MAXIM. et RUPR.	+	+	+	+	+	·	·	·	·
Fagaceae									
Quercus dentata THUNB.	+	+	+	+	+	+	+	·	+

Name of Plants	Korea	N. China	Far East U.S.S.R.	Japan				S. Sakhalin	S. Kuriles
				Hokkaido	Honshu	Shikoku	Kyushu		
Q. mongolica FISCH.	+	+	+	·	·	·	·	·	·
Ulmaceae									
Celtis aurantiaca NAKAI	+	·	·	·	·	·	·	·	·
C. Bungeana BLUME	·	+	·	·	·	·	·	·	·
Hemiptera Davidii PLANCH.	+	+	·	·	·	·	·	·	·
Ulmus laciniata MAYA	+	+	+	+	+	·	+	+	+
U. macrocarpa HANCE	+	+	+	·	·	·	·	·	·
U. propinqua KOIDZ.	+	+	+	+	+	+	+	+	+
Moraceae									
Morus bombycis KOIDZ.	+	+	·	+	+	+	+	+	+
M. mongolica SCHN.	+	+	·	·	·	·	·	·	·
Loranthaceae									
Viscum coloratum NAKAI var. *rubroaurantiacum* MAK.	+	+	+	+	×	×	×	·	·
Ranunculaceae									
Clematis brevicaudata DC.	+	·	+	·	·	·	·	·	·
C koreana KOMAR.	+	·	·	·	·	·	·	·	·
C. mandshurica RUPR.	+	+	+	·	·	·	·	·	·
C. patens MORR. et DEC.	+	+	·	·	+	+	·	·	·
C. serratifolia REHD.	+	·	+	+	·	·	·	·	·
Berberidaceae									
Berberis amurensis RUPR.	+	+	+	×	×	·	·	·	·
B. Poireti SCHN.	+	+	+	·	·	·	·	·	·
Menispremaceae									
Menispermum dauricum DC.	+	+	+	+	+	+	+	·	·
Magnoliaceae									
Schisandra chinensis BAILL.	+	+	+	+	+	·	·	+	+
Saxifragaceae									
Deutzia glabrata KOMAR.	+	+	+	·	·	·	·	·	·
D. parviflora BUNGE	·	+	+	·	·	·	·	·	·
D. prunifolia REHD.	+	·	·	·	·	·	·	·	·
Philadelphus Schrenkii RUPR.	+	·	+	·	·	·	+	·	·
P. tenuifolius RUPR. et MAXIM.	+	·	+	·	·	·	·	·	·

Name of Plants	Korea	N. China	Far East U.S.S.R.	Japan				S. Sakhalin	S. Kuriles
				Hokkaido	Honshu	Shikoku	Kyushu		
Ribes burejense FR. SCHM.	+	·	+	·	·	·	·	·	·
R. Diacantha PALL.	+	·	+	·	·	·	·	·	·
R. Komarovi A. POJARK.	+	·	+	·	·	·	·	·	·
R. mandshuricum KOMAR.	+	+	+	·	·	·	·	·	·
R. Maximowiczianum KOMAR.	+	·	+	·	+	·	·	·	·
R. pallidiflorum A. POJARK.	+	·	+	·	·	·	·	·	·
R. ussuriense JANCZ.	+	·	+	·	·	·	·	·	·
Spiraeaceae									
Physocarpus amurensis MAXIM.	+	·	+	·	·	·	·	·	·
Spiraea Fritischiana SCHN.	+	+	·	·	·	·	·	·	·
S. media SCHMIDT	+	·	+	+	+	·	·	+	+
S. pubescens TURCZ.	+	+	+	·	·	·	·	·	·
S. trichocarpa NAKAI	+	·	·	·	·	·	·	·	·
S. trilobata LINN.	+	+	+	·	·	·	·	·	·
Malaceae									
Crataegus Maximowiczii SCHN.	+	·	+	+	·	·	·	+	·
C. pinnatifida BUNGE	+	+	+	·	·	·	·	·	·
Pyrus ussuriensis MAXIM.	+	·	+	·	·	·	·	·	·
Sorbus alnifolia K. KOCH	+	+	+	+	+	+	+	·	+
S. amurensis KOEHNE	+	·	+	·	·	·	·	·	·
S. pohuashanensis HEDL.	·	+	·	·	·	·	·	·	·
Rosaceae									
Rosa Maximowicziana REGEL	+	·	+	·	·	·	·	·	·
Rubus crataegifolius BUNGE	+	+	+	+	+	+	+	·	·
R. parvifolius LINN.	+	+	·	+	+	+	+	·	+
Amygdalaceae									
Prunus Leveilleana KOEHNE	+	·	·	·	·	·	·	·	·
P. Maackii RUPR.	+	·	+	·	·	·	·	·	·
P. mandshurica KOEHNE	+	·	+	·	·	·	·	·	·
P. Maximowiczii RUPR.	+	·	+	+	+	·	+	+	+
Leguminosae									
Caragana chamlagu LAMARCK	·	+	+	·	·	·	·	·	·
C. manshurica KOMAR.	+	·	·	·	·	·	·	·	·

Name of Plants	Korea	N. China	Far East U.S.S.R.	Japan				S. Sakhalin	S. Kuriles
				Hokkaido	Honshu	Shikoku	Kyushu		
Lespedeza bicolor TURCZ.	+	+	+	+	+	+	+	+	+
L. cyrtobotrya MIQUEL	+	+	+	·	+	+	+	·	·
L. tomentosa SIEB.	+	+	+	·	+	·	+	·	·
Maackia amurensis RUPR. et MAXIM.	+	+	+	×	×	×	×	·	×
Pueraria lobata OHWI	+	+	·	+	+	+	+	·	·
Rutaceae									
Phellodendron amurense RUPR.	+	+	+	×	×	×	×	×	×
Simaroubaceae									
Picrasma quassioides BENN.	+	+	·	+	+	+	+	·	·
Euhorbiaceae									
Securinega suffruticosa REHDER	+	+	+	·	+	+	+	·	·
Celastraceae									
Celastrus flagellaris RUPR.	+	+	+	·	+	·	+	·	·
C. orbiculatus THUNB.	+	+	+	+	+	+	+	×	×
Euonymus alatus SIEB.	+	+	+	+	+	+	+	+	+
E. Maackii RUPR.	+	·	+	·	·	·	·	·	·
E. macropterus RUPR.	+	·	+	+	+	+	·	·	·
E. pauciflorus MAXIM.	+	·	+	·	·	·	·	·	·
E. planipes KOEH	+	·	+	+	+	·	·	·	+
Tripterygium Regelii SPRAGUE et TAKEDA	+	+	·	·	+	+	+	·	·
Staphyleaceae									
Staphylea Bumalda DE CONDOLLE	+	+	·	+	+	+	+	·	·
Aceraceae									
Acer barbinerve MAXIM.	+	·	+	·	·	·	·	·	·
A. Ginnala MAXIM.	+	+	+	·	·	·	·	·	·
A. mandshuricum MAXIM.	+	·	+	·	·	·	·	·	·
A. Mono MAXIM.	+	+	+	+	+	+	+	+	+
A. pseudo-Sieboldianum KOMAR.	+	·	+	·	·	·	·	·	·
A. tegumentosum MAXIM.	+	·	+	·	·	·	·	·	·
A. triflorum KOMAR.	+	·	·	·	·	·	·	·	·
A. ukurunduense TRAUTV. et MEY.	+	+	+	+	+	+	·	+	+

Name of Plants	Korea	N. China	Far East U.S.S.R.	Japan				S. Sakhalin	S. Kurile
				Hokkaido	Honshu	Shikoku	Kyushu		
Rhamnaceae									
Rhamnus arguta MAXIM.	·	+	·	·	·	·	·	·	·
R. parviflora BUNGE	+	+	+	·	·	·	·	·	·
R. Schneideri LEVL. et VNT. var. *mandshurica* NAKAI	+	·	·	·	·	·	·	·	·
Vitaceae									
Ampelopsis brevipedunculata TRAUTV.	+	+	+	+	+	+	+	+	+
Parthenocissus tricuspidata PLANCH.	+	+	+	+	+	+	+	·	·
Vitis amurensis RUPR.	+	·	+	·	·	·	·	·	·
Tiliaceae									
Tilia amurensis RUPR.	+	·	+	·	·	·	·	·	·
T. mandshurica RUPR. et MAXIM.	+	+	+	·	·	·	·	·	·
Actinidiaceae									
Actinidia arguta PLANCH.	+	+	+	+	+	+	+	+	+
A. Kolomikta MAXIM.	+	+	+	+	+	·	·	+	+
A. polygama PLANCH.	+	+	+	+	+	+	+	+	+
Alangiaceae									
Marlea platanifolia SIEB. et ZUCC. var. *triloba* MIQUEL	+	×	·	+	+	×	×	·	·
Araliaceae									
Acanthopanax sessiliflorus SEEMANN	+	+	+	·	·	·	·	·	·
A. senticosus HARMS	+	+	+	+	·	·	·	+	·
Aralia elata SEEMANN	+	+	+	+	+	+	+	+	+
Kalopanax pictus NAKAI	+	+	+	+	+	+	+	+	+
Cornaceae									
Cornus controversa HEMSL.	+	+	·	+	+	+	+	·	+
Ericaceae									
Rhododendron micranthum TURCZ.	+	+	·	·	·	·	·	·	·
R. mucronulatum TURCZ.	+	+	+	·	+	·	+	·	·
R. Schlechenbackii MAXIM.	+	·	+	·	·	·	·	·	·
Symplocaceae									
Symplocos chinensis DRUCE var. *leucocarpa* OHWI form. *pilosa* OHWI	+	+	·	+	+	+	+	·	·
Styracaceae									
**Styrax Obassia* SIEB. et ZUCC.	+	+	·	+	+	+	+	·	·

Name of Plants	Korea	N. China	Far East U.S.S.R.	Japan				S. Sakhalin	S. Kuriles
				Hokkaido	Honshu	Shikoku	Kyushu		
Oleaceae									
Fraxinus mandshurica RUPR.	+	+	+	+	+	·	·	+	+
F. rhynchophylla HANCE	+	+	+	·	·	·	·	·	·
Rangium mandshuricum UYEKI et KITAGAWA	+	+	+	·	·	·	·	·	·
Syringa oblata LINDL.	·	+	·	·	·	·	·	·	·
S. reticulata HARA var. *mandshurica*	+	+	+	+	+	·	+	+	+
S. Palibiniana NAKAI	+	·	·	·	·	·	·	·	·
S. robusta NAKAI	+	·	+	·	·	·	·	·	·
S. velutina KOMAR.	+	·	·	·	·	·	·	·	·
S. Wolfi SCHN.	+	·	·	·	·	·	·	·	·
Verbenaceae									
Chlerodendron trichotomum THUNB.	+	+	·	+	+	+	+	·	·
Caprifoliaceae									
Abelia coreana NAKAI	+	·	+	·	·	·	·	·	·
Lonicera chrysantha TURCZ.	+	+	+	+	·	·	·	+	+
L. Maackii MAXIM.	+	+	+	·	+	·	·	·	·
L. Maximowiczii MAXIM.	+	+	+	·	·	·	·	·	·
L. praeflorens BATAL.	+	·	+	·	+	·	·	·	·
L. Ruprechtiana REGEL	+	·	+	·	·	·	·	·	·
L. Tatarinowii MAXIM.	+	+	·	·	·	·	·	·	·
L. vesicaria KOMAR.	+	·	·	·	·	·	·	·	·
Sambucus Sieboldiana BLUME var. *Miqueli* HARA	+	×	+	+	+	×	×	+	+
S. Williamsii HANCE	+	+	·	·	·	·	·	·	·
Viburnum burejaeticum REGEL et HERDER	+	+	+	·	·	·	·	·	·
V. koreanum NAKAI	+	·	·	·	·	·	·	·	·
V. Sargenti KOEHNE	+	+	+	+	+	+	+	+	+
Weigela florida A. DC.	+	+	·	·	·	·	·	·	·
W. praecox BAILEY	+	·	·	·	·	·	·	·	·

To compare the phytogeographical character, the elements mentioned in the above table are divided into three groups: i) Common to Japan and Eastern Manchuria, ii) Not common to Japan and Eastern

Manchuria, iii) Endemic. In the first group, Japan are divided into four main islands, namely Hokkaido, Honshu, Shikoku and Kyushu while the temperate regions of the Far East into Korea, Northern China, Eastern Manchuria and the Far Eastern region of the U.S.S.R.

1) Common to Japan.

i) Common to Japan, Korea, Eastern Manchuria, Northern China and the Far Eastern region of U.S.S.R.

a) Common to Japan (Hokkaido, Honshu, Shikoku and Kyushu).
Salix gracilistyla, S. subfragilis, Alnus japonica, Carpinus cordata, Quercus dentata, Ulmus propinqua, Viscum coloratum, Menispermum dauricum, Sorbus alnifolia, Rubus crataegifolius, Lespedeza bicolor, Maackia amurensis, Phellodendron amurense, Celastrus orbiculatus, Euonymus alatus, Acer Mono, Ampelopsis brevipedunculata, Parthenocissus tricuspidata, Actinidia arguta, A. polygama, Aralia elata, Kalopanax pictus, Sambucus Sieboldiana, Viburnum Sargentii.

b) Common to Hokkaido.
Acanthopanax senticosus, Lonicera chrysantha.

c) Common to Hokkaido and Honshu.
Corylus mandshurica, Berberis amurensis, Schisandra chinensis, Actinidia Kolomikta, Fraxinus mandshurica.

d) Common to Hokkaido, Honshu and Shikoku.
Taxus cuspidata, Acer ukurunduense.

e) Common to Hokkaido, Honshu and Kyushu.
Ulmus laciniata, Syringa reticulata.

f) Common to Honshu, Shikoku and Kyushu.
Lespedeza crytobotrya, Securinega suffruticosa.

g) Common to Honshu and Kyushu.
Lespedeza tomentosa, Celastrus flagellaris, Rhododendron mucronulatum.

h) Common to Kyushu.
Philadelphus Schrenkii.

ii) Common to Japan, Korea, Eastern Manchuria and Northern China.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Morus bombycis, Rubus parvifolius, Pueraria lobata, Picrasma quassioides, Staphylea Bumalda, Marlea platanifolia, Cornus controversa, Symplocos chinensis, Styrax Obassia, Clerodendron

trichotomum.

b) Common to Honshu, Shikoku and Kyushu.
Tripterygium Regelii.

iii) Common to Japan, Korea, Eastern Manchuria and the Far Eastern region of the U.S.S.R.

a) Common to Hokkaido.
Clematis serratifolia, Crataegus Maximowiczii.

b) Common to Hokkaido and Honshu.
Spiraea media, Euonymus planipes.

c) Common to Hokkaido, Honshu and Shikoku.
Euonymus macropterus.

d) Common to Hokkaido, Honshu and Kyushu.
Salix integra, Prunus Maximowiczii.

e) Common to Hokkaido, Honshu, Shikoku and Kyushu.
Pinus densiflora.

f) Common to Honshu.
Pinus koraiensis, Betula Schmidtii, Ribes Maximowiczianum, Lonicera praeflorens, L. Maackii.

g) Common to Honshu and Shikoku.
Clematis patens.

iv) Common to Japan, Korea and Eastern Manchuria.

a) Common to Hokkaido, Honshu and Shikoku.
Salix Gilgiana.

b) Common to Honshu and Kyushu.
Salix koreensis.

2) Not common to Japan.

i) Common to Korea and Eastern Manchuria.

a) Common to Korea and Eastern Manchuria.
Celtis aurantiaca, Clematis koreana, Deutzia prunifolia, Spiraea trichocarpa, Prunus Leveilleana, Caragana mandshurica, Acer triflorum, Rhamnus Schneideri, Syringa Palibiniana, S. velutina, S. Wolfi, Lonicera vesicaria, Viburnum koreanum, Weigela praecox.

b) Common to Korea, Eastern Manchuria and China.
Betula chinensis, Hemiptera Davidii, Morus mongolica, Spiraea Fritischiana, Rhododendron micranthum, Lonicera Tatarinowii, Sambucus Williamsii, Weigela florida.

c) Common to Korea, Manchuria and the Far Eastern region

of the U.S.S.R.

Populus koreana, Toisusu cardiophylla var. *Maximowiczii, Juglans mandshurica, Betula costata, Clematis brevicaudata, Philadelphus tenuifolius, Ribes burejense, R. Diacantha, R. Komarovi, R. pallidiflorum, R. ussuriense, Physocarpus amurensis, Pyrus ussuriensis, Sorbus amurensis, Rosa Maximowicziana, Prunus Maackii, P. mandshurica, Euonymus Maackii, E. pauciflorus, Acer barbinerve, A. mandshuricum, A. pseudo-Sieboldianum, A. tegumentosum, Vitis amurensis, Tilia amurensis, Rhododendron Schlechenbackii, Syringa robusta, Abelia coreana, Lonicera Ruprechtiana.*

d) Common to Korea, Manchuria, Northern China and the Far Eastern region of the U.S.S.R.

Quercus mongolica, Ulmus macrocarpa, Clematis mandshurica, Berberis Poireti, Deutzia glabrata, Ribes mandshuricum, Spiraea pubescens, S. trilobata, Crataegus pinnatifida, Acer Ginnala, Rhamnus parviflora, Tilia mandshurica, Acanthopanax sessiliflorus, Fraxinus rhynchophylla, Lonicera Maximowiczii, Viburnum burejaeticum.

ii) Not common to Korea.

a) Common to Northern China and Eastern Manchuria.

Pinus tabulaeformis, Celtis Bungeana, Sorbus pohuashanensis, Rhamnus arguta, Syringa oblata.

b) Common to Northern China, Eastern Manchuria and the Far Eastern region of the U.S.S.R.

Deutzia parviflora, Caragana chamlagu.

3) Endemic.

Rangium mandshuricum UYEKI et KITAGAWA.

The elements enumerated above can be summarized as follows:

1) Common to Japan.

i) Common to Japan, Korea, Eastern Manchuria, Northern China and the Far Eastern region of the U.S.S.R.

a)	Common to Hokkaido, Honshu, Shikoku and Kyushu.	24
b)	Common to Hokkaido.	2
c)	Common to Hokkaido and Honshu.	5
d)	Common to Hokkaido, Honshu and Shikoku.	2
e)	Common to Hokkaido, Honshu and Kyushu.	2
f)	Common to Honshu, Shikoku and Kyushu.	2

g) Common to Honshu and Kyushu. 3
h) Common to Kyushu. 1

The species common to Japan, Korea, Eastern Manchuria, Northern China and the East of the U.S.S.R. are 41 in total and summed up as follows:—

Name of Islands	Number of Species	%
Honshu	35	85.4
Hokkaido	34	82.9
Kyushu	30	73.2
Shikoku	26	63.4

In Japan, Hokkaido and Honshu show rather same relationships.

ii) Common to Japan, Korea, Eastern Manchuria and Northern China.

a) Common to Hokkaido, Honshu, Shikoku and Kyushu. 10
b) Common to Honshu, Shikoku and Kyushu. 1

iii) Common to Japan, Korea, Eastern Manchuria and the Far Eastern region of the U.S.S.R.

a) Common to Hokkaido. 2
b) Common to Hokkaido and Honshu. 2
c) Common to Hokkaido, Honshu and Shikoku. 1
d) Common to Hokkaido, Honshu and Kyushu. 2
e) Common to Hokkaido, Honshu, Shikoku and Kyushu. 1
f) Common to Honshu. 5
g) Common to Honshu and Shikoku. 1

The species common to Japan, Korea, Eastern Manchuria and the Far Eastern region of the U.S.S.R. are 14 in total and summed up as follows:—

Name of Islands	Number of Species	%
Honshu	12	85.7
Hokkaido	8	57.1
Shikoku	3	21.4
Kyushu	3	21.4

The analysis of the group common to Japan and Eastern Manchuria is different among four main islands of Japan. Among them Honshu has the strongest affinity and includes the phytogeographically interesting species such as *Pinus koraiensis, Betula Schmidtii, Ribes Maximowiczianum, Lonicera praeflorens, L. Maackii* which are only restricted to

Honshu in Japan.

iv) Common to Japan, Korea and Eastern Manchuria.

a) Common to Hokkaido, Honshu and Shikoku. 1

b) Common to Honshu and Kyushu. 1

Common species to Japan and Eastern Manchuria amount to 68 in total. Their distributions in the main four islands of Japan are as follows:—

Name of Islands	Number of species	%
Honshu	63	92.6
Hokkaido	54	79.4
Kyushu	48	70.6
Shikoku	44	64.7

From the relation of the distribution to the continent of the Far East, they are divided into four groups as shown in the following table.

Name of regions	Number of species	%
J., K., M., C. and S.	41	60.3
J., K., M. and C.	11	16.2
J., K., M. and S.	14	20.6
J., K. and M.	2	2.9

J.=Japan; K.=Korea; M.=Eastern Manchuria; C.=Northern China; S.=The Far East region of the U.S.S.R.

All the species common to Japan and Eastern Manchuria are found in Korea. In this category, the wide ranging species from Japan, Korea, Northern China, Eastern Manchuria to the Far Eastern region of the U.S.S.R. are dominant. It is noteworthy that the species common to Japan, Korea and Eastern Manchuria attains only 2 species including *Salix*.

2) Not Common to Japan.

i) Common to Korea and Eastern Manchuria.

a) Common to Korea and Eastern Manchuria. 14

b) Common to Korea, Eastern Manchuria and Northern China. 8

c) Common to Korea, Eastern Manchuria and the Far Eastern region of the U.S.S.R. 29

d) Common to Korea, Eastern Manchuria, Northern China and the Far Eastern region of the U.S.S.R. 16

The species common to Korea and Eastern Manchuria are 69 in

total and summed up as follows:—

Name of region	Number of species	%
Northern China	24	35.8
Far Eastern region of U.S.S.R.	45	67.2

As shown in the above table, the Far Eastern region of the U.S.S.R. shows closer phytogeographical relationship than Northern China.

ii) Not Common to Korea.

a) Common to Northern China and Eastern Manchuria. 5

b) Common to Northern China, Eastern Manchuria and the Far Eastern region of the U.S.S.R. 2

The analysis of the group not common to Japan and Eastern Manchuria shows the remarkable difference between Korea and China. The latter can not attain half number of the former. The above table shows the close relationship among Eastern Manchuria, Korea and the Far Eastern region of the U.S.S.R.

3) Endemic.

Lastly it is noteworthy that there is only one endemic species restricted to Eastern Manchuria.

The total number of each region are as follows:—

Name of region	Number	%
Korea	135	94.4
Far Eastern region of the U.S.S.R.	101	70.6
China	84	58.7
Japan	68	47.6

From the phytogeographical point of view, the ligneous plants of the northern intermediate temperate zone or the mixed forest zone in Eastern Asia can be divided mainly into the following three groups; the elements of (1) the temperate, (2) the intermediate and (3) the subarctic zone. Among them, most of those elements of the mixed forest zone are not found in the subarctic zone. It is clear that the present elements except the last zone are not found so far to the north though they invade the subarctic zone and have a temperate character in their distribution.

iii. Scandinavia

The following families and genera are not found north of the mixed

forest zone.

a. Families

Taxaceae, Fagaceae, Ulmaceae, Loranthaceae, Celastraceae, Aceraceae, Rhamnaceae, Tiliaceae, Vitaceae, Oleaceae.

b. Genera

Taxus, Carpinus, Corylus, Fagus, Quercus, Ulmus, Viscum, Cotoneaster, Acer, Rhamnus, Tilia, Hedera, Fraxinus, Sambucus.

c. Species

The species of the ligneous plants distributed as far as the mixed forest zone of Scandinavia are as follows: (* invades the subarctic zone)

Taxaceae: *Taxus baccata* LINN.
Salicaceae: *Salix daphnoides* VILL, *S. fragilis* LINN., **S. triandra* LINN.
Myricaceae: **Myrica Gale* LINN.
Betulaceae: **Alnus glutinosa* GAERTN., *Carpinus Betulus* LINN., *Corylus Avellana* LINN.
Fagaceae: *Fagus sylvatica* LINN., *Quercus Robur* LINN.
Ulmaceae: **Ulmus glabra* HUDS.
Loranthaceae: *Viscum album* LINN.
Saxifragaceae: **Ribes alpinum* LINN., **R. nigrum* LINN., *R. Uva-crispa* LINN.
Malaceae: *Cotoneaster integerrimus* MED., *C. melanocarpus* LODD., *Crataegus calycina* PETERM., *C. monogyna* JACQ, *C. Oxyacantha* LINN., *Sorbus hybridum* LINN., *S. intermedia* PERS., *S. obtusifolia* HEDL., **S. salicifolia* HEDL.
Rosaceae: *Rosa canina* LINN., *R. dumalis* BECHST., *R. rubiginosa* LINN., *R. tomentosa* SM., **R. villosa* LINN., *Rubus caesius* LINN., *R. nessensis* HALL, *R. plicatus* W. et N., *R. pruinosus* ARRH., *R. sulcatus* VEST, *R. thyrsanthus* FOCKE, *R. Wahlbergii* ARRH.
Celastraceae: *Euonymus europaeus* LINN.
Aceraceae: *Acer platanoides* LINN.
Rhamancaceae: *Rhamnus cathartica* LINN.
Tiliaceae: *Tilia cordata* LINN.
Vitaceae: *Hedera Helix* LINN.
Cornaceae: *Cornus sanguinea* LINN.
Ericaceae: *Erica Tetralix* LINN.
Oleaceae: *Fraxinus excelsior* LINN.
Labiatae: **Thymus pulegioides* LINN.

Caprifoliaceae: *Lonicera coerulea* LINN., **L. Xylosterum* LINN., *Sambucus nigra* LINN., *S. racemosa* LINN.

3. Geographical Relationships of the Ligneous Flora of the Mixed Forest Zone in Eurasia

From the geobotanical view point, it is noteworthy to analyse the relationship of the distribution of the ligneous flora of the mixed forest zone in Eurasia. Concerning with Eurasia, the northern Japanese Archipelago including Hokkaido, southern Sakhalin and the Southern Kuriles, eastern Manchuria and Scandinavia have been selected for criticism, since precise data are available.

i. Families

The following table shows the common distribution of the ligneous families indigenous to the mixed forest zone in the northern Japanese Archipelago, eastern Manchuria or Scandinavia.

Name of Families	Distribution ranges		
	N. Japan	E. Manchuria	Scandinavia
Taxaceae	+	+	+
Abietaceae	+	+	+
Pinaceae	+	+	+
Juniperaceae	+	+	+
Myricaceae	+	·	+
Juglandaceae	+	+	·
Salicaceae	+	+	+
Betulaceae	+	+	+
Ulmaceae	+	+	+
Moraceae	+	+	·
Loranthaceae	+	+	+
Ranunculaceae	+	+	+
Menispermaceae	+	+	·
Magnoliaceae	+	+	·
Saxifragaceae	+	+	+
Spiraeaceae	+	+	+
Malaceae	+	+	+
Rosaceae	+	+	+
Amygdalaceae	+	+	+

Name of Families	Distribution ranges		
	N. Japan	E. Manchuria	Scandinavia
Leguminosae	+	+	+
Rutaceae	+	+	·
Simaroubaceae	+	+	·
Anacardiaceae	+	+	·
Celastraceae	+	+	+
Staphyleaceae	+	+	·
Aceraceae	+	+	+
Rhamnaceae	+	+	+
Vitaceae	+	+	+
Tiliaceae	+	+	+
Alangiaceae	+	+	·
Actinidiaceae	+	+	·
Araliaceae	+	+	·
Thymelaeaceae	+	+	+
Cornaceae	+	+	+
Empetraceae	+	+	+
Ericaceae	+	+	+
Symplocaceae	+	+	·
Styracaceae	+	+	·
Oleaceae	+	+	+
Verbenaceae	+	+	·
Labiatae	+	+	+
Caprifoliaceae	+	+	+

As shown in the above table, the following families are common to the northern Japanese Archipelago and to Eastern Manchuria but are not found in Scandinavia throughout the mixed forest zone.

Juglandaceae, Moraceae, Menispermaceae, Magnoliaceae, Rutaceae, Simaroubaceae, Anacardiaceae, Staphyleaceae, Alangiaceae, Actinidiaceae, Araliaceae, Symplocaceae, Styracaceae, Verbenaceae.

ii. Genera

From the geobotanical view point, it is also noteworthy to analyse the relationship of the distribution of the genera. The following table shows the common distribution of the ligneous genera indigenous to the mixed forest zone in the northern Japanese Archipelago including

Hokkaido, Sakhalin and the Southern Kuriles, Eastern Manchuria or Scandinavia.

Name of Genera	Distribution ranges		
	N. Japan	E. Manchuria	Scandinavia
Taxus	+	+	+
Abies	+	+	·
Larix	+	+	·
Picea	+	+	+
Pinus	+	+	+
Juniperus	+	+	+
Sabina	+	+	·
Populus	+	+	+
Salix	+	+	+
Toisusu	+	+	·
Myrica	+	·	+
Juglans	+	+	·
Alnus	+	+	+
Betula	+	+	+
Carpinus	+	+	+
Corylus	+	+	+
Ostrya	+	+	·
Fagus	+	·	+
Quercus	+	+	+
Celtis	+	+	·
Ulmus	+	+	+
Morus	+	+	·
Viscum	+	+	+
Clematis	+	+	+
Berberis	+	+	+
Menispermum	+	+	·
Magnolia	+	+	·
Schisandra	+	+	·
Deutzia	+	+	·
Hydrangea	+	+	·
Ribes	+	+	+
Spiraea	+	+	+
Crataegus	+	+	+
Malus	+	+	+

Name of Genera	Distribution ranges		
	N. Japan	E. Manchuria	Scandinavia
Sorbus	+	+	+
Rosa	+	+	+
Rubus	+	+	+
Prunus	+	+	+
Lespedeza	+	+	·
Maackia	+	+	·
Pueraria	+	+	·
Phellodendron	+	+	·
Picrasma	+	+	·
Rhus	+	+	·
Celastrus	+	+	·
Euonymus	+	+	+
Staphylea	+	+	·
Acer	+	+	+
Rhamnus	+	+	+
Ampelopsis	+	+	·
Parthenocissus	+	+	·
Vitis	+	+	·
Tilia	+	+	+
Actinidia	+	+	·
Daphne	+	+	+
Marlea	+	+	·
Acanthopanax	+	+	·
Aralia	+	+	·
Hedera	·	·	+
Kalopanax	+	+	·
Cornus	+	+	+
Empetrum	+	+	+
Andromeda	+	+	+
Chamaedaphne	+	·	+
Ledum	+	+	+
Oxycoccus	+	+	+
Rhododendron	+	+	+
Vaccinium	+	+	+
Symplocos	+	+	·
Styrax	+	+	·

Name of Genera	Distribution ranges		
	N. Japan	E. Manchuria	Scandinavia
Fraxinus	+	+	+
Ligustrum	+	·	+
Syringa	+	+	+
Clerodendron	+	+	·
Thymus	+	+	+
Lonicera	+	+	+
Sambucus	+	+	+
Viburnum	+	+	+
Weigela	+	+	·

As shown in the above table, the following 33 genera are common to the northern Japanese Archipelago and Eastern Manchuria, but not found in Scandinavia throughout the mixed forest zone.

Abies, Larix, Sabina, Toisusu, Juglans, Ostrya, Celtis, Morus, Menispermum, Magnolia, Schisandra, Deutzia, Hydrangea, Pueraria, Lespedeza, Maackia, Phellodendron, Picrasma, Rhus, Celastrus, Staphylea, Ampelopsis, Parthenocissus, Vitis, Actinidia, Marlea, Acanthopanax, Aralia, Kalopanax, Symplocos, Styrax, Clerodendron, Weigela.

In the pan-mixed forest of Eurasia, the following 19 genera are found only in the northern Japanese Archipelago but not in Scandinavia nor in the Far East. Most of them are only found in Hokkaido.

Cephalotaxus, Castanea, Akebia, Lindera, Schizophragma, Stephanandra, Pourthiaea, Skimmia, Zanthoxyllum, Daphniphyllum, Coriaria, Aesculus, Berchemia, Elaeagnus, Oplopanax, Aucuba, Tripetaleia, Sasa, Sasamorpha.

Among them the widely distributed genera in the northern Japanese Archipelago are *Skimmia, Tripetaleia* and *Sasa.*

On the other hand, in the same forest zone, two genera, namely *Philadelphus* and *Pyrus* are found in the continental East Asia but not found in the northern Japanese Archipelago. *Cotoneaster* occurs in the mixed forest zone of Scandinavia but not in the northern Japanese Archipelago nor in the mixed forest zone of the continental East Asia.

In the pan-mixed forest of Eurasia, the following 41 genera are common to the continental East Asia and Scandinavia.

Taxus, Picea, Pinus, Juniperus, Populus, Salix, Alnus, Betula, Carpinus, Corylus, Quercus, Ulmus, Viscum, Clematis, Berberis, Ribes, Spiraea,

Crataegus, Malus, Sorbus, Rosa, Rubus, Prunus, Euonymus, Acer, Rhamnus, Tilia, Daphne, Cornus, Empetrum, Andromeda, Ledum, Oxycoccus, Rhododendron, Vaccinium, Fraxinus, Syringa, Thymus, Lonicera, Sambucus, Viburnum.

iii. Species

It is an interesting problem that there are common and related species among the northern Japanese Archipelago including Southern Sakhalin and the Southern Kuriles, Eastern Manchuria or Scandinavia. The following table shows their geographical relation to each other.

N. Japan	E. Manchuria	Scandinavia
Taxus cuspidata	"	*T. baccata*
Larix kamtschatica	*L. olgensis*	—
Pinus densiflora	"	—
—	*Pinus sylvestris*	"
Pinus parviflora var. *pentaphylla*	*P. koraiensis*	—
Chosenia bracteosa	"	—
Populus jesoensis	*P. Davidiana*	*P. tremula*
Populus Maximowiczii	"	—
Salix gracilistyla	"	—
Salix Hultenii	*S. Caprea*	"
Salix integra	"	*S. multinervis*
Salix Pet-susu	*S. viminalis*	"
Salix rorida	"	*S. daphoides*
Salix subfragilis	"	*S. triandra*
Salix taraikensis	*S. xerophila*	"
Toisusu Urbaniana	*T. cardiophylla* var. *Maximowiczii*	—
Juglans ailanthifolia	*J. mandshurica*	—
Alnus hirsuta	"	*A. glutinosa*
Alnus japonica	"	—
Alnus Maximowiczii	*A. mandshurica*	*A. incana*
Betula davurica	"	—
Betula Ermani		*B. tortuosa*
Betula platyphylla		*B. verrucosa*
Carpinus cordata	"	—
Carpinus laxiflora	*C. Turczaninovii*	*C. Betulus*
Corylus mandshurica	*C. mandshurica*	*C. Avellana*
Quercus dentata	"	—
Quercus crispula	*Q. mongolica*	*Q. Robur*
Celtis jessoensis	*C. Bungeana*	—
Ulmns laciniata	"	—
Ulmus propinqua	"	*U. glabra*
Morus bombycis	"	—

N. Japan	E. Manchuria	Scandinavia
Viscum coloratum	"	*V. album*
Clematis fusca	"	—
Clematis ochotensis	"	*C. sibirica*
Clematis serratifolia	"	—
Menispermum dauricum	"	—
Schisandra chinensis	"	—
Sorbaria stellipila	"	*S. sorbifolia*
Spiraea media	"	—
Spiraea salicifolia	"	—
Malus baccata var. *mandshurica*	"	—
Sorbus alnifolia	"	*S. intermedia*
Sorbus commixta	*S. amurensis*	*S. Aucuparia*
Rosa acicularis	"	"
Rosa Marretii	*R. davurica*	*R. cinnamomea*
Rubus crataegifolia	"	—
Rubus Idaeus	"	"
Rubus parvifolius	"	—
—	*Rubus saxatilis*	"
Prunus Maximowicziii	"	—
Prunus Padus	"	"
Prunus Sargentii	*P. Leveilleana*	—
Lespedeza bicolor	"	—
Picrasma quassioidea	"	—
Rhus javanica	"	—
Celastrus orbiculatus	"	—
Euonymus alatus	"	—
Euonymus macropterus	"	—
Euonymus planipes	"	—
Euonymus Sieboldianus	"	*E. europaeus*
Staphylea Bumalda	"	—
Acer cissifolium	*A. triflorum*	—
Acer Mono	"	*A. platanoides*
Acer ukurunduense	"	—
Rhamnus japonica	*R. davurica*	*R. catharica*
Ampelopsis brevipedunculata	"	—
Parthenocissus tricuspidata	"	—
Vitis Coignetiae	*V. amurensis*	—
Tilia japonica	*T. amurensis*	*T. cordata*
Tilia Maximowicziana	*T. mandshurica*	*T. platyphylla*
Actinidia arguta	"	—
Actinidia Kolomikta	"	—
Actinidia polygama	"	

N. Japan	E. Manchuria	Scandinavia
Daphne jezoensis	*D. koreana*	*D. Mezereum*
Marlea patanifolia	"	—
Acanthopanax senticosus	"	—
Aralia elata	"	—
Hedera rhombea	—	*H. Helix*
Kalopanax pictus	"	—
Cornus alba	"	*C. sanguinea*
Cornus controversa	"	—
Rhododendron Albrechti	*R. Schlechenbachii*	—
Symplocos chinensis	"	—
Styrax Obassia	"	—
Fraxinus mandshurica	"	*F. exelsior*
Ligustrum Tschonoskii	—	*L. vulgare*
Syringa reticulata	"	—
Thymus japonicus	*T. quinquecostatus*	*T. Serphyllum*
Clerodendron trichotomum	"	—
Viburnum Sargenti	"	*V. Opuluster*
Viburnum dilatatum	*V. koreanum*	—
Weigela hortensis	*W. florida*	—

The geographical character mentioned above is shown as follows:

i) Common to the northern Japanese Archipelago and Manchuria, but not in Scandinavia.

Taxus: *Taxus cuspidata.*
Chosenia: *Chosenia bracteosa*
Populus: *Populus Maximowiczii.*
Salix: *Salix gracilistyla, S. integra, S. rorida, S. subfragilis.*
Alnus: *Alnus hirsuta, A. japonica.*
Betula: *Betula davurica. B. Ermani, B. platyphylla.*
Carpinus: *Carpinus cordata.*
Corylus: *Corylus mandshurica.*
Quercus: *Quercus dentata.*
Ulmus: *Ulmus laciniata, U. propinqua.*
Morus: *Morus bombycis.*
Viscum: *Viscum corolatum.*
Clematis: *Clematis fusca, C. ochotensis C. serratifolia.*
Menispermum: *Menispermum dauricum.*
Schisandra: *Schisandra chinensis.*
Sorbaria: *Sorbaria stellipila.*
Spiraea: *Spiraea media, S. salicifolia.*

Malus: *Malus baccata.* var. *mandshurica.*
Sorbus: *Sorbus alnifolia.*
Rubus: *Rubus crataegifolius, R. parvifolius.*
Prunus: *Prunus Maximowiczii.*
Lespedeza: *Lespedeza bicolor.*
Picrasma: *Picrasma quassioides.*
Rhus: *Rhus javanica.*
Celastrus: *Celastrus orbiculatus.*
Euonymus: *Euonymus alatus, E. planipes, E. macropterus, E. Sieboldianus.*
Staphylea: *Staphylea Bumalda.*
Acer: *Acer Mono, A. ukurunduense.*
Ampelopsis: *Ampelopsis brevipedunculata.*
Parthenocissus: *Parthenocissus tricuspidata.*
Actinidia: *Actinidia arguta, A. Kolomikta, A. polygama.*
Marlea: *Marlea platanifolia.*
Acanthopanax: *Acanthopanax senticosus.*
Aralia: *Aralia elata.*
Kalopanax: *Kalopanax pictus.*
Cornus: *Cornus alba, C. controversa.*
Symplocos: *Symplocos chinensis* var. *leucocarpa* f. *pilosa.*
Styrax: *Styrax Obassia.*
Fraxinus: *Fraxinus mandshurica.*
Syringa: *Syringa reticulata.*
Clerodendron: *Clerodendron trichotomum.*
Viburnum: *Viburnum Sargenti.*

ii) Found in Manchuria, but not in the northern Japanese Archipelago.

Spiraea: *Spiraea chamaedrifolia, S. Fritschiana, S. pubescens.*
Rosa: *Rosa davurica, R. koreana, R. Maximowicziana, R. pimpinellifolia.*
Rubus: *Rubus saxatilis.*
Rhododendron: *Rhododendron Schlechenbachii.*

iii) Common to Eastern Manchuria and Honshu, but not in Hokkaido. *Pinus koraiensis, Betula Schmidtii, Philadelphus Schrenkii, Rhododendron mucronulatum.*

iv) Common to Eastern Manchuria and Sakhalin, but not in Hokkaido. *Ribes procumbens, Cornus alba.*

Wide ranging species: There are distinct wide ranging species distributed from Japan to Scandinavia in the mixed forest zone. They

are *Rosa acicularis*. *Prunus Padus*, *Andromeda polifolia*, *Chamaedaphne calyculata*, *Ledum palustre*, *Oxycoccus microcarpus*, *Oxycoccus quadripetalus* and *Rubus Idaeus*. Most of them belong to the bog plants. In the following table the subspecies and varieties commonly found in the northern Japanese Archipelago, Eastern Manchuria or Scandinavia are listed.

N. Japan	E. Manchuria	Scandinavia
Myrica Gale var. *tomenotsa*	—	*M. Gale*
Berberia amurensis var. *japonica*	*B. amurensis*	—
Maackia amurensis var. *Buergeri*	*M. amurensis*	—
Phellodendron amurense var. *sachalinse*	*P. amurense*	—
Acer Ginnala var. *aidzuense*	*A. Ginnala*	—
Acer Tschonoskii	*A. Tschonoskii* var. *rubripes*	—
Empetrum nigrum var. *japonicum*	"	*E. nigrum*
Lonicera coerulea subsp. *edulis*	"	*L. coerulea*

Part III. Pan-Mixed Forest Zone

1. Outline of the Pan-Mixed Forest in Eurasia

According to the general map of world vegetation, the needle-leaved forest of the subarctic zone is often directly in contact with the temperate zone. But this is found not to be true in fact, if a detailed analysis is carried out. The purpose of this part of the present paper is to describe and compare the forests in question as they are found among the islands of the northern Japanese Archipelago including the Southern Kuriles, in the northeastern Far East and in Scandinavia.

Islands of the Northern Pacific Ocean: The needle-leaved forests of the subarctic zone of the Japanese Archipelago are represented by the *Picea jezoensis-Abies sachalinensis* and *Larix kamtschatica* forest: on the other hand, the typical temperate forest zone is represented by the *Fagus crenata* forest. As the boundary line of demarcation between the subarctic and the temperate zones in the present area, Prof. Y. Kudo indicated Schmidt's Line in Sakhalin and the writer Miyabe's Line in the Kurile Islands. These lines were previously cited. On the other hand, the *Fagus crenata* forest is only found as far northward as the KuromatsunaiDepression in Hokkaido. Speaking strictly, the

subarctic zone is restricted to the northward of those two lines.

There must therefore be some special zone lying among the Kuromatsunai Depression in Hokkaido, SCHMIDT's Line and MIYABE's Line, for the true temperate zone is developed to the southward from the Kuromatsunai Depression.

Northeastern part of the Far Eastern Continent: The subarctic needle-leaved forests of the northeastern part of the Far East portion of the Continent including Eastern Manchuria, Amur, Ussuri and the Maritime Province are represented by the *Larix olgensis-* and *Picea jezoensis-Abies nephrolepis* forest. From the geobotanical point of view, Eastern Manchuria cited here, is located to the east of the railway line of Shenyang-Changchun-Harbin as already mentioned. These forests of the larch, the fir and the spruce are reported from the mountain district and sometimes found in lower parts of E. Manchuria, but not cover its whole area. The *Pinus densiflora* forest is found in part. On the other hand, the rich flora of the Japanese-

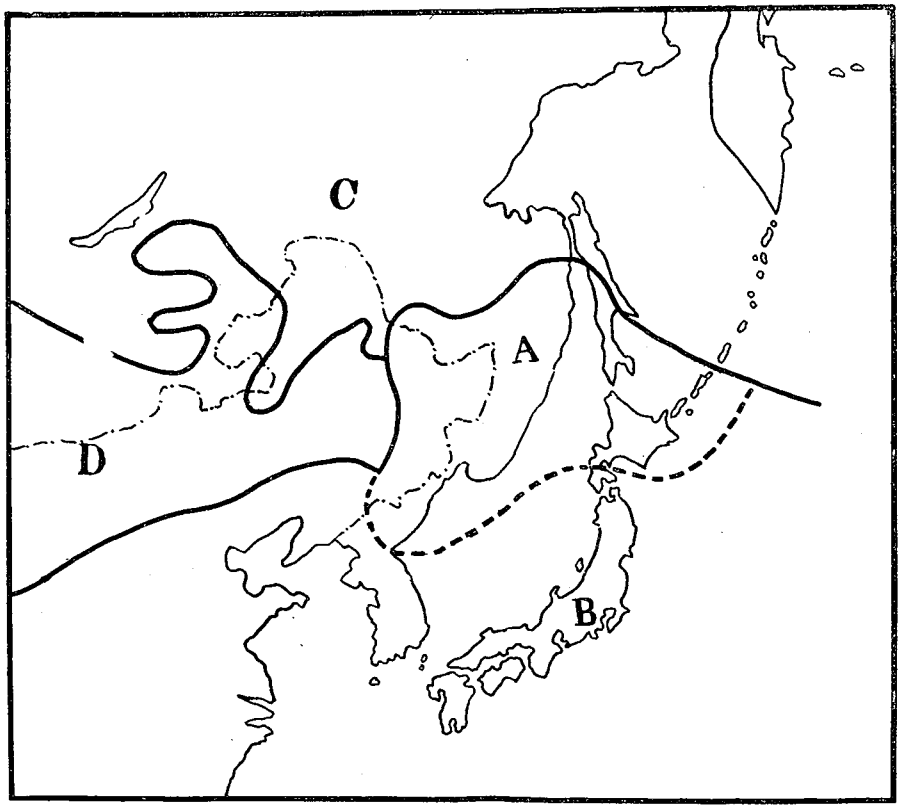

Fig. 13. Phytogeographical Zones of the Northeastern Far East
A. Intermediate Zones; B. Temperate Eastern Asiatic Zone
C. Siberian Subarctic Zone; D. Central Asiatic Zone

Chinese or the Eastern Asiatic Temperate zone (in a narrow sense) is well developed as far as Southern Manchuria and also partly found in E. Manchuria. As a result of researches there,[1~6] it may be said that the northeastern part of Far East portion of the Continent resembles the northern islands of the Japanese Archipelago, having intermediate characters between the subarctic- and the temperate forest zone. Briefly speaking, the Amur basin including Eastern Manchuria and the northern parts of the Japanese Archipelago including the Southern Kuriles from the Kuromatsunai Depression to SCHMIDT's and MIYABE's Lines from a homogenous zone or "The Northern Intermediate Temperate Zone of the Far East" or in other words "The mixed forest zone of the Far East." (Fig. 13)

Scandinavia: The needle-leaved forests of the subarctic zone of Scandinavia[7~15] are represented mostly by the *Picea Abies* forest and partly by the *Pinus sylvestris* forest in the northern part. On the other hand, the typical temperate forest zone is represented by the *Fagus*

1) OGA, I.: The vegetation on the plant distribution in Manchuria. (in Japanese) (1931)
2) NAKAI, T.: The phytogeography of Manchuria, Ussuri and Amur. Plants in Eastern Asia, 112~139. (in Japanese) (1935)
3) KITAGAWA, M.: Lineamenta Florae Manshuricae. (1939)
4) TATEWAKI, M.: The outline of the vegetation in Manchuria, Inner Mongolia and North China, with special reference to the distribution of the trees. (in Japanese) (1943)
5) TAKAHASHI, M.: Studies on the system of plant-ecology based on field investigations made in Nothern East-Asia. Journ. Fac. Sci. Imp. Univ. Tokyo, Sect. III. **5**-5. 427~649 (1944)
6) KIRA, T.: On the forest types of Manchuria. (in Japanese). Science, **1**-1. 23~30; **1**-3. 87~96. (1947)
7) DU RIETZ, G. E.: Die regionale Gliederung der Skandinavischen Vegetation. Sv. Växtsoc. Sällsk. Handl. 8. (1925)
8) " : Phytogeographical Excursions to the Surroundings of Lake Tornetrask in Torne Lappmark, Northern Sweden. (1950)
9) ENQUIST, F.: Tradgransundersokningar. (Deutsche Zusammenfassung: Baumgrenzuntersuchungen). Sv. Skogsvardsfor. Tidske. **31**. (1933) **41**-7.
10) LINDQUIST, B.: The main varieties of *Picea Abies* (L.) KARST. in Europe, with a contribution to the theory of a forest vegetation in Scandinavia during the last Pleistocene glaciation. Acta Horti Bergiani **14**-7. (1948)
11) ARNBORG, T.: Der Vallsjo-Wald, ein nordschwedischer Urwald. Acta Phytogeogr. Suec. **13**. 128~154. (1940)
12) " : Det nordsvenska skogstypsschemat. Sv. Skogsv.-foren. Forlag. (1945)
13) " : Synpunkter på vegetationsanalysen vid undersökningar av nordiska barrskogssamhällen. Sv. Botanisk Tidskrift, **43**-2~3. (1949)
14) " : Phytogeographical Forest Excursion to North Sweden. (1950)
15) ZOLLER, H.: Die boreale Gurtelserie. Ber. Geobot. Forsch. RÜBEL in Zürich (1955) 80~91. (1956)

sylvatica forest[1-5] in the southern part. But between the two zones, there is also an intermediate one as shown in the figure. (Fig. 14) It indeed coincides practically with the intermediate zone in the Far East. Swedish botanists[6-8] have already pointed out the boundary between the southern and the northern conifer region. Prof. SERNANDER called it the "limes norrlandicus" or the ecological Norrland limit. This line was also called the oak line which separates South Sweden from North Sweden. In this sense, South Sweden is named "the South Sweden conifer forest region with oak" by Prof. DU RIETZ. Those scholars have explained the presence of the temperate forests and the deciduous trees such as *Fraxinus excelsior*, *Quercus Robur*, *Acer platanoides*, *Tilia cordata*, *Ulmus glabra*, etc. in the southern conifer zone. In 1955, TATEWAKI[9] announced the mixed forest zone of Sweden and also in 1956 Dr. ZOLLER[10] published the same opinion. The homogenous constructions and arrangements of the various forests of the southern conifers zone are like the mixed forest zone in

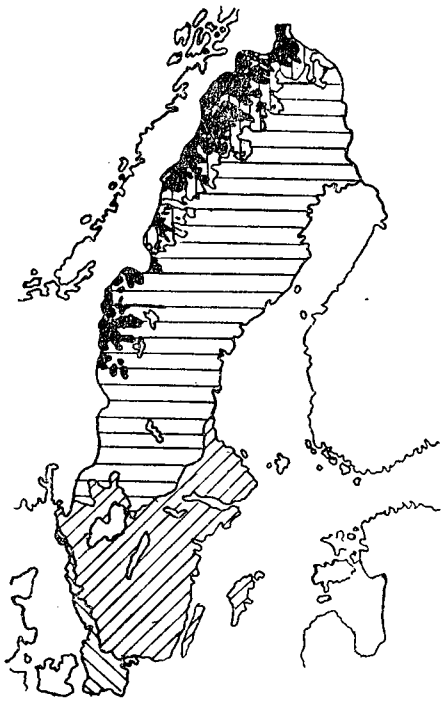

Fig. 14. Forest zones of Sweden

- Alpine zone
- *Betula tortuosa* forest zone
- Needle-leaved forest zone
- Mixed forest zone
- *Fagus sylvatica* forest zone

1) LINDQUIST, B.: The ecology of the Scandinavian beech-woods. Journ. of the Swedish Forestry Society, **3**. 179~532 (1931)
2) " : Dalby Soderskog. (1938)
3) " : Phytogeographical forest excursion in South Sweden. (1950)
4) FAEGRI, K.: On age and origin of the beech forest (*Fagus silvatica* L.) at Lygrefjorden near Bergen (Norway). Denmarks Geol. Unders. II. **80**. 230~249. (1954)
5) ZOLLER, H.: Die Subatlantische Buchen-Region. Ber. Geobot. Forsch. RÜBEL in Zurich (1955) 73. (1956)
6) DURIETZ, G. E.: Klima och jordman. (1935)
7) FRIES, M.: Limes norrlandicus-Studier. En vaxtgeografisk gransfraga historiskt belyst och exempliferad. Sv. Bot. Tidske. **42**-1. 51~69. (1948)
8) ARNBORG, T.: Phytogeographical forest excursion, North Sweden, **4**. (1950)
9) TATEWAKI, M.: Forest Zones of Sweden. Northern Forestry of Japan no. **77**. 4~7. (1955)
10) ZOLLER, H.: Die Nadellaubwald-Region Ber. Geobot. Forsch. RÜBEL in Zürich (1955) 78~81. (1956)

the Far East.

The genera common to the mixed forest in the islands of the Northern Pacific Ocean, in the northeastern Far East part of the Continent and also in Sweden, are *Quercus, Ulmus, Carpinus, Corylus,* and *Fraxinus* as the prominent temperate elements. According to the above observations, the notion of "Pan-Mixed Forest" will be clearly understood. Such forests in the northern Japanese Archipelago including the Southern Kuriles are situated in the easternmost part of Northeastern Asia in this category, and they have rich Temperate Eastern Asiatic elements. The Scandinavian flora of the mixed forest zone having been greatly influenced by the ice age, is very poor in species as well as genera, compared with those of the Far East. Departing from the above considerations, the points of general homology of the mixed forest zone between the arctic and the temperate forest zones in Eurasia are as follows:—

i) The needle-leaved or the deciduous broad-leaved forests belonging to the subarctic forest are not found in the whole area.

ii) Mosaic arrangements of the needle forests belonging to the subarctic zone and those of the deciduous forests belonging to the temperate zone.

iii) In the mixed forests, the mosaic mixture of the trees belonging to the subarctic and to the temperate element.

iv) Both in Eastern Asia and Northern Europe, the mixed forest have common genera of the ligneous flora.

But from the ecological point of view, the remarkable differences among the forests of the three parts of Eurasia are as follows:—

	N. Japanese Archipelago	NE. Far East	Scandinavia
Ligneous flora	rich	more or less rich	poor
Sasa strata	prominent	—	—
Climbing plants	+	±	—

2. Forests of the Intermediate Zone of Hokkaido

Among the forests of the intermediate zone of the Far East, those of Hokkaido have been studied most precisely from the view-point of synecology. In Hokkaido, the district to the northward from the Kuro-

matsunai Depression, is not occupied only by the forests belonging to the subarctic zone. In other words, *Picea jezoensis-Abies sachalinensis, Alnus hirsuta-* and *Betula Ermani* forests do not entirely maintain their vegetation of the low-land. Only such a pure subarctic or taiga type vegetation is found from 800 to 1300~1600 m high in central Hokkaido, but in some localities in the same district, for example on a branch (Tomuraushi) of the R. Tokachi, the mixed forests are found even as high as 800 m.

Coastal forests: The forest bordering the coast line of Hokkaido have changed considerably from their original composition. As a result of the coming of a fishing population, man was certain to alter the natural forest along the coast to a large extent. If one goes near the northernmost end (Wakkanai), he can find the *Abies sachalinensis* forest on sand dunes, but he will see the *Quercus dentata* forest in the same locality. If one goes down a little southward along the Sea of Japan, he can find also the *Abies sachalinensis* forest on sand dunes near the lower Teshio River, but he will see the *Quercus dentata* forest in the same locality. Similar conditions are observed near Shari, on the northeastern coast of Hokkaido on the Okhotsk Sea. Generally speaking, the *Quercus dentata* forest is found on sand dunes; on the other hand on the hills along the sea-shore of Hokkaido the *Acer Mono* forest is often met with and on sandy hills the *Quercus dentata* forest. Such forests of *Quercus dentata* or *Acer Mono* do not express the subactic character at all. Also similar conditions may be observed along the sea-coast in southeastern Hokkaido, he can often find forests of subarctic character, as the *Abies sachalinensis-*, the *Picea Glehni-* the *Alnus hirsuta-* and the *Betula Ermani* forest. But he will also surely note that the *Quercus crispula-*, the *Fraxinus mandshurica-*, the *Ulmus propinqua-* and the *Acer Mono* forests belonging to the temperate forest zone stand side by side with the subarctic forest. (Fig. 15) A clear idea of the mixed forest zone will be gained by considering the above examples.

Inland broad-leaved forest: At present, in the low lands of Hokkaido, it is becoming almost impossible to study the natural condition of the sort of forests now under consideration, owing to the development of argriculture and forestry. But an excellent example has been well preserved on Maruyama Hill (226 m) at Sapporo under protection as a "State Natural Conservation". It is clear that Maruyama Hill is covered mostly by forest of deciduous broad-leaved trees classified as *Tilia* (including *japonica* and *Maximowicziana*)-*Acer Mono* (in-

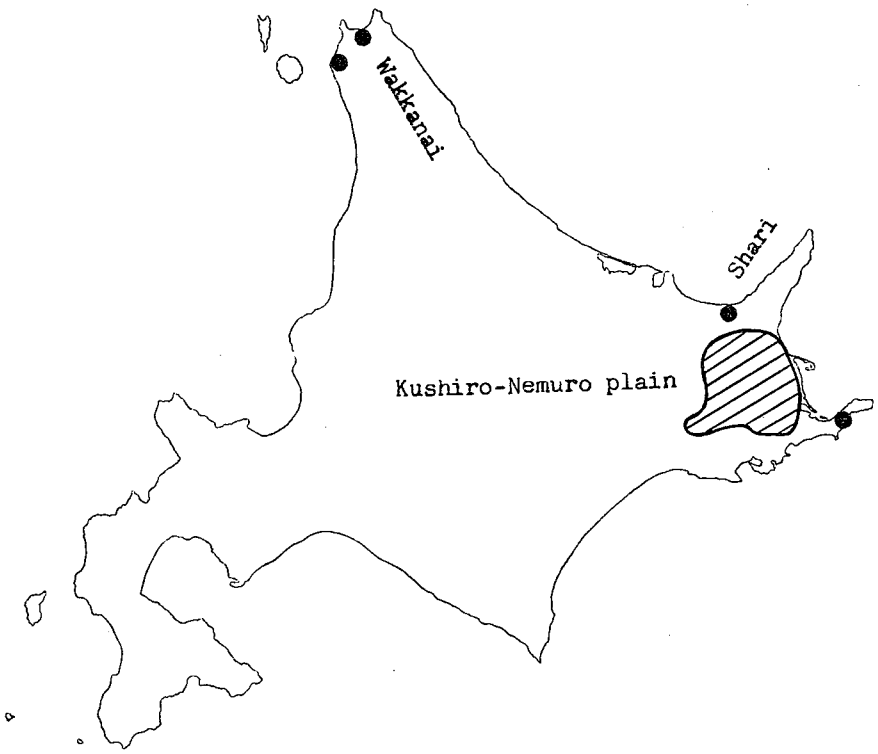

Fig. 15. Characteristic forest stands in Hokkaido
● : The Subarctic forest stand side by side with the temperate forests along the coast
▨ : Special deciduous broad-leaved forests

cluding *A. Mayri*)- and *Cercidiphyllum japonicum* forests after precise analysis of the forest composition.

On the rich soil of the inland plain in the area under consideration, the climax forest seems to be represented by the *Ulmus propinqua-Acer Mono* forest (sometimes *Ulmus propinqua* dominant). It is not usually found in natural stand at present, on account of the increased population and cultivation since World War II.

Along the valley, *Juglans ailanthifolia, Cercidiphyllum japonicum* and *Fraxinus mandshurica* are common on rich soils. They form pure forests, but they are often mixed with the needle-leaved trees such as *Abies sachalinensis* or *Picea jezoensis*.

The *Quercus crispula* forest is well developed on light soils. In Eastern Hokkaido such as in Provinces of Tokachi, Kushiro and Nemuro, such forest is commonly found on the inland plain or hilly place, characterised by the presence of a monotonous underlayer dominated

by *Sasa* (Sect. *Crassinodi*).

Kushiro-Nemuro: There is a very intersting district of broad-leaved forest developed on a wide area in the eastern part of Hokkaido. It is known as the Kushiro-Nemuro (Konsen) Plain. (Fig. 15) Here volcanic ashes form a thick horizon influenced by rather recent activity of Mashu Volcano. Needle-leaved or mixed forests are hardly found; only broad-leaved forests are met with. Previous to about 25 years ago, fine oak (*Quercus crispula*) forest was easily found, but it had been decreased by the felling of trees for the lumber industry. In addition to that, the development of agricultural reclamation has resulted in the almost entire destruction of the primaeval oak forest. So at present, the forests of the Kushiro-Nemuro Plain are usually in an unstable stage showing often the initial stage of the succession due to forestry and agricultural reclamation. As the broad-leaved trees composing the forests in this district, one can enumerate *Quercus crispula, Quercus dentata, Alnus hirsuta, Alnus japonica, Betula Ermani, Betula platyphylla* and *Populus Davidiana.* Especially *Betula platyphylla, Quercus dentata* and *Populus Davidiana* are common in burned-over area.

Mixed forests: True mixed forests are found very commonly in Hokkaido. They are composed of various combinations of needle- and broad-leaved trees. The composition of the general mixed forest in Hokkaido shows the character of the intermediate zone and affords a good example of the mixture of species belonging to the subarctic and the temperate elements. The examples of mixed forests can not be enumerated here. One of the most common ones is the *Abies sachalinensis-Quercus crispula* forest.

The same tendency of occurrence of the mixed zone is shown to the south of SCHMIDT's Line in Sakhalin, and also in the Southern Kuriles from MIYABE's Line. However, if one goes to the eastern side of Southern Sakhalin facing the Okhotsk Sea, the subarctic character will be noted to have often been caused to appear strongly by the influence of the cold current.

3. Vertical Distribution of the Forests of Hokkaido

The vertical distribution of the forest or the forest zonation of the mountain vegetation is one of the most conspicuous features in the temperate region. Among the islands of the Northern Pacific Ocean, that zonation in Hokkaido is remarkable. As already mentioned, the Central, the Northern Kuriles and also northernmost Sakhalin are

destitute of the needle-leaved forest. The Aleutian Islands are charactered by the absence of the forest, except only low willows found the valley. The districts mentioned above have a special physiognomy of vegetation in spite of belonging to the subarctic region from the view point of phytogeography. So the vertical arrangements of the forest zone of the mountains in Hokkaido are explained here as representatives.

i. Forest zones

The forest zone in the area under consideration may be divided into four climatic type zones according to the altitude rising from the low land:— the temperate or deciduous broad-leaved forest zone and the intermediate or mixed forest zone, the subarctic (subalpine) or needle-leaved forest zone and the alpine or shrub zone.

Temperate forest zone: The temperate forest zone represented by the *Fagus crenata* forest occurs in Southwestern Hokkaido as already explained.

Mixed forest zone: Beyond and to the north of the Japanese beech forest, the temperate forest zone represented by *Ulmus propinqua-Acer Mono-*, *Quercus crispula-* or *Tilia-Acer Mono* forests are often developed in the low land. The mixed forest zone occurs above or at the same level as the deciduous forest zone. The characteristic deciduous broad-leaved and the needle-leaved trees are already mentioned. Sometimes it extends up to an elevation of 800 m; special example has been cited along the upper Tomuraushi in Central Hokkaido. In this case, the uppermost mixed forest is represented by the *Picea jezoensis-Fraxinus mandshurica* forest. It is a good example of the character of the mixed forest of the Far East.

Needle-leaved forest zone: The present zone is divided into following three subzones:— the needle-leaved forest, the upper mixed forest zone and the *Betula Ermani* forest. The conifers which predominate in this zone are *Picea jezoensis*, *Abies sachalinensis* and sometimes *Picea Glehni*. *Picea jezoensis* increases in general with the higher elevation. Characteristic broad-leaved trees are *Betula Ermani*, *Prunus nipponica*, *Ilex Sugeroki*, *Euonymus macropterus*, *Acer ukurunduense*, *Acer Tschonoskii*, etc. The presence of such broad-leaved trees except *Betula Ermani* is very remarkable taking into consideration of the horizontal distribution of the subarctic forests.

Upper mixed forest: The upper mixed forest is often developed

between the needle-leaved and the *Betula Ermani* forest. It is usually represented by the *Picea jezoensis-Betula Ermani* forest and sometimes by *Picea Glehni-Betula Ermani* forest.

Betula Ermani forest: The zone above the needle-leaved forest represents by the *Betula Ermani* forest, which belongs to the subalpine zone in a wide sense, as shown as a result of floral analysis. The height of the trees gradually diminishes and at last they become dwarf and bushy in habit and clearly indicate the intermediate zone between the needle-leaved forest and the *Pinus pumila* (*Siberian dwarf pine*) thicket.

Alpine zone: The highest part of the mountains are generally occupied by *Pinus pumila* which often covers a considerable tract. Vegetation shows a luxuriant growth and forms a beautiful carpet of dark green. The other woody species of the alpine zone are all shrubby, while there are found also *Alnus Maximowiczii, Sorbus sambucifolia, Sorbus Matsumurana,* etc.

ii. Boundary Line of the Tree Limit

There are several kinds of forests along the boundary line on the mountains of Hokkadio. They shows one of the most interesting variabilities of forest physiognomy among the islands of the North Pacific Ocean.

Betula Ermani **forest:** Such forest is the commonest one forming the boundary line of the tree limit and showing the zonation. The width of this birch forest is variable according to the particular mountains.

Alnus Maximowiczii **thicket:** On Mt. Koma, Prov. Oshima, a recent volcano, this thicket forms the boundary line of the tree limit.

Picea Glehni **forest:** On Mt. Shiratori, a serpentine mountain, situated in the central western part of Hokkaido, and also on the western slopes of the volcanic mountains Mt. Tokachi and Mt. Meakan (the Tokachi-side) may be seen the development of *Picea Glehnii* forest in the boundary line of the tree limits. The underlayer of the former mountain is characterised by *Sasa*, but that of the latter is characterised by the presence of *Pinus pumila* in shrub stratum. There are special cases in the area under consideration.

Picea jezoensis **forest:** A special case observed on Mt. Tarumai, a recent volcanic mountain, has a characteristic boundary line of the tree limit represented by the *Picea jezoensis* forest.

Abies sachalinensis **forest:** An example is found on Mt. Meakan,

between the needle-leaved and the *Betula Ermani* forest. It is usually represented by the *Picea jezoensis-Betula Ermani* forest and sometimes by *Picea Glehni-Betula Ermani* forest.

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Abies sachalinensis **forest:** An example is found on Mt. Meakan,

Akan National Park. There is a well developed ERMAN's birch forest on Mt. Oakan standing opposite to Mt. Meakan across the Lake Akan.

iii. Altitude of the Forest Zones

The altitude of each forest zone in the mountain of Hokkaido will be examined from the following three main axes:— The southwestern part, the central part and the eastern part.

Southwestern part: The mountains of the southwestern part ranges from Mt. Sengen situated in the southwestern part of Oshima Peninsula to Mt. Kariba in Prov. Shiribeshi, including Mt. Yurap, Mt. Oshamanbe, Mt. Ohira. The presence of *Fagus crenata* forest well developed from the lower places and the absence of the needle forest in the upper part of these mountains express the characteristic forest physiognomy as shown in the mountains of the northeastern part of Honshu (the main island of Japan) along the Sea of Japan. In the upper part, the Japanese beech forest is succeeded by the *Betula Ermani* forest and the highest part is occupied by *Pinus pumila* thicket. The following table shows the altitude of each forest zone in these mountains of the southwestern part of Hokkaido.

Name of Mt.	Altitude	*Pinus pumila* thicket	*Betula Ermani* forest	*Fagus crenata* forest
Mt. Kariba	1519 m	~1500 (~1200) m	1300~800 m	800~ m
Mt. Ohira	1191	~1000 (~800)	1100~900 (~750)	900 (~750) ~
Mt. Yurap	1275	~1000	1000~800	800~
Mt. Oshamanbe	972	~ 950	950 (~700)	700~

Central part: The mountains of the central part form the back bone of Hokkaido in the long axis ranging from the southern part of Prov. Hidaka to the northern part of Prov. Kitami. A complete succession of rocks ranging from Paleozoic to recent is found there as has been already mentioned in this paper.

The following table shows the altitude of each forest zone of the central part from south to north.

Daisetsu Mountains Group situated in the center of Hokkaido is the highest point called "the roof of Hokkaido". The lower limit of *Pinus pumila* thicket and the *Betula Ermani* forest of main peaks of this mountain group is as follows:

Lower limit of *Pinus pumila*- and *Betula Ermani* zone

Name of Mt.	Altiude	Lower limit of *Pinus pumila* thicket	Lower limit of *Betula Ermani* forest	Lower Needle-leaved forest
Mt. Yuni-ishikari	1755 m	1600 m	1600~1500 m	800 m
Mt. Otofuke	1932	1800~1600	1450~1400	"
Mt. Ishikari	1980	1800~1600	1450~1200	"
Numanohara	1450	1420	1480~1380	"
Goshikigahara	1882	1500	1650~1350 (~1200)	"
Mt. Chubetsu	1063	1700~1500	1600~1400	"
Mt. Hiragatake	1781	1600~1500	1600~1300	"
Mt. Akadake	2076	1800~1600	1700~1300 (~1200)	"

Northeastern part: The mountains of the northeastern part range from Mt. Meakan, Prov. Kushiro to Mt. Shiretoko, Shiretoko Peninsula which protrudes as the northeastern end of Hokkaido forming the back bone of a long-tailed peninsula. They are all volcanoes. The vertical arrangement of the forest zones are sometimes irregular owing to the volcanic action as well as the special maritime climate. The following table shows the altitude of each forest zone of the mountains of Akan National Park.

Name of Mt.	Altitude	Lower limit of *Pinus pumila* thicket	*Betula Ermani* forest	Needle-leaved forest
Mt. Oakan	1371 m	1200 (~1100) m	1200~1100 m	1000~600 m
Mt. Meakan	1503	1100 (~800)	800~ 700 (~600)	1000~600(~500)
Mt. Mokoto	1000	700 (~600)	800~ 700 (~600)	(900~)800~500

4. Comparison of the Main Homologous Forests in Eurasia

The following table is based on the main forests of Hokkaido and the homologous forests in Eastern Manchuria and Sweden.

* Limited to the temperate forest zone.

** Restricted northerly as far as to the southern part of the mixed zone

Hokkaido	E. Manchuria	Sweden
Needle-*leaved* forest		
Picea jezoensis-Abies sachalinensis forest	*Picea jezoensis-Abies nephrolepis* forest	—
Picea Glehni forest	—	*Picea Abies* forest —
—	*Pinus densiflosa* forest	*Pinus sylvestris* forest
—	*Larix olgensis* forest	—
**Thujopsis dolabrata* var. *Hondai* forest	—	—
***Pinus parviflora* var. *pentaphylla* forest	*Pinus koraiensis* forest	—
Broad-leaved forest		
**Fagus crenata* forest	—	**Fagus sylvatica* forest
Ulmus propinqua forest	*Ulmus propinqua* forest	*Ulmus glabra* forest
Acer Mono-Tilia japonica forest	*Acer Mono-Tilia amurensis* forest	*Acer platanoides-Tilia cordata* forest
Quercus crispula forest	*Qercus mongolica* forest	*Quercus Robur* forest
Alnus hirsuta forest	*Alnus hirsuta* forest	*Alnus glutinosa* forest
Fraxinus mandshurica forest	*Fraxinus mandshurica* forest	*Fraxinus excelsior* forest
***Pterocarya rhoifolia-Aesculus turbinata* forest	—	—
Salix forest	*Salix* forest	*Salix* forest
Populus Maximowicziii-Toisusu Urbaniana forest	*Populus Maximowicziii-Toisusu cardiophylla* var. *Maximowicziii* forest	—
Alnus japonica var. *arguta* forest	—	—
Quercus dentata forest	—	—
Betula platyphylla forest	*Betula platyphylla* forest	*Betula verrucosa* forest
Betula davurica forest	*Betula davurica* forest	—
Populus Davidiana forest	*Populus Davidiana* forest	*Populus tremula* forest
Betula Ermani forest	*Betula Ermani* forest	*Betula tortuosa* forest
Alnus Maximowiczii forest	*Alnus Maximowiczii* forest	*Alnus incana* forest
Pinus pumila thicket	*Pinus pumila* thicket	—

Conclusion

Abuot 40 years have already passed since the author entered Hokkaido University as a student. Since then he has frequently had occasion to travel in the Kuriles, in Southern Sakhalin, and in Manchuria (N.-E. China). He also had the opportunity to visit the Maritime Province. The close relation of the flora and plant communities in these areas aroused his interest. The vegetation of Eastern Manchuria, especially, was very similar to that of Hokkaido although *Sasa* strata

were absent from the former. The intermediate zone between the subarctic zone of Eastern Asia and the Eastern Asiatic Temperate zone made a deep impression on the author and motivated him to begin and keep up the present study.

Certainly, Eastern Manchuria, a part of the Continent, exhibits the transitional phases of the flora and the vegetation of an intermediate character. A good chance was offered to the writer to visit Sweden, Norway and Denmark in 1954. There he remarked the homogenous relation of the flora and vegetation of Scandinavia to that of the Far East. He recognized that the northern Japanese Archipelago is situated in the outmost position of the mixed forest zone of the Eurasiatic Continent. In short, the remarkable difference between Scandinavia and Far East is shown by the poor flora of the former influenced by the Ice Age and the rich flora of the latter undisturbed by the influence of the Ice Age.

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EXPLANATION OF PLATES

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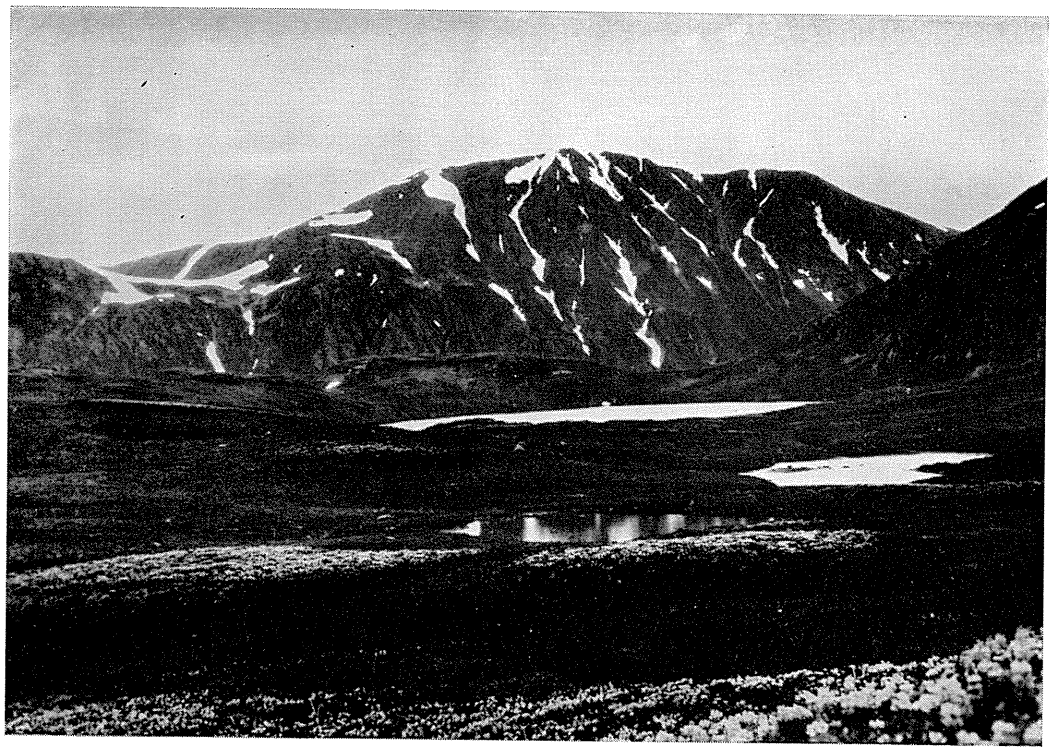
b. Heath, Isl. Amchitka, Aleutian Islands



a

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a. *Pinus pumila* thicket, Mts. Daisetsu, Prov. Ishikari, Central Hokkaido

b. *Pinus pumila* thicket in the low land, Murakamiwan, Isl. Paramushir, N. Kuriles

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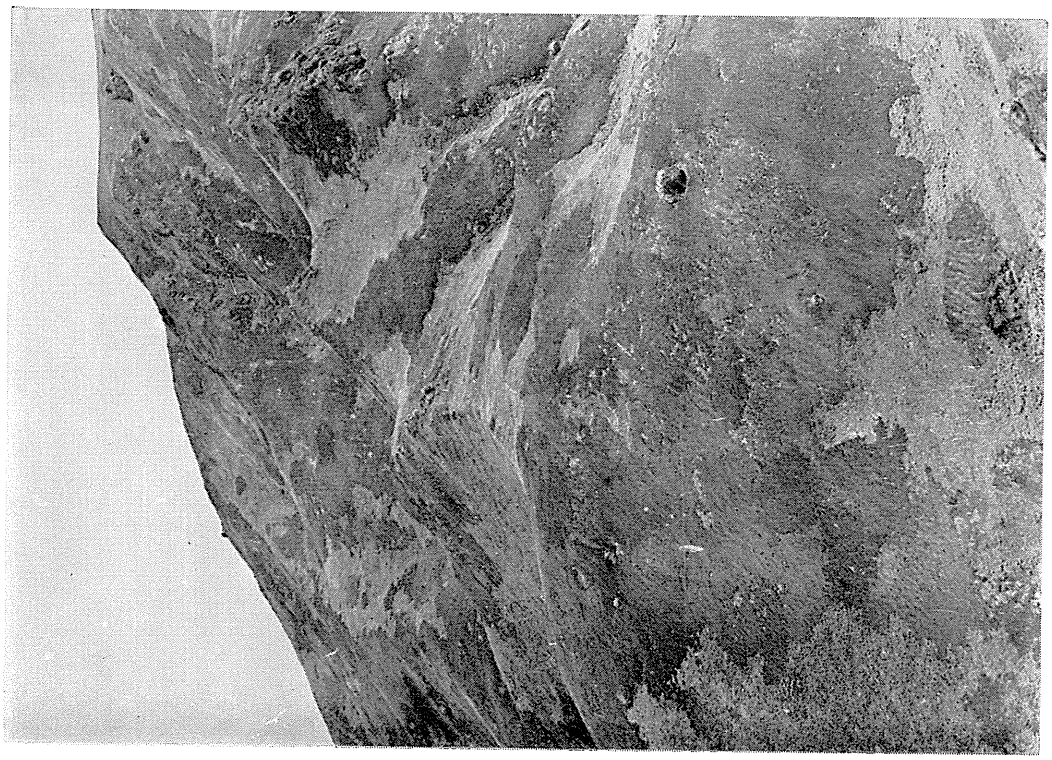
a. *Pinus pumila*, Mt. Rishiri, Prov. Kitami, N. Hokkaido

b. Pure thicket of *Sabina Sargeniii*, Osaki, Isl. Shikotan, S. Kuriles



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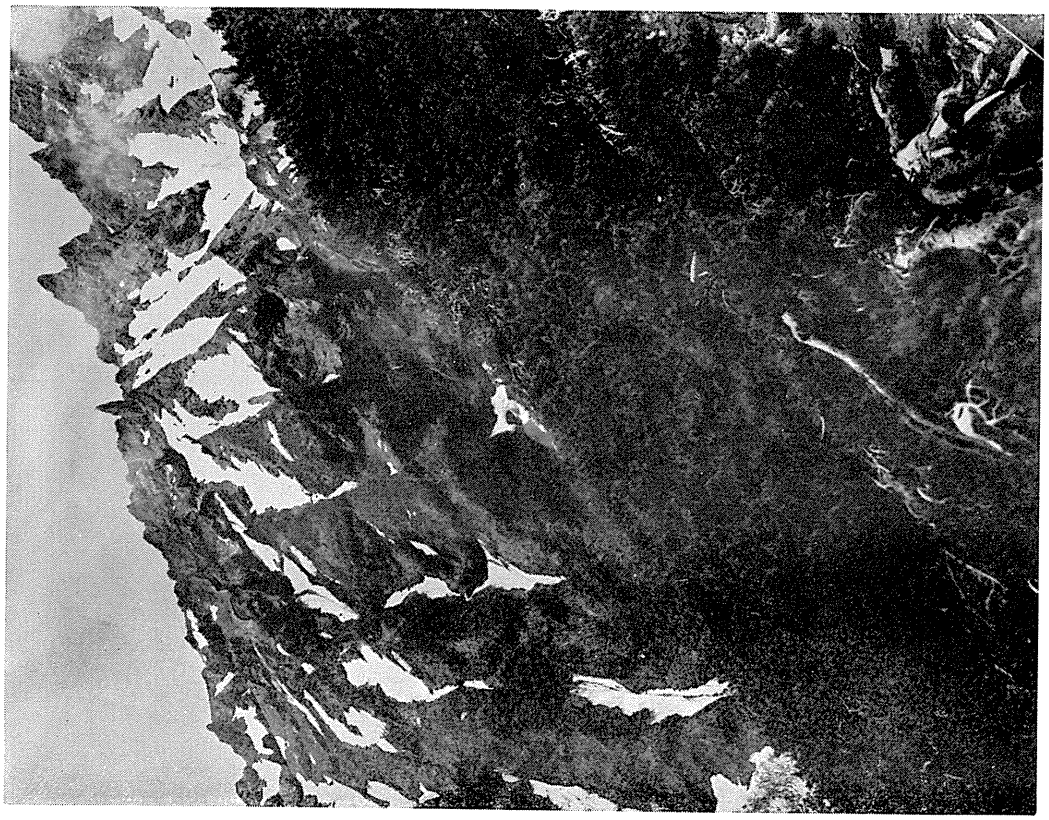


a

a. The upper limit of the thicket of *Alnus Maximowiczii*, Mt. Alaid, N. Kuriles

b. The pure thicket of *Alnus Maximowiczii*, Mt. Matua, Central Kuriles

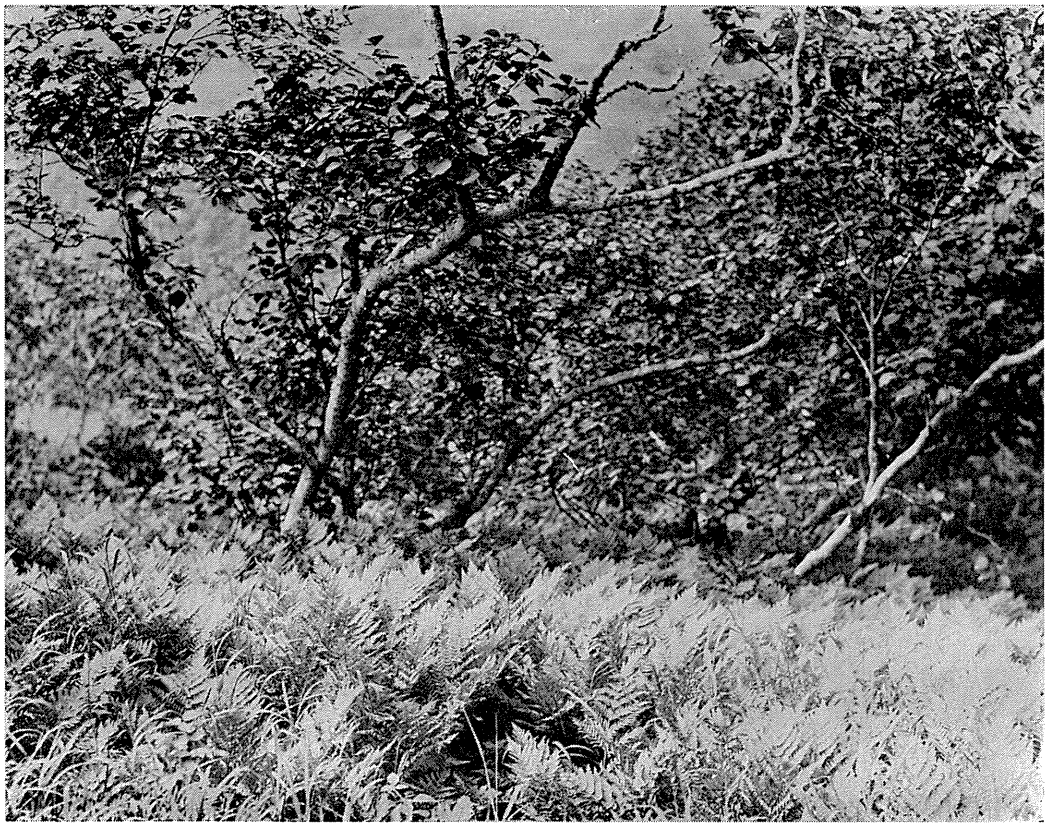
a

b

a. *Alnus Maximowiczii* forest along the gully, Mt. Rishiri, Prov. Kitami, N. Hokkaido

b. *Alnus Maximowiczii-Dyropteris austriaca* sociation, Isl. Shikotan, S. Kuriles

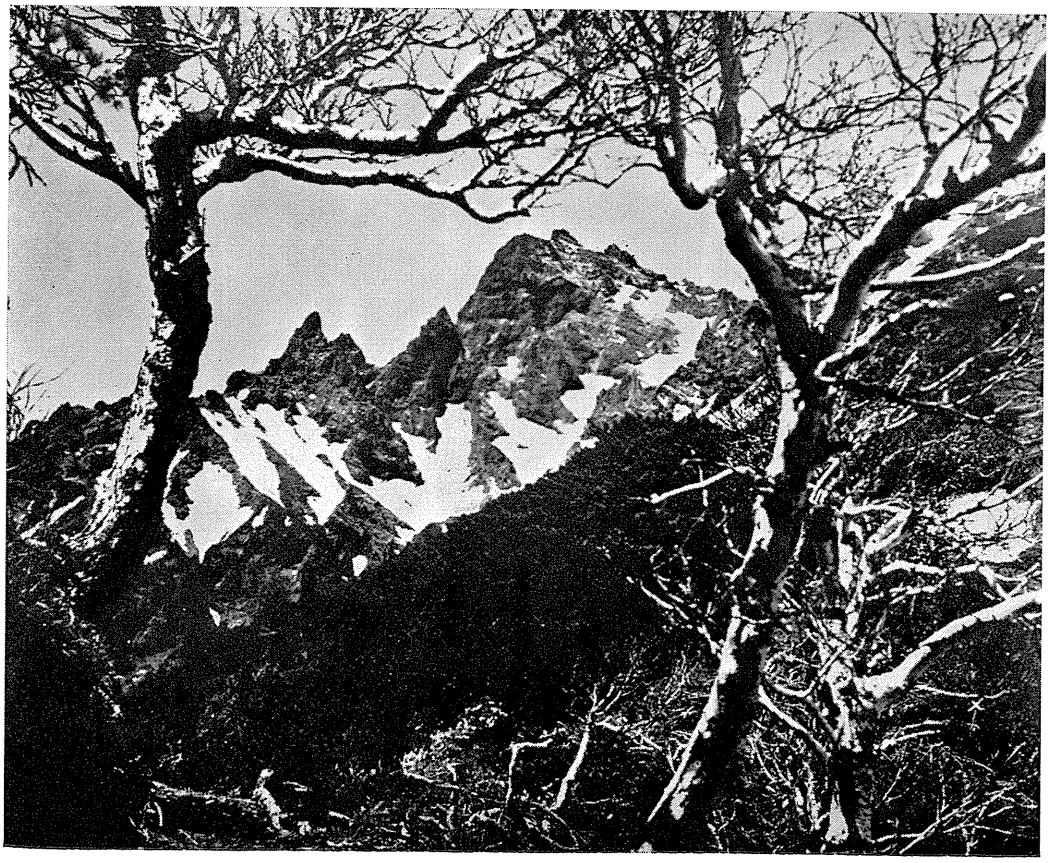
a



b

a. *Betula Ermani* forest, Mt. Rishiri, Prov. Kitami, N. Hokkaido

b. *Betula Ermani* forest near Mt. Esaomantottabetsu, Hidaka Range, Prov. Tokachi, E. Hokkaido



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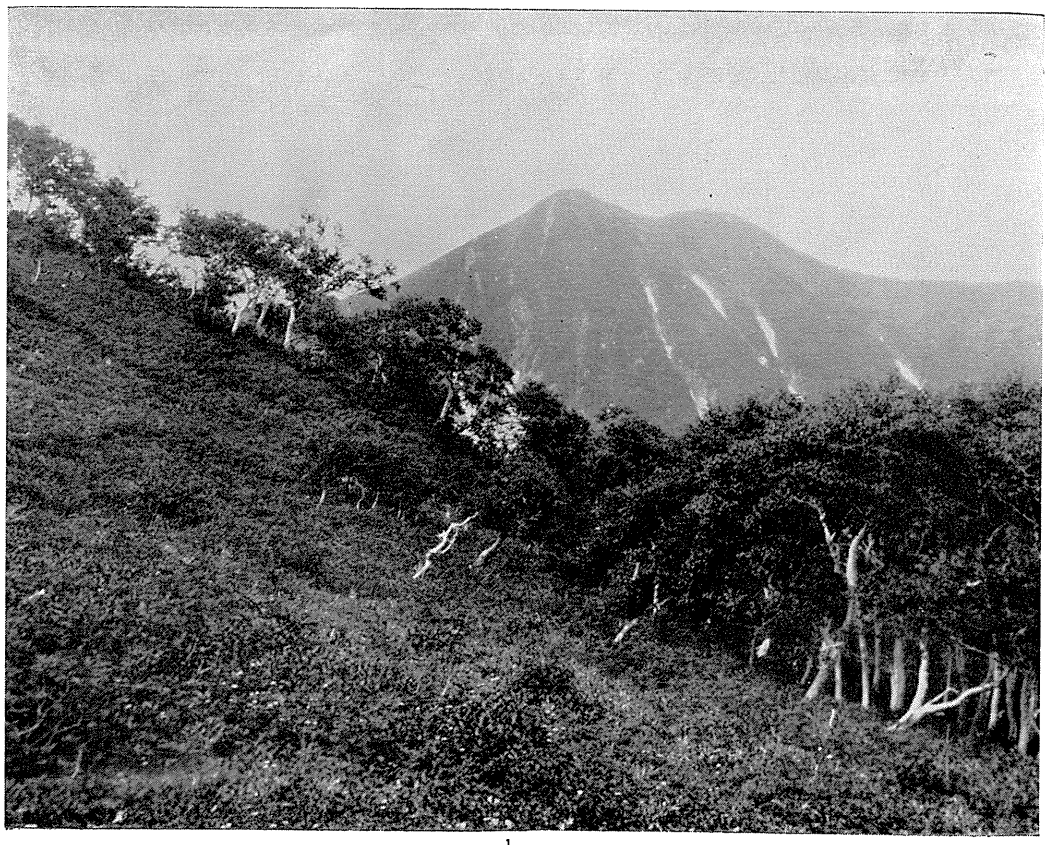

b

a. Needle-leaved forest, the Upper Ishikari, Prov. Ishikari, Central Hokkaido

b. Fallen trunks after the terrible typhoon in Sept. 1954, the Upper Ishikari, Prov. Ishikari, Central Hokkaido

a

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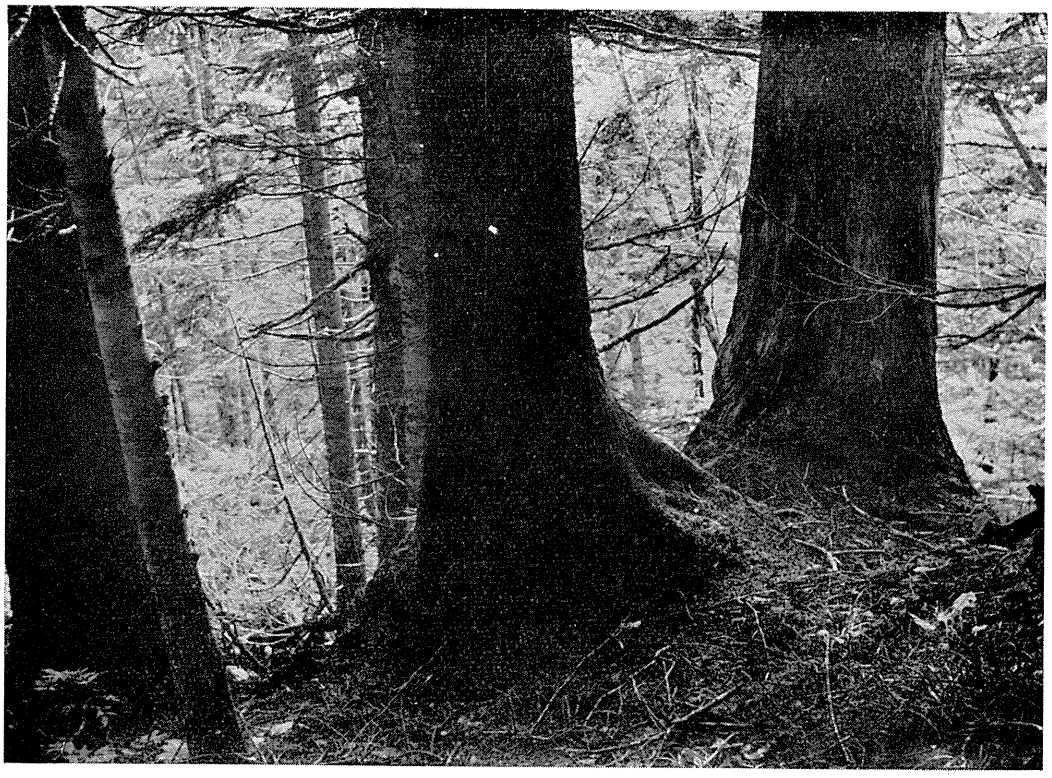
a. *Picea jezoensis-Abies sachalinensis-Sasa paniculata* sociation, the Upper Ishikari, Prov. Ishikari, Central Hokkaido

b. *Picea jezoensis-Abies sachalinensis*-non plant cover sociation, the Upper Ishikari, Prov. Ishikari, Central Hokkaido

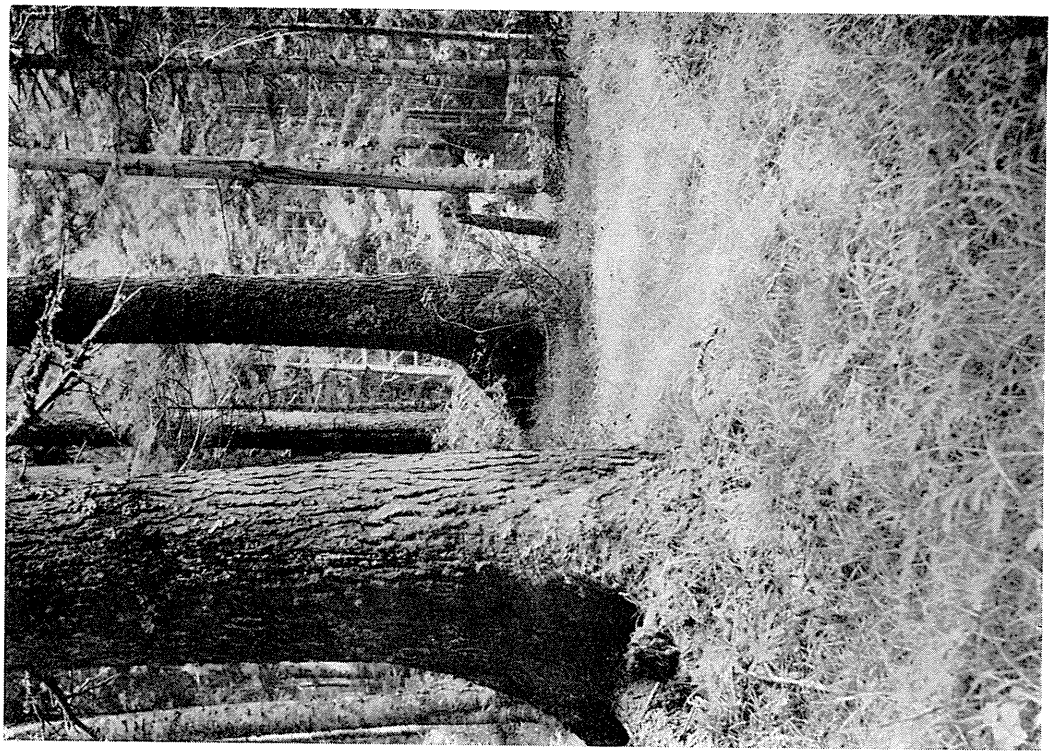
a



b

a. *Picea jezoensis-Abies sachalinensis-Dryopteris amurensis* sociation, Horo, SE. Sakhalin.

b. *Picea jezoensis-Abies sachalinensis-Carex sachalinensis* sociation, the Upper Ishikari, Prov. Ishikari, Central Hokkaido



b

a

a. *Abies sachalinensis-Sasa paniculata* sociation, Notoro near Abashiri, Prov. Kitami, E. Hokkaido

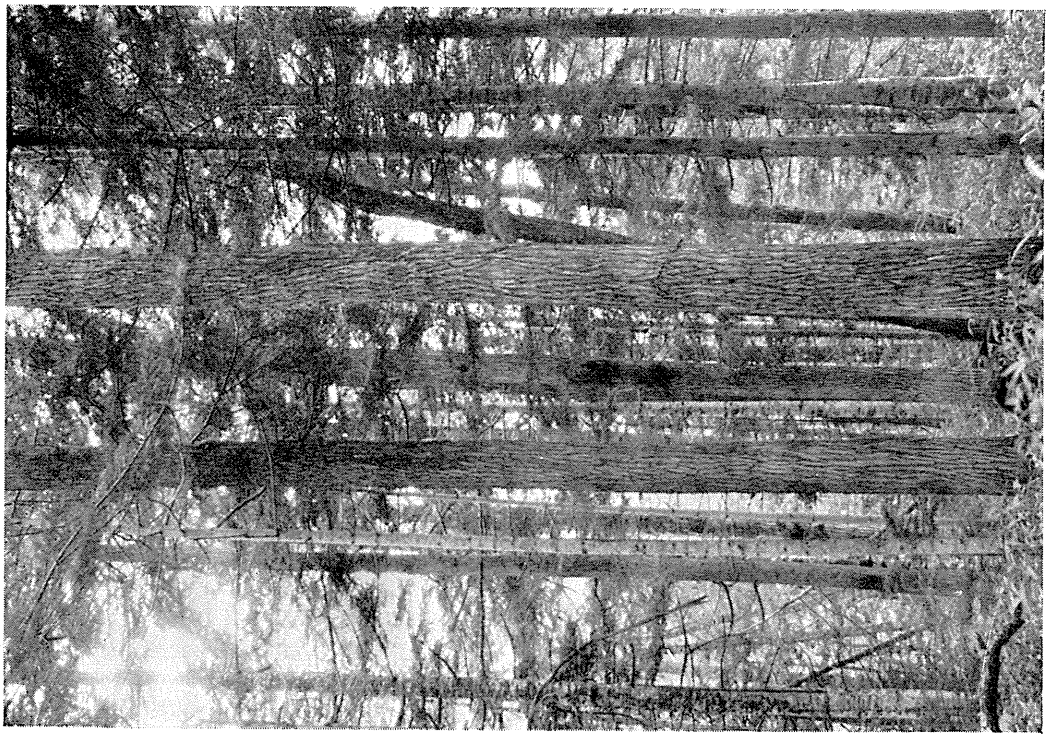
b. *Abies sachalinensis-Dryopteris crassirhizoma* sociation, Chimikeppu, Prov. Kitami, E. Hokkaido

a

b

a. *Picea jezoensis*, the Upper Ishikari, Prov. Ishikari, Central Hokkaido

b. *Picea jezoensis-Sasa paniculata* sociation, the Upper Ishikari, Prov. Ishikari, Central Hokkaido



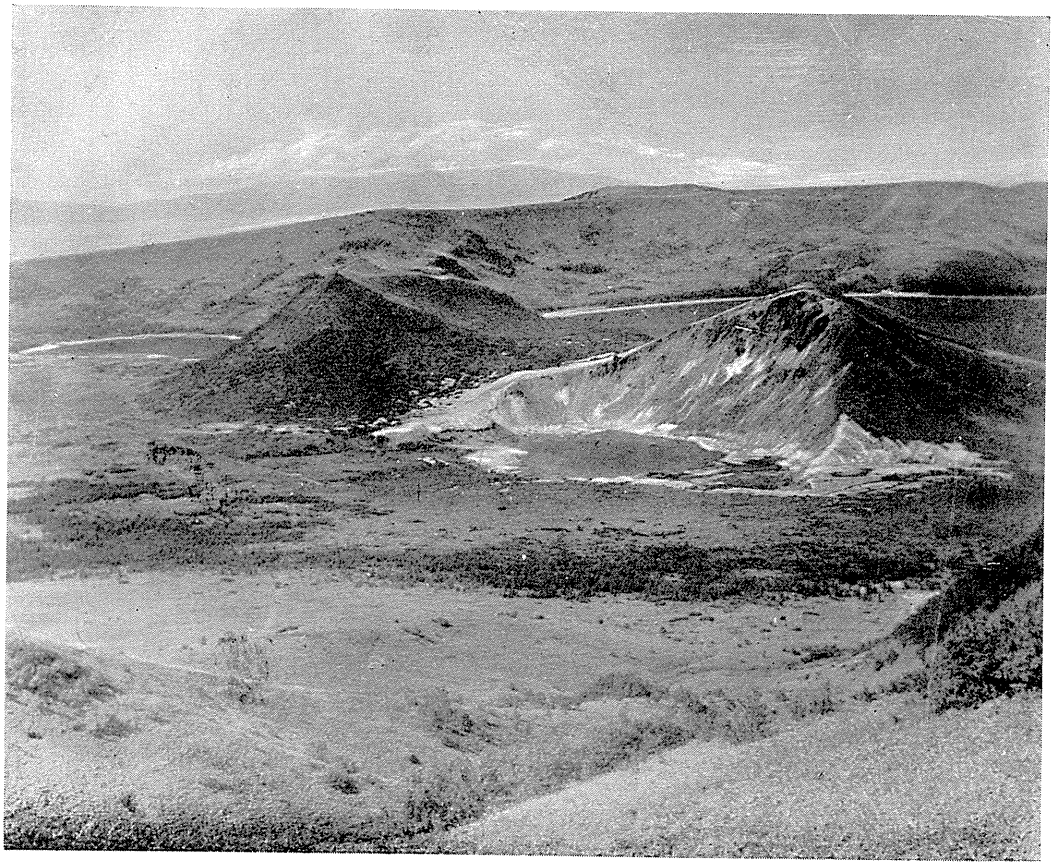
b

a

a. *Picea Glehni* forest along the Aniwa Bay, Enbuchi, S. Sakhalin

b. *Picea Glehni* forest in the atrio near Ponto, Isl. Kunashiri, S. Kuriles

a



b

a. *Picea Glehni-Carex Middendorffii* sociation, Teshio Experiment Forest (Hokkaido University), Prov. Teshio, N. Hokkaido

b. *Picea Glehni-Carex caespitosa* sociation, Kamioboro, Prov. Kushiro, E. Hokkaido

a

b

a. *Picea Glehni-Phragmites communis* sociation, Nonaka, Prov. Kushiro, E. Hokkaido

b. *Picea Glehni-Equisetum palustre* sociation, Nonaka, Prov. Kushiro, E. Hokkaido

a

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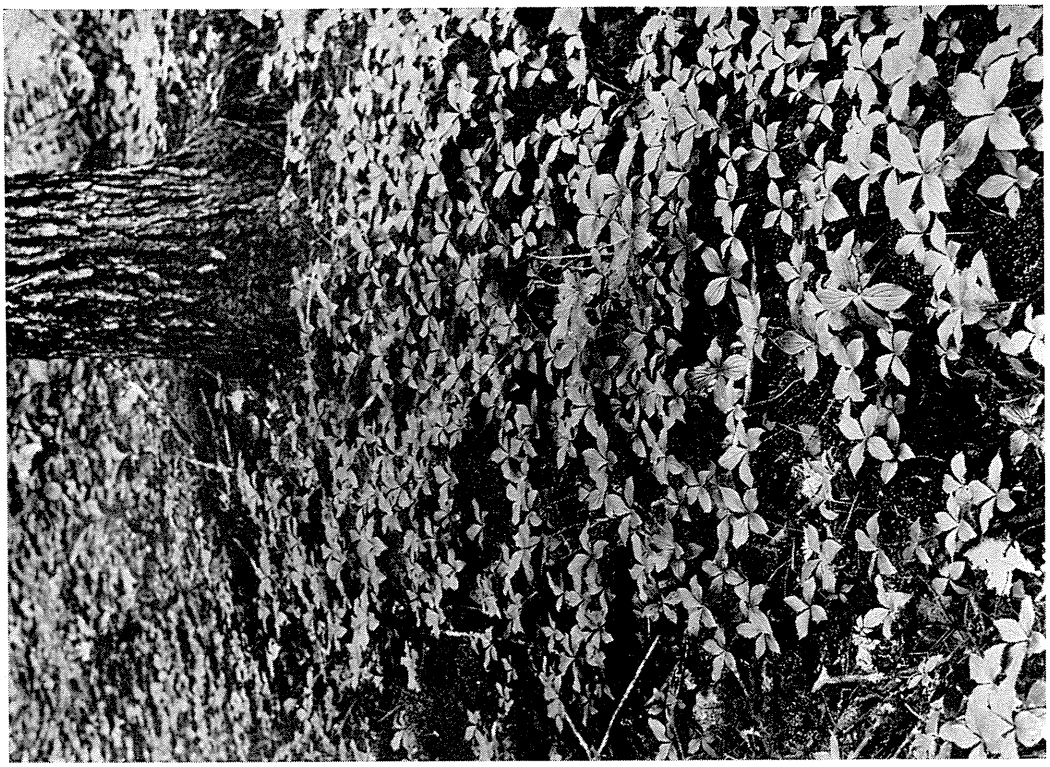
a. *Picea Glehni-Osmunda cinnamomea* sociation, Kawayu, Prov. Kushiro, E. Hokkaido

b. *Picea Glehni-Cornus canadensis* sociation, Nonaka, Prov. Kushiro, E. Hokkaido



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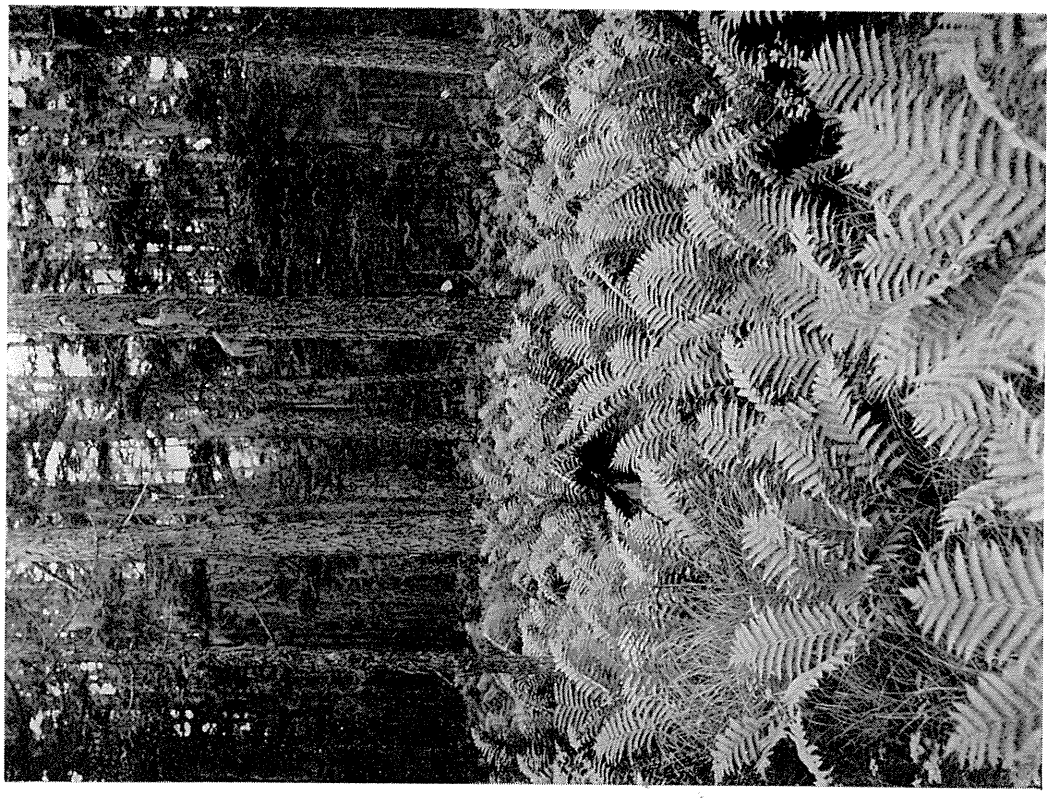

a

a. Young *Picea Glehni* forest after the forest-fire, Okedo, Prov. Kitami, E. Hokkaido

b. *Picea Glehni*-moss sociation near Nonaka Prov. Kushiro, E. Hokkaido

a

b

a. *Picea Glehni* forest. Serpentine district, Teshio Experiment Forest (Hokkaido University), Prov. Teshio, N. Hokkaido

b. *Picea Glehni* forest, Kawayu Spa, Prov. Kushiro, Hokkaido

a

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a. *Picea Glehi-Rhododendron Fauriae* sociation, Nonaka, Prov. Kushiro, E. Hokkaido

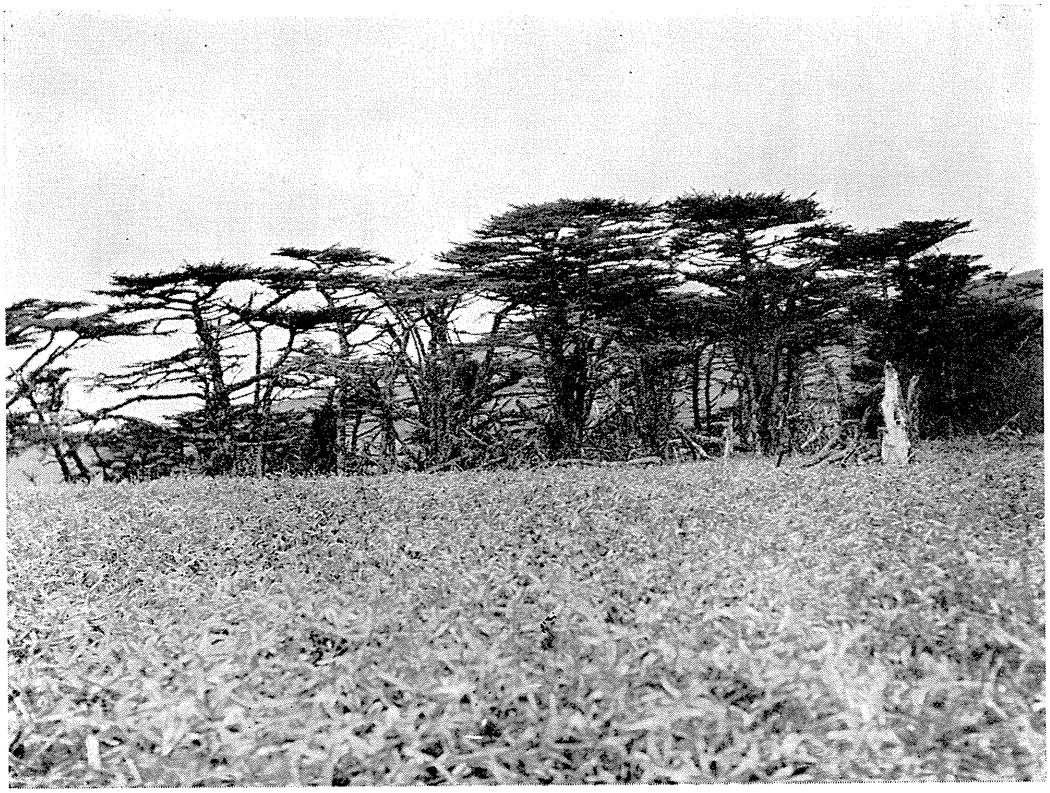
b. *Picea Glehni-Rhododendron dauricum* sociation, Okedo, Prov. Kitami, E. Hokkaido

a

b

a. *Larix kamtschatica* forest, Isl. Shikotan, S. Kuriles

b. *Larix kamtschatica* on windy slope, Isl. Shikotan, S. Kuriles



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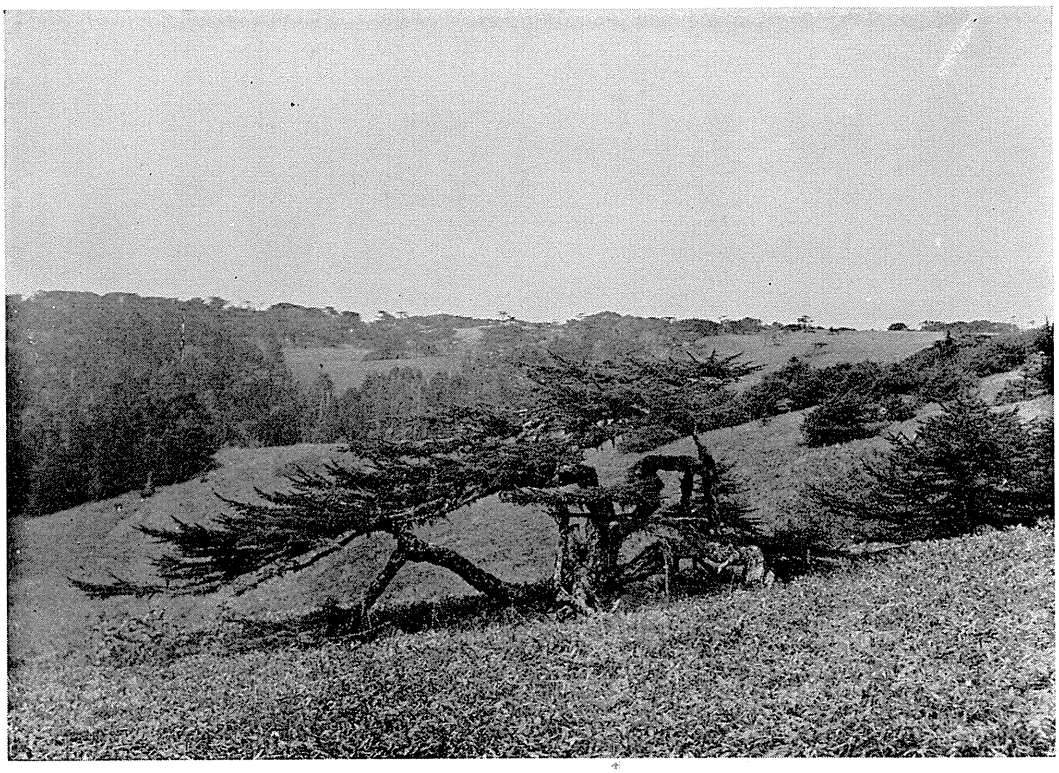
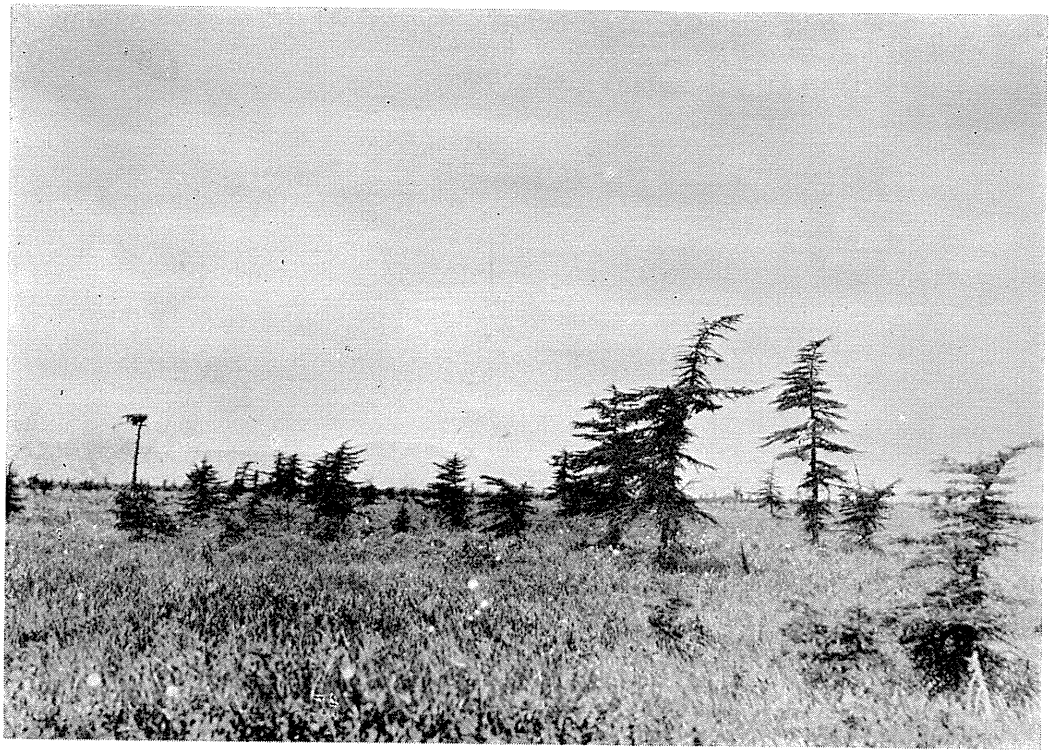


b

a. *Larix kamtschatica-Carex Middendorffii* sociation, Kurokawa, S. Sakhalin

b. *Larix kamtschatica-Ledum palustre* sociation, (*Pinus pumila* on the margin), Asase (near 50°N. L.), E. Sakhalin



a

b

a. *Taxus cuspidata* grove, Chanai, Prov. Kushiro, E. Hokkaido

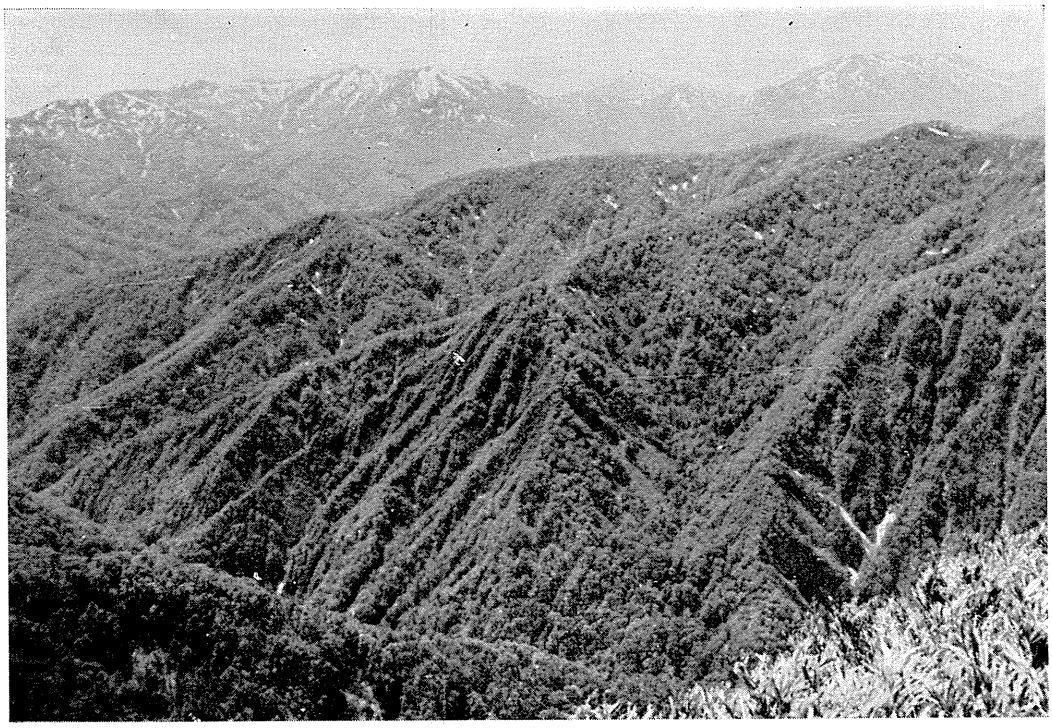
b. *Taxus cuspidata* grove, Kamioboro, Prov. Kushiro, E. Hokkaido

a

b

a. *Fagus crenata* forest along the R. Tomari, Nishishimamaki, Prov. Shiribeshi, SW. Hokkaido

b. *Fagus crenata-Sasa cernua* sociation, Utasai, Kuromatsunai, Prov. Shiribeshi, SW. Hokkaido



a

b

a. *Pterocarya rhoifolia*-fern sociation, Moheji, Prov. Oshima, SW. Hokkaido

b. *Aesculus turbinata*, Nanae, Prov. Oshima, SW. Hokkaido

b

a

a. *Quercus dentata* forest, Cape Erimo, Prov. Hidaka, S. Hokkaido

b. *Quercus dentata* forest, Obihiro, Prov. Tokachi, E. Hokkaido

a

b

a. *Acer Mono* forest, Isl. Kojima, Prov. Oshima, SW. Hokkaido

b. *Acer Mono* forest, Esashi, Prov. Oshima, SW. Hokkaido

a

b

a. *Alnus japonica-Lysichiton camtschatcense*, Lake Abashiri, Prov. Kitami, E. Hokkaido

b. *Fraxinus mandshuria-Urtica platyphylla* sociation, Chimikeppu, Prov. Kitami, E. Hokkaido

a

b

a. *Pinus parviflora* var. *pentaphylla* and *Betula Ermani*, Mt. Apoi, Prov. Hidaka, Hokkaido

b. *Cercidiphyllum japonicum*, Maruyama, Sapporo, Hokkaido

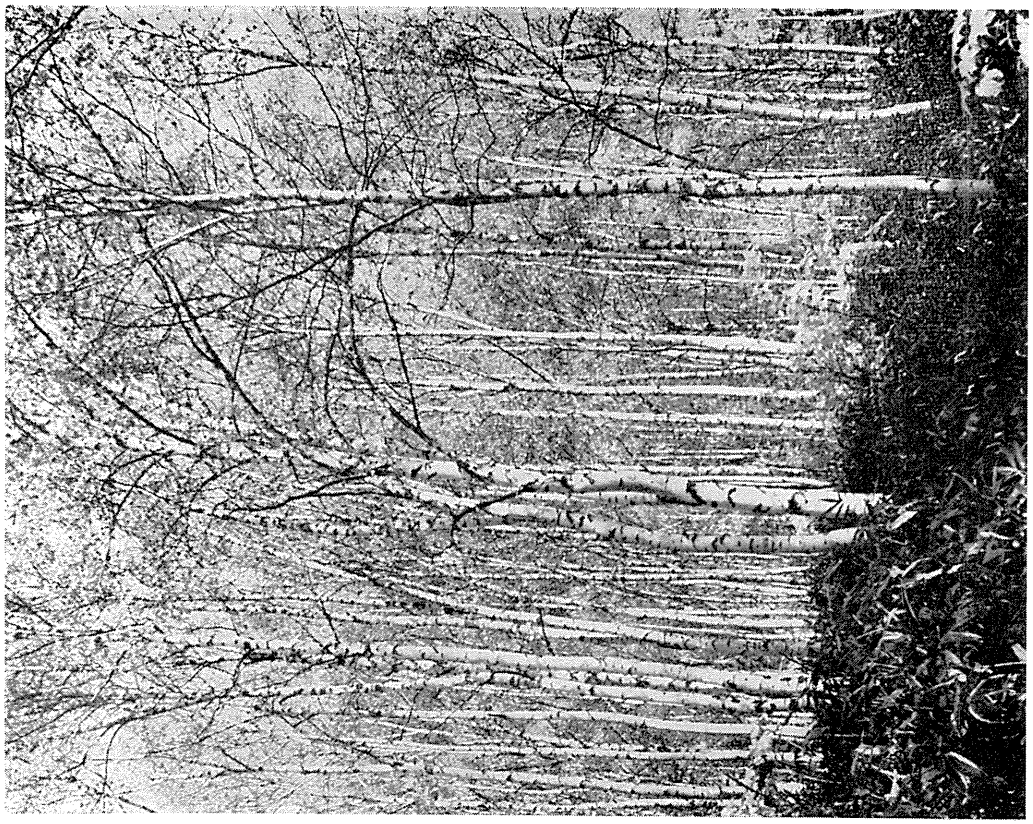
b

a

a. *Betula platyphylla-Sasa paniculata* sociation near Zenibako, Prov. Ishikari, W. Hokkaido

b. *Betula davurica*, Kamibihoro, Prov. Kitami, E. Hokkaido

b



a

a. *Tilia japonica*, Teshio Experiment Forest (Hokkaido University), Prov. Teshio, N. Hokkaido

b. *Populus Maximowiczii* along the Upper Ishikari, Prov. Ishikari, Central Hokkaido

a

b

a. *Toisusu Urbaniana-Urtica platyphylla* sociation, Okedo, Prov. Kitami, E. Hokkaido

b. *Chosenia bracteosa*, Asase (near 50°N. L.), E. Sakhalin

b

a