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THE GEOBOTANICAL RELATIONSHIP
BETWEEN BERINGIA AND NORTHERN JAPAN, WITH
SPECIAL REFERENCE TO THE ARCTIC-ALPINE
FLORA OF THE LATTER

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Preface

It is very unfortunate that there is very difficult problem in treating the plant distribution of the Bering Land Bridge, for we have very little data from around the Bering Strait. The area of the present study includes the Commander Islands, Karaginskii Island and the most north-easterly part of Asia in the west, the Aleutian Islands in the south, and the most north-easterly part of Alaska including the U. S. islands of the Bering Sea in the east.

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I. Oecological Distribution of the Common Plants

Under the ecological consideration, the important species except the arctic-alpine elements belong to the main groups such as weeds, sea-shore plants, the aquatic plants, swamp and bog plants. The important plants are enumerated below.

1. Weeds:

* widely distributed

Agropyron repens, *Agrostis stolonifera*, *Beckmannia erucaeformis*, *Bromus inermis*, *Lolium temulentum*, *Phleum pratense*, **Poa annua*, *Poa trivialis*, *Polygonum arviculare*, *Polygonum convolvulus*, *Rumex acetosa*, **Rumex acetosella*, *Cerastium fontanum*, **Stellaria media*, **Ranunculus repens*, **Capsella bursa-pastoris*, *Thraspi arvense*, *Nasturtium palustris*, *Trifolium hybridum*, *Trifolium pratense*, **Trifolium repens*, **Plantago*

major, **Matricaria matricarioides*, *Senecio vulgaris*.

2. Seashore plants :

The main vegetation of the seashore is generally divided into salt-marsh plants and sandy beach plants. The common plants growing in these communities are the widely distributed species.

i. Salt-marsh plants :

Stellaria humifusa, *Potentilla egardii*, *Triglochin maritimum*, *Triglochin palustre*, *Carex ramenskii*, *Carex subspathacea*, *Juncus balticus*.

ii. Sandy shore plants :

Chenopodium glaucum, *Atriplex gmelinii*, *Mertensia maritima*, *Senecio pseudo-arnica*, *Artemisia stelleriana*, *Elymus mollis*, *Poa eminens*.

3. Aquatic plants :

* not so widely distributed

**Polygonum amphibium*, **Nymphaea tetragona*, *Ranunculus trichophyllus*, *Myriophyllum spicatum*, *Hippuris vulgaris*, *Utricularia intermedia*, *Utricularia vulgaris*, *Sparganium angustifolium*, *Potamogeton gramineus*, *Potamogeton alpinus*, *Potamogeton filiformis*, *Potamogeton praelongus*, *Potamogeton perfoliatus*, *Potamogeton vaginatus*, **Ruppia spiralis*, *Zanichellia palustris*.

4. Swamp and Bog plants :

i. Swamp :

Equisetum fluviatile, *Myrica gale*, *Caltha palustris*, *Potentilla palustris*, *Callitriche verna*, *Epilobium palustre*, *Hippuris vulgaris*, *Angelica genuflexa*, *Lythimackia thirsiflora*, *Menianthes trifoliata*, *Limosella aquatica*, *Veronica americana*, *Carex augustinowiczii*, *Carex limosa*, *Carex lyngbyei*, *Calamagrostis langsdorfii*, *Calla palustris*.

ii. Bog :

In Hokkaido after 1945, bogs and swamps have been reduced in area through to the sudden development of agriculture. The important plants of swamps and bogs common to Beringia and Northern Japan are as follows : —

Selaginella sellaginoides, *Drosera anglica*, *Drosera rotundifolia*, *Rubus chamaemorus*, *Andromeda polifolia*, *Chamaedaphne calyculata*, *Ledum palustre*, *Oxycoccus microcarpus*, *Oxycoccus palustris*, *Vaccinium uliginosum*, *Carex canescens*, *Carex eleusinoides*, *Carex middendorffii*, *Eriophorum vaginatum*, *Eriophorum angustifolium*, *Eriophorum scheuchzerii*, *Scirpus caespitosus*.

II. The Geobotanical relationship of arctic-alpine plants between Beringia and Northern Japan

At present, there are important three problems concerning the plant distribution of the so-called alpine zone in Northern Japan: —

1) *Pinus pumila* zone; 2) Distributional analysis of the arctic-alpine plants common to Northern Japan and Beringia Region; 3) Disjunctive distribution of alpine plants.

1. The So-called Alpine Zone in Japan

Concerning the zones of the vertical plant distribution pose a serious problem, especially concerning the alpine zone in Japan. Even at the present, Japanese ecologists in general recognize the alpine zone as represented by the community of *Pinus pumila* on the highest part of the mountains in Japan. It is often developed forming a pure community in a very large area. A typical community is *Pinus pumila* alone, and having often no undergrowth. This peculiar composition was mentioned by Prof. Dr. KUDO in 1922, and also by TATEWAKI with particular reference to the Daisetsu Mountains.

The *Pinus pumila* community is often accompanied by fine meadows and heath land composed of the arctic-alpine plants in the higher parts, while in the lower parts it is associated with plants of the needle forest zone.

Homologous physiognomies were observed in the northern United States, and also in central and northern Europe. In some reports the same physiognomies of the vegetation were shown in the mountains of Eastern Siberia and also the Northern Great Hingang in China.

So the *Pinus pumila* zone in Japan is considered to be in the subarctic zone from the viewpoint of the vertical plant-distribution. In 1971, Dr. K. KOBAYASHI published "Phytosociological Studies on the scrub of Dwarf Pine (*Pinus pumila*) in Japan", in which he accepted the opinion of botanists in USSR that the Dwarf Pine belonged to the subalpinezone.

2. Analysis of the Distribution-type

It is very convenient to get the general idea of the phytogeographical composition of the distribution type by Prof. E. HULTEN. According to his system, the main species around Beringia are shown here.

i. Cosmopolite

Botrychium lunaria, *Lycopodium selago*, *Deschampsia flexuosa*, *Trisetum spicatum*, *Carex pyrenaica*.

These are widely distributed in the Bering Sea Region except for *Deschampsia flexuosa*. It is common in the volcanic mountains in Northern Japan, but not so common in the boreal needle forest of Northern Europe. On the other hand *Trisetum spicatum* occurs in the older volcanoes.

ii. Circumpolar Elements

Lycopodium alpinum, *Lycopodium sabinaefolium*, *Selaginella selaginoides*, *Botrychium lanceolatum*, *Juniperus communis*, *Oxyria digyna*, *Polygonum bistorta*, *Polygonum viviparum*, *Ranunculus acris*, *Dryas octopetala*, *Potentilla fruticosa*, *Potentilla nivea*, *Sibbaldia procumbens*, *Oxytropis campestris*, *Diapensia lapponica*, *Arctous alpina*, *Loiseleuria procumbens*, *Phyllodoce caerulea*, *Vaccinium uliginosum*, *Vaccinium vitis-idea*, *Empetrum nigrum*, *Androsace lehmanniana*, *Pinguicula vulgaris*, *Linnaea borealis*, *Sparganium angustifolium*, *Sparganium hyperborea*, *Agrostis borealis*, *Deschampsia caespitosa*, *Hierochloe alpina*, *Phleum, alpinum*, *Carex cappularis*, *Carex vaginata*, *Eriophorum scheuchzeri*, *Kobresia bellardii*, *Scirpus caespitosus*, *Juncus filiformis*, *Juncus triglumis*, *Luzula parviflora*.

iii. Northern Pacific Elements

Stellaria ruscifolia, *Geum calthifolia*, *Geum pentapetalum*, *Sanguisorba stipulata*, *Cassiope lycopodioides*, *Harrimanella stelleriana*, *Phyllodoce aleutica*, *Primula cuneifolia*, *Fauria crista-galli*, *Lagotis glauca*, *Pedicularis chamissonis*, *Veronica stelleri*, *Campanula chamissonis*, *Campanula lasiocarpa*, *Arnica unalascensis*, *Taraxacum trigonolobum*, *Juncus beringensis*, *Juncus mertensianus*.

iv. Eastern Asiatic—Western North American Elements

Saxifraga cherlerioides, *Spiraea betulifolia*, *Geranium erianthum*, *Rhododendron kamtschaticum*, *Gentiana glauca*, *Boschniakia rossica*, *Artemisia arctica*, *Artemisia trifurcata*, *Toffieldia coccinea*.

v. North American—Eastern Asiatic

Lycopodium sitchense, *Arabis lyrata*, *Vaccinium ovarifolium*, *Calamagrostis purpurascens*.

vi. Western European—North American—Eastern Asiatic Elements

Stellaria calycantha, *Vahlodea atropurpurea*, *Carex livida*.

vii. Eurasiatic—Western North American Elements

Cryptogramma crispa, *Anemone narcissiflora*, *Hedysarum hedysaroides*, *Viola repens*, *Pedicularis oederi*, *Pedicularis verticillata*, *Luzula wahlenbergii*, *Lloydia serotina*.

viii. Asiatic Elements

Pinus pumila, *Alnus fruticosa*, *Trollius riederianus*, *Rhododendron aureum*, *Carex melanocarpa*.

3. Disjunctive Distribution

Concerning the distribution of alpine plants in Northern Japan, there are two very important mountain groups, namely Mts. Yûbari, an ultra-basic rock formation, and Mts. Daisetsu, a volcanic formation. The former has a phytogeographical relationship with Eurasia and the latter with Beringia. A note of explanation is necessary concerning the latter.

One migrational route runs from the northeast through the Kuril Islands and the other runs from the continent through Sakhalin. The following are examples of species found in the Kuril Islands but not in Sakhalin.

Minuartia macrocarpa, *Stellaria calycantha*, *Sibbaldia procumbens*, *Gentiana algida*, *Gentiana glauca*, *Pedicularis oederi*, *Pedicularis verticillata*, *Artemisia trifurcata*, *Taraxacum trigonolobum*, *Luzula parviflora*, *Deschampsia atropurpurea*, *Phleum alpinum*, *Carex livida*, *Kobresia bellardii* and *Juncus triceps*.

The following tables show disjunctive distribution from the viewpoint of special distribution.

i. Circumpolar

Be. Bering; As. Asia; Am. America; Aleut. Aleutian Islands; W. West; M. Middle; E. East; Kam. Kamtschatka; C. Commander; K. Karaginskii

Species	Mountains	Be.		Aleut.			Kam.	
		As.	Am.	W.	M.	E.	C.	K.
<i>Botrychium lanceolatum</i>	Mt. Rishiri	+	+	+	•	+	•	•
<i>Sibbaldia procumbens</i>	Daisetsu Mts.	+	+	+	+	+	+	•
<i>Androsace lehmaniana</i>	Mt. Horonupuri	+	+	+	+	•	+	•
<i>Phlem alpinum</i>	Daisetsu Mts	•	+	+	+	+	+	•
<i>Carex capillaris</i>	Mt. Yûbari	+	+	+	•	•	•	•
<i>Carex vaginata</i>	Daisetsu Mts.	•	+	•	•	•	•	+
<i>Eriophorum scheuchzeri</i>	Daisetsu Mts.	+	+	•	•	+	•	•
<i>Kobresia bellardii</i>	Daisetsu Mts.	+	+	•	•	•	•	•
<i>Juncus triglumis</i>	Daisetsu Mts.	+	+	•	+	+	?	•
<i>Luzula parviflora</i>	Daisetsu Mts.	+	+	+	+	+	+	•

Of the circumpolar species, the most important are found in Daisetsu Mountains, attaining 7 species in number. Most of them are widely

distributed in Beringia. *Carex capillaris* occurs on Mt. Yûbari, belonging to ultra basic rock, and *Androsace lehmanniana* on Mt. Horonupuri, a paleozoic formation. *Botrychium lanceolatum* is a very rare plant. Up to the present, it has been found only once on Mt. Rishiri, which volcanic mountain situated in the most northwesterly part of Hokkaido.

ii. Northern Pacific

Species	Mountains	Be.		Aleut.			Kam.	
		As.	Am.	W.	M.	E.	C.	K.
<i>Lagotis glauca</i>	Mt. Futanami	+	+	+	•	+	+	+
<i>Taraxacum trigonolobum</i>	Daisetsu Mts.	•	•	+	+	+	+	•
<i>Juncus mertensianus</i>	Daisetsu Mts.	•	•	+	+	+	•	•

The distribution of Genus *Lagotis* in Hokkaido is very interesting. There are three species—*L. takedae*, *L. jezoensis* and *L. glauca*. The former two are endemic species, scattered in small localities of the namely Mt. Yûbari and Mt. Daisetsu. *Lagotis glauca* is found only on the Rebun Island in the Hokkaido region, but is quite common in the Kurils.

iii. Eastern Asiatic

Species	Mountains	Be.		Aleut.			Kam.	
		As.	Am.	W.	M.	E.	C.	K.
<i>Carex melanocarpa</i>	Mt. Yûbari	+	•	•	•	•	•	•

iv. Northern Asiatic-Western North American

Species	Mountains	Be.		Aleut.)			Kam.	
		As.	Am.	W.	M.	E.	C.	K.
<i>Minuartia macrocarpa</i>	Daisetsu Mts.	+	+	•	•	•	+	•
<i>Gentiana algida</i>	Daisetsu Mts.	+	+	•	+	+	•	•
<i>Gentiana glauca</i>	Daisetsu Mts.	+	+	•	•	•	+	•

v. Northern Asiatic Pacific

Species	Mountains	Be.		Aleut.			Kam.	
		As.	Am.	W.	M.	E.	C.	K.
<i>Gentiana auriculata</i>	Mt. Ôhira	•	•	+	•	•	+	+

It is only found on Mt. Ôhira, the calcareous mountain in the main Island of Hokkaido, but it occurs in the Islands of Rishiri and Rebun.

vi. Western European—North American—Eastern Asiatic

Species	Mountains	Be.		Aleut.			Kam.	
		As.	Am.	W.	M.	E.	C.	K.
<i>Stellaria calycantha</i>	Daisetsu Mts.	+	+	+	+	+	+	•
<i>Vahlodea atropurpurea</i>	Daisetsu Mts.	•	•	+	+	+	+	•
<i>Carex livida</i>	Daisetsu Mts.	•	•	+	•	•	•	•

All these species are limited to the Daisetsu Mountains and are not found in Sakhalin. It is also to be noticed that the last two species are found in the southern part of Beringia.

vii. Eurasiatic—Western North American

Species	Mountains	Be.		Aleut.			Kam.	
		As.	Am.	W.	M.	E.	C.	K.
<i>Pedicularis oederi</i>	Daisetsu Mts.	+	+	•	•	•	•	+
<i>Pedicularis verticillata</i>	Daisetsu Mts.	+	+	+	•	+	•	•
<i>Artemisia furcata</i>	Daisetsu Mts.	+	+	•	•	•	•	+

The problem of the occurrence of the disjunctive distribution of the alpine plants under consideration on Daisetsu Mountains is a difficult one. According to geologists, Mt. Koidzumi is the oldest volcano among the north Daisetsu Group, belonging to the Pleistocene Period (Dilluvium). The most important place in the Daisetsu Mountain Group is between Mt. Koidzumi and Takanegahara, which includes alpine meadow land, gravel beds and bogs.

The most important problem for future research is to explain satisfactorily the disjunctive distribution of the above-mentioned alpine plants.

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