NOTES ON THE FLORISTIC PHYTOGEOGRAPHY OF THE ALPINE FLORA OF HOKKAIDÔ, JAPAN

By

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(With 1 Table and 3 Text-figures)

I. Introduction

Hokkaidô is the northernmost island of the Japanese Archipelago showing an outline of rhombic shape like a kind of ray (Fig. 1). It possesses an area of 78,517 square kilometres, and extends from 41°24' to 45°31' N. Lat. and from 139°45' to 145°49' E. Long. Hokkaidô (or in its olden name "Yezo") has long been recognised by phytotaxonomists and phytogeographers as comprising many interesting and novel alpine plants. Such botanical richness of the alpine flora is to be explained by the reasons mentioned below (TOYOKUNI 1969, 1979) : (1) latitudinally, Hokkaidô is located in such a high position that the *Pinus pumila* forests develop as low as about 1,000m above sea-level, (2) geologically, the island is so polymorphous that not a few novelties, endemics or palaeo-endemics are growing mixed together with common alpine plant species even which are more numerous than those of the alpine zone of Honshû, and (3) geographically, it is situated in the portion connecting Honshû with the Kurils or with Sakhalin, and it is only about 290km from the Maritime Province of Siberia. The alpine flora of Hokkaidô, therefore, is composed of elements that have been distributed either from the northern part of the continent of Asia through Sakhalin, from the Kamchatka Peninsula and Alaska through the Kurils or the Aleutians, or from Honshû.

The alpine flora of Hokkaidô as a whole was phytogeographically dealt at first with by Dr. Yûshun KUDÔ in 1925; he enumerated 109 species of alpine plants that were growing in Hokkaidô. A labourious series of papers on the alpine plants of Hokkaidô was published in three parts from 1934 to 1938 by Dr. Misao TATEWAKI. In his papers are enumerated 436 vascular plants from the alpine region of Hokkaidô. The publication of this work made it possible to work out a

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2) Dedicated to the late Prof. Dr. Misao TATEWAKI who made the foundation of the phytogeography of the alpine flora in Hokkaidô.

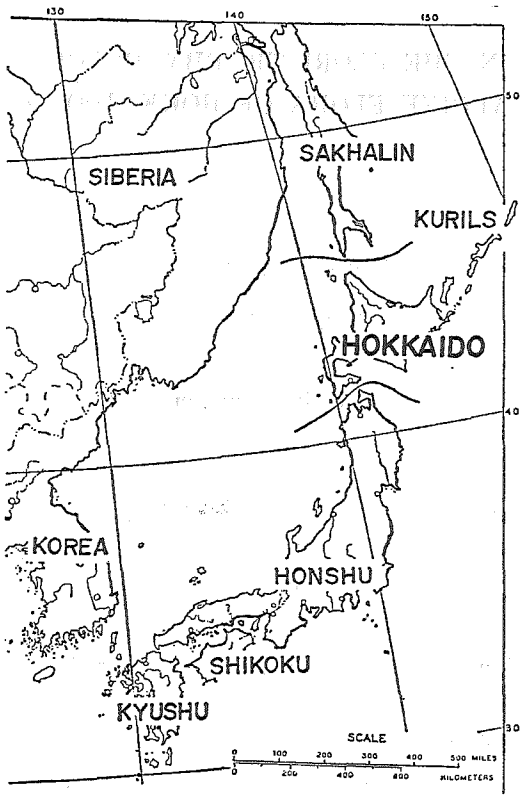

Fig. 1. A map showing the position of Hokkaidô in the Japanese Archipelago and neighbouring territories

number of statistical data concerning the plants growing in the alpine zone of Hokkaidô as a whole. He also published in 1963 a paper, describing a general feature of the alpine flora of Hokkaidô. In 1971, Dr. Shôichi KAWANO published a paper entitled "Studies on the alpine flora of Hokkaido, Japan, 1. Phytogeography" that was a part of his doctoral thesis submitted to the Université de Montréal in 1962, with later additions and corrections. In the paper he counted 416 species of vascular plants in the alpine zone of Hokkaidô, and analysed them phytogeographically. From 1974 to 1978, the present author, chiefly from the nomenclatural standpoint, indexed all the vascular plants recognised to be indigenous to the alpine zone of Hokkaidô, giving some new taxonomic positions to the taxa included in the index. The species number that he enumerated in that paper was 456. Dr. Shirô NOSAKA presented in 1979 a paper "The alpine plants of Hokkaidô", in which he counted 273 alpine vascular plants, analysing them phytogeographically into 5 elements from their distribution types.

The author has been interested in the alpine flora of Hokkaidô, and has published a few local alpine florulas since 1946, and as mentioned above, he

published an index of all the vascular plants indigenous to the alpine zone of that island in five parts from 1974 to 1978. This paper is based on the fundamental data of the above series of papers with a few nomenclatural corrections and additions which will be dealt with later.

II. Species Number of the Alpine Flora

The writer has enumerated 456 species, and their infraspecific taxa as native of the alpine zone of Hokkaidô (TOYOKUNI 1974–1978). However, so far as the recent knowledge and data either from specimens both dried and living or from the literature are concerned, the following changes became to be necessary.

(1) Species to be excluded:

Only one species, *Plantago major* LINNAEUS

The author enumerated this species as No. 280 in the part 4 of the index, and under this species made a new combination, *P. major* subsp. *togashii* (MIYABE et TATEWAKI) TOYOKUNI. Although this *Plantago* is to be found in the alpine zone of the Southern Kurils, the very plant in Hokkaidô is restricted to the littoral zone of the island of Okushiri. For such reason, the plant should be excluded from the *alpicolae* in Hokkaidô.

(2) Species to be added:

To the author's regret, the following two common alpine species have dropped from the index.

Rubus idaeus LINNAEUS

Therorhodion camtschaticum (PALLAS) SMALL

Both species are here and there met with in the alpine zone of Hokkaidô.

(3) Species of which nomenclatural change is necessary:

"*Isoëtes lacustris* LINNAEUS", No. 9 of the part 1 of the index must be called "*Isoëtes setacea* LAMARCK". When compiling "The Flora of Hokkaidô and Saghalien Vol. 1, Part 1", Dr. Kingo MIYABE and Dr. Yûshun KUDÔ sent an *Isoëtes* specimen from the Kuril islands to Dr. Karl Otto Robert Peter Paul GRAEBNER who was working in Berlin for identification, and he identified it to be the European species *Isoëtes lacustris* (MIYABE and KUDÔ 1930), and later Dr. TATEWAKI assumed the *Isoëtes* specimen from the high moors of the Taisetsu Mountains to be identical with the Kuril specimen that Dr. GRAEBNER identified as *I. lacustris*. However, current opinion revealed that the Kuril *Isoëtes* was not the true *I. lacustris*. Some authors regard the plant under discussion as *Isoëtes asiatica* (MAKINO) MAKINO, but the author, in adopting the view proposed by Dr. Eric HULTÉN in 1968, treats the plant here as *Isoëtes setacea* LAMARCK, because the classification of this group is very difficult, and the exact systematic position for the plant will

Fig. 2. Distribution of *Saxifraga yuparensis* NOSAKA

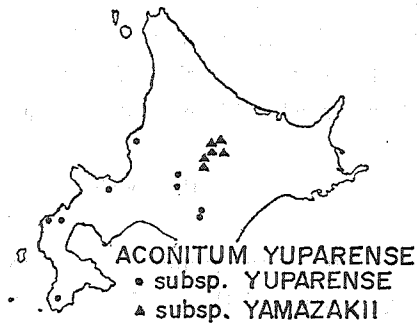

Fig. 3. Distribution of *Aconitum yuparense* TAKEDA

be determined after making further taxonomic revisions of the group.

After the above corrections and additions are made, the total number of species of vascular plants in the alpine zone of Hokkaidô is 457.

III. Floristic Composition of the Alpine Flora

For analysing all 457 species of vascular plants indigenous to the alpine zone of Hokkaidô from the phytogeographical viewpoint, they can be divided into five main elements by means of the distribution type: they are (1) Asian elements, (2) Asian–N. Pacific elements, (3) Asian–N. American elements, (4) Eurasiatic elements and (5) Circumpolar and Cosmopolite elements.

(1) Asian Elements

The species belonging to this category are further divided into three minor categories: (i) Japanese elements, which are subdivided into (i a) Endemic or Hokkaidô elements and (i b) Japan elements, (ii) Japanese–Sakhalin–Kurils elements, which are further subdivided into 6 – (ii a) Hokkaidô–Sakhalin elements, (ii b) Hokkaidô–Kurils elements, (ii c) Hokkaidô–Sakhalin–Kurils elements, (ii d) Japan–Sakhalin elements, (ii e) Japan–Kurils elements, and (ii f) Japan–Sakhalin–Kurils elements, and (iii) Asiatic elements.

(i a) Endemic or Hokkaidô elements

The plants that belong to this group are restricted to the island of Hokkaidô in their distribution areas: some species, e. g. *Saxifraga yuparensis* NOSAKA[3] has a quite limited distribution area on Mt. Yûpari, while *Aconitum yuparense* TAKEDA with its two subspecies, subsp. *yuparense* and subsp. *yamazakii* has rather wide areas as shown in Figs. 2 and 3. The following 44 species belong to this group:

3) In analysing the vascular plants of the alpine zone of Hokkaidô phytogeographically, each plant is considered only by the species level, in other words, the entire distribution area as the species is analysed according to the distribution type.

Salix hidaka-montana, *S. paludicola*, *S. pseudo-paludicola*, *S. yezoalpina*, *Betula apoiensis*, *Silene hidaka-alpina*, *Stellaria pterosperma*, *Aconitum apoiense*, *A. corymbiferum*, *A. yuparense*, *Callianthemum miyabeanum*, *Trollius pulcher*, *Corydalis curvicalcarata*, *Papaver fauriei*, *Draba igarashii*, *Thlaspi japonicum*, *Sedum cauticolum*, *Saxifraga nishidae*, *S. yuparensis*, *Astragalus yamamotoi*, *Oxytropis megalantha*, *Rhamnus ishidae*, *Hypericum samaniense*, *H. tatewakii*, *H. yamamotoi*, *H. yojiroanum*, *Viola alliariifolia*, *V. kitamiana*, *V. yubariana*, *Angelica stenoloba*, *Primula hidakana*, *P. sorachiana*, *P. takedana*, *P. yuparensis*, *Erigeron miyabeanus*, *Hypochaeris crepidioides*, *Saussurea chionophylla*, *S. yanagisawae*, *Scorzonera rebunensis*, *Taraxacum yuparense*, *Youngia gymnopus*, *Elymus yubaridakensis*, *Hierochloe pluriflora* and *Carex apoiensis*.

(i b) Japan elements

The plants of this group are distributed not only in Hokkaidô, but also in other parts of Japan. The following 56 species are Japan elements: *Athyrium melanolepis*, *Pleuropteropyrum nakaii*, *Arenaria katoana*, *Stellaria nipponica*, *Pulsatilla nipponica*, *Glaucidium palmatum*, *Cardamine nipponica*, *Draba japonica*, *D. kitadakensis*, *Rhodiola ishidae*, *Boykinia lycoctonifolia*, *Saxifraga japonica*, *Sorbus matsumurana*, *Alchemilla japonica*, *Rubus pseudo-japonicus*, *Oxytropis japonica*, *Geranium eriostemon*, *Ilex sugerokii*, *Hypericum erectum*, *Viola brevistipulata*, *Epilobium shiroumense*, *Angelica acutiloba*, *Bupleurum nipponicum*, *Coelopleurum multisectum*, *Peucedanum multivittatum*, *Tilingia holopetala*, *Pyrola alpina*, *Eubotryoides grayana*, *Gaultheria adenothrix*, *Phyllodoce nipponica*, *Tripetaleia bracteata*, *Schizocodon soldanelloides*, *Primula modesta*, *Gentiana nipponica*, *Gentianella yuparensis*, *Trigonotis guilielmi*, *Nepeta subsessilis*, *Pedicularis apodochila*, *Galium nakaii*, *Anaphalis alpicola*, *Leontopodium hayachinense*, *Sasa cernua*, *S. senanensis*, *Calamagrostis gigas*, *Poa hayachinensis*, *Carex doenitzii*, *C. podogyna*, *Rhynchospora fauriae*, *R. yasudana*, *Luzula rostrata*, *Tofieldia okuboi*, *Tricyrtis latifolia*, *Veratrum stamineum*, *Heloniopsis orientalis*, *Japonolirion osense* and *Pogonia minor*.

(ii a) Hokkaidô–Sakhalin elements

The plants belonging to this category are distributed in Hokkaidô and Sakhalin: they are *Aconitum sachalinense*, *Anemone yezoensis*, *Leontopodium discolor* and *Carex kabanovii*.

(ii b) Hokkaidô–Kurils elements

The plants of this group are distributed in Hokkaidô and the Kurils. They are *Salix hidewoi*, *Potentilla miyabei*, *Oxytropis retusa* and *Mertensia pterocarpa*.

(ii c) Hokkaidô–Sakhalin–Kurils elements

Saxifraga sachalinensis, *Cirsium pectinellum*, *Crepis hokkaidoensis*, *Senecio kawakamii* and *Platanthera metabifolia* belong to this category and are distributed in Hokkaidô, Sakhalin and the Kurils.

(ii d) Japan–Sakhalin elements

The distribution area of plants of this group is Japan and Sakhalin, and *Picea glehnii*, *Aconitum gigas*, *Diphylleia grayi*, *Macropodium pterospermum*, *Fragaria iinumae*, *Euonymus sachalinensis*, *Eritrichium nipponicum*, *Pedicularis yezoensis* and *Carex traiziscana* are included in this group.

(ii e) Japan–Kurils elements

Athyrium rupestre, *Salix reinii*, *Arenaria merckioides*, *Saxifraga fusca*, *Acer tschonoskii*, *Epilobium dielsii*, *E. fauriei*, *Conioselinum filicinum*, *Carex hakkodensis*, *C. jacens* and *C. omiana* are the plants of the Japan–Kurils elements which are encountered in Japan and the Kurils.

(ii f) Japan–Sakhalin–Kurils elements

Species that belong to this group are distributed in Japan, Sakhalin and the islands of Kurils: they are *Selaginella shakotanensis*, *Pleuropteropyrum weyrichii*, *Arabis serrata*, *Sorbus commixta*, *Prunus nipponica*, *Ilex rugosa*, *Hypericum yezoense*, *Menziesia pentandra*, *Vaccinium smallii*, *Veronica schmidtiana*, *Ligularia hodgsonii*, *Carex augustinowiczii*, *C. pseudo-loliacea*, *C. stenantha*, *Ephippianthus schmidtii* and *Platanthera ophrydioides*.

(iii) Asiatic elements

The plants of this group are the following 96 species: *Thelypteris quelpaertensis*, *Dryopteris amurensis*, *Pinus pumila*, *Juniperus chinensis*, *Betula ermanii*, *Pleuropteropyrum ajanense*, *Cerastium rubescens*, *Silene stenophylla*, *Stellaria fenzlii*, *S. ruscifolia*, *Anemone debilis*, *Aquilegia flabellata*, *Trautvetteria japonica*, *Trollius riederianus*, *Dicentra peregrina*, *Draba ussuriensis*, *Sedum pluricaule*, *Saxifraga fortunei*, *S. laciniata*, *S. merkii*, *Sorbus sambucifolia*, *Filipendula camtschatica*, *F. multijuga*, *Fragaria nipponica*, *Potentilla dickinsii*, *P. matsumurae*, *Sanguisorba tenuifolia*, *Astragalus membranaceus*, *Hedysarum vicioides*, *Oxytropis revoluta*, *Tithymalus sieboldianus*, *Acer ukurunduense*, *Hypericum kamtschaticum*, *Viola blandiformis*, *V. crassa*, *V. sacchalinensis*, *Bupleurum longeradiatum*, *Coelopleurum lucidum*, *Tilingia ajanensis*, *T. tachiroei*, *Monotropastrum globosum*, *Pyrola faurieana*, *Bryanthus gmelinii*, *Vaccinium hirtum*, *V. praestans*, *Frasera tetrapetala*, *Gentiana jamesii*, *G. triflora*, *Lagotis glauca*, *L. stelleri*, *Pedicularis resupinata*, *Lonicera chamissoi*, *Macrodiervilla middendorffiana*, *Patrinia sibirica*, *Adenophora pereskiaefolia*, *Erigeron thunbergii*, *Ixeris dentata*, *Saussurea acuminata*, *S. riederi*, *Taraxacum platypecidum*, *Potamogeton fryeri*, *Sasa kurilensis*, *Agrostis flaccida*, *Calamagrostis hakonensis*, *C. sachalinensis*, *C. sesquiflora*, *Glyceria alnasteretum*, *G. leptolepis*, *Carex blepharicarpa*, *C. dominii*, *C. eleusinoides*, *C. flavocuspis*, *C. hakonensis*, *C. melanocarpa*, *C. middendorffii*, *C. oxyandra*, *C. scita*, *C. tenuiformis*, *C. thunbergii*, *C. vanheurckii*, *Eleocharis intersita*, *Scirpus maximowiczii*, *Juncus kamschatcensis*, *J. potaninii*, *J. triceps*,

Luzula oligantha, *L. plumosa*, *Veratrum maackii*, *Zygadenus makinoanus*, *Hemerocallis middendorffii*, *Hosta rectifolia*, *Lilium medeoloides*, *Clintonia udensis*, *Listera nipponica*, *Neolindleya camtschatica* and *Pogonia japonica*. Most of these species have rather wide distribution areas, often stretching to Central Asia and southwards to the Himalayas.

(2) Asian–N. Pacific Elements

The plants of this group are distributed in Asia and northwards to the Northern Pacific regions, frequently arriving at the westernmost area of Alaska. They are 22 species: *Polystichum microchlamys*, *Draba borealis*, *Sieversia pentapetala*, *Arcterica nana*, *Cassiope lycopodioides*, *Gaultheria miqueliana*, *Phyllodoce aleutica*, *Rhododendron aureum*, *Therorhodion camtschaticum*, *Gentianella auriculata*, *Pedicularis chamissonis*, *Penellianthus frutescens*, *Arnica unalaschcensis*, *Cacalia auriculata*, *Cirsium kamtschaticum*, *Taraxacum trigonolobum*, *Poa macrocalyx*, *Juncus beringensis*, *Iris setosa*, *Dactylorhiza aristata*, *Platanthera chorisiana* and *P. tipuloides*.

(3) Asian–N. American Elements

The following 47 species belong to this group: *Diphasium sitchense*, *Alnus crispa*, *Minuartia macrocarpa*, *Coptis trifolia*, *Arabis lyrata*, *Barbarea orthoceras*, *Saxifraga bronchialis*, *S. punctata*, *Spiraea betulifolia*, *Acomastylis calthifolia*, *Rubus pedatus*, *R. spectabilis*, *Sanguisorba canadensis*, *S. stipulata*, *Astragalus adsurgens*, *Geranium erianthum*, *Viola langsdorfii*, *V. repens*, *Chamaepericlymenum canadense*, *Harrimanella stelleriana*, *Vaccinium ovalifolium*, *Primula cuneifolia*, *Fauria crista-galli*, *Gentiana algida*, *G. glauca*, *Veronica stelleri*, *Boschniakia rossica*, *Galium kamtschaticum*, *Campanula dasyantha*, *C. lasiocarpa*, *Achillea sibirica*, *Anaphalis margaritacea*, *Artemisia arctica*, *A. trifurcata*, *Agrostis trinii*, *Carex mertensii*, *C. michauxiana*, *Eleocharis kamtschatica*, *Lysichitum camschatcense*, *Juncus ensifolius*, *J. mertensianus*, *Luzula arcuata*, *Tofieldia coccinea*, *Fritillaria camschatcensis*, *Maianthemum dilatatum*, *Streptopus streptopoides* and *Platanthera hyperborea*. The plants of this group are distributed in Asia and N. America, often having rather wide ranges, but some species, e. g. *Rubus spectabilis*, *Carex mertensii*, etc. are rather restricted to small distribution areas.

(4) Eurasiatic Elements

The plants of this group are distributed both in Asia and in Europe, either continuously or more or less discontinuously showing gaps. 20 species are of this category: *Selaginella helvetica*, *Isoëtes setacea*, *Cryptogramma crispa*, *Salix nummularia*, *Rumex arifolius*, *Dianthus superbus*, *Minuartia verna*, *Thalictrum foetidum*, *Astragalus frigidus*, *Oxalis acetocella*, *Anthriscus sylvestris*, *Pleurospermum austriacum*, *Cortusa matthioli*, *Picris hieracioides*, *Glyceria lithuanica*, *Carex caespitosa*, *Veratrum album*, *Allium victorialis*, *Cypripedium macranthum* and

Gymnadenia conopsea.

(5) Circumpolar and Cosmopolite Elements

The circumpolar plants are those showing a circumpolar distribution pattern, irrespective of its complete continuity or more or less discontinuity in covering gyroflexously the arctic area around the North pole, but in this paper the cosmopolite plants with more world-wide distribution areas are also included. The following 123 species belong to this group: *Diphasium alpinum*, *D. complanatum*, *Huperzia selago*, *Lycopodium annotinum*, *Selaginella selaginoides*, *Equisetum sylvaticum*, *Botrychium lunaria*, *B. lanceolatum*, *Ophioglossum vulgatum*, *Phegopteris polypodioides*, *Carpogymnia dryopteris*, *C. robertiana*, *Dryopteris austriaca*, *Athyrium alpestre*, *Woodsia glabella*, *W. ilvensis*, *Asplenium trichomanes*, *A. viride*, *Juniperus communis*, *J. sibirica*, *Bistorta major*, *B. vivipara*, *Oxyria digyna*, *Minuartia arctica*, *Silene repens*, *Stellaria calycantha*, *Anemone narcissiflora*, *Caltha palustris*, *Clematis alpina*, *Ranunculus acris*, *Thalictrum aquilegifolium*, *T. minus*, *Drosera anglica*, *D. rotundifolia*, *D. rotundifolio-anglica*, *Rhodiola rosea*, *Parnassia palustris*, *Aruncus dioicus*, *Dryas octopetala*, *Potentilla fruticosa*, *P. nivea*, *Rosa acicularis*, *Rubus idaeus*, *Sibbaldia procumbens*, *Hedysarum hedysaroides*, *Oxytropis campestris*, *Viola biflora*, *V. selkirkii*, *Circaea alpina*, *Epilobium hornemanni*, *E. palustre*, *Bupleurum ranunculoides*, *Orthilia secunda*, *Andromeda polifolia*, *Arctous alpina*, *Ledum palustre*, *Loiseleuria procumbens*, *Oxycoccus quadripetalus*, *Phyllodoce caerulea*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Empetrum nigrum*, *Diapensia lapponica*, *Androsace chamaejasme*, *Trientalis europaea*, *Menyanthes trifoliata*, *Swertia perennis*, *Prunella vulgaris*, *Thymus serpyllum*, *Pedicularis oederi*, *P. verticillata*, *Veronica tenella*, *Pinguicula vulgaris*, *Linnaea borealis*, *Lonicera caerulea*, *Erigeron acris*, *Solidago virga-aurea*, *Sparganium angustifolium*, *S. hyperboreum*, *Scheuchzeria palustris*, *Agrostis mertensii*, *Anthoxanthum odoratum*, *Calamagrostis canadensis*, *C. neglecta*, *Deschampsia atropurpurea*, *D. caespitosa*, *D. flexuosa*, *Festuca ovina*, *F. rubra*, *Hierochloe alpina*, *Phleum alpinum*, *Trisetum spicatum*, *Carex atrata*, *C. bipartita*, *C. brunnescens*, *C. canescens*, *C. capillaris*, *C. limosa*, *C. livida*, *C. loliacea*, *C. muricata*, *C. pauciflora*, *C. pyrenaica*, *C. rupestris*, *C. vaginata*, *C. vesicaria*, *Eleocharis mamillata*, *Eriophorum schuchzeri*, *E. vaginatum*, *Fimbristylis dichotoma*, *Kobresia bellardii*, *Rhynchospora alba*, *Trichophorum caespitosum*, *Juncus filiformis*, *J. triglumis*, *Luzula parviflora*, *Allium schoenoprasum*, *Lloydia serotina*, *Maianthemum bifolium*, *Streptopus amplexifolius*, *Coeloglossum viride*, *Listera cordata* and *Microstylis monophyllos.*

Floristic composition of the alpine flora of Hokkaidô is summarised in Table 1. As Hokkaidô is located in the northeastern part of the Far East, the Asian element, of course, is very high showing 245 in species number or 53.61%.

TABLE 1. The floristic Composition of the Alpine Flora of Hokkaidô

DISTRIBUTION TYPE \ TAXON			Pter.	Spermat.			Total	
				Gym.	Angiosp.			
					Dicot.	Monocot.		
Asian	Japanese	Endemic (Hokkaidô)			41	3	44(9.63%)	245(53.61%)
		Japan	1		40	15	56(12.25%)	
	Japanese–Sakhalin–Kurils	Hokkaido–Sakhalin			3	1	4(0.88%)	
		Hokkaido–Kurils			4		4(0.88%)	
		Hokk. –Sakhal. –Kuril.			4	1	5(1.09%)	
		Japan–Sakhalin		1	7	1	9(1.97%)	
		Japan–Kurils	1		7	3	11(2.41%)	
		Jap. –Sakhal. –Kuril.	1		10	5	16(3.50%)	
	Asiatic		2	2	56	36	96(21.01%)	
Asian– N. Pacific			1		15	6	22(4.81%)	
Asian– N. American			1		33	13	47(10.28%)	
Eurasiatic			3		11	6	20(4.38%)	
Circumpolar and Cosmopolite			18	2	57	46	123(26.91%)	
Total			28	5	288	136	457	

Among the Asian elements, Japanese elements are 100 species (endemics in Hokkaidô 44 spp., endemics of Japan as a whole 56 spp.) or 21.88%. Japanese–Sakhalin–Kurils elements are only 49 species or 10.72%. The plants belonging to the Asiatic element exhibit rather wide areas in distribution, and are 96 species or 21.01%. Next to the Asian element comes the Circumpolar and Cosmopolite element showing high species number that exhibits 123 or 26.91%. The plants with amphi-Pacific trends in distribution are 69 species (Asian–N. Pacific 22 spp., Asian–N. American 47 spp.) or 15.09%. The distinction between the Asian–N. Pacific element and the Asian–N. American one sometimes becomes to be unclear, because the evidence of the complete distribution area of each component species is often lacking. The Eurasiatic element is lowest in the species number in the alpine flora of Hokkaidô, showing 20 species or 4.38%.

IV. On the Origin of the Alpine Flora

In the light of the above data, we can estimate the origin of the alpine flora of Hokkaidô.

During the Pleistocene of the Quaternary period, Cainozoic Era, glaciation took

place four times. During the maximum advance of the glaciers of Wisconsin age, nearly 27 percent of the present land areas were probably buried by ice (LEET and JUDSON 1962). As the glaciers went down southwards in the Ice Age, the plants that were distributed in the arctic region gradually went down southwards around the terminal margin of the glacier as indicated by HULTÉN (1937). At that time, such plants as circumpolar arctic ones remained alive on high mountains, possessing there their new territories when the glacier went back to the arctic, and those plants became to have a new mode of living during the Interglacial Age. In repeating such processes, many species of circumpolar plants are now distributed in high mountains in the Northern Hemisphere. This view is clearly borne out by the fact that about one fourth of the alpine plants of Hokkaidô are circumpolar and cosmopolite species.

According to the view of geologists (e. g. MINATO 1963) the south-western part of Hokkaidô formed the easternmost part of the continent of Asia during the Oligocene of the Tertiary period, but during the Miocene Japan was completely separated from the continent. Between the late Pliocene to the early Pleistocene the western side of Honshû was connected with the Korean peninsula. By such diverse geological changes, many plant species of the continent origin became to have their new home also in Japan as species common to the continent and the Japanese archipelago. This appears to be the main reason why Asiatic elements are now rich in Japan. After the last glaciation, however, Japan was again separated completely from the continent, and such a plant species that had been quite identical both in Japan and in the continent, gradually changed its character on the Japan side or *vice versa*, possessing new characters as a subspecies or a quite distinct species.

For the species common to the Eastern Asia and the N. Pacific or N. America, the Behring land-bridge appears to have played an important rôle. Many species came from the continent of America through the Behringia to E. Asia or *vice versa.*

By virtue of such complicate processes as mentioned above the primary framework of the alpine flora of Hokkaidô seems to have been established. After the establishment of the flora, local differentiations have taken place in not a few species, giving rise to produce geographically or morphologically distinct races or sometimes even species also, and as a result the present status of the alpine flora of Hokkaidô was stabilised and established (TOYOKUNI 1979b).

V. Summary

1. In this paper, the floristic phytogeography of the alpine flora of Hokkaidô,

Japan was dealt with.

2. On the basis of the author's work (TOYOKUNI 1974–1978) as well as on the current knowledge, vascular plants naturally growing in the alpine zone of Hokkaidô are 457 species in total.

3. The above 457 species were analysed phytogeographically, and the results are shown in Table 1.

4. Basing on the statistical data on the composition of the alpine flora of Hokkaidô, the origin of the flora was discussed.

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