

Geocological analysis of the Korea alpine and subalpine plants and landscapes^{*}

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Abstract—Present work aims to designate the alpine and subalpine plants and landscapes, and also to analyse the species composition, physiognomy, altitudinal ranges as well as formation processes of Korean alpine and subalpine belts and their geocology.

The alpine and subalpine floras of Korean mountains are evidently descended from immigrants from NE Asia during the epochs of the Ice Age. These plants, which are very intolerant of competition in warm and mild climates, have been able to persist in alpine and subalpine belts thanks to their harsh climatic conditions, sterile soil, rugged topography and cryoturbation.

Continuing works on the palaeoenvironment and thermal amplitude of alpine and subalpine elements on Korea high mountains may be enabled to understand better on the geocology and natural history of the Korean Peninsula, as well as the structures, functions, mechanism and dynamics of alpine and subalpine plants and landscapes.

Keywords: geocology, alpine and subalpine, plants, landscapes, Korea.

1 Introduction

Due to the rapid global warming trend, which took place in the 20th century, numerous unexpected environmental and ecological issues and problems have been raised. However, not many people seem to concern on the current vegetational and environmental changes in high mountains and the future of this isolated ecosystems and landscapes on the high mountains and even less is known about these features in the Korean Peninsula. In order to remedy this, so as to meet the growing need for a detailed information on the current situation of alpine and subalpine plants and landscapes in Korea, present work focused on the understanding of the geocology.

2 Materials and methods

Present work aims to designate and describe the alpine and subalpine belts based on the known distributions of cold-loving evergreen plants and the geocological interpretation of alpine and subalpine belts and their landscapes in terms of species composition, physiognomy and distributional pattern.

Basic designation and description have been achieved through the used of numerical analytical techniques of ordination and classification(Kong, 1989). Data sources have been collated from the floristic literature both domestic and international data as well as my own field works(Kong, 1991; 1995; 1996; 1997; 1998a, b, c).

3 Results

3.1 Designation of alpine and subalpine belts

Alpine belt is mainly found in the northern alpine region of Korea and includes eleven sites, such as Mts. Moosant (606m a. s. l.), Paikdoo(2750m), Kwanmo(2541m), Mantap(2205m), Keeju, Kapsan, Chilbo(906m), Hoochi(1335m), Ro(2210m), Keumpae(1676m) and Danchon (Fig. 1).

Subalpine Zone, however, occurs from northern to southern subalpine Korea and consist of twenty-one sites: Mts. Jung(1003m), Songjin(1146m), Chayoo(1500m), Seungjuk(1970m), Pirae(1470m), Peenanduk (1316m), Nangrim(2002m), Myohyang(1909m), Sasoo(1747m),

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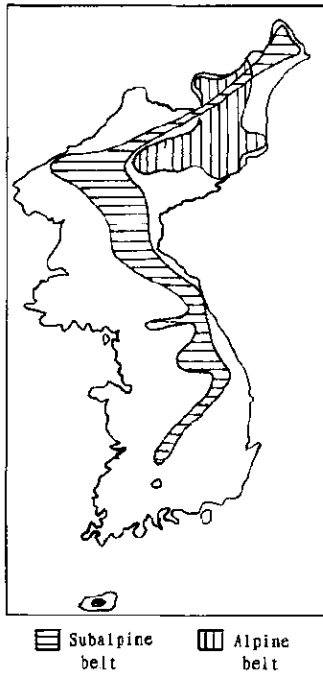


Fig. 1 Alpine and subalpine belts of the Korean peninsula

Haram(1486m), Chuae(1530m), Kumkang(1638m), Sorak(1708m), Myungji(1250m), Odae(1563m), Jaebang(1577m), Taeji(1300m), Chiak(1288m), Daesung(1307m), Taebaik(1561m) and Dukyoo(1508m). Though Mts. Chiri(1915m), and Hallasan(1950m) exclude in the alpine and subalpine belts of previous classification(Kong, 1989), these two sites also contain numerous arctic-alpine and alpine floristic elements and relevant landscapes(Fig. 1).

3.2 Species composition and physiognomy

Alpine belt contains twenty-five cold-loving plant species, such as *Taxus cuspidata* var. *latifolia*, *Juniperus sibirica*, *J. utilis*, *Picea intercedens*, *P. tonaiensis*, *Pinus pumila*, *Andromeda polifolia*, *A. polifolia* form. *acerosa*, *Chamaedaphne calyculata*, *Dryas octopetala* var. *asiatica*, *Empetrum nigrum* var. *japonicum*, *Ledum palustre* subsp. *decumbens*, *L. palustre* var. *latifolium*, *L. palustre* var. *maximum*, *L. palustre* var. *minus*, *L. palustre* var. *procumbens*, *L. palustre* var. *yesonense*, *Linnaeu borlalis*, *Oxycoccus microcarpus*, *O. quadripetalus*, *Phyllodoce caerulea*, *Rhododendron aureum*, *R. fauriae* form. *rufescens*, *R. parvifolium* and *Vaccinium vitis-idaea* var. *geuinum*.

Eighteen arctic-alpine and alpine evergreen broadleaved plants and four circumpolar evergreen coniferous plants and endemic species are noticed in the alpine belt. Shrubs and small shrubs with relatively small leaves are most commonly represented. The admixtures of decumbent small shrubs, procumbent small shrubs, species with small-sized leathery leaves, those with revolute leaves and those with hairy leaves is a good indication that there is a general morphological adaptation to cold climate conditions of the Korea alpiners. This belt is dominated by the arctic-alpine and alpine evergreen broadleaves plants, along with few evergreen coniferous plants, which reflect the mountainous landscape often very harsh environments.

Subalpine belt is composed of twenty-eight cryophilous species, for example *Abies nephrolepis*, *Biota orientalis*, *Juniperus utilis*, *Picea jezoensis*, *Pinus densiflora* var. *globosa*, *P. koraiensis*, *P. parvifolia*, *P. pumila*, *P. thunbergii*, *Sabina chinensis*, *S. chinensis* var. *horizontalis*, *S. sargentii* (= *Juniperus chinensis* var. *sargentii*), *Taxus cuspidata*, *T. cuspidata* var. *lartifolia*, *Thuja koraiensis*, *Psudisasa japonica*, *Sasamorpha pubescens* var. *borealis*, *Sinoarundinaria* (= *Phyllostachys*) *reticulata*, *Bladhia crenate* var. *taquetii*, *Buxus koreana*, *Hypoxis tanakae*, *Rhododendron aureum*, *R. dauricum*, *R. fauriae* form. *rufescens*, *R. fauriae* var. *roseum*, *R. micranthum*, *Vaccinium vitis-idaea* var. *minus* and *Viscum coloraratum* var. *lutescens*.

Subalpine belt consist of fifteen evergreen coniferous plants, ten green broadleaved plants and three evergreen bamboo, trees and shrubs with small leaves are common. There is diverse adaptations to cold climate, such as small-size leathery leaves, revolute leaves, and trimes. This belt is composed of both circumpolar evergreen coniferous and broadleaved plants as well as southern bamboo elements.

Several cryophilous trees such as *Abies koreana*, *Picea jezoensis*, *Taxus cuapidata* and *Sabina sargentii* are also found in Mt. Chiri, and *Abies koreana*, *A. holophylla*, *S. sargentii*, *Taxus cuapidata*, *Diapensia lapponica* subsp. *obovata*, *Empetrum nigrum* var. *japonicum*,

Rhododendron dauricum, *R. fauriae* var. *roseum*, *R. fauriae* form. *rufescens*, *Vaccinium bracteatum* and *V. vitis-idaea* var. *minus* are reported in Mt. Halla. The occurrences of small-sized coriaceous-leaved species and of northern evergreen coniferous plants imply the existence of both past and present cryo-climatic condition, mainly near the summit of Mt. Halla, Cheju Island. Presence of several arctic-alpine flora on the peak of Mt. Halla is of great importance both for the reconstruction of paleroenvironments and the understanding of present environments.

3.3 Altitudinal ranges

Four distinctive altitudinal range groups can be noticed in the alpine belt and include those: from 450 to 550 m which are occupied by evergreen coniferous plant *Juniperus utilis*; from 800 to 1500 m by circumpolar evergreen broadleaved plants *Rhododendron fauriae* form. *rufescens* and *R. parvifolium*; from 2000 to 2200 m by northern evergreen coniferous plants *P. pumila* and *Juniperus sibirica*; from 1500 to 2540 m by circumpolar evergreen broadleaved plants such *Ledum* spp., *Phyllodoce caerulea* and *Rhododendron aureum*.

Out of the seven altitudinal ranges in the subalpine belt four groups are composed of cold-loving plants, for example northern evergreen coniferous plants *Pinus koraiensis* and *Thuja koraensis* from 300 to 2300m, *Taxus cuapidata*, *Abies nephrolepis* and *Picea jezoensis* from 500 to 1900 m, northern evergreen coniferous plants *Pinus pumila* and *Sabina sargentii* from 700 to 2300, and circumpolar evergreen broadleaved plants *Rhododendron fauriae* form. *rufescens*, *R. aureum* and *Vaccinium vitis-idaea* var. *minus* from 800 to 2300m.

In the case of Mt. Halla circumpolar evergreen broadleaved plants *Diapensia lapponica* subsp. *obovata*, *Empetrum nigrum* var. *japonicum*, *Rhododendron dauricum*, *R. fauriae* var. *roseum*, *R. fauriae* form. *rufescens*, *Vaccinium bracteatum* and *V. vitis-idaea* var. *minus*, and the northern evergreen coniferous plants *Abies holophylla*, *S. sargentii* and *Taxus cuapidata* are found from 1800 to 1950 and endemic *Abies koreana* grow from 1300 to 1950.

The arctic-alpine and subalpine plants and landscape, which consist of circumpolar evergreen broadleaved plants and northern evergreen coniferous plants, are confined to their range on the northern alpine and north-south subalpine belts as well as to few high mountains in the south.

4 Discussions

The present-day alpine and subalpine belts as well as relevant arctic-alpine and alpine plants and landscapes are likely to have been formed during the post-glacial warming phase. The existence of north-south orientation of mountain ranges, and of scattered numerous mountains with the Korean Peninsula, along with the presence of different climatic regimes, enabling many arctic-alpine and alpine plant species to survive in the alpine and subalpine belts in both primary and secondary refugia during the both glacial and interglacial phases, respectively.

The present occurrence of several arctic-alpine species, in the alpine and subalpine belts of Korea, at the world's southernmost limit of their distribution, and of another species at the southernmost limit of their range in East Asia further promotes the idea of the existence of refugia for these species in the Korean peninsula. The presences of numerous arctic-alpine and alpine plants on the alpine and subalpine belts, mainly in the north, but also in the midlands, the south and Cheju Island are mainly due to their relative degree of sensitivity to high summer temperatures.

The disjunctive distribution of many alpine and subalpine plants, including *Diapensia lapponica* subsp. *obovata*, *Empetrum nigrum* var. *japonicum* etc. on the top of Mt. Halla, Cheju Island, as well as *Abies nephrolepis*, *Pinus pumila*, *Taxus cuspidata*, *T. caspitosa*, *Thuja koraiensis*, *Betula ermanii* var. *genuina*, *Rhododendron aureum*, etc. on the summit of Mt. Sorak, suggests a former continuous distribution of these both locally and on a broader scale, their range extension downslope and southward during the Pleistocene glacial phases, and the subsequent breakdown of a former continuous range into fragments as the climate ameliorated

during the post-glacial warming phase. The continued survivals of alpine and subalpine plants and landscapes in Korea is in danger if global warming associated the greenhouse effect takes place.

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