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Geological relict as the climatic refugia of plants

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Presence of large number of cold-tolerant A-AP and AP at heterogeneous habitats, such as alpine belt, island, and specific locations are biogeographically interesting phenomena, since it contains relict plants of geological periods, such as A-AP (Arctic-Alpine Plant) and AP (Alpine Plant). Air-hole or wind-hole, in which temperature is cooler in summer, but milder in winter, is normally found on the talus of mountains. It provides favourable micro climate for A-AP and AP to survive since the LGM (Last Glacial Maximum).

Disjunctive distribution (56km distance away) of A-AP, for example, *Vaccinium vitis-idaea* at on 1,200m a.s.l. of Soraksan and 350m a.s.l. at air hole of Hongcheon at its East Asian southern and lower distributional limits, might indicates previous floristic linkage among these populations refugia as a glacial relict. Disjunct presence of cold-tolerant flora, e.g., *Vaccinium vitis-idaea* at un-glaciated lowland air hole is the result of widespread range during the glacial period at a primary refugia and then retreat of its range onto secondary since the Holocene Period.

Isolated occurrence of *Vaccinium vitis-idaea* at lowland air hole needs scientific explanation in connection with both past and present environmental changes. On the basis of vertical or altitudinal distribution of *Vaccinium vitis-idaea* between Soraksan and Hongcheon air hole, the estimated mean annual temperature during the LGM might -6.6°C lower than today. Major current restriction factor for the distribution of cold-loving *Vaccinium vitis-idaea* seems to be summer maximum temperature. What happen if current global warming trend exceeds the physiological adaptation and migration speed of A-AP and AP? The species could be kicked out from lowland air hole habitat, and even face the extinction at their geographical limit, if current warming trend maintained.

Air-hole areas with unique landscape and ecological values need to be stressed and zoning of core, buffer, and transitional zones should be designated for the multi-dimensional preservation of peri-glacial landscape and ecosystem. Cold-tolerant but high temperature sensitive *Vaccinium vitis-idaea* have survived at the air hole, in which low summer temperatures are guaranteed. Air hole at Hongcheon lowland at ca. 350m a.s.l., successfully have served as a Holocene plant refugia which are vulnerable to climate change, especially, global warming will be function as a potential *in-situ* and *ex-situ* preservation sites in the future. However, *Vaccinium vitis-idaea* at Hongcheon could disappeared at their current habitat due to global warming and continuous competition with warmth-loving plants

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