

Rear-edge, low-diversity *Bupleurum euphorbioides* populations as interglacial refugia for this cold-adapted species

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April 28, 2020

Abstract

The high genetic diversity of rear-edge refugia has been predicted to result from repeated retreats of species' ranges to low latitudes during glacial periods in the course of Quaternary climate change. However, a few recent empirical studies of cold tolerant plants revealed an opposite pattern. We investigate whether current populations of the cold-adapted and range-restricted *Bupleurum euphorbioides* in the Baekdudaegan, South Korea and North Korea, could be interglacial refugia, and document how their rear-edge populations differ genetically from those of typical temperate species. Phylogeographic analysis and ecological niche modeling (ENM) were used. Genetic structure was analyzed using microsatellite markers and chloroplast DNA sequences. The congener *B. longiradiatum* was included as a typical temperate plant species. Despite having almost identical life history traits, these congeneric species exhibited contrasting patterns of genetic diversity. ENM revealed a wide range expansion along the Korean mountains to northern Far East Russia (Primorsky) during the Last Glacial Maximum, but not during the last interglacial. Thus, we hypothesize that *B. euphorbioides* retreated to refugia following maximum range contraction during interglacial periods. Unlike populations in the central region, the rear-edge populations were genetically impoverished and uniform, both within populations and in pooled regional populations. The rear-edge has endured at least one past interglacial, contributing to the species' genetic diversity. We believe that such genetic variation in the cold-adapted *B. euphorbioides* gives it the necessary adaptations that will enable it to survive an upcoming favorable environment (the next glacial), unless there is artificial environmental change.

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