

The cryptic genetic diversity of a mountain ant *Myrmica kotokui* (Hymenoptera: Formicidae) in Japan Alps

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Modern molecular phylogenetic techniques have revealed that some species comprise several genetically distinct species (cryptic species). The discovery of cryptic species is essential for evaluation of biodiversity, and the investigation of their distribution is crucial for biogeography and conservation biology.

Myrmica kotokui is a common species in Japan, which is distributed from Hokkaido, northern Japan, to Yakushima Islands, southern Japan. The ant species is thought to be originated from Eurasia and adapted to cold-temperate climate, thus the ant is restricted to high elevation in lower latitudes. For example, *M. kotokui* is restricted at altitudes of approximately 1,000 to 2,000 m in Japan Alps. The segregated distribution indicates that the ant can be divided into some genetically distinct lineages for each mountain region.

To test the hypothesis, we collected ant colonies at 36 sites from five mountain regions in Nagano, central Japan, and reconstructed molecular phylogeny of the mitochondrial *COI* gene. The phylogeny of the ants reveals four independent lineages, suggesting that there are some cryptic species in *M. kotokui*, which has been known as a single morphological species. The distribution pattern of the ant lineages did not support our hypothesis: genetic differentiation among different mountainous regions. All the lineages were widely distributed across all regions. On the other hand, we found a geographic pattern in the vertical distribution of the lineages; the lineage Mk-3 was distributed in higher elevation, and the others (Mk-1, Mk-2 and Mk-4) were in lower elevation. Thus, intra-species lineages of *M. kotokui* do not segregate by each mountain region but by elevation.

Did the genetic differentiation of the lineages in *M. kotokui* occur in Japan Alps or did the already-diverged lineages in the Eurasian continent migrate to Japan Alps? The differentiation of the lineages does not seem to occur in Japan Alps because 1) there is no physical barrier between altitudes in Japan, and 2) the genetic distances among the lineages are too large to be generated parapatrically. Thus, the stratified distribution of the ant lineages along altitudinal gradient may have been formed through multiple migrations from the continent and the following habitat segregation among differently coldness-adapted lineages. All in all, cryptic highland-lineages in the *Myrmica* ant are suggested and propose further hidden biodiversity in higher elevation.

Keywords: cryptic species, biodiversity, altitudinal gradient, molecular phylogenetic tree, mitochondrial *COI* gene, ant