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**Integrating species distribution
models, genetics and morphology to
infer species dynamics of New
Zealand *Phaulacridium* grasshoppers**

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Abstract

Species comparison studies have used a number of different methods that can contribute to our understanding of processes that influence the differences and similarities observed between species. This thesis describes the geographic distribution, spatial genetics, and morphology of two New Zealand *Phaulacridium* grasshoppers, the widespread *P. marginale* and the restricted *P. otagoense*. The primary focus was on *Phaulacridium* populations from the region of the southern South Island where the two species ranges overlap, for the purpose of examining the evolutionary and ecological interactions of the species.

The geographic distribution of the two species was analysed using the recorded and potential modern distribution of *Phaulacridium* grasshoppers. Models of environmental envelopes for each species demonstrated that the potential distribution of *P. marginale* covered the majority of New Zealand. In contrast, the potential distribution of *P. otagoense* is restricted to patches of land primarily in the southern South Island where this species is known to occur.

The phylogeographic structure of *Phaulacridium* species was analysed using dense population samples. Two main mtDNA COI sequence groups were found, one was shallow but geographically widespread, while the other was more diverse but geographically restricted. Within the southern South Island region both mitochondrial lineages co-occur within a single location. Demographic history analysis suggested that the widespread range of *P. marginale* is the result of recent population, and the restricted *P. otagoense* was recently represented in large populations.

The morphological variation of *Phaulacridium* grasshoppers was explored using traditional and geometric techniques. Two distinct morphotypes were apparent, the larger morph was geographically widespread and the smaller morph was restricted to the southern South Island. Both morphotypes co-occur in locations within the southern South Island region. Furthermore, several individuals could not be classified into a discrete morphotype, suggesting that these individuals had a mixture of morphological features, as expected of a hybrid.

Comparing the morphological and genetic data from the current study demonstrates the first reported case of introgression between *P. marginale* and *P. otagoense*. It is evident that *Phaulacridium* F₁ hybrids exist in the wild, however it is unknown whether these F₁ hybrids are fertile and also if F₂ hybrids (backcrossed from parental species or F₁ hybrids) are viable and fertile.

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