Breeding Systems and Rarity in New Zealand *Myosotis*

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Abstract

Rarity in New Zealand *Myosotis* was explored at several different levels for this thesis. Within the genus, there are many rare species, encompassing several different types of rarity, and many of these are considered threatened in some way. In addition, the genus contains species that exhibit a wide array of floral forms, each of which can be associated with a distinct form of rarity.

The reproductive biology of selected Nelson taxa was investigated in several species covering a range of floral morphologies, including the previously unstudied brush blossom floral syndrome. Species were found to fall into one of two mating types based on the degree of herkogamy[1] exhibited by the flowers. Species with flowers that are herkogamous throughout their life, require pollinators to set seed while those that are not herkogamous at some stage during anther dehiscence, are self-fertile and able to self-pollinate autonomously. All species studied were self-compatible. Considerable variation in seed production was observed under natural conditions for those species that required pollinators to set seed. For these pollinator-requiring species, local population density had strong effects on seed set, while population size had no effect. These plants were always pollen limited in low-density patches. For a self-fertile species, seed set was always high and unaffected by either local density or population size and pollen was never limiting. These results indicate reproductive success in pollinator-requiring species of *Myosotis* is subject to Allee effects and these effects occur at a very local scale. These results have implications for the assessment and management of threatened *Myosotis* species in particular and rare plants generally. It is essential to know the pollination requirements and levels of density dependence for reproduction both for the assessment of threat and for determining management strategies for threatened plants.

Self-compatible, but pollinator-requiring species are prone to autogamy and geitonogamy and therefore inbreeding depression. One strategy to avoid this is to increase dichogamy and synchronise inflorescence development. Pollination was studied in the geographically restricted, ultramafic endemic *Myosotis monroi,* a species that has a relatively large floral display and whose flowers often bear precocious styles prior to

[1] A glossary of technical terms follows the appendices

buds opening. In general, precocious styles are assumed to be receptive and indicate protogyny. Stigmas were receptive at this stage and some pollination occurs during this precocious phase. Stylar precocity effectively lengthens the female-only phase in this species. This is the first time that precocious styles have been proved to be receptive at this stage. *M. monroi* also shows far greater phenological synchrony of within plant flowering than five other species of New Zealand *Myosotis*. It is thought that the impact of a large floral display on levels of geitonogamy in *M. monroi* is alleviated to some degree by the relatively long, initial female-only phase and phenological synchrony of flowering stages.

Rarity is generally considered "the precursor to extinction" (Darwin, 1872). However, there are several different forms of rarity and not all rare species are threatened. I examined the different rarity patterns observed within New Zealand *Myosotis*. New Zealand *Myosotis* species are never common, all are rare in different ways and some species are threatened. Some species are known to occur at one locality where they may be locally common, others may occur in two or more widely disjunct geographic areas, while others may be widespread but never common where they occur. A comparative analysis was carried out to determine whether there are morphological correlates of the rarity patterns seen within the genus. Local abundance, population disjunctions and distribution patterns of 33 *Myosotis* taxa were compared to aspects of their morphologies, including traits related to mating systems, dispersal ability and life-histories. Taxa requiring pollinators to set seed had smaller range sizes and higher local population densities than those that were able to self-pollinate. Apparent adaptations for dispersal and life-history traits were not correlated with range size. The disjunct distributions exhibited by some taxa within the genus were not associated with any of the morphological traits. My results can assist threat assessment and conservation management for New Zealand *Myosotis*. Locally dense, geographically restricted taxa are pollinator requiring while sparse, widespread taxa are selfing. Cases that break this general rule may be used to identify taxa at risk.

In the most recent taxonomic treatment, New Zealand *Myosotis* is initially split into two major clades depending the degree of anther exertion exhibited by the flowers. This has led to the recognition of species that cannot be distinguished in any other way. Species limits were examined in one such species complex; the vegetatively indistinguishable *M.*

forsteri and *M. venosa*. Several floral and vegetative characters were measured and compared. Filament length was the only significant character that could be used to distinguish the species, and even this was not 100% reliable. Filament length determines the degree of self-pollination that can occur and whether or not reproduction is assured. The continuous variation observed in filament, style and anther lengths and corolla sizes shows that there is a lot of phenotypic variation within each taxon. Geographic clines are observed in vegetative traits that are independent of mating system. This, in addition to the continuous variation observed in floral characters, lends some strength to the proposition that this species pair may be switching between the two breeding systems.

The increased knowledge provided by the studies contained in this thesis on New Zealand *Myosotis* has provided a much-needed boost to our understanding of the population dynamics of these rare species, which ultimately can be used to guide conservation management for those taxa considered at risk of extinction. It can assist in identifying those populations that are not threatened and it can direct efforts towards the more pressing problem situations. It has also highlighted the necessity for a taxonomic revision for the southern hemisphere section of the genus.

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