School of Environmental Biology

Variation and population genetic structure in the Western Australian endemic genus *Geleznowia* Turcz. (Rutaceae)

Linda Marie Broadhurst

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Declaration

I declare that all work presented in this thesis is that of myself alone unless otherwise acknowledged. The contents of this thesis have not been submitted previously, in whole or in part, in respect of any other academic award.

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Abstract

The endemic wildflower, *Geleznowia verrucosa* Turcz. (Rutaceae), is widely distributed as small disjunct populations throughout the sandplains of Western Australia (21° 50'S, 116° 12'E to 31° 12'S, 117° 02'E). Although the genus is supposedly monospecific, three morphological forms can be recognised in the field:

(1) a small form (0.5-1 m) with small, often solitary flowers and small leaves;
(2) a large form (1-2 m) with larger, more abundant flowers and larger leaves; and,
(3) an intermediate form exhibiting mixed morphological characters.

The patterns of morphological, reproductive and genetic variation within and between populations of these three forms were investigated. Uni- and multivariate analyses of morphological traits found the large and intermediate forms to be closely allied, and distinguishable from the small form. Responses to controlled pollination experiments indicated that the small form favours selfing but maintains some level of outcrossing, while the large form exhibits a mixed mating system. The intermediate form displays a stronger self-pollination mechanism than the small form.

Patterns of genetic variation were analysed using both allozymes and randomly amplified polymorphic DNA (RAPDs). The allozyme analysis concurred with genetically depauperate expectations of endemic taxa (*A*, 1.4; *P*, 29.6%; H_o, 0.055; H_e, 0.097). Genetic diversity and patterns of allelic distribution, however, differed within the three forms. Lower levels of genetic diversity were found in the small form (H_T, 0.192) compared with the large form (H_T, 0.254), although both forms apportioned this diversity within populations (H_S, 0.122 and 0.164, respectively) rather than between (D_{ST}, 0.070 and 0.090, respectively). In contrast, populations of the intermediate form are highly divergent (G_{ST}, 54%), with genetic diversity apportioned between populations (D_{ST}, 0.121) rather than within (H_S,

0.105). Whereas the morphometric analyses had indicated closer affinity between the large and intermediate forms, both allozyme and RAPD analyses suggested that the intermediate form is closer to the small form than to the large form.

There is circumstantial evidence to suggest that the intermediate form has arisen following hybridisation between the small and large forms. Its hybrid origin is supported by the high level of genetic diversity between the intermediate form populations, as well as its strong autogamous tendencies and mixed morphological characteristics. In a putative zone of hybridisation between the small and large forms, asymmetric introgression was observed, indicating gene exchange between the two forms can occur when they come into contact.

It is speculated that three major events have shaped the evolution of *Geleznowia verrucosa* and contributed to hybridisation between the small and large forms. Firstly, the small form is derived from the large form; associated with this speciation was a shift in reproductive strategy from outcrossing to selfing when the small form migrated into a harsher and more unpredictable environment. Secondly, recurrent Tertiary and Quaternary climatic perturbations have facilitated range expansion and contraction of these forms, generating opportunities for spatially and temporally distributed hybridisation events. Finally, more recent evolution has been driven by population disjunction, limited gene flow, and bottleneck and/or associated founder effects.

From this study it is apparent that the genus *Geleznowia* consists of at least two taxa and a series of hybrid derivatives. On this basis, formal systematic revision of the genus is now warranted. Systematic clarification will also assist with the conservation and management of this valuable natural resource, which is currently under threat.

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