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Plant mating patterns change with different aspects of habitat fragmentation

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Background

Habitat fragmentation is considered to be one of the greatest causes of biodiversity loss worldwide. It impacts on a range of important biological processes that may contribute to the decline of remnant plant populations. Fragmentation may affect patterns of mating and dispersal of pollen by altering the availability and configuration of other plants as mates, and for animal-pollinated species, through changes to the composition, abundance and behaviour of pollinators. This can reduce opportunities for outcrossing and result in inbreeding and smaller neighbourhood sizes (groups of interbreeding plants), which in turn can reduce seed production and fitness, genetic variation and ultimately population persistence.

In south-west Western Australia, extensive land clearing for agriculture has created many fragments of native vegetation, that occur in different combinations of size, isolation, plant density and shape. Understanding how remnant vegetation characteristics influence mating among plants is critical for informed conservation planning and ecological restoration efforts. However there are few studies that have investigated which characteristics have the most influence. We sought to identify the relative influence of remnant characteristics on the mating system of populations of the bird-pollinated shrub *Banksia sphaerocarpa* var. *caesia* (Proteaceae) in the Dongolocking area of the wheatbelt. We assayed genetic parameters in adult plants and seeds collected from one large (>5000 plants) and eight small (15-64 plants) populations (Figure 1).

Findings

Compared with the large (least fragmented) population, plants in the small populations had much less effective mating systems in terms of a population's capacity to persist, with lower outcrossing rates, fewer fathers per seed crop (paternal diversity), a much lower neighbourhood size (an alternative measure of paternal diversity) and much higher pollen pool differentiation.

Among the eight small populations:

- outcrossing rates were lower in more isolated populations (Fig. 2a).
- less dense populations had a higher mean pollen dispersal distance (Fig. 2b).
- small populations had fewer fathers contributing to seed crops (Fig. 2c).
- populations with a more linear shape had lower neighbourhood sizes and higher differentiation between pollen pools available to plants (Fig. 2d,e).
- pollen dispersal into populations was low (2.8 – 16.5%) and not significantly related to any population parameter.

New and senesced inflorescences of *Banksia sphaerocarpa* var. *caesia*

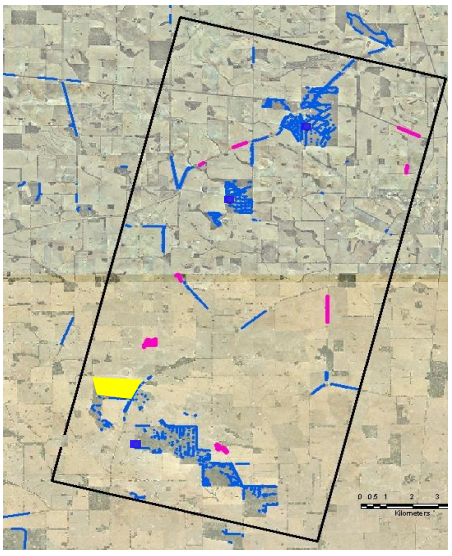

Figure 1. Map of 10 x 20 km study area. Yellow: large population; pink: small populations; blue: *B. sphaerocarpa* var. *caesia* occurrence.

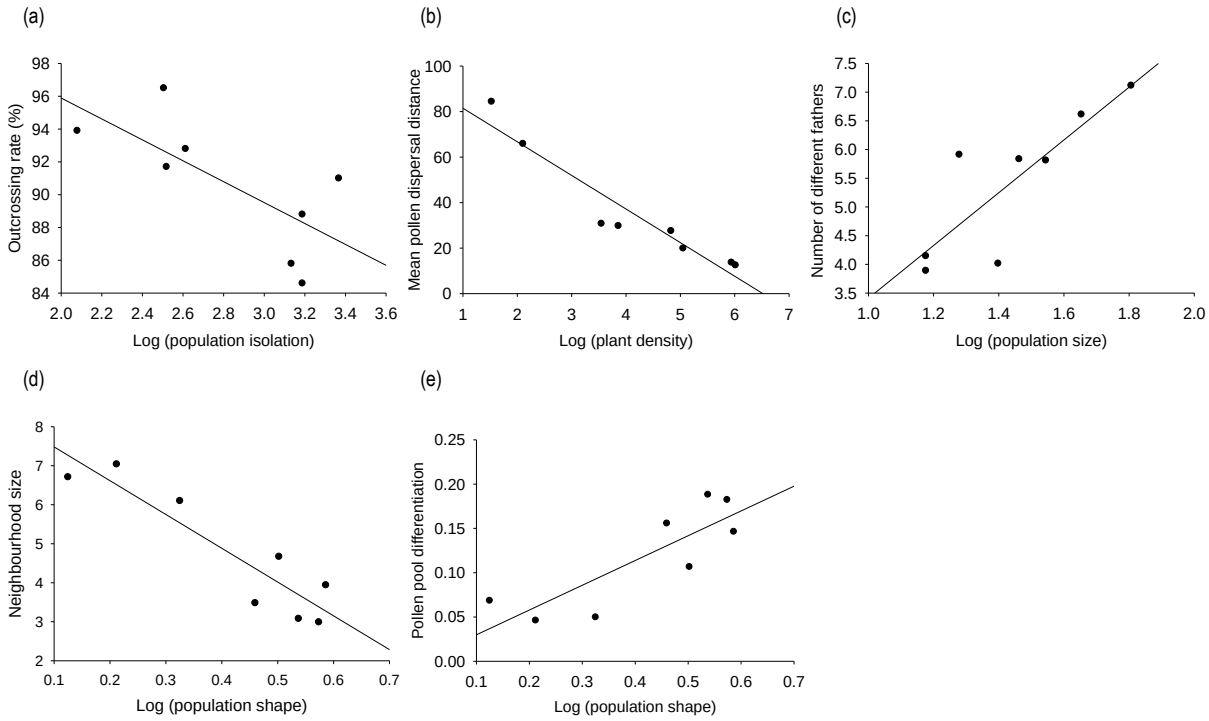

Figure 2. Relationships between fragmentation variables and mating system parameters for eight small populations of *Banksia sphaerocarpa* var. *caesia*. Population shape was a function of remnant perimeter and area – a larger value indicates a more complex edge-dominated shape, which in this study equates to greater linearity.

Management Implications

- Habitat fragmentation had detrimental and complex effects on the mating system of *Banksia sphaerocarpa* var. *caesia*. This places fragmented populations at increased risk of genetic and demographic decline. Multiple aspects of fragmentation are important, and can detrimentally affect different aspects of the mating system.
- Population shape was strongly related to two important aspects of the mating system that maintain genetic diversity in seeds. This novel result suggests that linear populations, a common feature of wheatbelt landscapes, are at risk from detrimental changes to the mating system. Ecological restoration which increases the width of the most valuable linear populations may alleviate these effects.
- In addition to shape, at least 300 reproductive adults may be required to achieve similar paternal diversity as that found in a large population. Many populations in wheatbelt fragments contain fewer than 300 plants and ecological restoration will be needed to increase their viability.
- Both small and large populations may be important sources of pollen dispersal (gene flow) into fragmented populations. All populations should form the nuclei of restoration efforts.
- In contrast to previous studies conducted in the same landscape, there was relatively low pollen immigration into populations. This illustrates that it is not always possible to generalise across species, even ones with similar life histories from the same landscape. A low level of cross-landscape gene flow further reinforces the need for ecological restoration of the fragments.

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Llorens, T.M., Byrne, M., Yates, C.J., Nistelberger, H.M., & Coates, D.J. (2012) Evaluating the influence of different aspects of habitat fragmentation on mating patterns and pollen dispersal in the bird-pollinated *Banksia sphaerocarpa* var. *caesia*. *Molecular Ecology* 21:314-328.

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