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Remnant shape strongly influences reproduction and progeny fitness in fragmented populations

by Tanya Llorens, Colin Yates, Margaret Byrne, Heidi Nistelberger, Matthew Williams and David Coates,
DEC Science Division (08) 9219 9096, tanya.llorens@dec.wa.gov.au

Background

Landscape modification and fragmentation in agricultural landscapes often leaves a complex mosaic of native vegetation remnants that are vital in retaining some regional biodiversity and providing important ecosystem services. However, these remnants have typically experienced many changes to their biological and physical characteristics. Management of native plants within these remnants has benefited from an understanding of how reduced population size and increased population isolation can affect pollen flow, the mating system, seed production and offspring fitness – all of which ultimately influence the viability and persistence of populations.

Yet little is known of the effects of population shape, even though the dominant geometry of remnant vegetation in many agricultural landscapes is not the patch but the linear strip along roads, railways or fence-lines. As population shape affects the configuration and abundance of mates, it could also influence patterns of mating, seed production and offspring fitness. Compared to non-linear patches of remnant vegetation, linear strips also have a much higher edge to area ratio and are more likely to be influenced by processes originating in the modified landscape; this could affect the availability of resources for growth and reproduction.

We investigated whether population shape has an impact on reproduction or offspring fitness in populations of the bird-pollinated shrub *Banksia sphaerocarpa* var. *caesia* in the Dongolocking area of the wheatbelt. We studied 12 populations that varied in their shape, size, isolation and density, and used statistical analysis to determine whether any of these parameters could explain variation in reproduction or fitness. Reproductive variables were measured in the field, and seeds were collected for germination and seedling growth experiments conducted in a shadehouse. All plants were genotyped to obtain mating system parameters (see Information Sheet 69), to determine whether changes to the mating system also lead to effects on offspring fitness.

Findings

Population shape was the only population parameter that could explain the variation observed in reproduction and fitness. Neither population size nor isolation nor density were related to reproduction or fitness after shape was taken into account.

- In linear populations, plants were much larger and produced many more cones and inflorescences (Fig. 1a). This can be explained by increased resources (water and nutrient runoff) available to plants in linear populations.
- In linear populations, seeds were much smaller (Fig. 1b) and seedlings had lower survival rates (Fig. 1c).
- Smaller seeds had poorer germination and produced smaller seedlings (Fig 2a,b) with poorer survival rates.
- Reduced seed size appears to arise from reduced paternal diversity – fewer fathers contributing to seed crops (Fig. 2c). In linear populations, plants have fewer near neighbours to mate with, bird pollinators would be forced to forage in a directional manner, and larger plants with more inflorescences would encourage fewer foraging movements among plants.

A linear roadside remnant containing *Banksia sphaerocarpa* var. *caesia*

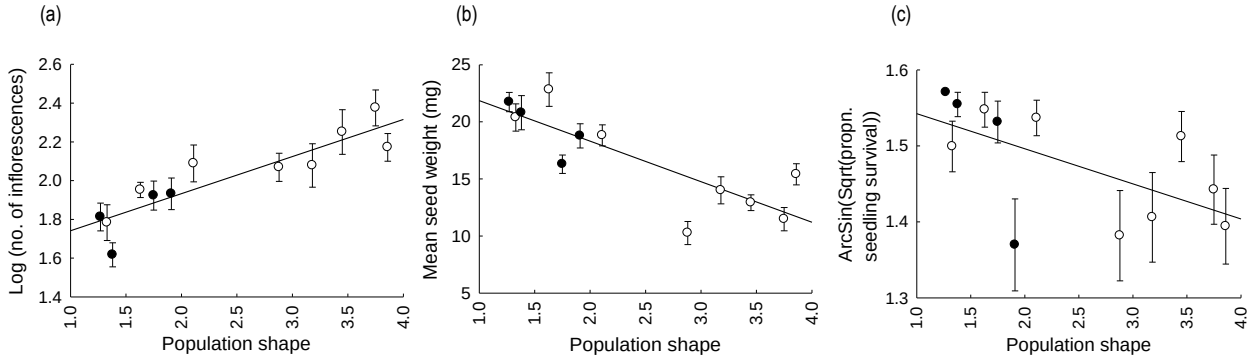

Figure 1. Relationships between population shape and (a) inflorescence production, (b) seed weight and (c) seedling survival for 12 populations of *Banksia sphaerocarpa* var. *caesia*. Population shape was a function of remnant perimeter and area – a larger value indicates a more complex edge-dominated shape, which in this study equates to greater linearity.

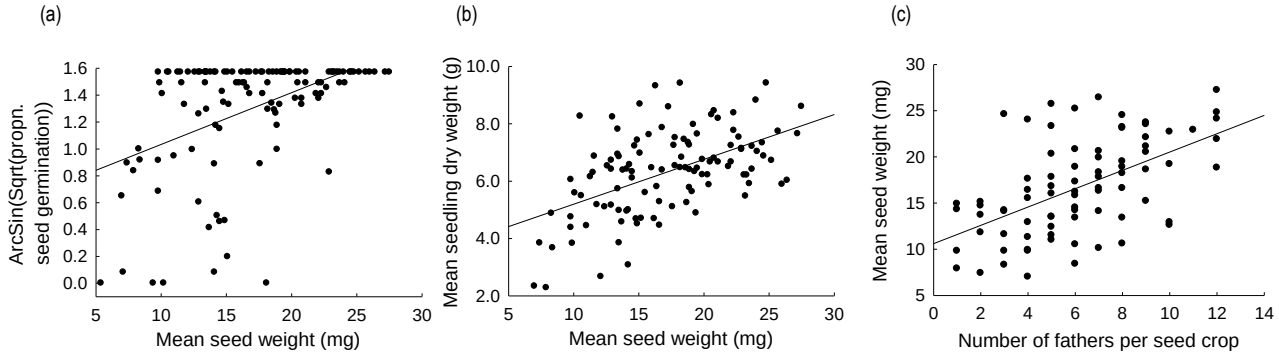

Figure 2. Relationships between mean seed weight and (a) seed germination, (b) seedling dry weight and (c) the number of fathers per seed crop (paternal diversity) for maternal plants of *Banksia sphaerocarpa* var. *caesia*.

Management Implications

- The potential detrimental effects of population shape on offspring fitness should be considered in a variety of management contexts. Reduced offspring fitness is likely to lead to poorer population viability over time.
- Increasing the width of the most valuable linear remnants may increase the long-term viability of their plant populations.
- When creating remnants, restoration plots or connectivity corridors, linear or edge-dominated geometries should be avoided in order to maximise long-term viability.
- Linear and edge-dominated remnants should be avoided when sourcing seeds for restoration. Abnormally large and productive plants do not necessarily produce the fittest seeds.

Top: A *Banksia sphaerocarpa* cone after burning to release seeds; a single winged seed

Bottom: Banksia sphaerocarpa seedlings during the growth experiment

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Llorens, T.M., Yates, C.J., Byrne, M., Nistelberger, H.M., Williams, M.R. & Coates, D.J. (2013) Complex interactions between remnant shape and the mating system strongly influence reproductive output and progeny performance in fragmented populations of a bird-pollinated shrub. *Biological Conservation* 164:129-139.

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