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Ecology, People & Environment

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Fringe festival! How do closely related species stay separate?

Many flowers have both male and female parts, and produce seeds when pollen (male) reaches the ovary (female). Some plants can use their own pollen to make seeds (**self-pollination**), however many rely on pollen from another plant (**cross-pollination**) for successful seed production (Figure 1).

Because plants stay still, animals are often required for pollen transfer. These animals are known as pollinators and include many species of birds and insects. Pollinators recognise useful rewards and will be attracted to flowers by their colour, scent, and/or shape. When closely related plant species have similar flowers and flower at the same time, the same set of pollinators may visit both species. This could lead to negative consequences for both plant species as another species' pollen (**heterospecific pollen**) may contaminate the flower. Heterospecific pollen may prevent the right pollen being delivered, or could produce sterile offspring.

Some flowers have evolved different ways to avoid interference from heterospecific pollen, such as attracting different pollinators, flowering at different times, or using chemical processes. Evolutionary biologists refer to these mechanisms as pre-mating and post-mating **reproductive isolation**, and they are critical mechanisms for species to maintain their separate identities.

Fringe lilies have showy purple flowers that are common in the spring and summer in Western Australia. There is a high level of visual similarity between flowers of different species and most rely on native bees for pollination. This raises questions about how these species maintain reproductive isolation.

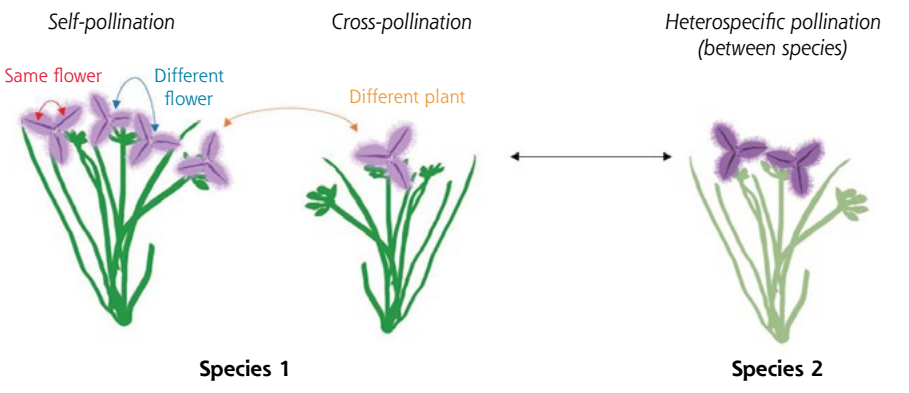

FIGURE 1 Different types of pollination which can occur in fringe lilies

Fringe lily facts

Buzz pollinated

Fringe lilies (*Thysanotus* species) are 'buzz pollinated'. Buzz pollination is where pollen is only released by vibration. Only native bees can do this.

40

There are around 40 different fringe lily species here in the southwest of WA.

A few hours

Each flower only lasts for a few hours!

Methods and results

We investigated two pairs of fringe lily (*Thysanotus*) species. Those in each pair are closely related and have similar flowers (Figure 2). We recorded the flowering of each species in an urban reserve and recorded the number of pollinators that visited the flowers.

Mating system trials: We examined the mating system of each species through hand pollination experiments. All four species had a mixed-mating system i.e. they set fruit from both self- and cross-pollination. However, few fruits were produced by three of the species when exposed to natural insect visitation.

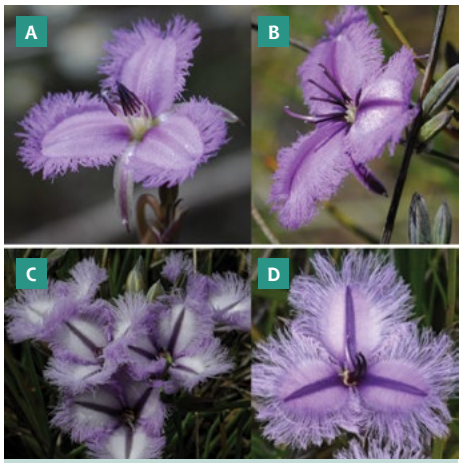

FIGURE 2 Pair 1 A. *Thysanotus tenellus*. B. *Thysanotus* sp. Pair 2 C. *Thysanotus triandrus*. D. *Thysanotus multiflorus*

Heterospecific pollination trial: We added heterospecific pollen to *T. tenellus* and *T. triandrus* then later added either self-pollen or cross-pollen. The proportion of flowers setting fruit after receiving heterospecific pollen was almost identical to the proportion setting fruit in the mating system investigation (Figure 3).

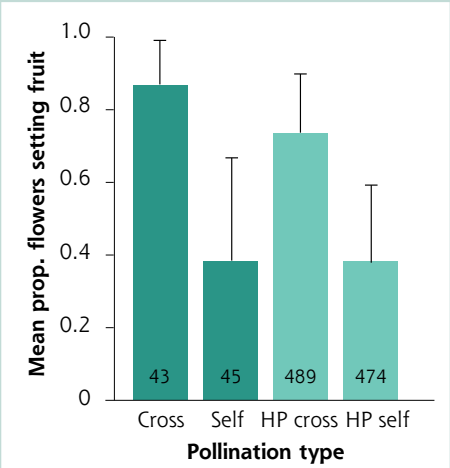

FIGURE 3 Results of the breeding system trial on mean fruit set in *T. triandrus*. For the heterospecific pollen trial (light green), *T. multiflorus* pollen was added to *T. triandrus*, followed by later cross (HP cross) or self (HP self) pollen. Sample sizes are given at the base of each column, and bars are 95% confidence intervals

Conclusions

The long-term survival and reproduction of a plant species relies on the production of seed. Landscape fragmentation can be unfavourable for plant populations, as small land fragments may support few pollinators or be difficult for pollinators to reach. In addition, small plant populations tend to have lower genetic diversity.

Fragmentation may influence the evolution of the mating system of plants, for example, in the absence of pollinators, self-pollination may increase and this can lead to **inbreeding depression**. In cases where plants cannot self-pollinate, lack of pollinators may also lead to local species extinctions.

We found that *T. tenellus* can self-pollinate without animal pollinators and still produced abundant fruit. The other lilies could also self-pollinate, however they had low fruit production and showed considerable **pollen limitation**.

Pollinators are unlikely to distinguish between the almost-identical flower colour and structure of our fringe lily pairs. Although pollen is an attractive food reward, buzzing is a rather specialised method of collecting pollen and only some bee species can do it. We expect that the sequential flowering and consistent flower appearance is likely to benefit the fringe lilies overall, as bees that are accustomed to the floral form and colour will reliably visit, even if the flowers are of different species.

Heterospecific pollination may incur a cost to the visited species (i.e. if pollen is lost to another species, it is no longer available for transfer to a flower of its own species). However, pollen loss is unlikely to have a negative impact in fringe lilies because during buzzing, pollen is often scattered. The bees cannot collect all the pollen scattered over their bodies, so some will always be available for transfer to flowers. Nevertheless, low visitation is still a problem for three of the lily species, and their dependence on native bees means they will be vulnerable to loss of pollinators.

Flowers with special requirements for pollination may have pre-mating isolation (structures that require specific visitors for successful pollen transfer). These requirements may limit reproduction if their pollinator is absent, but this was not the case in our study. Post-mating isolation is a better strategy than pre-mating isolation if low pollinator visitation is a regular problem, as overall community flowering will ensure that some pollinators are present that might visit the flowers. Although our *Thysanotus* flowers received pollen from multiple species, pollen from one species in each pair did not decrease seed set in the other. Therefore, it is likely that reproductive isolation between the species occurs after mating, despite their rather specialised pollination method. ■

More information

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References

1. Excerpt from: Eakin-Busher, E. L., Fontaine, J. B., and Ladd, P. G. (2016) The bees don't know and the flowers don't care: the effect of heterospecific pollen on reproduction in co-occurring *Thysanotus* species (Asparagaceae) with similar flowers. Botanical Journal of the Linnean Society. 181(4), 640–650.

Terminology

Reproductive isolation *different species live in the same area, but properties of individuals prevent them from interbreeding.*

Inbreeding depression *describes breeding between closely related individuals that lowers the population's ability to survive and reproduce (i.e., fitness).*

Pollen limitation *is where flowering plants produce fewer seeds than they would if they received more pollen.*

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