



Selfing versus out-crossing in six *Erica* species of the southern Cape



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ABSTRACT

Despite *Erica* being the most diverse genus in the Cape Floristic Region, very few studies have focused on their breeding systems. The ability to self-fertilise autonomously and to tolerate self-pollen was assessed in three bird-pollinated obligate seeder (*E. densifolia*, *E. sessiliflora* and *E. discolor*) and three insect-pollinated obligate seeder (*E. penicilliformis*, *E. scabriscula* and *E. formosa*) *Erica* species in the southern coastal part of the Cape Floristic Region. None of the species successfully reproduced through autogamy and only the bird-pollinated *E. sessiliflora* produced a significant proportion of viable seeds per fruit when selfed. With the other five *Erica* species examined, cross-pollination yielded a significantly higher proportion of viable seeds per fruit compared to other treatments (autogamy and self-pollination). This suggests that the role of pollinators is essential for the reproductive success of *Erica* regardless of their pollination system (bird- versus insect-pollination) and that most are out-crossers.

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1. Introduction

The genus *Erica* is the largest genus in the Cape Floristic Region, consisting of more than 680 species (Oliver and Oliver, 2002; Pirie et al., 2011). This spectacular speciation appears to be driven by floral innovation, given the diversity of floral forms present. Three major pollination systems (namely; insect, bird and wind) and a minor system (rodent) have been identified in the Cape *Erica* species (Oliver and Oliver, 2002; Turner, 2012). It has been put forward that high levels of pollen limitation due to widespread self-incompatibility and pollinator limitation, has set the scene for adaptive radiation and speciation in the Cape (Johnson et al., 1998; Goldblatt et al., 2000; Manning and Goldblatt, 2005). Despite the reproductive advantages that self-compatibility could confer when pollinators are few, many plant traits have nevertheless consistently evolved mechanisms to prevent self-pollination (Knight et al., 2005). Records of autogamous species have been rare in *Erica*, probably due to widespread protogyny (Rebello and Siegfried, 1985). Understanding the prolific and relatively recent speciation in *Erica* will benefit from descriptive data on whether they are an obligate out-crosser and in relation to pollination mode, yet only a few observational and experimental breeding system studies have focussed on *Erica* species to date.

Adopting geitonogamy in addition to cross-pollination as a reproductive strategy could be advantageous for some plant species

(Roberts et al., 2014). However, geitonogamy still requires a vector and thus cannot provide reproductive assurance in times of low pollinator abundance, for instance post-fire (Elle and Hare, 2002; Geerts, 2011). Nevertheless, geitonogamy might form part of a bet-hedging strategy that permits even small plant populations to generate a substantial seedbank (Roberts et al., 2014). In this study, we asked: are *Erica* species typically self-incompatible and does this vary with pollination mode (insect- versus bird-pollination)?

2. Methods

Species selection for the breeding system experiments was based on which *Erica* species were in flower in and around Nature's Valley (lat. 33.976754°S, long. 23.562155°E) from September to December 2015. The assumed pollination syndrome of the six species under investigation was established by use of literature and local botanical experts (Oliver and Oliver, 2002; R. Turner, Unpublished Data; Smuts, 2012). In this study, species with long tubular flowers (15 to 30 mm) – *E. densifolia*, *E. sessiliflora* and *E. discolor* (Fig. 1) – were considered to be pollinated by sunbirds (Smuts, 2012). The plant species with small corollas (2 to 4 mm) were all considered to be insect-pollinated species (pollinated by a suite of insect species within different functional types) – *E. penicilliformis*, *E. scabriscula* and *E. formosa* (Fig. 2; Smuts, 2012). All *Erica* species examined in this study were obligate seeders (R. Turner, Unpublished Data).

Controlled hand-pollination experiments were conducted from September to December 2015. Closed floral buds were bagged (bags made

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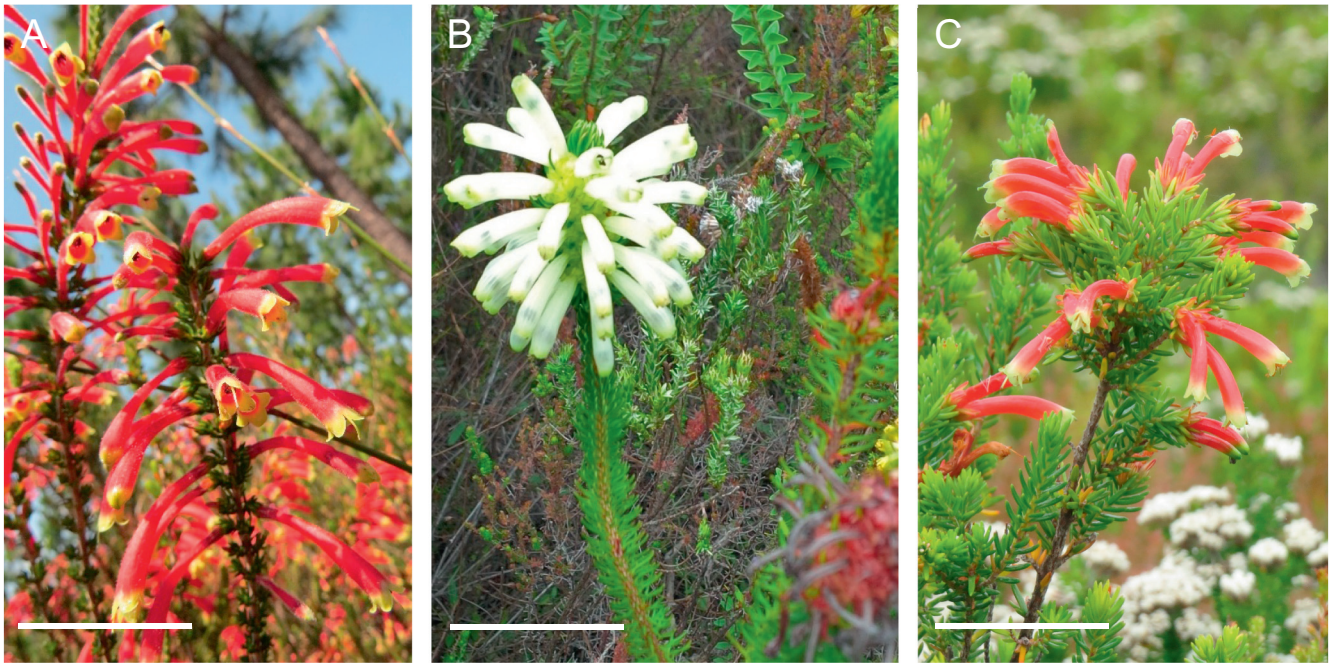


Fig. 1. Bird-pollinated *Erica* species. (A) *Erica densifolia*. Scale 40 mm. (B) *Erica sessiliflora*. Scale 30 mm. (C) *Erica discolor*. Scale 40 mm.

from bridal veil), hand-pollinated when they opened, re-bagged and thereafter their ripe fruit were collected six to eight weeks later depending on the *Erica* species. Four treatments were applied to each of the selected mature plants; 1) cross-pollination, 2) self-pollination with manual pollen transfer, 3) autonomous self-pollination, and 4) open-pollinated control. Each of these four treatments was applied on all selected plants. There were a minimum of 20 replicates (individual plants) per species. Pollen used for out-crossing was obtained from neighbouring plants that were at least

5 m distant. Anther rings of un-pollinated flowers were disturbed over a clean petri-dish to collect pollen. Using a micro dissecting spatula, pollen was applied to the receptive stigma (sticky to the feel and shiny surface) of a marked flower. The spatula surface was rinsed with clean water and dried after each pollen application. Flowers ($n = 20$ per species) were bagged but left un-manipulated to test for autogamy in the different species. Treated flowers were left in the bags to allow for fruits to mature for a minimum of six weeks. Toward the end of the ripening period, fruits were checked



Fig. 2. Insect-pollinated *Erica* species. (A) *Erica penicilliformis*. Scale 8 mm. (B) *Erica scabriscula*. Scale 8 mm. (C) *Erica formosa*. Scale 8 mm. (D) *Apis mellifera* pollinating *Erica scabriscula*. Scale 8 mm.

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