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Floral traits predict pollination syndrome in *Syzygium* species: a study on four endemic species of the Western Ghats, India

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Abstract. Pollination ecology and the breeding system of four endemic species of *Syzygium* (*S. heyneanum*, *S. travancoricum*, *S. laetum and S. mundagam*) of the Western Ghats, India are investigated. The floral traits are used for ordination analysis to understand if the species form any cryptic groups and whether this grouping predicts the pollination syndrome and the breeding system. Pollinators were distinguished from frequent visitors by studying their efficiency to transfer pollen to the stigma or induce fruit set following their exclusive visit to virgin flowers. The species formed two groups in the ordination map: the *S. heyneanum* and *S. travancoricum* group and the *S. laetum* and *S. mundagam* group. The flowers of studied species attracted 3–23 species of animals during the day, but none were encountered during the night. Flowers of *S. heyneanum* and *S. travancoricum* were visited by a large number of insect species of which only a limited number turned out to be the pollinators. *S. laetum* and *S. mundagam* attracted two bird species apart from a few insect species. In *S. laetum*, although birds did not bring about pollination directly, their visits facilitated anemophily by releasing pollen to the air by causing physical disturbance to the flowers. In *S. mundagam*, both birds and wind were involved in pollination. *S. heyeanum* and *S. travancoricum* were fully self-compatible, whereas *S. laetum* and *S. mundagam* were partially self-compatible.

Additional keywords: anemophily, breeding system, endemic species, ornithophily, partial self-incompatibility, plant–pollinator interaction, wet evergreen forest.

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Introduction

Syzygium (Myrtaceae) with over 1200 species is one of the most speciose angiosperm tree genus (Parnell *et al*. 2007). The genus is generally restricted to the tropical evergreen forests and its native range extends from Africa through Madagascar, south and south-east Asia to Australia and New Zealand (Mabberley 2008). Flowers of *Syzygium* are of brush type showing generalised pollination strategy. Studies on pollination biology in several *Syzygium* species especially of Australia and New Zealand have shown that the flowers are visited by several insect as well as vertebrate species (Hopper 1980; Crome and Irvine 1986; Beardsell *et al.* 1993; Law and Lean 1999; Boulter *et al*. 2005). In *Syzygium tierneyanum*, for example, as many as 45 species of animals have been reported to visit the flowers (Hopper 1980). Although the number of floral visitors has been recorded in several species, effective pollinators and their efficiency have not been assessed in most of these studies.

Syzygium is well represented in India with over 75 species. Many of the species of *Syzygium* reported from India are endemic to the Western Ghats biodiversity hotspot and a few of them are endangered (Nayar *et al*. 2006). Some of the species yield valuable timber and fruits of some species are edible. The leaves of several species are used as green manure by farmers. A few species are also of medicinal importance and some are used to extract natural dyes. Surprisingly, there is very little information on pollination biology of Indian species of *Syzygium*. A few available reports (Raju *et al*. 2014; Geethika and Sabu 2017; Varghese and Sreekala 2017) have largely documented floral visitors without distinguishing pollinators from casual visitors and also there is no information on pollinators' efficiency.

The present study attempts to investigate pollination ecology and the breeding system in four endemic species of *Syzygium*, i.e. *S. heyneanum*, *S. laetum*, *S. mundagam*, and *S. travancoricum* in the Western Ghats. All these four species are rare and distributed in small scattered populations in wet evergreen, riparian or swamp forests. Among these four species, *S. travancoricum* is considered critically endangered (Anonymous 2017). It has