Advantages of small-seeded species in forests: win-win for temporal and spatial dispersal among seeds in *Rhododendron*

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INTRODUCTION

The dynamics of seeds from maturity to germination and seedling establishment are the key links of the life cycle in angiosperms (e.g. Blendinger et al. 2011) and show that a series of strong life activities will influence the occurrence and distribution of species in plant communities (as reviewed in Donohue et al. 2010, Garciafayos et al. 1995). Since both seed germination and seedling establishment are products of natural selection through trade-offs in life history, they are closely related to the life history variables of plants, such as seed size, dispersal, dormancy, and seedling traits (e.g. Bu et al. 2008, Venable and Brown 2010, Volis and Bohrer 2013, de Waal et al. 2016). Seed size has always been considered to be a core character of plants that determines seed dispersal, predation, germination and seedling survival (Obeso et al. 2011). At present, it is generally believed that large seeds have more survival advantages in competition with small seeds, and this hypothesis has been supported by a large number of experimental observations (Bonfil 1998, Leishman et al. 2000, Bruun and Ten Brink 2008, Kosinski 2008, Petit 2011, Mishra et al. 2014). These results may be easy to understand because seed size reflects the amount of resources possessed by an individual offspring from the parent, such as the seed coat and their own embryo and endosperm. The abundant energy reserves provide the material basis for seedlings from a large seeds to cope with stresses from environment.

Nevertheless, a few studies showed that bigger is not always better. Bruun and Ten Brink (2008) found that although a bigger seed is of greater benefit in a closed forest, in