



Dispersal ability of island endemic plants: What can we learn using multiple dispersal traits?



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ABSTRACT

Island endemic species are expected to have lower dispersal ability than their non-endemic congeners. Several studies have demonstrated differences in diaspore morphology between endemic species and their non-endemic congeners. It is, however, relatively difficult to translate the differences in morphology of the diaspores into differences in dispersal ability. To avoid this problem, we measured directly dispersal values (anemo-, hydro-, exozoo- and endozoo-chory) of 27 pairs of closely related endemic and non-endemic species from Canary Islands. We did not explicitly support the hypothesis about the loss of dispersal ability of island species. The comparison of pairs of endemic and non-endemic species showed the reduction in dispersal potential only for endozoochory. In many cases, endemic species had, in fact, the same or better dispersal ability than their non-endemic congeners. Higher dispersal ability of endemic species could have been evolved as a consequence of species subsequent dispersal to neighboring islands. As a support for this we found that the endemic species dispersing better than their non-endemic congeners also occupy more islands within the archipelago. We conclude that reduction of dispersal ability of species on islands may not be as general as previously expected and we need to take into account multiple species traits to understand the possible evolution of species dispersal potential.

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Introduction

Oceanic islands have always fascinated scientists because of the various evolutionary phenomena arising from their specific conditions. One such phenomenon is the loss of dispersal ability of plant and animal species, which has been observed on many Pacific (Carlquist, 1965) and Atlantic islands (Talavera et al., 2012, 2013). According to Carlquist (1967) the main reason for the reduction of dispersal ability of island species is lower probability of propagules to be dispersed out to the sea. Additionally, due to relative stability of island habitats over time, species colonizing islands have no need to escape from such suitable sites (Cody and Overton, 1996; Kuno, 1981; McPeck and Holt, 1992).

According to these hypotheses, it could be predicted that selection will favor species with propagules of lower dispersability than was the dispersability of their ancestors when colonizing the island from the continent. Although the direct continental

ancestors may not exist any longer, the reduction of dispersability can be studied from comparison of dispersal abilities between island endemics and their continental relatives, as it was done by Carlquist (1974) on diaspores of various Hawaiian species. Carlquist (1974) demonstrated the loss of dispersal ability mainly as a reduction of seed morphological parameters enabling species to disperse.

A well-known example is the example of reduction of the awn length in island species of *Bidens* when compared to their mainland relatives (Carlquist, 1966). Assessing dispersal abilities from diaspore morphological parameters is a common method used in many studies on species dispersal (e.g., Bernardello et al., 2006; Cody and Overton, 1996; Hughes et al., 1994; Matlack, 1987; Ridley, 1930; van der Pijl, 1982; Willson et al., 1990). However, diaspore morphology may not always be a sufficient predictor of dispersal ability (Willson et al., 1990). This could be the reason, why Lavergne et al. (2004) did not find any differences between dispersal ability (estimated from parameters such as pappus length and surface) of 6 congeneric pairs of endemic and non-endemic species from the French Mediterranean region. As Sheldon and Burrows (1973) demonstrated on 18 species of the family Compositae, the differences in dispersal ability are given more likely in fine details of diaspore morphology such as the

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possession of hairs on achenes which are, however, not easily measurable. In fact, species with no apparent morphological adaptation can be also successfully dispersed as shown by e.g., Couvreur et al. (2004), Fischer et al. (1996); Heinken and Raudnitschka (2002) and Vargas et al. (2012). As a consequence, the results based on diaspore morphological parameters can differ from the results based on direct measurements of diaspore dispersal ability as demonstrated by Fresnillo and Ehlers (2008) on mainland and island populations.

In contrast to morphological parameters, direct determination of diaspore dispersal ability enables the estimation of the dispersal ability of all species by multiple vectors reducing the risk of overlooking an important dispersal agent in each particular species. Unlike morphological parameters, the values describing dispersal ability by different vectors are transferable into dispersal

distances (e.g., Tackenberg et al., 2003; Will and Tackenberg, 2008) and thus, are more appropriate for studying large groups of species with a large variation in diaspore types. Although the methodology for estimating dispersal ability of species by different modes (anemo-, hydro-, exo-, endozoochory, Knevel et al., 2005; Vazačová and Münzbergová, 2013) is well-elaborated, most studies are focused usually on one, most easily quantifiable vector. Such approach may, however, underestimate the real dispersal ability of the studied species because they usually do not disperse by only a single dispersal vector (Nathan, 2007; Vargas et al., 2012).

The comparison of traits between endemic and non-endemic species can also shed light on the evolutionary potential of different traits. The papers exploring the evolution of woodiness, growth form or floral type of island plants demonstrated that some traits are conserved remaining almost unchanged during evolution

Table 1

List of 27 species pairs used in the study (the first mentioned is endemic species).

Species name ^a	Family	Phylogeny	Analysed propagule
<i>Artemisia thuscula</i> Cav.	Asteraceae	Sanz et al., 2008	Seed
<i>Artemisia reptans</i> C. Sm. in Buch			
<i>Asteriscus graveolens</i> ssp. <i>stenophyllus</i> (Link) Greuter	Asteraceae	Goertzen et al., 2002	Achene (with pappus)
<i>Asteriscus aquaticus</i> (L.) Less.			
<i>Atractylis preauxiana</i> Sch. Bip.	Asteraceae	No	Achene (with pappus)
<i>Atractylis cancellata</i> L.			
<i>Brachypodium arbuscula</i> Knoche	Poaceae	Catalán and Olmstead, 2000	Seed (with glumes)
<i>Brachypodium sylvaticum</i> (Huds.) P. Beauv.			
<i>Carex canariensis</i> Kük.	Cyperaceae	Hendrichs et al., 2004	Seed (with utricle)
<i>Carex divulsa</i> ssp. <i>divulsa</i> Stokes			
<i>Cistus ocreatus</i> C. Sm. in L. von Buch	Cistaceae	Guzmán and Vargas, 2010	Seed
<i>Cistus monspeliensis</i> L.			
<i>Echium wildpretii</i> ssp. <i>wildpretii</i> Pearson ex Hook. f.	Boraginaceae	Böhle et al., 1996	Seed plus calyx
<i>Echium plantagineum</i> L.			
<i>Erica platycodon</i> spp. <i>platycodon</i> (Webb and Berthel.) Rivas-Mart. and al.	Ericaceae	McGuire and Kron, 2005	Seed
<i>Erica arborea</i> L.			
<i>Euphorbia atropurpurea</i> (Brouss.) Webb & Berthel.	Euphorbiaceae	Barres et al., 2011	Seed
<i>Euphorbia regis-jubae</i> Webb & Berthel.			
<i>Geranium reuteri</i> Aedo and Muñoz Garm.	Geraniaceae	Based only on morphology Yeo, 1973	Seed
<i>Geranium robertianum</i> L.			
<i>Helianthemum thymiphyllum</i> Svent.	Cistaceae	No	Seed
<i>Helianthemum canariense</i> (Jacq.) Pers.			
<i>Hypericum glandulosum</i> Aiton	Hypericaceae	No	Seed
<i>Hypericum perforatum</i> L.			
<i>Lotus tenellus</i> Dryand. in Aiton	Fabaceae	No	Seed
<i>Lotus glinoides</i> Delile			
<i>Pancratium canariense</i> Ker-Gawl.	Amaryllidaceae	No	Seed ^b
<i>Pancratium maritimum</i> L.			
<i>Phagnalon umbelliforme</i> DC.	Asteraceae	Montes-Moreno et al., 2010	Achene (with pappus)
<i>Phagnalon saxatile</i> (L.) Cass.			
<i>Plantago arborescens</i> ssp. <i>arborescens</i> Poir.	Plantaginaceae	Rahn, 1996	Seed
<i>Plantago afra</i> L.			
<i>Polycarpaea aristata</i> (Aiton) DC.	Caryophyllaceae	No	Seed
<i>Polycarpaea nivea</i> (Aiton) Webb			
<i>Reichardia ligulata</i> (Vent.) G. Kunkel & Sunding	Asteraceae	Kim et al., 2007	Achene (with pappus)
<i>Reichardia tingitana</i> (L.) Roth			
<i>Reseda crystallina</i> Webb and Berthel.	Resedaceae	Martín-Bravo et al., 2007	Seed
<i>Reseda luteola</i> L.			
<i>Rumex lunaria</i> L.	Polygonaceae	Navajas-Pérez et al., 2005	Achene
<i>Rumex vesicarius</i> L.			
<i>Salvia canariensis</i> L.	Lamiaceae	Walker and Sytsma, 2007	Seed
<i>Salvia aegyptiaca</i> L.			
<i>Scrophularia smithii</i> ssp. <i>smithii</i> Hornem.	Scrophulariaceae	No	Seed
<i>Scrophularia arguta</i> Sol. ex Aiton			
<i>Senecio palmensis</i> (C. Sm. in Buch) Link	Asteraceae	No	Achene (with pappus)
<i>Senecio glaucus</i> ssp. <i>coronopifolius</i> (Maire) C. Alexander			
<i>Solanum vespertilio</i> Aiton	Solanaceae	No	Seed
<i>Solanum nigrum</i> L.			
<i>Sonchus canariensis</i> ssp. <i>canariensis</i> (Sch. Bip.) Boulos	Asteraceae	Kim et al., 1996	Achene (with pappus)
<i>Sonchus oleraceus</i> L.			
<i>Tolpis laciniata</i> (Sch. Bip. ex Webb & Berthel.) Webb	Asteraceae	Moore et al., 2002	Achene (with pappus)
<i>Tolpis barbata</i> (L.) Gaertn.			
<i>Vicia cirrhosa</i> C. Sm. ex Webb & Berthel.	Fabaceae	Leht, 2005	Seed
<i>Vicia hirsuta</i> (L.) S. F. Gray			

^a The species names according to Arechavaleta et al. (2010).

^b Diaspores from the Botanical Garden.

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