Invasive plants disrupt native plant community dynamics, ecosystem function, agriculture, and forestry, globally costing billions of dollars in management each year (Pimentel, Zuniga & Morrison, 2005). Identifying the mechanisms underlying invasive plant establishment and native plant decline remains a central goal in ecology. A recent meta-analysis highlighted the widespread evidence that plant–plant interactions are involved in plant invasion dynamics (Kuebbing & Nunez, 2016). In particular, it was shown that under experimental conditions, native plants were more suppressed in growth than non-native plants when grown with non-native neighbors. Moreover, native neighbors tended not to suppress the growth of non-native focal plants at all (effect size overlaps with zero). These results suggest that native plants are weak competitors compared to non-native plants, suggesting that invasive plants displace native plants by outcompeting them.

For biodiversity hotspots, such as insular islands, plant invasions are particularly devastating and are the primary drivers of native plant declines (Caujape-Castells et al., 2010). Identifying mechanisms of plant invasions on islands will not only improve management efforts by targeting the most critical processes of invasive species success, but it can also shed light on predicted inherent differences between island and continental plants, the so-called "island rules" (Patino et al., 2017). For example, low species richness on islands could result in the availability of niche space, which when filled by fast growing and vigorous invasive species could lead to the displacement of native plants that are outcompeted by invasive species (Simberloff, 1995; Stachowicz & Tilman, 2005). To assess whether competition effects of non-native on native plants are generally stronger on islands than continents, we re-analyzed the Kuebbing and Nunez meta-dataset after adding the additional variable of site (island vs. continent).

Searches on Web of Science (using the same keywords as Kuebbing & Nunez, 2016 with the addition of "island") revealed no additional studies testing plant competition on islands published since 2016. In addition, we perused all publications that have cited Kuebbing and Nunez (2016), none of which provided new experimental tests of competition on islands. Thus, our new analyses were conducted on the meta-dataset published by Kuebbing and Nunez (2016). After reviewing the full meta-dataset, we determined that 10 of the 83 publications were conducted on islands (Britton,
We conducted a meta-analysis to test whether neighbor effects differed between islands and continents using the package 'metafor' (Viechtbauer, 2014) package in R version 3.4.3. The effect size used was Hedges’ d, which includes a correction factor for small sample sizes and is robust to unequal sampling variances (Gurevitch, Curtis & Jones, 2001). The significance of site (island vs. continent) was tested in mixed effects models using the rma.mv() function, including publication as a random factor. Model-generated group means and 95% confidence intervals are presented in Figure 1; significant effect sizes are those with confidence intervals that do not overlap with zero. This analysis revealed that as predicted, neighbor effects of non-native plants on other non-native plants on islands vs. continents ($Q_M = 5.4490, df = 1, p = 0.0196$; Figure 1), suggesting that in contrast to the island rule prediction, competitive interactions may be stronger among native island than continental plants. With the exception of New Zealand, the island floras represented in this analysis are comparable to temperate forests with relatively low species richness. Only Hawaii is sub-tropical, and it has much lower species richness than other sub-tropical and tropical forests (Ostertag, Inman-Narahari, Cordell, Giardina & Sack, 2014). Strong competition among native island plants could evolve due to the high likelihood of species co-occurring in the relatively low-richness island floras (Gilbert & Lechowicz, 2004; Hubbell, 2005). In contrast, in high-diversity forests, neutral theory has posited that community assembly via competitive niche partitioning is unlikely given the requirement of equilibrium, which is effectively never reached in time (Hubbell, 2005). Moreover, if competitive interactions do not consistently occur between species over evolutionary time due to the relatively low abundances within species, competitive niche partitioning may never arise in high-diversity forests (Hubbell, 2001). No difference was detected in the neighbor effects of non-native plants on other non-native plants on islands vs. continents ($Q_M = 0.0087, df = 1, p = 0.9258$; Figure 1), indicating that invasive species do not appear to be competing more aggressively against other invasive species on islands than continents.

This meta-analysis, which capitalizes on a previously published dataset (Kuebbing & Nunez, 2016), highlights important gaps in our knowledge of the role of competition in plant invasions on islands. Despite the primary role invasive plants play in the decline of native island floras (Caujape-Castells et al., 2010), there is a paucity of experimental studies directly testing competition between native vs. invasive island plants (D’Antonio, Hughes, Mack, Hitchcock & Vitousek, 1998). Although community-scale studies report patterns consistent with competition between invasive and native plants on islands (Cordell et al., 2009; Monty, Florens & Baider, 2013; Walker & Vitousek, 1991; Yessoufou, Bezeng, Gaoue, Bengu & van der Bank, 2018), there is an urgent need for studies designed explicitly to test competition. Finally, the research bias of primarily studying islands in temperate regions (e.g., Japan, Great Britain, New Zealand) means that the role of competition in plant invasions remains particularly unclear in tropical islands. High geographic isolation and endemism make tropical islands particularly vulnerable to plant invasions (Caujape-Castells et al., 2010), highlighting the importance of identifying mechanisms of invasion for conservation of these biodiversity hotspots.

ACKNOWLEDGMENTS

The authors thank K. Feliciano, A. Westerband and T. Lum for discussions contributing to this meta-analysis. Feedback from two reviewers improved the manuscript.

DATA ACCESSIBILITY

Data available from the Dryad Digital Repository: https://doi.org/10.5061/dryad.rc7bh42 (Barton & Wong, 2019).
REFERENCES


SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

How to cite this article: Barton KE, Wong A. Plant competition as a mechanism of invasion on islands: Revisiting the conclusions of Kuebbing and Nuñez (2016). Biotropica. 2019;51:316–318. https://doi.org/10.1111/btp.12659