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Fitness consequences of seed size in the valley oak *Quercus lobata* Née (Fagaceae)

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Abstract

• **Introduction** We examined the functional relationship between seed size and seedling performance in the valley oak (*Quercus lobata* Née) by means of a 13-year common garden experiment.

• **Materials and methods** Acorns were collected from five localities throughout the range of valley oak in autumn 1997, weighed and measured, and planted at Sedgwick Reserve, Santa Barbara County, California, USA.

• **Results** In the short term, larger acorns produced larger seedlings that had lower survival than seedlings from smaller acorns. In the longer term, large seeds correlated positively with both seedling size and survival, with path analyses indicating that the latter effect was primarily indirect via initial seedling size. The longer-term relative growth rate was only weakly related to seed size, being a combination of a slight positive direct influence of seed size on relative growth rate and a comparable negative indirect effect via larger initial seedling size.

• **Discussion** These results generally matched the predictions of the “seedling size effect hypothesis” (larger seeds

yield larger seedlings with greater competitive abilities), the only one of the three hypotheses we examined that predicts an inverse relationship between seed size and initial survival and a positive relationship between seed size and longer-term relative growth rate. The factors influencing the relationships between seed size and seedling performance are complex and may involve both direct effects of seed size and indirect effects mediated through initial seedling size. Although the seedling size effect was the most important in our study, other factors may be important under different environmental conditions and/or at different growth stages.

Keywords Acorn size · Fagaceae · *Quercus lobata* · Reserve effect · Seed size · Seedling size effect · Valley oak

1 Introduction

Numerous studies have demonstrated that larger seeds enhance seedling performance. However, the mechanisms by which this effect is achieved appear to be diverse and variable. Currently, three hypotheses are thought to be potentially important to this observation (Westoby et al. 1996). First is the “reserve effect,” whereby larger seeds retain extra metabolic resources that can be used to enhance survival if conditions are unfavorable (García-Cebrián et al. 2003; Green and Juniper 2004a; Myers and Kitajima 2007). Second is the “metabolic effect,” whereby seedlings from larger seeds have slower relative growth rates and consume resources more slowly, thus potentially enhancing long-term survival (Saverimuttu and Westoby 1996; Wright and Westoby 1999). Third is the “seedling size effect,” whereby larger seeds produce larger seedlings that are better competitors and thus better able to gain greater access to resources.

To date, most tests of these hypotheses have involved interspecific or interpopulation comparisons in which

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