Genotype by environment interactions in seed size are ubiquitous in relation to water availability: evolutionary potential through phenotypic plasticity

Eugenio Larios and Susan J. Mazer
Department of Ecology, Evolution, and Marine Biology
University of California, Santa Barbara

Abstract

Seed size is a key trait that influences seedling performance and individual fitness. The evolutionary trajectory of seed size depends, however, on whether seed size variation is determined by genetic variance. The expression of genetic sources of phenotypic variance in seed size may be also environment-dependent, reflecting genetic variation in phenotypic plasticity. Previous work in the desert annual, *Dithyrea californica*, showed that maternal plants that experienced more stressful conditions under natural conditions produced smaller seeds with higher dispersibility than maternal plants growing under low stress. This pattern suggested that a plastic response in which stress induces the production of smaller seeds may be selectively favored because it facilitates the escape of seeds from such conditions. In this study, we used a quantitative genetic approach to reveal the genetic basis of seed size and its plastic response to drought stress in *Dithyrea californica*. We used a diallel mating design in the greenhouse to estimate genetic and environmental variance components for seed size. We replicated diallels in two watering treatments to examine environmental effects on seed size and to detect genotype x environment interactions. We estimated general combining ability (GCA), specific combining ability (SCA), and reciprocal effects (RGCA and RSCA) and their interactions with water availability. We examined norms of reaction for maternal and paternal families to reveal the magnitude of genetic variation in phenotypic plasticity for seed size in three populations. Seed size variation in the sampled populations of *D. californica* was mostly determined by the combination of watering treatment and additive and maternal genetic variances, but neither maternal nor paternal identity alone consistently influenced seed size. Genetic variation in phenotypic plasticity on seed size is greater than variation among genotypes, indicating that seed size may evolve more readily through selection on plasticity than through selection on individual seed phenotype.