“Quantitative approaches to measuring natural selection on floral traits”

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Abstract

Flowers are suites of correlated complex traits and are commonly described as adaptations to pollination by specific animal pollinators. However, ecological studies often conclude flowers are visited by many pollinator species, and the preeminent role of pollinators as selective agents for flowering plant evolution is in question. Empirical evidence is presented using five years of pollination data collected in the field from three related species of wildflowers (*Silene caroliniana*, *S. virginica*, and *S. stellata*) that demonstrates (1) flowers specialize on subsets of all pollinators, as defined by relative frequency of visits (visitation rate) and effectiveness (pollen grain deposition), and (2) pollinators are sources of natural selection on floral traits. For (1), a simulation/ bootstrap method was developed to estimate the mean and upper and lower 95% confidence limits of a product of random variables (frequency * effectiveness). The method is compared to parametric estimates calculated using a result on the variance of a product of random variables and the probability distribution of a product of two normal random variates. For (2), second-order polynomial regression models were used to find correlative evidence of pollinator-mediated selection as the coefficients of linear (β) and nonlinear (γ) relationships between floral trait expression and plant fitness measured from *S. virginica* plants. Response surface methodology indicated curvature in latent orthogonal axes describing the selection surface. The statistical methodologies used were critical for accurately describing the specialized pollination systems and for demonstrating pollinator-mediated selection on floral traits and trait combinations.