Local Adaptation in two sister species of Neotropical Costus (Costaceae)

Grace F. Chen1,4 and Douglas W. Schemske2,3

1Biology Department, SUNY College at Oneonta, Oneonta, New York, 2Department of Plant Biology, Michigan State University, East Lansing, Michigan, 3W. K. Kellogg Biological Station, Hickory Corners, Michigan, 4Email: Grace.Chen@oneonta.edu

INTRODUCTION

Natural populations are typically adapted to their local environments. Such local adaptation is a consequence of divergent selection caused by geographic variation in environmental conditions (Kawecki and Ebert 2004). By driving the diversification of populations, adaptive divergence can contribute to speciation and to biodiversity (Sobel et al. 2010). Therefore, understanding the magnitude and mechanisms of local adaptation is of fundamental importance to understanding the relationships between ecological factors and the origin and maintenance of species.

Local adaptation studies have been commonly conducted in temperate plant communities, but rarely in the tropics (Leimu and Fischer 2008). To understand general patterns of local adaptation, such as identifying the major ecological variables and adaptive traits contributing to local adaptation, it is necessary to study plants both in temperate and tropical regions. Furthermore, as tropical communities typically have higher species richness than temperate ones, studying local adaptation in the tropics should contribute to our understanding of the mechanisms which contribute to latitudinal patterns of biodiversity. To this end, we studied the magnitude and the mechanisms of local adaptation in two recently diverged species of tropical herbs, Costus alleni and C. villosissimus (Costaceae) in central Panama.

MATERIALS and METHODS

Study System: C. alleni are found along ravines in the understory of primary forest, while C. villosissimus are found along forest edges. Study Site: Soberania National Park and Barro Colorado Nature Monument in central Panama

1. Determine the micro-spatial distribution of the two species in central Panama, where both species naturally occur.
2. Quantify precipitation, soil moisture, and light availability in habitats of the two species to determine if these factors differ between species, and hence might contribute to local adaptation.
3. Conduct reciprocal transplant experiments with seeds and clonal replicates to determine whether the current distribution of the two species is a consequence of local adaptation.
4. Measure four putative adaptive traits that may contribute to local adaptation:
   a. the timing of seed germination,
   b. leaf damage,
   c. drought tolerance,
   d. leaf mass per area (LMA).

RESULTS

1. Costus alleni and C. villosissimus display a parapatric distribution.

2. Costus alleni and C. villosissimus are found in distinct habitats.

3. The two species are locally adapted to their natural habitats.

DISCUSSION

Our reciprocal transplant experiments indicate that the parapatric distribution of C. alleni and C. villosissimus is a result of strong local adaptation. Furthermore, we find that Costus alleni has less leaf damage and higher leaf mass per area and occupies habitats with lower light availability, while C. villosissimus has higher drought tolerance and later seed germination, and occupies habitats with lower soil moisture. We suggest that C. alleni is adapted to shady, understory habitats by virtue of its greater defense against herbivores and its ability to grow in low-light environments, and that escape and tolerance to drought allow C. villosissimus to persist in dry, open habitats. Our results are consistent with Coley et al.’s hypothesis (1985) that when growing in shady habitats, sun-adapted plants are unable to produce new leaves fast enough to compensate for herbivore damage, and thus experience high mortality. Because C. alleni and C. villosissimus are mainly isolated by their microhabitats (Chen 2011), examining the magnitude and mechanisms by which these species have adapted to their different habitats enhances our knowledge of adaptation and speciation in the tropics.

LITERATURE CITED


