Appendix from J. M. Sobel, “Ecogeographic Isolation and Speciation in the Genus *Mimulus*”
(Am. Nat., vol. 184, no. 5, p. 565)

Species Distribution Modeling
Selection and Manipulation of Environmental Layers

All environmental layers were visualized and manipulated in ArcGIS, version 9.3 (ESRI, Redlands, CA). Eight variables were selected from the publicly available data set WORLDCLIM, which consists of ∼1-km²-resolution climatic grid layers (Hijmans et al. 2005). Variables were selected that are likely to be of ecological importance in determining the distribution of plant species, including variation in precipitation, temperature, and seasonality, many of which exhibit significant correlations (table 2). A geological map of California was also obtained from the U.S. Geological Survey (http://usgs.gov). This vector layer consists of a qualitative assessment of basic geologic parent material, broken into 51 categories (e.g., sandstone, serpentine), which was converted to raster data with the same resolution as the WORLDCLIM data. The availability and quality of geologic data varied considerably across states and countries. Therefore, all analyses were performed with a maximum extent limited to the borders of the state of California.

Construction of Species Distribution Models

Species distribution models (SDMs) were constructed for all 24 *Mimulus* species with Maxent software, version 3.3.1 (Phillips et al. 2006). Maxent is ideal for generating SDMs from herbaria records, because it makes use of presence-only data such as these (Elith et al. 2006; Phillips et al. 2006; Kozak et al. 2008) and has been consistently shown to offer improved predictions over alternatives (Elith et al. 2006). In addition to the environmental variables (table 2), a bias layer was provided to Maxent to control for spatial collection bias and grid size variation in WORLDCLIM layers over large spans of latitude (Elith et al. 2011). For each species, these layers were trimmed to limit the spatial extent of analysis to a 2° buffer surrounding collection records, as described in “Species Distribution Modeling” in the main text. The eight climatological-variable layers were specified as continuous data, while the geologic layer was treated as categorical. Jackknifing of these variables was used to estimate the relative importance of these layers. Collection records were assigned randomly to equal-sized training and testing partitions, and 100 bootstrap replicates were performed, such that a unique set of testing and training data was randomly drawn for each pseudoreplicate. Maxent estimates a probability distribution over every pixel in the study area; therefore, the sum of all pixel probability values is 1 (Phillips et al. 2006). The output format was set to “cumulative,” which provides continuous spatial output in which each pixel is assigned a summed value of all pixels with lesser probability of suitability. For feature types, the default “Auto features” was used, which allows Maxent to perform appropriate transformations on the environmental variables given as input.

The cumulative equal training sensitivity and specificity (ETSS) threshold was selected to produce binary SDMs from the Maxent output. This threshold is highly correlated with other choices (fig. A1), and produces qualitatively similar results. *Mimulus* has several rare species with very few collection records (table 1). One of the benefits of using Maxent is that it has been shown to be effective at very low sample sizes (Papes and Gaubert 2007; Pearson et al. 2007; Wisz et al. 2008). To accommodate these rare species, a “jackknife minus 1” cross-validation technique was used for any species with fewer than 50 accessions (following Pearson et al. 2007).
Figure A1: Correlation between alternate threshold values. The equal training sensitivity and specificity (ETSS) threshold chosen for use in distribution modeling and the maximum of the sum of sensitivity and specificity are highly correlated, resulting in similar spatial extents and values of isolation.

Literature Cited Only in the Appendix