April 13, 2016**. Adaptive radiation**

Reading:
Hodges, S. 1995. Spurring plant diversification: Are floral nectar spurs a key innovation? *Proc. Roy. Soc. London Ser. B* 262:343-348.

Harmon, L. J., J. A. Schulte, II, A. Larson, and J. B. Losos. 2003. Tempo and mode of evolutionary radiation in Iguanian lizards. *Science* 301:961-964.

Ackerly, D. D. 2009. Conservatism and diversification of plant functional traits: Evolutionary rates versus phylogenetic signal. *PNAS* 106:19699–19706.

1. Central questions of adaptive radiation research:
   - What is an adaptive radiation? Is it something special. Is it a category or a continuum (i.e. some clades are adaptive radiations and some aren't).
   - What is the link between trait and lineage diversification? One can imagine a 3x2 matrix with 6 different scenarios/phenomena. Fill in the blanks!

	Rate of lineage diversification	
Trait evolution	LOW	HIGH
Ancestral trait innovation		
Low rate of trait diversification		
High rate of trait diversification		

2. Key innovation and diversification
   The case of nectar spurs in *Aquilegia* (S. Hodges)
   Floral symmetry and sister clade diversification in angiosperms (Sargent)
   BISSE – trait dependent diversification (Maddison)

3. Adaptive radiation: evolution of disparity and diversification
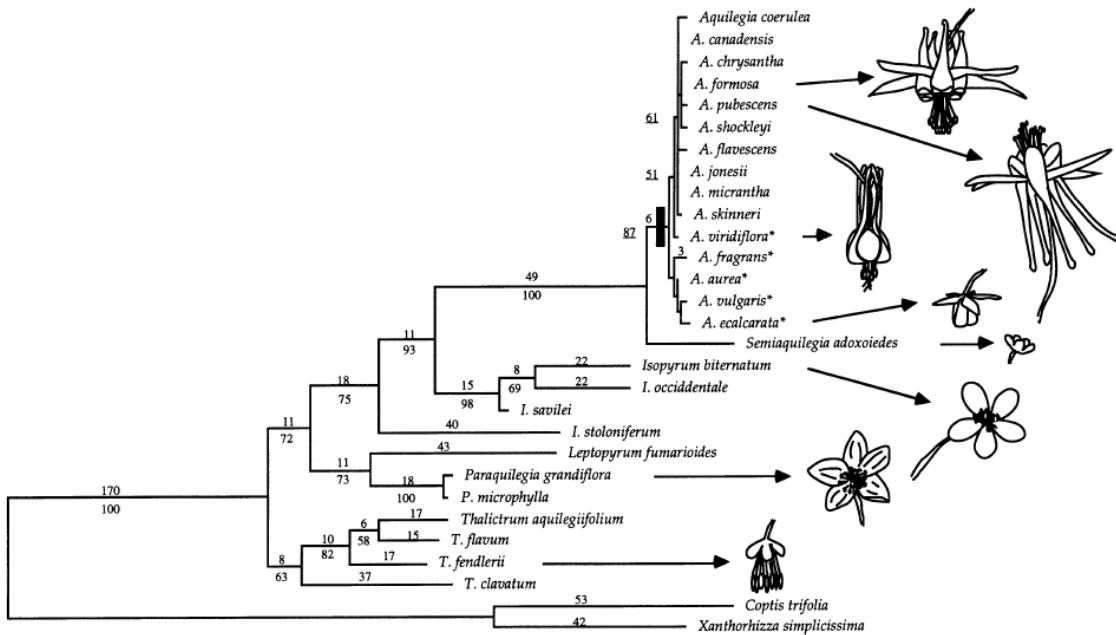   *Anolis* lizards:
   Ecomorphs and phylogeny (Losos)
   Macrohabitat radiations within ecomorphs (Glor)
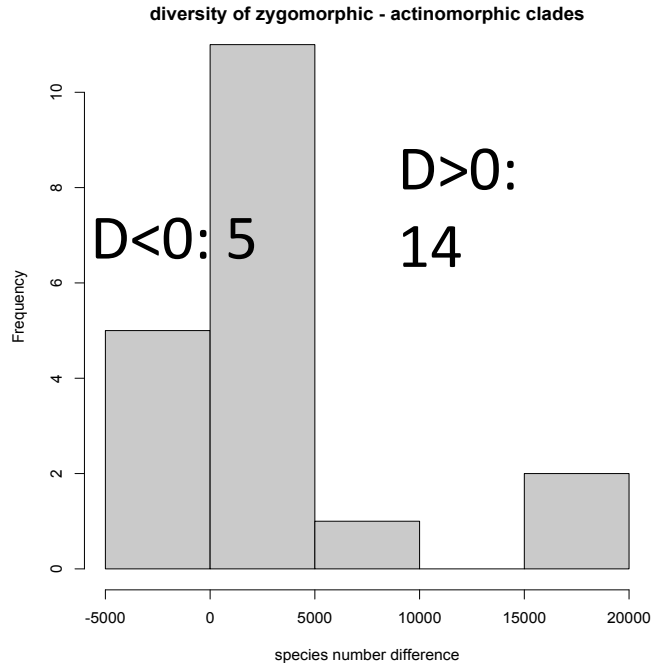   Disparity vs speciation (Harmon)

4. Testing for rate variation in continuous trait evolution
    O'Meara – brownie: ML test for 2 vs. 1 rate parameter
    Martin and Wainwright (2011) application to divergence in feeding morphology

Hodges and Arnold 1995 Proc Roy Soc

diversity of zygomorphic - actinomorphic clades

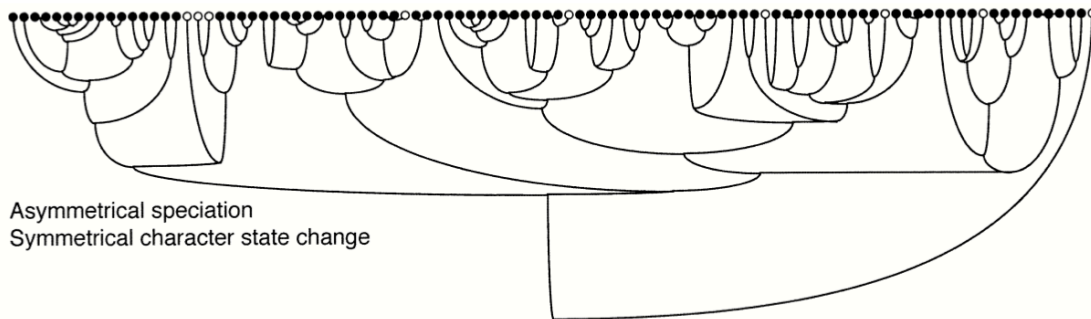D<0: 5

D>0: 14
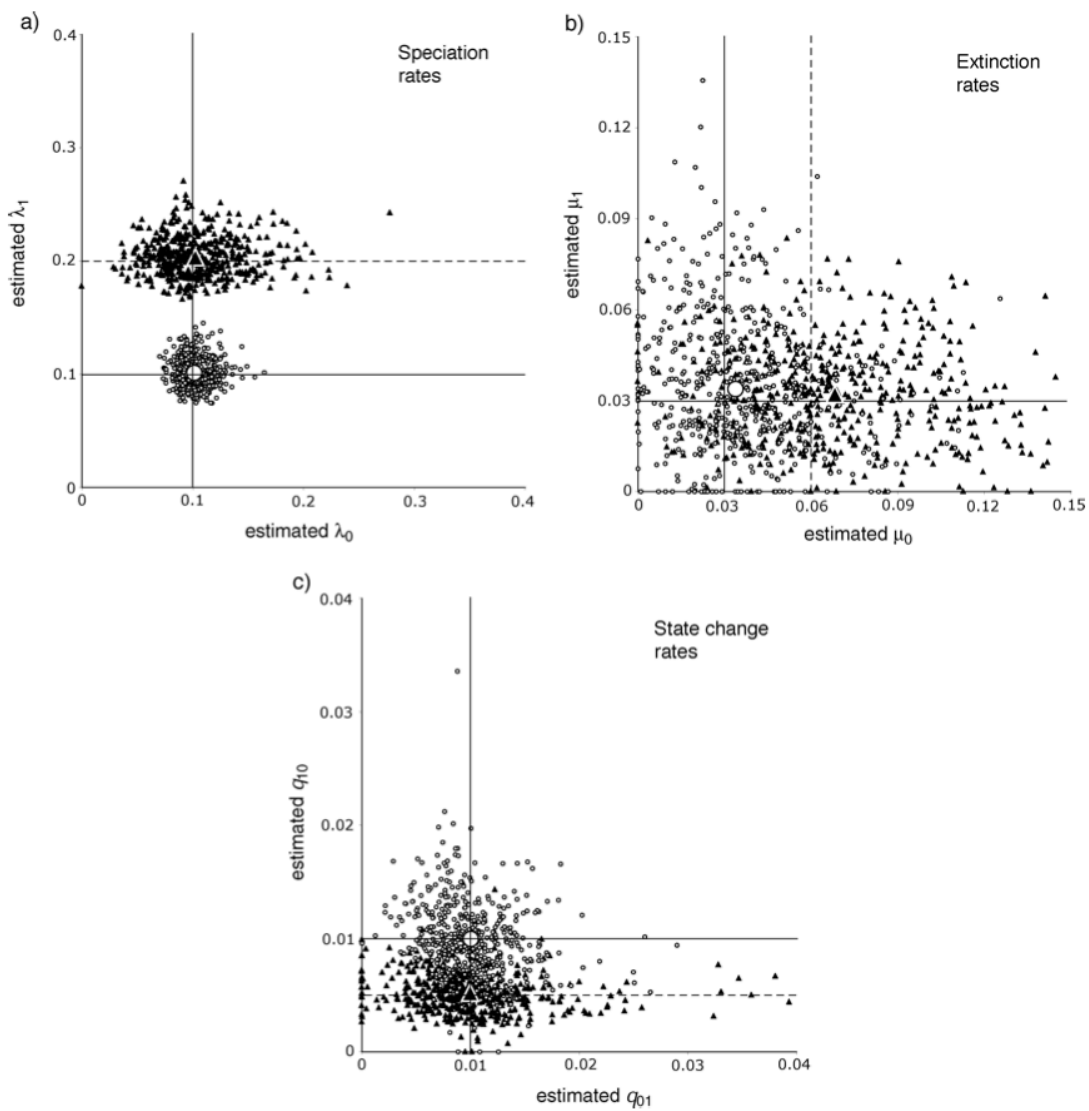
Sargent 2004 Proc Roy Soc Lond B

FIG. 1. An example tree and character distribution, simulated with biased speciation. Rate of speciation with state 1 (black) five times higher than rate of speciation with state 0 (white). States at internal nodes are parsimony reconstructions, not the actual ancestral states as simulated.

Maddison 2006 Evolution

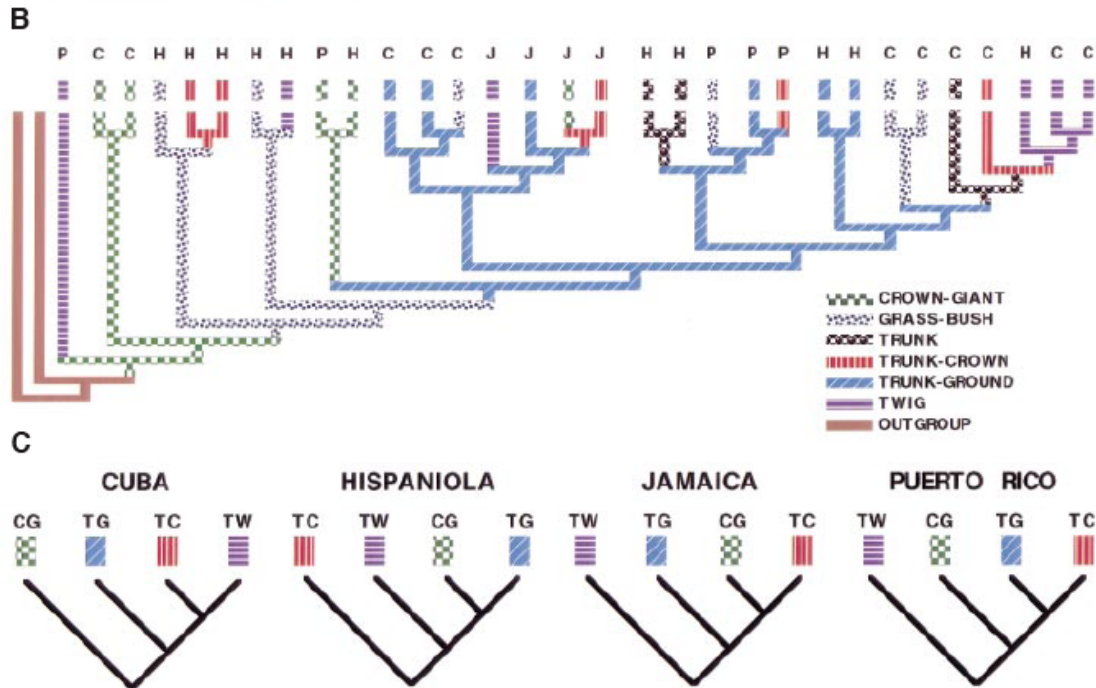

Maddison et al. 2007 Evolution
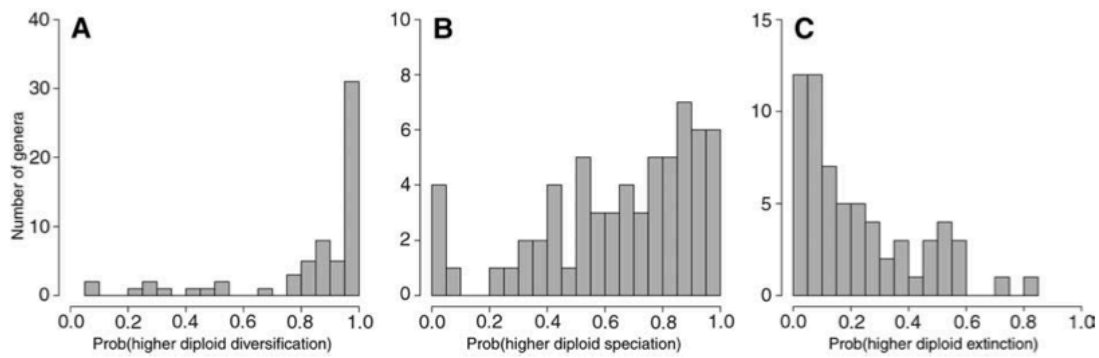
Fig. 1. The posterior probabilities that diploids exhibit higher rates of (**A**) diversification, (**B**) speciation, and (**C**) extinction than polyploids.

Mayrose et al. 2011
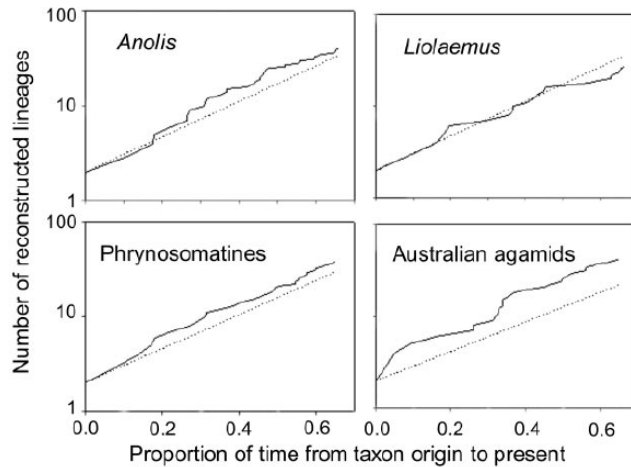

Losos et al. 1998 Science

Fig. 1. Lineage accumulation curves for four lizard taxa compared with expectations under the null pure-birth model. Time is expressed as a proportion of the total time since the first cladogenetic event inferred for the taxon. Only the first two-thirds of each phylogeny is shown. Expected curves are obtained using an exponential model with the first branching in a clade set to time = 0 and the number of extant species (Table 1) set to time = 1. Solid line, actual number of reconstructed lineages for the clade; dashed line, expected number of lineages under the null pure-birth model.
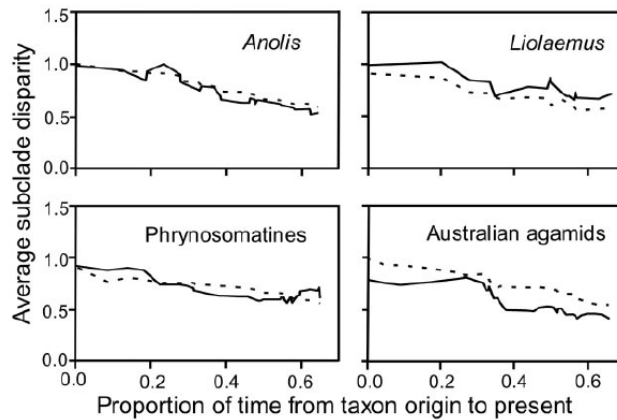

Fig. 3. Relationship between LDI and MDI. Data show a highly significant negative correlation (*19*) ($r = -0.998$, $P = 0.004$). A variety of analyses indicate that the among-clade relationship between LDI and MDI is well-supported and robust to relaxation of assumptions concerning mode of character evolution, sampling, and extinction (*19*) (figs. S6 and S7; 95% confidence limits were established by calculating MDI separately for each of the 1000 simulations of character evolution that were used to calculate MDI for each clade). This result is also significant if γ (corrected for incomplete sampling by subtracting the mean of the γ values in the MCCR test simulations and dividing by the standard deviation of these simulation γ values) and δ values are used for each clade (standardized γ versus δ_{MLE}, $r = 0.97$, $P = 0.03$; in this analysis, the correlation is positive because more negative values of γ reflect a slowdown in diversification, corresponding to larger values of our LDI statistic).

Harmon et al. 2003 Science
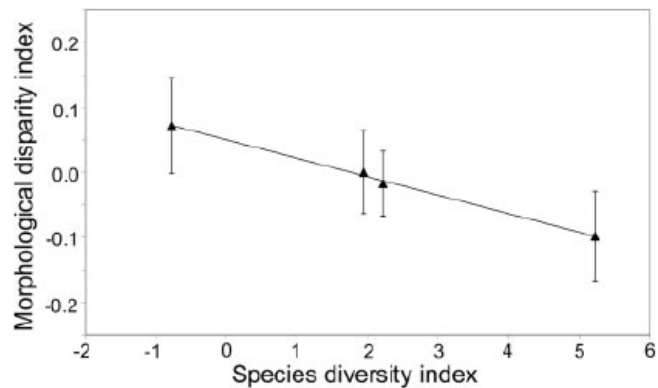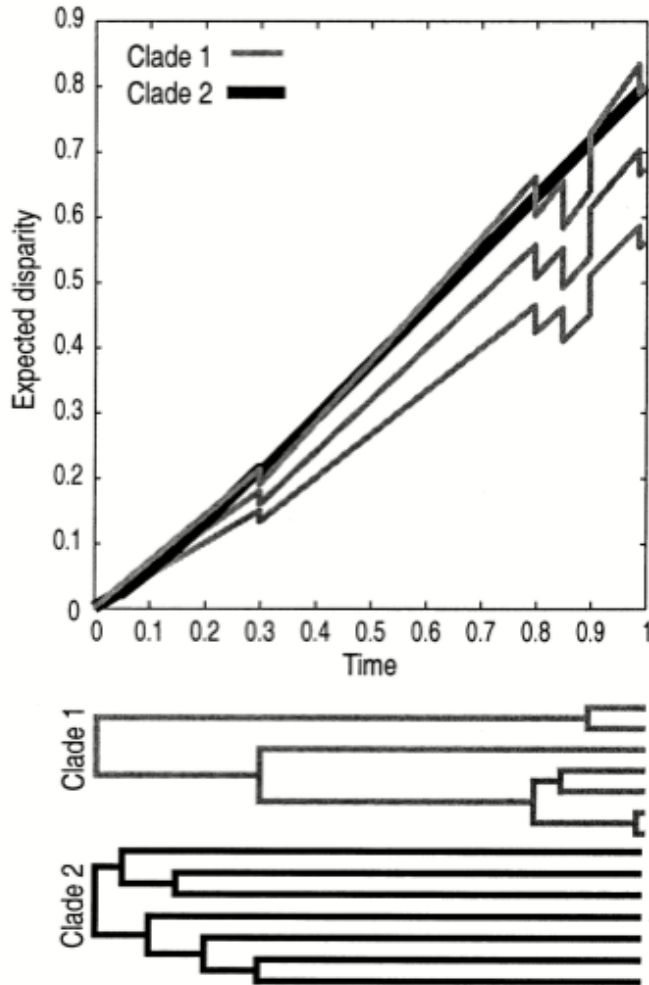
O'Meara et al. 2006 Evolution
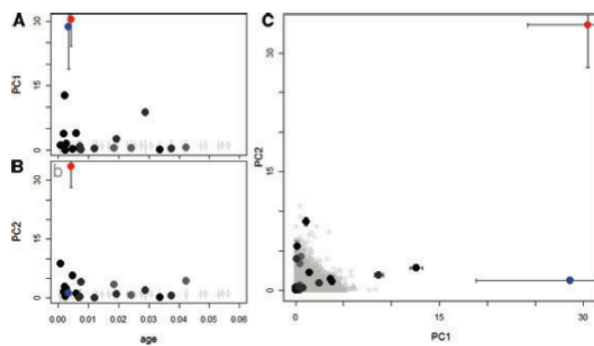
Figure 4. Relative rates of morphological diversification (mean ± SE) on the (A) first and (B) second principal component axes relative to clade age. (C) The morphological diversification rate-space (mean ± SE) on the first and second principal component axes. Observed rates are indicated for the Chichancanab (O) and San Salvador (●) clades, and all other two-species (●), three-species (●), and four-species (●) *Cyprinodon* clades measured; note that points are not statistically independent due to nested clade structure and shared histories. Means and standard errors were calculated by repeating rate analyses for 100 trees sampled from the stationary MCMC distribution. (A, B) Simulated relative rates of morphological diversification (mean ± 2SD) under a Brownian motion model for 1000 iterations are shown in gray (●). (C) Each simulation is indicated by one point (●) in the morphological diversification rate-space.

Martin and Wainwright 2011 Evolution

Reading list:

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O'Meara, B. C., C. M. Ane, M. J. Sanderson, and P. C. Wainwright. 2006. Testing for different rates of continuous trait evolution in different groups using likelihood. Evolution 60:922-933.

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