

April 10th, 2020. **Adaptive Radiations**

Assigned reading: R.G. Gillespie, 2013. Adaptive radiation: convergence and non-equilibrium.
Current Biology 23: R71R74
<https://www.sciencedirect.com/science/article/pii/S0960982212014327>

A. Definitions?

"Differentiation in habit in several directions from a primitive type" (Osborn 1902)

"The rapid proliferation of new taxa from a single ancestral group" (Stanley 1979)

"The spread of species of common ancestry into different niches" (Wilson 1992)

"Some organisms have features that allow them to speciate more prolifically or become extinct less frequently than organisms without these features" (Guyer and Slowinski 1993)

B. Decomposing the term:

- **adaptation**

- as discussed in an earlier lecture, but note that the "adaptation" in "adaptive radiation" is some times considered to be organism-level adaptation, other times clade-level adaptation!

- how would we decide which level of adaptation is occurring? A review.

- **radiation:**

- rapid diversification of lineages (concept of "key innovation")

- ecological diversification

- morphological diversification (*disparity*)

- genetic diversification (genetic disparity?)

C. Examples (many of which were covered in the last two lectures by David Ackerly):

1. Key innovation and diversification

- The case of nectar spurs in *Aquilegia* (S. Hodges)

- Floral symmetry and sister clade diversification in angiosperms (Sargent)

2. Environmental change, ecological opportunity, and diversification

- Inga* and *Phyllica* (Richardson)

- Bursera* (Becerra)

3. Adaptive radiation: evolution of disparity and diversification

Anolis lizards:

- Ecomorphs and phylogeny (Losos)
- Macrohabitat radiations within ecomorphs (Glor)
- Disparity vs speciation (Harmon)

4. Radiation of α vs. β traits: evolutionary sequences in speciation vs. radiation
Ceanothus in California (Ackerly et al.)
 Hawaiian Silversword Alliance (Baldwin & Sanderson 1990)
5. Measuring radiation: rate vs. pattern of evolution
 The 'felsen' - brownian motion rate parameter for calibrated trees
 (Ackerly 2009)

	Low rates of lineage diversification	High rates of lineage diversification
Trait (key innovation?)	?	?
Low rate of trait diversification (i.e. disparification)	?	?
High rate of trait diversification (i.e. disparification)	?	?

D. How could we study adaptive radiations in a rank-free world view?

1. sampling problem:

- how many lineages are there?
- how many "basal" lineages are there?

2. time estimation problem:

- can we assume a molecular clock?
- if there is no clock-like molecule, can we estimate one by rate smoothing?
- if we can get some kind of rough clock, how do we calibrate it?
- lineages-through-time plots.

3. divergence estimation problem ("disparity" revisited):

- ecology
- morphology
- genetics

E. levels of selection problem -- return to "key innovation" -- how do we assess whether selection among lineages is actually occurring?

F. Additional reading list:

- Ackerly, D. D., D. W. Schwilk, and C. O. Webb. 2006. Niche evolution and adaptive radiation: testing the order of trait divergence. *Ecology* 87:S50-S61.
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- Marks, C. O., and M. J. Lechowicz. 2006. Alternative designs and the evolution of functional diversity. *American Naturalist* 167:55-66.
- Richardson, J. E., R. T. Pennington, T. D. Pennington, and P. M. Hollingsworth. 2001. Rapid diversification of a species-rich genus of Neotropical rain forest trees. *Science* 293:2242-2245.
- Richardson, J., F. Weitz, M. Fay, Q. Cronk, H. Linder, G. Reeves, and M. Chase. 2001. Rapid and recent origin of species richness in the Cape flora of South Africa. *Nature* 412:181-183.
- Sanderson, M. 1998. Reappraising adaptive radiation. *Amer. J. Bot.* 85:1650-1655.
- Sanderson, M., and M. Donoghue. 1994. Shifts in diversification rate with the origin of angiosperms. *Science* 264:1590-1593.
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- Schluter, D. 2000. *The ecology of adaptive radiations*. Oxford University Press, Oxford.
- Silvertown, J., J. Francisco-Ortega, And M. Carine. 2005. The monophyly of island radiations: an evaluation of niche pre-emption and some alternative explanations. *Journal of Ecology* 93:653-657.