**Modifications to HHMI Lizard Module by Kristine Grayson for an introductory course in Ecology and Evolution to sophomore students at University of Richmond, Fall 2016**

Class duration: 1 hour, 15 minutes

My goal was to combine the image analysis in Virtual Lab 1 with the evolutionary take-homes in Virtual Lab 2 and get through it all in a single class period (bleeding into the next class for final discussion).

I started with the stand alone Lizard Phylogeny module (<http://www.hhmi.org/biointeractive/using-dna-explore-lizard-phylogeny>)

I made the following changes:

Part 1: Understanding ecomorphs

1. Due to time constraints, I removed the viewing of the film during class time. It could be given as a pre-assignment, but you don’t necessarily want to give away the take-home in advance. Instead, I showed a few of the short 2 minute clips in the virtual lab to prep them in the system.
2. I had the students measure the x-rays and count the toe pads themselves using Image J. My students were already slightly familiar with the program (though they had forgotten most of it). With more explicit instructions, I think a class could execute the image analysis in Image J even without prior exposure. Alternatively, the images could be provided printed for physical measurements and manual counting.
3. The activity asks a group to pick 1 or 2 species, conduct the measurements, and try to assign their species to an ecomorph. They enter their data in a spreadsheet with data on 52 species across four islands (accessed from HHMI Virtual Lab, Reference material for module 1: "Data set of anole body measurements" – I manually assigned the islands from Powell and Henderson, 2012 since the data only had the ecomorphs listed).
4. Similar to Virtual Lab 1, they visualize the trait space for each ecomorph and try to assign the species or species they measured. We are using JMP for analysis in this class, but I think I could modify the graphing instructions for Excel or perhaps an online applet could be made for visualization. I think one of the most powerful take-homes was the students understanding that the morphological variation in lizards partitions across ecomorphs, but NOT islands (so adding in the ability to visualize traits across islands). See graphs next page.

JMP output for ecomorphs, with an “unknown” species with student generated point highlighted



JMP output for islands (the data set available is biased towards Cuba and Hispaniola)



Part 2: Generating the phylogeny

1. One modification that I thought was really effective was to get the students to sketch the proposed phylogenetic relationships under the two hypotheses for Anole evolution themselves. And then I lead them in discussion that resulted in the students reasoning through the potential explanations for each tree.

So instead of providing them this information outright (from Phylogeny\_Student Handout):



I tried to get them to reason it for themselves (often with prompting, but I think they all got there!)

1. I continued to have them generate the phylogeny at [www.phylogeny.fr](http://www.phylogeny.fr), but this step was the most likely to get trimmed if time was getting short and then I just handed out the paper copies for coloring as needed.
2. I did reduce the phylogeny data set from 4 islands to 3 islands (I removed Puerto Rico). My reasons were 1) to speed processing with the online tree builder, 2) to reduce the number of branches on the tree to match up and color, and 3) to simplify the interpretation. The split in Puerto Rico at the basal node is more difficult to reason. The structure of the rest of the tree still remains the same. I like that the island groupings aren’t perfect and that the position of *Anolis shelplani* can generate conversation.
3. I would provide the full Figure from Daniel L. Rabosky, and Richard E. Glor PNAS 2010;107:22178-22183 instead of just (<http://media.hhmi.org/biointeractive/activities/lizard/Reference-Phylogeny.pdf>). I think the fact that there are different numbers of species on the different islands based on their size is also a really valuable lesson (again, we have an expectation that Anoles have evolved to fill niches on each island, but this doesn’t result in an identical set of four species on each island. They may look alike, but the speciation process still worked in its own way on each island).