Can a Computer Predict How Species Evolve?

Evolution has resulted in the *Anolis* lizards being amazingly well-adapted to their environments. Because we can't go back in time and watch evolution as it occurs, nor can we always keep a study going generation after generation, scientists must often rely on computers to model the process and make predictions about the future. Computer modeling is a very powerful tool for studying evolution because it enables scientists to set up computer "habitats" that mimic those in nature and then watch what happens over tens, hundreds, or even millions of years—all without leaving the lab! Recently, a group of biologists used computer models to help them answer the question: with enough information about the environment, would a computer model predict the patterns of evolution we can observe in *Anolis* lizards in the Caribbean? In other words, would the computer predict the pattern of *Anolis* evolution that has occurred so far, and if so, then could they then use the model to predict future evolution?

Figure 1. Map Showing the Locations of Islands Inhabited by *Anolis* Lizards.
Source: Modified from Wikimedia Commons.

Before they could set up their computer model, the scientists first needed to understand the relationships among the *Anolis* lizards in the Caribbean. They narrowed their study to lizard populations living on four islands: Cuba, Hispaniola, Jamaica, and Puerto Rico (**Figure 1**). Then, using genetic data, they generated a phylogenetic tree—another model!—part of which is shown in **Figure 2**. The figure shows that, for the most part, species living on the same island are more closely related to each other than to species living on other islands, even closer than those living in very similar habitats. Why? Because each island was likely colonized by one or more founding species that then underwent an adaptive radiation. **Adaptive radiation** is the process by which a single species or small group of species evolves over a relatively short amount of time into many species that live in different ways. As individual *Anolis* lizards in the founding population competed for resources on their island, groups diverged into different niches. An organism's **niche** includes not only where it lives, but *how* it lives there—what kind of foods it eats, what other organisms it competes with or cooperates with, that kind of thing.

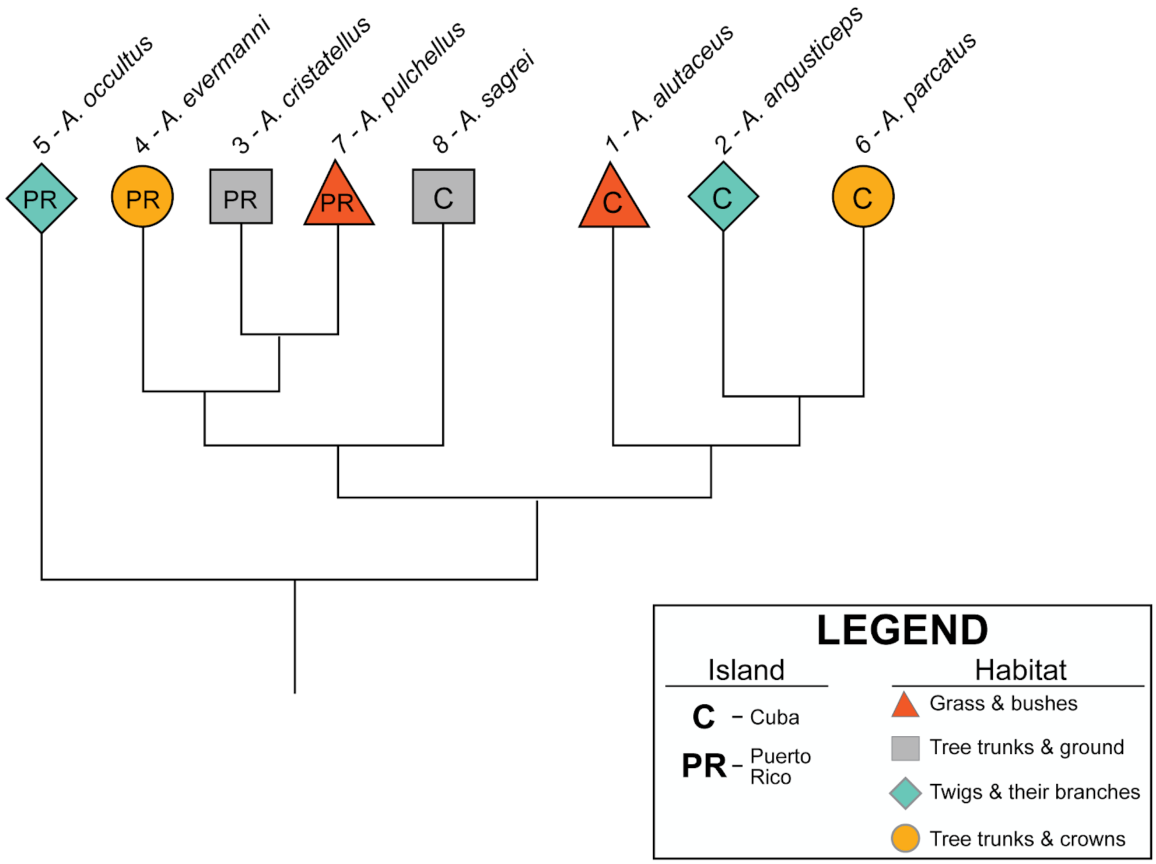

Figure 2. *Anolis* Evolutionary Relationships and Ecomorphs. This phylogeny indicates the relationships among a subset of species of *Anolis* lizards from Puerto Rico and Cuba. The ecomorph to which each species belongs is indicated by color and shape. The island on which they are found is indicated with a C for Cuba or PR for Puerto Rico. Numbers (1–8) correspond to the number on the species cards used in the *Trends in Evolution: Divergence and Convergence* activity. This phylogeny is meant to show relationships only; branch lengths do not have any significance. *Source:* Modified from Rabosky and Glor 2010.

As each *Anolis* group evolved a specialized set of traits that enabled them to access particular resources and increase their fitness, their traits diverged and they eventually became separate species. Since different species relied on different resources, competition among them was reduced. Although they do not share the closest relationship among the group (see Figure 2), species that came to occupy similar niches on different islands ended up looking very similarly to each other. A set of species that evolve similar traits because they occupy similar niches are said to belong to the same ecomorph. An **ecomorph** is a group of species with similar physical traits and behaviors that live in similar habitats but are not necessarily closely related. In other words, they have similar phenotypes without necessarily having similar genotypes.

What happened to *Anolis* lizards is a good example of **convergent evolution**, in which species independently evolve similar characteristics because the selection pressures they experience are similar. But the researchers wanted to understand why each island ended up with so many of the same ecomorphs? Was it chance? Or was something else going on? They used models of evolution to test whether the ecomorphs evolved due to chance or whether there was a predictable pattern. The researchers simulated the founding species, the landscape, and the environments on each island and then ran the model thousands of times—basically running and rerunning the last tens of millions of years over and over and over and over and…..well, you get the idea. Would it show that every re-run was the same, or did the same ecomorphs evolve each time?

Well, it turns out that in the case of the *Anolis* lizards, the scientists are about 99% sure that the ecomorphs arose due to convergence and not due to random chance. This means that similar founding species placed in similar landscapes can be expected to diverge along similar and predictable paths. The model even predicted that unique island-specific ecomorphs would occur on Cuba and Hispaniola, but not on other islands! This is really exciting because we may be able to predict the species diversity and types we would expect if a new island were populated by *Anolis* lizards.

References

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BiteScientist Profiles

Kari Taylor-Burt is a comparative animal biologist who studies how animals use their muscles to move. She is currently a graduate student at Harvard University and is studying the leg muscles in ducks as they walk, swim, and take-off. She is also very excited about science teaching and works to help students learn science by doing science at the university and K–12 level.

Jim Freyermuth is a high school biology teacher at Bridgewater-Raynham Regional High School with interests in anatomy/physiology and zoology. He came to ComSciCon looking to expand his curriculum development experience and learn what other educators are doing to further STEM curriculum. He was excited for the opportunity to discuss education with like-minded people and grow as an educator.