

HB218 The ecology and conservation of *Anolis* lizards in the Cayos Cochinos and Bay Islands

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Project introduction and rationale

The genus *Anolis* (anoles) consists of about 400 species of small, arboreal, insectivorous lizards that occur throughout the subtropical and tropical Western hemisphere, with nearly half occurring on Caribbean islands. Seven species of anole occur in the Cayos Cochinos and Bay Islands—two in the Cayos Cochinos, three on Utila, and three on Roatan. Among these, three are found nowhere else in the world—*A. bicaorum* and *A. utilensis* are found only on Utila, and *A. roatanensis* is found only on Roatan. *A. utilensis*, interestingly, is the only anole in the world that is found solely in mangrove forest habitat.

Although numerous studies have investigated the role that body size and prey partitioning play in island communities of anoles, little attention has been given to the role played by thermal biology. Because all biochemical reactions (such as those involved in digestion, muscle contraction, etc.) operate within optimal temperature ranges, and many lizards must behaviorally thermoregulate to maintain internal body temperatures within these ranges, the way by which they do this is an integral part of their ecology. The primary goals of our anole research in Honduras are to understand how the thermal biology of insular populations is related to their community ecology, behavior, and population dynamics, and to use this information to predict their response to climate change. As such, the following broad questions are being investigated:

- 1) Within an *Anolis* assemblage, what role do the thermal preferences and tolerances of the component populations play in determining community structure?**
- 2) How might the thermal ecology of *Anolis* lizards in the Cayos Cochinos and Bay Islands predict their response to climate change?**

More narrowly, we are asking:

- 1) How does temperature vary spatially and temporally across open and forested habitat types in the Bay Islands, and how will climate change affect these temperature distributions?**
- 2) How will changes in temperature caused by global warming affect performance and activity time in anole populations?**
- 3) How will changes in performance and activity time affect population dynamics?**
- 4) Will the open-habitat species on each island avoid rising temperatures by invading forested habitat? If so, will they out-compete forest species and drive them to extinction?**

The 'invasion hypothesis'

Evidence has recently emerged that suggests tropical, forest-dwelling lizards will be particularly hard-hit by global warming. While most temperate lizards have evolved plasticity in thermal physiology to deal with widely fluctuating temperature regimes, tropical lizards have evolved in relatively aseasonal thermal environments, and their thermal physiologies have thus evolved to optimize performance

within a narrow range of temperatures. Even slight increases in ambient temperature, then, can have dramatic effects on fitness. Moreover, tropical forest dwelling lizards (such as all endemic *Anolis* species in the Cayos Cochinos and Bay Islands) already live in the coolest parts of the landscape, and thus may have little opportunity for behavioral compensation if environmental temperatures continue to rise.

In addition to decreased fitness as a result of increasing ambient temperatures, the potential effects of climate change on the ability of forest lizards to compete with other species will further exacerbate the problem. Although shade-loving forest species have no respite from increasing temperatures, sympatric sun-loving species (that occur in open habitats) are predicted to invade forest habitat as environmental temperatures increase (Huey et al. 2009; see 'suggested reading'). The upshot of this is that open-habitat species may outcompete (and thus drive to extinction) forest species who are already experiencing a drop in fitness due to the effects of temperature alone. This phenomenon could spell disaster in the Cayos Cochinos and Bay Islands, where every endemic species of *Anolis* lizard not only occupies interior forest habitat, but is sympatric with a geographically widespread, open habitat species (*A. sericeus* on Utila and *A. allisoni* on Roatan and the Cayos Cochinos). As a result, this process has the potential to largely homogenize the anole communities of the archipelago.

Given the potential for massive loss in biodiversity over the next few decades, a major goal of our anole research is to test the invasion hypothesis put forth by Huey et al. (2009). Given the detailed information we are acquiring on the thermal ecology of anoles in the Bay Islands, is it likely that the invasion scenario will play out? If so, how long will it take for open-habitat species to invade? What variables seem to be driving these dynamics, and can we generalize our results to other systems?

Study sites and methods

During the Operation Wallacea field season, students will have the opportunity to conduct projects in the Cayos Cochinos, on Utila, or in both places. Lizards will be collected in the field using a small "noose" attached to the end of a fishing pole, and most student research projects will involve the collection of one or more of the following data types:

- 1) **Field-active body temperatures of free-ranging individuals.** These are the internal body temperatures of wild lizards. They will be taken with an internal thermometer immediately after capture.
- 2) **Environmental temperature distributions.** These are the temperatures available to a population of lizards (a 'null' distribution of temperatures in the lizards' environment). They will be obtained by placing temperature-logging models in the lizard's habitat. These models are designed to mimic the thermal properties of anoles.
- 3) **Thermal preference ranges.** These will be established by recording the body temperatures lizards acquire when housed in a laboratory thermal gradient.
- 4) **Thermal performance curves.** These are mathematical functions relating some ecologically relevant performance (such as running speed) with temperature. In our case, they will be acquired by heating and cooling individuals to a range of temperatures and allowing them to run along a dowel rod. Running speeds will be recorded using a high-speed digital video camera. These curves will give us some idea of how lizard performance will change as a result of climate change.

5) **Morphology.** Mass, body length, and hindlimb length are measured for every lizard captured. If interested, students can measure other morphological variables like dewlap size, tail length, head size, and toe-pad width.

6) **Habitat Use.** Canopy cover, perch height, and perch width is measured for every individual captured. Many other variables can be measured if they are relevant to a student's project.

There are many potential projects that could be conducted on anoles in the Cayos Cochinos and on Utila. Some potential project categories include:

- 1) The effect of temperature (or the potential effect of global warming) on abundance and activity time (foraging time).
- 2) Thermal niche partitioning between *A. lemurinus* and *A. allisoni*, two competing species, in the Cayos Cochinos.
- 3) The thermal basis of territoriality and social interaction of any of the anole species present (on a comparative or case-by-case basis).
- 4) The effects of prey density (i.e. invertebrate abundance) versus the thermal environment on body condition, population density, or intraspecific interactions of any of the anole species present.
- 5) Do males and females differ in thermal ecology? Many anole species are sexually dimorphic, which suggests the intriguing possibility that the sexes may differ in thermal physiology as well, leading to sex-based responses to climate change.
- 6) Comparison of *A. lemurinus* and *A. bicoarum* thermal ecology on Utila and the Cayos Cochinos. Will these sister species respond to climate change in different ways?
- 7) The relationship between male dominance and thermal territory quality.

Supervision

Students working on this project will be supervised in the field by Mike Logan (Michael.L.Logan@dartmouth.edu), a PhD student in the Department of Ecology and Evolutionary Biology at Dartmouth College in the United States. Mike has been studying the ecology of lizard populations in the Cayos Cochinos since 2007.

Reading List

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