

Submission deadline: July 31st 2018

Submit to: anolis2018@gmail.com

First and foremost, we want to maintain that this is an informal collection of activity updates, ideas, and data – so don't feel stressed to make sure everything looks beautiful!

However, it would be great to have articles formatted relatively similarly, so please keep text as Times New Roman, size 11, and black, with line spacing at 1.15. There is no need to include any page numbers on your individual articles, as we will add cumulative page numbers to the final article. Please make all author names and the article title bold and font size 14 (you can see the general structure in some example past documents below). As for how to structure your article, that's up to you too!

We also want to encourage the use of figures; black and white, color, or hand drawn. In the past there have been many insightful examples of perspective ideas demonstrated neatly using figures (e.g. Sandy Echternacht's wonderful idea about how the invasion of *A. sagrei* might change the social landscape of resident *A. carolinensis*; see below). And definitely please include pictures of your study species! The direct connection of data, notes, and thoughts with organisms should always be apparent.

Article lengths can range anywhere from 1-2 paragraphs providing a short update of your current or planned research projects, to up to 20 pages of notes, figures, and tables. Don't be worried about what to submit – if you think it's interesting, then it's likely that other people in the anole world will too! The newsletters aim to serve three general functions: to allow investigators to inform others of their current and future research; to provide an outlet for speculation and theoretical musings perhaps inappropriate for publication in more formal venues; and to given an opportunity to present data and ideas that otherwise might never be distributed.

Steven Poe

University of New Mexico

***Anolis* research in the Poe Lab**

We study systematics and evolution of *Anolis*. Our systematic work is concentrated in the phylogenetics of *Anolis* and the discovery and description of species. In recent years we have traveled to Panama, Costa Rica, Colombia, Ecuador, Peru, and Bolivia to collect tissues and search for new and rare species of *Anolis*. Recent highlights of these trips include three new species published from Panama and collection of good series of the rare anoles *A. orcesi* and *A. proboscis* during a trip to Ecuador. All of this work is done in collaboration with Latin American scientists and students.

Our phylogenetic work includes the collection of morphological and molecular data and combined analyses of multiple datasets using Bayesian and other approaches. Our morphological dataset is composed of over 300 species, including 254 that we have coded and are currently incorporating in phylogenetic analyses. We are collecting DNA sequence data with several international and U.S. collaborators thanks to the financial kindness of the National Science Foundation. The long-term goal is a comprehensive phylogeny of *Anolis*. But for now much of our work is concentrated on sequencing the rare species in our freezer for combination with results from the genome project and other groups. We also work on the phylogeny of smaller clades of *Anolis*, with emphasis on mainland groups.

Our evolutionary studies in *Anolis* are concerned with character evolution, adaptation vs. exaptation, and biogeography. We are testing Ernest Williams' idea of a colonizing type of *Anolis* by examining naturalized, solitary, and ancestrally reconstructed *Anolis* lineages. We are working on reconstructing the patterns of dispersal across islands and the mainland, and on examining the traits that favor or inhibit diversification. As with the alpha-taxonomy work, this research is done in collaboration with international and local scientists and students.

Graduate students in the lab are working on various projects in *Anolis*. Ian Latella is studying invasive *Anolis*. Recently he helped develop a predictive model to examine which species of *Anolis* are likely to become invaders. Eric Schaad studies the comparative evolution of communities of *Anolis*. He is interested in comparing the morphological and phylogenetic diversity of these communities between islands and the mainland. Mason Ryan has taken a break from working on nondescript frogs to study the beautiful and interesting solitary anoles—species that are historically endemic to islands lacking congeners. We are finding that solitary species share many unusual characteristics of size, shape, and scalation, and that most of these traits evolved exaptively rather than as adaptive responses to solitary existence...

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The evolution of anole behavior: ecological and physiological approaches

I am primarily interested in understanding the evolution of behavioral variation in anoles from two perspectives – how behaviors are associated with the ecological contexts in which they are performed, and how variation in the neural, endocrine, and muscular mechanisms that underlie behavior are associated with its evolution. My work integrates these two approaches to address the following questions:

What is the role of habitat use in the evolution of behavior?

Species that occur in similar environments often evolve similar morphological, physiological, and ecological traits; however, whether behaviors evolve as a function of a species' physical environment is not yet clear. In my dissertation work in the lab of Jonathan Losos, I examined whether *Anolis* lizards that use similar habitats evolve similar behavioral strategies using three classes of behavior: territoriality, foraging, and sleep. In our study of territorial behavior, we examined 13 species on four islands and found that structural habitat drives the evolution of territoriality along two axes: species in higher visibility habitats perform more frequent territorial display behaviors, and a species' perch height and diameter (the habitat measures that determine ecomorph categories in this group; Williams 1983) are significant factors in male-male territory overlap (Johnson, Revell, and Losos in press). In our study of foraging behavior, we found that ecomorph category (and thus, microhabitat) is strongly associated with rates of movement and prey capture in 31 species (Johnson et al. 2008). In both of these studies, we used phylogenetically-controlled analyses to demonstrate that species utilizing the same microhabitat on different islands have convergently evolved the same behavioral strategies for defending territories and procuring food. Our study of sleep examined sleeping sites of three species of Jamaican anoles. We showed that lizard species that occur in the same locality but are specialized for different microhabitats while active during the day also differ in their sleeping perches and in the dispersal of their sleeping sites; these differences parallel their diurnal habitat use (Singhal et al. 2007).

What neuromuscular and endocrine traits are associated with behavioral evolution?

In collaboration with Juli Wade, I am examining the relationship between sexual dimorphisms in morphology and behavior with dimorphisms in the neural and endocrine traits underlying these traits. In *Anolis* lizards, the dewlap is an important structure used in courtship and territorial behavior. In most species of anoles, including *A. carolinensis*, males have large dewlaps, while females have very small dewlaps. However, species in which males and females have similarly-sized dewlaps also exist, and we have compared dewlap-associated behavior and morphology of these relatively monomorphic species with closely-related species in which the dimorphism is large. Our study included a group of...

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Possible Causes for the Rapid Decline in Population Density of Green Anoles, *Anolis carolinensis* (Sauria: Polychrotidae) Following Invasion by the Brown Anole, *Anolis sagrei*, in the Southeastern United States Introduction.

The brown anole, *Anolis sagrei* (Sauria: Polychrotidae) is native to Cuba, Jamaica, the Bahamas, Swan Island, Little Cayman Island and Cayman Brac (Schwartz and Henderson 1991) and invaded the mainland of North America about 60 years ago (Lee 1985). The first colonizations were in southern Florida and, subsequently, the species has expanded its range northward into at least southern Georgia (Godley et al. 1981, Campbell 1996). Established populations have been reported at multiple sites in Louisiana (Thomas et al. 1990, Platt and Fontenot 1994) and Texas (King et al. 1987, Krusling et al. 1995). The entire North American range of the brown anole is contained within that of its native congener, the green anole, *Anolis carolinensis*. The brown anole co-occurs with members of the *Anolis carolinensis* complex on at least five island banks in the West Indies (Williams 1969). Green anoles utilize a wide variety of habitats, but their populations are densest in edge situations which feature small trees (dbh 5-15 cm) “imbedded” in an understory of low herbaceous vegetation and shrubs. We have been unable to locate any reports of population densities of green anoles prior to the arrival of brown anoles, but there are numerous anecdotal reports of rapid and dramatic declines in green anole populations following invasion by brown anoles. Observations indicate that these declines are most dramatic at disturbed sites, especially where the disturbance has included removal of the small trees, herbaceous vegetation and shrubs favored by the lizards. In general, however, it is only in the most disturbed sites that green anoles are completely excluded and in some habitats it is common to find adult males of both species defending largely overlapping territories. Anecdotally, the decline in population density of green anoles following invasion by brown anoles has been assumed to be the result of interspecific competition (e.g., Tokarz and Beck 1987). Here I present a preliminary model, based primarily on research conducted by our group, to account for the decline in population density of green anoles following invasion by brown anoles.

Behavioral Interference. In cage studies, Tokarz and Beck (1987) and Brown (1988) have demonstrated that levels of interspecific male-male aggression are reduced relative to intraspecific levels. Gerber (in prep.) has confirmed this with tether-release experiments in the field. Brown and Echternacht (1991), in observations of naturally-occurring interspecific encounters between non-tethered lizards in the field, noted that green anoles were more likely to chase and/or attack brown anoles than the reverse, and that brown anoles were more likely to retreat in the face of an interspecific encounter than were green anoles. Brown and Echternacht’s (1991) data were, however, weak because encounters were often already under way when they were first discovered, and because the history of the lizards relative to one another was unknown. Data available to date, however, does not support interspecific male-male aggression as playing a role in the decline in the population density of green anoles following invasion by brown anole.

Habitat Use. Green anoles have been characterized as occupying a trunk-crown ecological niche whereas brown anoles are said to occupy a trunk-ground niche (Williams 1969), but this applies to green anoles only where they occur in multi-anole (i.e., “complex,” Williams 1969) communities. In the southeastern United States in areas not yet invaded by brown anoles, green anoles occupy a crown-trunk-ground niche that is, therefore, the sum of niches occupied by green and brown anoles where they occur together. Following invasion, the structural niche of green anoles shifts upward such that they occupy the trunk-crown niche observed in multianole communities elsewhere. If this is due to competition, the resource being contested has yet to be identified, although it may simply be space. In any case, this shift by green anoles may play a role in their decline following the appearance of brown anoles. Prior to invasion, green anoles should have access to more territories than following invasion (Fig. 1).

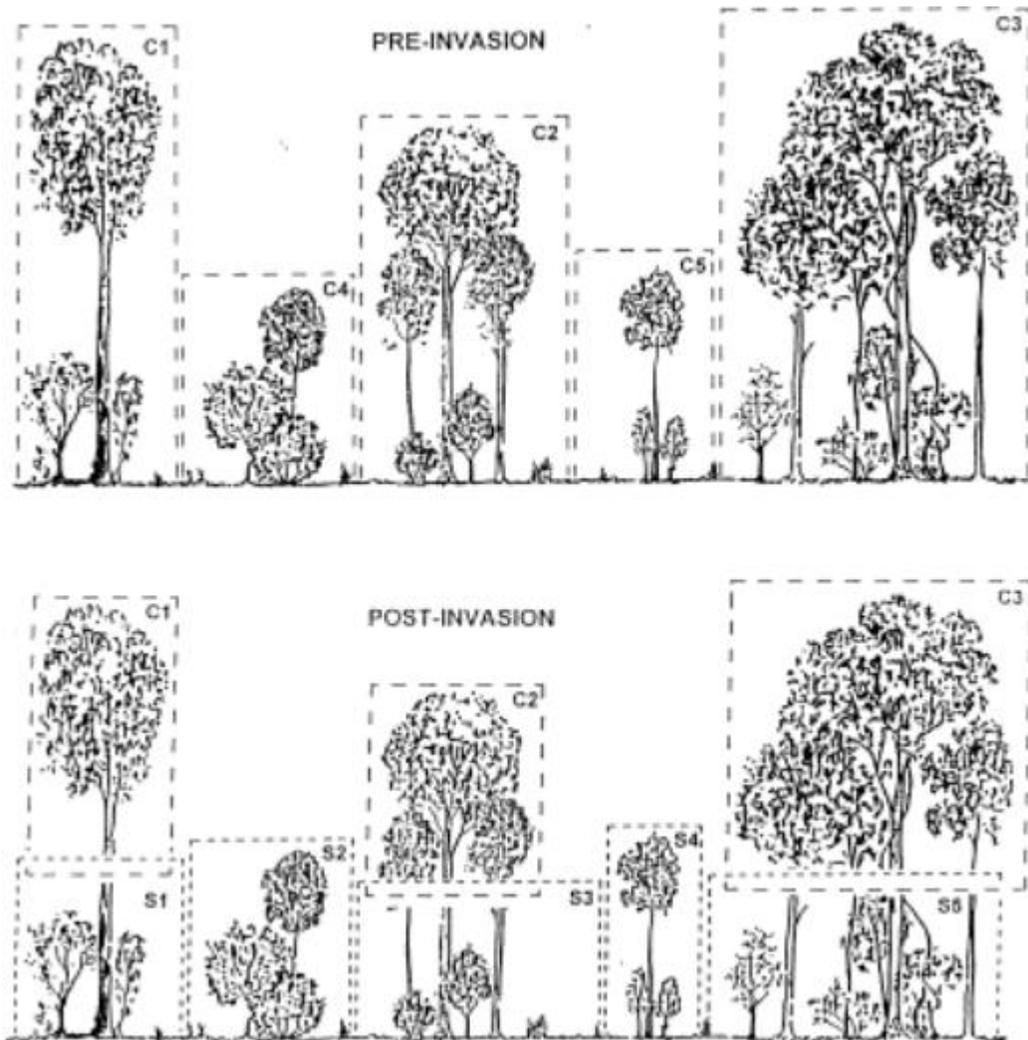


Figure 1. Hypothetical green anole (AC) territories at a site prior to (Upper) and following (Lower) invasion by brown anoles (AS). Note that the number of green anole territories is reduced from 5 to 3 following the invasion.

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**Proposed study of potential impacts of climate warming on Puerto Rican
*Anolis***

Landmark studies have documented that climate warming is having pronounced effects on the ranges, phenologies, interactions, and survival of organisms (Pounds et al. 1999, Parmesan and Yohe 2003, Root et al. 2003). Effects of warming on terrestrial species have been predicted to increase with latitude (Root et al. 2003, Parmesan 2007, Lee and Jetz 2008) because warming is faster at higher latitudes (IPCC 2007). Nevertheless, several empirical (Pounds et al. 1999, Clark et al. 2003, Burrowes et al. 2004, Whitfield et al. 2007, Raxworthy et al. 2008) and theoretical (Deutsch et al. 2008, Tewksbury et al. 2008, Huey et al. 2009, Kearney et al. 2009) studies have made a surprising prediction: Although absolute rates of tropical warming may be relatively slow, many tropical organisms will be strongly and negatively affected by warming.

What explains this apparent paradox? The biological relevance of any rate of climate change depends on the local contemporary variability; and climate variability is of course relatively low in the tropics (Williams et al. 2007). The impact of climate change also depends on the behavior, physiology, ecology, and genetics of organisms. Our recent studies (Deutsch et al. 2008, Tewksbury et al. 2008, Huey et al. 2009) propose that tropical forest ectotherms (those residing beneath the canopy, such as many *Anolis*) are especially vulnerable because they (a) are thermal specialists and thus relatively sensitive to temperature change, (b) have surprisingly low heat tolerance, (c) live in ‘operative’ environments that are already warm relative to their low thermal optima, (d) have few opportunities for behavioral evasion, (e) may have limited acclimation capacities, and (f) may face increased competition and predation from open-habitat (warm-adapted) ectotherms that can now invade warmed forests.

To test the prediction that warming has already had an impact on tropical ectotherms, we have assembled a team starting with five biologists (Álvarez, Gorman, Hertz, Huey, Lister) who intensively studied the thermal and reproductive ecology of Puerto Rican lizards in the ‘70s, ‘80s, and early ‘90s (e.g., Gorman and Licht 1974, Huey 1974, Lister 1981, Álvarez 1992, Hertz 1992). We add a climatologist (Deutsch), who will elucidate patterns of recent Caribbean warming, as well as three biologists (Pringle, Tewksbury, Wingfield) who bring diverse ecological and physiological expertise.

We are proposing to exploit detailed, baseline eco-physiological data (above) that we collected decades ago on multiple populations of two *Anolis* species in Puerto Rico. We hope to replicate our prior studies, compare old vs. new patterns, and then address the following questions:

- (1) *Has female reproduction been reduced by warming summers but increased by warming winters?*
- (2) *Are body temperatures (T_b) higher in both summer and winter now, as expected from weather records?*
- (3) *Are ‘operative’ (steady-state) temperatures (T_e) also warmer?*

(4) *Are open-habitat lizards, which require warmer T_b and T_e than forest species, beginning to invade warming forests and therefore increasing competition on forest species?*

We focus on *Anolis* lizards in part because their ecology, behavior, and physiology are exceptionally well known (Roughgarden 1995, Losos 2009) and in part because they play important roles in Caribbean ecosystems (Dial and Roughgarden 1995, Reagan 1996). Importantly, *Anolis* also serve as useful models for other Neotropical forest lizards, with which they share behavioral and thermal traits (Rand and Humphrey 1968, Álvarez 1992, Huey et al. 2009). Because we will replicate our own studies, any changes we detect will not be an artifact of between-worker differences, a potential conundrum for longitudinal studies in conservation (Willis et al. 2007).

We concentrate on *A. gundlachi* and *A. cristatellus*, sit-and-wait predators that are similar in morphology and in perch associations (,trunk-ground ecomorph,' Williams 1972, Losos 2009) but are not sister taxa (Poe 2004). They differ in thermal biology (Rand 1964, Heatwole et al. 1969, Huey and Webster 1976, Hertz 1992). They are abundant, easy to observe, and are among **the best-studied lizards in the world** in terms of behavior, ecology, and physiology (reviewed in Losos 2009).

We (Huey et al. 2009) recently used data from the 1970s and 1980s to predict the consequences of warming on the locomotor performance of *A. cristatellus*. Our analyses suggest that a 3°C increase in air temperature will be deleterious to lowland populations, at least in summer. Moreover, observed warming at El Verde may already have been sufficient to cause heat stress to *A. gundlachi* (a forest, low temperature species) and to enable *A. cristatellus* (which requires higher temperatures) to invade the forest.

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Miscellaneous notes on some rare and unusual anoles

In the fall of 2004, as a doctoral student at the University of California, Los Angeles, I began a study of the trans-Andean α -anoles (*Dactyloa* spp.) of Central and South America. During the course of my research, I made a few miscellaneous notes on some rare and unusual mainland dactyloids and β -anoles (*Norops* spp.) of Panamá and Ecuador. *Dactyloa purpurescens* (Cope) 1899. — **Panamá**. This species is presently known only from the holotype, USNM 4321 (Fig. 1). The specimen was collected during a survey expedition for a proposed ship canal connecting the Atlantic and Pacific Oceans via the valley of the Atrato, in Colombia (Michler, 1861).



Fig. 1. *Dactyloa purpurescens* holotype, ♂, SVL 77 mm (USNM 4321). Río Truando, Departamento de Chocó, Colombia.

USNM 4321 was previously listed as “*Anolis ??reticulatus*” by Cope (1862) and identified as a “♂ jr.,” by which Cope presumably meant a juvenile male. Williams (1988) concurred with this, although there is nothing in the proportions of the specimen to suggest it is a subadult. Cope lists a second specimen, USNM 4313, an adult male from Turbo on the coast of the Golfo de Uraba, Colombia...