The Distribution of Native and Exotic Anole Species in South Florida

The Inconspicuous Chamaeleons: Vernon Bush, Helena Matamoros, Donna Molfetto, Ramses Sanchez, and Karl Urban

Abstract

The purpose of this experiment was to compare the distribution of native and several exotic species of anole in various habitats in South Florida. We recorded the native *Anolis carolinensis*, and the exotic species *A. sagrei*, *A. cristatellus*, *A. distichus*, and *A. equestris*. Both disturbed and undisturbed habitats were sampled, to see whether anole species were evenly distributed regardless of human intervention. Data collection consisted of Visual Encounter Surveys in 30m by 10m transects. *A. carolinensis* was dominant in native habitats but *A. sagrei* was still found. *A. sagrei* was dominant in disturbed habitats but many other species were still found. This study shows that anole distribution can be strongly affected by habitat disturbance and the presence of invasive species.

Introduction

It is well known that South Florida has many different types of native, exotic, and invasive species. A native species is one which occurs naturally in the environment in which it lives and has not been introduced by humans. The difference between invasive and exotic species is that invasive species quickly reproduce and increase their range over a large area, usually affecting the native ecosystem. An exotic species is introduced, but does not spread very far and sometimes does not reproduce at all.

The purpose of this project was to determine where different species of native and invasive anoles are found in South Florida. Additionally, the study has shown whether a specific species of anole is more abundant in certain areas than the native anole, and whether anoles prefer disturbed or undisturbed habitats. The green anole (*Anolis carolinesis*) is the only anole native to South Florida. The brown anole (*A. sagrei*), bark anole (*A. distichus*), Cuban knight anole (*A. equestris*), Puerto Rican crested anole (*A. 
cristatellus), and Jamaican giant anole (A. garmani) are also known to be present. Anoles were chosen as model organisms for this experiment because anoles are a classic example of a native population competing with an invasive species (Losos and Spiller, 1999). In addition, anoles live in high densities and are easy to see and identify.

In this study both undisturbed and disturbed habitats were surveyed. An undisturbed habitat is an environment in which humans have not significantly altered the composition of that environment. An example of an undisturbed habitat is much of Everglades National Park. A disturbed habitat is one in which humans have significantly changed the natural environment, such as a farm, garden, or housing development.

In this study, various disturbed and undisturbed locations were surveyed, and the lizards within them were observed utilizing Visual Encounter Surveys with transect sampling. The transects were 30m by 10m areas in which each individual of each species of anole was tallied in a data table. Three different transects were done within the same habitat in each site visited. The locations visited were Fairchild Tropical Gardens, Tropical Park, University of Miami South Research Campus, outside Miami Metrozoo, and Fruit and Spice Park. The habitats ranged from pine scrub to cultivated arboretums and recreated rainforest.

**Methods**

To determine the frequency of each anole species in a sample area, we used Visual Encounter Surveys (VES) with transect sampling. To set up a transect, the area was first measured and marked without walking through it. Stepping in the sampling plot would negatively affect results by chasing anoles out before data was taken. We
performed three replicates in each habitat. Sampling procedures followed the methods of Heyer and Donnelly (1994).

Sampling plots were 10m wide by 30m long. We used flagging tape to mark the four edges of each transect. In each sample site, seven participants stood on a 10m edge of the transect. Each participant was assigned a lane to sample. Sampling procedure was to slowly walk straight across the transect, stopping frequently and recording any anoles seen. We recorded anoles only to the front and the right to avoid pseudoreplication in the sample transect caused by many participants counting the same animal more than once. The species that were counted were *Anolis sagrei, A. cristatellus, A. equestris, A. distichus, A. garmani, and A. carolinensis*.

The undisturbed habitats that we sampled were native Pine Scrub, at University of Miami South Research Campus and the outskirts of Miami Metro Zoo. These areas were dry with sandy soil. The vegetation was fairly dense and it was dominated by native pines, tall grasses, shrubs, and other short vegetation. The disturbed habitats that we sampled were Tropical park, both rainforest and arboretum areas at Fairchild Tropical Gardens, and Fruit and Spice Park. The vegetation was of varying densities, containing mostly introduced leafy trees, exotic vegetation, constant irrigation, and abundant shade.

To compare the abundance of anoles in disturbed and undisturbed habitats we used a Student’s T test. We compared the average total number of anoles found per site. We also calculated the Shannon-Weiner diversity index (H’) for each site. This index is used to describe how evenly individuals are distributed between species.

**Results**
As seen in Figure 1, we found *Anolis carolinensis* and *A. sagrei* in 5 out of 6 sites. *A. equestris* and *A. cristatellus* were the least widely distributed, and only found in 2 of the 6 sites. Figure 2 shows the total abundance of anoles found across all the habitats we visited. *A. sagrei*, the brown anole, was the most frequently seen. Figure 3 shows that anoles were much more abundant in disturbed habitats than undisturbed habitats, with 214 anoles found in the disturbed habitats and only 6 individuals found in the undisturbed habitats. In undisturbed habitats, the majority of anoles seen were *A. carolinensis*, the native species. Figure 4 shows the percentage of each species found in both undisturbed and disturbed habitats. Only *A. carolinensis* and *A. sagrei* were found in undisturbed habitats. By comparison, all 5 species were frequently seen in disturbed habitats, although *A. sagrei* was most common in those habitats. Figure 5 shows the percentage of each anole species at each site, as well as the Shannon-Weiner diversity index (H’) for each site.

**Discussion**

The purpose of this project was to determine where different species of native and invasive anoles are found in South Florida. The species found at each site are shown in Fig. 1. The native anole (*A. carolinensis*) was found in Fairchild Tropical Gardens, South Research Campus, Miami Metro Zoo, and Tropical Park. The brown anole (*A. sagrei*) was found at Metro Zoo, Fairchild Tropical Gardens, Tropical Park, and Fruit and Spice Park. The bark anole (*A. distichus*) was found in Tropical Park and Fairchild Tropical Gardens. The Cuban knight anole (*A. equestris*) was found in Fairchild Tropical Garden’s arboretum and Fruit and Spice Park. The Puerto Rican crested anole (*A. cristatellus*) was
the least frequently found at Fairchild Tropical Gardens only. *A. carolinensis* and *A. sagrei* were the most frequently found, at 5 sites each.

The data shows that the native anole is still seen in most areas. Most exotic anoles were not found in the undisturbed areas as often as the native anole, because each species is specialized to a certain habitat. Most of the exotic species in South Florida come from tropical areas in the Caribbean; therefore they need to find tropical or at least sub-tropical climates in which to thrive. Another reason more exotic species may inhabit the disturbed areas is that there may be more food and water in the disturbed areas due to human involvement, such as sprinklers and the fruiting or flowering plants that humans cultivate. Also, construction and landscaping has made the habitat more structurally complex, which means the area might be more conducive to creating different livable habitats for the exotic species. They will not find those climates in the undisturbed areas because those areas are dry pine scrubs. Exotic species will survive and reproduce best in the disturbed areas because they are more like the tropical climate. This conclusion is supported by the data because an average of only 3 anoles per site was found in undisturbed areas and an average of 53.5 anoles was found in disturbed areas (Fig. 3).

We also set out to show how different invasive anole species affect the native species. *A. carolinensis* made up only a third of the total anole population. This is a drastic change from conditions prior to the introduction of the invasive species when *A. carolinensis* was the only anole present. The data suggests that the main competitor to *A. carolinensis* is *A. sagrei*, which makes up 38% of the total population (Fig. 2). Another piece of evidence that *A. sagrei* is a strong competitor is that it lives in most environments where *A. carolinensis* lives. As seen in Fig. 2, individual exotic species (*A.
*equestris, A. distichus, and A. cristatellus*) do not overlap with the native anole as much as *A. sagrei*, but when taken as a whole they make up 31% of the observed population, forming possibly significant competition for the native anoles in the area. The data strongly suggests that *A. sagrei* along with the non-native species create significant competition for the native anole.

We also attempted to determine whether different anoles prefer disturbed or undisturbed habitats. Fig. 4 shows that *A. carolinensis* is more dominant in the undisturbed habitats than in disturbed habitats because it comprises 67% of the undisturbed and 31% of the disturbed environment (a 36% difference). It also shows that the only species of exotic anole that lives in the native habitat is *A. sagrei*, making up 33% of the observed population. Based on this data, *A. carolinensis* seems to be thriving in the native habitat in which it has evolved. The disturbed environment may also suit the native anole, but the exotic anoles are more accustomed to this moist, tropical, Caribbean-like environment and therefore they may be able to out-compete *A. carolinensis*. Moreover, the exotic species are not adapted to live in the undisturbed environment and therefore A. carolinensis may be able to out-compete them in these areas.

We calculated the Shannon-Weiner diversity for each site. We found disturbed habitats to be much more diverse than undisturbed habitats. Disturbed habitats had a much higher H’ than undisturbed habitats, which tended to be dominated by *A. carolinensis*; for example, Fairchild Tropical Gardens Arboretum had an H’ of 1.02, while South campus had an H’ of 0 (only *A. carolinensis* was present). This supports our conclusion that exotic anoles are best able to invade disturbed habitats.
During this study, there were several variables that could have affected the results. Weather could have been a factor because the anoles could have reacted differently to wet, dry, heat, cold, etc, thereby affecting how many anoles were seen. The time of day could have affected how active or visible the anoles were at that time. The group’s noises and movements could have scared the lizards out of sight. It is possible that pseudoreplication took place in the counting process, with more than one observer recording the same animal. Finally, the time spent doing transects was not strictly regulated; therefore the group could have spent more time in certain areas than others.

Acknowledgements

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As we sampled the many places of South Florida, we would also like to recognize the many understanding people at the Everglades National Park, Fruit and Spice Park, South Research Campus, and Fairchild Tropical Gardens for letting use their parks.

**Literature Cited**


## FIGURES AND TABLES

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**Figure 1.** Table showing the presence (X) or absence (-) of each anole species at each site sampled. CA = *A. carolinensis*, SA = *A. sagrei*, CR = *A. cristatellus*, DI = *A. distichus*, EQ = *A. equestris.*
Overall Distribution of Anole Species Across All Habitats

- A. carolinesis: 31%
- A. sagrei: 38%
- A. distichus: 14%
- A. cristatellus: 12%
- A. equestris: 2%
- Unknown: 3%

Figure 2. Each anole species as a percentage of all anoles found, across all habitats.
Figure 3. Number of anoles found per site (cumulatively over 3 replications), averaged for both disturbed and undisturbed habitats. Difference in average number of anoles per site was found to be statistically significant (T = -2.89, P = 0.01)
Frequency of Anole Species in Disturbed and Undisturbed Habitats

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Figure 4. Each anole species as a percentage of all animals recorded, cumulative for undisturbed and disturbed habitats.
Figure 5. Species composition and Shannon-Weiner diversity (H’) for each site sampled.