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"Carrion Feeding on *Anolis Sagrei* Carcasses in Urban and Wooded Areas of Central Florida"

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Carrion feeding on *Anolis sagrei* carcasses in urban and wooded areas of central Florida

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Abstract

Introduced species becoming invasive and even detrimental in habitats is an all too frequent occurrence. *Anolis sagrei*, the brown anolis lizard, is one of these species. *A. sagrei* has out-competed the native green anolis lizard, *A. carolinensis,* in many habitats and even sometimes preys on *A. carolinensis*. As an introduced species, *A. sagrei* has no naturally co-evolved predators in central Florida, and so my study set out to find what is happening to these abundant creatures after they die. I set up trials in designated urban and wooded areas with cameras to monitor activity to see what is scavenging on *A. sagrei* carrion. My results did not yield a significant difference between the scavenging rates or the scavenging species in urban and wooded areas.

Introduction

Introduced species are common in many areas. Davis (2003) reports that, though many older studies seemed to point to introduced species as a direct means for the decline and extinction of native species, these very theories are, in actuality, incorrect. His literature review states that competition from the introduced species has minimal effect on ecosystems above the community level. However, Davis (2003) does not ignore all mounting evidence that at least in some cases the introduction of new species alters the environment, and even suggests that in cases which the effects are detrimental to the ecosystem, something must be done immediately to remedy the problems as best we can and to prevent the further spread of these damaging species. It is when these introduced species become destructive and invasive that problems begin to arise.

Anolis sagrei is one of these invasive species. Introduced to south Florida in the 1880s by Cuban immigrants, *A. sagrei* had quickly spread across Florida by the 1970s (Goldberg and Bursey, 2002). Campbell and Echternacht (2003) preformed a study to recreate and observe how *A. sagrei* have invaded. They placed captured *A. sagrei* on "islands" in central Florida and found that not only did both populations grow rapidly, but that the first generations already were outliving their parents. Additional findings included that *A. sagrei* tended to be larger in size when introduced on Florida mainland as opposed to their native Caribbean islands. Similarly, Kolbe et al. (2004) found that *A. sagrei* have a high level of genetic variability to quickly adapt to their new environments. This gives support to the theory that *A. sagrei* can out-compete, and even consume, the native *A. carolinensis* (Campbell and Echternacht, 2003; Kolbe et al, 2004). Campbell and Echternacht (2003) also found that lower survival rate of *A. sagrei* on a forested island as opposed to more open land, leading to the assumption that *A. sagrei* must be highly consumed or otherwise decomposing very quickly. These theories, however, leave out an important point—there is an abundance of *A. sagrei* and not so many predators. What is happening to the *A. sagrei* carcasses?

A. sagrei, when not consumed directly by a predator, are presumed to be consumed as carrion. Many ecosystems are littered with animal carcasses; and vertebrate carrion feeders are plentiful in tropical, subtropical, and temperate climates (Downes, 1994; DeVault et al, 2004). However, very little time and study have been put into carrion-feeding, and so we are vastly unaware of how often assumed "disappearances" thought to be the work of predators are, in actuality, due to carrion-feeding (DeVault et al, 2003).

Insects in particular are rapid carrion users (DeVault et al, 2004). For example, *Nicrophorus* beetles are obligate carrion breeders—their young feed on the carcass on which they are born—and they prefer to bury and breed on small vertebrate carcasses (Smith and Merrick, 2001; Rauter and Moore, 2002). However, the species richness of carrion beetle communities has been steadily declining because of forest fragmentation, so it is feasible that in the not-so-distant future, these organisms will have little or no affect on carrion (Gibbs and Stanton, 2001). Additionally, carnivorous ants are major consumers of carrion and even pick the carcass clean to the bone (Stake and Cimprich, 2003; DeVault et al, 2004). Stake and Cimprich (2003) found that the ants preyed mostly at night on eggs which were in early enough developmental stages to be soft enough for them to break down. A carrion succession study conducted by Grassberger and Frank (2004) yielded results that demonstrated the importance of arthropod and blow fly species in decomposition. Furthermore, carrion is frequently broken down and consumed by bacteria, which Syvanen (1985) refers to as "the ultimate carrion eater."

Specialized scavengers, decomposers, and obligate carrion breeders are not the sole carrion-feeders, however. In fact, scavenging is an opportunistic alternative for most vertebrates (Kostecke et al, 2001 and DeVault et al, 2002). Switalski (2003) studied feeding and energy habits of coyotes in Yellowstone National Park. He found that, though coyotes are not normally scavengers, they would eat carrion if it became available. Switalski (2003) further found that when wolves were re-introduced, the coyotes often preferred to feed on carrion and therefore have more energy available to monitor possible dangers. In South Carolina, which has a similar climate, flora, and fauna to that of central Florida, raccoons and opossums were found to be the most common scavengers of rodent carrion (DeVault et al, 2004).

Based on these studies, I expect a higher frequency of scavenging to take place in the wooded areas relative to the urban areas. Kostecke et al. (2001) found the highest percent of scavenged carcasses to be in areas shielded by trees. DeVault et al. (2002) preformed a study in a similar landscape and found there to be much scavenging as well. They concluded that because of the warm weather, decomposition was increased which led to an increase in odor which in turn led to the attraction of more scavengers. Similarly, Shivik et al. (2000) found that the brown tree snake, *Boiga irregularis*, was attracted to placed mouse carrion, particularly in the dry seasons, and reasoned that this was due to increased microbial decay and therefore heightened scent which attracted *B. irregularis*.

I tested the hypothesis that there is no dominant carrion feeder of *A. sagrei*, and no significant difference in the scavenging rates and species between the urban and wooded areas. However, I do expect to see a variety of carrion consumers in both areas. Although *Nicrophorus* beetles are often to blame when carrion disappears, I do not expect them to be a factor in my study because they generally only take carrion to breed and their breeding season takes place in the spring (Rauter and Moore, 2002). Additionally, they are not often found in urban regions—they do not flourish in fragmented areas—and they specifically avoid open spaces (Cohn, 2005; Gibbs and Stanton, 2001). Insects I do expect to feed frequently on the *A. sagrei* carcasses are carnivorous ants.

Carrion was more likely to be consumed by mammals and reptiles than birds in the DeVault et al. (2004) South Carolina study, so I do not expect many avian predators in Florida. Kostecke et al. (2001) found in their study of avian carcasses that the rates of scavenging significantly increased during colder temperatures, possibly due to a lack of alternative food sources. However, DeVault et al. (2003, 2004) points out that particularly in warm climates, competition is fierce between microbes and macroscopic organisms for carrion because both microbial and insect activity are limited during colder weather and odors are stronger during warm weather. Due to the climate of central Florida, I overall expect to see a variety of carrion-feeders in this study including snakes, ants, and smaller mammals.

Methods

We caught *A. sagrei* were caught by hand on the Stetson University campus in Deland, Florida and placed them in a freezer at -87°C to both euthanize and preserve the specimens until they were needed. Once frozen, we weighed each specimen and measured the snout-vent length. The mean lizard weight was 2.8 grams and the mean snout-vent length was 4.5 cm.

Two main geographic areas—Lake Woodruff National Wildlife Refuge and Stetson University's Deland campus—were used as wooded and urban study sites. Six testing sites were randomly picked in the mesic forest zone of Lake Woodruff for the wooded trials. For each wooded site, the vegetation consisted mostly of scrub plants and sand pine and it had rained within the past few days so the ground was fairly dry. The wooded trials were performed during February and March of 2006. For the urban areas, six testing sites were selected around the Stetson campus which were located in scrub-like areas, again consisting mostly of scrub vegetation. I preformed the urban trials between October and November of 2005 and again during March of 2006. The total trials were eighteen in each area, a total of thirty-six trials.

I used three of the previously prepared *A. sagrei* for each trial. One specimen at each site was monitored by video camera. The setup consisted of a large plastic box which held the vcr, wires, and motorcycle battery. Outside of the box, connected by other wires, was the small camera mounted on a PVC pipe. The camera had a series of tiny near-infrared lights around the lens so the subject matter could be seen in the night. The other two specimens were randomly placed separately approximately three to five meters from the camera setup. Each trial was placed and left for approximately 24 hours and then picked up. Any missing specimens were documented and any tracks or other identifying evidence at the site were noted. All videos were viewed, whether that particular specimen had disappeared or not.

I analyzed the data by performing a two-by-two contingency table chi-squared test comparing probability of consumption in urban versus wooded areas, as well as a two-by-two contingency table chi-squared test comparing probability of consumption based on whether or not a camera was present.

Results

There was a combined total of eighteen *A. sagrei* carrion placed in both the urban and wooded areas. Of these, twenty were apparently eaten and sixteen were not consumed. For the purposes of this study, if the carrion was missing it was considered consumed and if there were no distinguishable tracks, the scavenger was considered "unknown." As seen in Figure 1, scavengers included ants, feral cats, and unknown.

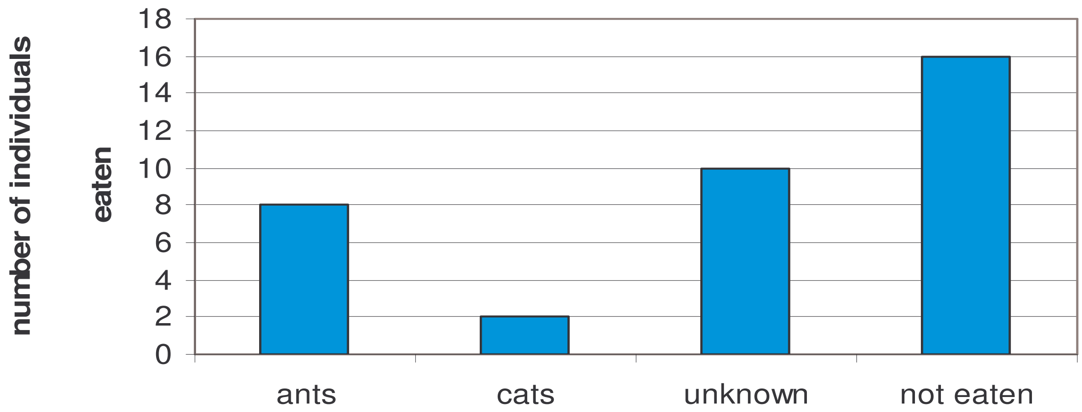

Figure 1. Total count of scavengers

The highest number of carrion was consumed by unknown scavengers, followed closely by ants. In the urban area, thirteen of the carrion were eaten and five were not. Scavengers in the urban area included ants, feral cats, and unknown. In the wooded area, all scavengers were labeled as unknown and only seven *A. sagrei* carrion were consumed.

This data is summarized in Figure 2, a comparison of scavengers in urban and wooded designated areas.

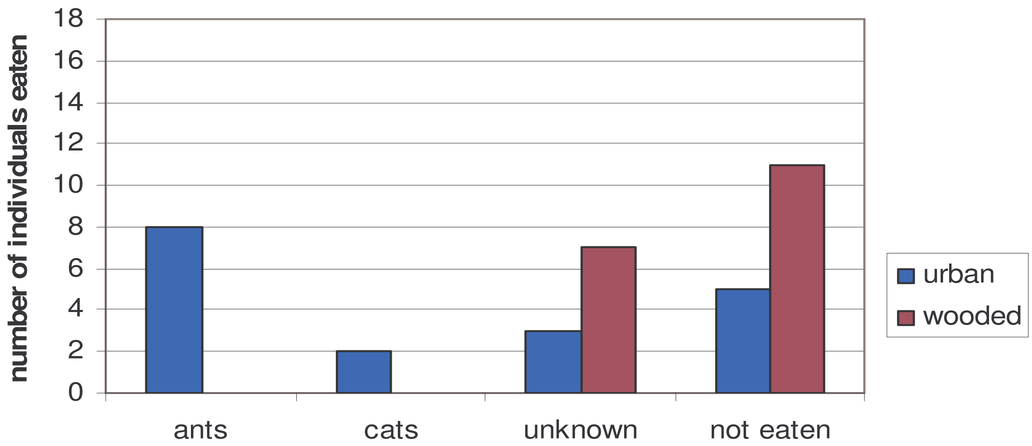

Figure 2. Urban versus wooded scavengers

Unfortunately there were no identifiable scavengers in the wooded area, and the majority of carrion placed in those areas were not consumed at all.

In a two-by-two contingency table chi-squared test comparing whether carrion was consumed in urban versus wooded areas, the p-value (p=0.221) came up far from significant as seen in Table One.

Table One. Consumed/Not Consumed Carcasses in Urban and Wooded Areas

	urban	wooded
eaten	13	7
not eaten	5	11

Likewise, a two-by-two contingency table chi-squared test comparing whether carrion was consumed where a camera was located yielded a non-significant p-value (p=0.297) as well, as seen in Table Two.

Table Two. Consumed/Not Consumed Carcasses Based on Camera Presence

	eaten	not eaten
camera	4	8
no camera	16	8

Discussion

Overall, my hypothesis was supported in that I did not find any dominant carrion-feeders and there was no significant difference in species which fed on the carrion between the urban and wooded areas. There was also no significant difference in scavenging rates between the urban and wooded areas. I had not expected to see feral cats as carrion-eaters in this study; however, they were only present at one of the six urban testing sites. Upon reflection, though, the feral cats were probably acting as opportunistic carrion feeders, as most mammals do (Kostecke et al. 2001 and DeVault et al. 2002). Kostecke et al (2001) also suggested that more scavenging of carrion occurs in shade-covered areas, however my results were not consistent with those conclusions. Had Kostecke et al.'s (2001) results concurred with mine; this study would have revealed more consumed *A. sagrei* in the wooded test sites than actually occurred.

My hypotheses concerning insects were supported—ants constituted 44% of recognizable urban scavengers, in concurrence with DeVault (2004) and Stake and Cimprich (2003), who both stated that insects are major users of carrion. Similarly, as expected, I did not find *Nicrophorus* beetles as carrion users in my study because they were not often found in urban areas and also because that species uses carrion for breeding, and their breeding season is not until spring (Rauter and Moore, 2002; Cohn, 2005; Gibbs and Stanton, 2001). Because of the short amount of time I left specimens out, they didn't have sufficient time to be decomposed by bacteria and fungi as Syvanen (1985) had suggested.

In the wooded areas, the majority of the carcasses were not consumed and those that were consumed were not consumed within view of the cameras. However, these disappointing data could be due to several factors. Firstly, at the time of the first wooded trial the temperature was colder than the normal average for that time of year. A colder temperature could have great influence because any reptiles in particular that I would have expected to scavenge on *A. sagrei* may have been too cold to forage. Additionally, other wildlife often stay within shelter until the warmer weather arrives.

A second factor which may have influenced scavenging rates in the wooded areas is the human scent I left behind at each site. Though I took care not to touch the specimens as I placed them, I had to stay within the area for at least five minutes to properly set up the video camera and my scent must have remained behind. Similarly, once again for the first wooded trial, several other people had helped me carry out the equipment and place it, which would have left an enormous human scent behind. Perhaps the camera setups themselves were a deterrent because, though the sounds and light they make are insignificant to the human senses, they may be a larger disturbance to scavengers than I would have expected.

Another reason why I may have had low scavenging rates within the wooded area could have also been due to the fact that in all my visits out to Lake Woodruff over the years, I have rarely observed *A. sagrei*. That may be because they do not prefer to reside so far from urban areas. By placing these organisms in an environment which they don't appear to be common, they may have been left alone simply because they have no natural predators in such areas and animals that could become scavengers did not respond because they have not learned to view *A. sagrei* as a food source.

Error might have been caused by bias in the placement of the carcasses. Though they were mostly placed at random, without realizing it I never actually placed them very close to trees, so it may be that scavengers of *A. sagrei* normally search for them around trees and because my trials were not near these trees, the scavengers never found their food. Although I found no particular research specifying that *A. sagrei* prefer to dwell on trees and shrubs, my experience with finding them at least in central Florida is that they seem to be frequently found hanging out on deciduous trees facing the sun.

I would suggest several changes for future studies on carrion feeding on *A. sagrei* for a more successful experiment. Firstly, preliminary studies which focus on habitats with high *A. sagrei* population density would be helpful. Additionally, future studies could perhaps leave the specimens for a longer period of time to see if further decomposition of the specimen would attract more predators, as DeVault et al (2003, 2004) suggested. I would also recommend that more advanced camera equipment be used, if the study is to be carried out in the same manner. It's possible that with equipment which was smaller and less noticeable to organisms that other scavengers may have approached the carrion. Similarly, I would advise the use of a camera which has a larger field of view without losing sight of the subject.

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