

OBSERVATIONS ON THE FAUNA THAT VISIT AFRICAN TULIP TREE (*SPATHODEA CAMPANULATA* BEAUV.) FORESTS IN PUERTO RICO

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ABSTRACT

Diurnal field observations in secondary forests dominated by the introduced African tulip tree (*Spathodea campanulata*) in Puerto Rico show a faunal assemblage that consists mostly of native species (81.1 percent). The most abundant species were common birds and reptiles, yet some uncommon fauna appear to be visiting or residing in these forests. The observations suggest these forests have the potential to provide resources and habitat for uncommon or endangered species. Systematic studies on the fauna associated to these forests are needed, especially for less conspicuous species and those with limited daytime activity such as bats, frogs, and invertebrates.

Keywords: introduced species, novel forests and plant-animal interactions.

INTRODUCTION

The African tulip tree, *Spathodea campanulata* Beauv. (Bignoniaceae), was introduced to Puerto Rico more than 90 years ago (Abelleira and Lugo 2008). It is now the most abundant tree in the secondary forests of Puerto Rico (Brandeis *et al.* 2007) and is very conspicuous during its flowering and fruiting season. When flowering, trees mass produce large (>5 cm long) attractive flowers of an intense orange-red color that cover the canopy and then the floor. During the fruiting season, trees loose most to all of their leaves, and the seed pods and bark are distinguishable from evergreen forest canopies. These traits seem to be attracting fauna to *S. campanulata* trees and forests.

There is a rising need to document the fauna associated to secondary forests because they are increasing in area in many parts of the world (Bowen *et al.* 2007). What follows is a series of casual observations on the fauna associated to *S. campanulata* trees made while completing a study on the ecology of forests dominated by this species

in northcentral Puerto Rico (Abelleira Martínez 2009). The observations are focused on the interactions arising between native and introduced species, and their environment. Management, conservation practices, and research needs are discussed.

METHODS

The observations are biased towards conspicuous daytime fauna and are meant to document but do not constitute a systematic study. Most of the observations were made in *S. campanulata* forests in rural northcentral Puerto Rico on alluvial and karst geological substrates, and less in volcanic substrate due to fewer visits (Abelleira Martínez 2009). These are complemented with observations of fauna associated to individual trees in rural to urban settings. I group my observations by major animal groups biased towards vertebrates. Each animal is reported by its common local or most familiar name, scientific names are given for those whose identification was certain, and all are native unless stated otherwise.

RESULTS

Amphibians

The common Coquí (*Eleutherodactylus coqui*), the Coquí Churí (*E. antillensis*), White-lipped Frog (*Leptodactylus albilabris*), and the introduced Cane Toad (*Bufo marinus*) were observed at most *S. campanulata* forests visited (Table 1). Egg masses of Coquí species were found in the leaf litter on the forest floor, and Cane Toad and possibly White-lipped Frog tadpoles thrived in vernal pools formed by old plow lines that trapped floodwater at alluvial sites. The same occurred in sites on karst depressions that remained flooded after major rain events due to the obstruction of sinkholes by debris.

Birds

In the *S. campanulata* forests of rural northcentral Puerto Rico there is a regular bird assemblage formed by the Bobo Mayor (*Saurothera vieilloti*), Carpintero (*Melanerpes portoricensis*), and Comeñame (*Loxigilla portoricensis*; Table 1), all endemic species. The Comeñame was observed consuming *S. campanulata* seeds, which are about 2 cm long, winged, and wind-dispersed, off the pods. Less frequent or conspicuous visitors were the Bobo Menor (*Coccyzus minor*), Calandria (*Icterus dominicensis*), Julián Chiví (*Vireo* spp.), Reina Mora (*Spindalis portoricensis*), Reinita (*Coereba flaveola*), San Pedrito (*Todus mexicanus*), and hummingbirds. The Martinete (*Butorides virescens*) visited flooded alluvial and karst sites. The Judío (*Crotophaga ani*) frequently perched on *S. campanulata* trees in pastures or forest edges, and introduced chickens (*Gallus domesticus*) sometimes visited sites near homesteads.

In rural to urban areas, insectivorous birds such as the Chango (*Quiscalus niger*), Pitirre (*Tyrannus dominicensis*), and Zorzal Pardo (*Margarops fuscatus*) can frequently be seen perching atop *S. campanulata* flower clusters (Table 1). They probably cross-pollinate the self-incompatible flowers while drinking rain water that accumulates in the flowers or foraging for insects in the nectar (Gentry 1974, Trigo and dos Santos 2000, Bittencourt *et al.* 2003, Fumero *pers. comm.*). In

urban Río Piedras, introduced Dominican Parakeets (*Aratinga chloroptera*) invade *S. campanulata* trees during fruiting season. They peel the seeds off the pods with their claws and consume the cotyledons, discarding the papery wings. These parakeets are found in many lowland rural municipalities such as Arecibo, Mayagüez, Salinas, and San Germán. Also in Río Piedras, I regularly observed a Guaraguao (*Buteo jamaicensis*) returning to the same *S. campanulata* tree at dusk. It either nested or used the tree to perch at night.

Invertebrates

The diversity of species in this group makes it the most limited in taxonomic resolution. I casually observed centipedes, praying mantis, walking sticks, spiders, and scorpions. Mosquitoes were so abundant at wet to flooded sites that they became unbearable. Wasps were seasonal in the forest understory and appeared to be most common during summer which coincided with forest canopy opening due to leaf fall (Abelleira Martínez 2009). The Brown Land Snail (*Caracolis caracola*) was very common in understory foliage, tree trunks, and forest floor leaf litter of alluvial and karst sites (Table 1). Other snails (*C. marginella* and *Polydontes lima*) were less common.

Mammals

Puerto Rico lacks native terrestrial non-flying mammals in present to recent times. Instead, I observed introduced stray dogs (*Cannis lupus familiaris*), feral cats (*Felis catus*), and mice (*Mus musculus*) sporadically at some sites (Table 1). However, although I never observed them directly for not visiting any sites at night, the most conspicuous evidence of any mammal was of bats. On the floor of alluvial and karst *S. campanulata* forests, localized clumps of seeds and seedlings of the trees *Andira inermis*, *Callophylum calaba*, *Melicoccus bijugatus*, *Terminalia catappa*, and *Thespesia grandiflora* are circumstantial evidence of this (Fleming and Heithaus 1981, Ortega and Castro Arellano 2001). In Puerto Rico, the Common Fruit Bat (*Artibeus jamaicensis*) can be dispersing these and other species with small-sized

TABLE 1. Fauna observed in *Spathodea campanulata* forests on alluvial, karst, and volcanic geological substrates in rural areas, and in individual *S. campanulata* trees in urban areas. Only fauna identified to genus or species are included. The observation time spans were similar between alluvial and karst sites, and these were about twenty-fold the time span on volcanic sites. In urban areas, observations were casual.

	Site Description			
	Alluvial	Karst	Volcanic	Urban
Amphibians				
<i>Bufo marinus</i> *	x	x		
<i>Eleutherodactylus antillensis</i> †		x		
<i>Eleutherodactylus coqui</i> †	x	x	x	
<i>Leptodactylus albilabris</i>	x	x	x	
Birds				
<i>Aratinga chloroptera</i> *				x
<i>Buteo jamaicensis</i>			x	x
<i>Butorides virescens</i>	x	x		
<i>Coccyzus minor</i>		x		
<i>Coereba flaveola</i>	x	x	x	
<i>Crotophaga ani</i>	x	x		
<i>Gallus domesticus</i> *	x	x		
<i>Icterus dominicensis</i>		x		
<i>Loxigilla portoricensis</i> †	x	x	x	
<i>Margarops fuscatus</i>	x	x	x	x
<i>Melanerpes portoricensis</i> †	x	x	x	x
<i>Quiscalus niger</i>	x			x
<i>Saurothera vieilloti</i> †	x	x		
<i>Spindalis portoricensis</i> †		x		
<i>Todus mexicanus</i> †		x	x	
<i>Tyrannus dominicensis</i>	x	x		x
<i>Vireo</i> spp.		x	x	
Invertebrates				
<i>Caracolus caracola</i>	x	x		
<i>Caracolus marginella</i>	x	x		
<i>Polydontes lima</i>	x	x		
Mammals				
<i>Cannis lupus familiaris</i> *	x			
<i>Felis catus</i> *		x		
<i>Mus musculus</i> *			x	

TABLE 1. Fauna observed in *Spathodea campanulata* forests on alluvial, karst, and volcanic geological substrates in rural areas, and in individual *S. campanulata* trees in urban areas. Only fauna identified to genus or species are included. The observation time spans were similar between alluvial and karst sites, and these were about twenty-fold the time span on volcanic sites. In urban areas, observations were casual. (continued).

	Site Description			
	Alluvial	Karst	Volcanic	Urban
Reptiles				
<i>Alsophis portoricensis</i> †	x	x	x	
<i>Ameiva exsul</i> †	x	x		
<i>Anolis cristatellus</i> †	x	x	x	
<i>Anolis cuvieri</i> †		x	x	
<i>Anolis pulchellus</i> †	x	x	x	
<i>Anolis stratulus</i> †	x	x		
<i>Arrhyton exiguum</i> †		x		
<i>Iguana iguana</i> *	x			x
<i>Mabuya mabouya sloani</i> †		x		
<i>Sphaerodactylus macrolepis</i>		x	x	

* Introduced species

† Native species endemic to Puerto Rico and the Virgin Islands.

fruits (2-4 cm long) found amongst juvenile trees in *S. campanulata* forests (Rodríguez Durán 2005), and it is probably the most common visitor.

Reptiles

Anoles or Lagartijos (*Anolis cristatellus* and *A. stratulus*) are the most common residents of *S. campanulata* forests in northcentral Puerto Rico (Table 1). The Lagartijo Jardinero (*A. pulchellus*) was common in forest edges. The canopy dwelling Lagarto Verde (*Anolis cuvieri*) was relatively common in forests on karst and volcanic substrates. In three out of ten visits to one volcanic site, I saw a Lagarto Verde on the same *S. campanulata* tree suggesting it was a resident. While visiting alluvial forests near the Cibuco and Plata rivers in rural to urban areas, I occasionally observed the introduced Green Iguana or Gallina de Palo (*Iguana iguana*) on river margins or sun bathing atop *S. campanulata* trees. I also observed their feces on the ground at some sites. Other possible residents are Siguanas (*Ameiva exsul*) and the litter

dwelling gecko Salamanquita (*Sphaerodactylus macrolepis*). On one occasion, I observed a Lucia (*Mabuya mabouya sloani*), a rare endemic skink, climbing a *S. campanulata* tree trunk at a karst site near Manatí which I only visited on two occasions. The common snakes Culebra Corredora (*Alsophis portoricensis*) and Culebra de Jardín (*Arrhyton exiguum*) were seen in the morning hours at alluvial and karst sites.

DISCUSSION

These observations show that *S. campanulata* forests on abandoned farmlands provide habitat and resources to many animal species. They also show how animals can be using this tree as a resource in rural to urban areas. Most of the animals observed are native to the Island (81.1 percent; Table 1), half of the native species are endemic to Puerto Rico and the Virgin Islands, and all species, whether introduced or native, are interacting with *S. campanulata* forests or trees under naturally occurring circumstances. The following discussion

focuses on the implications of the interactions of *S. campanulata* forests and trees with animals, with emphasis on uncommon and endangered species.

In Puerto Rico, most seasonally flooded karst depressions were deforested for agriculture and *S. campanulata* is now a dominant species where this practice has been abandoned (Doerr and Hoy 1957, Rivera and Aide 1998, Aukema *et al.* 2007). Out of seven *S. campanulata* forests described on karst in my study, four were on depressions where seasonal pools formed due to clogging of sinkholes (Abelleira Martínez 2009). The endangered endemic frog Sapo Concho (*Peltophryne lemur*) takes advantage of seasonal pools in the southern dry forests and there is evidence that this species once occurred in the northern moist karst forests (Rivero *et al.* 1980). Measures of habitat quality in Puerto Rico usually deem sites dominated by introduced species, such as *S. campanulata*, as degraded and of none to negative ecological value. This does not consider other important habitat characteristics such as hydrology (i.e., seasonality and extent of flooding) and food resources that can be important for successful reintroductions of the Sapo Concho in the northern region. The abundance of other frogs and food resources (i.e.; mosquitoes and other insects) suggests that *S. campanulata* forests on floodable karst depressions can be ideal sites for the reintroduction of this species. The presence of the introduced Cane Toad, which has been suggested to be a competitor and predator of the Sapo Concho, could complicate the establishment of successful populations yet they seem to be present in all the lowland moist regions of Puerto Rico (Rivero *et al.* 1980, Rivero 1998). The high productivity of *S. campanulata* forests offers vast resources for invertebrates that are the food staple of frogs and could allow the coexistence of these species.

Many of the birds found in *S. campanulata* forests are known tree seed dispersers. For example, the Comeñame, Julián Chiví, Reina Mora, and Zorzal Pardo consume and disperse the seeds of the native trees *Guarea guidonia*, *Cordia* spp., *Miconia* spp., and *Ocotea* spp. (Biaggi 1997,

Carlo *et al.* 2003). These are commonly found as juvenile trees in *S. campanulata* forests. In fact, most species found as juvenile trees in these forests have small sized fruits that are probably dispersed by birds (Abelleira Martínez 2009). As most of these juvenile trees lack parent trees at most sites, the birds must be seeking habitat or other resources while consuming fruits and dispersing seeds. A possibility is that they are foraging for *S. campanulata* seeds.

The Dominican Parakeet is a very close relative of the extinct endemic Puerto Rican Parakeet (*Aratinga chloroptera maugaei*) and a distant relative of the critically endangered Puerto Rican Parrot or Iguaca (*Amazona vitatta*; Biaggi 1997). The parakeets actively forage for the seeds and it could be possible that the Puerto Rican Parrot population that was recently reintroduced into Río Abajo state forest is using this resource in secondary forest areas. I am unaware of any studies on the nutritional value of *S. campanulata* seeds.

The year-round presence of insectivorous birds reflects high insect abundance in *S. campanulata* forests and their visits to flowers suggest they could be foraging while acting as pollinators. Suitable bird pollinators appear to be one of the reasons for *S. campanulata*'s invasion success in Puerto Rico (Kress and Horvitz 2005). This can have genetic and evolutionary implications for *S. campanulata* on the Island as birds could be selecting for larger flowers that serve as better perches or for flowers containing dead insects due to insecticidal compounds in the nectar (Abbott 1992, Trigo and dos Santos 2000). The effects of these compounds on invertebrate species on the Island need to be researched. On the other hand, researchers have observed that *S. campanulata* leaves and flowers are readily consumed by native freshwater shrimp (*Xiphocaris* spp.; Lugo 2004). Thus, it is probable that the effects of this relatively new food resource are not the same across native invertebrate species.

The leaf litter and organic matter accumulation in *S. campanulata* forests can bring back forest

dwelling invertebrates to deforested sites. For example, at alluvial *S. campanulata* forests formerly used for sugar cane, endemic *Onychochaeta borincana* and introduced *Pontoscolex corethrurus*, two earthworm species common in disturbed ground, coexist with other native earthworms of forest environments (*P. cynthiae* and *P. spirallis*; Lugo et al. 2006). The ant species composition of *S. campanulata* forests in the volcanic mountains of the Carite region consists of 15 litter and arboreal ants of which only one was introduced (Osorio Pérez et al. 2007). The microfauna found in the leaf litter of *S. campanulata* forests is currently being studied (Ortiz and Berberena pers. comm.). Like other conspicuous invertebrates observed in this study, wasps have returned to *S. campanulata* forests and they appear to have a seasonality that corresponds to the phenology of the forest canopy and understory trees. Where the wasps go when they are absent from the understory is uncertain yet a possibility is that leafing or flowering in the canopy offer resources for which they vertically migrate. More detailed studies of the invertebrates associated to *S. campanulata* forests are needed.

Caves sustain abundant bat populations which appear to contribute to high juvenile tree species richness on *S. campanulata* forests on karst through seed dispersal (Abelleira Martínez 2009). In West Africa, fruit bats visit *S. campanulata* flowers to lap the nectar by inserting their heads in the corolla, potentially acting as pollinators, or by tearing its side and robbing the nectar (Ayensu 1974). If they visit the flowers, bats could also act as pollinators in Puerto Rico. Studies on the bat populations and habits on or near *S. campanulata* forest sites could clarify their role in tree seed dispersal. Besides the Common Fruit Bat, other visitors could be the Antillean Fruit Bat (*Brachyphylla cavernarum*), the Brown Flower Bat (*Erophylla sezekorni*), the Greater Antillean Long Tongue Bat (*Monophyllus redmani*), and the Red Fruit Bat (*Stenoderma rufum*) judging from their distribution in Puerto Rico (Gannon et al. 2005).

Although reptiles are typically not recognized as seed dispersers in Puerto Rico, it is possible that the tree anole Lagarto Verde and the introduced Green

Iguana play that role in *S. campanulata* forests. Viable seeds and other plant material have been found in the gut of both species (Benítez Malvido et al. 2003, Vega Castillo and Cuevas 2009). In the more disturbed alluvial sites, the Green Iguana might be filling an ecological role once occupied by the Lagarto Verde, as the latter was not observed at alluvial sites. The Lagarto Verde was once rare due to deforestation but as abandoned agricultural lands have reverted to forested landscapes, this species seems to be increasing its numbers and is now a common sight in karst and volcanic secondary forests (Rivero 1998).

The views presented here suggest that the invasion of *S. campanulata* in abandoned agricultural lands in Puerto Rico can have many positive implications for recovering native forest fauna. In turn, many of these animals, particularly birds, bats, and reptiles, seem to be the main seed dispersal agents assembling the juvenile tree species composition found in these forests. The potential of *S. campanulata* trees and forests as resources and habitat for endangered species needs to be investigated as they could be providing an opportunity to facilitate the recovery of some of these species.

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