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Stinging Ant Species at Gopher Tortoise Burrows Change over Time with Habitat Change

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Abstract

Two invasive ant species known to attack vertebrates are common in South Florida: *Solenopsis invicta* and *Wasmannia auropunctata.* These two species have strikingly different habitat preferences: *S. invicta* colonies occur primarily in open, sunny areas such as pastures, cultivated fields, and mowed lawns, while *W. auropunctata* colonies are most common in shady areas with thick layers of leaf litter. Here, we examined how habitat change may affect the relative occurrence of these two ant species at the burrows of gopher tortoises (*Gopherus polyphemus*) in South Florida, and thus the ants' potential to impact the tortoises and commensal species that inhabit tortoise burrows. In 2002, 2008, 2012, and 2021, we surveyed ants at tortoise burrows in a section of the Abacoa Greenway, a preserve in Jupiter, Florida, established, in part, to protect gopher tortoises. In the four surveys, we found *S. invicta* at 16%–33% of the tortoise burrows, primarily near the edges of forested areas, although the locations of these edges changed as the forested areas expanded and forest gaps filled in. In contrast, the occurrence of *W. auropunctata* at burrows increased with each survey, from 3% in 2002 to 39% in 2021. The increase in *W. auropunctata* appears to relate to increased forest density and the accumulation of leaf litter due to reduction mowing and fire suppression. Similar changes may be expected in other Florida natural areas where fire is suppressed.

Introduction

Invasive ants, introduced outside their native ranges through human commerce, are a serious threat to native biodiversity, as well as to agriculture and other human activities. Two invasive ant species known to attack and negatively impact vertebrates are common in South Florida: the red imported fire ant, *Solenopsis invicta* Buren, 1972, and the little fire ant *Wasmannia auropunctata* (Roger, 1863). We examined the occurrence of these ant species at the burrows of the gopher tortoise (*Gopherus polyphemus* Daudin, 1802), a threatened species in South Florida. A wide variety of commensal organisms inhabit gopher tortoise burrows (Hipps, 2019).

The red imported fire ant, *S. invicta,* originally from the grasslands of South America, often becomes a dominant species outside of its native range. *Solenopsis invicta* commonly injures and kills hatchlings of ground-nesting reptiles and birds (Allen et al., 2004; Dziadzio et al., 2016). The little fire ant, *W. auropunctata*, with a broad native range in the Neotropics, has been reported stinging the eyes of wild and domestic vertebrates, sometimes leading to blindness (Wetterer & Porter, 2003). In disturbed areas, such as agricultural and forestry lands, and in regions outside its native range, *W. auropunctata* commonly shows extreme population explosions and "is capable under some circumstances of wiping out entire ant faunas over large areas… forming in many places a living blanket of ants that kill and eat nearly all other ants in their path" (Hölldobler & Wilson, 1990). *Solenopsis invicta* and *W. auropunctata* have strikingly different habitat preferences. *Solenopsis invicta* colonies typically occur in open, sunny areas, such as pastures,

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lawns, and cultivated fields, and are less common in heavily wooded areas. In contrast, *W. auropunctata* colonies are most common in shady areas with thick layers of leaf litter.

Gopher tortoises prefer habitats with sandy soils for burrows, herbaceous plants for food, and open sunny spots for nesting and basking (Diemer, 1992). Fire is a normal element in gopher tortoise habitats in Florida, and when natural fires are suppressed, these habitats can become overgrown. To maintain the open spaces necessary for herbaceous vegetation and tortoise nesting and basking sites, land managers often use prescribed burning or reduction mowing (Wade & Lunsford, 1989; Main & Tanner, 1999). Prescribed burns eliminate most leaf litter and other plant debris, leaving the area almost bare sand. In contrast, reduction mowing shreds the vegetation, leaving behind a thick layer of mulch.

In the present study, we surveyed ants at gopher tortoise burrows at the same site four times over a 19-year period to evaluate how successional changes in habitat related to changes in the ants found at gopher tortoise burrows.

Materials and Methods

In 2002, 2008, 2012, and 2021, we surveyed ants at tortoise burrows in a section of the Abacoa Greenway preserve southwest of the intersection of Fredrick Small Road and Central Boulevard in Jupiter, Florida (designated Range VIa; 26.897°N, 80.114°W; Fig 1). The greenway was established, in part, to protect the local gopher tortoise populations. To the south of the reserve section are baseball fields associated with the Roger Dean Stadium. A footpath ~2 m wide runs near the periphery of the range and is mowed every two to three weeks. Two linear areas of disturbances cross through the northern and eastern portions of the range; one is an overgrown trail along former fence-line and other is a mowed trail along a pipeline dug ~1999. The entire site is surrounded by chain-link fences with gates that allow for public recreational use. The southern and easternmost parts of Range VIa were cleared of vegetation and dug out to serve as a shallow retention basin during times of flooding (Fig 1). At the time of our first survey in 2002, the retention basin was being kept clear of vegetation using an herbicide (Fig 1). Over time, however, shrubs and pines have gradually filled in much of this area (Fig 1).

Although regular burns had been planned for our study site to maintain suitable gopher tortoise habitat, there have been no prescribed burns due in large part to the objections of neighborhood residents. Instead, in October and November 2006, reduction mowing reduced much of the overgrown understory of the range to a layer of mulched debris. However, almost all of the pines, oaks, and hollies were left standing, along with isolated patches of saw palmetto, typically around the burrows of gopher tortoises.

We surveyed ants using a folded index card with ~1 g of canned water-packed tuna inside, placed within 0.2 m of the burrow entrance. We returned 2 hours (± 10 minutes) later and collected the cards, placing each in a separate zip-lock bag. We found that 2 h was enough time to allow significant ant recruitment, but not complete bait removal (*see* Wetterer and Moore, 2005; Jones, 2013; Viluan, 2021 for more details on the study site and methods).

Results

The overall occurrence of *S. invicta* remained relatively stable in the four surveys, found at 16%-33% of the tortoise burrows (Table 1). In all years, *S. invicta* occurred primarily at burrows in relatively open areas along the mowed paths and at the outer edges of the forested area. However, the location of this edge changed as the forested area expanded and gaps filled in. After decreasing from 2002 to 2008 to 2012, we observed a rebound in 2021 in the proportion of tortoise burrows with *S. invicta* present. This appears to be due to gopher tortoises relocating their burrows from the overgrown interior of the site to more open areas along the peripheral path and in the catchment basin, places where *S. invicta* dominates. For example, in 2021, *S. invicta* was found at seven of nine gopher tortoise burrows in the far southeastern part of the catchment basin (Fig 1), an area where no tortoise burrows had been previously identified in the ant surveys. This area, which was completely cleared of vegetation in 2002, was still fairly open in 2021.

In contrast, the occurrence of *W. auropunctata* increased with each survey (Table 1). In 2002, we found only 3% of the tortoise burrows with *W. auropunctata* present. By 2012, *W. auropunctata* surpassed *S. invicta* as the most common stinging ant we found at the tortoise burrows. In 2021, we found *W. auropunctata* at 39% of the tortoise burrows.

Discussion

In 2002, when our study site was part of a newly established preserve, Wetterer and Moore (2005) found that *S. invicta* was the dominant stinging ant at gopher tortoise burrows, particularly near the edge of open areas. Nineteen years later, the preserve habitat has changed (Fig 1). Reduction mowing in 2006 created a thick mulch layer.

Table 1. Number of tortoise burrows with different ant species present in 2002, 2008, 2012, and 2021 surveys. n = number of burrows surveyed

Year	n	Solenopsis invicta	Wasmannia auropunctata
2002	154	51 = 33%	4 = 3%
2008	100	26 = 26%	22 = 22%
2012	74	12 = 16%	26 = 35%
2021	85	21 = 25%	33 = 39%

Fig 1. Study area in December 2002 (top; from US Geological Survey) and January 2019 (bottom; from Google Earth).

The usual burn/vegetation reduction cycle for this type of flatwood habitat is every 7-10 years. In 2021, it had been 15 years since the last mowing. As a result, forested areas have expanded, and the vegetation in the interior has become denser. These changes made much of the study site less favorable for *S. invicta*, but more favorable for *W. auropunctata*. As a result, *W. auropunctata* has become the dominant stinging ant found at gopher tortoise burrows. Similar changes in populations of stinging ants may be expected in other South Florida natural areas where fire is suppressed and reduction mowing is used as a management tool.

In natural areas in South Florida that are maintained through regular prescribed burns, both *S. invicta* and *W. auropunctata* are generally much less common at gopher tortoise burrows (Hipps, 2019). Unfortunately, such management has not been possible at our study site. The significant increase in vegetation density (Fig 1) has made much of the study site less favorable for gopher tortoises. To continue supporting

the large population of tortoises on the site, it appears that additional reduction mowing will be necessary.

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Authors' Contribution

JKW: conceptualization, methodology, investigation, analysis, writing, visualization, supervision.
RCJ: conceptualization, investigation, analysis, writing.
JM: conceptualization, investigation, analysis, writing, visualization, supervision.
VV: investigation, analysis, writing.

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