Observations on the High Diversity of Native Ant Species Coexisting with Imported Fire Ants at a Microspatial Scale in Mississippi

Joe A. MacGown[1,*] and Richard L. Brown[1]

Abstract - A case study reporting a high diversity of native ants co-existing with imported fire ants is presented. Thirty-six species of ants were collected within one meter of the base and on the lower two meters of the trunk of a *Quercus pagoda* (cherry bark oak) in Tombigbee National Forest, Winston County, MS, on five dates during 2003 and 2004. Twenty-three of these species, including the imported fire ant hybrid, *Solenopsis invicta* x *richteri*, were nesting in the same area. A list of all species collected at the site is provided. Notes are given on the nesting habits of *Polyergus lucidus longicornis* and its slave, *Formica dolosa*, and also for other species in the area. Potential explanations for high diversity including the island effect of an isolated habitat, differing diets and foraging behaviors, habitat partitioning, and seasonal activity are discussed.

Introduction

The imported fire ants, *Solenopsis richteri* Forel, *S. invicta* Buren, and their hybrid, *S. richteri* x *invicta*, have frequently been reported to adversely affect species richness of native ants (Camilo and Phillips 1990, Holway et al. 2002, Jusino-Altresino and Phillips 1994, Morris and Steigman 1993, Porter and Savignano 1990). However, in a follow-up study 12 years after that of Porter and Savignano, Morrison (2002) found that arthropod diversity had returned to levels that were comparable to those prior to invasion of *S. invicta*. Other studies in Florida and Texas have documented high diversity of native ants coexisting with *S. invicta* (Helms and Vinson 2001, Morrison and Porter 2003). Tschinkel (1988) speculated that predation by *Solenopsis molesta* (Say) upon brood of *S. invicta* may restrict *S. invicta* to disturbed habitats where *S. molesta* is absent.

Our knowledge of the ant fauna in Mississippi is based primarily on the early inventory of M.R. Smith (1924a,b,c; 1927; 1928a,b; 1931a,b; 1932). Smith's inventory, subsequent records by other workers, and recent surveys have documented 151 species of ants for Mississippi (Baroni Urbani and De Andrade 2003; Bolton 2000; DuBois and Davis 1998; Hill and Brown 2005; MacGown and Brown, in press; MacGown et al. 2005; MacKay 1993; Shoemaker et al. 1994; Smith 1979; Snelling 1995; Trager 1984, 1988, Trager et al., in press; Umphrey 1996; Ward 1985; Watkins 1985; Wilson 2003). An additional 14 new state records of ant species will be reported in

[1]Mississippi Entomological Museum, Box 9775, Department of Entomology and Plant Pathology, Mississippi State, MS 39762. [*]Corresponding author - jmacgown@entomology.msstate.edu.

the future, bringing the total to 165 species known to occur in Mississippi (J.A. MacGown and R.L. Brown, unpubl. data).

This report documents a case study of high species richness of native ants co-existing with the imported fire ant hybrid, *S. richteri* X *invicta,* at a microspatial scale in Tombigbee National Forest, Winston County, MS. In addition, a nest containing the rarely detected *Polyergus lucidus longicornis* Smith, and its slave, *Formica dolosa* Buren, is described. Nesting habits and behavior of other species are also described.

Study Area and Collection Methods

The study site was in the Tombigbee National Forest (Ackerman Unit) in Winston County, MS at 33°12'30"N, 89°04'32"W and included the basal two meters of a mature and partially decayed *Quercus pagoda* Rafinesque (cherrybark oak; Fagaceae) and one meter of soil and litter around the perimeter of the tree (Fig. 1). The oak tree was located at the edge of a sandy gravel parking area next to an old cemetery (Noxubee Hill Cemetery) in a relatively open and somewhat dry area on a ridge bordered by a rich mixed forest on steep sloped ravines. The tree had a circumference of 3.21 meters at 0.91 meters above ground level, and it was surrounded by a rich layer of litter at its base.

The serendipitous checking of the oak tree by J.A. MacGown during an afternoon rainstorm on 10 July 2003 resulted in discovery of a nest containing *Polyergus lucidus longicornis* and its slave, *Formica dolosa*. In order to collect specimens of the *Polyergus*, litter and soil from the nest area were collected and sifted with a screen into a shallow pan from which specimens of the *Polyergus* and additional species of ants were collected. A sample of the sifted litter and soil was collected in a gallon-sized (3.79-L) plastic bag for extraction with Berlese funnels, and the excess screened litter and soil was placed back onto the nest. Other ants were collected as they were sighted on the base of the tree or adjacent ground. All collecting was done within one hour during which time there was continual rain.

Subsequent visits to this site were made on 15 July 2003 (J.A. MacGown), 21 October 2003 (J.A. MacGown), 11 November 2003 (J.A. MacGown and R.L. Brown), and 26 June 2004 (J.A. MacGown). Visits on 15 July and 21 October were limited to less than a half hour, and collecting on these days was limited to use of baits. On both 11 November and 26 June, ants were collected for about an hour by visual examination of the basal two meters of the tree trunk and surrounding ground within one meter of its base, sifting litter, and baiting. Baits included cookies (Keebler Sandies Pecan Shortbread®), tuna (StarKist® chunk light in water), and peanut butter (generic brand). Cookie bait on six white cards (15 July) and tuna bait on 12 white cards (21 October) were evenly spaced around the perimeter of the tree. Both tuna and cookie baits on cards were used in the same pattern on 11 November. Cookie and peanut butter baits were placed on the tree trunk approximately 1.5 to 2 meters high on 26 June. Soil and litter samples were

taken on 11 November (5 one-gallon bags) and 26 June (1 one-gallon bag) for extraction of ants with Berlese funnels.

Results

During the five visits to this site over the duration of a year, 36 species of ants, including the hybrid fire ant, *Solenopsis invicta x richteri*, were collected on the lower trunk of the oak tree or within one meter from its base (Table 1). These 36 species, collected in less than four hours, represent more than half of the species that were collected at 21 sites in the Tombigbee National Forest from 1999 to 2004 (MacGown and Brown, in press).

Figure 1. Joe MacGown searching for ants at the base of a *Quercus pagoda* (cherrybark oak) in Tombigbee National Forest, Winston County, MS.

Twenty-three species were collected on the first visit on 10 July, one species was added on 21 October, and six species were added on each of the last two visits when collecting was more intense. Based on the presence of colonies or the collection of both workers and dealate queens, 22 species were determined to be nesting at the site. This number of nesting species is probably conservative because small species, such as *Pyramica* spp. and *Brachymyrmex depilis* Emery, do not forage far from their nests, and therefore likely had colonies in the area.

Table 1. Ant species collected at an individual cherrybark oak tree in Tombigbee National Forest with collection dates and indication if they were foraging (F), collected at bait (cookies-C, peanut butter-P, or tuna-T), found nesting (N), or extracted from soil and litter in Berlese funnels (B).

	2003				2004						
Species	Jul 10	Jul 15	Oct 21	Nov 11	Jun 26	F	C	P	T	N	B
Aphaenogaster carolinensis	X			X						X	X
Aphaenogaster fulva	X	X	X	X	X	X			X	X	X
Aphaenogaster lamellidens				X	X	X	X			X	
Aphaenogaster mariae				X	X	X		X		X	
Brachymyrmex depilis	X										X
Camponotus nearcticus					X	X	X				
Camponotus pennsylvanicus	X	X			X	X	X				X
Camponotus snellingi	X			X	X	X	X			X	
Crematogaster lineolata	X	X					X				X
Formica dolosa	X				X	X				X	
Formica pallidefulva					X	X	X	X		X	
Hypoponera opacior	X			X	X					X	X
Monomorium minimum	X				X	X	X	X			
Myrmecina americana	X			X	X	X				X	
Paratrechina arenivaga					X	X				X	
Paratrechina faisonensis	X		X	X	X				X	X	X
Paratrechina vividula	X									X	X
Pheidole bicarinata	X	X		X		X	X			X	
Pheidole dentata	X			X	X	X		X		X	
Pheidole dentigula	X			X	X					X	X
Pheidole tysoni	X			X	X	X			X	X	
Polyergus lucidus longicornis	X									X	
Ponera pennsylvanica	X			X	X					X	X
Prenolepis imparis			X	X		X	X		X		
Proceratium silaceum					X						X
Pyramica angulata	X										X
Pyramica dietrichi				X						X	X
Pyramica ornata	X			X							X
Pyramica pulchella				X							X
Solenopsis invicta x *richteri*	X	X	X	X	X	X	X		X	X	
Solenopsis molesta	X			X	X	X				X	X
Strumigenys louisianae	X			X	X					X	X
Temnothorax curvispinosus				X							X
Temnothorax pergandei				X		X					
Temnothorax schaumii					X	X		X			
Trachymyrmex septentrionalis					X	X				X	

The initial detection of the *Polyergus lucidus longicornis* workers on 10 July led to an investigation of its nest in the soil beneath the leaf litter. The nest was somewhat trapezoidal in shape, with its greatest width of approximately 50 cm at a point farthest from the tree and its narrowest width of approximately 39 cm wide nearest the tree. A large *Pheidole dentata* Mayr nest was adjacent to the *Polyergus* nest, and the line of separation between them was not well defined. The *Polyergus* nest extended into the soil at least 20 cm deep to a level where the roots of the tree prevented further digging. The nest contained hundreds of *Polyergus* and *Formica dolosa* workers in approximately equal numbers. After the nest was excavated, the *Polyergu*s and *Formica* ran erratically on the ground near the base of the tree. A large number of phorid flies, which were not collected nor identified, were observed flying around the ants when the nest was disturbed, but the phorids appeared to be flying at *P. dentata* major workers rather than the *Polyergus* or *Formica* workers. Winged queens of the *Polyergus* were found in the nest, and a chamber containing cocoons of *F. dolosa* was found about 15 to 20 cm deep.

Berlese funnel extraction of ants from one gallon of the litter and soil mixture of the *Polyergus* and *Pheidole* nest included three additional nesting species: *Paratrechina vividula* (Nylander), *Strumigenys louisianae* Roger, and *Solenopsis molesta*. Other species found in the same soil sample included *Brachymyrmex depilis*, *Paratrechina faisonensis* (Forel), *Camponotus pennsylvanicus* (DeGeer), *Hypoponera opacior* (Forel), *Ponera pennsylvanica* Buckley, *Pyramica angulata* (Smith), *P. ornata* (Mayr), *Aphaenogaster carolinensis* Wheeler, *A. fulva* Roger, *Pheidole dentigula* Smith, and *Crematogaster lineolata* (Say).

Ants found within one meter of the *Polyergus* nest included *Solenopsis invicta x richteri*, *Pheidole bicarinata* Mayr, *P. tysoni* Forel, and *Myrmecina americana* Emery, all on the ground; *Camponotus pennsylvanicus* on the tree trunk; and *Paratrechina vividula*, *C. snellingi* Bolton, *Monomorium minimum* (Buckley), and *Solenopsis molesta* under bark of a decayed portion of the tree.

A second visit to the site on 15 July revealed that the nest of *Polyergus* and *Formica* had been abandoned and reoccupied by *Aphaenogaster fulva*. The only other collections made at the site that day were at cookie bait, which was placed on six white cards evenly spaced around the tree one meter from its base. The bait was observed for approximately 30 minutes, and collections were made of *Camponotus pennsylvanicus*, *Pheidole bicarinata*, *Crematogaster lineolata*, and *Solenopsis invicta* x *richteri*, all of which were at separate bait stations.

The imported fire ant hybrid, *Solenopsis invicta x richteri,* was the most numerous species that came to tuna bait on 21 October. *Paratrechina faisonensis, Prenolepis imparis* (Say), and *Aphaenogaster fulva* also were collected at baits, but each of the baited cards attracted only a single species.

On 11 November, *Prenolepis imparis*, *Solenopsis invicta* x *richteri, Aphaenogaster lamellidens* Mayr, *Pheidole bicarinata*, *P. dentata*, *P. tysoni* Forel, and *Temnothorax pergandei* Emery were collected while they foraged on the ground. *Pheidole tysoni* was the only ground-foraging species whose nest was found and also the only species collected at the tuna bait. *Prenolepis imparis* was the most abundant species seen on the ground as well as at the cookie bait. The nest of *Camponotus snellingi* was found in a low-hanging, dead branch of the tree. A large colony of *Aphaenogaster lamellidens* was collected under bark in a dead section of the tree approximately 1.6 meters above ground. Species extracted from five gallons of soil/litter in Berlese funnels included *Paratrechina faisonensis, Hypoponera opacior, Ponera pennsylvanica*, *Pyramica dietrichi* (Smith), *P. ornata*, *P. pulchella* (Emery), *Strumigenys louisianae, Solenopsis invicta* x *richteri*, *S. molesta*, *Aphaenogaster carolinensis*, *A. fulva*, *A. lamellidens*, *A. mariae* Forel, *Pheidole dentigula*, *P. tysoni*, *Temnothorax curvispinosus* Mayr, and *Myrmecina americana*. The only two *A. mariae* specimens collected from the soil samples were dealate queens. This rare species has been speculated to be a temporary parasite of *A. fulva* (Smith 1979), which was also collected in the soil. The imported fire ant hybrid, *Solenopsis invicta x richteri*, was reduced in numbers compared to previous visits, and only two specimens were collected. Twenty-two total species were collected on this visit, and species collected for the first time included *Pyramica dietrichi*, *P. pulchella*, *Aphaenogaster lamellidens*, *A. mariae*, *Temnothorax curvispinosus*, and *T. pergandei*.

Twenty-three species were collected on 26 June, either on the tree or in the soil at its base. *Paratrechina arenivaga* (Wheeler), *P. faisonensis*, *Hypoponera opacior, Trachymyrmex septentrionalis* (McCook), *Solenopsis invicta* x *richteri*, *Aphaenogaster fulva*, *A. lamellidens*, and *Pheidole dentigula* were all found nesting at the base of the tree. *Ponera pennsylvanica*, *Proceratium silaceum* Roger, *Strumigenys louisianae*, *Solenopsis molesta, Pheidole tysoni*, and *Myrmecina americana* were found in a sample of soil and litter taken at the base of the tree and were extracted from a Berlese funnel. *Formica dolosa* was collected crawling on the tree trunk. *Camponotus nearcticus* Emery, *C. pennsylvanicus, C. snellingi, Formica pallidefulva* (Latreille), *Monomorium minimum, Solenopsis invicta* x *richteri,* and *Aphaenogaster lamellidens* were collected at cookie bait that had been placed at various points on the tree at a height between 1.5 and 2 meters. *Formica pallidefulva, Monomorium minimum, Aphaenogaster mariae, Pheidole dentata,* and *Temnothorax schaumii* Roger were collected at peanut butter bait in the same area of the tree trunk. Workers of *A. mariae* were observed climbing into the upper reaches of the tree, presumably toward their nest. A nest of *F. pallidefulva* was located in the soil in the open parking area approximately 5 meters from the tree. Hybrid fire ants were more common than on any previous

visit, and their nests with simple holes for entrances also were found beneath the soil in the parking area. Much of the parking area was covered with leaf litter, and when leaves were moved away, the fire ants were seen foraging in great abundance. Six of the 23 species collected on 26 June were new for the site and included *Paratrechina arenivaga*, *Camponotus nearcticus*, *Formica pallidefulva*, *Proceratium silaceum*, *Trachymyrmex septentrionalis,* and *Temnothorax schaumii*.

Discussion

Much anecdotal information is available from myrmecologists to support the finding that large number of species can be found at a microspatial scale. The largest number of ant species reported from a single point sample was 43 species in 21 genera obtained by fogging a single tree in Amazonia (Wilson 1987). This point sample included about 32% of the total diversity of species collected by fogging canopies of trees in four forest types in 14 sites during two months. However, Wilson's study dealt primarily with arboricolous species, rather than species that reside in soil or litter. A study documenting soil and leaf-litter dwelling ants in a Malaysian rain forest (Agosti et al 1994) reported finding 37 species of ants in an 8-m^2 plot and 104 species in a 20-m^2 plot. The Malaysian study differed from the present study in that the size of the areas sampled was considerably larger (although still relatively small). A study of ant communities in *Pinus palustris* Miller (longleaf pine) flatwoods in northern Florida (Lubertazzi and Tschinkel 2003) yielded 72 total species of ants, with a high of 55 species reported from one of the 70-x 80-m plots. Similar to the results found in these studies, J.A. MacGown has collected up to 40 species of ants in relatively small areas (less than 100 m^2) within single habitats in Mississippi on numerous occasions. The 23 species collected in the present study at the base and periphery of the oak tree during approximately one hour on both 10 July and 26 June represent 32% of the 72 species reported from Tombigbee National Forest (MacGown and Brown, in press). For the five sampling dates at the same site, the total of 36 species collected on the lower two meters of the tree trunk and within one meter of its base represents 50% of the species richness documented in Tombigbee National Forest during a five-year period. This is the highest number of ant species to have been reported from this small of an area in North America.

The question can be raised as to how a community of so many ant species can exist in such a small area, especially if the introduced fire ant adversely affects species richness as previously reported. Hölldobler and Wilson (1990) considered interspecific competition to be the most obvious interaction affecting community organization. Andersen (2000) emphasized environmental stress and disturbance as determinants of ant

community organization in Australia, and he defined seven functional groups in relation to stress and disturbance. In the three-tiered classification of dominance by Vepsäläinen and Pisarski (1982), the lowest level of dominance includes species that defend only their nests, and these appear to be the same as the "opportunistic" species found at food baits (Wilson 1971). The intermediate level includes species that defend their nests and food finds. The highest level of dominance includes species that defend their nests and all their foraging area, which is the same as the dominant Dolichoderinae functional group recognized by Andersen (2000). Various authors have shown that ant communities can be influenced by several factors of niche differentiation, including feeding habits, habitat preferences, temporal partitioning, and other aspects (Brown 1975, Hölldobler and Wilson 1990, Torres 1984).

The species composition at the Tombigbee National Forest site was possibly affected by the act of collecting at the site, in particular by the disturbance of the *Polyergus* nest. However, several of the species not collected on the first date (10 July) were collected on subsequent trips and were likely also present on 10 July. Collections on this date were made in the rain, no baits were used near or on the tree, and only one soil-litter sample was taken from the *Polyergus* nest at the base of the tree. *Camponotus nearcticus, A. mariae, T. schaumii* (all arboreal species), *F. pallidefulva* (a ground-nesting species), and *A. lamellidens* (later found nesting in the tree) were collected at baits on the tree at later dates. The cryptic soil species, *Proceratium silaceum, Pyramica pulchella,* and *Temnothorax curvispinosus*, were collected later in litter and soil samples from different locations around the base of the tree than where the first litter sample was taken. *Paratrechina arenivaga* was found nesting in the soil near the tree on a later date, but that immediate area was not searched on the first collection date. Only two species were not likely there on 10 July: *Prenolepis imparis*, a cool-weather species, and *Trachymyrmex septentrionalis*, whose distinctive nest was not seen until after the *Polyergus* vacated their nest. There is no reason to doubt that all four species of *Aphaenogaster* could have coexisted, because they were all collected on 11 November. Likewise, all three species of *Camponotus* were collected together on 26 June, as were both species of *Formica*.

The study area was a disturbed site with an oak tree in a gravel parking area beside a cemetery surrounded by relatively undisturbed forest, but the diversity of ants was quite high. Typically, diversity of ant species is low in disturbed habitats (Andersen 2000), but in this situation, the large tree with its rich soil and humus layer at its base may have acted as an island for ant species that were more dispersed in the adjacent forest. This does not appear to be an isolated situation as J.A. MacGown has observed many similar instances in a variety of habitats, where isolated large trees in disturbed areas that were near undisturbed forests had

high numbers of ant species. In addition, the openness of the immediate area provided nesting habitat for species not usually found in the forested areas, which added to the total number of species. Another significant factor was that no dominant species of Dolichoderinae, such as *Forelius* spp. or *Linepithema humile* (Mayr), was present at the study site although these species are widespread throughout Mississippi. The introduced fire ants *Solenopsis invicta*, *S. richteri*, and their hybrid are often dominant species in open areas, but they do not appear to exhibit the same level of dominance in forested areas.

Another potential explanation for the high diversity of ant species collected at this oak tree may be differences in diets and foraging behavior. Many of the species at this oak tree were opportunistic species that are generalists in their diets, including *Brachymyrmex depilis, Paratrechina* spp., *Prenolepis imparis, Camponotus* spp., *Formica* spp., *Monomorium minimum, Solenopsis* spp., *Aphaenogaster* spp., *Pheidole* spp., *Crematogaster lineolata,* and *Temnothorax* spp. Many of these species were attracted to baits, in agreement with observations of Wilson (1971), whereas other species of ants were much more specialized in their diet. For example, *Trachymyrmex septentrionalis* grow fungus in vegetative matter and insect feces, whereas other species are specialized predators. *Proceratium silaceum and Myrmecina americana* are specialized predators on spider eggs and mites, respectively (Brown 1958, 2000). *Pyramica* spp. and *Strumigenys louisianae* are predators of various species of Collembola, and it has been speculated that the spongiform bodies on these dacetine ants may be a lure for their prey (Bolton 2000). These dacetine ants also have highly modified elongate mandibles that vary greatly in their length, dentition, and setation. Species with longer mandibles are typically more mobile and hunt by stealth, whereas those with shorter mandibles simply lie in wait for their prey (Hölldolber and Wilson 1990). Due to the unique structural modifications of mandibles and spongiform bodies that differentiate dacetine species from one another, it is unlikely that their prey selection is the same.

Opportunistic species appear to have a variety of methods to deal with competition including speed, size, aggressiveness, and the ability to forage far from their colonies. The large *Camponotus* species are very fast moving ants that can forage (both diurnally and nocturnally) many meters from their colonies (Hansen and Klotz 2005). At the study site, both *Camponotus* spp. and *Formica* spp. were observed moving rapidly about baits, but never taking over a bait with large numbers of individuals. This behavior was contrary to the actions of other opportunistic species that monopolized the bait after it was discovered. Two of the arboreal species, *A. mariae* and *T. schaumii*, exhibited different behavior from the other generalists by moving slowly and cryptically along the bark of the tree near the baits. Smaller sized opportunists, e.g., *B. depilis* and *S. molesta*, may

avoid competition by their diminutive size and need for less food than larger species. Some species, such as *S. invicta x richteri,* are much more aggressive than others and out-compete other species at baits. However, when observing ants at baits on the ground at this study site, it appeared to be "first come, first serve," with species that got to the bait first maintaining control of the bait. The rules of engagement at baits on the ground did not seem to apply to the baits placed on the tree, and it was not unusual to see several species together on the bait on the tree including *C. nearcticus, C. snellingi, C. pennsylvanica,* and *F. pallidefulva* at cookie bait and *F. pallidefulva*, *A. mariae,* and *T. schaumii* at peanut butter bait.

Another factor allowing for many species to live in a small area is habitat partitioning of related species in different microhabitats within the same area. This is not a major issue for minute species or those with small colony size, but it is more important for larger species that occupy more space. In the case of colonies of *Paratrechina* spp., *P. faisonensis* was nesting in the rich litter layer at the base of the tree, *P. vividula* was found nesting under bark of the tree, and *P. arenivaga* was nesting in the open and somewhat sandy soil. *Camponotus nearcticus*, whose nests were not found, is known to nest in twigs and branches in trees (Smith 1965), and *C. snellingi* nests were found in a dead branch and under bark in a rotting section of the tree about one meter high. No confirmed colony of *C. pennsylvanicus* was found, but many individuals were collected from the lower area of the tree in a somewhat hollowed section with rotting wood present. Workers of *Formica pallidefulva* were collected crawling on the tree, but the only nest that was found was located approximately 10 meters from the tree in an open area in the ground. *Solenopsis invicta x richteri* nests were found scattered around the entire open area under a light layer of leaf litter, although no visible mounds were seen. *Solenopsis molesta* was only found nesting at the base of the tree in the soil and leaf litter. Four species of *Aphaenogaster* were collected at the site, three of which were nesting in slightly different areas. Although the nest of *Aphaenogaster mariae* was not found, workers were observed carrying bait up high into the tree where they were apparently nesting. *A. lamellidens* was nesting under bark and in the rotting wood of the tree, *A. fulva* was nesting in the soil and packed litter at the base of the tree with the nest extending into the roots of the tree, and *A. carolinensis* was nesting in the soil itself. Four species of *Pheidole* were found nesting at the site including: *Pheidole dentata*, which had a large colony at the base of the tree; *P. dentigula*, which was nesting in the rich litter layer at the base of the tree; and *P. bicarinata* and *P. tysoni*, both of which had colonies in open soil surrounding the tree. Three species of *Temnothorax* were collected: *T. curvispinosus, T. pergandei,* and *T. schaumii;* however, no colonies were found. *Temnothorax schaumii* workers were only collected at bait on the bark of the tree. This species is known to nest under

and in the bark of trees, and it is assumed that they were nesting somewhere in the tree. *Temnothorax curvispinosus* colonies have been collected elsewhere in the National Forest (MacGown and Brown, in press) nesting in twigs or nuts of *Carya glabra* (P. Mill.) Sweet (Juglandaceae), and *T. pergandei* has been found in the National Forest nesting in soil and in nuts of *C. glabra*.

Seasonal differences in species composition and relative abundance were evident among the various species during the sampling period. *Prenolepis imparis,* which is known to be more common in the cooler months of the year, was first seen in small numbers on 21 October and then in large numbers on 11 November. In contrast, the hybrid fire ant, *S. invicta x richteri*, which is most active during warmer months, was the most common ant seen on 21 October, but only one individual was seen on 11 November.

Acknowledgments

This research was funded by Mississippi Agricultural and Forestry Experiment Station, Project MIS-311080, the US Forest Service (Tombigbee National Forest), and USDA-ARS Areawide Management of Imported Fire Ant Project (Richard L. Brown, Principal Investigator).

Literature Cited

Agosti, D., M. Mohamed, and C.Y.C. Arthur. 1994. Has the diversity of tropical ant fauna been underestimated? An indication from leaf litter studies in a west Malaysian lowland rain forest. Tropical Biodiversity 2:270–275.

Anderson, A.N. 2000. Global ecology of rainforest ants: Functional groups in relation to environmental stress and disturbance. Pp. 25–34, *In* D. Agosti, J.D. Majer, L.E. Alonso, and T.R. Schultz (Eds.). Ants: Standard Methods for Measuring and Monitoring Biodiversity. Smithsonian Institution Press, Washington, DC. xix + 280 pp.

Baroni Urbani, C., and M.L. De Andrade. 2003. The ant genus *Proceratium* in the extant and fossil record (Hymenoptera: Formicidae). Museo Regionale di Scienze Naturali, Monografie 36:1–480.

Bolton, B. 2000. The ant tribe Dacetini. Memoirs of the American Entomological Institute 65:1–1028.

Brown, R.L. 1975. Behavioral observations on *Aethalion reticulatum* (Hem., Aethalionidae) and associated ants. Insectes Sociaux 23:99–107.

Brown, W.L. 1958. Predation of arthropod eggs by the ant genera *Proceratium* and *Discothyrea*. Psyche 64:115.

Brown, W.L. 2000. Diversity of ants. Pp. 45–79, *In* D. Agosti, J.D. Majer, L.E. Alonso, and T.R. Schultz (Eds.). Ants: Standard Methods for Measuring and Monitoring Biodiversity. Smithsonian Institution Press, Washington, DC. xix + 280 pp.

Camilo, G.R., and S.A. Phillips, Jr. 1990. Evolution of ant communities in response to invasion by the fire ant *Solenopsis invicta*. Pp. 190–198, *In* R.K. Vander Meer, K. Jaffe, and A. Cedeno (Eds.). Applied Myrmecology: A World Perspective. Westview Press, Boulder, CO.

DuBois, M., and L.R. Davis. 1998. *Stenamma foveolocephalum* (= *S. carolinense*) rediscovered (Hymenoptera: Formicidae: Myrmicinae). Sociobiology 32:125–138.

Hansen, L.D., and J.H. Klotz. 2005. Carpenter Ants of the United States and Canada. Cornell University Press, Ithaca, NY. xii + 204 pp.

Helms, K.R., and S.B. Vinson. 2001. Coexistence of native ants with the red imported fire ant, *Solenopsis invicta*. Southwestern Naturalist 46:396–400.

Hill, J.G., and R.L. Brown. 2005. The first record of the genus *Polyergus* (Hymenoptera: Formicidae) in Mississippi. Journal of the Mississippi Academy of Sciences 5:120.

Hölldobler, B., and E.O. Wilson. 1990. The Ants. Belknap Press of Harvard University Press, Cambridge, MA. 732 pp.

Holway, D.A., L. Lach, A.V. Suarez, N.D. Tsutsui, and T.J. Case. 2002. The causes and consequences of ant invasions. Annual Review of Ecology and Systematics 33:181–233.

Jusino-Altresino, R., and S.A. Phillips, Jr. 1994. Impact of red imported fire ants on the ant fauna of central Texas. Pp. 259–268, *In* D.F. Williams (Ed.). Exotic Ants: Biology, Impact, and Control of Introduced Species. Westview Press, Boulder, CO.

Lubertazzi, D., and W.R. Tschinkel. 2003. Ant-community change across a ground-vegetation gradient in north Florida's longleaf pine flatwoods. Journal of Insect Science 3(21):1–17.

MacGown, J.A., and R.L. Brown. In Press. Survey of ants (Hymenoptera: Formicidae) of the Tombigbee National Forest in Mississippi. Journal of the Kansas Entomological Society.

MacGown, J.A., R.L. Brown, and J.G. Hill. 2005. An annotated list of the *Pyramica* (Hymenoptera: Formicidae: Dacetini) of Mississippi. Journal of the Kansas Entomological Society 78:285–289.

MacKay, W.P. 1993. A review of the New World ants of the genus *Dolichoderus* (Hymenoptera: Formicidae). Sociobiology 22:1–148.

Morris, J.R., and K.L. Steigman. 1993. Effects of polygyne fire ant invasion on native ants of a blackland prairie in Texas. Southwestern Naturalist 38:126–140.

Morrison, L.W. 2002. Long-term impacts of an arthropod-community invasion by the imported fire ant, *Solenopsis invicta*. Ecology 83:2337–2345.

Morrison, L.W., and S.A. Porter. 2003. Positive association between densities of the red imported fire ant, *Solenopsis invicta* (Hymenoptera: Formicidae), and generalized ant and arthropod diversity. Environmental Entomology 32:548–554.

Porter, S.D., and D.A. Savignano. 1990. Invasion of polygyne fire ants decimates native ants and disrupts arthropod community. Ecology 71:2095–2106.

Shoemaker, D.D., K.G. Ross, and M.L. Arnold. 1994. Development of RAPD markers in two introduced fire ants, *Solenopsis invicta* and *S. richteri*, and their application to the study of a hybrid zone. Molecular Biology 3:531–539.

Smith, D.R. 1979. Superfamily Formicoidea. Pp. 1323–1467, *In* K.V. Krombein, P.D. Hurd, Jr., D.R. Smith, and B.D. Burks (Eds.). Catalog of Hymenoptera in America North of Mexico, Vol. 2: Apocrita (Aculeata). Smithsonian Institution Press, Washington, DC. xvi + 1199–2209 pp.

Smith, M.R. 1924a. An annotated list of the ants of Mississippi (Hym.). Entomological News 35:47–54.

Smith, M.R. 1924b. An annotated list of the ants of Mississippi (Hym.). Entomological News 35:77–85.

Smith, M.R. 1924c. An annotated list of the ants of Mississippi (Hym.). Entomological News 35:121–127.

Smith, M.R. 1927. An additional annotated list of the ants of Mississippi with a description of a new species of *Pheidole* (Hym.: Formicidae). Entomological News 38:308–314.

Smith, M.R. 1928a. An additional annotated list of the ants of Mississippi with a description of a new species of *Aphaenogaster* (Hym.: Formicidae). Entomological News 39:242–246.

Smith, M. R. 1928b. An additional annotated list of the ants of Mississippi with a description of a new species of *Aphaenogaster* (Hym.: Formicidae). Entomological News 39:275–279.

Smith, M.R. 1931a. An additional annotated list of the ants of Mississippi (Hym.: Formicidae). Entomological News 42:16–24.

Smith, M.R. 1931b. A revision of the genus *Strumigenys* of America, north of Mexico, based on a study of the workers. Annals of the Entomological Society of America 24:384–387.

Smith, M.R. 1932. An additional annotated list of the ants of Mississippi (Hym.: Formicidae). Entomological News 42:157–160.

Smith, M.R. 1965. House-infesting ants of the eastern United States: Their recognition, biology, and economic importance. United States Department of Agriculture Technical Bulletin No. 1326: ii + 1–105.

Snelling, R.R. 1995. Systematics of Nearctic ants of the genus *Dorymyrmex* (Hymenoptera: Formicidae). Contributions in Science (Los Angeles) 454:1–14.

Torres, J.A. 1984. Niches and coexistence of ant communities in Puerto Rico: Repeated patterns. Biotropica 16:284–295.

Trager, J.C. 1984. A revision of the genus *Paratrechina* (Hymenoptera: Formicidae) of the continental United States. Sociobiology 9:49–162.

Trager, J.C. 1988. A revision of the *Conomyrma* (Hymenoptera: Fomicidae) from the southeastern United States, especially Florida, with keys to the species. Florida Entomologist 71:11–29.

Trager, J.C., J.A. MacGown, and M.D. Trager. In Press. Revision of the Nearctic endemic *Formica pallidefulva* group (Hymenoptera: Formicidae: Formicinae). Memoirs of the American Entomological Institute.

Tschinkel, W.R. 1988. Distribution of the fire ants *Solenopsis invicta* and *S. geminata* (Hymenoptera: Formicidae) in northern Florida in relation to habitat and disturbance. Annals of the Entomological Society of America 81:76–81.

Umphrey, G.J. 1996. Morphometric discrimination among sibling species in the *fulva-rudis-texana* complex of the ant genus *Aphaenogaster* (Hymenoptera: Formicidae). Canadian Journal of Zoology 74:528–559.

Vepsäläinen, K., and B. Pisarski. 1982. The taxonomy of the *Formica rufa* group: Chaos before order. Pp. 27–35, *In* P.E. Howse and J.-L. Clément (Eds.). Biosystematics of Social Insects, Systematics Association Special Volume No. 19. Academic Press, NY.

Ward, P.S. 1985. The Nearctic species of the genus *Pseudomyrmex* (Hymenoptera: Formicidae). Quaestiones Entomologicae 21:209–246.

Watkins, J.F. 1985. The identification and distribution of the army ants of the United States of America (Hymenoptera, Formicidae, Ecitoninae). Journal of the Kansas Entomological Society 58:479–502.

Wilson, E.O. 1971. The Insect Societies. Belknap Press of Harvard University Press, Cambridge, MA. x + 548 pp.

Wilson, E.O. 1987. The arboreal ant fauna of Peruvian forests: A first assessment. Biotropica 19:245–251.

Wilson, E.O. 2003. Pheidole in the New World: A Dominant, Hyperdiverse Ant Genus. Harvard University Press, Cambridge, MA. 794 pp.