ENVIRONMENTAL VARIABLES AFFECTING ANT (FORMICIDAE) COMMUNITY COMPOSITION IN MISSISSIPPI'S BLACK BELT AND FLATWOODS REGIONS

By

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ENVIRONMENTAL VARIABLES AFFECTING ANT (FORMICIDAE)

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The relationship of ant community composition to various habitat characteristics is compared across four habitat types and 12 environmental variables in Mississippi. The four habitat types include pasture, prairie, and oak-hickory forests in the Black Belt and forests in the Flatwoods physiographic region. Ants were sampled using pitfall traps, litter sampling, baiting and hand collecting. A total of 20,916 ants representing 68 species were collected. NMS and ANCOVA both revealed three distinct ant communities (pasture, prairie, and "forests") based on species composition and mean ant abundance per habitat type between the four habitat types. Principal component analysis (PCA) partitioned the 12 environmental variation into four axes with eigenvalues $\geq$1. Axis 1 differentiated open grass-dominated habitats from woodlands. In contrast axis two mainly separated pastures from prairie remnants. Multiple regression models using the four significant PCA axes revealed that total species richness was significantly affected

by variation in the first two PCA axes. Forested sites supported approximately nine more species of ants than prairies and 21 more than pastures. Comparisons of the abundance of ant functional groups were also made between the four habitat types with multiple regression models to investigate how the environmental variables affected certain groups of ants. Annotated notes are included for each ant species encountered during this study.

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CHAPTER I

INTRODUCTION

Ants (Hymenoptera: Formicidae) are often of interest to ecologists due to their many functions in nature and involvement in many ecological processes. They directly and indirectly affect faunal and floral groups by predation, scavenging, tending homopterans, protecting certain plants, dispersing seeds, and they also aid in nutrient and soil turnover (Wheeler, 1910; Hölldobler and Wilson, 1990; Agosti et al., 2000; Shultz and McGlynn, 2000; Gorb and Gorb, 2003). Ants also are of interest because of the many deleterious effects caused by non-native species, especially the imported fire ants, *Solenopsis invicta* Buren, *S. richteri* Forel, and their hybrid *S. invicta X richteri*, which negatively affect human endeavors and reduce biodiversity in the communities they invade (Porter and Savignano, 1990; Morris and Steigman, 1993; Vinson, 1997; Gotelli and Arnett, 2000; Kaspari, 2000).

Ants are an important taxon for comparing habitat diversity and monitoring environmental changes because numerous species have habitat preferences and respond quickly to disturbances to their environment (Andersen, 1990; Alsonso, 2000; Kaspari and Majer, 2000). In Australia, ants have been uses extensively as bioindicators, (Majer, 1983; Greenslade and Greenslade, 1984; Andersen, 1990 and 1997a; King et al. 1998; and Lassau and Hochuli 2004), particularly in relation to minesite restoration (Majer et al.

1984; Majer, 1985; Andersen, 1997), and disturbances such as fire, grazing, and logging (Neuman, 1992; York, 1994; Vanderwoude et al. 1997) for several decades. The use of ants in a similar manner has gained in popularity recently in North America, with several studies investigating the relationships between various aspects of the plant community, soil properties, and/or habitat management practices on ant communities (Wang et al., 2001; Gotelli and Ellison, 2002; Harrison et al., 2003; Izahaki et al., 2003; Lubertazzi and Tschinkel, 2003; Boulton et al., 2005; and Ratchford et al. 2005). This study attempts to further the knowledge of how ant community composition is related to environmental factors by examining the ant communities and environmental variables across four habitat types in the Black Belt Prairie and Flatwoods physiographic regions of Mississippi, to determine 1) if the ant community of these four habitats differ, if so then, 2) why they differ, and 3) how they differ. The four habitat types include prairie, actively grazed pasture, and oak-hickory forests in the Black Belt region and forests in the Flatwoods region.

Natural History of the Black Belt Prairie

The Black Belt Prairie physiographic region extends from McNairy County, Tennessee in an arc south through eastern Mississippi to Russell Co. Alabama and contains a “heavy, tenacious, calcareous, loamy clay, dark gray when dry, but almost black when wet” soil for which the region is named (Lowe 1919, Schauwecker, 1996; Schiefer, 1998). These soils originated from Selma chalk that was formed from marine deposits when the Mississippi embayment occupied the region during the Cretaceous period (Logan, 1903).

In the past the Black Belt Prairie was a mosaic of open prairie and several types of forest. These prairies represent rare, naturally open areas in the Southeast, a region typically thought of as forested (Kaye, 1974; Barone, 2005). Floristic surveys of the prairies have revealed a distinct plant community similar to that of the Great Plains with several rare or critically imperiled plants (Schuster and McDaniel, 1973; MacDonald, 1996; Leidolf and McDaniel, 1998). This community is dominated by grasses with *Andropogon virginicus* L., *Andropogon gerardii* Vitman*, Bouteloua curtipendula* (Michx.), *Panicum virgatum* L, *Schizachyrium scoparium* (Michx.), *Setaria geniculata* (Lam.), *Sorghastrum nutans* (L.), and *Sporobolus vaginiflorus* (Torr.) being the most common. The most prominent forbs include *Asclepias viridis* Walter, *Chrysopsis camporum* Green, *Dalea candida* Willd., *D. purpurea* Vent., *Liatris squarrosa* (L.), *L. squarrulosa* Michx., *Ratibida pinnata* (Vent.), *Silphium laciniatum* (L.), and *S. terebinthinaceum* (Jacq.). A few of the rare plants include *Agalinus auriculata* (Ell.) and *Spiranthes magnicamporum* Sheviak.

Black Belt prairies are currently one of most endangered habitats in the state, if not all of the southeastern states. Most of the original Black Belt prairie has been lost to agriculture, development, the incursion of Eastern Red Cedar (*Juniperus virginiana* L.), and erosion. Some of the prairie that still persists is largely restricted to small roadside relics. In recent years several of the higher quality roadside relics have been lost to the expansion of U.S. Highway 45 (Hill, 2004). The Mississippi Natural Heritage Program gives Black Belt prairies a ranking of S1, meaning they are "critically imperiled" within the state due to extreme rarity or factors making their biota vulnerable to extirpation (Mississippi Museum of Natural Science, 2002).

The few remaining prairie relics present a unique opportunity for study. During the last fifteen years the Mississippi Entomological Museum has been conducting faunistic surveys of insects in the Black Belt. These surveys have found populations of moths, beetles, a grasshopper and a bee that are disjunct from other populations in the Great Plains and other grassland habitats (MacGown and Schiefer, 1992; Schiefer, 1998; Brown, 2003; Hill, 2005). The carabid beetle, *Cyclotrechelus hyperpiformis* Freitag, the scarab beetle *Phyllophaga davisi* Langston, and the crambid moth, *Neodactria oktibbeha* Landry and Brown are considered endemic to the Black Belt (Brown, 2003; Landry and Brown, 2005). Several insects considered rare throughout their range or in the Southeast are abundant in the Black Belt (Brown, 2003). Ants were not a group included in the previous surveys.

The oak hickory forests of the Black Belt historically occurred “on the lighter and usually higher reddish soil areas, which dot the prairie surface like islands” (Lowe 1919). These islands of forest support a “rather dwarfish growth of a few species of trees” (Lowe 1919). In oak hickory forests the most common species of trees found in the forests are: *Carya ovata* (Mill.), *C. tomentosa* (Poir.), *Quercus marilandica* Muench., *Q. velutina* Lam., *Q. falcata* Michx., and *Q. stellata* Wangenh. *Quercus durrandii* Buckl. and *Carya myristiciformis* (Michx.), two relatively common trees in the Black Belt, are considered to be rare or to have localized distributions throughout their range.

Natural History of the Flatwoods

The Flatwoods physiographic region is adjacent to the Black Belt, and the forests of the regions are quite different. The Flatwoods physiographic region extends south of Houston, Chickasaw County, along the western edge of the Black Belt into Alabama, and ranges from three to fifteen miles wide (Lowe, 1919). Lowe goes on to characterize this region by the following statement:

> "The soil of this region is prevailingly a heavy, tenacious dark gray clay with poor drainage, usually wet and cold, except in dry years, and more or less acid. This soil is lacking in lime and is deficient in other elements of plant food. The close texture of the heavy clay soil makes it very tenacious, so that it is either too wet to favor plant growth, or when dry becomes too hard and compact. The region is not one of rich growth and those species present are usually of xerophytic habit, which fits them for the extreme alternate conditions of sterile, water-logged, acid soil, and dry soil of stony hardness."

Lowe lists *Pinus taeda*, *Quercus falcata*, and *Q. stellata* as the dominant tree species forming "open" forest. *Liquidambar styraciflau* L., sweetgum, and *Acer rubrum* L., red maple, are also dominant tree species today.

Figure 1. Physiognomic variation among the four habitats in which ants were sampled: a, Pasture; b, Prairie; c, Oak-Hickory; d, Flatwoods.

CHAPTER II

METHODS

Study Sites

Three sites were chosen for each of the four habitat types: prairie, pasture, and oak-hickory forest in the Black Belt, and mixed pine forests in the Flatwoods (Figure 2.). Three circular plots measuring 25 m in diameter were established within each of the twelve sites. Thus, a total of nine plots were established in each habitat type, and 36 plots were established in all. Prairie sites were located at Crawford (Lowndes Co.), 30°18'4"N 88°36'46"W, Osborn (Oktibbeha Co.), 33°30'21"N 88°44'09"W, and the Trace Unit of Tombigbee National Forest (Chickasaw Co.), 33°55'38"N88°51'17"W. Oak-hickory sites were located at Crawford, 33°17'57"N 88°36'30"W, Osborn, 33°30'51"N 88°43'51"W, and at the junction of U.S. Highways 82 and 45A (Lowndes Co.), 33°29'06"N 88°39'39"W. Pasture sites were located at Crawford, 33°18"17"N 88°37'41"W, 3 miles east of Starkville (Oktibbeha Co), 33º25'43"N 88º44'06W, and Trebloc, (Chickasaw Co.) 33º49'51"N 88º48'32"W. These pasture sites were placed in areas that were historically covered by prairie (Barone, 2005), and have been converted to pasture and are actively grazed. The three Flatwoods sites, all in Oktibbeha County, were located five miles southwest of Starkville 33°22'48"N 88°49'46"W, eight miles south of Starkville, 33º20'38"N88º49'00"W, and 13.5 miles south of Starkville in Noxubee National Wildlife Refuge, 33°20'45"N 88°54'32"W. A map of the sites is provided in Figure 2.

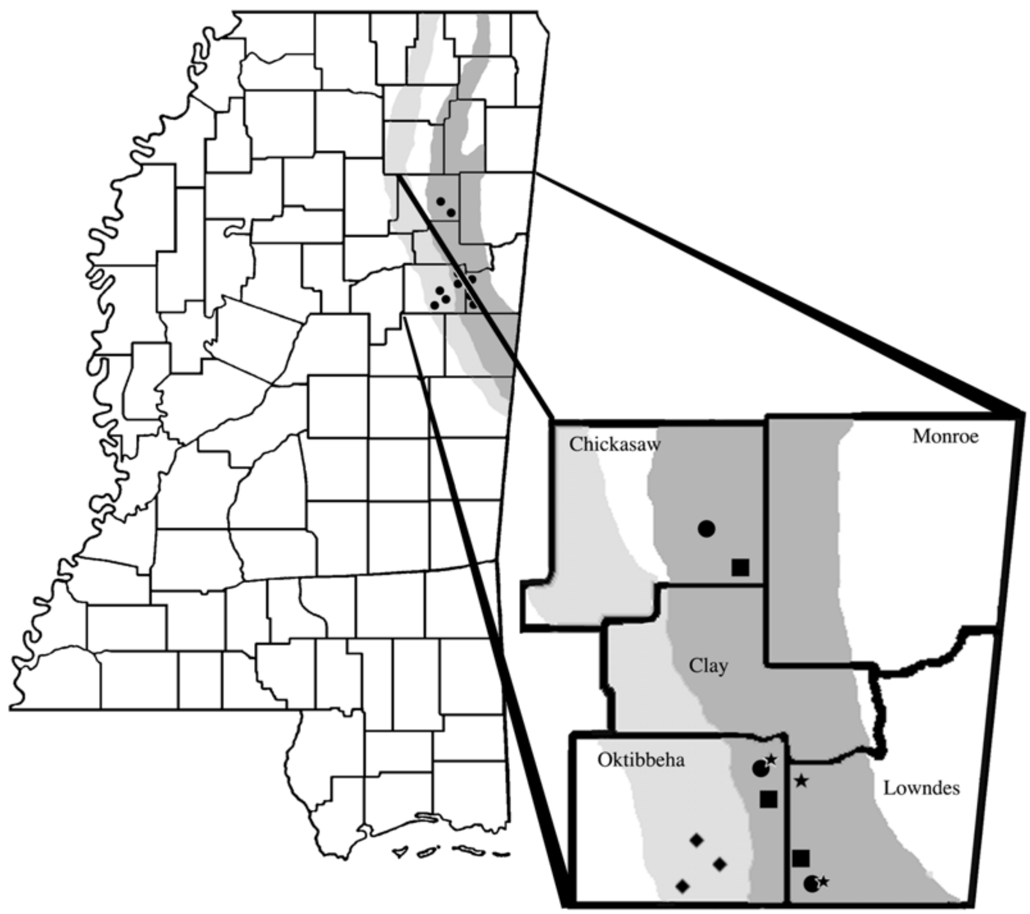

Figure 2. Map of Mississippi showing the Black Belt (dark gray) and Flatwoods (light gray) and position of study sites: Prairie ●, Pasture ■, Oak Hickory ★, and Flatwoods ◆.

Ant Collections

Pitfall trap stations were operated in each of the 36 plots for seven-day periods on alternating weeks from June to October, 2003. Each station consisted of a series of six pitfall traps grouped into three sets of two with a sheet metal barrier measuring 45 cm x 7.5 cm between the two traps to deflect any passing ants. The three sets of traps were arranged in an equilateral triangle with 10 meters between each set. Each site had 18 pitfalls resulting in 54 pitfalls per habitat, and 216 total traps over the entire study area. The traps consisted of a plastic delicatessen cup with an internal diameter of 10.5 cm and a depth of 7.5 cm. These cups were placed so that their tops were flush with the ground surface, and cups were filled halfway with a solution of 50% propylene glycol and 50% ethanol (70%). Each cup was covered with a hexagonal, sheet metal cover, elevated by three bent corners, to prevent entry of rain and evaporation of preservatives in traps exposed to sunlight.

From June to October, 2003 and April to December, 2004, samples of litter and soil were collected from each forest plot to fill 3.75 L plastic bags once a month in 2003 and twice a month in 2004. For extraction of ants, these samples were placed in a Berlese funnel under a forty-watt light bulb until the litter was dry, which usually required 3-5 days. General collecting was performed within each plot for 30 minutes twice a month during the sampling periods in 2003 and 2004, with all individuals observed being collected. This collecting consisted of hand sifting of soil, grass duff, and leaf litter, active searching, and baiting. Searching consisted of looking for nests and foragers on the open ground, under rocks and logs, and inside rotten logs, stems and other plant parts. Tuna fish in water, pecan shortbread cookies, and peanut butter were used as baits at each site. These three baits were typically rotated per collection date and placed in three locations within the plot on the bare ground, on the trunks of trees, or on both, and all individuals present at the bait were collected after 30 minutes.

Specimens of each species from each site were pinned and labeled, and the remainder of the sample was stored in 90% ethyl alcohol, with separate species in each vial. Pinned and alcohol specimens were labeled with state, county, nearest town, latitude and longitude, date, collector, collection method, and habitat type. Voucher specimens have been deposited in the Mississippi Entomological Museum (MEM).

Ant taxonomy is based on Bolton (2003), except *Polyergus*, which follows Smith (1947), *Pheidole*, which follows Wilson (2003), and *Crematogaster,* which follows Johnson (1988) and Deyrup (2003). Identifications were made using the above references and Creighton (1950), Trager (1984, 1991), Johnson (1988) Snelling (1988), Umphrey, (1996) Bolton (2000), McKay (2000), and Wilson (2003).

Measuring Environmental Variables

To better understand the factors that influence differences in the ant communities in these habitats, for each plot, the following environmental variables were measured: plant species richness and diversity, diameter at breast height (DBH) of trees, percent canopy cover, herbaceous/shrubby vegetation height, the amount of coarse woody debris (CWD) on the ground, and soil attributes. Percent grass, C3/C4 graminoid ratio, and herbaceous richness were calculated from plant richness and diversity measures that were sampled using eight-one fourth meter squared wire frames that were randomly placed within the plots. Every plant within each frame was identified and counted during June-July 2004. DBH values were used to calculate basal area (m^2/ ha) for all plots. Percent canopy cover was measured by taking the mean of five random desitometer measurements within the plots. Soil values were obtained by taking soil from the first 2 cm from several areas within the plot. These samples were analyzed at the Mississippi State University Extension Service's soil testing laboratory for the follow attributes: percent organic matter (OM), pH, Ca (milliquivalents/100g), P (kg/ha), percent clay, percent sand, and percent silt.

Data Analysis

A species accumulation curve comparing the number of sites against the number of species collected, based on an average of a series of 1000 randomizations of the species data was generated using EstimateS (Colwell, 2005), to ensure that the ant communities of the four habitat types were sampled efficiently. This randomization allows for a species accumulation curve that is independent of the order in which the samples were collected or added to the analysis (Colwell, 2005). To determine if the ant communities differed between the four habitats sampled, an ANCOVA (PROC GLM; SAS Institute 2003) was used to see if ant species richness differed among the four habitat types. Also, non-metric multidimensional scaling (NMS), performed using PC-ORD (McCune and Mefford, 1999), was used to determine if the ant communities differed between each of the four habitats. A multiple regression model was then used to relate the number of ant species found in each habitat type to variation in the environmental variables among the four habitats. The selected environmental variables displayed a high level of multicollinearity, which is known to bias the results of regression models, particularly for significance tests of parameter estimates (Philippi, 1993, Summerville et al., 2005). Following the recommendation of Graham (2003), a principal components analysis (PCA) was used to identify vectors that accounted for the greatest variation in our measurements of the environmental variables. The PCA was performed using SAS 9.1 (PROC PRINCOMP; SAS Institute 2003) and a total of 12 variables from the vegetation and soil sampling (Table 1). Because the units of measurement for these variables differed considerably, the correlation matrix among variables was used to generate PCA scores rather than their covariance matrix (Philippi, 1993). Also, because one limitation of PCA is that ecological interpretation of the principal components may be difficult, a 0.35 minimum loading coefficient also was selected as a requirement to include an environmental variable in the interpretation of a given principal component after Summerville et al., 2005.

To investigate whether the number of species found within a site was a function of a particular PCA axis, a multiple regression analysis (SAS PROC REG) was performed using the scores of the orthogonal principal components as predictor variables (Graham, 2003, Summerville et al,, 2005). Only PCA axes with an eigenvalue $\geq$1.0 were included in the multiple regression analysis, because they explained >10% of the variance among sites (Philippi 1993, Summerville et al., 2005). Regressions were performed using total species richness and abundance as response variables.

The placement of ant species into functional groups has been used extensively in Australia to better understand how the structure and function of an ant community varies between habitat types, and this method is beginning to gain interest in the United States (Andersen, 1995, 1997, and 2000; Izhaki et al., 2003). For this study all ants were placed into one of six functional groups, and the abundances for each species within a particular functional group then were combined for each site. Assignment of a species to a functional group was based on the classification system proposed by Andersen (1997) and Izhaki et al. (2003). Modifications were made to this system based on observations made during this study and information from the literature (Table 2). The following functional groups were present: cold climate (species active only during the cooler seasons of the year), cryptic (minute species that live mostly in the litter, rotting logs, or soil), dominant Dolichoderinae (aggressive and dominant species that favor hot and open areas), generalized Myrmicinae (species of the subfamily Myrmicinae that are found in many type habitats and defend resources by recruitment), opportunists (unspecialized, poorly competitive species whose distribution is limited by competition from other ants and disturbance), and subordinate Camponotini (submissive to dominant Dolichoderinae and foraging primarily at night). Regression models were constructed using the abundance of individuals within each functional group per site to investigate how variation in the environmental variables affects these different groups of ants.

Table 1. Functional groups with assigned ant species collected in all habitats.

Cold Climate
Stenamma meridionale Smith
Prenolepis imparis (Say)

Cryptic
Amblyopone pallipes (Haldeman)
Discothyrea testacea Roger
Ponera exotica Smith
Ponera pennsylvanica Buckley
Hypoponera inexorata (Wheeler)
Hypoponera opaciceps (Mayr)
Hypoponera opacior (Forel)
Proceratium pergandei (Emery)
Strumigenys louisianae Roger
Pyramica creightoni (Smith)
Pyramica clypeata (Roger)
Pyramica dietrichi (Smith)
Pyramica missouriensis (Smith)
Pyramica ohioensis (Kennedy & Schramm)
Pyramica ornata (Mayr)
Pyramica pulchella (Emery)
Pyramica rostrata (Emery)
Pyramica talpa (Weber)

Dominant Dolichoderinae
Forelius mccooki (McCook).
Tapinoma sessile (Say)

Generalized Myrmicinae
Aphaenogaster caroliensis Wheeler
Aphaenogaster fulva Roger
Aphaenogaster lamellidens Mayr
Pheidole bicarinata Mayr
Pheidole dentata Mayr
Pheidole dentigula Smith
Pheidole tysoni Forel
Crematogaster ashmeadi Mayr
Crematogaster lineolata (Say)
Crematogaster minutissima Mayr
Crematogaster missouriensis Emery
Crematogaster pilosa Emery
Monomorium minimum (Buckley)
Solenopsis invicta X richteri
Solenopsis richteri Forel
Solenopsis molesta (Say)

Subordinate Camponotini
Camponotus americanus Mayr
Camponotus chromaiodes Bolton
Camponotus pennsylvanicus (DeGeer)
Camponotus castaneus (Latrielle)
Camponotus snellingi Emery
Camponotus subbarbatus Emery
Camponotus decipiens Emery
Camponotus mississippiensis Smith
Camponotus impressus (Roger)

Opportunists
Pseudomyrmex pallidus (Smith)
Myrmica punctiventris Roger
Myrmica pinetorum Wheeler
Aphaenogaster flemingi Smith
Aphaenogaster treatae Forel
Pheidole pilifera (Roger)
Temnothorax curvispinosus Mayr
Temnothorax schaumii Roger
Temnothorax pergandei Emery
Myrmecina americana Emery
Trachymyrmex septentrionalis (McCook)
Lasius alienus (Foerster)
Lasius umbratus (Nylander)
Paratrechina arenivaga (Wheeler)
Paratrechina faisonensis (Forel)
Paratrechina vividula (Nylander)
Formica pallidefulva Latrielle
Formica dolosa Buren
Formica subsericea Say
Polyergus lucidus longicornis Smith
Polyergus lucidus montivagus Wheeler

Figure 3. Functional groups of ants: Cold Climate Specialists: a. *Stenamma meridionale* Smith, b. *Prenolepis imparis* (Say). Cryptic species: c. *Pyramica ornata* (Mayr), d. *Hypoponera inexorata* (Wheeler). Dominant Dolichoderinae: e. *Forelius mccooki* (McCook), f. *Tapinoma sessile* (Say).

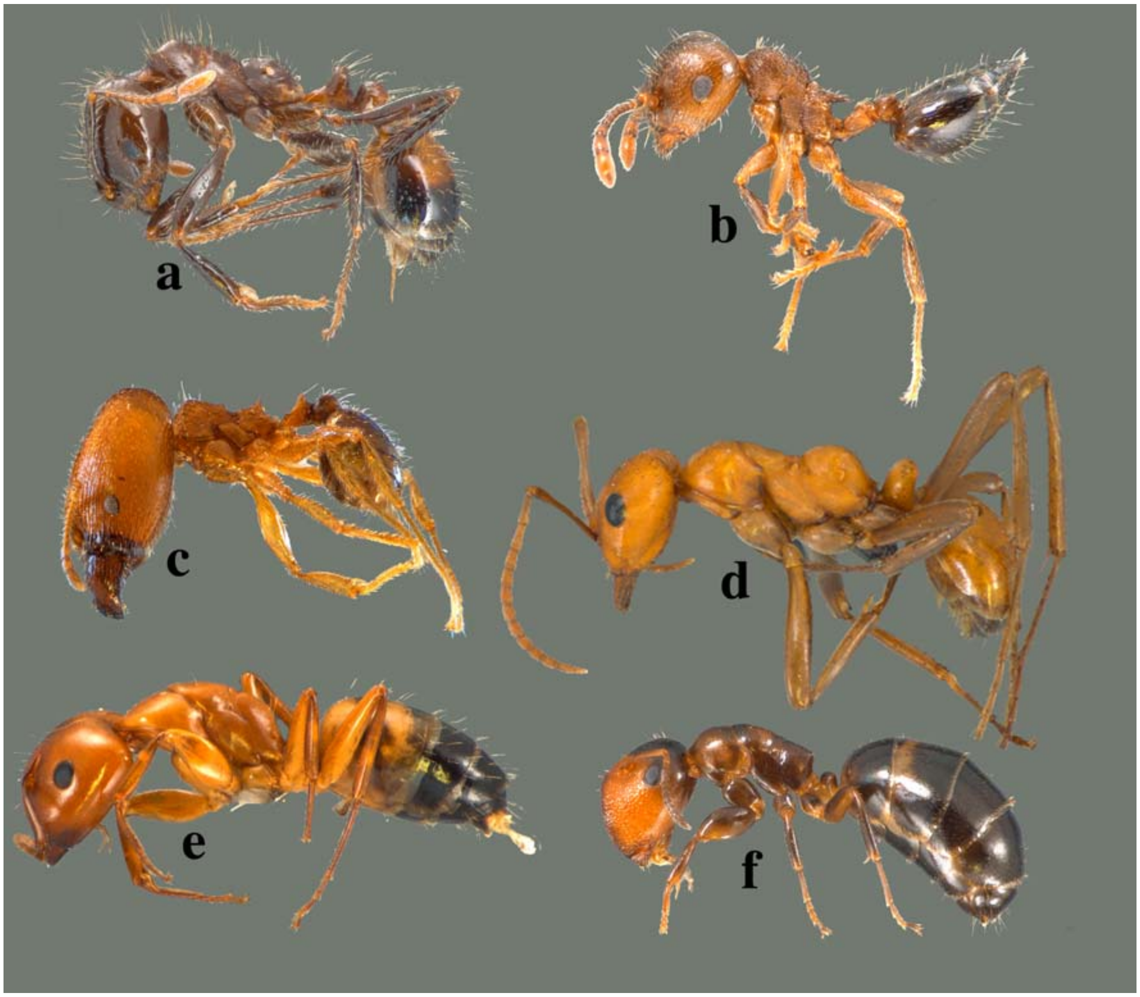

Figure 4. Functional groups of ants: Generalized Myrmicinae: a. *Solenopsis richteri* Forel, b. *Crematogaster lineolata* (Say) Opportunists: c. *Pheidole pilifera* (Roger), d. *Polyergus lucidus longicornis* Smith, Subordinate Camponotini: e. *Camponotus snellingi* Bolton, f. *Camponotus mississippiensis* Smith.

CHAPTER III

RESULTS AND DISCUSSION

A total of 20,916 ants representing 68 species including the hybrid imported fire ant, *Solenopsis invicta* X *richteri*, were collected. The most commonly collected species was *S. invicta* X *richteri* (4,319 individuals), and combined with the 951 individuals collected of the black imported fire ant, *S. richteri* (Forel), they total 5,270 individuals, almost 2.5 times as many as the next most commonly collected species, *Crematogaster lineolata* (Say) (2,057). Ten species comprised 75% of the total number of individuals collected. The remaining 25% was comprised of 58 species. *Solenopsis invicta* X *richteri* and *S. richteri* were the only two exotic ant species collected in these regions during this study. The ant fauna of these regions in Mississippi appear to be characterized by having a small number of frequently sampled species which are habitat generalists, and a large number of infrequently sampled species of which, 14 were restricted to a single habitat.

The species accumulation curve (Figure 5) shows that the sampling reached an asymptote with an expected species richness of 70.14 species which suggests my sampling was 97% efficient. The NMS ordination revealed three distinct ant communities based on species composition from the four habitat types (Figure 6). Pasture and prairie grouped independent of each other and the two forest types, however, NMS placed sites from the two forest types, oak-hickory and Flatwoods, into one cluster.

Using ANCOVA comparisons of ant species richness across the four habitat types also resulted in three significantly different categories: forests (oak-hickory and Flatwoods), prairie, and pasture (Figure 7) based on species richness. The ANCOVA models also suggested that habitat type played a significant role in determining ant species richness (Table 2). The PCA partitioned the 12 environmental variables into four axes (PCA1, PCA 2, PCA 3, and PCA 4) with eigenvalues ≥ 1 (Table 3.) The four principal components axes combined to explain 78% of the variance in environmental variables among the four habitat types. All of the environmental variables except P had a significant effect on the variation between the four habitat types. Sites that loaded positively on the first PCA axis had a high soil pH, soil Ca content, and herbaceous richness, with low canopy cover and basal area. This axis essentially divides the four habitats into two types, open and forested (Figure 8). Sites that loaded positively on the second PCA axis (PCA2) had a high % soil organic matter content, a high % C3 graminoid content and low % sand content. On the third PCA axis (PCA 3), sites that loaded positively had high herbaceous height and C3 diversity and a low % soil organic matter. Sites loading positively on the fourth PCA axis (PCA 4) had a high coarse woody debris content and low graminoid content.

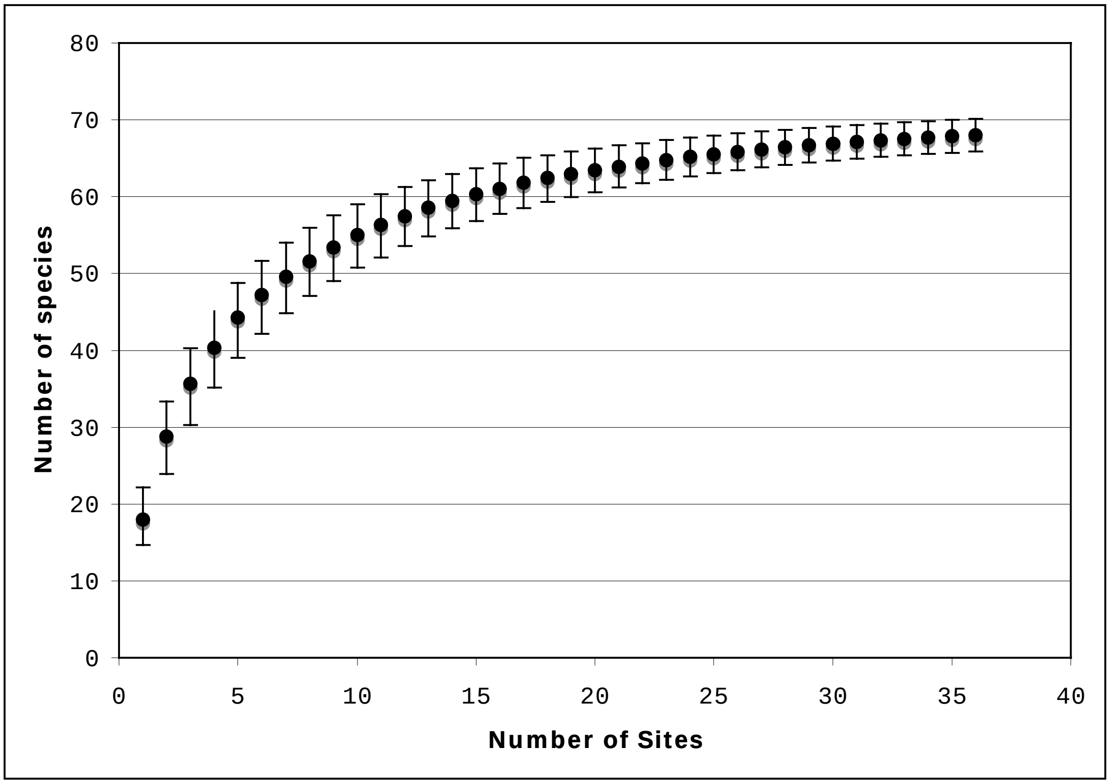

Figure 5. Species-accumulation curve derived from 612 samples pooled over entire study area based on an average of a series of 1000 randomizations of the species-sample data.

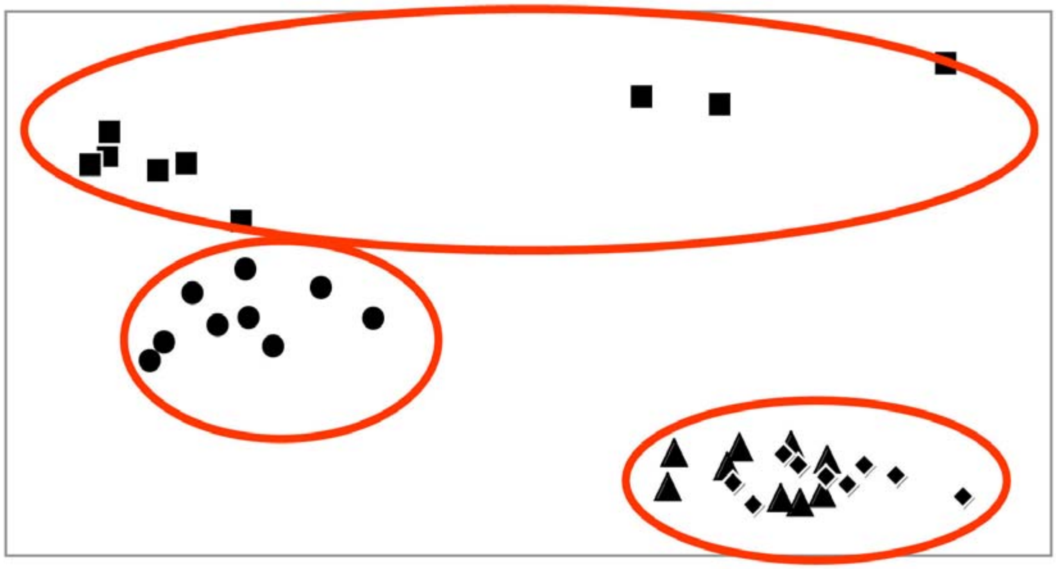

Figure 6. NMS ordination of the focus habitat types: Pasture ■, Prairie ●, Oak-Hickory ▲, and Flatwoods ◆.

Functional Groups

The most species rich functional group was the opportunists with 21 species followed by cryptic (18 spp.), generalized Myrmicinae (16 spp.), Subordinate Camponotini (9 spp.), cold climate specialists (2 spp.), and dominant Dolichoderinae (2 spp.). However, in terms of dominance of individuals the generalized Myrmicinae ranked first with 14,698 individuals followed by the opportunists (3,041individuals), dominant Dolichoderinae (1,164 individuals), cryptic species (1,008 individuals), Subordinate Camponotini (780 individuals), and cold climate specialists (225 individuals).

The functional group importance in a habitat was influenced largely by the first PCA axis (PCA 1) (Table 4). This is mostly due to the separation of some groups favoring forested areas (cold climate, cryptic species, and subordinate Camponotini) and some favoring open areas (dominant Dolichoderinae). Cold climate specialists contained the fewest numbers of individuals captured, which may be attributed in part to a lack of sampling during winter months, and their numbers were not significantly different across all four habitat types. The variance that is seen between the four habitat types is best explained by PCA 1 that shows the cold climate specialists as favoring sites with a high percentage of canopy cover, a high amount of tree basal area, and a low pH (forests). This is expected as the two species that comprise this group, *Prenolepis imparis*, and *Stenamma meridionale,* are mostly associated with forests (Figure 9.).

Cryptic species were numerically most abundant in the forested habitats, marginally less in the prairie, and significantly less in the pastures. These species had higher numbers of individuals in the forested habitats, especially those having higher coarse woody debris content and fewer grasses (PCA1 and PCA4). Numbers of cryptic species occurring in the open habitats were negatively correlated with grazing disturbance (PCA2), being more numerous in the prairie habitat.

The dominant Dolichoderinae were numerically most dominant in the prairie and significantly less dominant in the pasture and two forested habitats (Figure 9). The dominant Dolichoderinae were positively correlated with PCA1, meaning they preferred open areas, but were negatively correlated with PCA2, suggesting that they are also susceptible to the grazing disturbance. This is in agreement with Andersen (2000) who states that the dominant Dolichoderinae predominate in areas that experience low levels of stress and disturbance, especially hot and open environments.

Species in the opportunist functional group were numerically more abundant in the Flatwoods, oak-hickory, and prairie, respectively, and significantly lower in the pasture (Figure 9). Their numbers were correlated negatively with PCA1 and PCA 2. This suggests that they are negatively influenced by the presence of the grazing disturbance.

The subordinate Camponotini were numerically most abundant in the two forest types, and occurred marginally less than in prairie, and significantly less than pastures (Figure 9). The abundance of this functional group was negatively correlated with PCA 1 and PCA 3. PCA 1 suggests that the subordinate Camponotini primarily prefer forested habitats, whereas PCA 3 suggests they prefer sites with low herbaceous vegetation height, high soil organic matter, and higher C3 graminoid content. This may be influenced by the presence of *Camponotus castaneus* in the prairie.

The generalized Myrmicinae were numerically most dominant in the pastures, and showed no significant difference in abundance between the prairie, and two forest types (Figure 9). The generalized Myrmicinae were not significantly influenced by any of the measured environmental variables.

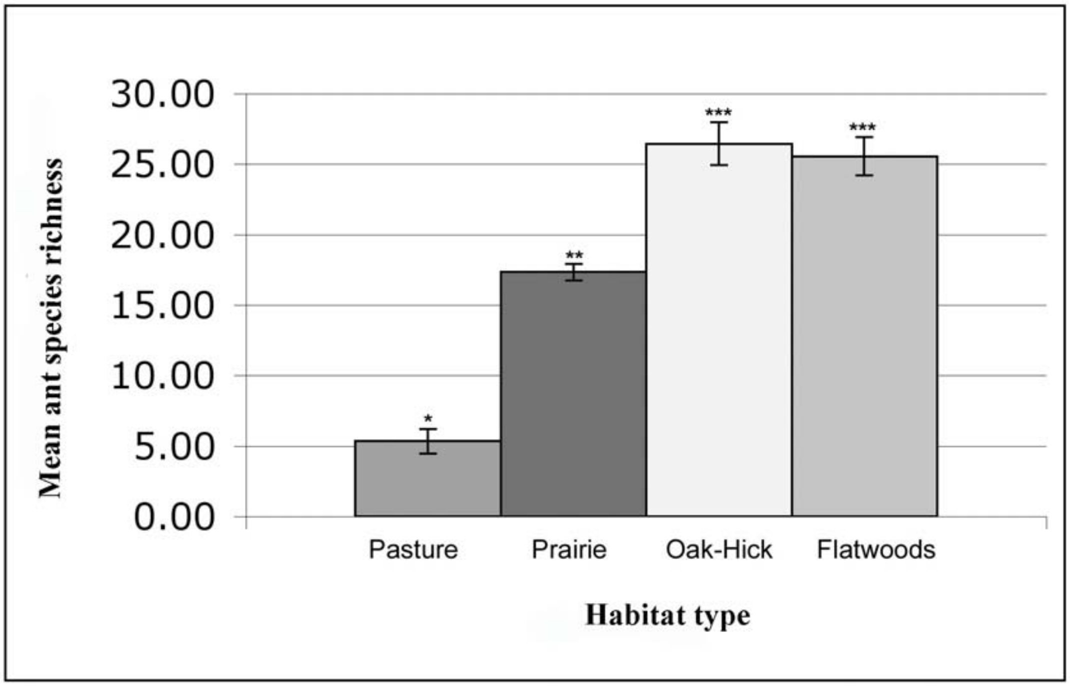

Figure 7. Mean ants species richness in the four habitat types. Means with differing "*" are significantly different (P<0.05).

Table 2. Results of ANCOVA models testing whether ant species richness were affected by habitat type (4 levels: pasture, prairie, oak-hickory, and Flatwoods) or the number of individuals collected (Log ant abundance).

Source of Variation	df	MS	F	p
Habitat type	3	815.79	78.13	.0001
Log ant abundance	1	52.76	5.05	.0318
Error	31	10.44		

Table 3. Results of PCA for 12 environmental variables measured across 36 plots from pasture, prairie, oak-hickory forest, and Flatwoods.

	Principal component axis			
	1	2	3	4
% OM	0.132	**0.448**	**-0.384**	0.327
Herbaceous height (cm)	0.175	-0.283	**0.467**	0.328
% Grass	0.200	0.255	**0.432**	**-0.517**
CWD (m^2/ha)	-0.131	0.101	0.267	**0.493**
pH	**0.448**	-0.072	0.083	0.032
C3/C4 Graminoid ratio	-0.137	**0.389**	**0.511**	0.002
% Canopy Cover	**-0.427**	0.127	-0.077	0.197
P (kg/ha)	0.237	0.304	-0.183	-0.247
Basal area (m^2/ha)	**-0.385**	0.011	0.183	0.048
Ca (milliquivalents/100g)	**0.374**	0.242	0.133	0.288
Herbaceous richness	**0.381**	-0.241	-0.101	0.263
% Sand	-0.050	**-0.512**	0.106	-0.143
Eigenvalue	4.373	2.476	1.364	1.166
Cumulative variance explained by axis	0.364	0.571	0.684	0.782

To further investigate what variables influence imported fire ant abundance, they were placed in a separate group from the generalized Myrmicinae functional group and the two groups were analyzed separately against the environmental variables. This analysis showed that imported fire ants were numerically most dominant in pastures with significantly lower numbers in prairie remnants and the two forest types (Figure 10). The principal component analysis showed that imported fire ants predominated in open areas with little coarse woody debris. The generalized Myrmicinae minus fire ants were most abundant in the prairie remnants and two forest types and were significantly lower in the pastures (Figure 11). The principal component analysis showed that the generalized

Myrmicinae minus fire ants had a preference for forested habitats with more herbaceous vegetative height.

Whitcomb et al. (1972) suggested that the presence or absence of imported fire ants may be the single most important biotic factor affecting native ant populations. However, these results seem to indicate that the structure of the habitat is also important. Native ant numbers were significantly higher in undisturbed and more structured habitats, whereas fire ants dominated in the more disturbed (pasture) habitats. Fire ants are typically associated with open habitats although they may be found in forested habitats where they are less numerous, and occur along edges of the forest or in places where the canopy has been opened. Fire ants were present in significantly lower numbers in the naturally open prairie remnants than in pastures, being the 4th most common species out of 41, and making up 11% of the total number of individuals collected. In pastures they were the most common of 13 and comprising 88% of the total number of individuals collected.

Simberlof (1986) suggested that the success of an invading species depends on the interactions of the resident species within their community and with the invading species. The general trend of the data in this study suggests that more ant species are likely to be found in more structured habitats. The disturbed/structurally simple habitats, such as pastures, contained fewer native ant species which resulted in less competition for the imported fire ant, an invasive species. Habitat quality is clearly an important factor in determining imported fire ant abundances and ant community structure in these habitats.

Fauna of Each Habitat

Ant diversity was significantly lower in the pastures. This habitat supported only 13 species, which represented a relatively depauperate fauna when compared with the prairie and the two forest types. Based on the results of the PCA, grazing and associated land management practices were the reason for this lower richness. The presence of high soil organic matter and low percent sand content found in the pastures can be linked to the influence of grazing. Grazing is known to increase soil organic matter levels through higher rates of root turn over, which would proportionally lower the levels of the sand fraction levels in the soil (USDA, 2001, Neff et al., 2005). The higher diversity of C3 graminoids can be attributed mostly to the practice of planting cool season grasses such as *Festuca* sp. in pastures for forage purposes. Also, the presence of low herbaceous height is an obvious effect of grazing that removes vertical vegetative structure resulting in limited niche availability.

Imported fire ants were numerically the most abundant species in pastures, followed by *Monomorium minimum*, and *Forelius mccooki*. In contrast *Paratrechina arenivaga* (Wheeler), *P. terricola* (Buckley), *M. minimum* (Buckley), and a *Pheidole* sp. occurred in areas of high imported fire ant density in southern Texas (Stein and Thorvilson, 1989; Morris and Steigman, 1991 and 1993), while *Pheidole dentata* Mayr, *Forelius foetidus* (Buckley), and *M. minimum* occurred in areas of high imported fire ant density in south-central Texas (Jones and Phillips, 1990).

The ant community of the prairie differed from and was more diverse than that of the pastures. The prairies supported 33 species, the most numerous of which were

Crematogaster lineolata followed by *F. mccooki* and *M. minimum*. Based on the results of the PCA, the environmental variables that most influenced this was the higher sand content of the prairie soil, lower C3 graminoid richness, and higher herbaceous height. This habitat is in contrast with the pasture by having more structural diversity in the way of a standing (non-grazed) native plant diversity that provides more niches for ant species to occupy.

The two forest types (oak-hickory and Flatwoods) supported a different ant community and higher diversity than prairie or pasture habitats. However, based on the results of the NMS and ANCOVA, the two forest habitats (oak-hickory and Flatwoods) did not differ significantly in species richness or composition. The first PCA axis separates them from the open habitats (pasture and prairie) with the forested sites having low soil pH and Ca content, low herbaceous richness, and high canopy cover. There was no obvious separation of the forested sites by the second PCA axis. The third PCA axis separated the two forest types by oak-hickory having taller herbaceous height, less C3 graminoid diversity, and low percent matter content, and the Flatwoods having shorter herbaceous height, more C3 graminoid diversity, and a higher percent organic matter content. The fourth PCA axis marginally separated the oak-hickory and Flatwoods sites by the latter having higher coarse woody debris content and a lower graminoid content, which had a marginal effect on the abundance of the Cryptic species functional group. Although several of these environmental variables differed between the oak-hickory and Flatwoods, they did not have enough of an influence to cause a significant difference in ant species richness or composition between the two forest types. Essentially in these two physiographic regions of Mississippi, a forest is a forest to an ant.

Of the four habitats examined in the Black Belt and Flatwoods, the two forest types were the most species rich, having 51 and 47 species, respectively. In comparison, MacGown and Brown (in press) found 71 species in a study of the ant fauna of the Ackerman Unit of the Tombigbee National Forest, which lies predominantly in the North Central Plateau physiographic region, on the western boarder of the Flatwoods. Additionally, collections made by JoVonn Hill in Lauderdale County, Mississippi, which also lies in the North Central Plateau, have documented 73 species of ants. The lower species richness of the Black Belt and Flatwoods is most likely due to the harsher soil conditions and flatter topography of these two regions, as compared to that of the North Central Plateau, which is characterized by fertile soils and an upland topography that is typically described as containing deeply dissected hills and steep ravines (Lowe, 1913 and Cross et al., 1974).

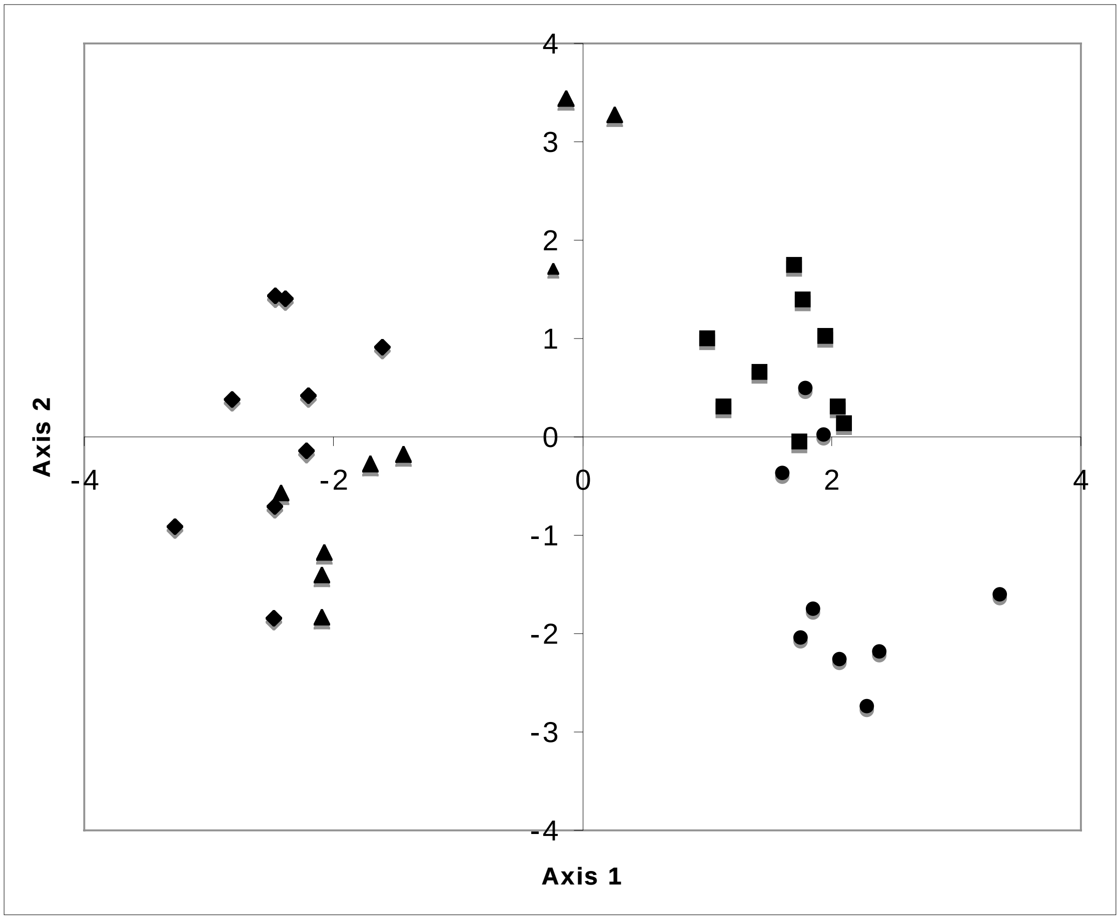

Figure 8. Plot of the first two PCA axes. Pasture ■, Prairie ●, Oak-Hickory ▲, and Flatwoods ◆.

Table 4. Multiple regression models using the first four principal component axes, total species richness, and functional group abundance.

Dependent variable	Predictor variable (PCA Axis #)	df	R^2	F	p	Parameter Estimate (SE)
Ant species richness $_{total}$	**Full Model**	**4**	**.72**	**19.64**	**.0001**	
	PCA1	**1**		**-7.75**	**.0001**	**-3.19 (0.41)**
	PCA2	**1**		**-3.36**	**.0021**	**-1.84 (0.54)**
	PCA3	1		-1.68	0.10	_________
	PCA4	**1**		**2.10**	**0.04**	**1.67 (0.79)**
Cold climate $_{(individuals)}$	Full model	4	.22	2.16	.09	
	PCA1	**1**		**-2.22**	**.03**	**-1.98 (0.89)**
	PCA2	1		1.79	.08	_________
	PCA3	1		-0.55	.58	_________
	PCA4	1		.49	.62	_________
Cryptic species $_{(individuals)}$	**Full model**	**4**	**.42**	**5.83**	**.0001**	
	PCA1	**1**		**-3.88**	**.0005**	**-7.95 (2.05)**
	PCA2	1		-1.56	0.12	_________
	PCA3	1		-1.28	-2.11	_________
	PCA4	**1**		**2.06**	**0.05**	**8.19 (3.97)**
Dominant Dolichoderinae $_{(individuals)}$	**Full model**	**4**	**.52**	**8.61**	**.0001**	
	PCA1	**1**		**4.79**	**.0001**	**15.67 (6.75)**
	PCA2	**1**		**-2.91**	**.0067**	**-12.64 (4.35)**
	PCA3	1		1.20	0.24	_________
	PCA4	1		1.27	0.21	_________
Generalized Myrmicinae $_{(individuals)}$	Full model	4	.10	0.86	0.50	
	PCA1	1		1.36	0.14	_________
	PCA2	1		-0.66	.511	_________
	PCA3	1		-0.82	0.41	_________
	PCA4	1		-0.69	0.49	_________
Opportunists $_{(individuals)}$	**Full model**	**4**	**.41**	**5.44**	**0.002**	
	PCA1	**1**		**-3.58**	**.0011**	**-18.47 (10.64)**
	PCA2	**1**		**-2.06**	**.048**	**-14.15 (5.16)**
	PCA3	1		-1.69	0.10	_________
	PCA4	1		-1.34	0.18	_________
Subordinate Camponotini $_{(individuals)}$	**Full model**	**4**	**.41**	**5.28**	**.0023**	
	PCA1	**1**		**-3.70**	**.0008**	**-10.48 (2.83)**
	PCA2	1		-0.84	0.41	_________
	PCA3	**1**		**-2.59**	**0.01**	**-13.11 (5.06)**
	PCA4	1		-0.11	0.91	_________

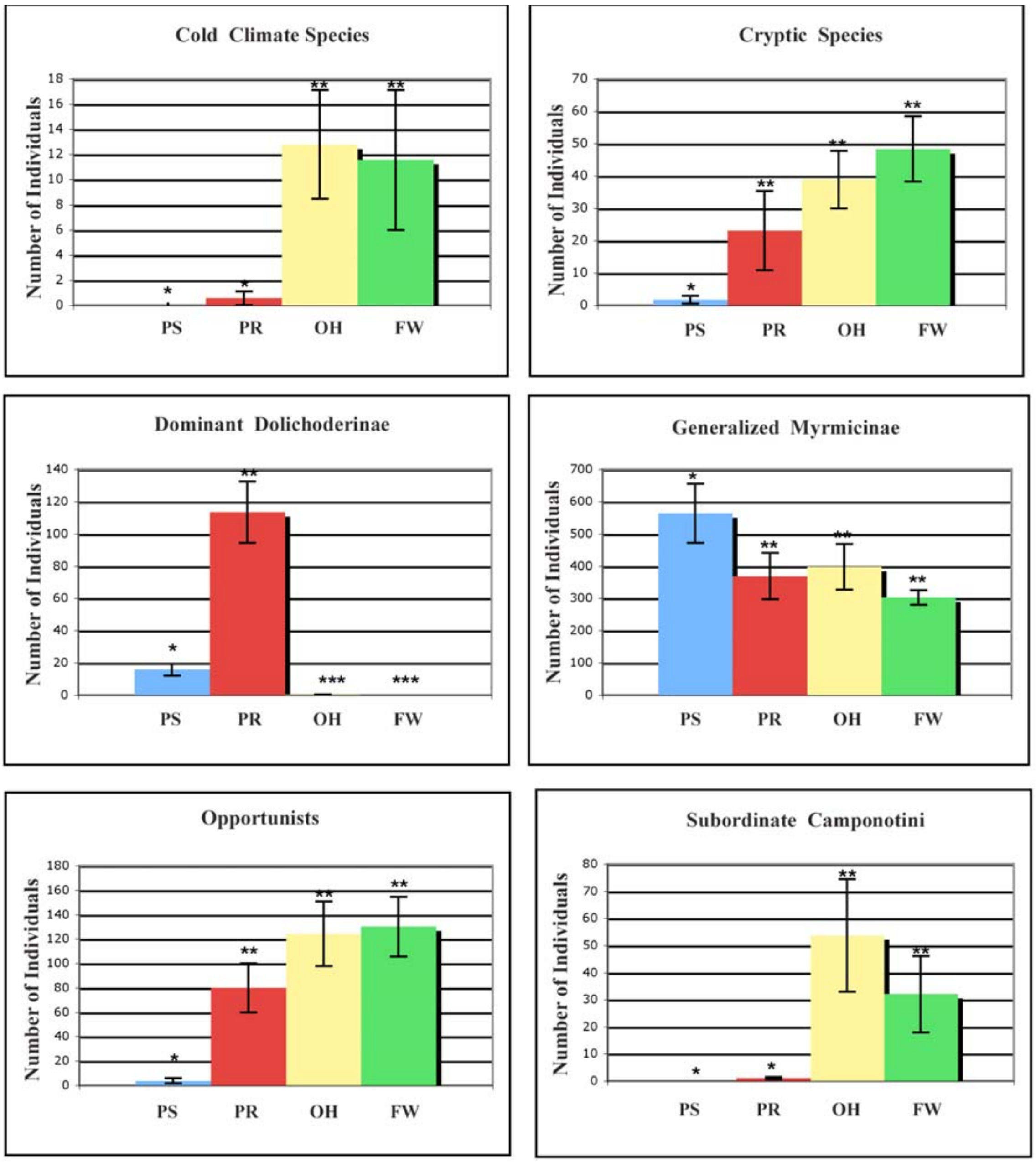

Figure 9. Abundances of functional groups in the four habitat types.

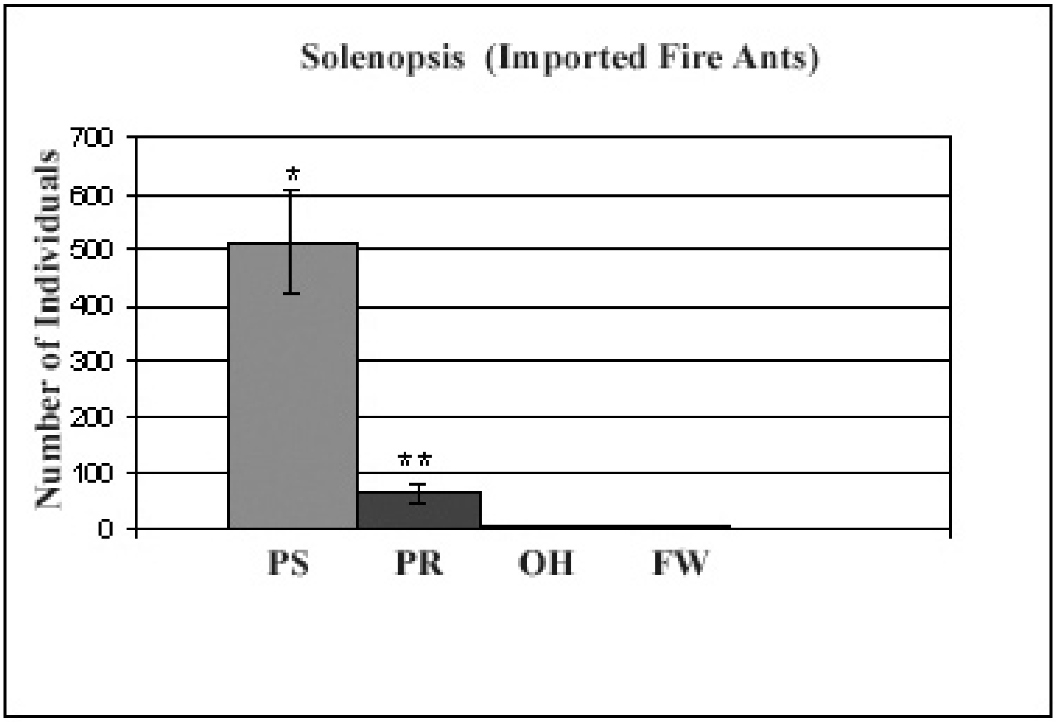

Figure 10. Results of ANCOVA analysis of the *Solenopsis richteri* and *S. invicta* X. *richteri* functional group. Different "*" represent significant differences.

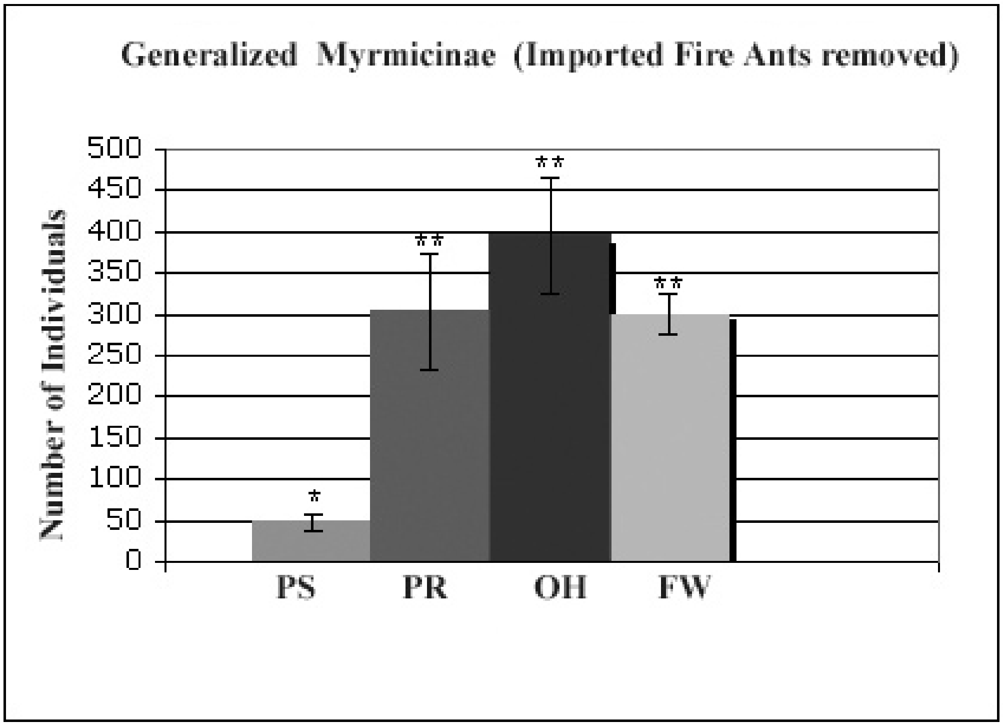

Figure 11. Results of an ANCOVA analysis of the generalized Myrmicinae functional group with the imported fire ants removed. Different "*" represent significant differences.

Management Issues

Different ant communities will be present in open versus forested habitats, as indicated by PCA axis 1. In order to minimize imported fire ant populations and increase native ant diversity, open areas should be managed for increased herbaceous diversity and height, less C3 graminoid diversity and less intensive grazing that may help reduce the proportions of organic matter in the soil as indicated by PCA axis 2. Also the retention of coarse woody debris in forested habitats are important for certain groups of ants, such as the cryptic species, thus removal of coarse woody debris by repeated burning to remove wildfire fuel or other management goals may have a negative effect on these species, as indicated by PCA axis 4.

Table 5. List of species collected and their number and percentage of the total number collected in each habitat.

Species	# in Pas	% ants Pas	# in Pra	% ants Pra	# in O-H	% in O-H	# in FW	% in FW	# ants all sites	% ants all sites
Amblyopone pallipes	0	0	0	0	1	0.02	0	0	1	.005
Aphaenogaster carolinensis	0	0	2	0.04	550	9.74	693	14.67	1245	5.95
Aphaenogaster flemingi	0	0	1	0.02	0	0	0	0	1	.005
Aphaenogaster fulva	0	0	0	0	80	1.42	105	2.22	185	0.88
Aphaenogaster lamellidens	0	0	1	0.02	818	14.49	298	6.31	1117	5.34
Aphaenogaster treatae	0	0	27	0.51	0	0	3	0.06	30	0.14
Camponotus americanus	0	0	0	0	70	1.24	13	0.28	83	0.40
Camponotus chromaiodes	0	0	1	0.02	71	1.26	149	3.15	221	1.06
Camponotus pennsylvanicus	0	0	0	0	42	0.74	7	0.15	49	0.23
Camponotus impressus	0	0	1	0.02	1	0.02	1	0.02	3	0.01
Camponotus mississippiensis	0	0	0	0	25	0.44	0	0	25	0.12
Camponotus snellingi	0	0	2	0.04	69	1.22	2	0.04	73	0.35
Camponotus subbarbatus	0	0	0	0	0	0	76	1.61	76	0.36
Camponotus castaneus	0	0	4	0.08	90	1.59	40	0.85	134	0.64
Camponotus decipiens	0	0	1	0.02	115	2.04	0	0	116	0.55
Crematogaster ashmeadi	0	0	0	0	247	4.37	18	0.38	265	1.27
Crematogaster lineolata	20	0.38	1030	19.50	757	13.41	250	5.29	2057	9.83
Crematogaster minutissima	0	0	0	0	14	0.25	1	0.02	15	0.07
Crematogaster missouriensis	7	0.13	60	1.14	0	0	0	0	67	0.32
Crematogaster pilosa	0	0	14	0.27	0	0	0	0	14	0.07
Discothyrea testacea	0	0	0	0	0	0	1	0.02	1	.005
Forelius mccooki	142	2.70	968	18.33	2	0.04	0	0	1112	5.32
Formica dolosa	0	0	82	1.55	4	0.07	0	0	86	0.41
Formica pallidefulva	0	0	0	0	42	0.74	186	3.94	228	1.09
Formica subsericea	0	0	0	0	26	0.46	0	0	26	0.12
Hypoponera inexorata	0	0	96	1.82	1	0.02	1	0.02	98	0.47
Hypoponera opaciceps	0	0	1	0.02	5	0.09	1	0.02	7	0.03
Hypoponera opacior	15	0.28	22	0.42	91	1.61	22	0.47	150	0.72
Lasius umbratus	0	0	0	0	0	0	25	0.53	25	0.12

Table 5. Cont.

Species	# in Pas	% ants Pas	# in Pra	% ants Pra	# in O-H	% in O-H	# in FW	% in FW	# ants all sites	% ants all sites
Lasius alienus	0	0	0	0	8	0.14	281	5.95	289	1.38
Monomorium minimum	353	6.70	972	18.41	14	0.25	8	0.17	1347	6.44
Myrmecina americana	0	0	6	0.11	75	1.33	98	2.07	179	0.86
Myrmica pinetorum	0	0	0	0	81	1.43	0	0	81	0.37
Myrmica punctiventris	0	0	0	0	0	0.00	22	0.47	22	0.11
Paratrechina arenivaga	0	0	97	1.84	0	0	0	0	97	0.46
Paratrechina faisonensis	0	0	7	0.13	368	6.52	467	9.89	842	4.03
Paratrechina vividula	33	0.63	108	2.05	15	0.27	0	0	156	0.75
Pheidole bicarinata	21	0.40	0	0	0	0	0	0	21	0.10
Pheidole dentata	1	0.02	192	3.64	437	7.74	227	4.81	857	4.10
Pheidole dentigula	0	0	0	0	120	2.13	53	1.12	173	0.83
Pheidole pilifera	0	0	119	2.25	0	0	0	0	119	0.57
Pheidole tysoni	0	0	127	2.40	0	0	0	0	127	0.61
Polyergus lucidus longicornis	0	0	0	0	7	0.12	0	0	7	0.03
Polyergus lucidus montivagus	0	0	61	1.16	8	0.14	2	0.04	71	0.34
Ponera exotica	0	0	0	0	11	0.19	20	0.42	31	0.15
Ponera pennsylvanica	0	0	52	0.98	148	2.62	170	3.60	370	1.77
Prenolepis imparis	1	0.02	5	0.09	102	1.81	104	2.20	212	1.01
Proceratium pergandei	0	0	1	0.02	0	0	1	0.02	2	0.01
Pseudomyrmex pallidus	0	0	0	0	1	0.02	0	0	1	.005
Pyramica clypeata	0	0	0	0	0	0	66	1.40	66	0.32
Pyramica creightoni	0	0	2	0.04	7	0.12	1	0.02	10	0.05
Pyramica dietrichi	0	0	20	0.38	0	0	0	0	20	0.10
Pyramica missouriensis	0	0	0	0	0	0	1	0.02	1	.005
Pyramica ohioensis	0	0	0	0	3	0.05	108	2.29	111	0.53
Pyramica ornata	0	0	1	0.02	39	0.69	10	0.21	50	0.24
Pyramica pulchella	0	0	0	0	1	0.02	1	0.02	2	0.01
Pyramica rostrata	0	0	0	0	0	0	21	0.44	21	0.10
Pyramica talpa	0	0	10	0.19	2	0.04	3	0.06	15	0.07
Solenopsis invicta X *richteri*	3688	70.05	578	10.94	25	0.44	28	0.59	4319	20.65
Solenopsis molesta	37	0.70	343	6.49	512	9.07	1046	22.14	1938	9.27
Solenopsis richteri	946	17.97	2	0.04	3	0.05	0	0	951	4.55
Stenamma meridionale	0	0	0	0	13	0.23	0	0	13	0.06
Strumigenys louisianae	0	0	3	0.06	41	0.73	8	0.17	52	0.25
Tapinoma sessile	0	0	52	0.98	0	0	0	0	52	0.25

Table 5. Cont.

Species	**# in Pas**	**% ants Pas**	**# in Pra**	**% ants Pra**	**# in O-H**	**% in O-H**	**# in FW**	**% in FW**	**# ants all sites**	**% ants all sites**
Temnothorax pergandei	0	0	**137**	**2.59**	**241**	**4.27**	**22**	**0.47**	**400**	**1.91**
Temnothorax curvispinosus	**1**	**0.02**	**4**	**0.08**	**233**	**4.13**	**60**	**1.27**	**298**	**1.42**
Temnothorax schaumii	0	0	0	0	**5**	**0.09**	**1**	**0.02**	**6**	**0.03**
Trachymyrmex septentrionalis	0	0	**69**	**1.31**	**5**	**0.09**	**3**	**0.06**	**77**	**0.37**
	5265	**100**	**5281**	**100**	**5646**	**100**	**4724**	**100**	**2091 6**	**100**

CHAPTER IV

SPECIES NOTES

The following list is arranged by subfamily and genus according to Bolton, (2003). Names follow Bolton (2003), *Pheidole* (Wilson, 2003), *Aphaenogaster* (Umphrey, 1996), and *Crematogaster* (Johnson, 1988). Each species is annotated with habits, habitats, microhabitats, county records, and collection method. Collection methods are abbreviated as follows: H= hand collection, B, =bait (shortbread cookie or tuna fish), BF= Berlese Funnel, and P= pitfall.

Formicidae

Subfamily Dolichoderinae

<u>Tribe Dolichoderini</u>

***Forelius mccooki* (Roger)**.

This species was found typically in open habitats. It was a dominant ant in the prairie habitat, and also one of the most active ants during the hottest time of day. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, B, P. (Figure 3)

***Tapinoma sessile* (Say)**.

This ant was collected only in the Crawford prairie sites. (Lowndes Co.) H, B. (Figure 3)

Subfamily Formicinae

Tribe Lasiini

***Lasius* (*Lasius*) *alienus* (Foerster).**

Alates were present on 18 June 2004 and, 25 September 2003. This species was common in the Flatwoods with colonies typically found at the base of large trees. (Lowndes and Oktibbeha Cos.) H, BF, B, P.

Tribe Plagiolepidini

***Paratrechina* (*Nylanderia*) *arenivaga* (Wheeler)**.

This species was collected only in the prairie habitat. Workers of this species were most commonly observed foraging on cloudy days or during the early morning and late afternoon periods. Also see information under *Pheidole pilifera* (Roger). (Chickasaw, Lowndes, and Oktibbeha Cos.) H, B, P.

***Paratrechina* (*Nylanderia*) *faisonensis* (Forel)**.

Alates of this species were present on 25 September 2005. This species was common in both forested habitats. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, BF, B, P.

***Paratrechina* (*Nylanderia*) *vividula* (Nylander)**.

This species was usually collected in open habitats, particularly in the pastures or disturbed portions of prairie. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, B, P.

***Prenolepis imparis* (Say)**.

This ant is a cool season species that was the dominant species in the forests during the winter months. It was found in open areas where some trees were present. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, BF, B, P. (Figure 3)

<u>Tribe Camponotini</u>

***Camponotus* (*Camponotus*) *americanus* Mayr**.

This species was associated with forests. On 26 June 2003, a colony was discovered in an oak-hickory forest at Osborn, MS. The colony was in a mound of soil with the entrance hole in the middle, with the ants in the process of excavating and bringing soil up from inside. (Lowndes and Oktibbeha Cos.) H, B, and P.

***Camponotus* (*Camponotus*) *chromaiodes* Bolton** .

This species was common in the forests of the Black Belt and Flatwoods, usually nesting in the soil near the base of a tree or under a log. (Lowndes and Oktibbeha Cos.) H, B, BF, P.

***Camponotus* (*Camponotus*) *pennsylvanicus* (DeGeer)**.

A colony was found in a dead, standing *Q. stellata*. On 24 July 2003, phorid flies were observed hovering above workers of this species as they moved along a foraging trail.

The flies evaded capture, so their identity remains unknown. (Lowndes and Oktibbeha Cos.) H, B, P.

***Camponotus* (*Colobopsis*) *impressus* Roger**.

One specimen of this species was collected in the prairie, oak-hickory, and Flatwoods each. The prairie specimen was an alate queen that was on a *S. scoparium* stem in the open prairie. (Oktibbeha Co.) H.

***Camponotus* (*Colobopsis*) *mississippiensis* Smith**.

The 25 specimens of this species were collected in oak-hickory forests. Colonies were found in stems of green ash, *Fraxinus pennsylvanica* Marsh,. (Lowndes and Oktibbeha Cos.) H and P. (Figure 4)

***Camponotus* (*Myrmentoma*) *decipiens* Emery**.

This species was found on an isolated *Diospyros virginiana* and on the surrounding ground in open prairie. (Chickasaw Co.) H, B.

***Camponotus* (*Myrmentoma*) *snellingi* Bolton**.

Colonies of this species were found in standing, dead *Q. stellata* and *C. ovata* trees. (Lowndes and Oktibbeha) H, B, P. (Figure 4.)

***Camponotus* (*Myrmentoma*) *subbarbatus* Emery**.

A colony was found on 28 October 2003 in a dead oak branch on the ground that was about 35 cm long and one cm in diameter. The colony contained 38 minors, 6 majors, 6 alate queens, and 2 males. (Lowndes and Oktibbeha Cos.) H and P.

***Camponotus* (*Tanaemyrmex*) *castaneus* (Latreille)**.

This species usually was observed nesting in the soil, but one colony was found about 1.7 meters above the ground in the crotch of a *J. virginiana*. This species was collected in the prairie, oak-hickory and Flatwoods. (Lowndes and Oktibbeha Cos.) H, B, P.

Tribe Formicini

***Formica pallidefulva* Latreille**.

This species was collected only in the two forest habitats. (Lowndes and Oktibbeha Cos.) H, B, P .

***Formica dolosa* Buren**.

This species was collected only in the prairie habitat, where nests were found in clumps of *S. scoparium*. A worker was observed being attacked by a *Pheidole dentata* major at a cookie bait close to the *Pheidole* colony. The *Pheidole* major clamped down on the middle leg of the *Formica*, which caused this worker to leave the bait with the *Pheidole* still attached. Workers of this species have been followed from a bait station to their colony that was approximately 7.6 meters away. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, B, P.

***Formica subsericea* Say**.

24 July 2003: This species was collected only in the oak-hickory forests, where it nested in the soil and underneath the leaf litter. (Oktibbeha Co.) H and B.

***Polyergus lucidus longicornis* Smith**.

Hill and Brown (2004) first reported this slave-making genus from Mississippi from specimens that were collected during this study. This species previously was known only from the Carolinas and Georgia. This subspecies was found in a one-hectare oak-hickory forest in the Black Belt region of Oktibbeha County Mississippi. A slave raid was observed around 5:30 p.m. on June 19, 2003. The raid appeared to contain approximately 100 soldiers moving in a southeasterly direction. This subspecies was collected only in the oak-hickory forests. (Oktibbeha Co.) H and P. (Figure 4)

***Polyergus lucidus montivagus* Wheeler**.

Hill and Brown (2004) also reported this subspecies from Mississippi for the first time. This subspecies is widely distributed, ranging from Maryland and the Carolinas west to Nebraska and New Mexico. It was first collected with pitfall traps at two locations. The first was in an oak-hickory forest in the Black Belt Prairie region of Lowndes Co. MS. The trap contained eight soldiers of *Polyergus*, some with *Formica* pupae in the mandibles, as well as several workers of *Formica pallidefulva* Latrielle. The second collection was at a Black Belt prairie remnant in the Trace Unit of Tombigbee National Forest in Chickasaw Co. The pitfalls were placed at least 25 meters away from any trees in an open area of prairie. The traps here contained 48 soldiers of *P. lucidus montivagus*, as well as several workers of *Formica dolosa* Wheeler. Two specimens were collected in pitfall traps in the Flatwoods habitat later in the study. (Chickasaw and Lowndes Cos.) P.

Subfamily Pseudomyrmecinae

<u>Tribe Pseudomyrmecini</u>

***Pseudomyrmex pallidus* (Smith)**.

One specimen was collected in an oak hickory forest on *F. pennsylvanica* Marsh. (Oktibbeha Co.) H.

Subfamily Amblyoponinae

<u>Tribe Amblyoponini</u>

***Amblyopone pallipes* (Haldeman)**.

One specimen was collected from a well rotted, pine stump in an oak hickory forest. (Oktibbeha Co.) BF.

Subfamily Ponerinae

<u>Tribe Ponerini</u>

***Hypoponera inexorata* (Wheeler)**.

This ant was collected most often by scraping away the surface of the soil around grass clumps or under cedar trees. On October 24, 2004 a colony consisting of 32 workers and 4 de-alated queens, and several pupae was found underneath a small fire ant colony. The colony extended approximately 20 cm deep and was approximately 20 cm wide. (Lowndes and Oktibbeha Cos.) H. (Figure 3)

***Hypoponera opaciceps* (Mayr)**.

This species was rarely collected in this study and was represented by seven specimens from the prairie, oak-hickory and Flatwoods. (Lowndes and Oktibbeha Cos.) H and BF.

***Hypoponera opacior* (Forel)**.

This species was collected in all four habitat types. In pastures it was found under dried cow manure. (Chickasaw, Lowndes, and Oktibbeha Cos.) H and BF.

***Ponera exotica* Smith**.

This species was collected most often at the bases of large trees or under rotting logs in both forest types. (Lowndes and Oktibbeha Cos.) H and B.

***Ponera pennsylvanica* Buckley**.

Alates of this species were present in a nest on 25 September 2003. De-alate queens were found inside *C. myristiciformis* nuts on 22 January 2004. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, BF, B, P.

Subfamily Proceratiinae

Tribe Proceratiini

***Discothyrea testacea* Roger**.

The one specimen of this species collected during this study was from leaf litter taken from open ground in Flatwoods. (Oktibbeha Co.) B.

***Proceratium pergandei* (Emery)**.

One alate queen of this species was collected from under a small (> 1m tall) *J. virginiana* in open prairie, and one worker was collected in leaf litter from the base of *Q. falcata* in Flatwoods. (Oktibbeha Co.) H, B.

Subfamily Myrmicinae

Tribe Dacetini

***Pyramica clypeata* (Roger)**.

This species was the second most frequently collected member of the genus in this study. A colony was collected within an oak-hickory forest that contained 4 queens and 20 workers on 25 September 2003, another colony was found nesting in a clump of *S. scoparium* in a prairie remnant. (Lowndes and Oktibbeha Cos.) H, B, P.

***Pyramica dietrichi* (Smith)**.

A colony was found under the base of a small cedar (>1m tall) in open prairie. This species was also common in litter under larger *J. virginiana* trees. (Lowndes Co.) H.

***Pyramica ohioensis* (Kennedy and Schramm)**.

This was the most frequently collected Dacetine during this study. It was found most often in the leaf litter of Flatwood forests. One colony was found with 2 dealated queens and 77 workers. (Lowndes and Oktibbeha Cos.) H, B, P.

***Pyramica ornata* (Mayr)**.

This species was the third most frequently collected member of the genus in this study. It was found frequently in leaf litter under large *J. virginiana* trees in open prairie or in leaf litter of both forest types. A colony with approximately 26 individuals was collected on 8 June 2004 at the base of *Q. durrandii* in an oak-hickory forest. (Lowndes and Oktibbeha Cos.) H, B, P.

***Pyramica pulchella* (Emery)**.

Only two specimens of this ant were collected, one in each forest type. (Oktibbeha Co.) B and P.

***Pyramica rostrata* (Emery)**.

The 14 specimens collected during this study came only from the Flatwoods sites. (Oktibbeha Co.) H, BF, P.

***Pyramica talpa* (Weber)**.

One worker was observed crawling on pitfall trap cover in Flatwoods. This species was collected frequently in litter under large *J. virginiana*, and by scraping *S. scoparium* clumps in open prairies. (Lowndes and Oktibbeha Cos.) H, B, P.

***Strumigenys louisianae* Roger**.

This species was collected frequently in litter under large *J. virginiana* trees in the prairie sites and in both forest types under logs and in leaf litter. (Lowndes and Oktibbeha Cos.) H, BF, P.

Tribe Attini

***Trachymyrmex septentrionalis* (McCook)**.

This ant was found sporadically in all habitat types except pastures. On 26 June 2003 workers were observed exiting a nest opening carrying small pieces of a white fungus in their mandibles. This species was also observed carrying bits of dead insects and cookie bait, and carrying what appeared to be caterpillar feces. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, BF, B, P.

Tribe Stenammini

***Stenamma meridionale* Smith**.

This ant was found only on the cooler sampling dates in both forested habitats. On 25 July 2003 a colony of this ant that seemed to be aestivating was found approximately 0.5 m underground. (Lowndes and Oktibbeha Cos.) H and B.

Tribe Solenopsidini

***Monomorium minimum* (Buckley)**.

This species occurred in all four habitat types, but was most common in the non-forested sites. It was observed being preyed upon by *Cincindela rufiventris* Dej. (Carabidae) on an area of bare chalk in a prairie remnant. It was frequently observed at nectaries of vetch, *Vica* spp. (Fabaceae), and maypop, *Passiflora incarnata* L. (Passifloracea), and it was also observed frequently at flowers of butterfly weed, *Asclepias tuberosa* L.

(Asclepiadaceae) and dandelion, *Taraxacum officinale* (Weber) (Asteraceae). (Chickasaw, Lowndes, and Oktibbeha Cos.) H, BF, B, P.

Solenopsis invicta* X *richteri.

This hybrid was the most common ant collected in this study. It was most common in the pasture habitat, where colonies would make either large mounds or nest under dried cow manure. In the prairie the nests were found most frequently occurring on the interface of a prairie and chalk outcrop or along some sort of disturbance, such as a vehicle trail. It was observed carrying live maggots (Diptera) away from a rat carcass. One major worker was observed following an *Oebalus pugnax* (Fabricius) (Pentatomidae) on the ground and eventually up a stem of *S. scoparium*, upon which the *O. pugnax* secreted a drop of brown fluid, which the fire ant would not pass. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, BF, B, P.

***Solenopsis molesta* (Say)**.

This ant was collected frequently in the Flatwoods. However, colonies could be found in either forest type at the bases of pine trees, and under the first layer of bark. In the prairies colonies were found nesting in the ground and in the pastures under dried cow manure. Most of the colonies found during this study contained multiple (usually two) queens. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, BF, B, P.

***Solenopsis richteri* (Forel)**.

This imported fire ant species was collected mostly in the more northernly pasture sites in Chickasaw Co, but a few were collected in the Crawford prairie and oak-hickory sites.

On 16 November 2004 workers of this ant were scarce at bait (cookies), but instead were seen gathering dead plant debris, such as grass duff, and carrying them into the nest. (Lowndes and Oktibbeha Cos.) H, BF, B, P.

Tribe Myrmicini

***Myrmica punctiventris* Roger**.

The 22 specimens of this species were collected only in the Flatwood forests. (Oktibbeha Co.) H, BF, B, P.

***Myrmica pinetorum* Wheeler**.

The 81 specimens of this species were collected only in the oak-hickory forests of the Black Belt. (Lowndes and Oktibbeha Cos.) H, BF, P.

Tribe Pheidolini

***Aphaenogaster fulva* Roger**.

This species was found most frequently nesting in rotting tree stumps. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, BF, B, P.

***Aphaenogaster lamellidens* Mayr**.

This species was common in both forest types, and it was the most common ant in the oak-hickory forests. It was usually one of the first species to appear at a bait. Workers were observed carrying a dead termite (Isoptera), and a dead spider. The head capsule of this species was a predominant component in the debris on the back of a *Chrysopidae*

(Neuroptera) larvae found in an oak-hickory forest. (Lowndes and Oktibbeha Cos.) H, BF, B, P.

***Aphaenogaster treatae* Forel**.

In prairie remnants this species was found nesting in the open and around the bases of isolated, large *J. virginiana* trees. The nests were either a mound of soil in a clump of *S. scoparium* or in the ground with the only visible evidence being a hole in the ground about the diameter of a pencil. One colony was found under a rotting *J. virginiana* log. One specimen of this species was collected in Flatwoods. (Chickasaw and Oktibbeha Cos.) H, B, P.

***Aphaenogaster carolinensis* Wheeler**.

This species is in the *Aphaenogaster fulva-rudis-texana* group and is either *A. carolinensis* or *A.* new species N19 (Umphrey, 1996). Newly founded colonies containing one dealate queen and a small clutch of eggs were found under several logs on 18 August 2004. This species was collected predominantly in both forest types, although several specimens were taken in the prairie habitat. (Lowndes and Oktibbeha Cos.) H, BF, B, P.

***Pheidole bicarinata* Mayr**.

This species was collected only in the pasture habitat. (Chickasaw Co.) H, B.

***Pheidole dentata* Mayr**.

On 10 July 2004 foraging workers were followed back to their nest. The nest entrance appeared to be inside an abandoned burrow of a wolf spider (Lycosidae). A bait was placed just outside of the entrance, and shortly thereafter, both minors and majors were present. After 20 minutes a large number of *M. minimum* workers had displaced them. On 24 July 2003 major workers were observed being attacked by females of *Apocephalus tenuipes* Borgmeier (Diptera: Phoridae) (Hill and Brown, In Press). This ant species was collected in the prairie and both forested habitats. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, BR, B, P.

***Pheidole dentigula* Smith**.

This species was collected in the leaf litter of both forest types. (Lowndes and Oktibbeha Cos.) H, BF, B, P.

***Pheidole pilifera* (Roger)**.

This species was collected only in the prairie habitat. From approximately 2:30 to 5:30 P.M. on 15 November 2004, several foraging minor workers of *P. pilifera* were followed back to their nest. The only noticeable evidence of the nest site was a small hole in the ground, approximately 3 mm in diameter. The area immediately surrounding the nest consisted of 80% bare ground, based on visual estimate, and several small clumps of *Schizachyrium scoparium* (Michx.) (Poaceae) that were 15 cm tall. Foraging minors exited the colony and either headed north or west. The minors that went west were followed for further observation. These minors went approximately 1.5 m, then the group split with some individuals going north and others continuing west. After another two meters the latter group of minors branched into individuals that appeared to be searching randomly. One of these workers was followed for 10 meters away from the nest, and then visual contact with the ant was lost. All of the returning workers appeared to be carrying the seeds of *Panicum virgatum* L. (Poaceae). No *P. pilifera* were found on the seed heads of *P. virgatum* in the immediate foraging area or in spider webs in several of those seed heads. It was not clear where the minors were finding the seeds, but they may have been taking advantage of the previous day's storm, which probably knocked down many seeds, negating the need for the ants to go up the grass stems to harvest the seeds.

A small feeding trial was made by placing piles of seeds from various species of plants from the surrounding area along the foraging trail, starting 20 cm away from the colony entrance. Seeds were placed in the following order heading away from the colony: *Ratibida pinnata* (Vent) (Asteraceae), *Erigeron* sp. (Asteraceae), *Aster patens* Ait. (Asteraceae), *Liatris squarrosa* (L.) (Asteraceae), *Schizachyrium scoparium, Sorghastrum nutans* (L.) (Poaceae), *Silphium laciniatum* (L.) (Asteraceae), and *Panicum virgatum*. Minor workers quickly selected the *P. virgatum* seeds from the pile and carried them into the nest. The other seeds were ignored except for four *S. nutans* seeds and one *S. scoparium* seed that were carried from the pile, but these seeds, with the exception of one *S. nutans* seed, were abandoned after several minutes and not taken into the colony. This was possibly due to the larger size of the *S. scoparium* and *S. nutans* seeds, as the minors appeared to have difficulty transporting them. During this time several workers of *Paratrechina arenivaga* were observed moving freely through the foraging trail of *P. pilifera* and around the nest entrance.

Approximately one hour after the seeds were presented, a dead mosquito (Diptera: Culicidae) was placed between the *S. nutans* and *S. scoparium* seed piles. Several *P. pilifera* minors began to transport the dead insect as a group and managed to move it about eight cm before a single *P. arenivaga* worker quickly seized the mosquito. After this, whenever a *P. pilifera* minor, usually carrying a seed, approached the mosquito, which was still on the *P. pilifera* trail, the *P. arenivaga* worker attacked the *P. pilifera* minors. The *Paratrechina* worker pounced on top of an individual *P. pilifera* minor, faced the rear of the body and then held it down for several seconds while curling its gaster under, presumably spraying the *P. pilifera* in the face with formic acid. Upon their release the *P. pilifera* minors staggered away while leaving their seeds behind. Next, a hind femur of *Amblytropidia mysteca* (Saussure) (Orthoptera: Acrididae) was placed adjacent to the entrance of the *P. pilifera* nest. A major *P. pilifera* worker, the first one seen during this observation period, quickly picked up the leg and dragged it into the nest. After the leg was taken into the nest, the influx of *P. virgatum* seeds began to fill up the nest entrance until a small pile had accumulated on top of it. This suggests that the grasshopper leg might have become stuck at some point, or the major was moving into the nest slower than the minors were bringing in seeds. Six *Paratrechina* workers were observed moving rapidly around the *P. pilifera* nest entrance. They began removing the accumulation of seeds from the nest entrance, while continuously warding off the addition of new seeds that were being added by the *P. pilifera* minors. After they cleared the entrance, the *Paratrechina* workers disappeared into *P*. *pilifera* nest. After about thirty minutes the *Paratrechina* workers reappeared at the *P*. *pilifera* nest entrance and were attempting to remove the grasshopper leg. Meanwhile, the returning *P*. *pilifera* minors would either drop their seeds into, or just outside of, the nest entrance, which seemingly made it more difficult for the *Paratrechina* to remove the grasshopper leg. It was not clear whether or not the *P*. *pilifera* minor was still attempting to pull the leg into the nest, but based on the movements of the *Paratrechina* it seemed to be the case. These observations continued for about one hour and thirty minutes with the *Paratrechina* pulling the leg close to the entrance whereupon the leg would disappear back down into the nest, apparently being pulled by workers of *P*. *pilifera*. After thirty minutes and with darkness approaching, the grasshopper leg was removed with forceps from the nest. The *Paratrechina* left the area soon thereafter. (Lowndes and Oktibbeha Cos.) H, B. P.

***Pheidole tysoni* Forel**.

This species was only collected in prairies, quite frequently at baits. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, B, P.

<u>Tribe Crematogastrini</u>

***Crematogaster* (*Crematogaster*) *ashmeadi* Mayr**.

This species was associated usually with trees, where it was frequently taken at bait. One colony was found inside a dead cedar-apple gall. (Lowndes and Oktibbeha Cos.) H, B, P.

***Crematogaster* (*Crematogaster*) *lineolata* (Say)**.

This was the second most frequently collected species, and it occurred in all four habitat types. In the prairie it frequently made its nest in clumps of *S. scoparium*. In forested habitats it was found nesting in rotting logs or stumps, in leaf litter, or in hollow stems. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, BF, B, P.

***Crematogaster* (*Crematogaster*) *pilosa* Emery**.

Several colonies of this species were found nesting inside hollowed stems *Silphium laciniatum* L. and *S. terebinthinaceum* Jacquin (Asteraceae) from the previous year. Colonies also were found nesting under *J. virginiana* trees in the prairies. It also was observed carrying fly eggs away from a snapping turtle, *Chelydra serpentina* (L.) carcass. (Chickasaw Co.) H, B, P.

***Crematogaster* (*Orthocrema*) *minutissima* Mayr**.

This species was collected only from the base of several shagbark hickory, *C. ovata* trees in the oak-hickory habitat. (Lowndes Co.) B.

***Crematogaster missouriensis* Emery**.

This species was collected only from prairie remnants. (Chickasaw and Lowndes Cos.) H and B.

<u>Tribe Formicoxenini</u>

Temnothorax curvispinosus **(Mayr).**

This species was collected in both forest types and the prairie, although rarely in the latter. Colonies were found occasionally in dead twigs of *C. ovata* that were still attached to tree. One colony of 69 workers and one queen was found inside a *C. ovata* fruit on December 13, 2005. An apparently newly founded colony of three workers and one queen was found inside a *C. myrsticiformis* nut on 22 January 2004. (Lowndes and Oktibbeha Cos.) H, BF, B, P.

Temnothorax pergandei **(Emery)**.

This species was collected in both forest types and the prairie. A colony was found in the fruit of *C. ovata* on 22 January 2004 and one in the fruit of *C. myrsticiformis* on 15 September 2004, with the former containing 62 workers and a single queen and the latter containing 69 workers and a single queen. An apparently newly founded colony was found inside a *C. ovata* fruit on 13 December 2005 with a queen, a worker and several eggs. Colonies also were found in *Q. stellata* acorns and in rotten logs. Colonies were commonly found in the soil in the open prairie. Colonies were found most frequently in small irregular shaped mounds either in clumps of *S. scoparium* or on open ground. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, BF, B, P.

Temnothorax schaumii **(Roger)**.

Workers of this species were observed foraging on live, dead, and fallen *Q. stellata* and on a *Pinus taeda* log. (Lowndes and Oktibbeha Cos.) H and B.

<u>Tribe Myrmecinini</u>

***Myrmecina americana* Emery**.

This species was found nesting frequently at the bases of large trees in both forest types as well as under or near *J. virginiana* in the prairies. (Chickasaw, Lowndes, and Oktibbeha Cos.) H, B, P.

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APPENDIX A

PLANT DATA

Table A1. Plant data from sub sites. (pr) prairie, (ps) pasture, (oh) oak-hickory, and (fw) Flatwoods.

Site	Herbaceous Height (cm)	Graminoid Ratio	CWD (m^2/ha)	C3 Graminoid Ratio	% Canopy Cover	Basal area (m^2/ha)	Herbaceous Richness
Osborn pr1	28.88	0.19	0.00	0.40	0.00	0.04	27.00
Osborn pr2	24.25	0.17	0.01	0.50	0.50	0.20	24.00
Osborn pr3	26.00	0.20	0.02	0.40	2.00	0.37	25.00
Crawford pr1	22.94	0.16	0.00	0.67	2.30	0.69	19.00
Crawford pr2	12.38	0.24	0.02	0.75	1.30	1.07	17.00
Crawford pr3	29.90	0.24	0.00	0.75	0.50	0.50	17.00
Tombigbee pr1	55.53	0.23	0.03	0.29	0.00	0.08	30.00
Tombigbee pr2	41.25	0.20	0.01	0.20	0.00	0.00	25.00
Tombigbee pr3	51.34	0.16	0.00	0.25	0.00	0.00	25.00
Crawford ps1	8.63	0.22	0.00	0.50	0.00	0.00	18.00
Crawford ps2	21.25	0.20	0.00	0.50	0.00	0.00	20.00
Crawford ps3	11.88	0.25	0.00	0.67	0.00	0.00	12.00
Starkville ps1	7.50	0.57	0.00	0.75	3.00	0.03	7.00
Starkville ps2	30.75	0.25	0.00	0.75	0.00	0.00	16.00
Starkville ps3	35.50	0.18	0.00	0.67	0.00	0.00	17.00
Trebloc ps1	17.25	0.25	0.00	0.50	0.00	0.00	8.00
Trebloc ps2	28.50	0.33	0.00	0.50	0.00	0.02	6.00
Trebloc ps3	6.50	0.43	0.00	0.67	0.00	0.00	7.00
Osborn oh1	6.50	0.18	0.75	1.00	54.00	229.44	11.00
Osborn oh2	9.88	0.14	0.56	1.00	58.00	129.38	7.00
Osborn oh3	8.63	0.29	0.90	1.00	46.00	57.66	7.00
82x 45A oh1	7.98	0.00	0.16	0.00	78.00	61.74	4.00
82x 45A oh2	5.20	0.00	0.00	0.00	69.00	84.90	4.00
82x 45A oh3	3.85	0.00	0.47	0.00	66.60	108.12	1.00
Crawford oh1	13.00	0.09	1.87	1.00	78.00	67.14	11.00
Crawford oh2	15.53	0.10	0.36	1.00	84.00	65.19	10.00
Crawford oh3	16.31	0.22	0.04	1.00	62.60	147.06	9.00
Noxubee fw1	34.63	0.20	4.29	1.00	72.00	385.90	5.00
Noxubee fw2	33.75	0.17	1.73	1.00	52.00	174.95	6.00
Noxubee fw3	19.50	0.00	0.00	0.00	46.00	170.01	3.00
5mi S Starkville fw1	38.50	0.25	0.10	1.00	82.00	125.32	4.00
5mi S Starkville fw2	8.25	0.20	0.51	1.00	81.00	114.45	5.00
5mi S Starkville fw3	21.29	0.17	0.55	1.00	67.00	93.20	6.00
8mi S Starkville fw1	8.53	0.17	1.28	1.00	77.00	245.09	6.00
8mi S Starkville fw2	26.00	0.14	37.50	1.00	69.60	83.06	7.00
8mi S Starkville fw3	14.03	0.33	1.47	1.00	58.00	77.26	3.00

APPENDIX B

SOIL DATA

Table B1. Soil data from sub sites. (pr) prairie, (ps) pasture, (oh) oak-hickory, and (fw) Flatwoods.

Site	% Organic matter	pH	Phosphorus (kg/ha)	Calcium (kg/ha)	% Sand
Osborn pr1	2.44	8.10	1.13	15.43	56.25
Osborn pr2	2.73	7.90	1.28	14.63	56.25
Osborn pr3	3.21	7.80	1.00	14.98	56.25
Crawford pr1	3.90	7.90	1.13	24.25	31.00
Crawford pr2	4.43	7.90	0.83	29.25	31.00
Crawford pr3	2.89	7.90	1.09	15.80	31.00
Tombigbee pr1	5.08	7.90	1.16	27.00	50.25
Tombigbee pr2	2.87	8.00	1.20	16.78	50.25
Tombigbee pr3	2.23	8.00	1.09	17.20	50.25
Crawford ps1	5.82	7.20	1.28	23.55	31.50
Crawford ps2	4.58	7.80	1.25	20.13	31.50
Crawford ps3	5.73	7.30	1.30	23.98	31.50
Starkville ps1	3.49	7.80	1.33	17.10	29.00
Starkville ps2	5.50	7.00	1.20	18.05	29.00
Starkville ps3	2.20	7.90	1.39	13.33	29.00
Trebloc ps1	4.12	7.50	1.33	17.75	30.25
Trebloc ps2	4.02	7.30	1.16	11.33	30.25
Trebloc ps3	5.66	6.40	2.23	15.93	30.25
Osborn oh1	3.19	4.90	0.95	5.36	57.50
Osborn oh2	3.55	6.20	1.20	8.90	57.50
Osborn oh3	3.23	4.60	1.00	2.66	57.50
82x 45A oh1	4.49	4.70	1.13	3.19	53.75
82x 45A oh2	4.28	5.10	0.95	4.80	53.75
82x 45A oh3	2.82	4.50	0.89	1.47	53.75
Crawford oh1	5.02	6.30	0.89	27.50	18.25
Crawford oh2	7.92	6.20	1.45	29.50	18.25
Crawford oh3	8.24	5.90	1.37	27.50	18.25
Noxubee fw1	1.74	5.70	0.83	3.43	43.75
Noxubee fw2	2.68	4.20	0.95	0.71	43.75
Noxubee fw3	2.65	4.40	1.00	0.42	43.75
5mi S Starkville fw1	1.97	4.90	0.89	3.33	29.00
5mi S Starkville fw2	2.22	4.40	0.83	3.02	29.00
5mi S Starkville fw3	2.74	4.20	1.13	1.00	29.00
8mi S Starkville fw1	4.34	5.10	1.16	9.22	29.50
8mi S Starkville fw2	4.82	4.70	1.09	4.80	29.50
8mi S Starkville fw3	2.54	5.00	1.00	7.94	29.50