Ordination Analysis of Ant Faunae along the Range Expansion Front of the Red Imported Fire Ant in South-Central Texas

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ABSTRACT

The red imported fire ant (RIFA), *Solenopsis invicta*, is expanding its range into western Texas. Although few native ant species have been found to be either directly or indirectly competitive with the RIFA, collectively or individually native species may offer some resistance, resulting in a decrease in the rate of RIFA infestation. The objective of the present study was to characterize the predominant ant species at the westernmost edge of RIFA infestation and to determine through niche overlap which native ants may be in competition with the RIFA.

Ants from four habitats (juniper, oak, cypress, and pasture) were sampled monthly with pitfall traps in Kerr and Bandera Counties, Texas, for one year. A total of 27,683 individuals representing five subfamilies and at least 37 species was collected. The most commonly collected ants from all habitats were *Solenopsis invicta* (RIFA), *Solenopsis geminata, Pheidole* spp., *Monomorium minimum, Forelius pruinosus,* and *Paratrechina terricola.*

Data analysis by Wisconsin/polar ordination distinctly separates the several habitats in space through time (seasons); whereas, quartile analysis of the prominant ant species emphasizes habitat-season interactions. Factor gradients that determine species prominance within and among habitats are strongly indicated. However, our data indicate that native species may offer only little resistance to the RIFA.

INTRODUCTION

The red imported fire ant (RIFA), **Solenopsis invicta**, is a pest in the southern and southeastern United States, and 12 states have recorded this pest within their borders. The red imported fire ant now infests at least 110 Texas counties and is extending its range westward (Francke et al., 1983).

The geographical distribution of the RIFA and the biotic/abiotic factors affecting its range have been reviewed by Buren et al. (1974), Hung et al. (1977), and Hung and Vinson (1978). Buren et al. (1974) stated that the northward expansion of the RIFA will be limited by winter kill. In fact, the 0° F isoline in the USDA Plant Hardiness Zone Map was originally proposed as the ecological range limit for the RIFA (USDA, 1972). Hung and Vinson (1978) stated that the RIFA may eventually extend its range beyond this proposed limitation and infest most of Texas and Oklahoma. However, Pimm and Bartell (1980) developed a statistical model for predicting range expansion of the RIFA and stated that the 0° F isoline proposed by the USDA is probably accurate for Texas but may not be accurate for Oklahoma. Finally, Francke et al. (1986) stated that the RIFA exhibits only limited physiological adaptations toward coldhardiness, and that nest construction may be more significant in explaining the northward distribution of this species.

Although several native ant species have been reported as either predators or competitors of the RIFA (Bhatkar et al., 1972; Whitcomb et al., 1973; Hung, 1974; O'Neal, 1974; Nickerson et al., 1975), these species appear to have little effect on halting or delaying the range expansion of the RIFA (Hung and Vinson, 1978). In fact, the RIFA seems to be displacing and thus eliminating the native fire ants, **Solenopsis geminata**, and **Solenopsis xyloni** from eastern Texas (Hung and Vinson, 1978).

The major objective of our study was to characterize the predominant ant species with respect to four habitats at the westernmost edge of RIFA infestation in Texas. An additional objective was to quantitatively compare the foraging activities of the RIFA with the other major associated species. From these comparisons, similarities or dissimilarities in activity could lead to the formulation of hypotheses with respect to niche overlap and subsequent competitive displacement involving the RIFA and native ants of Texas.

MATERIALS AND METHODS

Four study sites were demarked in Kerr and Bandera Counties (Fig.1), which are located on the Edwards Plateau in south-central Texas at the western edge of RIFA infestation (Francke et al., 1983). Vegetational communities and site locations were established as follows: juniper (**Juniperus ashei** Buchholz) - grassland community, 0.7 miles SSE of Center Point, along Elm Pass Road; live oak (**Quercus virginia** Miller) - grassland community, 1.5 miles S of Center Point adjacent to Elm Pass Road; southern cypress [**Taxodium distichum** (L.)] - grassland community, 0.9 miles W of Bandera, southwest of State Highway 16 and Farm Road 470 intersection; and Bermuda pasture [**Cynodon dactylon** (L.)] - grassland community, located 0.1 miles SW of State Highway 16 on Farm Road 470.

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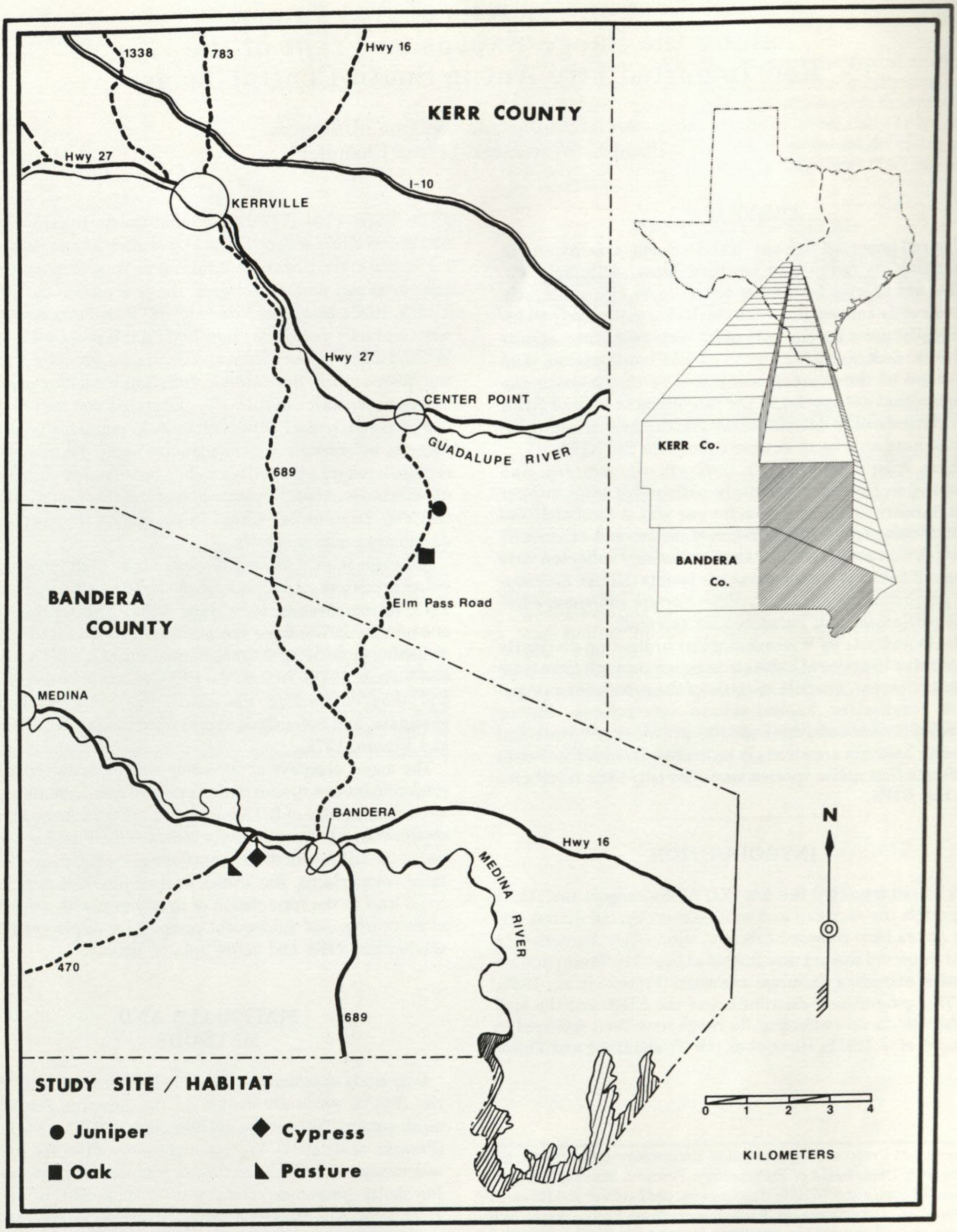

Figure 1. Location of study sites in Kerr and Bandera Cos., Texas. Dotted line on Texas map depicts western edge of RIFA infestation.

A line transect of 20 pitfall traps (16 oz. plastic cups containing ethylene glycol placed approximately 15 ft. apart) was established in each site. An asphalt roofing shingle was secured above each trap to form a protective cover. Traps were placed in the field the beginning of each month, and were left for a period of 7 days from May 1983 through April 1984. All ant specimens trapped were identified and tallied. Identifications were verified from determined specimens in the Entomological Collection, The Museum, Texas Tech University.

Although problems are associated with interpreting the results of pitfall trap sampling, Adis (1979) contends that this method does indicate temporal patterns of dispersal and annual periodicities of activity. Pitfall trapping can also reveal the composition of different habitats through time. In addition, pitfall traps are commonly used to monitor ground foraging arthropod populations.

Data were analyzed by the Wisconsin/polar ordination technique (Bray and Curtis, 1957; Beals, 1960; Burlington, 1962; Della Lûcia et al., 1982). The method is valuable in the analysis of ant activity in selected habitats (Munsee, 1966; Lawson, 1974; Della Lucia et al., 1982). Some of the data collected during this study could not be analyzed because: 1) the pasture did not form an "activity continuum" with the other three habitats; 2) the first three collections in the cypress habitat were negated by a change in study site; and 3) the winter collections in the juniper habitat were considered to be zero (one individual of **Pachychondyla harpax** was taken). The large number of **S. geminata** taken during the summer was the major difference between the pasture and other sites. Secondarily, the pasture exhibited an internal difference among seasons of greater magnitude than the other three habitats; and, the pattern of activity is one of continuous decline, unlike that of the other habitats.

RESULTS

Thirty-seven species representing five subfamilies were detected in the study (Table 1). The subfamily Myrmecinae contained the largest number of species (19), whereas Ponerinae contained the smallest number of species (3). The most commonly occurring myrmecines in descending order were **Solenopsis geminata, Solenopsis invicta** (RIFA), **Monomorium minimum** and **Pheidole** spp. These species were most prevalent in the pasture and cypress habitats. Although the numbers of individuals were small, the most commonly detected species of Ponerinae were **Leptogenys elongata** and **Pachycondyla harpax**. The most commonly occurring species of Dolichoderinae were **Forelius pruinosus** and **Forelius foetidus**. Few dolichoderines were taken in the cypress habitat. **Labidus coecus** was the most commonly collected species of Dorylinae, and it was most prevalent in the pasture habitat. Finally, the most commonly detected member of Formicinae was **Paratrechina terricola**. This species was quite common in the juniper and pasture habitats.

Table 1. Number of individuals/taxa collected from each of four study sites in Kerr and Bandera Counties, Texas, during 12 monthly sampling periods from May 1983-April 1984.

	No. of individuals by study site			
Taxa	Juniper	Oak	Cypress	Pasture
DOLICHODERINAE				
Conomyrma bicolor (Wheeler)	63	0	0	87
Conomyrma spp.	0	0	0	7
Conomyrma insana (Buckley)	20	0	0	11
Forelius pruinosus (Roger)	185	233	2	189
Forelius foetidus (Buckley)	77	8	3	70
DORYLINAE				
Labidus coecus (Latreille)	53	7	0	178
Neivamyrmex nigrescens (Cresson)	0	2	0	0
Neivamyrmex opacithorax (Emery)	1	12	1	27
Neivamyrmex spp.	9	4	0	43
FORMICINAE				
Paratrechina terricola (Buckley)	203	70	52	309
Brachymyrmex depilis Emery	1	0	2	0
Camponotus spp.	2	7	0	1
MYRMICINAE				
Atta texana (Buckley)	0	0	134	57
Crematogaster laeviuscula Mayr	10	136	24	1
Crematogaster minutissima Mayr	1	0	0	0
Crematogaster punctulata Emery	4	11	3	0
Strumigenys louisianae Roger	0	2	3	3
Xiphomyrmex spinosus Wheeler	0	0	14	1
Trachymyrmex turrifex (Wheeler)	3	0	0	0
Myrmecina americana Emery	0	0	1	0
Monomorium minimum (Buckley)	219	311	338	1,197
Pheidole spp.	268	253	500	300
Pogonomyrmex barbatus (Smith)	1	1	1	124
Solenopsis invicta Buren	8	298	1,238	1,369
Solenopsis geminata (F.)	3	32	22	18,669
Solenopsis molesta (Say)	15	9	30	12
Leptothorax schaumi Roger	2	0	1	0
Leptothorax spp.	2	0	1	0
Cyphomyrmex rimosus (Spinola)	0	0	1	0
PONERINAE				
Leptogenys elongata (Buckley)	1	8	18	0
Pachycondyla harpax (F.)	9	20	0	55
Hypoponera punctatissima (Roger)	0	0	6	1
TOTAL	1,160	1,424	2,395	22,704

Ordination showed (prominence values given in Table 2) the cypress, juniper, and oak habitats to be very dissimilar with respect to major species activity (Fig. 2). This dissimilarity or partitioning of habitats may indicate moisture gradient differences in the three vegetational communities. However, ordination indicated both similarities and dissimilarities in the six most predominant taxa, based on major species activity (Fig. 3).

Table 2. Coefficients of similarity and dissimilarity as based on prominence values obtained from numbers of individuals and frequency of occurrence of each ant species detected seasonally in each habitat. Codes are as follows: 0 = oak, J = juniper, C = cypress; S = summer, F = fall, W = winter, SP = spring.

SIMILARITY (below the diagonal) / DISSIMILARITY (above the diagonal)

	OS	OF	OW	OSP	JS	JF	JSP	CS	CF	CW	CSP
OS	-	68.3	85.0	67.1	62.7	88.0	75.1	85.8	88.6	74.9	85.2
OF	31.7	-	76.3	87.7	71.7	90.8	94.9	96.7	92.9	88.5	95.0
OW	15.0	23.7	-	95.9	94.3	81.0	97.0	98.1	93.3	90.1	96.7
OSP	32.9	12.3	4.1	-	75.0	97.3	29.6	51.3	80.0	72.5	70.0
JS	37.3	28.3	5.7	25.0	-	93.9	53.8	85.9	95.7	87.0	90.3
JF	12.0	9.2	19.0	2.7	6.1	-	96.1	98.3	40.0	88.3	96.0
JSP	24.9	5.1	3.0	70.4	46.2	3.9	-	57.2	97.0	90.5	82.6
CS	14.2	3.3	1.9	48.7	14.1	1.7	42.8	-	66.6	80.1	45.3
CF	11.4	7.1	6.7	20.0	4.3	60.0	3.0	33.4	-	44.2	30.9
CW	25.1	11.5	9.9	27.5	13.0	11.7	9.5	19.9	55.8	-	55.2
CSP	14.8	5.0	3.3	30.0	9.7	4.0	17.4	54.7	69.1	44.8	-

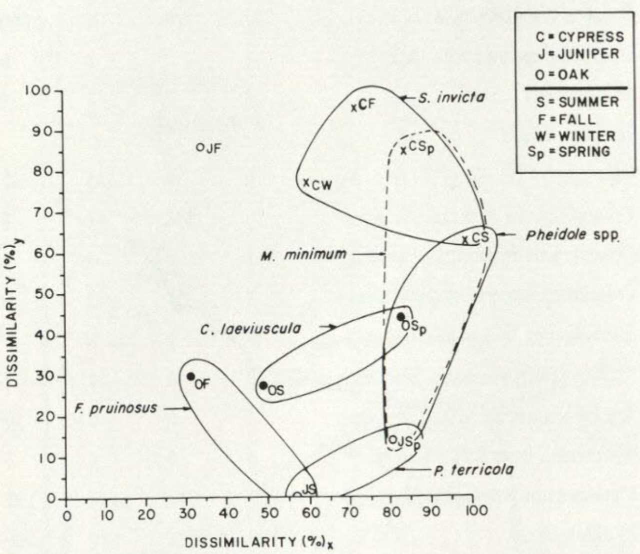

Figure 2. Major ant species activity of three vegetational communities in Kerr and Bandera Cos., Texas (May 1982-April 1983), as plotted by Wisconsin/polar ordination. Data plotted from Table 2.

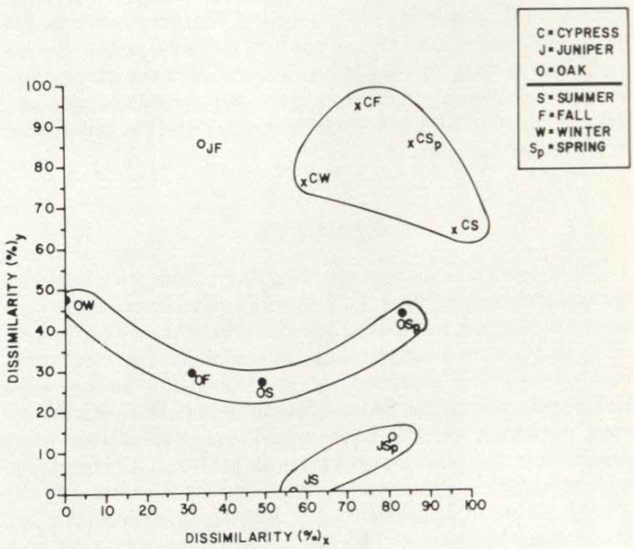

Figure 3. Seasonal activity of major ant species of three vegetational communities in Kerr and Bandera Cos., Texas (May 1982-April 1983), as plotted by Wisconsin/polar ordination. Data plotted from Table 2.

DISCUSSION

Although **Conomyrma insana** reportedly preys on dealated RIFA queens (Nickerson et al., 1975; Hung, 1974), this species is not well represented from our sampling (less than 0.5% of the ant faunae). Also, **S. geminata**, which has been reported to offer some resistance to range expansion by the RIFA (Hung and Vinson, 1978), comprised a large portion of the ants trapped in our study; however, a major habitat separation exists between it and the RIFA. Two other species which reportedly prey on the RIFA, **P. terricola** and **F. pruinosus** were well represented in our study. However, both of these species and the RIFA were very dissimilar in activity. This finding is in agreement with that of Claborn (1985) in which he found a significantly negative association between **F. pruinosus** and the RIFA in a study conducted during the summer using pitfall traps. The only species in our study that overlaps in activity with that of the RIFA are **M. minimum and Pheidole** spp. Although never observed preying on the RIFA, **M. minimum** has been reported to successfully compete with the RIFA (Baroni-Urbani and Kannowski, 1974). In addition, **M. minimum was well represented by our sampling in the juniper, oak, and cypress habitats. Pheidole** spp., which in our study does not overlap in activity with the RIFA as much as **M. minimum,** is stated to be negatively impacted by the RIFA (Whitcomb et al., 1972).

CONCLUSION

Of the five most frequently detected, and therefore predominant, sympatric species found in association with the RIFA, only two overlap in activity. Of these species, **Pheidole** spp. may be negatively impacted by the RIFA. However, **M. minimum** may offer some resistance to RIFA spread. Two other species, **F. pruinosus** and **P. terricola**, prey on RIFA queens; however, our data suggest a lack of niche overlap with the RIFA, indicating either that their impact would be minimal, or that they are preventing niche overlap by preying on founding RIFA queens. **Crematogaster laeviuscula** has not been reported as a factor in RIFA range expansion.

In conclusion, several known ant predators and competitors of the RIFA were detected in the westernmost infested counties of Texas. However, their apparent lack of dominance make them suspect with respect to their potential impact on the RIFA in this region. In fact, the RIFA may be adversely affecting the native ant faunae of Texas through indirect competition, perhaps for limited resources such as food. Therefore the population dynamics of the native species and the interaction of these species with the RIFA should be monitored on a continual basis to determine the impact the RIFA is having on the native ant funae at the westernmost edge of infestation in Texas.

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