Short-Term Effects of Fire on Sky Island Ant Communities

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Abstract—*Few studies investigating effects of fire on ant communities have been conducted worldwide, and none in the biologically diverse and fire prone region of the Sky Islands. Ant genera richness and total abundance are significantly higher in burned areas. Ant community structure changes between unburned and burned sites, implying that disturbance may influence the role of ant communities in Sky Island ecosystems.*

Introduction

Ants are known to have a significant affect on the terrestrial environment. Competing effectively with vertebrates for seed resources (Agosti et al. 2000), ants are notably responsible for the seed dispersal of 35% of all herbaceous plants. Moving the same amount of soil as earthworms in some locations, ants similarly transport plant and animal matter, and can increase the flow of 13 elements 16-98 times over areas without ants (Hölldobler and Wilson 1990). Ants are among the leading predators of other insects and small invertebrates and play an important role in regulating their populations (Hölldobler and Wilson 1990; Jeanne1979). When combined with their global distribution, these factors make ants ubiquitous and essential members of most ecosystems (Hölldobler and Wilson 1990). Likewise, disturbance plays a crucial role in the structuring of biological communities, and a study investigating the effects of disturbance on ant communities would be of interest considering the important roles ants play in ecosystems.

Fire is a common disturbance of biological communities that affects insolation, vegetation, and ground humidity level (see Hoffmann 2003 and included references). Fire changes the structure of the plant habitat and reduces living area for ants to the soil surface. Studies in Australia show a marked increase in ant species richness and abundance after fire (Andersen and Yen 1985). The effects of fire are also indirect; fire induces modifications to habitat, food supplies, and interspecific competition (Andersen and Yen 1985). To our knowledge, the effect of fire on ant communities has never been studied in the Americas or in such highly diverse habitats as the Chihuahuan Desert.

Methods

This study was conducted over two years in the high elevation Chihuahuan Desert (approximately 1,500 m) of Senora, Mexico, on the ranches of Joe and Valer Austin. We established four pairs of plots in adjacent burned and unburned habitat at the sites of two different fires (figure 1). Burned/unburned habitats were 50-100 m apart while each paired plot was at least 200 m apart. The different fires were separated by at least one kilometer. We attempted to control for plant community composition, slope, and aspect between burned and unburned habitats. Ant species richness, abundance, and diversity did not differ significantly between 3 of the 4 plots at both fire sites. Because these plots were separated by at least 200 m, our paired control and burned habitats are likely to contain similar ant species assemblages (as they were only 50-100 m apart). Ants were sampled using arrays of 6 pitfall traps (7 cm diameter Dixie cups) that were lined with flouon. Traps were partially filled with a mixture of propylene glycol, ethanol, soap, and water. Pitfall traps were set 15 m apart and kept

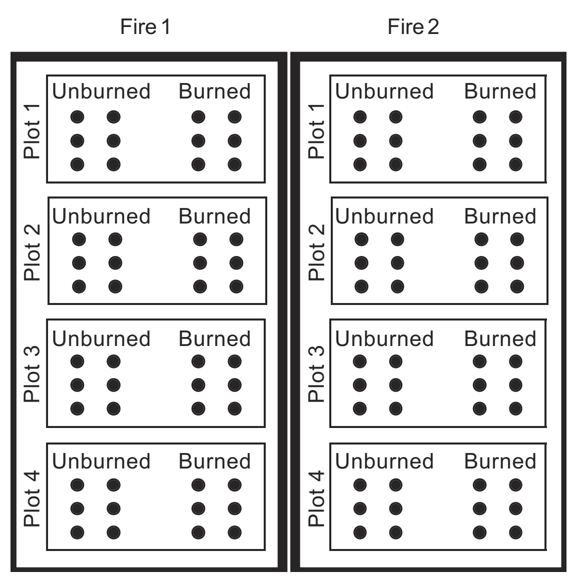

Figure 1—Experimental design.

open for five days at the beginning of the 2002 and 2003 monsoon seasons.

Measurements of vegetation height and richness within 1 m, distance to nearest shrub and tree, and coverage of nearest shrub and tree were taken at each sample point in year two. Common plant genera included: *Agave*, *Mimosa*, *Nolina, Prosopsis*, *Yucca, Quercus*, *Juniperus*, *Guterrezia*, *Opunita*, and *Alhagi* . The only vegetative parameter to differ significantly between plots was distance to nearest tree, indicating that any vegetative differences seen between burned and unburned habitats within plots is likely due to effects of fire, and not to underlying variation in the vegetative community.All insects were removed from pitfalls using salt-water extraction (according to Lattke 2000) and sorted to genus. Ant genera were then assigned to functional groups that have ecological significance in ant communities. Our functional groups were based on Andersen's (2000) assignments that classify ants based on a combination of dominance level, response to stress, and tolerance to disturbance. Differences in generic richness, abundance, and diversity (H') between treatments were analyzed using ANOVA.

Results

Overall ant genera richness (figure 2a) and total abundance (figure 2b) were significantly higher in burned plots than in unburned plots in the first year, but not in the second year (Treatment X Year interaction-richness: F = 7.16, P < 0.01; abundance: F = 3.871, P = 0.051). This pattern indicates recovery of overall ant community richness and abundance to unburned levels within one year after burning, and is similar to patterns observed in other studies investigating the effects on fire on ant communities in Australia (Hoffmann and Andersen 2003).

The relative abundance of specialist herbivores was significantly higher in burned habitats ($F_{1,126}$ = 4.055, P = 0.046), while the relative abundances of both generalist myrmicinae and subordinate camponotini were lower in burned habitats, but non-significantly (Gen-$F_{1,126}$ = 2.960, P= 0.088, Sub-$F_{1,126}$ = 1.859, P = 0.175) (figure 3). Hot climate specialists showed no significant difference between burned and unburned habitats in the first year, but were more abundant in burned plots in the second year (Treatment by year interaction: $F_{1,126}$ = 4.029, P = 0.047).

Three of the six vegetation parameters showed differences between burned and unburned habitat in year two. Distance to the nearest shrub was significantly higher in burned habitats (figure 4a: F = 4.657, P < 0.05), while tree coverage was significantly lower in burned habitats (4b: F = 4.979, P < 0.05). Vegetation height within 1 m of traps was also lower in burned habitats, but this difference was not significant (4c: F = 2.971, P = 0.091). In general burned habitats exhibited lower vegetation density, coverage, and height.

Discussion

Initial increases in the overall richness and abundance of ant communities after fire have so far been explained by the role of fire in reducing habitat complexity (see Hoffmann and Andersen 2003 and included references). Consumption of vegetation and litter by fire effectively concentrates all foraging into two dimensions and drastically decreases surface area in the habitat. Simplifying the habitat in this way is expected to result in increased trapping success (abundance) and increased likelihood of trapping rare species. As a result, ant community recovery to pre-fire or control levels is understood to be a function of vegetative recovery.

However, multiple vegetative parameters show differences between burned and unburned habitats in the second year in our study, and the vegetative community was not observed to have recovered significantly as a whole (Wilkinson, personal observation). Recovery of the ant community to unburned levels in the second year is independent of vegetative recovery in our study. Therefore, it is unlikely that greater ant community richness and abundance in newly burned habitats (year 1) is due solely to decreases in habitat complexity caused by fire. Unmeasured resource pulses after fire may be partially responsible for the observed trends.

Although overall richness and abundance of burned habitats return to unburned levels by year two, functional group composition, and therefore ant community structure, has changed. These structural changes may have implications for the roles that ant communities play in Chihuahuan Desert ecosystems.

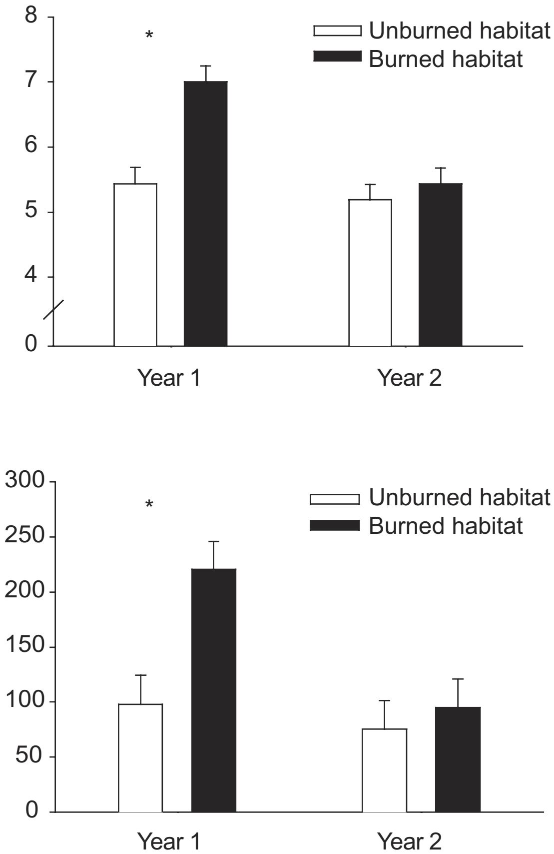

Figure 2—The effect of fire on (a) generic richness and (b) total abundance across study years.

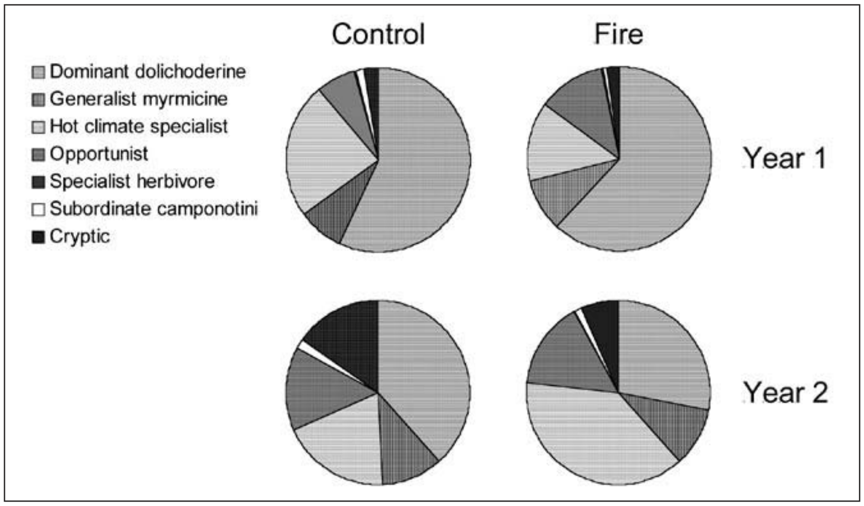

Figure 3—Relative abundance of dominant dolichoderines, generalist myrmicines, hot climate specialists, opportunists, specialist herbivores, subordinate camponotini, and cryptic species in control and fire habitats over both study years.

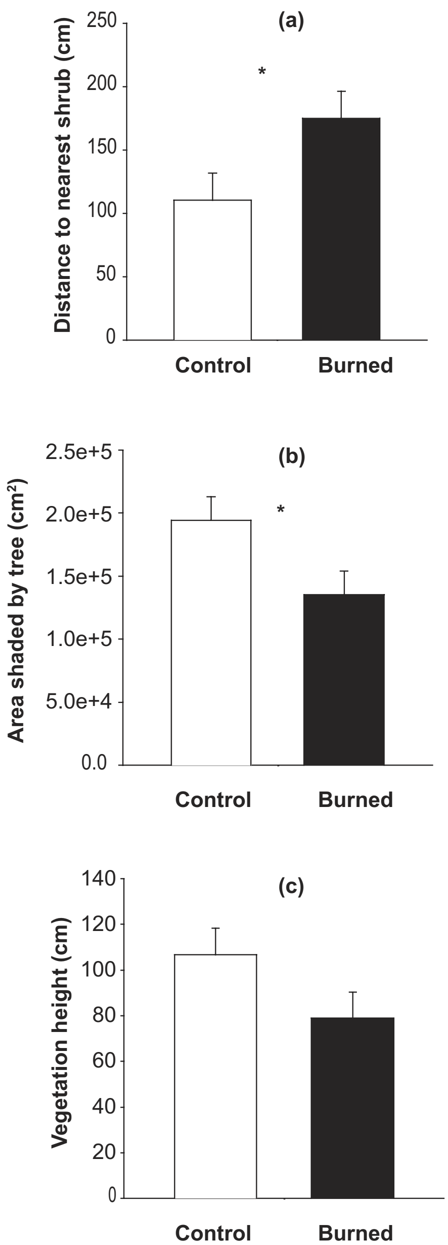

Figure 4—The effect of fire on vegetation parameters. (a) distance to nearest shrub, (b) area shaded by nearest tree, and (c) highest vegetation within 1 m of sample point.

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