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Effect of Fire on Ant Assemblages in Brazilian Cerrado in Areas containing Vereda Wetlands

CB Costa-Milanez[1], FF Ribeiro[1]; PTA Castro[1], JD Majer[2], SP Ribeiro[1]

1 - Universidade Federal de Ouro Preto, Ouro Preto, Minas Gerais, Brazil
2 - Curtin University, Perth, Australia

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Corresponding author
Cinthia Borges da Costa Milanez
Department of Geology
Universidade Federal de Ouro Preto
35.400-000, Ouro Preto-MG, Brazil
E-Mail: cborgesdacosta@gmail.com

Abstract

Cerrado is a biome whose evolution is intimately influenced by constant fire events. Although many species are capable of dealing with this predictable impact, many others may be negatively affected, resulting in community changes after fire. Using ants as bioindicators of changes in biodiversity and environmental conditions, this study evaluated the effects of fire in two Cerrado vegetation types: "cerrado" *sensu stricto*, a xeric savanna, and wetland "veredas", a mesic vegetation on floodable soils, where water concentrates and ultimately flows towards rivers. We examined the effects of fire on both habitats in two independent sites, but with special consideration to the wetlands, which are not fully adapted to fire. Ant sampling was conducted twice before and twice after a fire event, using 288 baits and 416 pitfall traps (soil and arboreal), and 16 hand collections along three random replicate transects per area. Ant species richness and abundance were resilient to fire, and exhibited a remarkably consistent seasonal variation at unburned and burned sites. On the other hand, the fire markedly changed the ant species composition. In the wetlands, the fire spread underground due to the high concentration of peat. The impact on ant assemblages was substantial and visually perceptible for some species like *Camponotus rufipes*, which suffered a considerable reduction in the number of individuals after fire in this habitat. In the cerrado, a similar result was observed for *Crematogaster* nr. *obscurata*, which disappeared after fire. The wetland vegetation having little adaptation to fire, plus low resilience in the ant community resulted in a severely changed fauna, both in guild predominance and species composition, and return to an original state is uncertain.

Introduction

The Brazilian Cerrado is a mosaic of vegetation types, with interspersed savanna formations, woodlands, grasslands, gallery forests and wetland vegetation, whose composition is mainly determined by edaphic conditions, although heavily influenced by fire (Eiten, 1972; Vasconcelos et al., 2009). Fire in Cerrado is an ancient phenomenon, evidenced by the presence of charcoal samples dated between 27,100 to 41,700 years b.p. (Vicentini, 1993). Fire is considered as one of the most influential factors defining the Cerrado's physiognomy (Sato, 2003). However, the influence of fire is not necessarily negative, and Van-Wilgen (2009) pointed that a good deal of vegetation heterogeneity in cerrado may be positively influenced by fire and other intermediate disturbance regimes.

The intensity and frequency of fire are determinants of its actual effect on the ecological community. The more frequent the fire, the less intense it is, because there is less accumulation of fuel on the ground. Nevertheless, a mild fire pattern consumes herbaceous substrate and seedlings, which tend not to reach adulthood in sites constantly burned. Fire drastically alters microclimate and habitat heterogeneity, leading to modifications in community dynamics, along with changes in species diversity and composition (Kapos, 1989). On the other hand, the total exclusion of fire in fire-prone ecosystems could reduce resilience, once the accumulation of fuel enables favorable conditions for very intense fires (Ramos-Neto & Pivello, 2000).

Despite the long-term adaptation of Cerrado communities to fire, such as through thick rhytidome, tubers, bulbs, corms and underground rhizomes, it could have a

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negative impact at an ecological time scale. For instance, there are records of 97% plant biomass destruction, local extinction of tree species that are only recruited by seeds, and severe release of greenhouse gases into the atmosphere (Cortês et al., 2011). Moreover, the impact of fire on seed dispersers has hardly been studied (Hoffmann, 1996; Camargos et al., 2013).

Changes caused by fire on ant communities may result in substantial indirect impacts on the vegetation at a mid-term scale (Carvalho et al., 2012; Beaumont et al., 2013). Research on ant community responses to the impact of natural or prescription fire suggests that ants are resilient and resistant to vegetation burning (Knoechelmann & Morais, 2008; Andersen et al., 2012; Frizzo et al., 2012; Alves-Silva & Del-Claro, 2013). However, to our knowledge no study has taken into consideration ant communities inhabiting ecosystems such as veredas that are sensitive and with low resilience to the fire.

The effect of fire can be more pronounced in ecosystems that are sensitive to change and which have little capacity for regeneration, such as wetland communities (Alves & Silva, 2011). This is the case of veredas situated inside the Cerrado domain, which are wetland ecosystems formed on sandy soils with high concentrations of peat, and which are responsible for recharging important aquiferous reservoirs of the Central Brazilian Plateau. Veredas are ecologically and socially important wetland systems (Oliveira & Ferreira, 2007; Ferreira, 2009), initially colonized by an endemic species of palm, the Buriti (*Mauritia flexuosa* L. f.). The extent of the impacts of fire on the Cerrado is well known (Coutinho, 1978; 1982; 1990; Hoffmann, 1996; Alves & Silva, 2011; Cortês et al., 2011), but the effect of fire on veredas and its entomofauna is poorly understood.

There is an urgent need to improve our knowledge of these impacts, as fire frequency escalates yearly due to climate change (i.e. longer dry seasons, smaller time interval between El Niño phenomena) and the expansion of agriculture and cattle farming. Although soil fauna in cerrado is mostly hypogeal (Coutinho, 1978; Castanheira de Morais & Benson, 1988), and thus well protected from mild fires, the direct effect of fire on the arboreal fauna, or the indirect effect on soil fauna due to litter destruction, has hardly been studied. Ants are a taxonomic assemblage that exhibits substantial responses to impacts such as fire (Philpott et al., 2010) and have also been extensively studied in the cerrado, but their responses to fire in terms of abundance and species composition are minimally understood (Frizzo et al., 2007; Frizzo et al., 2012).

We studied the effects of fire in the wetland vereda and Cerrado *sensu stricto* using ants as tools to evaluate changes in biodiversity and environment conditions. We predict that ant response will be stronger in the wetlands than in the cerrado, due to their lower resilience to loss of heterogeneity, along with lack of plant species adapted to fire events. We further predict that with the death of certain ant colonies previously present, generalist ant species, especially those nesting in soil, can quickly colonize the burned sites from nests outside the directly affected area. With the local extinction of rare and sensitive species, an increase in foraging activity by generalist species is expected, leading to an impoverishment of the fauna.

Material and Methods

Study Area

The area of Cerrado studied in this project is located in the northwest region of Minas Gerais State. The veredas are located in the municipalities of São Gonçalo do Abaeté (18°29'10.61"S and 045°40'03.01"W) and Andrequicé (a district of Três Marias - 18°27'08.69"S and 044°50'51.12"W. The climate in the region of the high–mid San Francisco river basin is characterized Aw, according to Köppen's climatic divisions, being tropical and seasonal, with an average temperature of 24°C, prevalent rainfall in summer, dry winters, and an average rainfall of 1000 mm to 1800 mm (Ribeiro, 2007).

The field work was carried out in two independent locations: a preserved vereda habitat (Curral das Éguas, Control Site) with an adjacent area of cerrado habitat (*sensu stricto*); and a vereda habitat recently disturbed by fire (São José, Burned Site) with a neighboring cerrado habitat (*sensu stricto*) area which was also burnt at the same time. Both vereda habitats are geomorphologically classified as hillside (Boaventura, 1978), and have vegetation predominantly composed of plants from the Alismataceae, Arecaceae, Asteraceae, Cyperaceae, and Melastomataceae. The fire occurred during the prolonged and intense dry season of 2011, under the influence of an El Niño year. Within each habitat unit we established three replicated transects (Fig. 1). Hereafter, the two habitat types are referred to as: We – wetland habitats, under the direct influence of yearly floods, and Ce – cerrado habitats surrounding the wetland.

Ant Sampling Design

Ant sampling was conducted in May 2010 and February 2011, before the fire, then in October 2011 and March 2012, after the fire (as the fire was accidental, we do not know the exact fire date or if it lasted for more than one day). Three replicated 20 m linear grids, with 10 m between replicates, were established in each habitat (wetland and cerrado; see Fig. 1). The distance of 10 m between transects was set in order to establish independent replicates, as in Ribeiro et al. (2013). We used three complementary sampling methods, namely baits (soil 192 and arboreal 96 making a total of 288), pitfall traps (soil 288 and arboreal 128 making a total of 416), and hand collections (a total of 16, one of each habitat for sampling). Pitfall traps was placed so as to alternate with baits, 5 m apart from each other along the linear grid (in each line grid three pitfall traps and two baits in soil). The ground pitfall traps were adapted from the method used by Holway (2005), but traps were left in the ground for 3 days. In order to minimize affects of water flow, which hinders the installation of the soil pitfalls traps during the rainy season, the traps were placed on non-flooded sediments when close to the wetland. Arboreal pitfall traps followed the methodology proposed by Majer (1983) and installed only in buritis (wetland). The baits followed the method used by Espírito Santo et al. (2012), the arboreal baits was installed only in cerrado. The hand collection was performed for 1 hour in each habitat, as in Costa et al. (2010). Sampled ants were sorted and identified to genus level, and then separated into morphospecies or species by consulting a specialist. The reference collection is stored at the Department of Biodiversity and Evolution, ICEB, Federal University of Ouro Preto (UFOP), Brazil.

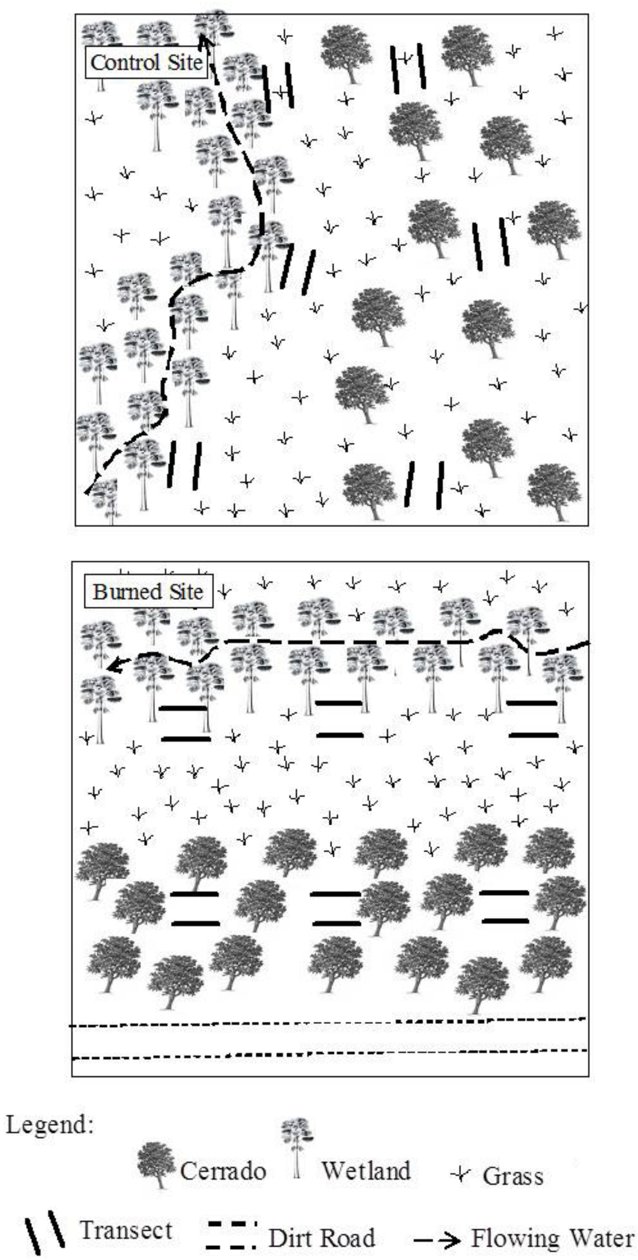

Fig 1. Layout of transects for ant sampling in the veredas, each comprising paired 20 m transects set of 10 m apart (without scale).

Data Analysis

Ant species richness and abundance were calculated from the combined transect pairs, using all the information from all sampling methods together. The ant species richness and abundance data were compared by a nested analysis of variance. We considered "vereda" (with levels control and burned), and "habitat" (with levels cerrado and wetland) as fixed factors, the effect "fire" (with levels before and after), and the transects considered as nested fixed and random blocks respectively.

Using ant species presence/absence data, non-metric multi-dimensional scaling (NMDS) was performed with a Jaccard similarity matrix to produce ordinations. Analyses of similarities (ANOSIM – one way) were performed to test for differences in ant composition for "habitat" (with levels cerrado and wetland), "vereda " (with levels control and burned), and "fire" (with levels before and after). Similarity percentages (SIMPER) identified the contribution of ant species to the dissimilarity between selected factors. The above analyses were performed using Past version 2.04 (Hammer et al., 2001).

In order to further investigate the change in species composition, we performed Cochran's Q Test, which takes the number of common and unique species among treatments, comparing the factors "habitat" (with levels cerrado and wetland), "vereda" (with levels control and burned), and "fire" (with levels before and after). Hence, this analysis verifies the influence of rare (singletons and exclusive) species distribution among the sites, while ANOSIM focuses on general patterns caused by dominant species.

Results

A total of 20,519 ants were collected from all methods, belonging to seven subfamilies, 33 genera and 141 species (Table S1). The ant assemblages sampled were predominantly composed of species from the subfamilies Myrmicinae and Formicinae, with 72 (50%) and 30 (21%) species, respectively. Before fire, 10,609 ants were collected, distributed in 113 species (79%). After fire, 9,910 ants were collected, distributed in 110 species. Overall ant species richness did not differ significantly when comparing unburned and burned veredas (ANOVA, $F_{(1,20)} = 0.204$; $P = 0.655$; Fig 2 A; Table 1), and neither did abundance, which followed a similar pattern to richness (ANOVA, $F_{(1,20)} = 1.098$; $P = 0.307$; Fig 2 B; Table 1). However, ant species richness tended to increase after the period when fire occurred, but the pattern was observed both in the unburned and burned sites, suggesting a response to season (ANOVA richness x season, $F_{(1,20)} = 8.269$; $P=0.009$; Table 1).

Before the fire, the most abundant species in the cerrado was *Crematogaster* nr. *obscurata*, and in the wetland habitat it was *Pheidole gertrudae*. After fire, in both unburned and burned cerrado habitats, *Crematogaster torosa* and *Cr. acuta* were the most abundant species, while in the unburned and burned wetland habitat *Atta sexdens* and *Solenopsis invicta* were the most abundant species, respectively.

Table 1. Analysis of variance for richness and abundance of ants in control and burned veredas.

Source	Sum of Squares	df	F – Statistics	P - Value
Richness*Fire	0.0061	1	0.20491	0.65565
Abundance*Fire	0.2487	1	8.26964	0.00934
Season*Fire	0.1490	1	1.09807	0.30718
Error		20		

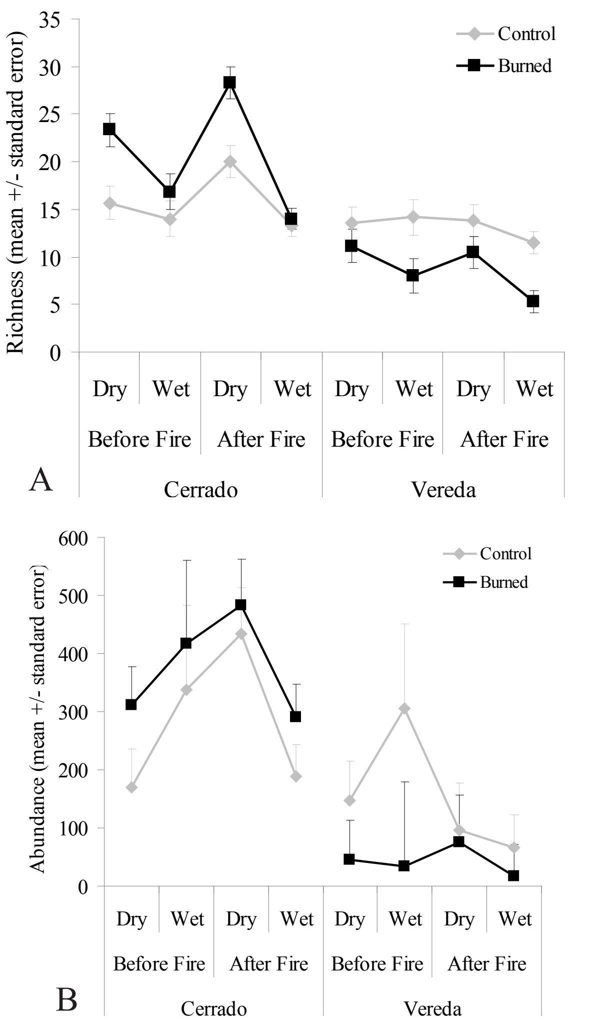

Fig 2. Richness (A) and abundance. (B) of ants in wetland and cerrado habitats for each vereda sampled before and after the fire. Bars are standard deviations.

Ant species richness in the vereda wetlands before the fire reached 56 species, while after the fire the number of species decreased to 38, with only 26 species represented in both dates. After the fire, a drastic reduction in abundance of *Camponotus rufipes* was observed and colonization by species such as *S. invicta* occurred in the wetland habitat. By contrast, the cerrado had 68 species before the fire, but after the fire this increased to 71 species, with 44 species being common to samples taken before and after the fire. Some opportunist species, such as *Cr. acuta*, *Cr. torosa* and *Forelius maranhaoensis* appeared after the fire.

Therefore, the fire affected the ant species composition in the cerrado and in the wetland (Figure 3 A and B, Tables 2 and 3). For both habitats, there were significant differences in species composition between unburned and burned sites, whenever comparing before or after the time when fire occurred (ANOSIM, Cerrado: R = 0.64; P = 0.0001; Wetlands: ANOSIM, R = 0.34; P = 0.0001). Hence, those sites were distinct in fauna regardless of fire, and continued to be so after it. On the other hand, the species composition between unburned sites before and after the time when the fire occurred did not differ significantly, while it was significantly different before and after fire for the burned sites of both cerrado and wetlands (NMDS cerrado: Stresss 0.23, Fig. 3 A; NMDS wetland: Stress 0.34, Fig. 3 B).

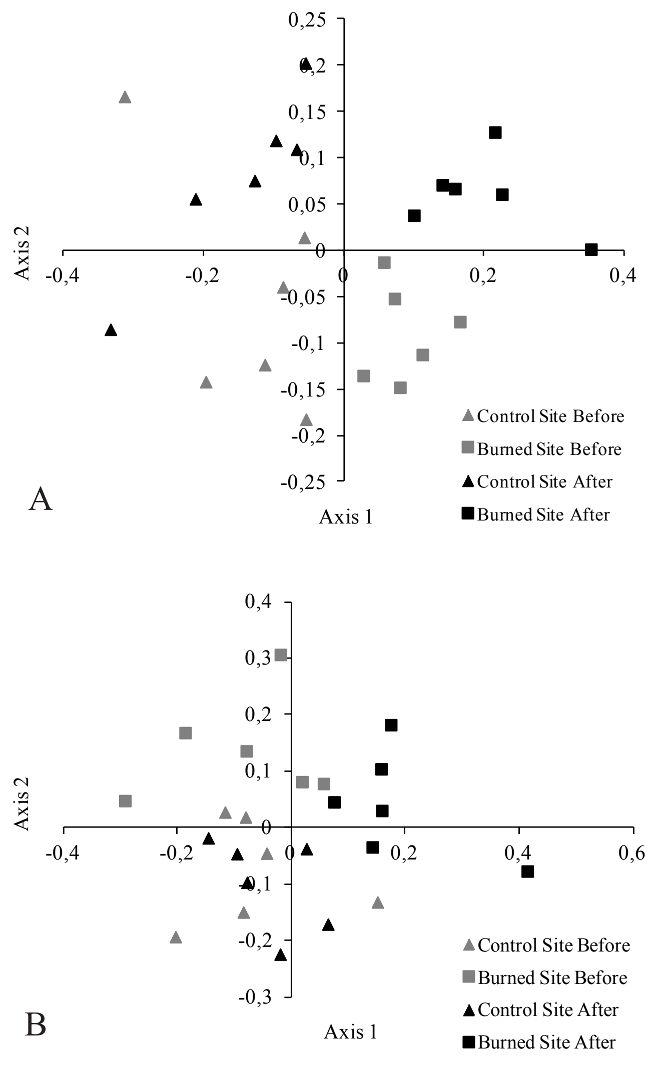

Fig 3. Distribution of (A) cerrado habitat and (B) wetland habitats on the NMDS ordination, based on Jaccard similarity, derived using ant presence/absence data.

The most influential species in discriminating cerrado habitats before fire were *Wasmannia auropunctata* (1.82%), *Pheidole* sp.27 (1.56%), and *A. sexdens* (1.32%). After the fire, the major discriminating species were *Pheidole* sp.34 (1.94%), *Pheidole* sp.27 (1.65%), and *Ectatomma edentattum* (1.65%).

Table 2. Comparison of the variation of similarities (ANOSIM) of ant species composition among the cerrado sites before and after fire.

R- values / P – values	Unburned Site Before	Burned Site Before	Unburned Site After	Burned Site After
Unburned Site Before	0/0			
Burned Site Before	0.478/0.0014	0/0		
Unburned Site After	0.276/0.0094	0.862/0.0023	0/0	
Burned Site After	0.860/0.0021	0.738/0.0024	0.827/0.0026	0/0

The species which contributed strongly to this separation in the wetland habitat in burned sites before fire were *Pheidole* sp.4 (2.15%), *Camponotus melanoticus* (1.81%) and *P. gertrudae* (1.61%), and after the fire they were *Dorymyrmex jheringi* (2.01%), *Pheidole* sp.24 (2.00%) and *Pseudomyrmex termitarius* (1.95%). Finally, when taking into consideration the relative importance of singletons and exclusive species in a comparison between the sites, only the ant species composition of wetlands was significantly affected by the fire (Cochran Q Test: Q = 7.714; P = 0.005).

Table 3. Comparison of the variation of similarities (ANOSIM) of ant species composition among the wetland site before and after fire.

R - values / P – values	Control Site Before	Burned Site Before	Control Site After	Burned Site After
Unburned Site Before	0/0			
Burned Site Before	0.221/0.0346	0/0		
Unburned Site After	0.185/0.0618	0.450/0.0024	0/0	
Burned Site After	0.652/0.002	0.225/0.0258	0.570/0.0023	0/0

Discussion

Fire promotes changes in biomass, species diversity and energy flux (Peterson et al., 1998). In Australia, York (1994) showed that one week after a fire, generalist and opportunistic ant species moved into the disturbed areas, thereby increasing the number of species and individuals. On the other hand, fire reduces the abundance of other arthropod groups, such as collembolans, mites, and beetles, which are killed or forced to disperse to unburned sites (Gillon, 1983). A similar effect could be detected up to five months after the fire in our study. Species composition changed dramatically, with an increasing number of generalist species offsetting the loss of community components.

Despite the invasion of generalist species and disappearance of sensitive ones in all burned sites, the cerrado vegetation manintained a higher proportion of its original fauna compared with the wetlands (65% in the cerrado against 46% for wetlands). As a consequence, the overall summing up of species in cerrado was positive, with an addition of five percent against an overall loss of 38% of species diversity in the wetlands.

The soil of cerrado is comprised of quartz sands with a high concentration of iron and aluminum (Gomes, 2006), which are features that prevent the fire from spreading underground, and this may be related to the well known resilience of cerrado communities to fire. The vegetation has several adaptations to fire, such as the possession of thick rhytidome, and xylopodium, tubers, bulbs, corms and underground rhizomes, which assist plants to survive the fire (Bond & Keeley, 2005; Silva & Batalha, 2010). The species of ants with colonies no deeper than 5 cm in the soil have lower chances of surviving fire, due to exposure to flames and associated high temperatures (Castanheira de Morais & Benson, 1988), which may range from 85°C to 840°C in the air, and 29°C to 55°C in the ground at 1 cm depth. Nevertheless, ants with deeper nests are more likely to survive, as natural fires do not cause large elevations in the underground temperatures (Coutinho, 1978). This is the case with the attines (*Atta* and *Acromyrmex*), which build deep nests and, due to their architecture, are able to stabilize fluctuations in temperature and humidity (Farji-Brener, 2000; Carvalho et al., 2012).

A few other noteworthy cases may contribute to clarifying overall fire effects. For instance, in the present case *Ca. rufipes* suffered a considerable reduction in the number of individuals, especially in the wetland habitat. This species nests on the ground, forming shallow and tall mounds of litter and fine debris (similar to the temperate *Formica rufa* L.) that are highly inflammable. However, the colony may survive due to arboreal satellite nests, as described by Espírito Santo et al. (2012). Such strategies may reflect the general adaptation of typical savanna species to survive common fire events. However, after fire a further decline in the colonies may be observed, in part due to the reduction of food resources used for this ant, or because the fire actually burns most of the colonies or the cavity-nesting ant sites (Fagundes et al., 2015).

Similar fire effects may have been related to the observed decline of the genus *Crematogaster*. *Crematogaster* nr. *obscurata* almost disappeared from the cerrado vegetation, which was then colonized by *Cr. acuta* and *Cr. torosa*. The genus *Crematogaster* is a cosmopolitan lineage of Myrmicinae, and the majority of species nests on trees (Hölldobler & Wilson, 1990), which reduces insect herbivore attacks (Del-Claro & Marquis, 2015). However, *Cr. torosa* and *Cr. acuta* occur primarily in open and dry areas, which are often highly disturbed, and nest in dead wood (AntWeb, 2012), a behavior that clearly may favor their colonization after fire. In contrast, *Ca. melanoticus*, another species typical of the Brazilian savanna, did not change in abundance after the fire. Therefore, the fire can interfere with the survival rate of certain species, destroying their basic niche requirements, but can confer advantage to other species better adapted to live in more xeric conditions (Frizzo et al., 2011).

The fire has a strong potential to damage wetlands, where the plant species tend to have no mechanisms for fire protection (Maillard et al., 2009). Furthermore, the wetland's soils are rich in peat, which can lead to underground fires, with high temperatures causing severe damage to plant roots, which can further increase the rate of local extinction of many species (Cortês et al., 2011). In our work, the impact of fire was more substantial in the wetland habitat, resulting in a more intense post-fire colonization by generalist ant species such as *P. gertrudae*, *D. jheringi* and *S. invicta*. These genera live in various habitats, ranging from the humid tropics to deserts (Naves, 1985; Helms & Vison, 2002), frequent the litter and soil, have populous colonies, and are aggressive, competitive and omnivorous. The combination of these characteristics makes them effective at colonizing many habitats and excluding competitors (McGlynn, 1999; Ramos et al., 2003).

Nonetheless, a dramatically negative fire effect was detected on the genus *Ectatomma*. After fire in the wetlands, seven species of this genus disappeared, with *E. brunneum* Smith being the only species of *Ectatomma* to be sampled again in a burned wetland site. This species lives in secondary forest, is a generalist predator of terrestrial arthropods, and has preference for termites and other species of ants (Tofolo & Giannotti, 2005). In contrast, in the more resilient cerrado habitat four species of this genus survived the fire. It is worth noting that *E. edentatum* was hardly affected by the fire. The fact that *E. edentatum* is an aggressive, generalist predator or scavenger, foraging in vegetation or on the ground (Silvestre et al., 2003), may have contributed to the maintenance of its abundance after the fire event.

Our results suggest that the wetlands are less resilient than the surrounding cerrado to the impact of fire. The lack of plants adapted to fire in this vegetation, along with the soil traits that favor intense fire on and beneath the ground, may have reduced soil meso - and macro-fauna. Fire promotes the formation of a surface crust, which reduces the porosity and water infiltration into the soil, leading to drying out of the wetland veredas, with immediate consequences to the soil fauna (Spera et al., 2000). Although some species benefit from the fire, some unique, sensitive, species may disappear without substitutes for their vacant niches. Further, ecological functions may be seriously affected by increasing populations of dominant, generalist species (Andersen et al., 2012).

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Appendix. Ant species sampled in theUnburned and Burned Sites (before and after the fire) in wetland (We) and cerrado (Ce) habitats.

Species	Areas							
	Unburned Site				Burned Site			
	Before		After		Before		After	
	We	Ce	We	Ce	We	Ce	We	Ce
Dolichoderinae								
Azteca sp.1		6	4		1			4
Dolichoderus bispinosus Olivier	1		12					
Dolichoderus germaini Emery					6			
Dolichoderus lutosus Smith			13					
Dorymyrmex jheringi Forel	424	31	18	730	2	60		45
Dorymyrmex sp.1		5				20		
Dorymyrmex sp.2	6		2	45	1	12		192
Forelius brasiliensis Forel			2					
Forelius maranhaoensis Cuezzo			1	1				239
Gracilidris pombero Wild & Cuezzo	2					2		
Linepihema anathema Wild					3		10	
Linepithema humile Mayr	79	16	5	6	17	9	10	6
Linepithema micans Forel	17	26	28	14	5	1	1	6
Ecitoninae								
Labidus praedator Smith	1				5			
Neivamyrmex pseudops Forel					1	6		
Neivamyrmex sp.2							3	
Ectatomminae								
Ectatomma brunneum Smith	46	102	24	26	10	25	16	
Ectatomma edentatum Roger	2	2			6	52		52
Ectatomma lugens Emery	2	2		1	1	4		
Ectatomma opaciventre Roger		5		1		11		19
Ectatomma permagnum Forel	3	5	1		1	4		1
Ectatomma planidens Borgmeier		37	1	1	1	54		27
Ectatomma nr. *suzanae* Almeida						3		2
Gnamptogenys acuminata Emery			1					1
Gnamptogenys striatula Mayr				1	1			
Formicinae								
Brachymyrmex sp.1	10	35		33	17	28		10
Brachymyrmex sp.2	2	55			1	2	2	2
Brachymyrmex sp.3	7							
Camponotus arboreus Smith	38	12	11	1	20		20	4
Camponotus atriceps Smith	4	10	39	20	7	22	28	35
Camponotus blandus Smith	103	157	73	479	4	19		62
Camponotus bonariensis Mayr						1		
Camponotus cameranoi Forel					1			
Camponotus cingulatus Maur	1	11	1	5		10	2	7
Camponotus crassus Mayr	42	179	91	77	42	521	34	172
Camponotus leydigi Forel	2	4	3	16	1	6	3	7
Camponotus melanoticus Emery	8	15	11	128	1	20	4	25
Camponotus rufipes Fabricius	25	6	3	2	183	10	13	8
Camponotus sericeiventris Guérin-Méneville	7				2		4	

Appendix. Ant species sampled in the Sites Unburned and Burned (before and after the fire) in wetland (We) and cerrado (Ce) habitats (Cont.).

Species	Areas							
	Unburned Site				Burned Site			
	Before		After		Before		After	
	We	Ce	We	Ce	We	Ce	We	Ce
Formicinae (Continuation)								
Camponotus sexgutattus Fabricius							2	
Camponotus trapezoideus Mayr			4		1		1	
Camponotus (Myrmobrachys gr.) sp.1	51	186	51	306	4	19		61
Camponotus (*Myrmothrix* gr.) sp.2	7	33	13	32	1	37	2	15
Camponotus (Myrmothrix gr.) sp.3		2						
Camponotus (*Tanaemyrmex* gr). sp.1		1				2		
Camponotus sp.13					2	3		
Camponotus sp.15			9	36				4
Camponotus sp.16						1		
Camponotus sp.19			1					
Camponotus sp.20	4	4	1		1	20		
Camponotus sp.22					1			
Camponotus sp.23	5							
Camponotus sp.24	1							
Nylanderia nr. *fulva* Mayr	10		2	3				
Myrmicinae								
Acromyrmex balzani Emery		11			3	38	1	79
Acromyrmex crassispinus Forel	3	1				5		3
Apterostigma sp.1						1		1
Atta laevigata Smith								1
Atta sexdens Linneaus	104	56	177	16	1	94	12	124
Cephalotes atratus Lineaus		117		1				
Cephalotes borgmeieri Kempf				13				
Cephalotes cristopherseni Andrade & Baroni Urbani							5	
Cephalotes eduarduli Forel	1	22		15				
Cephalotes maculatus Smith F.		3			1	17		6
Cephalotes pusillus Klug	25	44	2	17	2	53	1	43
Crematogaster acuta Fabricius	14			398	18			1412
Crematogaster limata Smith F.	3				1			
Crematogaster torosa Mayr	10	316		797		211		1022
Crematogaster nr. *obscurata* Emery		1255		15		1680	1	65
Crematogaster sp.2							2	
Crematogaster sp.3								17
Cyphomyrmex rimosus Spinola			4	4	3	1	1	
Cyphomyrmex peltatus Kempf				1			1	21
Cyphomyrmex sp.4				1				
Mycocepurus goeldii Forel	2	4		21		7		29
Myrmicocrypta sp.1		1				8		
Nesomyrmex spininodis Mayr								1
Pheidole gertrudae Forel	666		23	39				4
Pheidole (Flavens gr.) sp.1	1	20		2	13	15	1	5
Pheidole (flavens gr.) sp.3	1	6						

Appendix. Ant species sampled in the Sites Unburned and Burned (before and after the fire) in wetland (We) and cerrado (Ce) habitats (Cont.).

Species	Areas							
	Unburned Site				Burned Site			
	Before		After		Before		After	
	We	Ce	We	Ce	We	Ce	We	Ce
Myrmicinae (Continuation)								
Pheidole sp.1				7				5
Pheidole sp.6		1	3	2		17		4
Pheidole sp.7	2		3					2
Pheidole sp.19	4	33	1	24	6	31	5	39
Pheidole sp.21		1		16				
Pheidole sp.22	4	11		24		7		
Pheidole sp.23		5			1	23	50	10
Pheidole sp.24	69	75	22	41	16	44	17	79
Pheidole sp.25	9							
Pheidole sp.26	15	10	16	158		37		19
Pheidole sp.27		3				33		239
Pheidole sp.28					18	8		
Pheidole sp.29						5		
Pheidole sp.31						2		
Pheidole sp.32		2		12			18	
Pheidole sp.33						3		
Pheidole sp.34	1					15		8
Pheidole sp.35			1	19		1	10	3
Pheidole sp.36				6				
Pheidole sp.37						175		
Pheidole sp.38								3
Pheidole sp.39				5			1	63
Pheidole sp.40						1		11
Pheidole sp.41	28		4					
Pheidole sp.42			1					
Pheidole sp.43		1		7		30		34
Pheidole sp.44								17
Pheidole sp.45	15	62	23	15		9		
Pheidole sp.46		4						
Pheidole sp.47	1							
Pheidole sp.48	1	2	9	29				1
Pogonomyrmex naegelii Emery			1	5	3	1		35
Rogeria sp.1	1	1		2				4
Sericomyrmex parvulus Forel	1							
Solenopsis invicta Buren	317	13	9			582	152	165
Solenopsis (Geminata gr.) sp.1	3	3						
Solenopsis sp.1		2	1	5	1	2	111	25
Solenopsis sp.8								6
Trachymyrmex compactus Mayhé-Nunes e Brandão			1	1				
Trachymyrmex dichrous Kempf						1		7
Trachymyrmex fuscus Emery		2	4	17				1

Appendix. Ant species sampled in the Sites Unburned and Burned (before and after the fire) in wetland (We) and cerrado (Ce) habitats (Cont.).

Species	Areas							
	Unburned Site				Burned Site			
	Before		After		Before		After	
	We	Ce	We	Ce	We	Ce	We	Ce
Myrmicinae (Continuation)								
Trachymyrmex (*Opulentus* gr.) sp.1								12
Trachymyrmex sp.1			1			3		
Trachymyrmex sp.3				2				2
Wasmannia auropunctata Roger	471		183	7	16	50	1	7
Wasmannia rochai Forel						2		
Ponerinae								
Anochetus (Inermis gr.) sp1				1				
Odontomachus haematodus Emery	1							
Odontomachus meinerti Forel	1				3			1
Pachycondyla ferruginea Smith	1						1	
Pachycondyla obscuricornis Emery	20		15	4	12		10	
Pachycondyla stigma Fabricius				1				
Pachycondyla villosa Fabricius	1		4		2			
Pseudomyrmecinae								
Pseudomyrmex acanthobius Emery	1			1	1			
Pseudomyrmex gracillis Fabricius			1	1				
Pseudomyrmex termitarius Smith	5	7	18	27	2			1
Pseudomyrmex nr. *urbanus* Smith	3	1		2	2			
Pseudomyrmex oculatus gr. sp.1				5				1
Pseudomyrmex sp.2		1			5			
Pseudomyrmex sp.3			1	1	4		1	
Pseudomyrmex sp.8								1