

## Research Article

# Comparison of the Ant Assemblages in Three Phytophysionomies: Rocky Field, Secondary Forest, and Riparian Forest—A Case Study in the State Park of Ibitipoca, Brazil

Juliane Floriano Santos Lopes,<sup>1</sup> Noelle Martins dos Reis Hallack,<sup>1</sup>  
Tatiane Archanjo de Sales,<sup>2</sup> Mariana Silva Brugger,<sup>3</sup> Laila Fieto Ribeiro,<sup>1</sup>  
Isabel Neto Hastenreiter,<sup>2</sup> and Roberto da Silva Camargo<sup>1</sup>

<sup>1</sup> Pós-Graduação em Comportamento e Biologia Animal, Instituto de Ciências Biológicas, Universidade Federal de Juiz de Fora, Campus Universitário de Martelos, 36.036-330 Juiz de Fora, MG, Brazil

<sup>2</sup> Pós-Graduação em Ecologia, Instituto de Ciências Biológicas, Universidade Federal de Juiz de Fora, Campus Universitário de Martelos, 36.036-330 Juiz de Fora, MG, Brazil

<sup>3</sup> Departamento de Produção Vegetal, UNESP, Faculdade de Ciências Agrônomicas, Caixa Postal 237, 18.603-979 Botucatu, SP, Brazil

Correspondence should be addressed to Juliane Floriano Santos Lopes, julianeflopes@yahoo.com.br

Received 13 September 2012; Revised 23 October 2012; Accepted 25 October 2012

Academic Editor: Kleber Del-Claro

Copyright © 2012 Juliane Floriano Santos Lopes et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Ant assemblages are almost all related with the vegetation composition and so can provide us important information for conservation strategies, which are especially relevant to an environmentally protected area. We sampled the ant fauna in three different phytophysionomies in order to verify if the composition of ant species is different among the areas, especially because one of the areas is a Rocky Field and there is little information about the ant fauna in this habitat. A total of 8730 individuals were registered and an NMDS analysis showed that the ant assemblies are different at the three phytophysionomies (Rocky Field, Riparian Forest, and Secondary Forest). This study shows that the species that compose the ant assemblies in different phytophysionomies are a reflex of the environment, supporting the hypothesis that the vegetational composition results in different compositions in the ant assembly. Vegetal composition is determinant in the formation of the litter and consequently in the occurrence of ant species that depend on this layer of organic matter for nesting and foraging.

## 1. Introduction

Ants exert important effects in most ecosystems due to their abundance, population stability, and foraging activity [1, 2]. Some of their main activities are the nutrient cycling and control of other invertebrate populations [3]. They also participate actively in the composition of vegetation through seeds dissipation [4, 5], which gives them great importance in recovering degraded areas [6].

Besides their ecological importance, the Neotropical ants fauna are still little studied, especially if we consider the region of “Mata Atlântica” (Atlantic Forest) which occupies

only 7% of its original area, according to the Ministry of Environment data [7]. Studies made in this biome indicate a high diversity of endemic species, which may comprise 50% of total species and 95% in certain groups [8, 9].

Actually in recent years, myrmecologists attention has been concerned essentially with ant communities, ant-plant relations, mutualisms, biomonitoring, biogeography, morphology and anatomy, genetics and cytogenetics, and taxonomy [10]. Ant species inventories made in Brazil are used to evaluate the conservation state of the environments, especially in fragmented areas, as the Atlantic Forest [11]. Also, according to Delabie et al. [10] perusal of recent papers

indicates there are still new ant species to be described in Neotropical.

Inserted in the Atlantic Forest Biome, the State Park of Ibitipoca (PEIb) is classified in the category of “Extreme Biological Importance” because of endemism of some species, the relevance, the speleological singularity, and the diversity of habitats [12]. This park occupies an isolated hilly area from other areas of Rocky Field, presenting a distinctive flora of “Cadeia do Espinhaço” itself, being considered a disjunction concerning this Range [13].

PEIb presents significant diversity not only of vegetation, but also of fauna, landforms, soils, and microclimates [14] and covers two areas of regional vegetation, originally composed by semideciduous seasonal forests and “cerrados” [15]. It may be distinguished by five basic types of phytophysionomies—altitude “cerrado”, Rocky Fields, Riparian Forest, capon of forest, and an area of dense ombrophilous secondary forest.

The Rocky Fields are distinguished mainly by the grassland vegetation consisting of grass, herbs, and shrubs on outcrops of quartzitic rocks associated to shallow soils and high solar incidence [16]. The PEIb floristic studies indicate predominance of “candeia” specimens (*Vanillosmopsis erythropappa*).

The Semideciduous Secondary Forest covers an area of 90 hectares at the south of the PEIb and it is totally surrounded by woodlands, being named “Mata Grande.” Due to the presence of anticlinal crests, this environment is greatly influenced by clouds, winds, and lightning [17]. There is marked abundance of epiphytic plants and lichens, with predominance of high trees (up to 25 m) [18].

The Riparian Forest in its extension mostly consists of shrubs patches that accompany the distribution of thicker soils, in slope conditions or concave lands. This subtype of vegetation is humid, with reduced wind action and remarkable presence of bromeliads and mosses and, in the edges or less shaded areas, many kinds of lichens [19].

Considering that the vegetation is a good predictor of the structure of community of ants [20–23], one could suppose that in different phytophysionomies the composition of ant species is equally distinct. In this context, a comparison of ant assemblies in three distinct phytophysionomies was accomplished—Rocky Field, Semideciduous Secondary Forest, and Riparian Forest—in the PEIb. The knowledge of how the ant species composition varies according to different characteristics of habitat provides important information for conservation strategies, which are especially relevant to an environmentally protected area.

## 2. Material and Methods

**2.1. Area of Study.** This study was conducted in the State Park of Ibitipoca—PEIb (21°40′44″ S and 43°52′55″ W) in the city of Lima Duarte, Minas Gerais, Brazil (Figure 1). The PEIb has approximately 1.488 ha with a mesothermic humid climate (Köppen classification), with dry winters, pleasant summers, and average annual temperature around 18.9°C. The influence of the relief over the climate is very important,

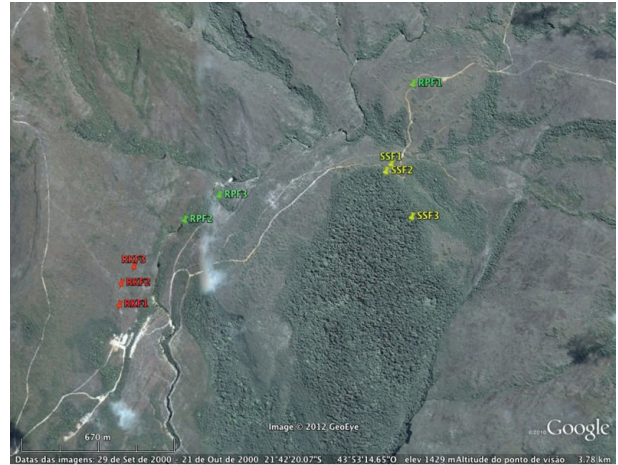


FIGURE 1: Parque Estadual do Ibitipoca (PEIb) in Minas Gerais State, Brazil. Red pins: Rocky Fields (RKF); Green pins: Riparian Forest (RPF); Yellow pins: Semideciduous Secondary Forest (SSF). Font: Google Earth, 2010.

because the altitude and topography are differentiated and the anticlinal crests in the PEIb stand out locally concerning the neighboring areas, leading to a differentiated climate in the area [17]. In the PEIb three phytophysionomies were sampled: Rocky Fields (RKF), Semideciduous Secondary Forest (SSF), and Riparian Forest (RPF).

**2.2. Ants Sampling.** In each of the three phytophysionomies, three quadrants of 800 m<sup>2</sup> each were established. The minimum distance between the quadrants within the same phytophysionomy was 50 m. The sampling of ants was accomplished monthly between July and December 2008.

In each quadrant three parallel transects were established, spaced from each other by 10 m. Along each transect the sampling points were determined apart from each other also by 10 m, in a total of 15 samples/quadrant. In each transect a different method was employed, as follows: honey and sardine attractive baits, pit-fall traps, and extraction in Berlese funnel of litter samples.

The baits contained 5 g of a mixed paste of honey and sardine (1 : 1 vol), distributed over paper tissues. The baits remained in the field for 60 min [24], after been collected for screening. Pitfall traps consisted of 500 mL plastic cups filled with 200 mL of water and liquid neutral detergent (10%). Pitfall traps remained in field for 24 h. Litter samples were standardized with a plastic grid of 0.25 m<sup>2</sup> on soil. The litter was put in Berlese funnel for 48 h for screening material.

In the quadrants of Rocky Fields, the pitfall traps and the litter samples were replaced by the attractive bait, considering the impossibility of using these methods, because litter is absent in the Rocky Fields and the installation of pitfalls under the rock is infeasible.

Collected ants were sorted, counted, and stored in alcohol 90%, recording phytophysionomy, method, and date of collect. After, a taxonomic identification was made under stereoscopic microscope (Leica), from dichotomous keys

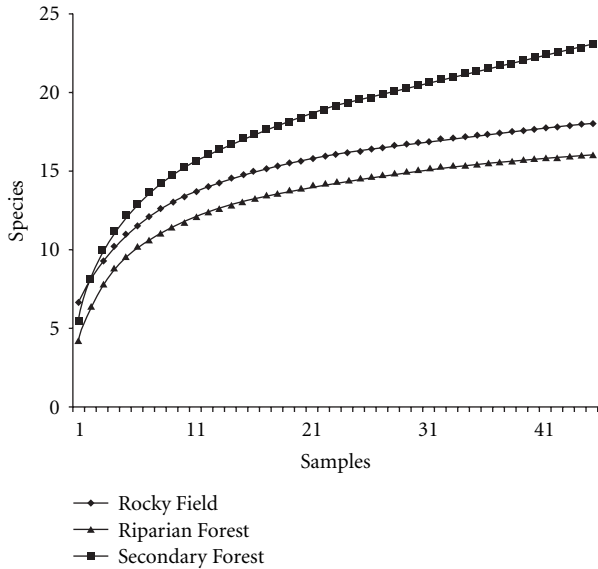


FIGURE 2: Sample-based rarefaction curves for the ant species at three phytophysionomies at Parque Estadual do Ibitipoca—Brazil. July–December, 2008.

[25, 26]. Ants were coded at genera level and separated in morph-species. Dr. Rodrigo Feitosa from the Museum of Zoology of São Paulo confirmed the species identification. The specimens were mounted and deposited in the thematic collection of MirmecoLab, ICB-UFJF (Campus Universitário, Cidade Universitária-s/n, Juiz de Fora-MG, CEP: 36036900).

**2.3. Data Analysis.** To evaluate the sampling effort, we constructed a rarefaction curve [27], using the program EstimateS [28]. Sample-based rarefaction curves indicate that sampling effort was significant for three phytophysionomies (Figure 2).

The content of five samples per method of collect was grouped to obtain a single sample for each transect in each quadrant. To compare the ant species composition from different phytophysionomies, we used multivariate analysis with the program PAST [29]. Data were organized in a binary matrix, considering the taxonomic level of genera (presence and absence) and submitted to nonmetric multidimensional ordination (NMDS). The dissimilarity between the phytophysionomies was calculated through the Bray-Curtis index, which is less affected by the occurrence of rare species in the samples [30]. The stress index calculated by NMDS is a measure of goodness-of-fit [31].

Also a one-way analysis of similarity was applied (one-way ANOSIM), with 10 thousand permutations. This analysis compares the differences between the averages of the ranked similarities among the samples within and between the phytophysionomies, verifying if there are significant differences in the composition of genera. ANOSIM generates a statistic  $R$ , which is a measure of dissimilarity between the areas.  $R$  values near zero indicate high similarity while  $R$  values near 1 indicate low similarity [32]. To calculate

ANOSIM, the Bray-Curtis index was also used and each  $R$  value has its corresponding probability.

A similarity percentage test (SIMPER) was applied, which permits to determine which genera more contributed to discriminate among assemblies. SIMPER analysis provides a percentage of dissimilarity among the phytophysionomies, presenting a percentage of contribution of each genera for such dissimilarity [31].

### 3. Results

A total of 8.730 individuals were collected, belonging to 46 species, 20 genera, and eight subfamilies: Ecitoninae, Ectatomminae, Heteroponerinae, Ponerinae, Formicinae, Dolichoderinae, Pseudomyrmecinae, and Myrmicinae, providing a list of ant species that occur in the PEIb (Table 1).

The greatest number of species was recorded for Riparian Forest, followed by Rocky Field and Secondary Forest, listing as exclusive species of Riparian Forest: *Pheidole* sp6, *Strumigenys louisianae*, *Brachymyrmex* sp2, *Paratrechina* sp1, and *Labidus* sp1. As unique species of Rocky Field are listed up: *Cephalotes pusillus*, *Brachymyrmex* sp3, *Camponotus genatus*, *Myrmelachista* sp2, *Myrmelachista* sp3, and *Pseudomyrmex* sp1; and in the Secondary Forest: *Brachymyrmex* sp1, *Myrmelachista* sp1, and *Hypoponera foreli* (Table 1).

Among the 19 ant species shared within the three studied areas, the most representative genera were *Pheidole* (7 species), *Camponotus* (4 species), and *Hypoponera* (3 species). We highlight the *Camponotus* absence in the Secondary Forest and the exclusive occurrence of each one of the three *Brachymyrmex* species in each phytophysionomy (Table 1).

Ant species composition in the three phytophysionomies differed significantly. (ANOSIM,  $R = 0.48$ ,  $P = 0.0001$ ), being more similar to the samples belonging to the same phytophysionomies (Figure 3, Table 2). The ordination NMDS indicates a stress value of 0.16, with the coordinates 1 and 2 explaining 48% and 26% of data variation, respectively. Actually, the greatest values of dissimilarity were verified between the Secondary Forest and the Rocky Fields (Table 3), being their samples, respectively, separated by coordinate 1.

According to the SIMPER test, the genera that most contributed for the dissimilarity among the phytophysionomies were *Crematogaster* and *Myrmelachista* which are responsible for 66.58% of the variation of species composition among the phytophysionomies (Table 4).

### 4. Discussion

The phytophysionomies showed differences in the composition of ant species, especially between SSF and RKF (Figure 3), evidencing the relationship between the vegetation and the ant fauna.

The SSF presents larger diversity of vegetal species, with genera of the families Rubiaceae, Lauraceae, Myrtaceae, Euphorbiaceae, Nyctaginaceae, Melastomataceae, Annonaceae, Palmae, Apocynaceae, and Monimiaceae [19]. This

TABLE 1: Relative frequency of occurrence of ant species in the three phytophysionomies in the Parque Estadual do Ibitipoca, Brazil. July–December, 2008.

Species	Rocky Field	Riparian Forest	Secondary Forest
<b>Myrmicinae</b>			
<i>Acromyrmex aspersus</i> F. Smith, 1858	0.00	92.29	7.71
<i>Acromyrmex hispidus</i> Santschi, 1925	20.08	78.74	1.18
<i>Apterostigma</i> (gr. <i>pilosum</i> ) sp1 Mayr	20.00	40.00	40.00
<i>Apterostigma</i> sp2 Mayr	94.12	0.00	5.88
<i>Cephalotes pavonii</i> Latreille, 1809	93.52	6.48	0.00
<i>Cephalotes pusillus</i> Klung, 1824	100.00	0.00	0.00
<i>Crematogaster sericea</i> Forel, 1912	98.46	1.50	0.05
<i>Octostruma balzani</i> Emery, 1894	0.00	37.50	62.50
<i>Octostruma rugifera</i> Mayr, 1887	0.00	50.00	50.00
<i>Pheidole obscurithorax</i> Forel, 1985	77.78	15.56	6.67
<i>Pheidole radoskowskii</i> Mayr, 1884	44.32	5.68	50.00
<i>Pheidole</i> sp1 Westwood	21.90	59.65	18.45
<i>Pheidole</i> sp2 Westwood	39.20	14.20	46.60
<i>Pheidole</i> sp3 Westwood	48.88	26.85	24.27
<i>Pheidole</i> sp4 Westwood	33.33	18.52	48.15
<i>Pheidole</i> sp5 Westwood	60.14	17.39	22.46
<i>Pheidole</i> sp6 Westwood	0.00	100.00	0.00
<i>Solenopsis</i> sp1 Westwood	1.03	97.94	1.03
<i>Solenopsis</i> sp2 Westwood	38.96	57.14	3.90
<i>Strumigenys louisianae</i> Roger, 1863	0.00	100.00	0.00
<i>Wasmannia affinis</i> Santschi, 1929	27.78	50.00	22.22
<i>Wasmannia auropunctata</i> Roger, 1863	19.28	57.83	22.89
<b>Formicinae</b>			
<i>Brachymyrmex</i> sp1 Mayr	0.00	0.00	100.00
<i>Brachymyrmex</i> sp2 Mayr	0.00	100.00	0.00
<i>Brachymyrmex</i> sp3 Mayr	100.00	0.00	0.00
<i>Camponotus crassus</i> Mayr, 1862	92.14	7.86	0.00
<i>Camponotus genatus</i> Santschi, 1922	100.00	0.00	0.00
<i>Camponotus melanoticus</i> Emery, 1894	59.46	40.54	0.00
<i>Camponotus</i> pr <i>bonariensis</i> Mayr, 1868	60.00	40.00	0.00
<i>Camponotus renggeri</i> Emery, 1894	78.02	21.98	0.00
<i>Myrmelachista</i> sp1 Roger	0.00	0.00	100.00
<i>Myrmelachista</i> sp2 Roger	100.00	0.00	0.00
<i>Myrmelachista</i> sp3 Roger	100.00	0.00	0.00
<i>Paratrechina</i> sp1 Motschoulsky	0.00	100.00	0.00
<b>Ectatominae</b>			
<i>Ectatomma edentatum</i> Roger, 1863	58.23	40.51	1.27
<b>Heteroponerinae</b>			
<i>Heteroponera dentinodis</i> Mayr, 1887	0.00	18.75	81.25
<i>Heteroponera inemis</i> Emery, 1894	0.00	5.56	94.44
<b>Ponerinae</b>			
<i>Hypoponera foreli</i> Mayr, 1887	0.00	0.00	100.00
<i>Hypoponera</i> sp1 Santschi	1.75	8.77	89.47
<i>Hypoponera</i> sp2 Santschi	25.00	25.00	50.00
<i>Hypoponera</i> sp3 Santschi	0.00	7.32	92.68
<i>Pachycondyla striata</i> Smith, 1858	22.22	50.00	27.78
<b>Ecitoninae</b>			
<i>Labidus</i> sp1 Jurine	0.00	100.00	0.00



TABLE 1: Continued.

Species	Rocky Field	Riparian Forest	Secondary Forest
Dolichoderinae			
<i>Linepithema cerradense</i> Wild, 2007	89.61	7.79	2.60
<i>Linepithema pulex</i> Wild, 2007	9.35	90.65	0.00
Pseudomyrmicinae			
<i>Pseudomyrmex</i> sp1 Lund	100.00	0.00	0.00

TABLE 2: Comparisons ANOSIM paired of the composition of ant species in the three phytophysiognomies sampled in the Parque Estadual do Ibitipoca, Brazil. July–December, 2008.

	Riparian Forest	Secondary Forest	Rocky Field
Riparian Forest	—	0.257 ( $P = 0.0003$ )	0.435 ( $P = 0.0003$ )
Secondary Forest		—	0.747 ( $P = 0.0003$ )
Rocky Field			—

TABLE 3: Dissimilarity values (SIMPER) between the three phytophysiognomies sampled in the Parque Estadual do Ibitipoca, Brazil. July–December, 2008.

	Riparian Forest	Secondary Forest	Rocky Field
Riparian Forest	—	83.45	86.31
Secondary Forest		—	88.61
Rocky Field			—

vegetation composition promotes the litter formation and, consequently the occurrence of cryptic ant species that depend on this layer to their nesting and foraging [33].

Actually we sampled seven and six cryptic ant species at SSF and RPF, respectively, while there are just four cryptic ant species at RKF. We pointed out that among these four cryptic species at RKF, two of them are arboricolous (*Myrmelachista*) [34], so they are not litter-dependent for nesting or foraging.

The Rocky Field presents characteristics completely different from the other areas. With a rocky soil, this open environment has a predominance of small trees with extra floral nectaries, especially of the genera *Vanillosmopsis* (“candeia”). Also the lack of nearby water bodies makes this phytophysionomy a hostile environment. According to Campos [16], rocky and sand exposed at the top of these fields are among the most extreme combinations of an environment. Mountainous areas, on which are found the rocky fields, are comparable to islands separated by very different ecological conditions [35]. The occurrence of arboreal ant species that present association with plants (*Crematogaster*, *Cephalotes*, *Pheidole*, *Camponotus*, *Myrmelachista*, *Linepithema*, and *Pseudomyrmex*) is a reflex of Rocky Field characteristics.

We emphasize the high frequency of *Camponotus* in the Rocky Field in contrast to its absence in the Secondary Forest. *Camponotus* is cited as the most frequent in open habitats such as sandbanks [36], “cerrado” [37–39], and “caatinga” [40]. This study includes Rocky Field as a habitat that allows to its occurrence. The absence of *Camponotus* in

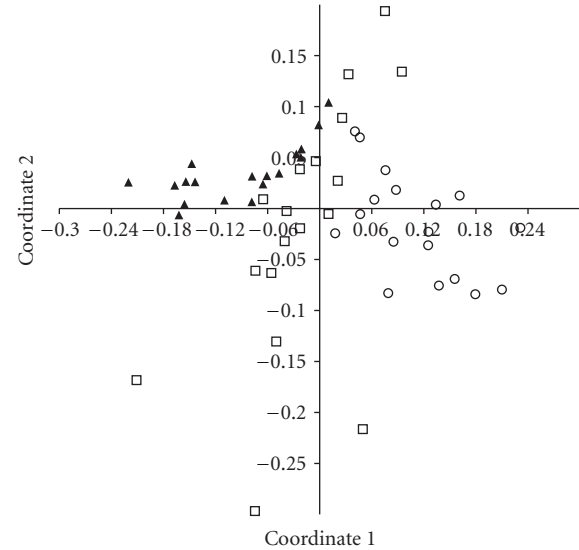


FIGURE 3: Nonmetric multidimensional ordination (NMDS) of ant species composition in three phytophysiognomies sampled in the Parque Estadual do Ibitipoca, Brazil. July–December, 2008. Secondary Forest (triangles), Riparian Forest (squares), and Rocky Field (circles). Stress value = 0.16.

the Secondary Forest could be related to the achievement of collects exclusively in soil, combined with the high scale of the vegetation in this area.

Besides *Camponotus*, *Brachymyrmex* is also noteworthy, given the observed spatial segregation in which each of the three species was exclusively sampled in one of the areas. This spatial segregation can be explained given the high level of aggression recorded for the genera, even in intraspecific interactions [41].

For Riparian Forests the values of dissimilarity are near 50% and can be considered as a transition range between the two other phytophysiognomies, agreeing with the spatial location of this habitat in the PEIb (Figure 1) and with the presence of specialist (e.g., *Acromyrmex*, *Labidus*), invasive (e.g., *Solenopsis*, *Paratrechina*), and cryptic ant species (*Strumigenys*).

This study shows that the species that compose the ant assemblies in different phytophysiognomies are a reflex of the environment, especially of the plant species, supporting the hypothesis that differences in the vegetational composition result in different compositions in the ant assembly.

Also the vegetational composition is determinant in the formation of the litter and consequently in the occurrence of ant species that depend on this layer of organic matter for

TABLE 4: Cumulative contribution of ant genera for the dissimilarities among the phytophysionomies (SIMPER) sampled at Parque Estadual do Ibitipoca, Brazil. July–December, 2008.

Genus	Cumulative contribution %	Average abundance		
		Rocky Field	Riparian Forest	Secondary Forest
<i>Crematogaster</i>	42.64	1.78	0.05	0
<i>Myrmelachista</i>	66.58	0	1.78	0.05
<i>Pheidole</i>	80.35	0.05	0.27	2.78
<i>Acromyrmex</i>	93.13	3.83	0.33	0.11
<i>Camponotus</i>	96.92	0	0.22	2.83
<i>Linepithema</i>	98.83	0.22	0.5	0.27
<i>Solenopsis</i>	99.41	0.88	0	0.05
<i>Wasmannia</i>	99.68	0.11	0.11	0.27
<i>Heteroponera</i>	99.85	0	0.05	0
<i>Strumigenys</i>	100	0.11	0	0

nesting and foraging as the cryptic ant species [42]. Obtained data suggest that determination of ant fauna in the Secondary Forest and Riparian Forest is dependent of the conditions and resources provided by these phytophysionomies, for instance, the presence of litter, shaded areas, and high trees. Unlike, in the Rocky Field, it is expected that the competition is the most important factor in determining the species that compose the assembly, considering the absence of litter, high insolation, and scarcity of resources.

## Acknowledgments

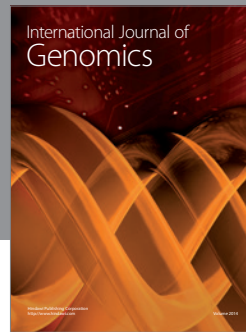
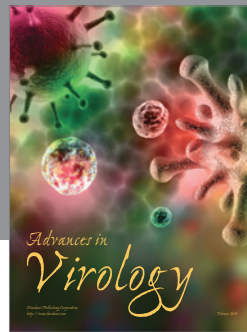
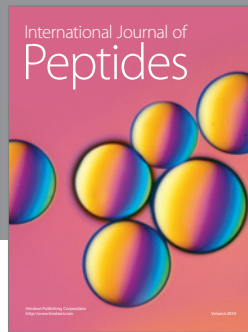
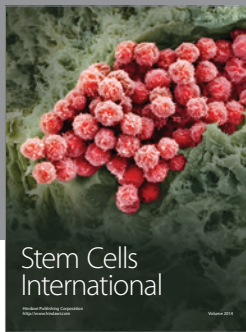
The authors thank the Instituto Estadual de Florestas (IEF) from Minas Gerais State and the Parque Estadual do Ibitipoca Administration for allowing the research and for facilities in the Park, especially to João Carlos Lima de Oliveira and Clarice Nascimento Lantelme Silva. The IBAMA for permission to collect the ants, R. Feitosa for identifying the ants at the taxonomic level of species, FAPEMIG (Fundação de Amparo a Pesquisa do Estado de Minas Gerais) (Proc. APQ 00411-08) for funding and CNPq for the Grant to the first author (Proc. 307335/2009-7). The authors declare that they have no conflict of interests.

## References

- [1] E. O. Wilson, *The Insect Societies*, The Belknap Press of Harvard University Press, Cambridge, Mass, USA, 1971.
- [2] B. Hölldobler and E. O. Wilson, *The Ants*, The Belknap Press of Harvard University Press, Cambridge, Mass, USA, 1990.
- [3] L. P. M. Macedo, *Diversidade De Formigas Edáficas (Hymenoptera, Formicidae) Em Fragmentos Da Mata Atlântica Do estado De São Paulo*, Tese de Doutorado Esalq, Piracicaba, Brazil, 2004.
- [4] H. C. Morais and W. W. Benson, “Recolonização de vegetação de cerrado, após queimadas por formigas arborícolas,” *Revista Brasileira De Biologia*, vol. 48, pp. 459–466, 1998.
- [5] K. Del-Claro, V. Berto, and W. Réu, “Effect of herbivore deterrence by ants on the fruit set of an extrafloral nectary plant, *Qualea multiflora* (Vochysiaceae),” *Journal of Tropical Ecology*, vol. 12, no. 6, pp. 887–892, 1996.
- [6] A. N. Andersen, “A classification of Australian ant communities, based on functional groups which parallel plant life-forms in relation to stress and disturbance,” *Journal of Biogeography*, vol. 22, no. 1, pp. 15–29, 1995.
- [7] MMA—Ministério do Meio Ambiente, <http://www.mma.org/>, 2010.
- [8] K. S. Brown Jr. and G. G. Brown, “Habitat alteration and species loss in Brazilian forests,” in *Tropical Deforestation and Species Extinction*, T. C. Whitmore and J. A. Sayer, Eds., pp. 129–142, Chapman and Hall, London, UK, 1992.
- [9] L. P. C. Morellato, D. C. Talora, A. Takahasi, C. C. Bencke, E. C. Romera, and V. B. Zipparro, “Phenology of Atlantic rain forest trees: a comparative study,” *Biotropica*, vol. 32, no. 4 B, pp. 811–823, 2001.
- [10] J. H. C. Delabie, F. Fernandez, and J. Majer, “Advances in neotropical myrmecology,” *Psyche*, vol. 2012, Article ID 286273, 3 pages, 2012.
- [11] E. C. Underwood and B. L. Fisher, “The role of ants in conservation monitoring: if, when, and how,” *Biological Conservation*, vol. 132, no. 2, pp. 166–182, 2006.
- [12] C. M. R. Costa, G. Hermann, C. S. Martins, L. V. Lins, and I. R. Lamas, *Biodiversidade Em Minas Gerais: Um Atlas Para Sua Conservação*, Fundação Biodiversitas, Belo Horizonte, Brazil, 1998.
- [13] A. M. Giuliatti and J. R. Pirani, “Patterns of geographic distribution of some species from the Espinhaço Range, Minas Gerais and Bahia, Brazil,” in *Proceedings of the Workshop on Neotropical Distributions Patterns*, P. E. Vanzolini and W. R. Meyer, Eds., pp. 39–69, Academia Brasileira de Ciências e Letras, Rio de Janeiro, Brazil, 1988.
- [14] L. G. Rodela, “Cerrados de altitude e campos rupestres do Parque Estadual do Ibitipoca, sudeste de Minas Gerais: distribuição e florística por subfisionomias da vegetação,” *Revista do Departamento de Geografia*, vol. 12, pp. 163–189, 1999.
- [15] J. C. C. Ururahy, J. E. R. Collares, M. M. Santos, and R. A. A. Barreto, “Vegetação: as regiões fitoecológicas, sua natureza e seus recursos econômicos: estudo fitogeográfico,” in *Projeto RadamBrazil: Levantamento de Recursos Naturais*, pp. 555–623, Ministério das Minas e Energia, Secretaria Geral, Rio de Janeiro, Brazil, 1993, (Folhas SF. 23/24 - Rio de Janeiro/Vitória).
- [16] B. C. Campos, *A família Melastomataceae nos Campos Rupestres e Cerrado de Altitude do Parque Estadual do Ibitipoca*,

- Lima Duarte, MG, Brazil, Dissertação de Mestrado, Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, Rio de Janeiro, Brazil, 2005.
- [17] L. G. Rodela and J. R. Tarifa, "O clima da Serra do Ibitipoca, sudeste de Minas Gerais," *Revista GEOUSP*, vol. 1, pp. 101–113, 2002.
- [18] A. T. Oliveira-Filho and M. A. L. Fontes, "Patterns of floristic differentiation among atlantic forests in southeastern Brazil and the influence of climate," *Biotropica*, vol. 32, no. 4B, pp. 793–810, 2001.
- [19] M. A. L. Fontes, *Análise da Composição Florística das Florestas do Parque Estadual do Ibitipoca, Minas Gerais*, Dissertação de Mestrado, Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil, 1997.
- [20] J. Retana and X. Cerdá, "Patterns of diversity and composition of Mediterranean ground ant communities tracking spatial and temporal variability in the thermal environment," *Oecologia*, vol. 123, no. 3, pp. 436–444, 2000.
- [21] C. Wang, J. Strazanac, and L. Butler, "A comparison of pitfall traps with bait traps for studying leaf litter ant communities," *Journal of Economic Entomology*, vol. 94, no. 3, pp. 761–765, 2001.
- [22] J. Fahr and E. K. V. Kalko, "Biome transitions as centres of diversity: habitat heterogeneity and diversity patterns of West African bat assemblages across spatial scales," *Ecography*, vol. 34, no. 2, pp. 177–195, 2011.
- [23] R. Pacheco and H. L. Vasconcelos, "Habitat diversity enhances ant diversity in a naturally heterogeneous Brazilian landscape," *Biodiversity and Conservation*, vol. 21, pp. 797–809, 2012.
- [24] A. V. L. Freitas, R. B. Francini, and K. S. Brown Jr., "Insetos como indicadores ambientais," in *Métodos de Estudos em Biologia da Conservação e Manejo da Vida Silvestre*, L. Cullen Jr., R. Rudran, and C. Valladares-Pádua, Eds., pp. 125–151, Fundação O Boticário de Proteção à Natureza, Curitiba, Brazil, 2003, Editora da UFPR.
- [25] B. Bolton, *Identification Guide to the Ant Genera of the World*, Harvard University Press, Cambridge, UK, 1994.
- [26] F. Fernández, *Introducción a las Hormigas de la región Neotropical*, Instituto de Investigación de Recursos Biológicos Alexander Von Humboldt, Bogotá, Colombia, 2003.
- [27] R. K. Colwell, X. M. Chang, and J. Chang, "Interpolating, extrapolating, and comparing incidence-based species accumulation curves," *Ecology*, vol. 85, no. 10, pp. 2717–2727, 2004.
- [28] R. K. Colwell, "Estimates: Statistical estimation of species richness and shared species from sample," <http://purl.oclc.org/estimates/>, Version 8, Persistent URL, 2006.
- [29] O. Hammer, D. A. T. Harper, and P. D. Ryan, "Past: paleontological statistics software package for education and data analysis," *Palaeontologia Electronica*, vol. 4, pp. 1–9, 2001.
- [30] C. J. Krebs, *Ecological Methodology*, Harper & Hall, New York, NY, USA, 1989.
- [31] K. R. Clarke, "Non-parametric multivariate analyses of changes in community structure," *Australian Journal of Ecology*, vol. 18, no. 1, pp. 117–143, 1993.
- [32] K. R. Clarke and R. H. Green, "Statistical design and analysis for a "biological effects" study," *Marine Ecology Progress Series*, vol. 46, pp. 213–226, 1988.
- [33] J. H. C. Delabie and F. Blard, "The tramp ant *Hypoconerops punctatissima* (Roger) (Hymenoptera: Formicidae: Ponerinae): new records from the southern hemisphere," *Neotropical Entomology*, vol. 31, no. 1, pp. 149–151, 2002.
- [34] J. T. Longino, "A taxonomic review of the genus *Myrmelachista* (Hymenoptera: Formicidae) in Costa Rica," *Zootaxa*, no. 1141, pp. 1–54, 2006.
- [35] R. M. Harley, "Introduction," in *Flora of the Pico das Almas, Chapada Diamantina, Bahia, Brazil*, B. L. Stannard, Y. B. Harvey, and R. M. Harler, Eds., pp. 1–42, Royal Botanic Gardens, Kew, UK, 1995.
- [36] C. R. Gonçalves and A. M. Nunes, "Formigas das praias e restingas do Brasil," in *Restingas: Origem, Estrutura e Processos*, L. D. de Lacerda, D. S. D. Araújo, R. Cerqueira, and B. Turcq, Eds., pp. 373–378, Editora da Universidade Federal Fluminense, Rio de Janeiro, Brazil, 1984.
- [37] C. G. S. Marinho, R. Zanetti, J. H. C. Delabie et al., "Diversidade de formigas (Hymenoptera: Formicidae) da serapilheira em eucaliptais (*Myrtaceae*) e área de cerrado em Minas Gerais," *Neotropical Entomology*, vol. 31, pp. 187–195, 2002.
- [38] G. D. V. Marques and K. Del-Claro, "The ant fauna in a cerrado area: the influence of vegetation structure and seasonality (Hymenoptera: Formicidae)," *Sociobiology*, vol. 47, no. 1, pp. 235–252, 2006.
- [39] T. Andrade, G. D. V. Marques, and K. Del-Claro, "Diversity of ground dwelling ants in cerrado: an analysis of temporal variations and distinctive physiognomies of vegetation (Hymenoptera: Formicidae)," *Sociobiology*, vol. 50, no. 1, pp. 121–134, 2007.
- [40] I. R. Leal, "Diversidade de formigas em diferentes unidades da paisagem da Caatinga," in *Ecologia E conservação Da Caatinga*, I. R. Leal, M. Tabarelli, and J. M. Silva, Eds., pp. 435–460, Editora da Universidade Federal de Pernambuco, Recife, Brazil, 2003.
- [41] T. Delsinne, Y. Roisin, and M. Leponce, "Spatial and temporal foraging overlaps in a Chacoan ground-foraging ant assemblage," *Journal of Arid Environments*, vol. 71, no. 1, pp. 29–44, 2007.
- [42] L. Theunis, M. Gilbert, Y. Roisin, and M. Leponce, "Spatial structure of litter-dwelling ant distribution in a subtropical dry forest," *Insectes Sociaux*, vol. 52, no. 4, pp. 366–377, 2005.





**Hindawi**

Submit your manuscripts at  
<http://www.hindawi.com>

