

CONTRIBUTION TO THE CURRENT KNOWLEDGE OF ANT COMMUNITIES (HYMENOPTERA: FORMICIDAE) IN A XEROPHITIC SCRUBLAND OF SOUTHEAST DURANGO, DURANGO

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ABSTRACT

In order to assess the species richness and diversity of ants in a xerophitic scrubland, a total of three areas were monitored in the Southeast of Durango within the municipalities of Nombre de Dios and Durango. Specific richness, relative abundance as well as Shannon's, Simpson's and Pielou's indices of the ant community were obtained. A total of 19 species from 15 genera within four subfamilies were collected: Myrmicinae, Formicinae, Pseudomyrmicinae and Dolichoderinae. The subfamily with the greatest species richness was Myrmicinae (seven species), while Pseudomyrmicinae had the lowest richness with only two species. Dolichoderinae showed the highest relative abundance (76.5% of the total sample). Four new records of two genera were obtained for the State: *Carebara* and *Linepithema* and two species: *Atta texana* and *Myrmecocystus mendax*. Shannon's diversity index reached $H' = 1.36$, Pielou's evenness index was $J' = 0.46$ and Simpson's index was $\lambda = 0.38$. Further targeted studies are required with different sampling techniques in order to obtain a more detailed listing of ants and increase our knowledge on this group of insects in the study region, which shows high diversity potential.

Keywords: Diversity, Abundance, *Atta texana*, *Myrmecocystus mendax*

1. INTRODUCTION

Insects are the most diverse and evolved group within land arthropods, representing the main functional groups that maintain diversity within ecosystems, with some studies showing their sensitivity to environmental changes caused by anthropogenic activities (Lawton *et al.*, 1998). Research on arthropod biodiversity has been carried out in the valleys of Durango by researchers the CIIDIR-IPN-Dgo. from which a preliminary study on some insect groups within the State was done. Ants were considered within these

studied groups, since it is a high-interest group in terms of its biodiversity and due to the functions they carry out within ecosystems. The present work establishes some of the community parameters of this group of insects.

Ants are grouped within the Formicidae family which is placed within the Vespoidea superfamily of the Order Hymenoptera (Rojas, 2001). Currently this family has 21 subfamilies, 307 genera and 12 855 species (AntWeb. Available at <http://www.antweb.org>, Accessed October 29th, 2013). They have a widespread distribution in various biogeographical areas covering a wide variety of habitats worldwide (Hölldobler and Wilson, 1990;

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Bolton, 1995). They are an important fauna component within arid and semiarid areas due to their high species richness of some taxa having a strong space-time heterogeneity, as well as due to their contribution to the definition of plant community structure and the biological interactions that they establish with other organisms (Polis, 1991; Mackay, 1991; Ríos-Casanova *et al.*, 2004). It has been shown that within these environments there is a surprising level of diversity and abundance of ants and that it is possible to recognize a large variety of trophic interactions and habits that can vary throughout time (Mackay, 1991; Rojas and Fragoso, 2000). Ants reach their highest diversity and abundance within the tropics where there are more species, genera and endemism than in any other region (Bolton, 1995; Fisher *et al.*, 2010). They are the most successful of eusocial insects and have been used as a model for determining fundamental aspects of ecology, evolution, behavior and development (Smith *et al.*, 2009). Studies have been undertaken in some countries using ants as indicators of diversity (Ambrecht and Ulloa-Chacon, 2003) environmental changes and species that efficiently exploit the resources in disturbed ecosystems (Andersen, 1997; Andersen *et al.*, 2002; Andersen and Majer, 2004; Graham *et al.*, 2004; Delabie *et al.*, 2009; Brandao *et al.*, 2012; Achury *et al.*, 2012).

In Mexico, there are 12 formicid subfamilies, with 94 genera and 973 species (Ríos-Casanova, 2013), albeit there are few studies in this country that have been carried out in arid regions. For example, Rico-Gray *et al.* (2004) evaluated the variation of ant-plant interaction; Rico-Gray (1998) studied the seasonal variation and ant-plant interaction richness in the semiarid Zapotitlan valley; Bestelmeyer and Schooley (1999) studied the dynamics and composition of the ant community in the Sonoran and Chihuahuan desert; Zavala-Hurtado *et al.* (2000) determined the influence of ant activity on the plant community in Zapotitlan Salinas; Ríos-Casanova *et al.* (2004) carried out research on ants of the Tehuacan valley; Guzman (2004) carried out work on the foraging pattern of *Pogonomyrmex barbatus* within two contrasting environments in terms of their diversity and plant cover in the semiarid Zapotitlan Salinas valley, Puebla; Hernández-Ruíz and Castaño-Meneses (2006) studied ant diversity in agricultural ecosystems in the Mezquital valley, Hidalgo; Guzman-Mendoza and Castano-Meneses (2007) studied the foraging activity of *Camponotus rubrithorax* in the Zapotitlan Salinas valley, Puebla; and finally Varela-Hernández (2013) determined the temporal variation of ant communities in xerophile scrubland with dominance of *Cephalocereus senilis* and *Stenocereus dumortieri* in the Mezquitlan Biosphere Reserve, Hidalgo. In terms of studies carried out in the northern arid regions of

the country, to our knowledge there is only the work carried out by Rojas and Fragoso (2000) in the Mapimi Reserve in the Chihuahuan desert; that of Bestelmeyer and Schooley (1999) and Vasquez-Bolanos (2011) in the southwestern part of the Sonoran desert; the work by Alatorre-Bracamontes and Vasquez-Bolanos (2010) carried out in various northern States of the country; that of Vasquez-Bolanos (INIFAP, 2011) in which the ant species are listed per State in Mexico; and that of Coronado-Blanco *et al.* (2013) and Gonzalez *et al.* (2007) which reports the studies carried out on formicids in the State of Tamaulipas. In light of this, formicids are one of the least known families of the North-Central part of the country.

Species inventories are carried out as a way to gain knowledge on the number of them in a specific habitat, thus the objective of this study was to contribute to the information known on ants within a xerophitic scrubland plant community in Southeast Durango in terms of species richness, abundance and diversity as a basis for future mid- and long-term diversity assessments.

2. MATERIALS AND METHODS

Within the framework of the arthropod biodiversity study in the Durango valleys sampling was carried out using entomological nets, yellow traps and manually. The present work reports on biological material obtained from yellow traps and manually.

Study area. The present work was carried out from March 2009 to October 2010 in the municipalities of Nombre de Dios and Durango (Gonzalez-Castillo *et al.*, 2011). A total of three areas representative of xerophitic scrubland were established within these municipalities in the Southeast of Durango State. Information on temperature and annual rainfall was taken from information published by INIFAP (2011). General characteristics of each area are described in **Table 1**.

Ant sampling. A total of 15 sites were established within each of the three sampling areas. Within each site a 4x4 m² quadrant was established from which ants observed on plants and on the ground were quantified and collected. A total of 10 quadrants were established, separated from each other by 50 meters. In total 2400 m² were sampled per area giving a total coverage by this study of 7200 m².

While yellow traps are not the most recommended method for collecting ants, we obtained good species richness using this method. A trap was placed in each quadrant on the ground using water, to prevent the escape of ants and other specimens, with detergent to break surface tension and 5 gr of sodium borate (borax) for preservation following a modification of the technique proposed by Southwood (1978). Traps were checked and emptied once a week.

Table 1. Location and brief description of the areas where sampling of ants was carried out in a xerophitic scrubland community in the Southeast of Durango State

Site	Geographical coordinates	Average annual temperature (°C)	Average annual rainfall mm.	Elevation m	Plant associations
Tuitán (T), Nombre de Dios	Lat. N 24° 02' 32'' Long. W 104° 14' 01''	16.6	452	1886	<i>Opuntia</i> sp., <i>Acacia</i> sp., <i>Dasylirium</i> sp., (Gonzalez-municipality, Dgo Castillo <i>et al.</i> , 2011), <i>Yucca</i> sp., <i>Mimosa biuncifera</i> (Benth) <i>Bouteloua gracilis</i> (Will.ex Kunth).
Nombre de Dios (ND), Nombre de Dios municipality, Dgo.	Lat. N 23° 49' 26'' Long. W 104° 13' 28''	16.9	367	1809	<i>Prosopis</i> sp., <i>Acacia</i> sp., <i>Opuntia</i> sp. <i>Agave durangensis</i> Gentry
Sierra El Registro (SR), Durango municipality, Dgo.	Lat. N 23° 37' 47'' Long. W 104°22.5' 13''	16	400	1928	<i>Agave durangensis</i> Gentry, <i>Prosopis laevigata</i> (Hum. Et Bonpl. Ex Willd), <i>Acacia schaffneri</i> (S. Watson), <i>Dasylirium duranguense</i> (Trel), <i>Bouteloua gracilis</i> Willd. Ex Kunt) Lag. (Gonzalez <i>et al.</i> , 2007).

Sampling of ants was complemented by manually picking them as they were observed in dead leaves and under rocks and rotten tree trunks using paintbrushes dipped in 70% alcohol as well as entomological tweezers.

Biological material was taken to the Entomology Laboratory of the CIIDIR-IPN, U. Dgo., for their separation and quantification.

Approximately 10 individuals from each species were mounted using entomological pins while the remainder of the material was placed in jars with 70% ethanol. Ants were classified taxonomically to the genus level (some to species level) using Mackay and Mackay (1989) and Bolton (1994) taxonomic keys as well as the help of an expert from the Faculty of Sciences of the National Autonomous University of Mexico (UNAM). All specimens were deposited in the Entomological Collection of CIIDIR-IPN, U. Dgo. Analysis of diversity. Specific species richness was assessed (number of species) while Moreno (2001) index was used to calculate the average richness. Absolute abundance (N) of species, species morphs, genera and subfamilies was determined for the entire study area, as well as the relative abundance (%). Relative abundance was obtained using the frequency of occurrence of species in each area (Sanchez and Antonio, 2004). A total of 15 sites per area were obtained totaling 45 sites in the study.

Diversity in the study area was estimated using Shannon's (H') index which is a maximum likelihood estimator and is the most sensitive to changes in abundance of rare families (Magurran, 1989; Gonzalez-Castillo *et al.*, 2011), the index ranges between 1.5 and 3.5 representing the uncertainty there is when collecting an individual of a species in terms of the species to which the next individual will belong to. Pielou's evenness (J) index, which expresses evenness as the proportion of the observed diversity in regards to the maximum expected diversity, was also estimated (Moreno, 2001; Magurran, 1989; Gonzalez-Castillo *et al.*, 2011). Furthermore,

Simpson's (λ) index, which manifests the probability that two individuals randomly chosen from a sample are from the same species and that is influenced by the most abundant species in the sample, was also calculated (Moreno, 2001; Magurran, 1989).

3. RESULTS

Richness, composition and abundance. Taking into consideration the entire study area, a total of 19,480 ants were collected belonging to 15 species morphs and four species within 15 genera of four subfamilies. Myrmicinae, Formicinae, Pseudomyrmicinae and Dolichoderinae (**Table 2**). The subfamily with the highest species richness was Myrmicinae (seven species) while that which had the least richness was Pseudomyrmicinae with only two species. **Figure 1** shows that Dolichoderinae had the highest relative abundance (76.5%) while Pseudomyrmicinae had the lowest relative abundance (<1 %).

The specific richness of the study area reached 19.

Of the 15 genera found, *Forelius* had the greatest species richness (3), while *Camponotus* and *Pseudomyrmex* had two species each and the remaining genera had only one species or species morph each.

The relative abundance was obtained from the species frequency per area; as such in the study area it was *Pheidole* sp. which showed the highest relative abundance, followed by *Myrmecocystus mendax* Wheeler, *Monomorium* sp., *Liometopum* sp., *Camponotus* sp. and *Brachymyrmex depilis* Emery, with the remaining species and species morphs representing less than 5% (**Fig. 2**).

Species diversity. Globally from the study area Shannon's diversity index reached $H' = 1.3$. Pielou's evenness index reached $J' = 0.46$ and Simpson's index was $\lambda = 0.38$.

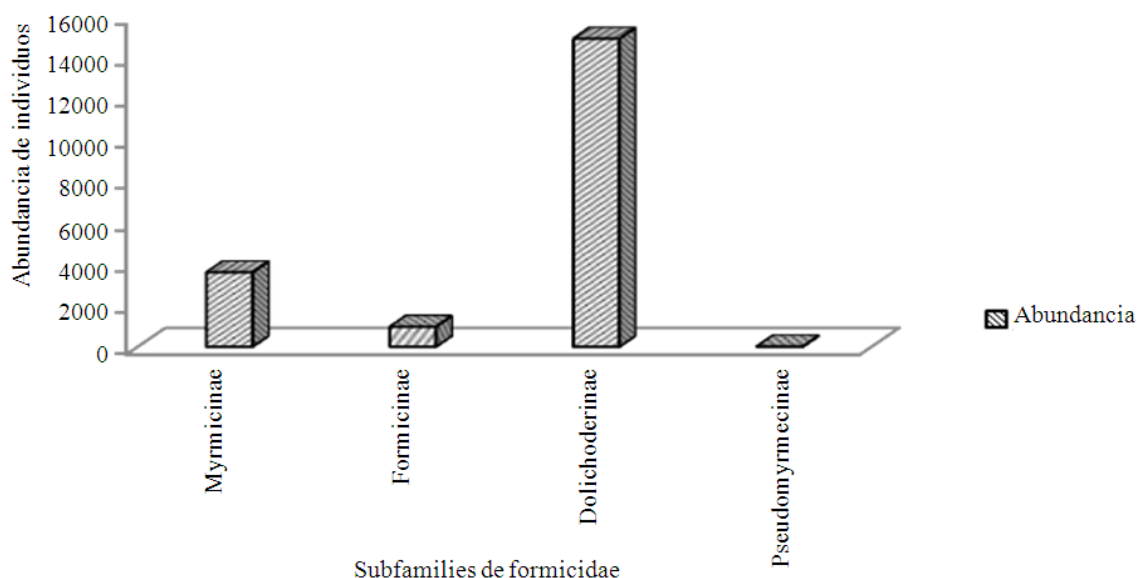


Fig. 1. Abundance of the ant subfamilies represented in the xerophitic scrubland

Table 2. Total genera, species and species morphs of ants collected from xerophitic scrubland in the Southeast of Durango State. The genera and species names in bold are new records for the State

Subfamilies / Tribes	Genera/Species /Species specimens	Total Morphs
Dolichoderinae		
Dolichoderini	<i>Doryrmex</i> sp.	2585
	<i>Forelius</i> sp. I	1046
	<i>Forelius</i> sp. II	9
	<i>Forelius</i> sp. III	8
	<i>Linepithema</i> sp.	22
	<i>Liometopum</i> sp.	11234
Formicinae		
Camponotini	<i>Camponotus</i> sp. I	116
	<i>Camponotus</i> sp. II	1
Lasini	<i>Myrmecocystus mendax</i> Wheller	688
Plagiolepidini	<i>Brachymyrmex depilis</i> Emery	162
Pseudomyrmecinae		
seudomyrmecini	<i>Pseudomyrmex pallidus</i> (Smith)	11
	<i>Pseudomyrmex</i> sp.	1
Myrmicinae		
Attini	<i>Atta texana</i> Buckley	4
Crematogastrini	<i>Crematogaster</i> sp.	41
Myrmecini	<i>Pogonomyrmex</i> sp.	1
Pheidolini	<i>Aphaenogaster</i> sp.	1
	<i>Pheidole</i> sp.	2909
Solenopsidini	<i>Carebara</i> sp.	6
	<i>Monomorium</i> sp.	635
Total		19480

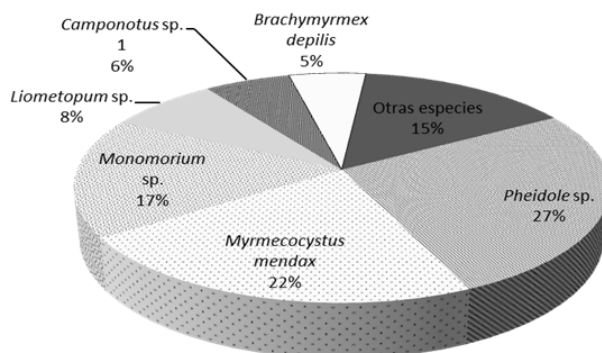


Fig. 2. Relative abundance of ant species and species morphs in the xerophitic scrubland under study other species

4. DISCUSSION

Richness, composition and abundance. It is noteworthy that in a 7200 m² area two species in two genera were found to be new records for the State directly contributing to the local diversity partly due to the heterogeneity of xerophile scrubland since there is a great diversity of plant species in the studied area creating specific favorable conditions to accommodate various ant species.

The Myrmicinae subfamily showed the highest genera and species richness in agreement with other studies carried out in arid or semiarid areas at the state, national (Rojas, 2001; Ríos-Casanova, 2013) and worldwide (Wilson, 2003) levels, where it is seen as the

most numerous. It is also considered to be an indicator of disturbed environments (Fernandez, 2003). This subfamily was followed in order of importance by Dolichoderinae, Mirmicinae and Pseudomyrmicinae, the latter with the least number of species.

In regards to the relative abundance per subfamily, Dolichoderinae showed the highest level at 76.5% followed by Myrmicinae with 18.5% and Formicinae with 5%, while Pseudomyrmicinae represented less than 0.1%. The abundance of Dolichoderinae was due to the fact that *Liometopum* sp accounted for many of the ants collected, but these were not found within all sites. This species morph was located within brush, grassland and mainly on *Agave durangensis* Gentry, possibly preferring agave because of the sugary secretions of the agave scale *Acutaspis agavis* Townsend and Cockerell. Furthermore, the fact that *Liometopum* sp is dominant within an ecosystem provides insight into the level of disturbance or alterations that various areas have. According to several studies, such as that of Andersen *et al.* (2002) they are considered as indicators of disturbance and therefore they could be used as sentinels in environmental impact studies. Notwithstanding, the high dominance of this species morph could also be due to a lower predator density (Rao *et al.*, 2001).

Regarding the relative abundance by species and species morphs, **Fig. 2** clearly shows that *Pheidole* sp. *Myrmecocystus mendax* Wheeler and *Monomorim* sp. constitute 66% of the species. Furthermore, *Brachymyrmex depilis* Emery, *Camponotus* sp. and *Liometopum* sp. 1 constitute between 5 and 8%, while *Forelius* sp., *Linepithema* sp., *Crematogaster* sp., *Camponotus* sp. 2, *Pseudomyrmex* sp. 2, *Pseudomyrmex pallidus* (Smith) *Forelius* sp. 2, *Dorymyrmex* sp., *Carebara* sp., *Aphaenogaster* sp., *Forelius* sp. 3 and *Atta texana* Buckley represented less than 5% of the relative abundance. It must be noted that *Pheidole* sp also prefers agave due to the sugary secretions of the agave scale *A. agavis*. As stated in other studies, *M. mendax* is one of the most important omnivorous species of arid areas since they consume a large amount of insect cadavers and plant and animal sugary exudates and have the special adaptation to extreme conditions in which they store sweet fluids within the body of specific individuals in their colonies for their use in times of shortage (Rojas, 2001). This ant can be found in at least six States in the Mexican Republic (Vasquez-Bolanos, 2011).

In contrast, *Dorymyrmex* sp is one of the species with the least relative abundance. This genus is exclusively found in America with more than 80 described species, 50 of which are found in the neotropical zone.

Furthermore, species in this genus have been described to construct their nests on the ground of arid and semiarid regions preferring open spaces with little plant cover where they are dominant from an ecological point of view. They encompass the entire continent, from the United States of America to Argentina (Cuezzo, 2003). In Mexico, six species of this genus have been collected in 11 States, with one species found in Durango (Vasquez-Bolanos, 2011).

Forelius sp. 1 are known to always nest in soil of desert or semi-desert environments with little plant cover and has two distinct apparently disjointed distribution areas, one in central and southern United States, northern Mexico, Cuba, Honduras and islands in Central America, while the other is located in South America, Bolivia, Brazil, Uruguay, Paraguay, Chile and Argentina (Calle *et al.*, 2013).

Furthermore, *B. depilis* was found to be associated to mesquite which is in agreement with studies by Fernandez (2003) where he mentions that they are frequently associated with leguminous plants. This ant species has been previously collected in six States in Mexico, including Durango (Vasquez-Bolanos, 2011). *Pseudomyrmex pallida* (Smith) is widely distributed throughout Mexico with records encompassing 21 States (Vasquez-Bolanos, 2011). Finally, for *Aphaenogaster* sp. two species have been recorded for Durango (Vasquez-Bolanos, 2011), although several species of this genus have been observed more frequently in areas with tropical climate (Escalante *et al.*, 2004).

The fact that four dominant species were found within the three sites and that 11 species/species morphs were exclusive suggests that within xerophitic scrubland there are microclimates, microhabitats and resources for species with contrasting habits, with some predominating on the ground and others on the vegetation feeding on the sugary secretions of pseudococcids of certain plants and on larvae of insects and other arthropods (Longino and Hanson, 1996).

Shannon's diversity index was low at $H' = 1.3$ and Majer (1983) states that Shannon's index levels below 1.5 are frequently associated with altered environments.

New ant records for the State. It is noteworthy that for the first time two new genera and two new species were recorded in the State which are *Carebara* and *Linepithema* and the species *Myrmecocystus mendax* Wheeler and *Atta texana* Buckley. *Carebara* was scantily observed and only one species has been found in two Mexican States (Vasquez-Bolanos, 2011). Also, three species of the *Linepithema* genus have been recorded in three States in the country (Vasquez-Bolanos, 2011). The majority of the species in this genus build their nests on the ground, fallen

leaves or under rocks and have been observed in grasslands and disturbed habitats (Will, 2007).

Atta texana was also scantily observed (<1%) and is considered to be a leaf cutter and fungus cultivator (Hölldobler and Wilson, 1990). It has been collected in clearings with pecan (*Carya illinoensis* (Wangenh) K. Koch) and sweet acacia (*Acacia farnesiana* (L.) Willd) (Sánchez-Peña, 2010), in six States of the Mexican Republic (Vasquez-Bolanos, 2011; Escoto *et al.*, 2001). This species is known as “chicatana” and is eaten by people in Cordoba, Papantla and Teocelo in Veracruz (Landro-Torres *et al.*, 2004).

Vasquez-Bolanos (2011) listed a total of 884 ant species for Mexico, of which 58 were found in Durango, although Ríos-Casanova (2013) mentioned that there were in fact 60 species. In this study we found 19 species, or less than 50% of what has been reported previously, albeit of these 19 species four are new records for the State increasing the total species expected to be in the State to 64.

Variation can be seen in terms of species found, when comparing the present study with other previously published from similar areas, mainly due to the differences in habitats sampled, sampling methods, length of sampling, repetitiveness of the sampling and emphasis of sampling of ants in the different studies. Delabie and Blard (2002) state that the use of different sampling methods increases the probability of finding new species in each study area. The amount of species found in this study area places it as a highly important one for the biological conservation of xerophilic scrubland.

5. CONCLUSION

Even though sampling in this study was not specific for ants and the traps used were not ideal for them it was possible to find four new records for the State. Nevertheless, greater efforts must be placed on sampling using other methods (fall traps, baits, pitfall and others) that are complementary and optimal for the different types of vegetation in the State, which would allow a more detailed listing to be obtained increasing the current knowledge on this group of insects in the study region that already shows high diversity potential. It would also allow the establishment of the relationship there is between ants, vegetation types and environmental parameters. Detailed species determination is needed for all ants collected since only 21% of them achieved such level of classification.

Predominance of the Myrmicinae family suggests that the study area suffers from a certain degree of disturbance. It was possible to observe that there is a transformation of the natural environment into agricultural landscapes, grasslands and human habitation, which are factors that

modify the structure of ant communities and in turn making species composition different between study sites. This agrees with several authors that have stated that ants are an indicator of specific environmental conditions in regards to their environmental preferences and tolerance to conspicuous factors such as temperature and habitat selection (Majer, 1983; Power, 1996).

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