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Research Article

The Ants (Hymenoptera: Formicidae) of Jaragua National Park, Dominican Republic

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This study examined ant species richness in Jaragua National Park (Pedernales Province, Dominican Republic). Ants were sampled at 15 sites during late March and early April, 2012. Habitats sampled included dry forest, beach scrub, lakeside acacia scrub, and thorn woodland. Sixty-four species from 23 genera were collected. Species richness was higher than expected, considering only 125 species had previously been reported for all of Hispaniola. Jaragua National Park is part of the Jaragua-Bahoruco-Enriquillo Biosphere Reserve. The ant species richness observed in this study suggests that the park, along with larger reserve, is successful in preserving important habitat for insects.

1. Introduction

The Caribbean region is notable for its biodiversity and endemism [1–3]. The larger islands of the West Indies (Greater Antilles) in particular harbor some of the area's most diverse floras and faunas. Hispaniola (Figure 1) has the second largest land area (Cuba = 104,556 km^2 and Hispaniola = 48,442 km^2) and the widest elevation range (three mountain summits > 3000 m to a −40 m saline lake depression) and was once covered by a variety of natural habitats. While native peoples disturbed the island's land to some unknown extent, notable and sustained habitat loss began with the arrival of European explorers more than 500 years ago. Today only a small percentage of naturally occurring habitat remains.

Haiti occupies the western third of Hispaniola and is ecologically devastated. The Dominican Republic comprises the remaining two-thirds of the island and has one of the most comprehensive national park systems in the Caribbean. These parks collectively cover a large area, encompass a range of habitats, and are known to be important for supporting local and regional avian richness [4–6]. Beyond birds and a few other vertebrate groups, most animal taxa occurring on Hispaniola are poorly known, to the extent that we do not even have a fair accounting of their within-group species diversity. Studying and documenting invertebrate biodiversity in natural habitats is needed simply to learn more about what species occur here. Such work can produce valuable baseline data and can be used to inform assessments of how well habitat preservation may be facilitating the conservation of nonvertebrate animal taxa.

One recent study has significantly improved our understanding of the fauna of Hispaniola. Perez-Gelabert [7] provides an accounting of all the arthropods reported from the island, providing species lists for the taxa that comprise the earth's richest animal phylum. Many of the genera and species lists for specific orders and families were either the first such list ever produced for Hispaniola or were updates to lists that were woefully inadequate. Endemic species were shown to make up more than 50% of the known species for 4 of the 11 most species rich (>25 species present on Hispaniola) insect orders. This finding is perhaps not surprising in light of our knowledge that the Caribbean is a biodiversity hotspot and that many arthropod groups and insects in particular are quite species rich. Despite this important step forward there still remains much to be discovered regarding Hispaniola's fauna. Perez-Gelabert [7], commenting on arthropod species richness, noted "As an indication of how much there is still to be discovered in the island, exhaustive collections throughout

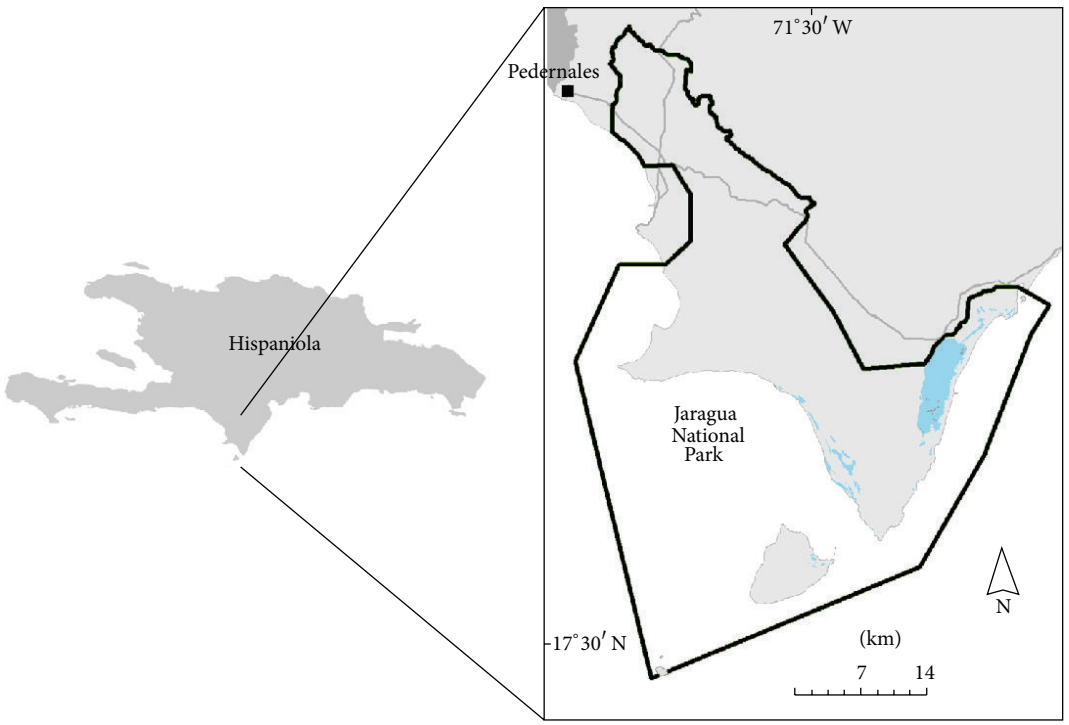

Figure 1: A map of the island of Hispaniola, the approximate location of the park in Hispaniola, and a map of Jaragua National Park. The Dominican Republic town of Pedernales, shown just beyond the northwestern boundary of the park, shares a border with the Haitian town of Anse-à-Pitres.

its varied geography focusing on particular groups, along with specialized study, commonly double the number of species in a group."

Perez-Gelabert [7] listed 125 extant Formicidae species that are known to occur on Hispaniola. This work brings together information from some of the earliest and most productive ant collecting [8, 9] with more contemporary taxonomic revisions of ant genera having representatives on Hispaniola (e.g., [10–12]). The island's ants have been well studied relative to many other insect groups but ant sampling overall has been spotty in its geographic coverage, sampling rigor and through time. There has never been a published study of a survey of the ant fauna from any specific habitat or meaningful delineated area. Without more comprehensive surveys it is difficult to understand if the number of currently reported ant species is reasonably accurate or is a low estimate of the actual richness. Studying the ant fauna of the island, through careful and thorough sampling of specific habitats and locations, should prove informative. This paper represents the results of the first study of the Formicidae from a delineated area of the island. The focus of this sampling study was to assess the ant species richness in naturally occurring habitats of Jaragua National Park (Jaragua NP).

2. Materials and Methods

Jaragua NP is located in the southwest corner of the Dominican Republic (Figure 1). The majority of its 76,547 ha of terrestrial area is located at the southern end of the Peninsula de Barahona. This peninsula borders the Caribbean Sea on its southwestern, southern, and southeastern edges. Elevation ranges from sea level to 234 m. Jaragua NP is part of the Jaragua-Bahoruco-Enriquillo Biosphere Reserve [13], which forms one of the largest conservation areas in Hispaniola. This reserve and its parks, each designated key biodiversity areas [2], provide vital habitat for more than 30 endemic birds [14], Hispaniola's two extant nonvolant land mammals [15, 16], and two endemic iguanas [17].

We sought to sample ants from the widest range of natural habitat types and sites, given limitations of site accessibility and time available for sampling. Staff from Grupo Jaragua (a Dominican NGO supporting management and conservation in the Biosphere Reserve) assisted with site selection and field sampling. Fifteen sites were sampled over seven days (March 26 to 27 and March 29 to April 2, 2012). Each site included up to a half-hectare of area. With the exception of the relatively narrow fringe of land along the coast and a few small islands that are part of the park, the dominant terrestrial habitat of Jaragua NP is dry forest [6, 18]. This forest grows on a limestone escarpment that has little in the way of developed soils. The botanical composition and overall growth form of the dry forest varies with topography and substrate. As a reflection of its dominance within the park a majority ($N = 11$) of our sampling sites were located in dry forest. We also collected from a site along the shore of Laguna de Oviedo (lakeside acacia scrub habitat), two thorn woodland [18] sites and a beach scrub habitat near Cabo Rojo. This last area was just beyond the park boundary but was

representative of similar areas found within the park (Ernst Rupp, personal communication). We did not sample from mangrove, coastal forest, or salt marsh habitats. These occur within but make up only a small portion of the park. We also did not visit the park's islands or sample from disturbed areas. These nonsampled habitats likely contain a number of species that are not accounted for in our collections.

Hand sampling was used for surveying ants. At each site two experienced collectors spent two to three hours searching for ants. Our sampling was focused on collecting as many of the species that were present as possible. Collection efforts included but were not limited to turning rocks, the use of Davis sifters to examine litter, examining rotten wood and soil, visually searching vegetation, breaking apart sticks, and beating vegetation. Our choice of sampling methods was constrained by local conditions. A majority of the land within the park is situated on exposed limestone with a poorly developed soil and litter layer. These conditions were not conducive to pitfall trapping or litter sampling. Mini-Winkler sampling was attempted but proved unproductive due to a lack of litter within most sites. The use of Davis sifters was more informative in sites where some ground litter and soil were present.

3. Results

Sixty-four species and morphospecies from 23 genera (Table 1) and 6 subfamilies (Amblyoponinae, Dorylinae, Formicinae, Myrmicinae, Ponerinae, and Pseudomyrmecinae) were collected. All ants were determined to genus, with a majority identified to species ($n = 40$). The remaining forms were determined to genus and sorted to morphospecies ($n = 24$). These ants belonged to eight different genera (*Brachymyrmex*, *Camponotus*, *Hypoponera*, *Nylanderia*, *Pseudomyrmex*, *Rogeria*, *Solenopsis*, and *Temnothorax*). Specimens were deposited in the entomology collection in the Museum of Comparative Zoology, Harvard University (MCZ). Specimen data, including sampling locations, can be accessed online using MCZBase [19]. Voucher specimens were also deposited in the Universidad Autónoma de Santo Domingo entomology collection in Santo Domingo (UASD). A list of ant species, representative automontage images of workers, and additional species information is available online at Antwiki [20].

Nine of the 40 named species were new occurrence records for Hispaniola (*Dorymyrmex antillana*, *Monomorium pharaonis*, *Pheidole jelskii*, *Pheidole subarmata*, *Rogeria curvipubens*, *Solenopsis terricola*, *Stigmatomma falcatum*, *Strumigenys gundlachi*, and *Tetramorium lanuginosum*). Six species are introduced. Five of these, *Cardiocondyla emeryi*, *Monomorium floricola*, *Monomorium pharaonis*, *Tetramorium caldarium*, and *Tetramorium lanuginosum*, are considered tramp species while the sixth is the well-known invasive pest *Tapinoma melanocephalum*.

Dry forest sites had the highest species richness (Table 1). Low elevation sites (Cabo Rojo and adjacent to Lake Oviedo) had considerable fewer species. Thorn woodland habitat was remarkable in that no ants were found. One of the dry forest sites was grading into thorn woodland and, in places where there were isolated pockets of soil and litter, a few species were found (*Hypoponera* sp., *Odontomachus bauri*, and *Solenopsis globularia*). One species, *Monomorium ebeninum*, was included as part of our list of ants from the park but was collected in a disturbed dry forest site that was not part of our 15 sample sites. Our study did not focus on disturbed habitat but it is likely that such areas within the park harbor additional ant species.

4. Discussion

This study reveals that there are likely many more than 125 ant species inhabiting Hispaniola. Taking the list by Perez-Gelabert as a starting point and only counting the number of species and morphospecies we found, our sampling nominally shows Jaragua NP harbors 51% of the island's ant species. We actually found nine species that were not previously listed as occurring on the island, increasing the number of known, validly named species to 134. Considering that this survey represents the first study of the ant fauna from any meaningfully delineated area or habitat on the island it is perhaps unsurprising that 9 of the 64 species we sampled were new occurrence records for Hispaniola. The species richness we observed suggests the natural habitats in the park are important for conserving insect species. It is imperative that Jaragua NP has its native habitats preserved and that we continue to study the biodiversity within these areas.

Numerous introduced species were found within Jaragua NP's natural habitats but they do not appear to be problematic. None of these exotic ants were found to occur in high abundance in any of our sampled sites. Further sampling within Jaragua NP and in other areas beyond the park is needed to more definitely understand the potential influence and abundance of nonnative ants.

Our ability to quantitatively compare ant species richness across our sites and by habitat was constrained by the local conditions limiting our sampling to hand collecting. Our field impressions, informed by our subsequent determinations and specimen data, allow for drawing some qualitative conclusions. The dry forest in Jaragua NP supports a diverse ant fauna. A few species were found across many sites but no single ant species was overwhelmingly dominant within the dry forest; species richness and evenness appear to be relatively high. The low elevation sites in the park, as observed at Cabo Rojo and along the shore of Lake Oviedo, were not as diverse. The ant species occurring here showed some overlap with the dry forest fauna. Our impression is that quantitative sampling would reveal that the lowest elevation sites along the coast exhibit ant diversity typical of areas with high disturbance: fair ant abundance but relatively low evenness and species richness. Low elevation sites in the park are subject to fluctuating water levels and exposure to salt water and their exposed sandy open areas experience wide variation in their diurnal temperature. Moving away from the coast and/or increasing in elevation provides more stability and

Table 1: Ant species of Jaragua National Park.

Genus	Species/morphospecies	# sites	Habitat
Anochetus	*mayri* Emery, 1884	3	DF
Brachymyrmex	*heeri* Forel, 1874	5	DF
	sp1	4	DF, LE
	sp2	1	DF
Camponotus	sp1	3	DF
	sp2	2	DF
	sp3	2	DF
	sp4	1	DF
Cardiocondyla	*emeryi** Forel, 1881	2	DF, LE
Cephalotes	*decoloratus* De Andrade, 1999	2	DF
	unimaculatus (Smith, F., 1853)	6	DF
Crematogaster	*steinheili* Forel, 1881	6	DF, LE
Cyphomyrmex	*minutus* Mayr, 1862	7	DF
Dorymyrmex	*antillana* Snelling, R.R., 2005	8	DF, LE
Hypoponera	*opacior* (Forel, 1893)	2	DF
	sp1	1	DF
	sp2	3	DF
	sp3	3	DF
	sp4	1	DF
Monomorium	*ebeninum* Forel, 1891	1	*
	*floricola** (Jerdon, 1851)	3	DF, LE
	*pharaonis** (Linnaeus, 1758)	1	DF
Nylanderia	*steinheili* (Forel, 1893)	1	DF
	sp1	2	DF
Odontomachus	*bauri* Emery, 1892	12	DF, LE
	sp1	1	DF
Pheidole	*drepanon* Wilson, 2003	6	DF, LE
	jamaicensis Wheeler, 1908	3	DF
	jelskii Mayr, 1884	2	DF, LE
	moerens Wheeler, W.M., 1908	7	DF
	subarmata Mayr, 1884	1	LE
	terresi Wheeler, W.M. & Mann, 1914	1	DF
Pogonomyrmex	*saucius* Wheeler, W.M. & Mann, 1914	2	DF
	schmitti Forel, 1901	5	DF
Pseudomyrmex	*cubaensis* Forel, 1901	8	DF, LE
	simplex (Smith, F., 1877)	1	DF
	subater (Wheeler, W. M. & Mann, 1914)	1	DF
	sp1	3	DF
Rogeria	*alzatei* Kugler, C., 1994	2	DF
	brunnea Santschi, 1930	4	DF
	curvipubens Emery, 1894	3	DF
	sp1	1	DF
	sp2	1	DF
	sp3	1	DF
	sp4	1	DF

Table 1: Continued.

Genus	Species/morphospecies	# sites	Habitat
Solenopsis	*geminata* (Fabricius, 1804)	6	DF, LE
	globularia (Smith, F., 1858)	6	DF
	pollux Forel, 1893	1	LE
	terricola Menozzi, 1931	1	DF
	sp1	1	DF
	sp2	2	DF, LE
	sp3	2	DF
	sp4	1	DF
Stigmatomma	*falcatum* (Lattke, 1991)	1	DF
Strumigenys	*gundlachi* Roger, 1862	3	DF
	nigrescens Wheeler, W.M., 1911	1	DF
Tapinoma	*melanocephalum** (Fabricius, 1793)	5	DF, LE
Temnothorax	*ciferrii* (Menozzi & Russo, 1930)	2	DF
	sp1	4	DF
	sp2	2	DF
	sp3	1	DF
Tetramorium	*caldarium** (Roger, 1857)	2	DF, LE
	*lanuginosum** Mayr, 1870	1	DF
Trachymyrmex	*jamaicensis* André, 1893	4	DF

Species are listed alphabetically by genus. Introduced species are indicated by a * following the specific epithet. Valid names are listed with their author and year of description. Morphospecies, indicated by sp., denotes a form that is morphologically distinct from all others listed for that genus. The *# sites* column indicates the number of locations a form was sampled from and the *Habitat* column notes the habitat where each form was found: DF: dry forest and LE: low elevation (Cabo Rojo beach site and the shore of Lake Oviedo). Specimen data, including geolocations, are available online at MCZbase [19].

greater vegetative diversity. This in turn provides opportunity for more species to coexist.

The thorn woodland habitat was surprising in its lack of ants. This was likely the result of the harsh conditions and a paucity of suitable nesting sites. During hand sampling it became apparent that there were few places that could contain an ant nest or even a nest fragment. The sparse downed wood was consistently very dry and any objects on the ground that might hide some ants under them were inevitably found to be underlain by dry limestone. Suitable refugia that could provide protection from the persistent hot and dry conditions in the thorn woodlands either are not present or are quite limited. It is possible that rain or a humid night would provide conditions that would lead to revealing ants that may be inhabiting this habitat. Yet even if ants are found to be present it seems unlikely this would be a rich assortment of species.

The eight genera with unidentified morphospecies highlight taxonomic problems for these taxa within Hispaniola and more generally across the Caribbean region. Some species we sampled are new undescribed species (Stefan Cover, person communication). Others belong to genera that are in such a state of taxonomic disarray, either within the region or overall, that it is not possible to determine what forms are assignable to valid names and which may be new species. A recent worldwide revision of the genus *Solenopsis* [21] and a relatively modern worldwide revision of the genus *Rogeria* [10] proved to be unsatisfactory for identifying many of our specimens from these genera. The species listed as occurring in Hispaniola in both of these revisions are notable as being documented from very few specimens from the island. Specimens from this present study can be compared to the existing descriptions, and in some cases can also be compared with existing samples in the MCZ entomology collection that are noted in these revisions, without being able to satisfactorily resolve their identity. Additional sampling, including the collection of nests, series, and further taxonomic studies are needed to clarify species boundaries for Hispaniola ants in all eight of these problematic genera.

Determining how low the current count of 134 species of ants occurring on Hispaniola is from the actual number of species is not possible with what is presently known. Additional studies examining the ant fauna in other areas of the island, whether in different or similar habitats, are needed in order to gain a more comprehensive picture of Hispaniola's ant fauna.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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