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MEXICO ANTS: incidence and abundance along the Nearctic-Neotropical interface

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Abstract. Mexico is one of the most biodiverse countries in the world, with an important proportion of endemism mainly due to the convergence of the Nearctic and Neotropical biogeographic regions, which generate great diversity and species turnover at different spatial scales. However, most of our knowledge of the Mexican ant biota is limited to a few well-studied taxa, and we lack a comprehensive synthesis of ant biodiversity information. For instance, most of the knowledge available in the literature on Mexican ant fauna refers only to species lists by states, or is focused on only a few regions of the country, which prevents the study of several basic and applied aspects of ants, from diversity and distribution to conservation. Our aims in this data paper are therefore to (i) compile all the information available regarding ants across the Mexican territory, and (ii) identify major patterns in the gathered dataset and geographic gaps in order to direct future sampling efforts. All records were obtained from raw data, including both unpublished and published information. After exhaustive filtering and updating information and synonyms, we compiled a total of 21,731 records for 887 ant species distributed throughout Mexico from 1894 to 2018. These records were concentrated mainly in the states of Chiapas (n= 6,902, 32.76%) and Veracruz de Ignacio de la Llave (n= 4,329, 19.92%), which together comprise half the records. The subfamily with the highest number of records was Myrmicinae (n=10,458 records, 48.12%), followed by Formicinae (n= 3,284, 15.11%) and Ponerinae (n= 1,914, 8.8%). Most ant records were collected in the Neotropical region of the country (n= 12,646, 58.19%), followed by the Mexican transition zone (n= 5,237, 24.09%) and the Nearctic region (n= 3,848, 17.72%). Native species comprised 95.46% of the records (n= 20,745). To the best of our knowledge, this is the most complete data set available to date in the literature for the country. We hope that this compilation will encourage researchers to explore different aspects of the population and community research of ants at different spatial scales, and to aid in the establishment of conservation policies and actions. There are no copyright restrictions. Please cite this data paper when using its data for publications or teaching events.

Key words: biodiversity hotspot, Formicidae, geographic range, Hymenoptera, inventory, Mexican fauna, sampling methods, species abundance, species incidence.

The complete data set is available as Supporting Information at: [*to be completed at proof stage*].

Data Availability

Associated data is also available at Zenodo: http://doi.org/10.5281/zenodo.3529855

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INTRODUCTION

Ants (Hymenoptera: Formicidae) are one of the most diverse, abundant and ecologically important taxa in most terrestrial environments (Hölldobler and Wilson 1990, Lach et al. 2010), with most species diversity currently found in the New World tropics and subtropics (Moreau and Bell 2013). The main characteristics that lead ants to be successful and notably ecologically important in the most diverse habitats and environmental conditions across the globe are the great variety of food resources that they use, together with their social and nesting behaviors (Hölldobler and Wilson 2009, Andersen 2019). Moreover, ants are critical participants in multiple ecosystem services and regulate fundamental ecological processes, such as the improvement of soil aeration, plant pollination, and nutrient cycling (Schultz and McGlynn 2000, Rico-Gray and Oliveira 2007, Hölldobler and Wilson 2009).

A total of 13,594 described valid ant species are known globally (including synonyms and excluding subgenera, subspecies, and fossil taxa), and are distributed within 17 subfamilies and 334 genera (Bolton 2019). Despite the high number of synonyms made every year, based on the yearly rate of descriptions of new species and the estimated number of species still not scientifically named, the total number of existing ant species is estimated to be about 30,000 (Fisher 2010). Regardless of the high diversity and great ecological importance of ants, there are gaps in our information about their diversity and distribution, and the lack of a synthesis limits knowledge of these organisms in some regions of the world (Alonso 2010, Guénard et al. 2017).

Mexico is one of the top five richest countries in terms of biodiversity and endemism (Mittermeier et al. 1997). The great diversity and turnover of species throughout the Mexican territory have been associated with its large variety of ecosystems (from deserts to tropical rainforests) and the topographic complexity of the territory, with elevations ranging from 0 up to almost 6000 m above sea level (Sarukhán et al. 1996, Arita 1997, Campbell 1999). Moreover, in central Mexico, the southern and northern limits of the Nearctic and Neotropical biogeographic regions, respectively, converge, bringing into contact biotas with marked evolutionary histories that, together with endemism, increase biodiversity in the country (Halffter 1987, Halffter and Morrone 2017). Although Mexico is an important biodiversity hotspot and an interesting biogeographic area, most of the knowledge about its biota has been historically focused on the study of plants (Rzedowski and Huerta 1994, Llorente-Bousquets and Ocegueda 2008, Villaseñor 2016) and vertebrates (Rodríguez et al. 2003, Rojas-Soto et al. 2012, Álvarez-Castañeda et al. 2012), with other groups such as arthropods, including ants, inevitably often neglected.

A total of 973 ant species are currently known from Mexico (ca. 6% of the world's total) (AntWeb 2019). The first zoological study that attempted to synthesize information about the ant fauna in the country dates back only to the mid-1990s and reported 501 ant species (Rojas-Fernández 1996). There has been no comprehensive effort to synthesize knowledge on the diversity of Mexican ants since then and knowledge of the geographic distribution of ants across Mexico has been particularly scarce. Because little is known about the geographic distribution of ant species across Mexico, the available databases with a global focus fail to accurately represent Mexican ant distribution (e.g., Gibb et al. 2017, Guénard et al. 2017, Parr et al. 2017). Most of the available knowledge on Mexican ants in the literature refers to information such as species lists within broad political divisions in the country, such as states (Vásquez-Bolaños 2011, 2015) or focuses on only a few habitat types (e.g., tropical dry and rain forests) (Ríos-Casanova 2014, Ahuatzin et al. 2019). The current lack of systematic records on ant species diversity and distribution limits research on a large spatial scale, and, therefore our ability to answer key questions, such as about the threats to ants from landscape modification, climate change and invasive species. Based on all the above, we believe that compiling the information currently available for Mexican ants could allow the use of spatially explicit information regarding distributions of this insect group in a megadiverse country.

In this data paper, we compiled all the available published and unpublished geographic information (including both incidence and abundance records) about native and exotic ant species recorded within Mexico over 124 years (from 1894–2018). After exhaustive filtering, the updating of information and the curation of synonyms, our data set contains 21,731 records of 887 ant species distributed throughout Mexico. To the best of our knowledge, this is the most complete data set available in the literature for the country at the moment. We hope that this compilation of the MEXICO ANTS data set will encourage researchers to explore different aspects of the population and community ecology of ants, and will provide useful information for establishing conservation policies and actions. Just as we were encouraged by the incredible work of the ATLANTIC SERIES initiative, whose objective is to compile all sorts of information from this biodiversity hotspot, we hope that our data set stimulates other Mexican research groups to organize their collections and data and make them publicly available.

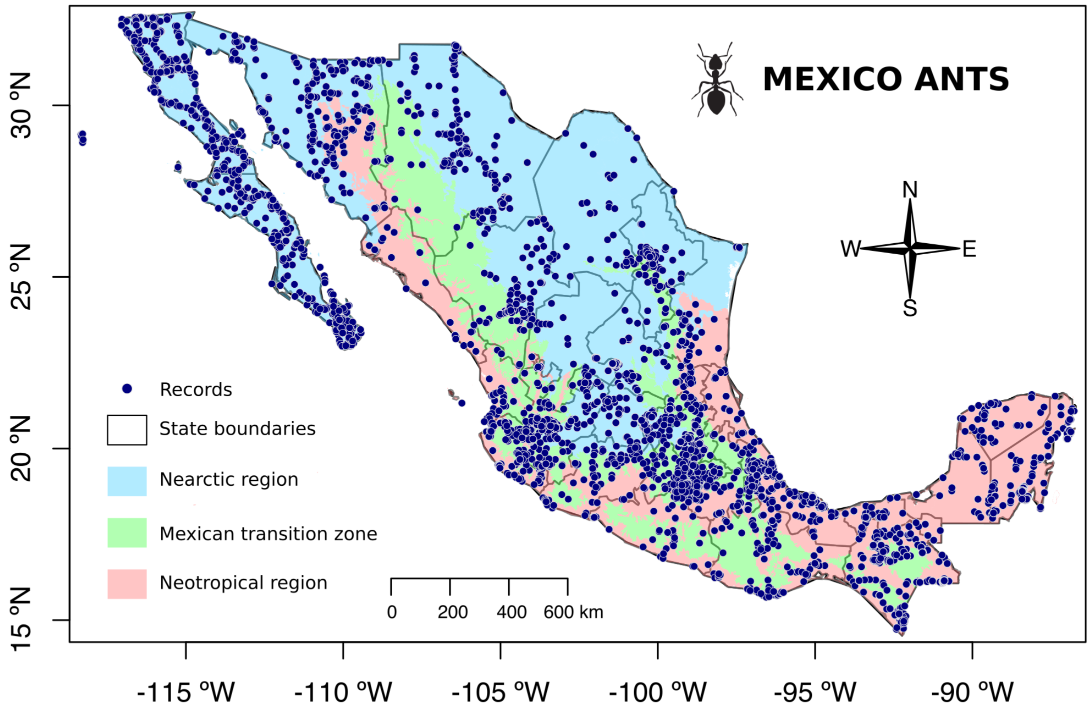

Fig. 1. Distribution of the 21,731 records in the MEXICO ANTS data set throughout the Mexican territory, compiled from 1894 to 2018. Limits of regionalization of Mexican biogeographic regions follow Morrone et al. (2017). Data that appears to be outside the continent represents records made in Mexican insular environments.

METADATA S1

Class I - Data set descriptors

A. Data set identity

Title: MEXICO ANTS: INCIDENCE AND ABUNDANCE ALONG THE NEARCTIC-NEOTROPICAL INTERFACE

B. Data set identification code

Data set: MEXICO_ANTS_DATASET.csv

Metadata: MEXICO_ANTS_METADATA.doc

C. Data set description

1. Originators:

i) Wesley Dáttilo, Red de Ecoetología, Instituto de Ecología A.C., Carretera Antigua a Coatepec 351, El Haya, CP 91073, Xalapa, Veracruz, Mexico.

ii) Miguel Vásquez Bolaños, Centro de Estudios en Zoología, Departamento de Botánica y Zoología, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Km. 15.5 Carr. Nogales, Las Agujas, CP 45110, Zapopan, Jalisco, Mexico.

2. ABSTRACT

Mexico is one of the most biodiverse countries in the world, with an important proportion of endemism mainly due to the convergence of the Nearctic and Neotropical biogeographic regions, which generate great diversity and species turnover at different spatial scales. However, most of our knowledge of the Mexican ant biota is limited to a few well-studied taxa, and we lack a comprehensive synthesis of ant biodiversity information. For instance, most of the knowledge available in the literature on Mexican

ant fauna refers only to species lists by states, or is focused on only a few regions of the country, which prevents the study of several basic and applied aspects of ants, from diversity and distribution to conservation. Our aims in this data paper are therefore to (i) compile all the information available regarding ants across the Mexican territory, and (ii) identify major patterns in the gathered dataset and geographic gaps in order to direct future sampling efforts. All records were obtained from raw data, including both unpublished and published information. After exhaustive filtering and updating information and synonyms, we compiled a total of 21,731 records for 887 ant species distributed throughout Mexico from 1894 to 2018. These records were concentrated mainly in the states of Chiapas (n= 6,902, 32.76%) and Veracruz de Ignacio de la Llave (n= 4,329, 19.92%), which together comprise half the records. The subfamily with the highest number of records was Myrmicinae (n=10,458 records, 48.12%), followed by Formicinae (n= 3,284, 15.11%) and Ponerinae (n= 1,914, 8.8%). Most ant records were collected in the Neotropical region of the country (n= 12,646, 58.19%), followed by the Mexican transition zone (n= 5,237, 24.09%) and the Nearctic region (n= 3,848, 17.72%). Native species comprised 95.46% of the records (n= 20,745). To the best of our knowledge, this is the most complete data set available to date in the literature for the country. We hope that this compilation will encourage researchers to explore different aspects of the population and community research of ants at different spatial scales, and to aid in the establishment of conservation policies and actions. There are no copyright restrictions. Please cite this data paper when using its data for publications or teaching events.

D. Keywords: biodiversity hotspot, Formicidae, geographic range, Hymenoptera, inventory, Mexican fauna, sampling methods, species abundance, species incidence.

E. Description

We selected all continental land and islands and merged all polygons into a single shapefile to organize the data set of ant records within the Mexican territory (Fig. 1). Our data set is comprised of 21,731 records of ants with taxonomic certainty to species-level identification. Our ant records were obtained from 242 different data collectors who were individually responsible for 4,683 records (21.55%), and 3,149 records (14.49%) that were the joint efforts between two and four collectors. This information was not available for the remaining 14,569 records (63.96%). Only 23 collectors contributed more than 50 ant records (Fig. 2). It is important to note that, in our data set, 'collectors' are defined as people who personally retrieve the specimens from the field. We extracted the state and municipality names from the latitudinal and longitudinal information of our ant records using the current and official shapefile from the National Institute of Statistics and Geography of Mexico (INEGI) in a WGS84 projection and with a spatial resolution of 250 m (Available at: http://www.conabio.gob.mx/informacion/metadata/gis/muni_2018gw.xml?httpcache=yes&_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent=no). We obtained records from 32 Mexican states, however, these records are mainly concentrated in a few states (Fig. 1 and 3). The states of Chiapas (n = 6,902, 31.76%), and Veracruz de Ignacio de la Llave (n = 4,329, 19.92%) hold just over half the records, and Colima (n = 50, 0.23%), Ciudad de México (n = 40, 0.18%), and Aguascalientes (n = 39, 0.18%) each have only a handful of records. There are ant records for 829 different municipalities, with Ocosingo (state of Chiapas) and San Andrés Tuxtla (state of Veracruz de Ignacio de la Llave) holding the highest number of records, 2,703 (12.44%) and 1,211 (5.57%) respectively (Fig. 4). We obtained 15,916 ant records (73.24%) made within 96 different plant associations and land cover types. Note that the collectors made these classifications directly in the field, and most were made in tropical rainforest (n = 5,811, 26.74%), secondary forest (n = 1,299, 5.98%) and cloud forest (n = 1,247, 5.73%) (Fig. 5).

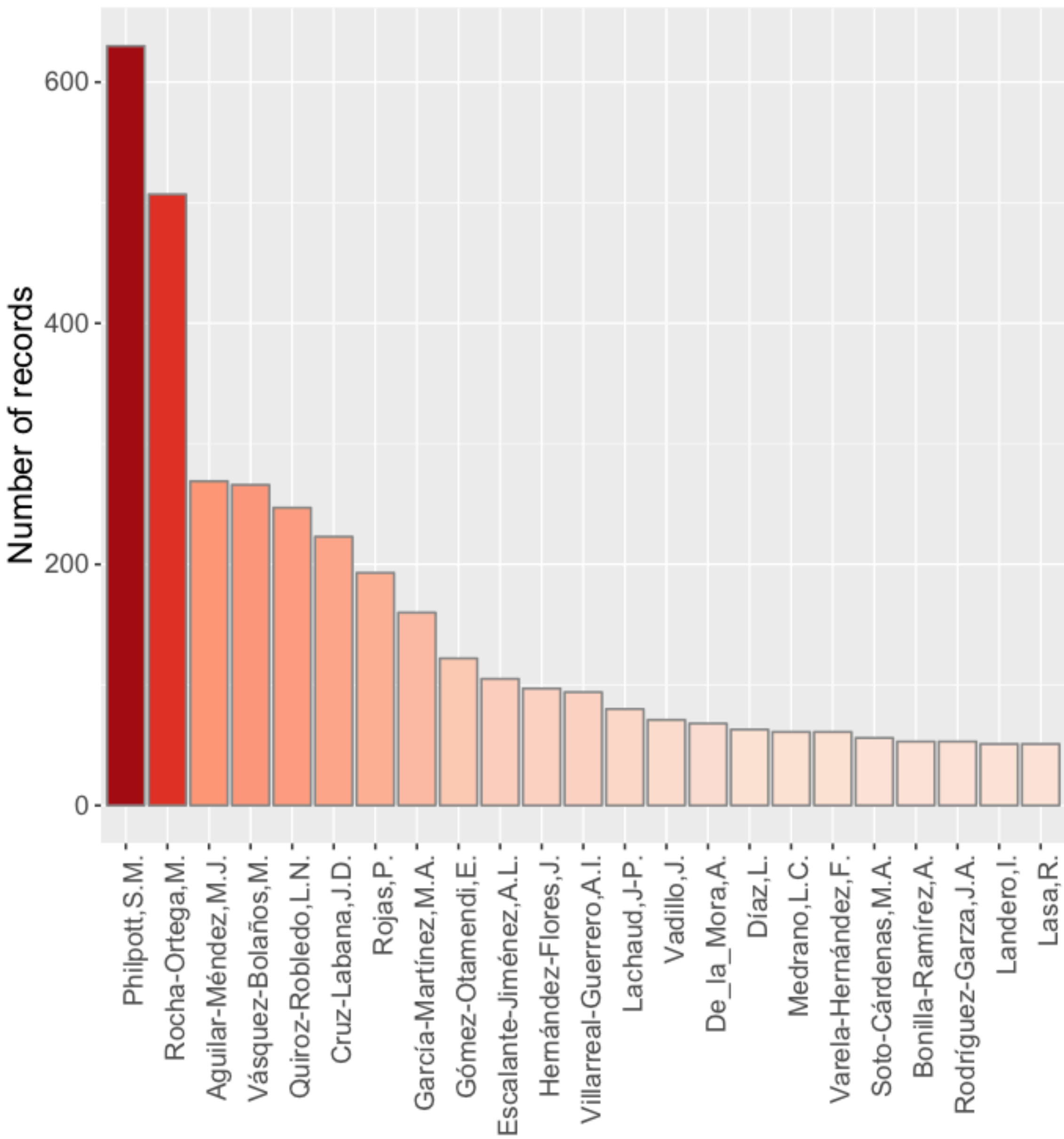

Fig. 2. Number of records per collector (only those people with more than 50 records are included) within the MEXICO ANTS data set.

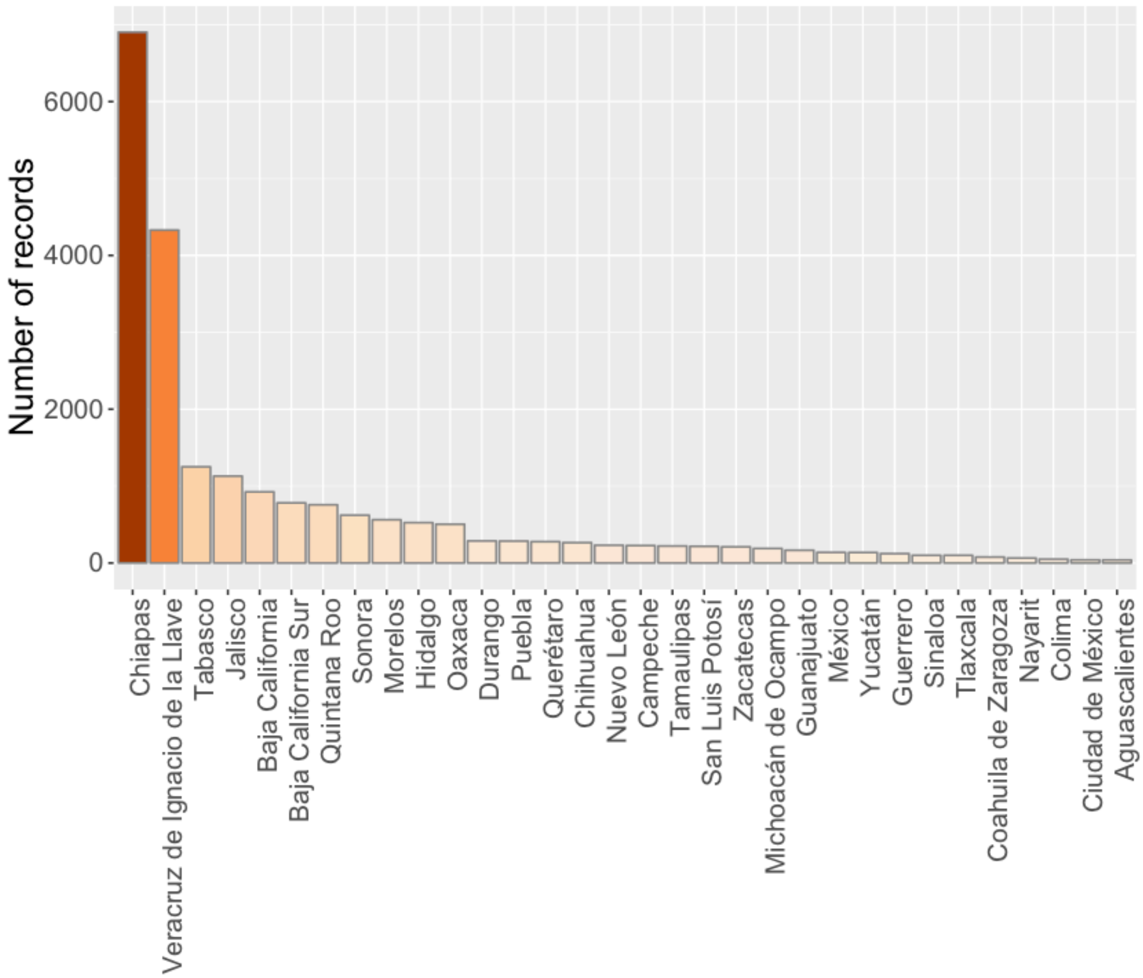

Fig. 3. Number of records per state within the MEXICO ANTS data set.

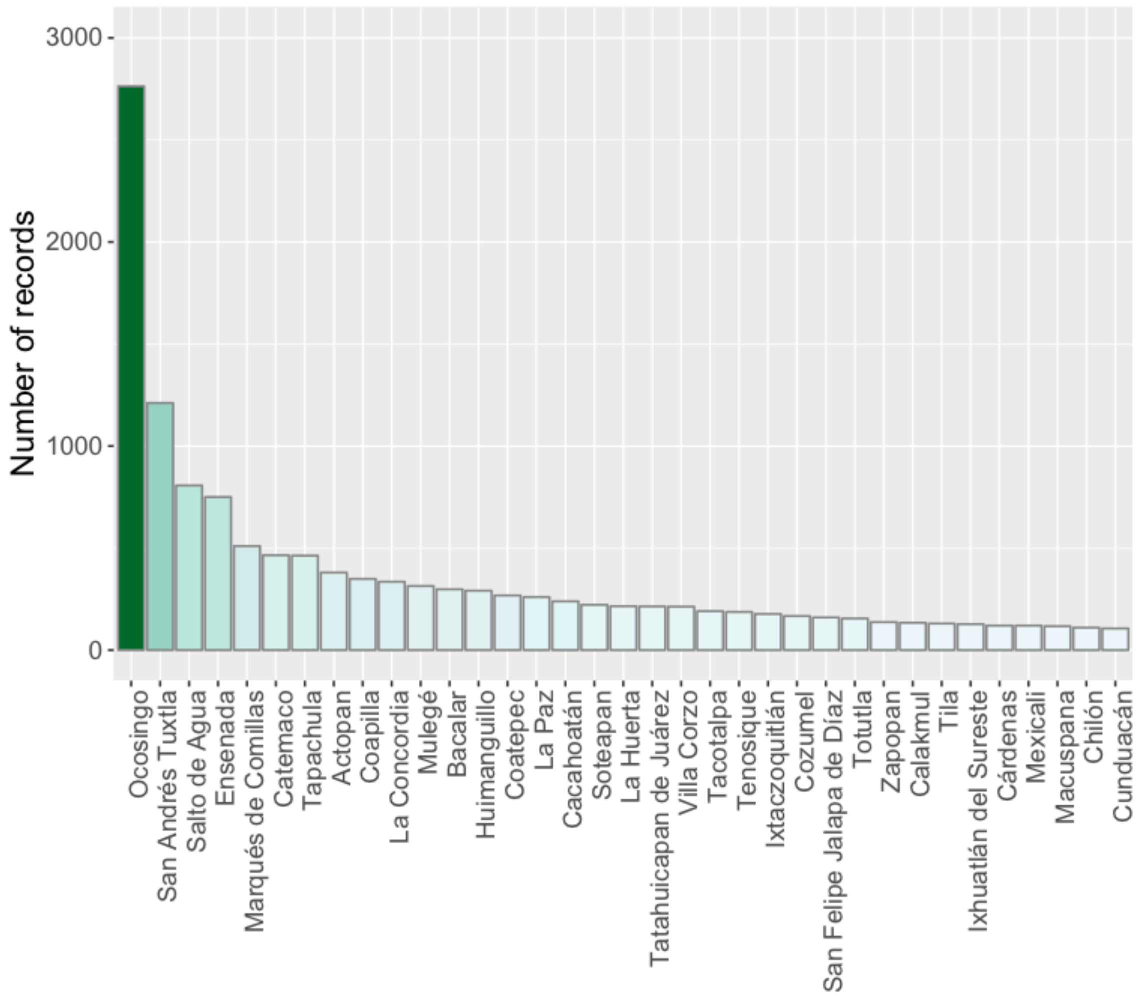

Fig. 4. Number of records per municipality (only those with more than 100 records are included) within the MEXICO ANTS data set.

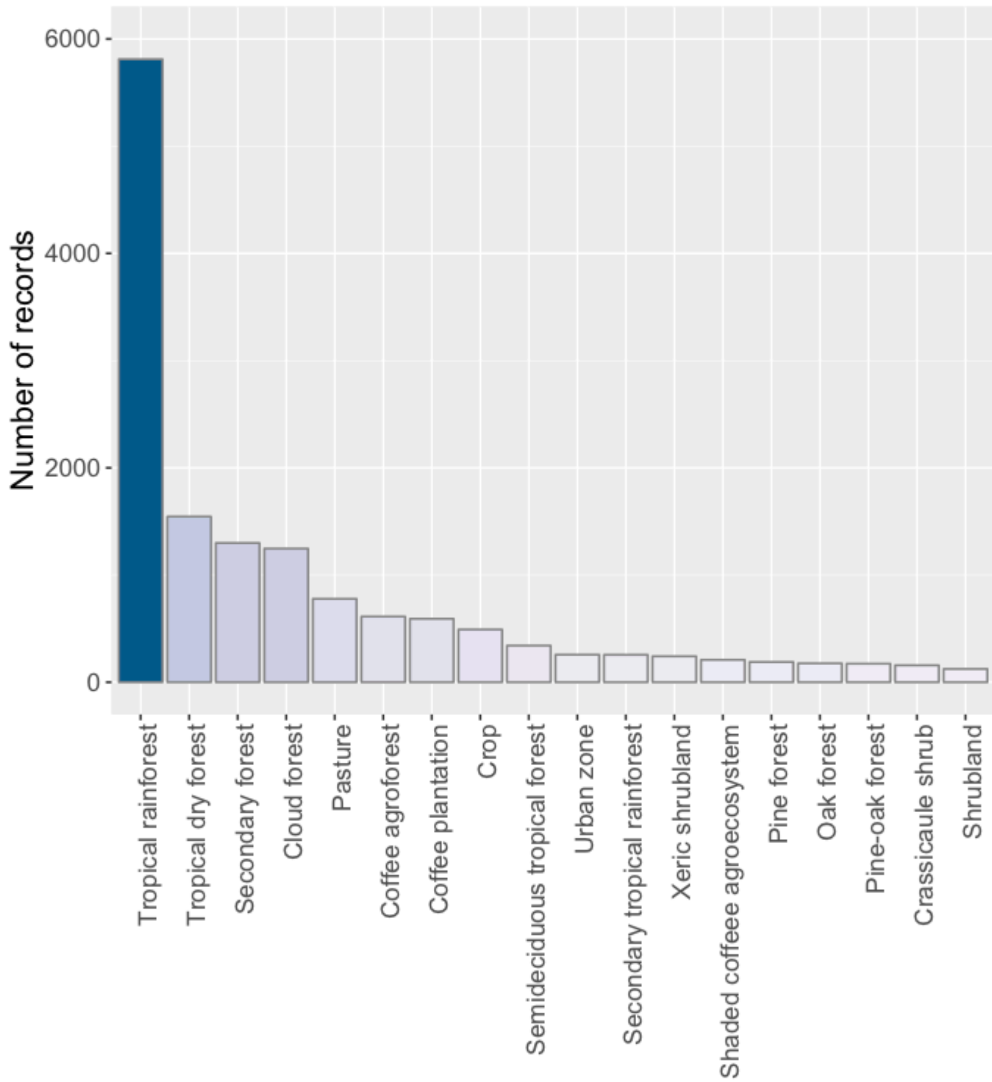

Fig. 5. Number of records per vegetation or land cover type (only those with more than 100 records are included) within the MEXICO ANTS data set.

We characterized the environmental conditions and elevation at the sampling points for all records from the geographical coordinates (i.e., latitude and longitude information) of the sampling sites. To do this, we first overlapped all geographical coordinates with the climate layers, using the “extract” function of the raster package (Hijmans 2017) in the R program (R Core Team 2017). The raster files corresponding to the annual mean temperature and precipitation values were obtained from the WorldClim database version 2 (http://www.worldclim.org/version2) with a spatial resolution of 30 seconds/~1 km^2). We used the SRTM Digital Elevation database version 4.1 to obtain elevation data, (https://cgiarcsi.community/data/srtm-90m-digital-elevation-database-v4-1/) with a spatial resolution of 250 m. The elevation of our sampling sites ranged from 0 to 3,685 m (mean ± SD: 763 ± 715 m a.s.l.), and most sites (n = 14,126, 65,00%) are below 1,000 m in elevation, followed by the categories: (i) from 1,000 m up to the limit of the 2,000 m mark with 5,628 records (25.90%); (ii) from 2,000 m up to the limit of the 3,000 m mark with 1,599 records (7.36%); and (iii) those above 3000 m with only 15 records (0.07%) (Fig. 6). The mean annual temperature of the sampling sites ranged from 5.74 to 28.55 °C (mean ± SD: 21.72 ± 3.56 °C) and was concentrated mainly between 20 and 28.55° C (n = 15,489 records, 71.28%) (Fig. 6). The mean annual precipitation of the sampling sites ranged from 53.59 to 4557 mm (mean ± SD: 1645.8 ± 1020.45 mm), although most of the sampling sites were concentrated between 1,000 and 3,000 mm of rainfall (n = 11,304 records, 52.02%) (Fig. 6).

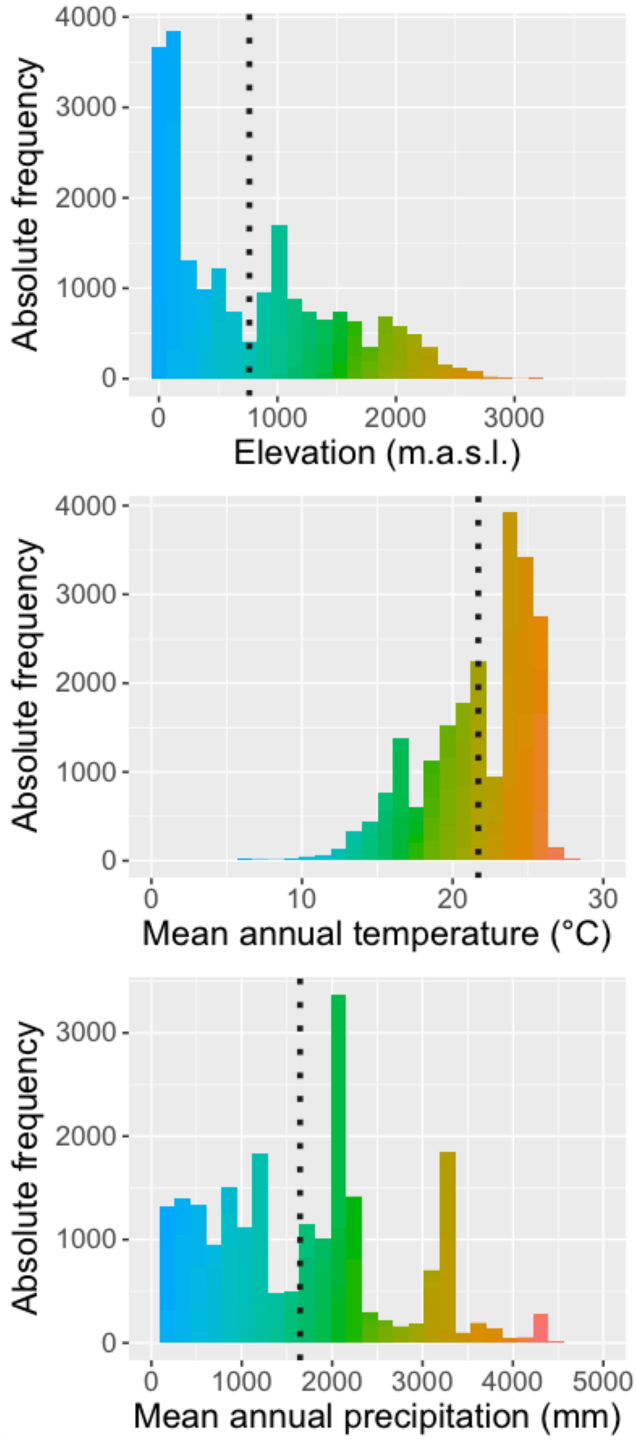

Fig. 6. Variation of elevation, mean annual temperature, and mean annual precipitation (top to bottom) of the sampling sites within the MEXICO ANTS data set. Dashed lines represent the mean of the distribution of values.

The subfamily with the most records was Myrmicinae (n = 10,458, 48.12%), followed by Formicinae (n = 3,284, 15.11%), Ponerinae (n = 1,914, 8.81%), Pseudomyrmecinae (n = 1,863, 8.57%), Dolichoderinae (n = 1,802, 8.29%), Dorylinae (n = 1,077, 4.96%), Ectatomminae (n = 788, 3.63%), Proceratiinae (n = 293, 1.35%), Amblyoponinae (n = 222, 1.02%) Agroecomyrmecinae (n = 19, 0.09%) Heteroponerinae (n = 11, 0.05%) (Fig. 7). Our records are distributed among 96 genera of ants, where *Camponotus* (n = 2,122, 9.76%), *Pseudomyrmex* (n = 1,863, 8.57%), and *Pheidole* (n = 1,536, 7.07%) were the genera with the largest number of records, accounting for 25.41% of all records. The genera *Discothyrea*, *Mycetophylax*, *Myrmicocrypta*, and *Probolomyrmex* had the fewest records in the data set (only one record each) (Fig. 8). Of the 887 ant species recorded, 28 species represent 33.76% of the records (Fig. 9). The five most recorded species were *Solenopsis geminata* (n = 501 records), followed by *Octostruma balzani* (n = 435), *Atta mexicana* (n = 430), *Cyphomyrmex rimosus* (n = 427), and *Liometopum apiculatum* (n = 398). All ant species were identified by 72 independent people, of whom 15 identified 25.68% of all records (n = 5,580) (Fig. 10). We extracted the biogeographical region at which the records were obtained from the latitude and longitude information of our ant records, using the shapefile proposed by Morrone et al. (2017). The majority of the ant records were registered in the Neotropical region of the country (n = 12,646, 58.19%), followed by the Mexican Transition Zone (n = 5,237, 24.10%) and the Nearctic region (n = 3,848, 17.71%) (Fig. 11). The native species (i.e., those species that historically occur in Mexico) comprised 95.46% of the records (n = 20,745), followed by exotic species (i.e., those species that have been transported to Mexico beyond their natural geographic dispersal barriers) (n = 614, 2.83%), and those classified as exotic and invasive (i.e., those ant species which are naturally or transported by humans to Mexico, and that decrease the local diversity of native species mainly through competitive displacement) (n = 372, 1.71%) (Fig. 12).

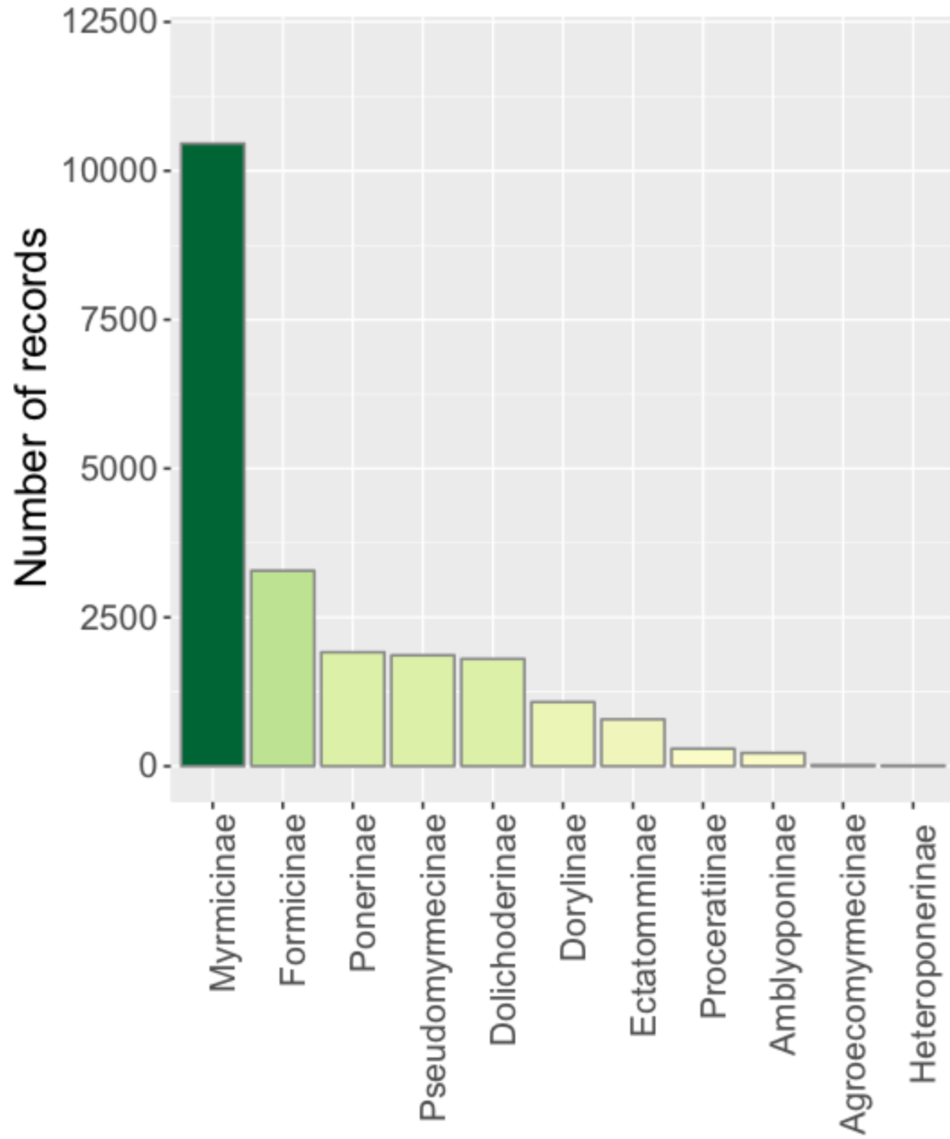

Fig. 7. Number of records per ant subfamily within the MEXICO ANTS data set.

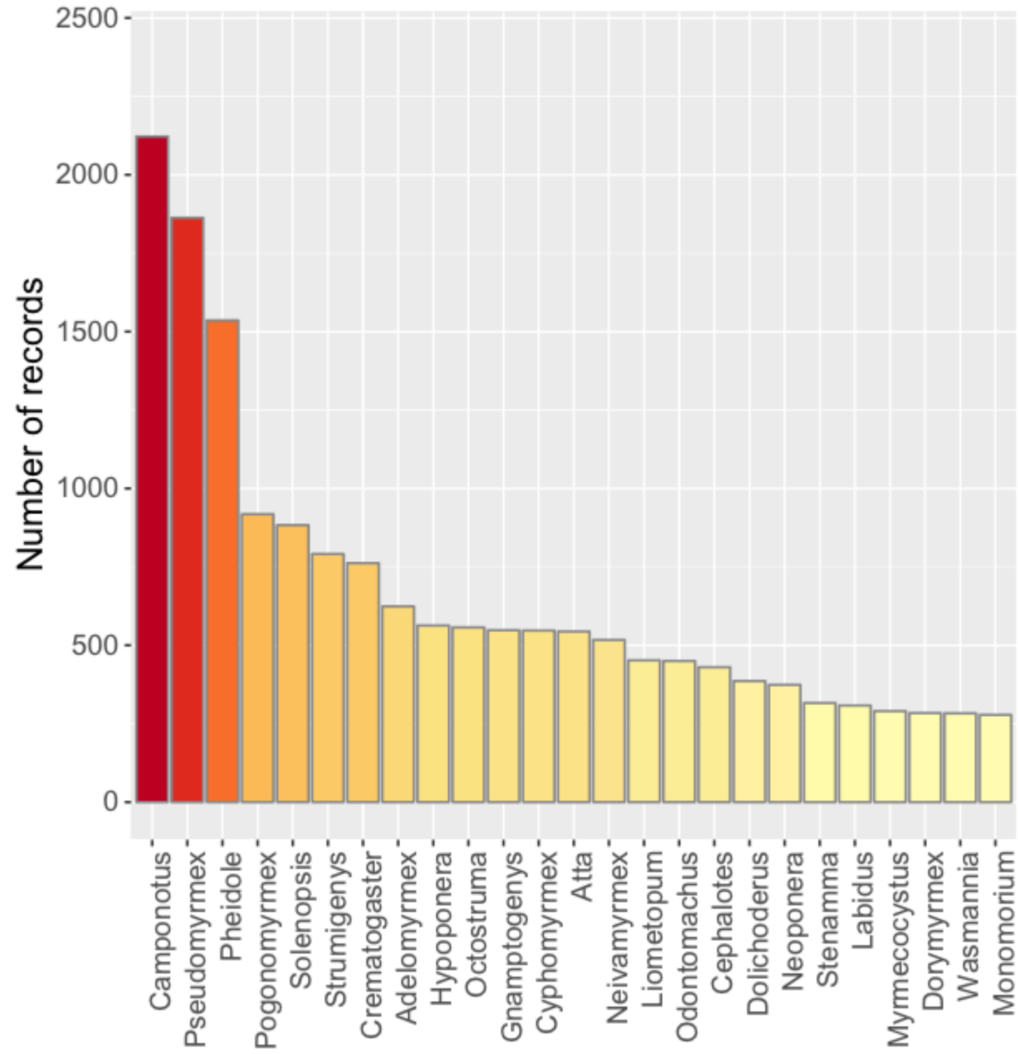

Fig. 8. Number of records per ant genus (only those with more than 250 records are included) within the MEXICO ANTS data set.

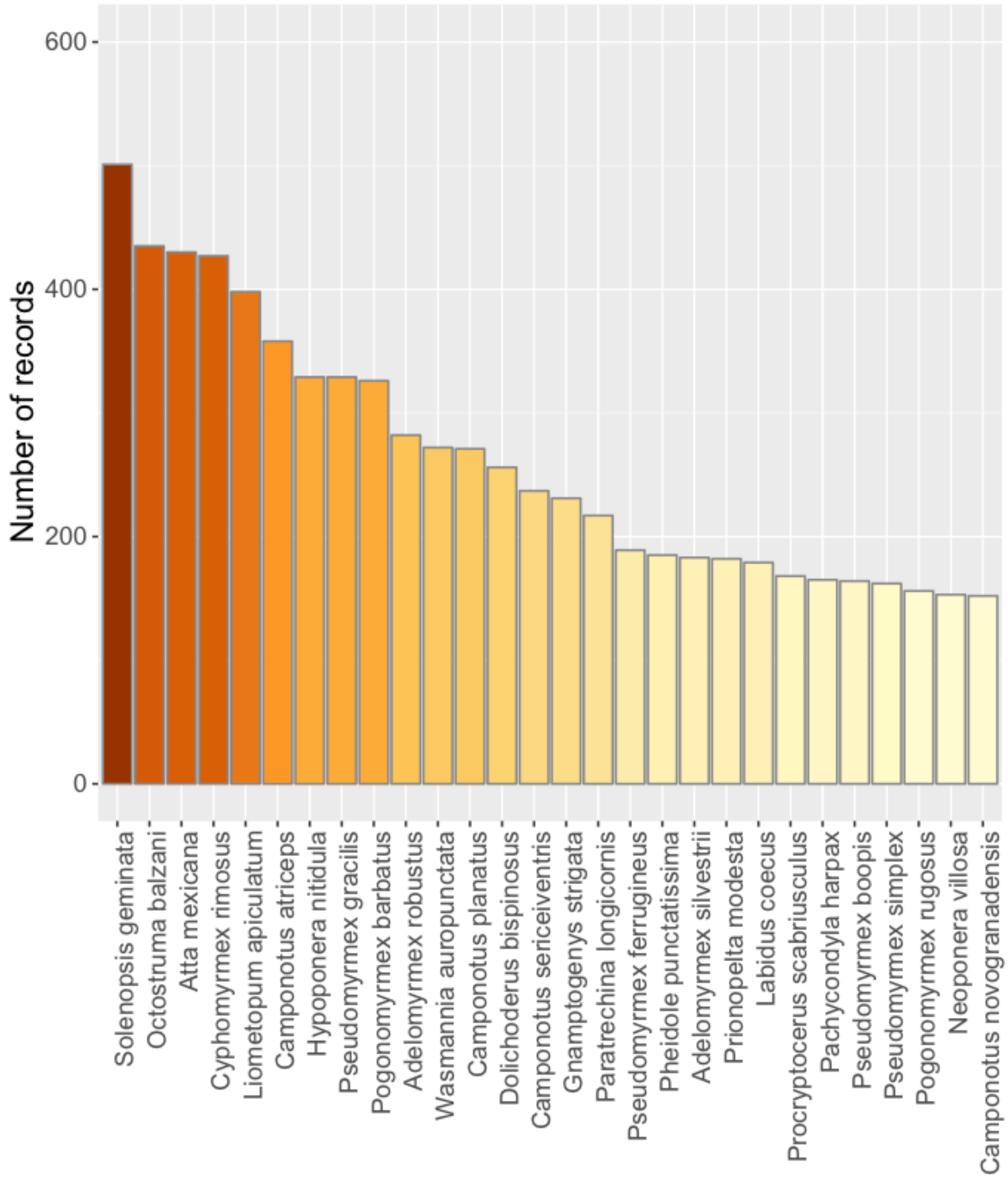

Fig. 9. Number of records per ant species (only those with more than 150 records are included) within the MEXICO ANTS data set.

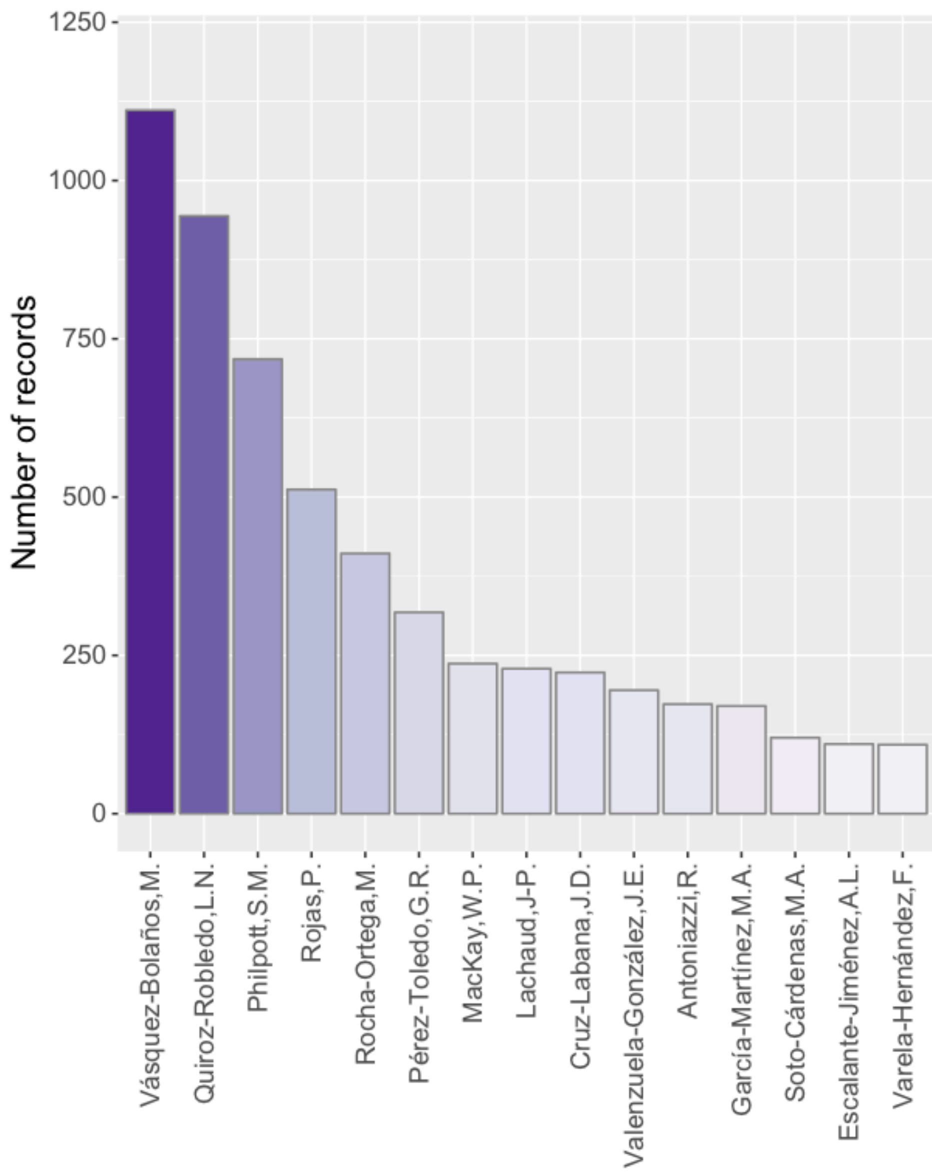

Fig. 10. Number of records per specialist who identified the ants (only those with more than 100 records are included) within the MEXICO ANTS data set.

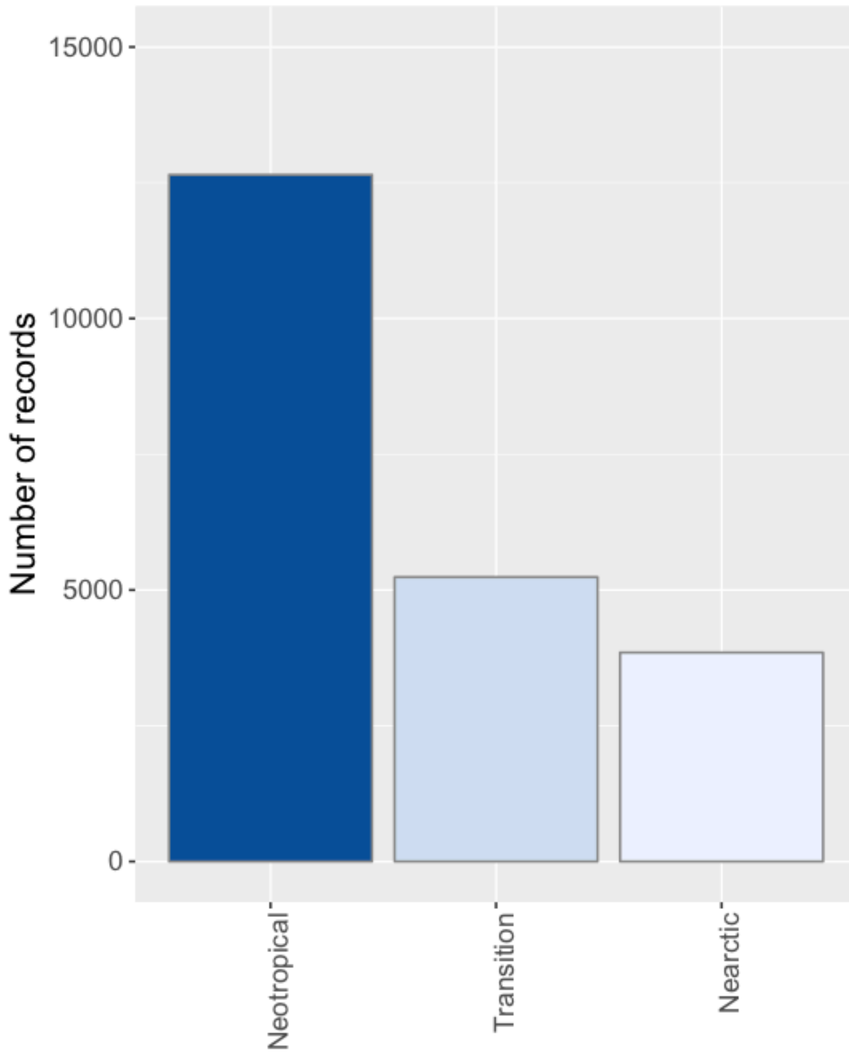

Fig. 11. Number of records in each biogeographical region (i.e., Neotropical, Nearctic or Mexican transition zone) within the MEXICO ANTS data set. Biogeographical regions of the country are classified according to Morrone et al. (2017).

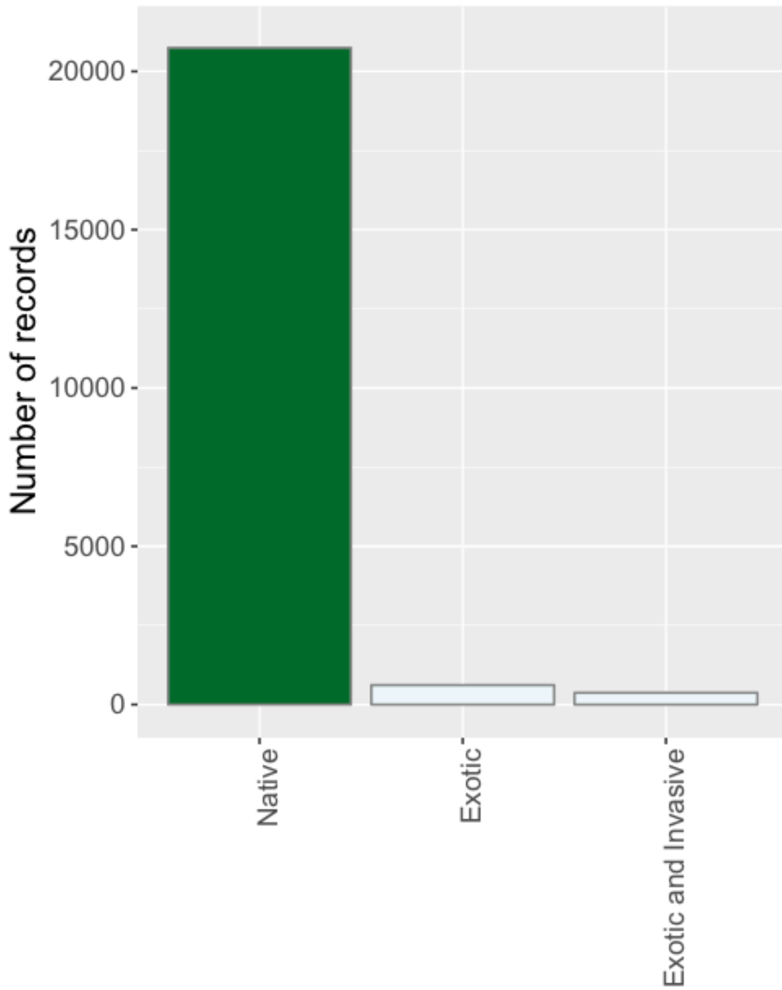

Fig. 12. Number of records of native, exotic, and both exotic and invasive ant species within the MEXICO ANTS data set.

We were able to determine whether the sampling records were inside (n = 2,849, 39.97%) or outside (n = 4,279, 60.03%) protected areas for 32.80% (n = 7,128) of records (Fig. 13). When fragment sizes could be obtained directly by the authors or through the information available for protected areas (SEMARNAT-CONANP 2017) (n=4122, 18.96 %), they ranged from 0.14 to 723.185 ha, in which 25.16% of the fragments were less than 100 ha in size (Fig. 14). Of the ant records recorded inside protected areas, 33.45%

(n = 953) were from the Estación de Biología Tropical Los Tuxtlas, followed by Reserva de la Biósfera Los Tuxtlas (n = 590, 20.71%), and Centro de Investigaciones Costeras La Mancha (n = 273, 9.58%) (Fig. 15).

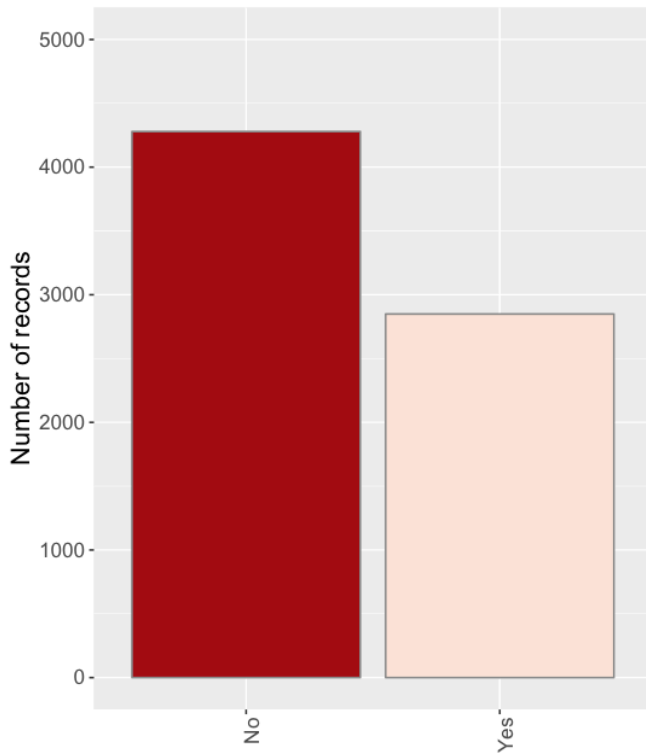

Fig. 13. Number of records outside (No) or inside (Yes) protected areas within the MEXICO ANTS data set.

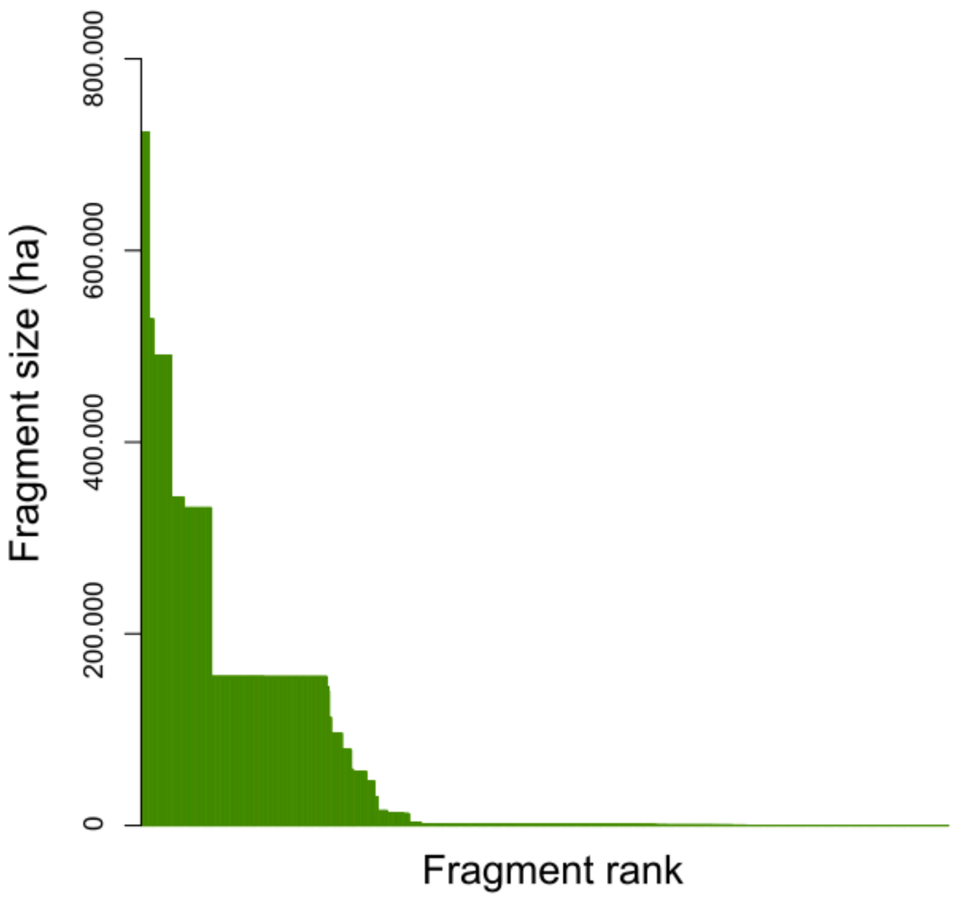

Fig. 14. Rank of the fragment size distributions within the MEXICO ANTS data set. Fragment size was obtained either directly from the authors or through the information available for protected areas.

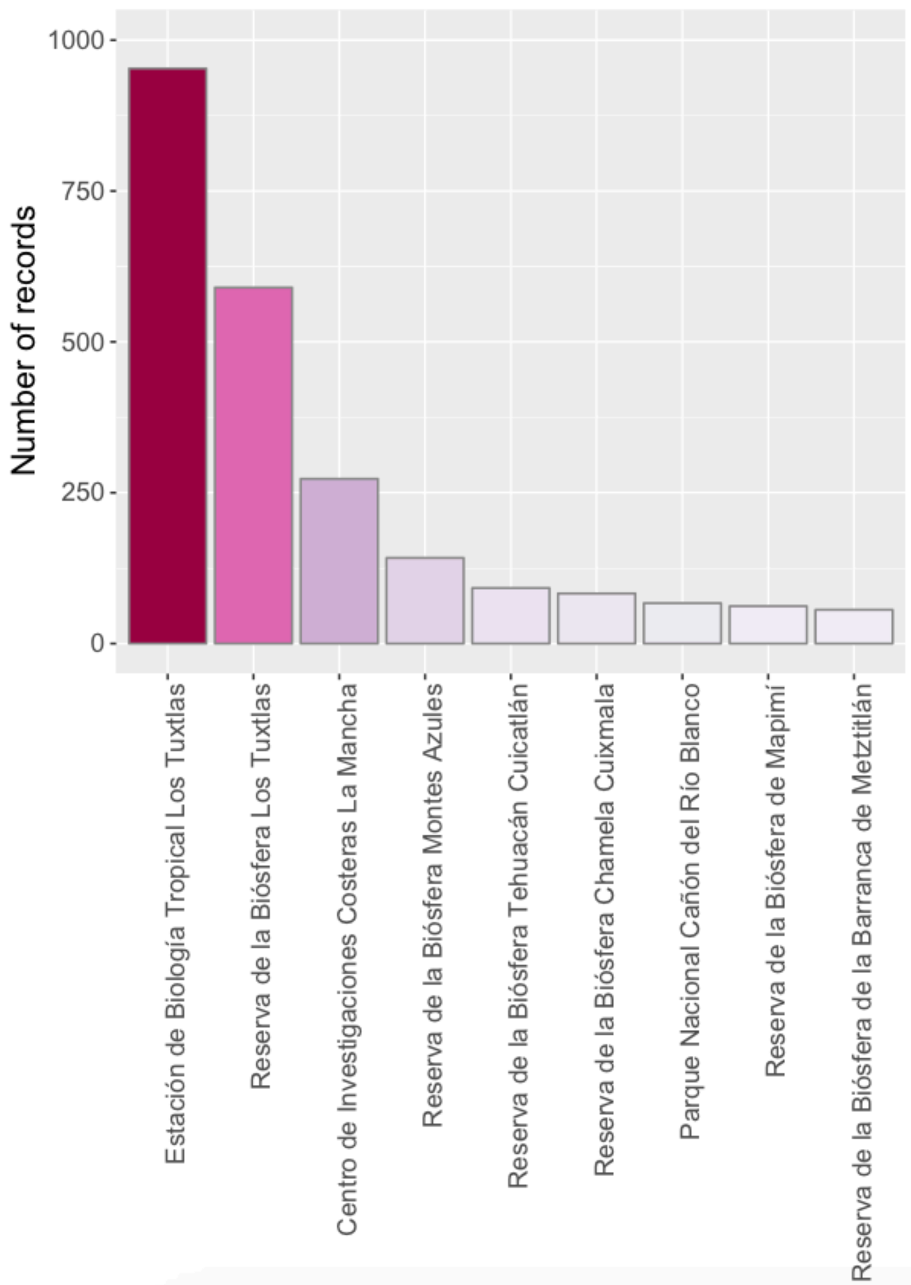

Fig. 15. Number of ant records per protected area within the MEXICO ANTS data set.

Of the sample methods used to obtain all records (n= 10,828), 41.51% of records were collected by hand (n = 2,932) or with pitfall traps (n = 1,563) (Fig. 16). Most of our records (n = 16,001, 73.63%) are of species incidence rather than ant abundance (n =

5,130, 23.61%) (Fig. 17). Of the 50 different scientific collections where the ants are deposited, the CAS-ENT Entomology Collection (California Academy of Sciences, United States of America), IEXA Entomological Collection (Instituto de Ecología A.C., Mexico), and CZUG Entomological Collection (Universidad de Guadalajara, Mexico) have the highest number of records, with 5,414 (38.88%), 3,315 (23.81%) and 1,387 (9.96%) records respectively (Fig. 18). Although we compiled information on records for 124 years (1894 to 2018), more than 90% of the records were from between 2000 and 2018 (Fig. 19). 33.88% of the ant records were obtained from databases (i.e., those records available within official online repositories such as collections, GBIF and SNIB-CONABIO), only (n = 7,363), 32.25% were obtained from scientific papers (n = 7,009), and 24.16% were from unpublished data (i.e., records that are not available publicly, but were sent directly by the authors) (n = 5,251). Another 9.71% were obtained from various other sources, such as records from iNaturalist observations, records from abstracts of scientific meetings, non-digitized records of collections and personal websites), as well as book chapters, thesis, and books (n = 2,188) (Fig. 20). We separated published records (n = 16,480, 75.83%) into study categories. We found that most studies were diversity studies (i.e., inventories, checklists, surveys) (n= 12,972 records, 78.71%), followed by taxonomy and systematics studies (i.e., taxa descriptions, revisions, morphology, genetics, phylogenies and evolution) (n= 1,782 records, 10.81%), ecological studies (i.e., population, community and other hypothesis-based ecological studies) (n= 1,460 records, 8.85%), and studies on ant control and management (i.e., economical and sanitary impact of ants) (n= 266 records, 1.61%) (Fig. 21).

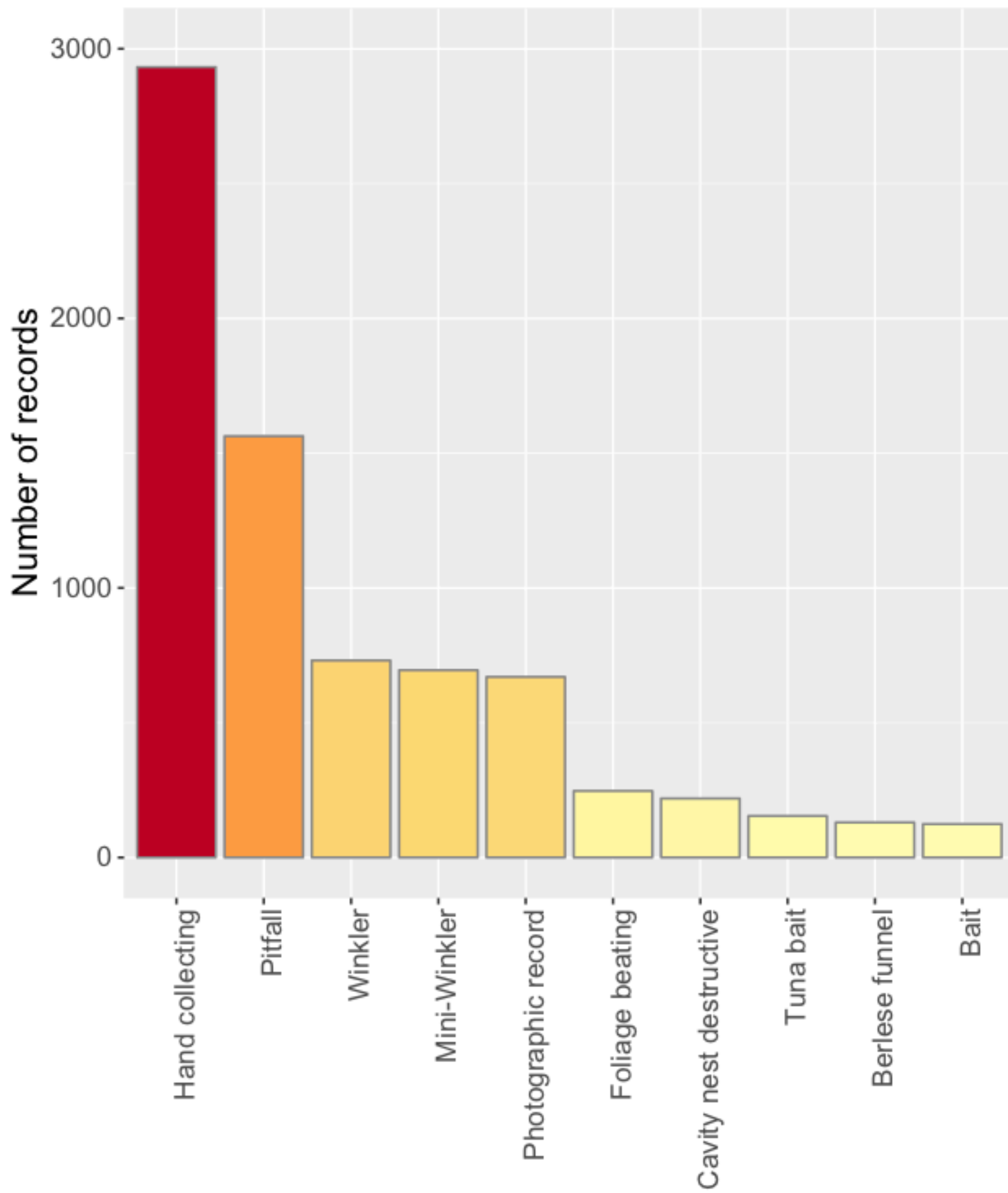

Fig. 16. Number of records per sampling method within the MEXICO ANTS data set.

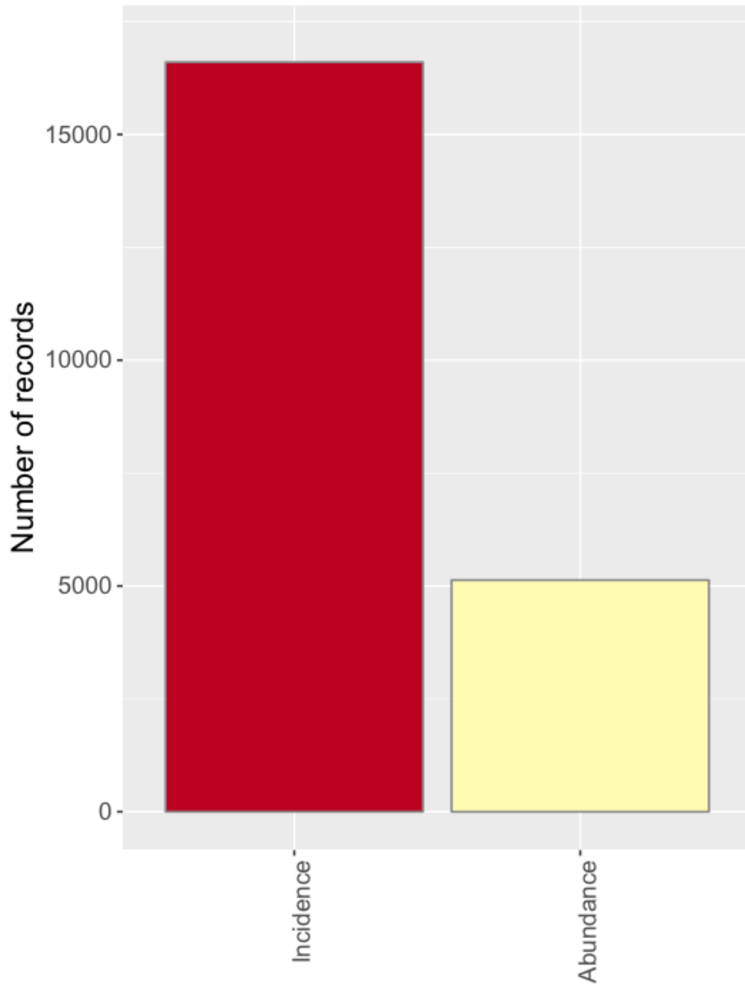

Fig. 17. Number of records by data category (incidence or abundance) within the MEXICO ANTS data set.

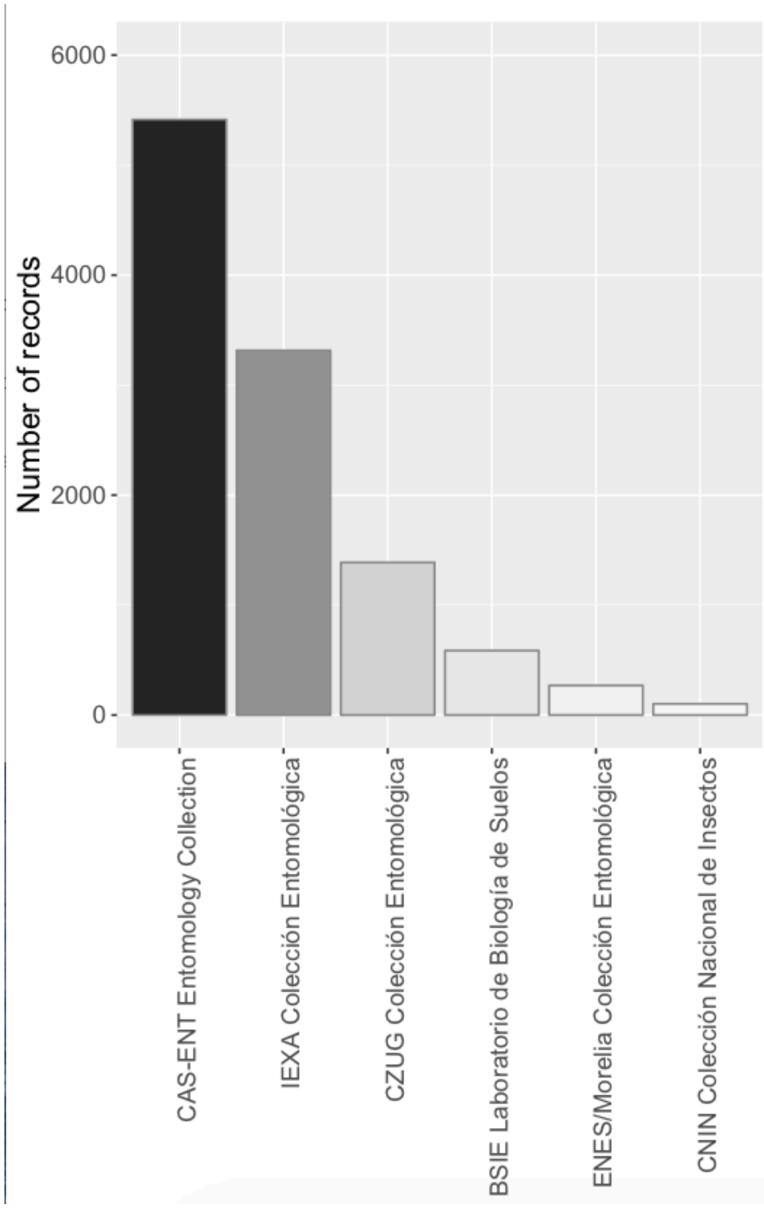

Fig. 18. Number of records per scientific collection within the MEXICO ANTS data set.

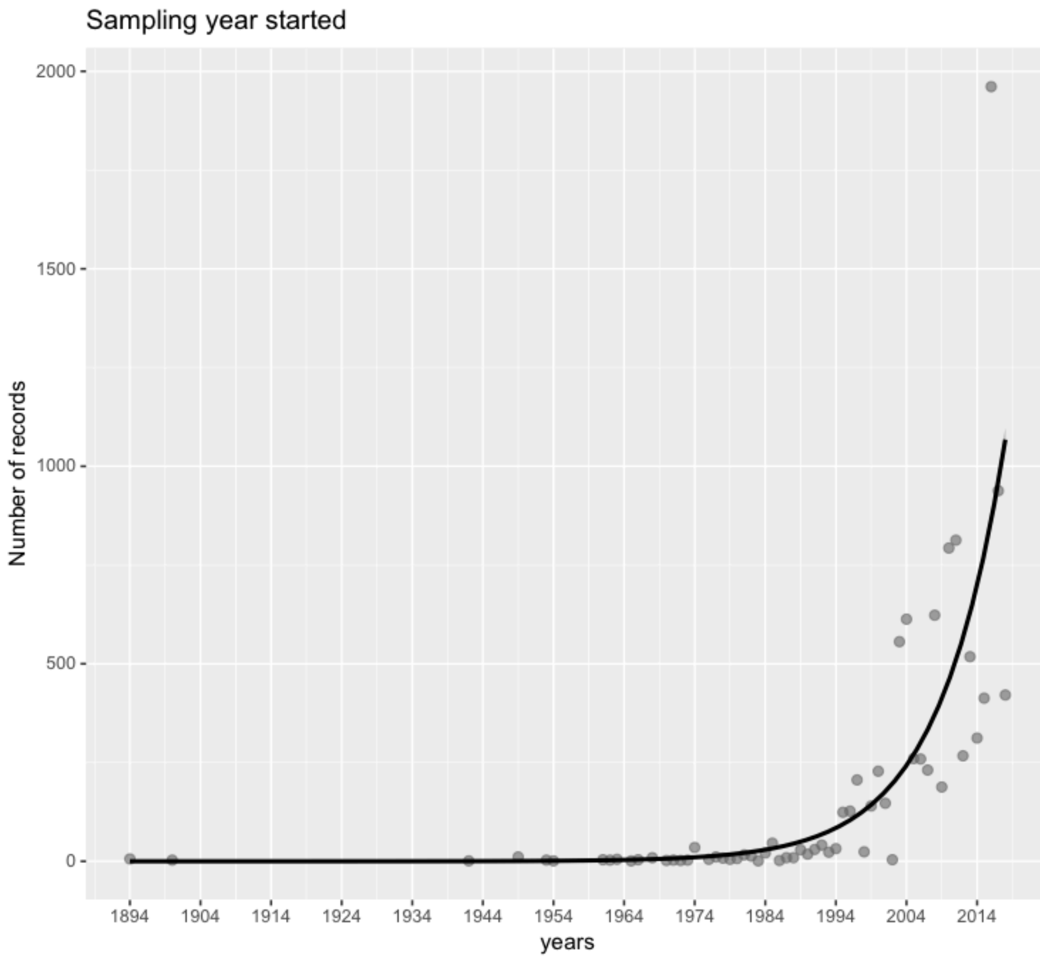

Fig. 19. Distribution of the number of records from 1894 to 2018 within the MEXICO ANTS data set.

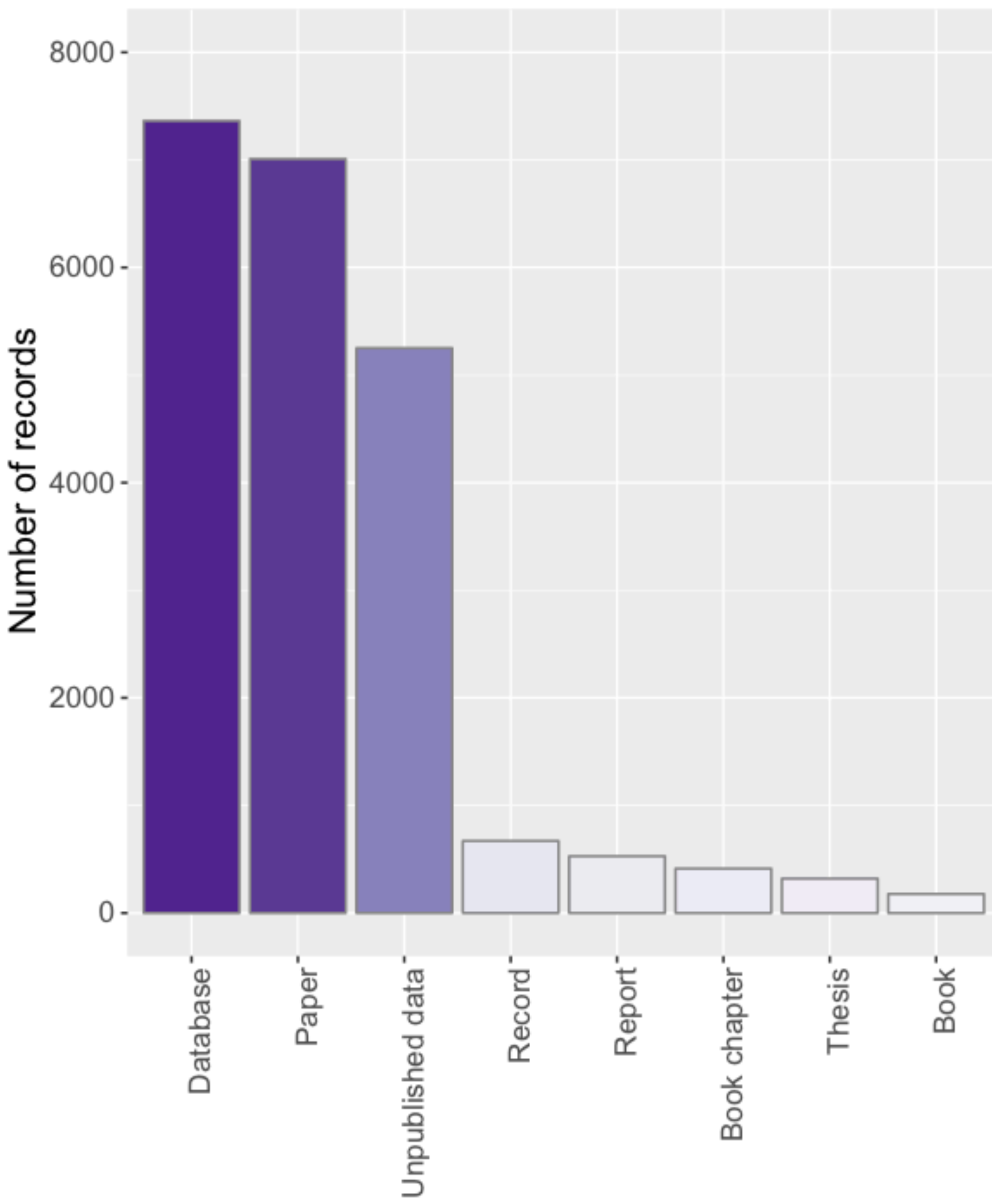

Fig. 20. Number of records per reference type within the MEXICO ANTS data set.

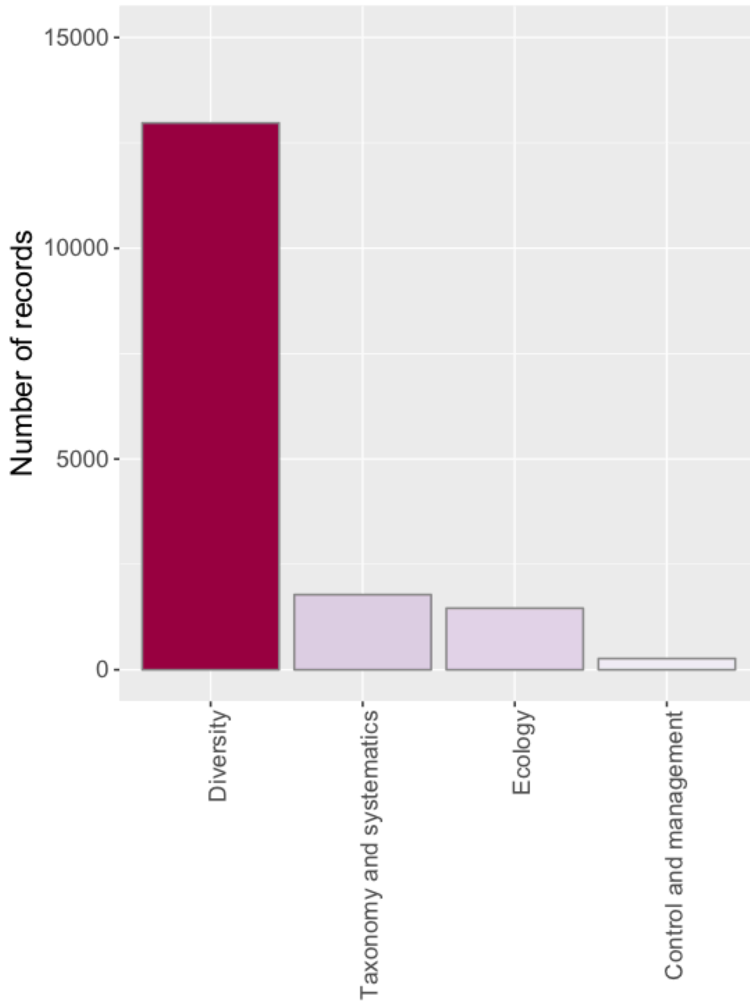

Fig. 21. Number of records per category of study within the MEXICO ANTS data set.

CLASS II. RESEARCH ORIGIN DESCRIPTORS

A. Overall project description

Identity: A compilation of ant records within Mexican territory.

Originators: The MEXICO ANTS project was coordinated by the research groups of Wesley Dáttilo from Instituto de Ecología A.C. (INECOL) and Miguel Vásquez-Bolaños from Universidad de Guadalajara (UDG). The database was assembled with help from all the other authors.

Period of Study: Data sampling ranged from 1894 to 2018.

Objectives: The aims of this data paper were to i) compile the information available in the English, Spanish, and Portuguese literature on sampling sites of ant communities throughout Mexico, and to (ii) identify major patterns in the ant records and identify knowledge gaps to guide future sampling efforts. Our data set is a first attempt to obtain a large-scale catalog of ant communities in Mexico for use on a wide variety of scales – from local to landscape, regional, and macroecological perspectives.

Abstract: As above.

Sources of funding: The compilation of this data set was supported by grants, scholarships and for funding for field work from Consejo Nacional de Ciencia y Tecnologia (CONACYT grants: 2013/223033, SEP-CB-2015-01-251388, CB 2008/101542-F, #482721, #321229, #173801, #548241/307175, DICB-2016-282471, Scholarship #416525, Scholarship #584340, Scholarship #609173, Scholarship #34925, FORDECYT-296354), Instituto Politécnico Nacional (grants SIP-20170564, #1808, SIP-20181619), Bat Conservation International (grant SS1806), Rufford Foundation (grant 24551-1) Universidad Nacional Autónoma de México (grants PAPIIT-IN206818, PAPIIT-IA203515, PAPIIT-IN202117, PAPIITIN214014, FESI-DIP-PAPCA-2014-38), National Science Foundation (grant DEB-1020096), Instituto de Ecología A.C. (grant PO-20030-11581), Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO grants GEF-083999, FB1773-ME014-15, G-032), Global Environment Facility (TSBF-CIAT, Project: Conservation and Sustainable Management of Below-Ground Biodiversity), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior

(CAPES), UCMEXUS-CONACYT Postdoctoral Fellowship program, Institute of the University of Michigan and Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG).

B. Specific subproject description

Site description: We adopted a broad delimitation of the Mexican territory according to the National Institute of Statistics and Geography of Mexico (INEGI 2018) (Fig. 1), which encompasses several biomes and biogeographical regions, thus ensuring a more comprehensive inclusion of ant inventories in the country.

Data compilation: Data was obtained from raw unpublished data (records, reports, databases) and published information (including books, book chapters, scientific papers, and thesis). We searched for potential information in the following sources: (i) online academic databases (e.g., Scielo, Scopus, ISI Web of Knowledge, Google Academic, GBIF, EncicloVida/CONABIO, iNaturalist); (ii) references cited in literature, and (iii) by formal petition through direct contact with authors and other experts to request the contribution of their raw data. The searches were performed with the following keywords: ant(s), inventory(ies), and Mexico. Search terms in the academic databases were used in English, Spanish, and Portuguese. Ant records were compiled from 282 studies (for more detailed information, please see our data set) and our own observations. Our basic criteria included information on the geographical coordinates of the records (i.e., latitude and longitude) and the identification of specimens to species level. Missing information was labeled "NA" in the data set. We used the following filters for records extracted from iNaturalist (https://www.inaturalist.org): (i) quality rating: “Research”, (ii) revised: “Yes”, (iii) identification: “Most users agree”, (iv) country: "Mexico", (v) species or group: "Formicidae", and (vi) exact range: "Species".

Taxonomic data: We used the taxonomic names provided by the AntWeb/California Academy of Sciences (2019), which is derived from three sources: The Bolton Catalog of ant names (https://www.antweb.org/world.jsp), specimen records, and user-created species lists (e.g., regions and projects). We therefore updated the identity of some ant species to the most recent nomenclature.

Validation: Specialists (Dr. Miguel Vásquez Bolaños and Dr. Wesley Dáttilo) verified all information compiled and excluded records that were erroneous (i.e., names for each ant species, synonyms, and duplicate data). Sampling coordinates were verified using the World Geodetic System (WGS84) as the spatial reference system gathering all records within the extent of the Mexican territory. Specifically, we searched for extreme values, corrected any transcription errors and homogenized taxonomic information.

C. Data limitations and potential enhancements

Ants are an extremely diverse group in terms of species richness, habitat use and behavior, however, many taxonomic groups are represented by cryptic species, mainly leaf litter ants. For this reason, we did not compile information on ant morphotype records, since these morphotypes from different research groups and scientific papers are not comparable. In this sense, we prefer to be conservative in using only species identified to the species level and validating the species name to the most recent taxonomy and adjoining synonyms.

Despite the large number of records that we were able to compile (21,731 records involving 887 ant species), this represents only a subset of one of the planet's most diverse terrestrial organisms. In fact most of the states of Mexico (n = 21, 65.63%) had fewer than 300 ant records, indicating that most of the country is under-sampled and this fauna is underestimated. Many records come from indirect sampling, or samples resulting from studies that were not directly intended to study ants, such as studies of the diets of other animals (birds and lizards), fossils, culinary practices, and funerary bundles. This type of data is extremely important for ant records, as it complements traditional sampling methods. We also used 670 records (3.08%) from the citizen science website iNaturalist (https://www.inaturalist.org), a website that allows naturalists to map and share photographic observations of biodiversity across the globe. The identification of those records may not always be reliable, however, and, therefore we left the source information of the record, allowing the potential users of this data paper to choose whether or not to use such records. One major limitation of our database is the difference in the standardization of sampling methods and efforts, which means that the ant communities in many regions cannot be compared with each other. Another limitation in our dataset is the classification of vegetation and land cover types. Although this classification was made directly in the field by collectors, which makes the records reliable, there could be limitations to the standardization of categories between different records. Accordingly, we suggest caution in using this information to avoid inappropriate inferences. It is also important to note that in some of the compiled studies, the authors do not explicitly separate maxi-Winkler from mini-Winkler records. We therefore cannot assume exactly which technique was employed for extracting ants from leaf-litter since in some cases the paper or label only noted the Winkler method. Finally, the geographical accuracy of data is another important topic that deserves attention. In this case, geographical coordinates were provided by the authors and we extracted them from scientific papers with different levels of precision (in meters). This difference in the accuracy of the data could represent a bias (in the extraction of the name of the municipalities, precipitation, temperature, elevation and sampling point) in our data set when information is required on a finer scale.

Despite all these limitations, we were able to compile the largest and most complete data set of ant species for Mexico. After viewing the information compiled in this data set, we suggest that upcoming studies on Mexican ants should attempt (i) to standardize sampling methods and efforts, (ii) to perform long-term inventories, (iii) to deposit sample specimens in scientific collections, and (iv) to provide the record information in online repositories (preferably free of charge to users). We expect that the users of this data set will be able to determine priority areas for ant conservation and conduct research into macroecological and biogeographical patterns, as well as fulfilling many other ecological and conservation-related knowledge gaps.

Class III - Data set Status and Accessibility

A. Status

Latest update

December 2018.

Latest archive date

December 2018.

Metadata status

December 2018.

B. Accessibility

Storage location and medium:

Original MEXICO ANTS data set can be accessed on the ECOLOGY repository.

Updated versions of this dataset and some extra information can be accessed at Zenodo:

https://doi.org/10.5281/zenodo.3529855

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Copyright restrictions

None

Proprietary restrictions

Please cite this data paper when using its data for publications or teaching events.

Costs

None

Class IV - Data Structural Descriptors

A. Data set file

Identity:

MEXICO_ANTS_DATASET.csv

Size:

MEXICO_ANTS_DATASET.csv, 38 columns, 21,731 records, 10,461 KB.

Format and storage mode:

Comma-separated values (.csv)

Header Information:

See column descriptors in Section B.

Alphanumeric attributes:

Mixed.

Data anomalies:

If no information is available for a given record, this is indicated as 'NA'.

B. Variable information

Table 1. Description of the fields related to the data set linked to the file MEXICO_ANTS_DATASET.csv.

Variables	Description	Levels	Example
Collector	Person or people responsible for collecting the record	355	Dáttilo, W.
Longitude	Corrected and transformed coordinates of longitude in decimal degrees (Datum WGS84)	decimal degree	-92.33593
Latitude	Corrected and transformed coordinates of latitude in decimal degrees (Datum WGS84)	decimal degree	15.17067
Country	English name of the country	Mexico	Mexico

State	State or province of the study site based on the geographic coordinates	32	Jalisco
Municipality	Municipality of the study site based on the geographic coordinates	829	Guadalajara
Vegetation_or_land_cover_type	Vegetation or land cover type based on the original information compiled from the literature or availability by data collector	96	Tropical rainforest

Elevation	Meters above sea level range obtained later based on the corrected coordinates	0 to 3685	3327
Temperature	Annual mean temperature. WorldClim v. 2., in Celsius degrees, available in http://www.worldclim.org/version2	5.74 to 28.55	26.4
Precipitation	Annual mean precipitation. WorldClim v. 2., in millimeters, available in http://www.worldclim.org/version2	53.59 to 4557	1274
Kingdom	Taxonomic kingdom	1	Animalia
Phylum	Taxonomic phylum	1	Arthropoda
Class	Taxonomic class	1	Insecta

Order	Taxonomic order	1	Hymenoptera
Family	Taxonomic family	1	Formicidae
Subfamily	Taxonomic subfamily	17	Myrmicinae
Genus	Taxonomic genus	96	Cephalotes
Species	Taxonomic species	887	Atta mexicana
Insect_identification	Person or people responsible for the specimen identification	72	Vásquez-Bolaños,M.
Bioregion	Mexican biogeographic province according to Morrone et al. (2017)	3	Neotropical

Exotic_and_or_Invasive	Classification into native, exotic, and exotic and invasive species according to Deyrup et al. 2000, Guénard et al. 2017, Holway et al. 2002, Lowe et al. 2000, Pyšek et al. 2008, Suarez et al. 2005, http://www.antkey.org/en , http://idtools.org/id/ants/pia/	3	Native
Protected_area	Records inside (i.e., Yes) or outside (i.e., No) protected areas provided by the data collectors	2	Yes

Fragment_size	Area (in Ha) of reserves, parks, conservation units sampled in study locations provided by the data collectors	0.14 to 723,185	0.14
Name_of_the_protected_area	Name of reserves, parks, conservation units sampled in study locations provided by the data collectors	55	Estación de Biología Tropical Los Tuxtlas
Sampling_method	Sampling method described in the reference paper or by the data collector	74	Winkler
Number_of_samples	Number of sampling points	1 to 2904	77
Distance_between_samples	Distance in meters between the sampling points	0.8 to 10000	10

Duration_hours	Sampling effort measured in hours	0.05 to 21600	48
Data_type	Whether the ant records were based on incidence or abundance	2	Abundance
Number_of_individuals	Number of ant individuals sampled	1 to 14777	61
Collection	Scientific collection in which the specimens were deposited	50	IEXA Entomological Collection
Institution	Institution in which where the specimens were deposited	40	Instituto de Ecología AC
Collection_Country	Country where the specimens were deposited	5	Mexico
Sampling_year_Started	Year that data collection started	1894 to 2018	2004
Sampling_year_Finished	Year that data collection ended	1894 to 2018	2005

Reference_type	Type of reference from which the data was obtained	8	Paper
Knowledge_area	Knowledge area regarding the records obtained from published information	4	Diversity
Reference	Source from which the records were obtained	958	Ahuatzin, D. A., E. J. Corro, A. Aguirre, J. Valenzuela-González, R. M. Feitosa, M. C. Ribeiro, J. C. Acosta, R. Coates, and W. Dáttilo. 2019. Forest cover drives leaf litter ant diversity in primary rainforest remnants within human-modified tropical landscapes. Biodiversity and Conservation **28**: 1091-1107.

CLASS V. SUPPLEMENTAL DESCRIPTORS

A. Data acquisition

1. Data request history: None

2. Data set updates history: None

3. Data entry/verification procedures

G. History of data set usage

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