



Fundación
Miguel Lillo
Tucumán
Argentina

doi

New voucher-supported records for two different species of the leaf-cutting ant genus *Atta* (Hymenoptera: Formicidae) in Córdoba, Argentina: *Atta saltensis* and *Atta vollenweideri*

Nuevos registros con ejemplares de referencia de dos especies diferentes del género de hormigas cortadoras de hojas *Atta* (Hymenoptera: Formicidae) en Córdoba, Argentina: *Atta saltensis* y *Atta vollenweideri*

Mariana Pereyra^{1*} , Corina A. Barrera² 

¹ Laboratorio de Ecología Evolutiva y Biología Floral, Instituto Multidisciplinario de Biología Vegetal, Universidad Nacional de Córdoba – Consejo Nacional de Investigaciones Científicas y Técnicas, Av. Vélez Sarsfield 1611, X5016GCA, Córdoba, Argentina.

² Fundación para el Estudio de Especies Invasivas (FuEDEI), General Simón Bolívar 1559, CP 1686 Hurlingham, Buenos Aires, Argentina.

* Corresponding author: <mpereyra@imbiv.unc.edu.ar>

Abstract

Leaf-cutting ants are exceptionally dominant Neotropical herbivores, with their southernmost distribution found in Argentina. Ants of the genus *Atta* perform several functions that can significantly impact the environment, one of the most important being the construction of large nests, which has earned them the well-deserved name of 'ecosystem engineers'. However, the profound impacts these ants have on ecosystems, such as the removal of large amounts of biomass, can be devastating in some human-modified environments. Understanding the distribution of these key ant species is fundamentally important. Although leaf-cutting ants have been extensively studied, the distribution of some *Atta* species remains incompletely documented in Argentina,

► Ref. bibliográfica: Pereyra, M.; Barrera, C. A. 2026. "New voucher-supported records for two different species of the leaf-cutting ant genus *Atta* (Hymenoptera: Formicidae) in Córdoba, Argentina: *Atta saltensis* and *Atta vollenweideri*". *Acta Zoológica Lilloana* 70 (2): 901-915. DOI: <https://doi.org/10.30550/j.azl/2455>

► Recibido: 30 de julio 2026 – Aceptado: 29 de septiembre 2026.

► URL de la revista: <http://actazoologica.lillo.org.ar>



OPEN ACCESS

► Esta obra está bajo una Licencia Creative Commons Atribución – No Comercial – Sin Obra Derivada 4.0 Internacional.

particularly because several historical records lack precise locality data or verifiable voucher information. This article reports two voucher-supported collection records of *Atta* ant species (*Atta saltensis* and *Atta vollenweideri*) in Córdoba Province, central Argentina.

Keywords: Central Argentina, fungus-growing ants, dominant herbivorous, ecosystem engineers.

Resumen

Las hormigas cortadoras de hojas son herbívoros neotropicales excepcionalmente dominantes, y su límite sur de distribución se encuentra en Argentina. Las hormigas del género *Atta* desempeñan varias funciones que pueden tener un impacto significativo en el medio ambiente, siendo una de las más importantes la construcción de grandes nidos, lo que les ha valido el merecido nombre de «ingenieras del ecosistema». Sin embargo, los profundos impactos que estas hormigas tienen en los ecosistemas, como el consumo de grandes cantidades de biomasa, pueden resultar devastadores en algunos entornos modificados por el ser humano. Comprender la distribución de estas especies clave de hormigas es de vital importancia. Aunque las hormigas cortadoras de hojas han sido objeto de numerosos estudios, la distribución de algunas especies de *Atta* sigue sin estar completamente documentada en Argentina, sobre todo porque varios registros históricos carecen de datos precisos sobre la localidad o de información verificable sobre los especímenes de referencia. Este artículo presenta dos registros de recolección, respaldados por especímenes de referencia, de especies de hormigas *Atta* (*Atta saltensis* y *Atta vollenweideri*) en la provincia de Córdoba, en el centro de Argentina.

Palabras clave: Argentina central, hormigas cultivadoras de hongos, herbívoros dominantes, ingenieras del ecosistema.

INTRODUCTION

Leaf-cutting ants (LCAs) are among the dominant herbivores in many Neotropical ecosystems. They are considered pests in some regions because they feed on crops grown by humans (Hölldobler and Wilson, 1990; Wirth et al., 2003; Masiulionis and Samuels, 2025). LCAs comprise a monophyletic lineage currently represented by the genera *Atta*, *Acromyrmex*, and *Amoimyrmex*. These ant genera belong to the fungus-growing “attine” ants (Formicidae: Myrmicinae: Attini: Attina; Ward et al., 2015). While several species cultivate fungus, LCAs practice a highly derived form of fungus agriculture (Mehdiabadi and Schultz, 2010).

Leaf-cutting ants obligately depend on mutualistic fungal cultivars, which comprise distinct phylogenetic lineages whose associations may vary among ant species and according to their foraging ecology (Mueller et al., 2017). Within “higher agriculture”, that performed by LCAs, the ants feed the fungus cultivars with fresh vegetation, such as grasses, leaves and flowers (Schultz et al., 2024). Furthermore, the fungus is unable to survive independently outside of this symbiotic relationship, meaning they are entirely dependent on each other (ant-fungus) (Schultz and Brady, 2008; Schultz et al., 2024). This evolutionary innovation allows these ants to be considered equivalent to vertebrate herbivores in terms of the biomass they can consume (Hölldobler and Wilson, 1990).

The genus *Atta* Fabricius, 1804 is an evolutionarily young, monophyletic lineage of LCAs comprising 15 recognized extant species (Barrera et al., 2022; Bolton, 2025). Species of *Atta* are distributed throughout the Neotropics, from the southern portion of North America to Argentina, which represents the southern limit of the genus’ distribution (Farji-Brener and Ruggiero, 1994; Barrera et al., 2022). Mature colonies of some *Atta* species may contain several million workers, with estimates reaching approximately eight million individuals (Fernández et al., 2015), and they harvest plant material from a wide variety of monocotyledonous and dicotyledonous plants. Mature colonies may harvest approximately 1–2 tons of fresh plant material annually, although harvesting rates vary among species and environmental conditions (Blanton and Ewel, 1985; Folgarait, 1998; Swanson et al., 2019). Nests of *Atta vollenweideri* can be particularly large and complex, reaching approximately 50–78.5 m² in external area, 127–170 m² in estimated internal surface area, and containing 250–3,000 chambers (Jonkman, 1980; Swanson et al., 2019). Through vegetation harvesting and extensive nest construction, *Atta* colonies can substantially influence ecosystem processes.

Although LCAs have been extensively studied, the distribution of some *Atta* species remains incompletely documented in Argentina, particularly because several historical records lack precise locality data or verifiable voucher information. Three species of *Atta* are currently reported from Argentina: *A. sexdens*, *A. vollenweideri*, and *A. saltensis* (Kusnezov, 1978; Farji-Brener and Ruggiero, 1994; Barrera et al., 2022). *Atta vollenweideri* was described by Forel (1893), whereas *A. saltensis* was described later by Forel (1913). Historical records indicate the presence of *A. vollenweideri* in Villa María, Córdoba (Gonçalves, 1942; Borgmeier, 1950), while Kempf (1972) and Cuezco (1998) also reported *A. vollenweideri* and *A. saltensis* for Córdoba without precise locality information. Salvador (2013) subsequently reported and photographically documented *A. vollenweideri* from Villa María and surrounding areas, although the publication does not report the deposition of voucher specimens. Therefore, these historical records should be distinguished from the new, precisely documented and voucher-supported collection records presented in the present study.

Accurate occurrence data are essential for understanding species' biogeographic histories and for assessing contemporary changes in their distributions. Climate warming can contribute to shifts in species geographic ranges (Chen et al., 2011), particularly in ectothermic organisms whose distributions may be constrained by thermal tolerance (Nascimento et al., 2022). Sánchez-Restrepo (2020) developed ecological niche models for several LCAs, including *Atta saltensis* and *A. vollenweideri*, using occurrence records obtained from field surveys, literature, biodiversity repositories, and biological collections. These models indicated high climatic suitability for *A. saltensis* mainly within the Dry Chaco and for *A. vollenweideri* within the Espinal, Humid Chaco, and Dry Chaco ecoregions. Additional well-documented occurrence records can contribute to refining the known distributions of these species and provide valuable information for future ecological niche models. Here, we provide new voucher-supported records of *A. saltensis* and *A. vollenweideri* from Córdoba Province, central Argentina.

MATERIAL AND METHODS

Study Area

Córdoba Province is located in central Argentina and covers approximately 165,321 km². Its native woody vegetation comprises a heterogeneous mosaic of seasonally dry ecosystems, mainly associated with the Chaco and Espinal phytogeographic regions. In Córdoba, Chaco vegetation predominates toward the western portion of the province, whereas Espinal vegetation is mainly represented toward the east (Cabrera, 1976; Cabido et al., 2018). Specimens were collected at two sites located in contrasting environmental regions of the province: a western site associated with Chaco vegetation and an eastern site associated with the Chaco–Espinal transition.

Atta saltensis was collected in Traslasierra National Park (west location). This park, which was created in 2018, is a new protected region located near the Mallín area. The study location is characterized by a tropical xeric bioclimate (Rivas Martínez et al., 2011). The region has a strongly seasonal climate, with annual precipitation decreasing from more than 500 mm in the eastern portion of the Arid Chaco to approximately 250–300 mm toward the west; more than 70% of annual rainfall occurs during the warm season, from November to April (Karlin et al., 2013; Zeballos et al., 2023). The decrease in rainfall is accompanied by an extension of the dry season from five to seven months (Morello et al., 1985). The vegetation is of the Chaco Arid type, including forests, woodlands, and shrublands with tree cover ranging from 30–40% to scattered individuals. This vegetation type includes open forests dominated by the evergreen *Aspidosperma quebracho-blanco* Schltdl. tree and an open to closed shrub understory, as well as shrublands with scattered emergent trees.

Other common deciduous trees include *Sarcomphalus mistol* (Griseb.) Hauenschild, *Castela coccinea* Griseb., *Parkinsonia praecox* (Ruiz & Pav. ex Hook.) Hawkins and *Neltuma flexuosa* (DC.) C.E. Hughes & G.P. Lewis. The most common shrubs in the understory were *Larrea divaricata* Cav., *Justicia squarrosa* Griseb., *Senegalia gilliesii* (Steud.) Seigler & Ebinger, *Mimozyanthus carinatus* (Griseb.) Burkart, *Celtis pallida* Torr. var. *pallida*, *Monteverdia spinosa* (Griseb.) Biral, *Condalia microphylla* Cav. and *Atamisquea emarginata* Miers ex Hook. & Arn. These shrubs may dominate in areas where the tree canopy is more open. A notable feature of these forests is the presence of several epiphytic *Tillandsia* species, as well as the bromeliad *Bromelia urbaniana* (Mez) L.B. Sm., which are diagnostic of this vegetation type (Zeballos et al., 2023).

Atta vollenweideri was collected in the east of the province within the area currently included in Ansenuza National Park. A new protected area was created in 2022, to protect the Mar Chiquita lagoon and the associated wetlands of the Río Dulce floodplain. The vegetation surrounding it is characterized by an ecotone transition between Espinal and Chaco forests. Espinal forests are characterized by a mixture of forests and secondary communities. The diagnostic taxa are trees such as *Neltuma nigra* (Griseb.) C.E. Hughes & G.P. Lewis, *Neltuma caldenia* (Burkart) C.E. Hughes & G.P. Lewis, *Celtis ehrenbergiana* (Klotzsch) Liebm., *Schinus fasciculata* (Griseb.) I.M. Johnst. and the exotic *Morus alba* L., as well as the climbers *Araujia odorata* (Hook. & Arn.) Fontella & Goyder and *Clematis montevidensis* A. St.-Hil. (Cabido et al., 2018).

Ant Collection

The ants were manually collected in vials containing absolute ethanol. Once in the laboratory, the ants were mounted and identified. Identification was performed using the available taxonomic keys, in particular, we used the following keys: Borgmeier, 1959; Kusnezov, 1978; Barrera et al., 2022. Diagnostic morphological characters used for species identification are described below. The ants were then photographed using an Axiocam 208 color Zeiss camera mounted on a Leica M420 macroscope. Voucher specimens have been deposited at the Colección Entomológica Córdoba (ENTOCOR-UNC-CONICET).

RESULTS

Materials Examined

Atta vollenweideri Forel, 1893

New voucher-supported record. ARGENTINA. Córdoba Province, within the present-day Ansenusa National Park; 30°54'49.61"S, 62°39'45.55"W; WGS84, 77 m a.s.l.; 3 June 2022; M. Pereyra leg.; manual collection; 6 workers; voucher ENTOCOR 2636 (Fig. 1; Fig. 2A; Fig. 2B).

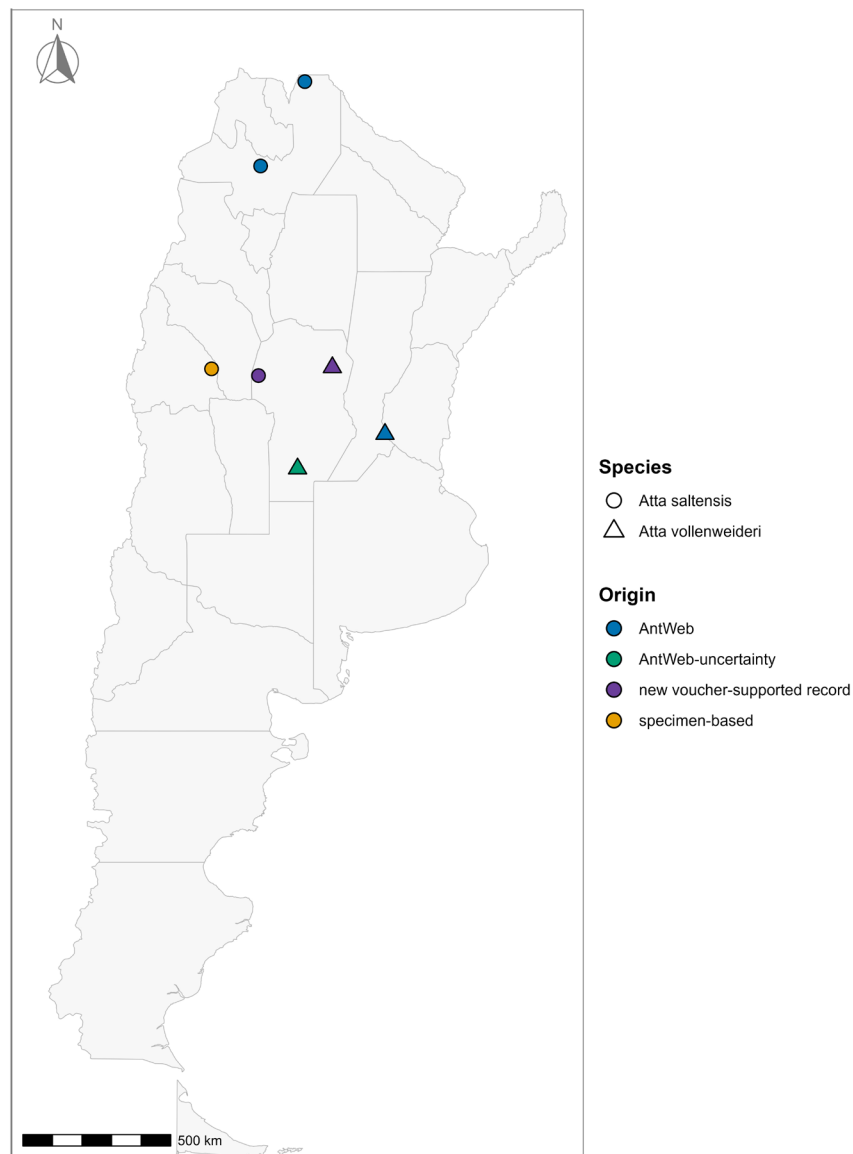


Figure 1. Map showing previous georeferenced records corresponding to AntWeb, (including uncertainty points), specimen-based records and the new voucher-supported records for both species of *Atta*: *Atta vollenweideri* and *Atta saltensis*.

Figura 1. Mapa que muestra los registros georreferenciados previos de AntWeb (incluidos los puntos de incertidumbre), los registros basados en especímenes y los nuevos registros respaldados por ejemplares de referencia para ambas especies de *Atta*: *Atta vollenweideri* y *Atta saltensis*.

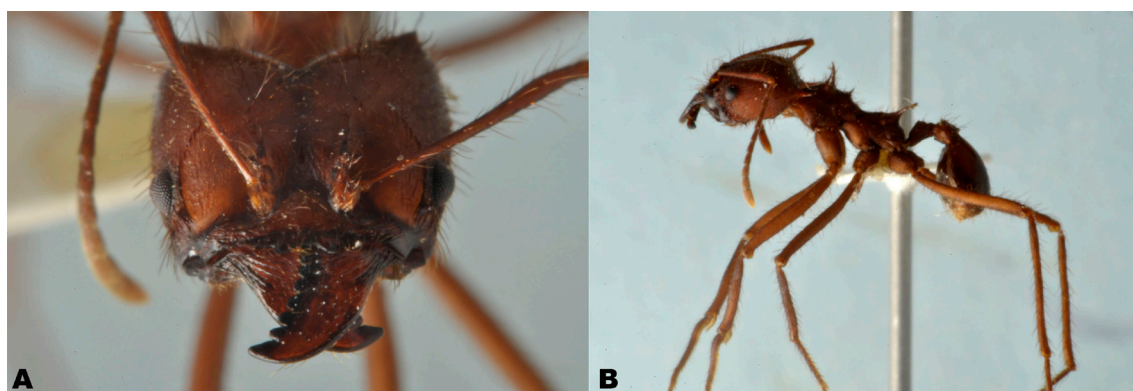


Figure 2. Minor worker of *Atta vollenweideri*. (A) Frontal view. (B) Lateral view.

Figura 2. Obrera menor de *Atta vollenweideri*. (A) Vista frontal. (B) Vista lateral.

Identification.— Workers of *Atta vollenweideri* (Fig. 2A; Fig. 2B) can be distinguished from *A. sexdens* by the relatively glabrous head, particularly in the anterior frontal region and vertex, and by the slender, elongated anterior mesonotal spines. They differ from *A. saltensis* mainly in having dull occipital lobes bearing distinct tubercles and a postpetiole with a median keel or conspicuous tooth. *Atta vollenweideri* can also be distinguished from the morphologically related *A. goiana* by the first gastral tergite, which is shiny and nearly glabrous (Borgmeier, 1959; Kusnezov, 1978).

Distribution.— Based on previous searches of two important web databases on ant biodiversity: AntMaps and AntWeb, we found that our country (Argentina) has recorded three species of the genus *Atta*: *A. sexdens*, *A. vollenweideri* and *A. saltensis*. (Guénard et al., 2017; Janicki et al., 2016; www.antweb.org). According to AntMaps, as consulted on September 1, 2026, *A. vollenweideri* is the most widely distributed species in Argentina, spanning 13 provinces, including Córdoba. It is important to note that most of these records are based on literature. Regarding Córdoba Province, Gonçalves (1942) and Borgmeier (1950) are specimen-based historical records. Kempf (1972) and Cuezso (1998) are literature-based records. As was also mentioned earlier, Salvador (2013) reported and photographically documented *A. vollenweideri* from Villa María and surrounding areas, although the publication does not report the deposition of voucher specimens. AntWeb, as consulted on September 1, 2026, contains two records for *A. vollenweideri*, one for Santa Fe and one for Córdoba (see Fig. 1) (Collection codes for Santa Fe points: FoCol2967; tc-1460449303; ANTC35960; the last two were not included on the map because they do not have coordinates or specific location). The Córdoba record is geographically imprecise and should be interpreted with caution because its coordinates are associated with georeferencing uncertainty (it was included on the map as well; collection codes: ANTC31882; FoCol2968). In the present article, we report a new precisely georeferenced and voucher-supported occurrence.

Atta saltensis Forel, 1913

New voucher-supported record. ARGENTINA. Córdoba Province, Traslasierra National Park; 31°09'54.06"S, 65°30'07.85"W; WGS84, 264 m a.s.l.; 17 May 2022; M. Pereyra leg.; manual collection; 3 workers; voucher ENTOCOR 2635 (Fig. 1; Fig. 3A; Fig. 3B).

Identification.— Unlike *Atta vollenweideri*, *A. saltensis* is characterized by very shiny or polished occipital lobes on the head, without tubercles or with faintly marked tubercles, a rounded postpetiole without a keel or tooth, and shiny, smooth mesonotal spines with few or no hairs (Borgmeier, 1959; Kusnezov, 1978) (Fig. 3A; Fig. 3B).

Distribution.— Available records indicate that *Atta saltensis* occurs in several provinces of northern and central-western Argentina. Historical records for Córdoba have been reported by Kempf (1972) and Cuezco (1998), although these records lack precise locality information. Importantly, specimen-based records of *A. saltensis* have also been documented from San Juan Province (Murúa et al., 1999). AntWeb, as consulted on September 1, 2026, currently includes georeferenced records from Salta (Collection codes: ANTC31883; ANTC35957; tc309065249; the latter was not included on the map because it has no coordinates or specific location). Whereas the present study provides a precisely georeferenced and voucher-supported occurrence from Córdoba Province (Fig. 1). This record therefore represents an important addition to the documented distribution of *A. saltensis* in central Argentina. Its status as the southernmost known occurrence should be confirmed through comparison with all previously published specimen-based and georeferenced records.



Figure 3. Minor worker of *Atta saltensis*. (A) Frontal view. (B) Lateral view.

Figura 3. Obrera menor de *Atta saltensis*. (A) Vista frontal. (B) Vista lateral.

DISCUSSION

Our review of available occurrence data indicates that the distribution of *Atta* species in Córdoba Province remains incompletely documented, with much of the historical information derived from literature records that often lack precise locality data or readily traceable voucher information. Some online records are also associated with substantial georeferencing uncertainty; however, such uncertainty should not by itself be interpreted as evidence that an occurrence is incorrect. The new records presented here provide precisely georeferenced, voucher-supported occurrences of *A. vollenweideri* and *A. saltensis* in Córdoba Province and therefore improve the documentation of their known distributions in central Argentina. The *A. saltensis* record may represent an important southern occurrence of the species, although its status as the southernmost known record should be confirmed through comparison with all available specimen-based and historical records, particularly those from San Juan Province (Murúa et al., 1999). These findings also emphasize the value of voucher specimens, which allow taxonomic identifications and associated distributional data to be independently verified.

Previous surveys of leaf-cutting ants in Córdoba Province did not record species of *Atta*. Barrera et al. (2015), working in fragmented Chaco Serrano forests and adjacent agricultural matrices, recorded only species of *Acromyrmex*, whereas Peirone-Cappri et al. (2025) surveyed leaf-cutting ants along an elevational gradient in the Córdoba mountains without reporting *Atta*. In contrast, the records documented here were obtained in lower-elevation, seasonally dry environments: *A. saltensis* in the Arid Chaco and *A. vollenweideri* in an eastern Chaco–Espinal transitional environment. These differences suggest that habitat and regional environmental conditions may contribute to the spatial distribution of leaf-cutting ant species in Córdoba. Barrera et al. (2022) showed that geographic distribution within *Atta* is associated with differences in foraging specialization. In this context, *A. vollenweideri* is primarily associated with grass and other monocotyledonous resources, whereas *A. saltensis* has been reported predominantly as a dicotyledon harvester (Fowler et al., 1989; Gonçalves, 1971; Mueller et al., 2017).

The geographic distributions of *Atta* species have been shaped by historical biogeographic processes and environmental constraints. Barrera et al. (2022) suggested that the relatively restricted distribution of *A. saltensis* may be associated with climatic barriers, particularly differences between the Dry and Humid Chaco toward the north and decreasing temperatures toward the southern portion of its range. Both *A. saltensis* and *A. vollenweideri* belong to the Epiatta clade and occur predominantly in semi-arid and dry regions of South America, although their realized distributions may also reflect differences in habitat requirements, dispersal history, and sampling effort (Barrera et al., 2022). The new records reported here expand the set

of documented localities for both species in Córdoba Province; however, additional sampling will be required to determine whether they represent previously overlooked populations, gaps in historical sampling, or actual changes in geographic range.

Anthropogenic land-use changes can alter the abundance and local distribution of some *Atta* species. For example, road construction and habitat disturbance can facilitate colony establishment and population growth in *A. laevigata* (Vasconcelos et al., 2006; Vieira-Neto et al., 2016), whereas the replacement of native vegetation by grasslands and agricultural habitats has been proposed to facilitate the geographic expansion of the grass-cutting species *A. capiguara* (Forti et al., 2020; Barrera et al., 2022). However, there is currently insufficient evidence to determine whether similar processes explain the occurrence of *A. saltensis* and *A. vollenweideri* in Córdoba.

Differences in the number of available records between *Atta vollenweideri* and *A. saltensis* may partly reflect differences in research and monitoring effort. Leaf-cutting ants have received considerable attention because of their ecological and economic importance, particularly in agricultural, forestry, and livestock systems (Sánchez-Restrepo, 2020). *Atta vollenweideri*, for example, has been studied extensively in South American rangelands because of its potential interaction with livestock production, although recent assessments indicate that its economic impact may be lower than traditionally assumed and strongly dependent on colony density (Sabattini and Bollazzi, 2023). Conversely, the comparatively limited number of records available for *A. saltensis* may reflect lower sampling intensity rather than true rarity. Moreover, leaf-cutting ants are often subject to control where they are perceived as pests, sometimes without species-specific assessment (Fowler et al., 1989). Therefore, improving taxonomically verified and georeferenced occurrence data is important for understanding the distribution and ecological roles of these species and for supporting evidence-based management and conservation decisions.

ACKNOWLEDGEMENTS

We are grateful to Sebastián R. Zeballos for field help and to Andrea A. Cocucci who helped us to take the photographs of the ants.

AUTHORS' CONTRIBUTIONS

MP, CAB: Conceptualization; MP, CAB: Methodology, Software, Data curation, Formal analysis, Writing – original draft, Visualization, Investigation; MP: Writing – review & editing; MP, CAB: Supervision. All authors actively participated in the discussion of the results, they reviewed and approved the final version of the paper.

CONFLICTS OF INTEREST

Authors declare there are no conflicts of interest.

REFERENCES

- Barrera, C. A., Buffa, L. M., Valladares, G. (2015). Do leaf-cutting ants benefit from forest fragmentation? Insights from community and species-specific responses in a fragmented dry forest. *Insect Conservation and Diversity*, 8(5), 456-463. <https://doi.org/10.1111/icad.12125>
- Barrera, C. A., Sosa-Calvo, J., Schultz, T. R., Rabeling, C., Bacci Jr, M. (2022). Phylogenomic reconstruction reveals new insights into the evolution and biogeography of *Atta* leaf-cutting ants (Hymenoptera: Formicidae). *Systematic Entomology*, 47(1), 13-35. <https://doi.org/10.1111/syen.12513>
- Blanton, C. M., Ewel, J. J. (1985). Leaf-cutting ant herbivory in successional and agricultural tropical ecosystems. *Ecology*, 66(3), 861-869. <https://doi.org/10.2307/1940548>
- Bolton, B. (2025) An Online Catalog of the Ants of the World [WWWdocument]. <https://antcat.org/> [accessed on 10 October 2025].
- Borgmeier, T. (1950) Estudos sobre *Atta* (Hym. Formicidae). Memórias do Instituto Oswaldo Cruz. Rio de Janeiro 48, 239-263.
- Borgmeier, T. (1959) Revision der Gattung *Atta* Fabricius (Hym., Formicidae). *Studia Entomologica*, 2, 321-390.
- Cabido, M., Zeballos, S. R., Zak, M., Carranza, M. L., Giorgis, M. A., Cantero, J. J., Acosta, A. T. (2018). Native woody vegetation in central Argentina: Classification of Chaco and Espinal forests. *Applied Vegetation Science*, 21(2), 298-311. <https://doi.org/10.1111/avsc.12369>
- Cabrera, A. L. (1976) Regiones fitogeográficas argentinas. In: Kugler WF (Ed.) Enciclopedia Argentina de Agricultura y Jardinería. Acme, Buenos Aires, 85 pp

- Chen, I.-C., Hill, J. K., Ohlemüller, R., Roy, D. B., Thomas, C. D. (2011). Rapid range shifts of species associated with high levels of climate warming. *Science*, 333(6045), 1024–1026. <https://doi.org/10.1126/science.1206432>
- Cuezzo, F. (1998). Formicidae. In J. J. Morrone & S. Coscarón (Eds.), *Biodiversidad de artrópodos argentinos: Una perspectiva biotaxonomica* (pp. 452–462). Ediciones Sur.
- Farji-Brener, A. G., Ruggiero, A. (1994). Leaf-cutting ants (*Atta* and *Acromyrmex*) inhabiting Argentina: patterns in species richness and geographical range sizes. *Journal of Biogeography*, 391–399.
- Fernández, F., Castro-Huertas, V., Serna, F. (2015). Hormigas cortadoras de hojas de Colombia: *Acromyrmex* & *Atta* (Hymenoptera: Formicidae). *Fauna de Colombia, Monografía No. 5*. Instituto de Ciencias Naturales, Universidad Nacional de Colombia.
- Folgarait, P. J. (1998). Ant biodiversity and its relationship to ecosystem functioning: a review. *Biodiversity & Conservation*, 7, 1221–1244. <https://doi.org/10.1023/A:1008891901953>
- Forel, A. (1893). Note sur les Attini. *Annales de la Société Entomologique de Belgique*, 37, 586–607.
- Forel, A. (1913) Fourmis d'Argentine, du Brésil, du Guatemala & de Cuba reçues de M. M. Bruch, Prof. v. Ihering, Mlle Baez, M. Peper et M. Rovereto. *Bulletin de la Société Vaudoise des Sciences Naturelles*, 49, 203–250.
- Forti, L. C., Rando, J. S., da Silva Camargo, R., Moreira, A. A., Castellani, M. A., Leite, S. A., Andrade Sousa, K. K., Caldato, N. (2020). Occurrence of leaf-cutting and grass-cutting ants of the Genus *Atta* (Hymenoptera: Formicidae) in geographic regions of Brazil. *Sociobiology*, 67(4), 514–525.
- Fowler, H.G., Pagani, M.I., Da Silva, O.A., Forti, L.C., Da Silva, V.P., De Vasconcelos, H.L. (1989). A pest is a pest is a pest? The dilemma of neotropical leaf-cutting ants: keystone taxa of natural ecosystems. *Environmental Management*, 13, 671–675. DOI: <https://doi.org/10.1007/BF01868306>
- Gonçalves, C. R. (1942). Contribuição para o conhecimento do gênero *Atta* Fabr., das formigas saúvas. *Boletim da Sociedade Brasileira de Agronomia*, 5, 333–358.
- Gonçalves, C. R. (1971). As saúvas de Mato Grosso, Brasil (Hymenoptera, Formicidae). *Arquivos do Museu Nacional*, 54, 249–253.
- Guénard, B., Weiser, M. D., Gómez, K., Narula, N., Economo, E. P. (2017). The Global Ant Biodiversity Informatics (GABI) database: Synthesizing data on the geographic distribution of ant species (Hymenoptera: Formicidae). *Myrmecological News*, 24, 83–89. https://doi.org/10.25849/myrmecol.news_024:083
- Hölldobler, B., Wilson, E. O. (1990). *The ants*. Harvard University Press.

- Janicki, J., Narula, N., Ziegler, M., Guénard, B., Economo, E. P. (2016). Visualizing and interacting with large-volume biodiversity data using client-server web-mapping applications: The design and implementation of antmaps.org. *Ecological Informatics*, 32, 185–193. <https://doi.org/10.1016/j.ecoinf.2016.02.006>
- Jonkman, J. C. M. (1980). The external and internal structure and growth of nests of the leaf-cutting ant *Atta vollenweideri* Forel, 1893 (Hym.: Formicidae). *Zeitschrift für Angewandte Entomologie*, 89, 217–246. <https://doi.org/10.1111/j.1439-0418.1980.tb03461.x>
- Karlin, M.S., Karlin, U.O., Coirini, R.O., Reati, R.G., Zapata, R.M. (2013) El Chaco Árido. Editorial Brujas, Córdoba.
- Kempff, W.W. (1972). Catálogo abreviado das formigas da região Neotropical. *Studia Entomologica*, 15, 3-344.
- Kusnezov, N. (1978). Hormigas Argentinas. Clave para su identificación. Miscelanea-Fundacion Miguel Lillo (Argentina), 61.
- Masiulionis, V. E., Samuels, R. I. (2025). Investigating the biology of leaf-cutting ants to support the development of alternative methods for the control and management of these agricultural pests. *Agriculture*, 15(6), 642. <https://doi.org/10.3390/agriculture15060642>
- Mehdiabadi, N. J., Schultz, T. R. (2010). Natural history and phylogeny of the fungus-farming ants (Hymenoptera: Formicidae: Myrmicinae: Attini). *Myrmecological News*, 13, 37-55.
- Morello, J., Protomastro, J., Sancho, L., Blanco, C. (1985). Estudio Macroecológico de los Llanos de La Rioja. Serie del Cincuentenario de la Administración de Parques Nacionales, Buenos Aires.
- Mueller, U.G., Ishak, H.D., Bruschi, S.M., Smith, C.C., Herman, J.J., Solomon, S.E., Mikheyev, A.S., Rabeling, C., Scott, J.J., Cooper, M., Rodrigues, A., Ortiz, A., Brandão, C.R.F., Lattke, J.E., Pagnocca, F.C., Rehner, S.A., Schultz, T.R., Vasconcelos, H.R., Adams, R.M.M., Bollazzi, M., Clark, R. M., Himler, A. G., LaPolla, J. S., Leal, I. R., Johnson, R. A., Roces, F., Sosa-Calvo, J., Wirth, R., Bacci Jr, M. (2017). Biogeography of mutualistic fungi cultivated by leafcutter ants. *Molecular Ecology*, 26, 6921–6937. DOI: <https://doi.org/10.1111/mec.14431>
- Murúa, A. F., Cuezco, F., Acosta, J. C. (1999). La fauna de hormigas del Gran Bajo Oriental del departamento Valle Fértil (San Juan, Argentina). *Revista de la Sociedad Entomológica Argentina*, 58(3–4), 135–138.
- Nascimento, G., Câmara, T., Arnan, X. (2022). Critical thermal limits in ants and their implications under climate change. *Biological Reviews*, 97(4), 1287-1305. <https://doi.org/10.1111/brv.12843>
- Peirone-Cappri, L., Cingolani, A. M., Alvarez Pringles, A. P., Sánchez-Restrepo, A. F. (2025). Leaf-cutting ants' distribution in an elevation gradient in central Argentina. *Studies on Neotropical Fauna and Environment*, 60(1), 58-67. <https://doi.org/10.1080/01650521.2024.2381976>

- Rivas Martínez, S., Navarro, G., Penas, A., Costa, M. (2011). Biogeographic Map of South America. A preliminary survey. *International Journal of Geobotany Research*, 1, 21–40. <https://doi.org/10.5616/ijgr110002>
- Sabattini, J., Bollazzi, M. (2023). Herbivory by *Atta vollenweideri*: Reviewing the significance of grass-cutting ants as a pest of livestock. *Frontiers in Insect Science*, 3, 1101445. <https://doi.org/10.3389/finsc.2023.1101445>
- Salvador, S. A. (2013). Hormigas Isaú (*Atta vollenweideri*) en la alimentación de algunas aves de Villa María, Córdoba, Argentina. *Nuestras Aves*, 58, 63–64.
- Sánchez-Restrepo, A. F. (2020). Historia evolutiva y distribución geográfica de las hormigas cortadoras de hojas (géneros *Acromyrmex* spp. y *Atta* spp.) en el cono sur de Sudamérica (Doctoral dissertation, Universidad de Buenos Aires).
- Schultz, T. R., Brady, S. G. (2008). Major evolutionary transitions in ant agriculture. *Proceedings of the National Academy of Sciences*, 105(14), 5435–5440. <https://doi.org/10.1073/pnas.0711024105>
- Schultz, T. R., Sosa-Calvo, J., Kveskin, M. P., Lloyd, M. W., Dentinger, B., Kooij, P. W., Vellinga, E. C., Rehner, S. A., Rodrigues, A., Montoya, Q. V., Fernández-Marín, H., Ješovnik, A., Niskanen, T., Liimatainen, K., Leal-Dutra, C. A., Solomon, S. E., Gerardo, N. M., Currie, C. R., Bacci Jr, M., Vasconcelos, H. L., Rabelling, C., Faircloth, V.C., Doyle, V. P. (2024). The coevolution of fungus-ant agriculture. *Science*, 386(6717), 105–110. <https://doi.org/10.1126/science.adn7179>
- Swanson, A. C., Schwendenmann, L., Allen, M. F., Aronson, E. L., Artavia-León, A., Dierick, D., Fernandez-Bou, A.S., Harmon, T.C., Murillo-Cruz, C., Oberbauer, S.F., Pinto-Tomás, A.A., Runde, P.W., Zelikova, T. J. (2019). Welcome to the *Atta* world: A framework for understanding the effects of leaf-cutter ants on ecosystem functions. *Functional Ecology*, 33(8), 1386–1399. <https://doi.org/10.1111/1365-2435.13319>
- Vasconcelos, H. L., Vieira-Neto, E. H. M., Mundim, F. M., Bruna, E. M. (2006). Roads alter the colonization dynamics of a keystone herbivore in Neotropical savannas. *Biotropica*, 38, 661–666.
- Vieira-Neto, E. H., Vasconcelos, H. L., Bruna, E. M. (2016). Roads increase population growth rates of a native leaf-cutter ant in Neotropical savannas. *Journal of Applied Ecology*, 53(4), 983–992.
- Ward, P. S., Brady, S. G., Fisher, B. L., Schultz, T. R. (2015). The evolution of myrmicine ants: phylogeny and biogeography of a hyperdiverse ant clade (hymenoptera: Formicidae). *Systematic Entomology*, 40(1), 61–81. <https://doi.org/10.1111/syen.12090>
- Wirth R., Beyschlag, W., Ryel, R., Herz, H., Hölldobler, B. (2003). The Herbivory of Leaf-cutting Ants. A Case Study on *Atta colombica* in the Tropical Rainforest of Panama. Springer, Berlin, Germany.

Zeballos, S. R., Acosta, A. T., Agüero, W. D., Ahumada, R. J., Almirón, M. G., Argibay, D. S., Arroyo, D.N., Blanco, L.J., Biurrun, F.N., Cantero, J.J., Márquez, J., Quiroga, A., Quiroga, R.E, Cabido, M.R. (2023). Vegetation types of the Arid Chaco in Central-Western Argentina. *Vegetation Classification and Survey*, 4, 167-188. <https://doi.org/10.3897/VCS.100532>