

BRAZILIAN MYRMECOLOGY – A BRIEF HISTORICAL REVIEW

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"O total das formigas conhecidas no mundo inteiro e no período actual foi calculado pelo Prof. H. Ludwig, — no anno de 1886, em 1200 especies [...]. E por um recente trabalho do Prof. Dr. A. Forel (1893) vejo que elle avalia hoje em dia o total já em 2000 especies (e 150 generos). Tomando, por base a primeira indicação, o Brazil participaria com bastante mais de um terço do total, e guiando-nos pela segunda avaliação (Forel) obteriamos a proporção de 9:40, ou um pouco menos que a quarta parte. Seja como for, é intuitivo, que a riqueza faunística d'este paiz mais uma vez se manifesta em relação á família dos Formicidas".

Pará, 1 de janeiro de 1895.

Dr. Emílio A. Goeldi.

ABSTRACT

Given their abundance in nature and cultural significance, it is not surprising that ants have influenced historical events and engaged the interest of researchers over time. Despite the challenges facing Entomology, Myrmecology has solidified itself as a prominent field in scientific research, particularly in Brazil. Recognized for its immense biodiversity, the country has become a reference center for ant studies, reflecting the growing interest of researchers who, over the years, have dedicated their careers to this field, which is important both nationally and for global scientific advancement. This chapter explores some of the central events, initiatives, and legacies that shaped the development of Myrmecology in Brazil. Based on the collaboration of various professionals and historical sources, we present an overview of the field's trajectory in the country. The chapter is organized around broad themes that highlight the integration of Myrmecology into Brazilian science, the institutional and collaborative efforts that supported its development, the establishment of research groups and training programs, and the initiatives that consolidated its position in both academic and applied contexts. While inevitably constrained by the scarcity of dedicated historical studies in Myrmecology, this chapter reflects on the field's development in Brazil. By emphasizing the value of historical perspectives, we aim to enrich scientific inquiry, encourage future research and strengthen the understanding of ants.

Keywords: Ants; biodiversity; entomology; history of science; scientific research.

INTRODUCTION

The history of science serves many purposes: it not only helps us understand scientific content and methods within the context of contemporary practice but also enriches scientific knowledge where modern science may remain limited (Chang, 2017). It fosters critical thinking, revives forgotten or overlooked knowledge, acknowledges achievements, and underscores the importance of ethical standards (Casadevall; Fang, 2015). While the history of science is often portrayed through stories of heroic scientists, tragic figures, accidental discoveries, or eccentric experiments, sometimes simplifying the complexities of the scientific process, beyond these myths lies a deeper importance. Understanding the evolution of our current knowledge is important, as it not only enhances our comprehension of scientific concepts but also strengthens the foundation of science by providing a more rigorous justification for results and situating them within their historical context (Chang, 2017).

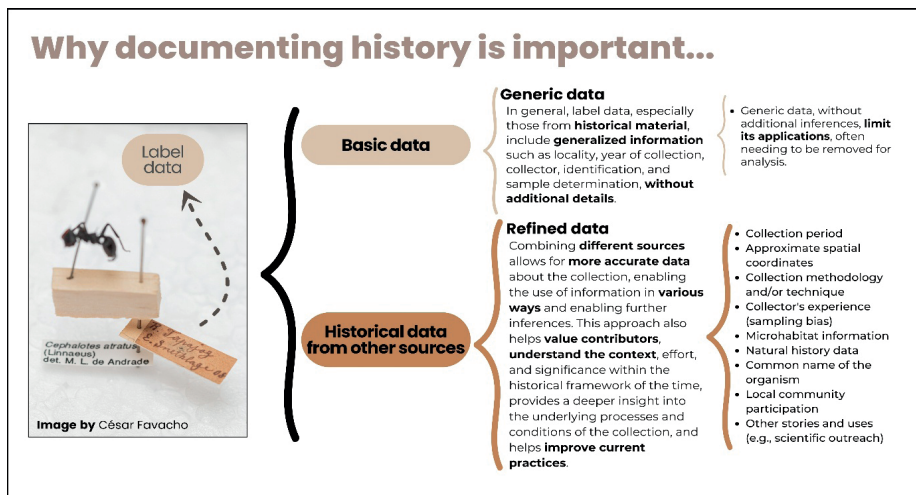
Documenting scientific processes and consulting historical data should be standard practices among scientists, as they advance knowledge and enhance science's role within society. However, this step is often undervalued, treated superficially, and lacks formal protocols in many institutions (Sanjad; Costa, 2021). In Myrmecology, as in many fields, historical documentation is still limited. While there are libraries, memory centers, and individual efforts, these initiatives remain in their early stages. Additionally, few specialists focus on this area, and historical training is not a major component of undergraduate or graduate programs, unlike in fields such as law, economics, and social sciences, where the historical background is indispensable for a deeper understanding of the field (Casadevall; Fang, 2015).

In this chapter, we present a brief history of Brazilian Myrmecology, though we do not aim to cover the entire history of the field in Brazil, as our knowledge remains limited in light of the complexity of this journey. However, through the collaboration of various professionals and the consultation of different sources, we make an initial, although limited, attempt to tell this story. Our intention is not only to provide an overview of the expansion of the field but also to inspire new investigations and reflections that broaden this knowledge. The chapter is structured into five main sections, each addressing a different aspect of Brazilian

Myrmecology's history and development. In the first, we explore the introduction of Myrmecology into Brazil's scientific agenda, emphasizing the role of expeditions, collections, and Taxonomy in the field's development. Next, we discuss the consolidation of Myrmecology through key events, journals, and scientific societies. In the third section, we examine the formation of research groups, the role of graduate programs, and the establishment of courses focused on the study of ants. We also assess the significance of large projects and initiatives dedicated to Myrmecological research in Brazil. Finally, in the last section, we provide a current overview of Myrmecology in the country, addressing its perspectives from both scientific research and historical study viewpoints.

For this chapter, we adopt the concept of knowledge networks, which refers to how individuals, institutions, and scientific communities collaborate to produce, transmit, and validate knowledge over time. These networks can be formal or informal and encompass the dissemination of ideas, techniques, practices, and the trajectories of scientific objects/organisms (Secord, 2004). To this end, we consulted source literature, gathered information from various researchers who actively participated in the development of the discipline and experienced many of the events described (see the acknowledgments section), and examined museum registers, field notebooks, and historical files. Our findings also rely on the collaboration of the archives of the *Serviço de Arquivo e Memória do Museu Paraense Emílio Goeldi* (SEARM/MPEG), *Fundo Museu Paraense Emílio Goeldi – Gestão Emília Snethlage/Arquivo Guilherme de La Penha/Museu Paraense Emílio Goeldi/MCTI*, Belém, Pará, Brazil, and the Library, Hymenoptera Lab, *Centro de Memória* of the *Museu de Zoologia da Universidade de São Paulo* (MZUSP) and the personal library of Professor William L. Overal. Additionally, we utilized data deposited in myrmecological collections, which, aside from offering opportunities for biodiversity studies, allow for investigating the various uses attributed to these collections over time and the knowledge generated through their interpretation (Figure 1). These data are fundamental for recording the trajectory of each specimen and for understanding the processes underlying the construction of biological knowledge (Sanjad; Costa, 2021).

Figure 1 - Example of how historical knowledge and complementary sources can enhance data use. The image shows a *Cephalotes atratus* worker collected by Emilie Snethlage during a legendary expedition to the Tapajós River region in 1908 (MPEG). For more details about this expedition, see Snethlage, 2002 [1910]. Research on the scientist's career has helped link valuable scientific and historical information to the collected samples.



THE ANTS

A remarkable treatise on ants, *Ants: Their Structure, Development, and Behavior*, written by William Morton Wheeler in 1910, states:

"Ants are to be found everywhere, from the arctic regions to the tropics, from timberline on the loftiest mountains to the shifting sands of the dunes and seashores, and from the dampest forest to the driest deserts."

Even those who have never had the pleasure of reading this book have likely referenced something similar in a paper, project, or talk about ants. After all, ants are present in nearly all environments and inspire many aspects of human culture. Their impact reaches from agriculture, with ants being the pioneers of this practice for tens of millions of years, long before humans (Schultz *et al.*, 2024), to indigenous rituals and cuisine, as mentioned by von Ihering (1940). In folklore, there are numerous fascinating stories of popular knowledge collected by Lenko & Papavero (1979), including, for example, the 44 common names exclusively recorded for fungus-growing ants. Additionally, these insects have been widely

mentioned by naturalists, politicians, and religious figures throughout history (Lenko; Papavero, 1979). And we have only referred to accounts of fungus-growing ants so far.

Given their abundance in nature and importance in culture, it is not surprising that ants have influenced historical events and captured the interest of various researchers over time. Despite the gaps and barriers in Entomology (Cardoso *et al.*, 2011), Myrmecology has built a solid space in scientific research. Brazil, a country that hosts one of the most diverse biotas in the world, is affectionately recognized as the “Capital das Formigas” (the Ant Capital), a term coined by Edward O. Wilson during the *XXIII Simpósio de Mirmecologia: An International Ant Meeting*, held in Curitiba, Paraná, in 2017. In fact, Brazil plays a pivotal role in the international Myrmecology scenario due to its unparalleled ant diversity, thriving research community, and contributions to evolutionary biology, Ecology, and applied sciences. From there, we turn our attention to understanding the events, initiatives, and stories that led researchers from all regions of Brazil to dedicate their careers to Myrmecology.

MYRMECOLOGY IN BRAZIL - FOUNDATIONS

The early development of myrmecology reflected the society of its time. It was led mainly by male scientists with access to financial resources and intellectual circles. Others, though fewer, pursued research despite limited opportunities. The field’s history also includes clergy who balanced religious and scientific responsibilities, war refugees, and a few women who worked as volunteers, supported their husbands’ research, or had to make considerable sacrifices to obtain formal research positions. This group, comprising researchers, naturalists, technicians, collectors, curators, students and interns, established Myrmecology in Brazil.

Although records of ants in Brazil date back to the 16th century, appearing in the letters and treatises of Father Anchieta and Gabriel Soares de Souza (LENKO and PAPAVERO, 1979), it is likely that numerous Indigenous references to these insects exist, though they remain largely undocumented in the scientific literature (WHEELER, 1907). In the development of Myrmecology in Brazil, three key pillars stand out: expeditions, which drove the discovery of new species

and expanded sampling areas; Taxonomy, which organized and systematized this knowledge; and collections, which played a fundamental role in preserving specimens and disseminating biodiversity information.

Within a taxonomic context, the first ant species recorded in Brazil were described in *Systema Naturae* (1758), the seminal work of zoological Taxonomy by Carolus Linnaeus, regarded as the father of modern Taxonomy. Among the 55 ant taxa he described, seven are now recognized as occurring in Brazil (*Atta cephalotes*, *Atta sexdens*, *Cephalotes atratus*, *Dolichoderus bidens*, *Monomorium pharaonis*, *Odontomachus haematodus*, and *Neoponera foetida*). Although Linnaeus broadly attributed these species to America Meridionali (South America), and they are indeed widely distributed in Brazil, it is now known that the specimens he studied were collected in Suriname during expeditions led by the Swedish naturalist Daniel Rolander from 1753 to 1756 (PAPAVERO, 1971; BACCARO *et al.*, 2015). However, even before Rolander's collections, several expeditions had already taken place in Brazil, including those specifically focused on collecting insects such as ants. These scientific journeys were documented in works by authors such as Papavero (1971) and Vanzolini (2004), among others. Yet, records of ants from this period appear only sporadically in broader studies of Brazil's regional fauna. To date, no comprehensive list consolidates data on the ant species collected during these early explorations, limiting our understanding of the historical development of Myrmecology in Brazil.

Moving into the period when Myrmecology was becoming established as a scientific field both in Brazil and globally, with researchers around the world dedicating themselves to the study of ants as a primary focus, two institutions stood out and continue to play a central role in ant research in Brazil: the *Museu Paraense Emílio Goeldi* (MPEG) and the *Museu de Zoologia da Universidade de São Paulo* (MZUSP). Founded in 1866, the MPEG, despite its challenging and resilient early history (LEITE, 1993; FAULHABER and TOLEDO, 2001), played a key role in advancing Myrmecology, operating comprehensively for the standards of its time. The museum staff supported collecting expeditions conducted by foreign researchers, organized collection efforts to obtain specimens in the Brazilian Amazon, though not limited to this region, and sent these specimens to international specialists for identification and description. In addition, the MPEG maintained a scientific journal from its inception (as will be detailed later),

which was fundamental in disseminating early Myrmecological contributions. Two names stand out in this process as central figures in the global scientific landscape of the time: Emílio Goeldi and Emilie Snethlage, who served not only as researchers and collectors but also as directors of the museum. The Stanford Expedition to Brazil, which took place in 1911 and resulted in William W. Mann's doctoral thesis and a publication (MANN, 1916), is an example of an expedition supported by the MPEG under Emilie Snethlage's leadership. The first checklist of ants from Brazil, published by Forel (1895), was made possible thanks to the shipment of specimens to the author by the MPEG. Notably, this work, titled "A Fauna das Formigas do Brazil", was published in Portuguese and in a Brazilian journal (then *Boletim do Museu Paraense*) at the request of Emílio Goeldi and in alignment with the journal's editorial policy. For these reasons, it is common to find ant species with specific epithets such as "goeldii", in reference to Emílio Goeldi, and "emiliae", in honor of Emilie Snethlage, particularly among species described between the late 19th and early 20th centuries (Prado *et al.*, 2020). However, much of the material sent to foreign institutions was never returned to Brazil, including type specimens. Throughout its turbulent history following the decline of the rubber boom in the Amazon, the MPEG suffered significant losses, not only to foreign interests but also due to individuals who took advantage of various circumstances and pretexts (LA PENHA, 1982). As a result, most of the historical myrmecological collection of the MPEG is no longer housed within the institution.

The MZUSP, on the other hand, originated as the Zoology section of the *Museu Paulista*, founded in 1834. Later, in 1939, it became part of the *Departamento de Zoologia da Secretaria da Agricultura do Estado de São Paulo*, until its definitive integration into the University of São Paulo in 1969 (Vanzolini, 1994). Although the first records of ants correspond to material collected by Hermann von Lüderwaldt and Hermann von Ihering in the early 20th century, the history of the collection expanded with the incorporation of several collections and the deposit of material from different origins with a Neotropical scope, along with continuous curatorial work. This work was initially carried out by curator Karol Lenko and intern Aristides Rocha, who dedicated themselves to curatorship, collection, and material exchange. However, perhaps the most important milestone was the incorporation of the ant collections and libraries of the

entomologists and friars Thomas Borgmeier and Walter W. Kempf, acquired by MZUSP from the Franciscan Order in 1977, with financial support from the *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq) and the *Fundação de Apoio à Pesquisa do Estado de São Paulo* (FAPESP). This event, followed by the curatorial and taxonomic leadership of Carlos Roberto Ferreira Brandão, consolidated MZUSP's collection as one of the most relevant in the world, continuously revealing new species and scientific findings (PRADO *et al.*, 2021). With continuous curatorial work and stability in research funding, something historically achieved only by the state of São Paulo within Brazilian standards, the MZUSP ant collection is recognized as one of the most representative in the Neotropical region, both in the number of types and species and in geographical coverage.

In recent decades, the growing interest in myrmecological studies in Brazil has led to the development of several ant-focused collections or the transformation of previously established collections, which have since become key reference centers for taxonomic, ecological, and evolutionary research. Today, these collections play complementary and strategic roles in advancing knowledge on ant biodiversity in the country. Among some notable examples is the *Coleção de Formicidae do Centro de Pesquisas do Cacau* (CPDC), created in 1990, which is oriented toward ecological and taxonomic studies and holds a particularly rich assemblage of samples from various agricultural systems and natural areas in southern Bahia state (DELABIE *et al.*, 2020). Similarly, the *Coleção Entomológica Adolph Hempel* (IBSP/IB) is recognized for the specimens of great historical importance deposited therein since 1920, predominantly originating from cultivated areas (IDE *et al.*, 2005; OLIVEIRA *et al.*, 2020). The *Coleção Entomológica do Laboratório de Coleoptera da Universidade Federal de Viçosa* (CELC – UFV), which began to appear more frequently in the literature starting in 2019, incorporated the collection of LABECOL (*Laboratório de Ecologia de Comunidades da UFV*), which has existed since the 1990s. Currently, in addition to conducting studies on extant taxa, CELC stands out for its contributions to fossil ant research and for its leadership in the sharing, digitization, and high-resolution imaging of myrmecological material on the AntWeb.org platform. The *Coleção Entomológica Padre Jesus Santiago Moure* (DZUP), in turn, has become an important center for training ant taxonomists since 2013 and

serves as a reference for the identification and sorting of material from various regions of Brazil (Andrade; Feitosa, 2020). An emerging example is the *Coleção de Referência Silvia Sayuri Suguituru* (LAMAT) (founded in 2000), at the *Universidade de Mogi das Cruzes*, which is dedicated to the detailed documentation of the ant fauna of the Upper Tietê River. This collection employs integrative approaches compatible with various disciplines and has contributed to the development of public policies related to regional biodiversity (Souza-Campana *et al.*, 2020). In the Amazonia region, the Instituto Nacional de Pesquisas da Amazônia (INPA), whose ant collection holds specimens since the beginning of the 1920 decade, has a long-standing tradition in ecological research and, more recently, in taxonomic investigations, positioning itself as a key center for biodiversity monitoring (Fernandes; Oliveira, 2020). The MPEG currently conducts projects focused on the development of extensive biodiversity databases, the enhancement of collaborative research networks, and field expeditions focusing on remote Amazonian areas as well as regions undergoing land-use change and management. The MZUSP, in addition to housing one of the most representative ant collections in the world, has taken a leading role in the so-called 'museomics' era, with emphasis on the use of ancient and historical DNA extracted from museum specimens, contributing to advances in systematics and phylogenomics. The trajectory and relevance of most of these collections in the development of Brazilian Myrmecology are documented in the special issue of the *Boletim do Museu Paraense Emílio Goeldi – Ciências Naturais*, entitled "*A Mirmecologia Brasileira no Século XXI*" (2020), which provides a comprehensive overview of the evolution of the field in the country.

OTHER INFLUENCES ON THE DISSEMINATION OF MYRMECOLOGY IN BRAZIL

Far beyond expeditions, the establishment of collections, and the publication of works focused on the description and organization of Brazil's biodiversity, several other factors have influenced and continue to shape the trajectory of Myrmecology in the country. While the impact of each of these elements across Brazil's political regions remains insufficiently understood, it is clear that the more inclusive these initiatives are, the greater their influence on strengthening

the discipline. Scientific practices, after all, are not limited to the production of knowledge alone, but also involve communication, application, and institutionalization, shaped by diverse dynamics, standards of conduct, and interactions within the scientific community that ultimately lead to concrete outcomes (Silveira *et al.*, 2015).

Another fascinating aspect is to explore the history of the earliest scientific events in Myrmecology and how they have evolved over time. Understanding the development of these gatherings in their various dimensions can reveal key elements that help explain the directions the field has taken. Part of this progress is due, though not exclusively, to the active engagement of myrmecologists working in diverse contexts. These initiatives have driven scientific advancement, improved biological collections, secured research funding, promoted the dissemination of knowledge, fostered collaborative networks, expanded the reach of studies, supported technological development, enabled information sharing, and refined technical protocols, making the field more democratic and accessible. In this context, we highlight some of these elements that have contributed to the development and expansion of Myrmecology in Brazil. We present selected examples that, in different ways, reflect the evolving structure, institutional engagement, and collaborative nature of the field over time.

Brazilian Journals

Scientific journals historically published in Brazil have played a fundamental role in strengthening research in the country, especially throughout the 20th century. With different formats, goals, and editorial policies, each journal had its relevance shaped by the historical and scientific context of its time. Since the late 19th and early 20th centuries, publications such as *Boletim do Museu Paraense Emílio Goeldi*, *Archivos do Museu Nacional do Rio de Janeiro*, *Arquivos do Instituto Biológico* and *Naturalia* among others, that underwent reformulations and name changes over time, contributed to the dissemination of scientific knowledge on the biodiversity, especially in the Neotropical region. Some of these journals stood out, for instance, by adopting editorial policies focused on publishing in Portuguese, which made knowledge more accessible to local audiences, valued national scientific production, and confronted the prejudices prevailing in a time

when science was still consolidating in the country. However, the irregularity of publications, often caused by financial limitations, with gaps of over a decade between issues (e.g., Leite 1993), led to the emergence of new journals dedicated to specific fields such as Entomology (Garmus, 2012).

An important milestone was the creation of the *Revista de Entomologia*, founded in 1931 by Friar Borgmeier. Motivated by the difficulty of quickly publishing his research results, Friar Borgmeier took on the roles of editor and publisher, ensuring a more efficient editorial flow. Unique in its field at the time, the journal reached subscribers in 21 countries and published articles in seven languages. A total of 22 volumes were published until 1951, when the journal was discontinued. In 1958, the publication was revived under the name *Studia Entomologica*, remaining active until 1976, with issues coordinated by Friars Borgmeier and Kempf. *Studia Entomologica* became a landmark in Brazilian and international Entomology, particularly in the areas of taxonomy and insect diversity. Its high editorial quality, the excellence of its published articles, and its openness to international collaboration made it one of the most respected journals in the world at the time (personal communication with Nelson Papavero and Dione Seripieri, 2022). A notable example was the Catalogue of the Ants of the Neotropical Region, published by Kempf in 1972. Until then, the most recent catalogs had been published by Emery in the 1920s (e.g., Emery, 1925). Kempf's catalog was the first comprehensive one for the Neotropical region. Taxonomic catalogs remain essential tools, but in a world without the internet, their importance was even more evident. As Kempf (1972) stated (freely translated):

"Zoological catalogs need no justification regarding their usefulness and timeliness. They are repositories of quick and organized information about the number, nomenclature, distribution, and classification of known organisms within certain groups. Therefore, they represent a remarkable aid to many fields of biological research."

A particularly interesting feature of these pioneering journals was the presence of sections dedicated to brief communications, in which researchers could express opinions, announce discoveries, pay tribute, or present critiques on scientific issues. These more informal and dialogic spaces enriched the scientific debate of the time, although they have disappeared from most current

publications. Today, several journals continue to play a relevant role in disseminating myrmecological research in Brazil, many of them with myrmecologists serving on their editorial boards. Some examples include: *Revista Brasileira de Entomologia*, *Acta Amazonica*, *Sociobiology*, *Papéis Avulsos de Zoologia*, *Entomological Communications*, among others. Despite their importance, these journals still face persistent challenges regarding visibility and investment, both nationally and internationally.

Scientific Events

Scientific events are diverse instruments for the dissemination of knowledge, enabling multiple forms of communication and exchange. In Brazil, a variety of events have traditionally been held that include the participation of myrmecologists, ranging from broad conferences to more specialized meetings. Examples include the *Congresso Brasileiro de Zoologia*, the *Congresso Brasileiro de Entomologia*, and the meetings and workshops organized by the *Brazilian Section of the International Union for the Study of Social Insects* (IUSI-SecBras).

However, the most emblematic event for the global myrmecological community is undoubtedly the *Simpósio de Mirmecologia*. The event was born as a small meeting in 1980 with the *I Encontro de Mirmecologia do Estado de São Paulo*, organized by the *Departamento de Biologia* at the *Instituto de Biociências* of the *Universidade Estadual Paulista* (UNESP), Rio Claro campus. Over the years, the meeting expanded both in scope and audience, and in its 16th edition held in Florianópolis (Santa Catarina) in 2003, it was officially renamed *Simpósio de Mirmecologia*. In 2011, during the 20th edition in Petrópolis (Rio de Janeiro), the event emphasized the participation of the Latin American community under the title *20º Simpósio de Mirmecologia / 1º Encuentro de Mirmecologistas de las Américas*. The current format was consolidated in the 21st edition held in Fortaleza (Ceará) in 2013, adopting the name *Simpósio de Mirmecologia: An International Ant Meeting*, and has since been hosted in different regions of Brazil. Today, the event is informally referred to as *Ant Meeting* by the international community and as *Mirmeco* by the broader community.

Throughout its history, *Mirmeco* has adopted a variety of formats, from informal gatherings focused on sharing experiences and providing training

through workshops and courses, to its current model, which is broader and more inclusive. Today, the event is held biennially and includes plenary sessions, round tables, oral and poster presentations, cultural activities, and science outreach initiatives. It has become the largest meeting of myrmecologists in the world, bringing together around 300 specialists from Brazil and various other countries. By rotating its location throughout different cities in the country, the current format has played a key role in decentralizing Myrmecology in Brazil, allowing for broader local engagement and promoting more diverse regional experiences. This dynamic has helped strengthen local research networks, expand access to knowledge, and encourage the inclusion of researchers from historically underrepresented areas. As a result, it has become the largest meeting of myrmecologists in the world, featuring strong international participation while continuing to highlight and disseminate ant research conducted in Brazil.

Courses and Academic Training in Science

In a broader context, but with the active participation of myrmecologists as both instructors and students, several initiatives have contributed to the training of multiple generations of specialists. In the field of *Cursos Especiais de Sistemática Zoológica* promoted by CNPq were fundamental in guiding numerous generations of researchers in the study and application of modern systematic theories. Held throughout the 1980s at various universities and regions across Brazil, these courses played a central role in the training of experts in zoological systematics (Klassa; Santos, 2012), significantly contributing to establishing Brazil as one of the most productive countries in this field worldwide (Rafael *et al.*, 2009). Among these initiatives, several insect collection training courses were organized by institutions, laboratories, and research groups (Figure 2A). In the field of Ecology, intensive field courses stand out, especially in regions with major knowledge gaps. An example is the course *Ecologia da Floresta Amazônica*, part of the *Projeto Dinâmica Biológica de Fragmentos Florestais* (PDBFF), which has had nearly 30 editions and has been mainly integrated into INPA's graduate programs. Another example is the field course *Ecologia e Conservação da Caatinga*, linked to the graduate programs in *Biologia Vegetal* and *Biologia Animal* at the *Universidade Federal de Pernambuco* (UFPE), and the *Ecologia*

de Campo course/class offered by the Graduate Program in Ecology at the *Universidade Estadual de Campinas* (UNICAMP), initiated in 1976. These courses offer immersive experiences in scientific practice, covering everything from field observations of biological phenomena to the formulation of research questions, method selection, experimental design, data analysis, and discussion of results. Thematic undergraduate courses have also made progress. One of the most traditional is the *Curso de Verão em Entomologia*, organized since 2003 by students and faculty from the Graduate Program in Entomology at the *Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto da Universidade de São Paulo*. Currently, similar initiatives are being carried out across all regions of Brazil.

In the specific context of Myrmecology, the pioneering work of Donat Agosti and Jacques Delabie stands out. They were responsible for introducing the Winkler extractor methodology in Brazil. Initially tested in cacao plantations and local forests in Bahia, the technique was consolidated during the ALL Workshop (*Leaf-Litter Ants*), held in Ilhéus in 1996 (Figure 2B). This meeting led to the development of the book *Ants: Standard Methods for Measuring and Monitoring Biodiversity*, published in 2000 by Agosti *et al.*, and widely used since then. The publication established Winkler extractors as the standard method for studying leaf-litter ant diversity. In 1997, Agosti, in collaboration with Delabie, Jim Carpenter, Sofia Campiolo, and other researchers, organized a field course in Uruçuca (Bahia) aimed at presenting field and laboratory methodologies for the study of ants to Brazilian students (Figure 2). Considered the first course of its kind in South America, this event marked a turning point for Myrmecology in the region, fostering the dissemination of one of the main sampling techniques still in use today (Delabie, 2018). More recently, the course *Sistemática e Biologia de Formigas*, coordinated by Rodrigo Feitosa at UFPR, has played an important role in introducing graduate students to the study of ants. The course provides taxonomic updates, a broad overview of various research contexts, and encourages the inclusion of ants in scientific projects. It has been offered in different formats (in-person, online, and hybrid) and several regions of the country and is currently taught at UFPR. Another remarkable effort is the course *Formigas do Brasil*, launched in 2012 (Figure 2C). Held biennially, it has covered several Brazilian biomes with support from universities across the country. Organized by Fernando Schmidt (UFAC), Carla Ribas (UFLA), and Rodrigo Feitosa (UFPR),

the course offers a comprehensive approach to various areas of Myrmecology through lectures, fieldwork, and activities focused on ant sample identification and sorting.

Figure 2 - Some images of field activities. A. Dr. William Overal conducting a field collection training for students, technicians, and interns at MPEG, who are also some of the collectors named on the labels of the MPEG ant collection. B. Participants of the ALL Workshop in front of the Cocoa Research Center (CEPEC/CEPLAC), Ilhéus, Brazil. C. Participants of the Formigas do Brasil course – Pantanal edition.



Network-based initiatives

In a broader context, network-based initiatives stand out. Despite numerous challenges, Brazil has followed a promising path in fostering scientific collaboration focused on biodiversity. Several research programs have promoted the development of collaborative networks, primarily supported by *CNPq* and the *Fundações Estaduais de Amparo à Pesquisa (FAPs)*, but also through international contributions, private resources, and sectoral funds. Among the most notable examples are the *Programa de Pesquisa em Biodiversidade (PPBio)*, the *Programa de Pesquisas Ecológicas de Longa Duração (PELD)*, the *Institutos Nacionais de Ciência e Tecnologia (INCTs)*, the *Iniciativa Amazônia +10*, and *Biota-FAPESP*. As new funding calls are launched, these networks have increasingly integrated emerging demands, helping science in Brazil become more responsive to society and its needs. These programs have not only strengthened scientific infrastructure but have also played a key role in training new generations of researchers. They have served as a foundation for undergraduate research, master's, and doctoral projects. Moreover, the most structured data and materials produced by these initiatives have been incorporated into scientific collections and have supported ecological studies, biodiversity monitoring

efforts, and taxonomic research. More recently, thematic networks have been established to address specific questions about certain biological groups, such as ants. One example is the work carried out by the *Formigas do Brasil* group, responsible for a series of scientific publications (Schmidt *et al.*, 2022; Feitosa *et al.*, 2023; Wilker *et al.*, 2024), with collaboration by researchers from various regions of the country and by students affiliated with the initiative's leadership. Another highlight is the *Atlantic Ants* project, led by Rogério R. Silva, which resulted in the development of a datapaper on Atlantic Forest ants (Silva *et al.*, 2022), currently one of the most robust databases for these ants, comprising around 150,000 records. These include validated published and unpublished data, along with records from scientific collections. This network is an example of an open and democratic initiative, allowing anyone to share data and be included in the publication, thus promoting the collective use of information. The database was made publicly available, encouraging its use by other researchers and enabling impactful research, especially in regions with limited resources and infrastructure.

Scientific Societies

Scientific societies play a crucial role in advancing knowledge about biodiversity by fostering collaboration, disseminating research, and promoting best practices in conservation and taxonomy. These organizations bring together researchers, educators, and policymakers, facilitating the exchange of ideas and data across disciplines. Through conferences, journals, and working groups, they help standardize methodologies, ensuring that biodiversity studies are comparable and reproducible. By supporting early-career scientists and funding fieldwork, societies also drive innovation in ecological and taxonomic research.

Moreover, scientific societies advocate for evidence-based conservation policies, translating complex research into actionable recommendations for governments and NGOs. They often lead initiatives to document endangered species, monitor ecosystem health, and combat biodiversity loss. This is also the case with Myrmecology. Founded in 1937, the *Sociedade Brasileira de Entomologia* (Brazilian Society of Entomology - SBE) is the oldest entomological association in Brazil, being one of the first to be founded in Latin America. Throughout its nearly 90 years of existence, SBE has had some of the most prominent names

in Entomology worldwide on its directive body, including Friar Kempf, arguably the most important name in Brazilian ant taxonomy. SBE's mission is to promote basic and applied scientific research in the different areas of Entomology, contributing to the advancement of knowledge about the diversity, evolution, ecological, economic, and sanitary importance of insects. These objectives are also promoted by supporting the training of young Brazilian entomologists through grant notices and the organization of scientific events focused on Entomology. In addition, since 1954, SBE has been the manager of the "*Revista Brasileira de Entomologia: A Journal of Insect Diversity and Evolution*", the most traditional entomological journal in Latin America, where several contributions on ant taxonomy and diversity are published to the current day.

Still, regarding the support to Brazilian Myrmecology, societies like the *Sociedade Entomológica do Brasil* (SEB) and the Brazilian section of the International Union for the Study of Social Insects (IUSI) have been instrumental in shaping biodiversity science in Brazil and beyond, promoting both local and global research networks. SEB and IUSI-Brazil are also of extreme importance for the dissemination of knowledge on Brazilian ants by publishing several studies in their respective entomological journals, *Neotropical Entomology* and *Insectes Sociaux*. Ultimately, these organizations amplify the impact of individual researchers, creating a collective force that accelerates discoveries and informs sustainable practices. Their work is essential for understanding Brazilian ant diversity and preserving it for future generations.

THE ANTS OF BRAZIL TODAY

With ongoing advancements and emerging opportunities, research groups and graduate programs have become increasingly consolidated, many of which are responsible for key initiatives driving the growth of Myrmecology in Brazil. These programs demonstrate that science is being built through increasingly collaborative efforts, bringing together technicians, field assistants, undergraduate and graduate students, postdoctoral researchers, fellows, and other dedicated contributors. These individuals often move between laboratories across Brazil, field expeditions, and academic networks, connecting diverse contexts of knowledge production and sustaining the momentum of research.

Today, laboratories dedicated to the study of ants, or incorporating ant research as a core focus, are present in all regions of the country. As the field continues to strengthen, initiatives have also begun to emerge in more remote areas, far from major research centers. These efforts not only support regional scientific development but also help fill long-standing gaps in knowledge about Brazilian ant diversity. Another defining characteristic of Brazilian Myrmecology is the integration of different scientific disciplines, particularly the interplay between Ecology and Taxonomy. This synergy has expanded both the scope and impact of the research, promoting broader approaches to biodiversity studies.

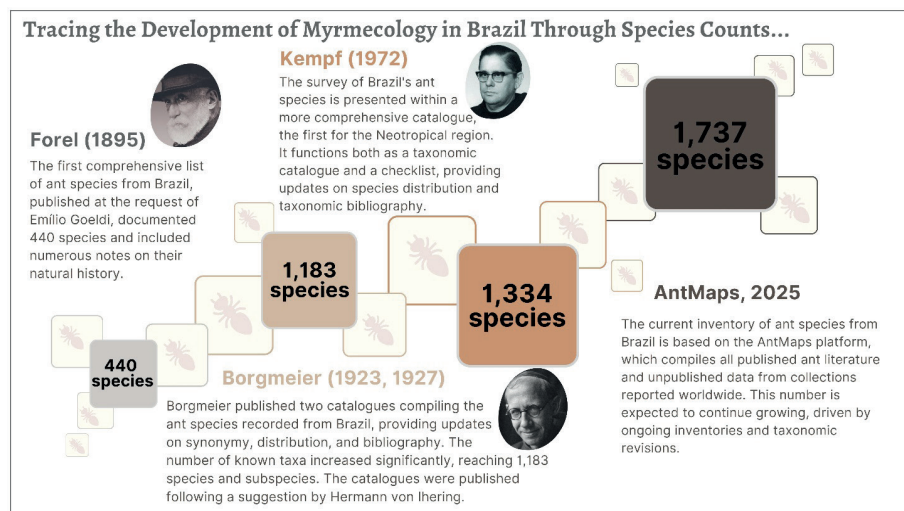
The establishment of dedicated ant research laboratories in Brazil transformed Myrmecology from a primarily taxonomic discipline into a dynamic field integrating Ecology, behavior, conservation, and control. As aforementioned, before the 1980s, Myrmecology in Brazil was mostly descriptive, with taxonomists mainly documenting species diversity. Institutions like Universidade Estadual Paulista “Julio de Mesquita Filho”, Universidade Federal do Acre, Universidade Federal de Viçosa, UNICAMP, Universidade Federal de Uberlândia, UFPE, and INPA (among many others across Brazil), along with their researchers, have been instrumental in positioning Brazil as a global leader in ant studies. Additionally, there is a growing, though still emerging, trend toward expanding scientific outputs beyond academia to inform public policy and engage broader audiences. Together, these developments reflect the vitality of Brazilian Myrmecology and its potential to foster social and environmental transformation, both within and beyond academic spheres.

The Ants of Brazil: Centuries of Discoveries, Diversity & Dedication

When Forel published the first list of ant species from Brazil in 1895, comprising around 440 species and subspecies (checklist and supplement), Myrmecology was still emerging as a scientific field on the globe. His work marked the beginning of the systematic documentation of Brazil’s ant diversity, at a time when few researchers were exclusively dedicated to this group. A few decades later, with myrmecologists already active in the country, Borgmeier compiled two key catalogs (1923, 1927), expanding the number of known species and subspecies to 1,183 (checklist and supplement). This period was

fundamental for the consolidation of a national scientific community focused on ants and for the growing recognition of the richness of the fauna, both in terms of diversity and geographic distribution. Species descriptions increasingly came to be framed within more rigorous taxonomic revisions, incorporating discussions on synonymy and intraspecific morphological variation. By the 1970s, ant taxonomy in Brazil had reached a new level. The catalog published by Kempf in 1972 reflected this advancement, listing 1,334 species and subspecies and consolidating decades of taxonomic work. This landmark publication became a key reference and helped drive further studies on Neotropical ant fauna. As of 2025, Brazil harbors the greatest known ant diversity on the planet, with 1,737 recorded species and subspecies (AntMaps.org; Janicki *et al.*, 2016), a number that continues to grow thanks to ongoing efforts in collection, description, revision, and data integration. Generations of researchers have contributed to expanding our understanding of this biodiversity, approaching it from multiple perspectives, ranging from Ecology to Biotechnology, and strengthening the interface between science and society through science communication and citizen science initiatives (Figure 3).

Figure 3 - Growth in the number of ant species and subspecies recorded from Brazil over time, based on major taxonomic milestones: Forel (1895), Borgmeier (1923, 1927), Kempf (1972), and AntMaps (2025). These compilations reflect the expansion of myrmecological knowledge in the country, driven by continued efforts in species description, taxonomic revision, and biodiversity inventories.



ACKNOWLEDGMENTS

LPP and RMF acknowledge and were funded by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) processes No. 382108/2024-8 and 304012/2023-8, respectively. LPP also thanks the Programa de Pesquisa em Biodiversidade (CNPq), process No. 441201/2023-7, and the Programa Conhecimento Brasil (CNPq), process No. 445024/2024-0. The authors thank the Fundo Museu Paraense Emílio Goeldi – Gestão Emília Snethlage/Arquivo Guilherme de La Penha/Museu Paraense Emílio Goeldi/MCTI. Belém, Pará, Brazil and the Centro de Memória, Biblioteca and the Biblioteca do Hymenoptera Lab of the Museu de Zoologia da Universidade de São Paulo for providing access to the documents for consultation. The authors also thank the two reviewers, Rogério R. Silva and William L. Overal, for their valuable contributions and suggestions. LPP expresses her gratitude to Alvaro Dória dos Santos, Aristides Rocha, Carlos Roberto Ferreira Brandão, Carmina Lupo, Frei Clarêncio Neotti, Dione Seripierri, Elisabete Barbero, Fernando da Silva Braga, Gabriela Camacho, Henrique Pereira Moleiro, Heraldo Antonio Britski, Jorge Diniz, José Antônio Nunes Pena, José Orlando Dias (*in memoriam*), Joudellys Andrade Silva, Leonardo Boff, Mauricio Martins da Rocha, Nelson Papavero, Pablo Borges, Raimundo Nonato, Rodrigo Paiva and Samara Santos for generously sharing stories and materials about Brazilian Myrmecology during several occasions. A special acknowledgment goes to William L. Overal, who generously dedicated his time in numerous conversations, providing information, suggestions, and valuable guidance for this chapter, as well as donating extensive material on myrmecology and the history of science. Due to space limitations and also the authors' knowledge, not all contents and suggestions could be incorporated here, but they will certainly be considered in future publications. We dedicate this chapter to Friar Walter Kempf and Karol Lenko, two of the most fascinating figures in Brazilian myrmecology, whose remarkable legacies continue to open paths yet to be explored.

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