



THE DISTRIBUTION OF *Apuleia leiocarpa* IN BRAZIL: INSIGHTS FOR THE CONSERVATION AND SOCIO-ENVIRONMENTAL MANAGEMENT OF NATIVE SPECIES

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ABSTRACT

Objective: This article analyzes the geographical distribution of *Apuleia leiocarpa* in Brazil from 1939 to 2025, aiming to understand its spatial and temporal patterns and to discuss how these findings can support public policies for biodiversity conservation, forest management, and ecological restoration.

Theoretical Framework: The study is grounded in biogeographical conservation theory, knowledge shortfalls in botanical knowledge, and the role of digital tools such as virtual herbaria in socio-environmental governance. It emphasizes the consequences of data gaps in species distributions for conservation planning.

Method: Data from the JABOT Virtual Herbarium were used to track both historical records and recent occurrences. The study examines the chronology of first records by state and maps new records between 2005 and 2025. Data were processed in Excel and analyzed in R 4.3.0 using the tidyverse, readxl, and ggplot2 packages.

Results and Discussion: The species is recorded in 25 of Brazil's 27 states. Initial records were concentrated in the Northeast, with subsequent expansion to the Southeast and South. Recent records show its presence in ecotones and disturbed areas, supporting its use in restoration programs. The lack of records in parts of the Amazon may indicate persistent sampling gaps. These data can inform sustainable use, risk status reassessment, and ecological corridor planning.

Research Implications: The findings reinforce the strategic role of herbarium data in shaping environmental policies aligned with the Sustainable Development Goals (SDGs 13 and 15).

Originality/Value: This study bridges botany, public policy, and conservation practice by showing how historical records of a native tree can inform concrete biodiversity management and restoration actions.

Keywords: *Apuleia leiocarpa*, Biodiversity Conservation, Digital Herbaria, Environmental Policies, Ecological Restoration.

A DISTRIBUIÇÃO DE *Apuleia leiocarpa* NO BRASIL E SEUS SUBSÍDIOS PARA A CONSERVAÇÃO E GESTÃO SOCIOAMBIENTAL DE ESPÉCIES NATIVAS

RESUMO

Objetivo: Este artigo analisa a distribuição geográfica de *Apuleia leiocarpa* no território brasileiro entre 1939 a 2025, com o objetivo de compreender os padrões espaciais e temporais de ocorrência da espécie e discutir como essas informações podem subsidiar políticas públicas de conservação, manejo florestal e restauração ecológica.

Referencial Teórico: Fundamenta-se em abordagens da biogeografia da conservação, lacunas de conhecimento botânico (*shortfalls*) e o papel de ferramentas digitais como os herbários virtuais no apoio à gestão socioambiental. Destacam-se as implicações do déficit de informação sobre a distribuição de espécies e o uso de dados de ocorrência para planejamento territorial e conservação de biodiversidade.

Método: Utilizaram-se dados do Herbário Virtual JABOT, com extração de registros históricos e recentes da espécie. Foram analisadas a cronologia dos primeiros registros por unidade federativa e as novas ocorrências

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documentadas entre 2005 e 2025. Os dados foram tratados em planilhas eletrônicas (Excel) e analisados em R 4.3.0, com suporte dos pacotes *tidyverse*, *readxl*, *ggplot2*.

Resultados e Discussão: A grávia apresenta ampla distribuição, com ocorrência registrada em 25 das 27 unidades federativas. Os padrões históricos indicam uma expansão inicial no Nordeste, seguida de documentação no Sudeste e Sul. As novas ocorrências revelam a presença da espécie em ecótonos e áreas perturbadas, destacando seu valor para programas de restauração ecológica. A ausência de registros em estados da Amazônia Ocidental evidencia a persistência de lacunas amostrais relevantes.

Implicações da Pesquisa: Este estudo reforça o papel estratégico de dados de herbário na formulação de políticas ambientais, contribuindo para a conservação da biodiversidade, recomposição florestal e cumprimento dos Objetivos de Desenvolvimento Sustentável (ODS 13 e 15)

Originalidade/Valor: Este trabalho contribui para a integração entre botânica, gestão pública e conservação ambiental, ao explorar como registros históricos de uma espécie nativa podem orientar ações concretas de manejo e restauração no Brasil.

Palavras-chave: *Apuleia leiocarpa*, Conservação da Biodiversidade, Herbários Digitais, Políticas Ambientais, Restauração Ecológica.

LA DISTRIBUCIÓN DE *Apuleia leiocarpa* EN BRASIL Y SUS APORTES PARA LA CONSERVACIÓN Y LA GESTIÓN SOCIO-AMBIENTAL DE ESPECIES NATIVAS

RESUMEN

Objetivo: Este artículo analiza la distribución geográfica de *Apuleia leiocarpa* en Brasil entre 1939 y 2025, con el objetivo de comprender los patrones espaciales y temporales de ocurrencia y discutir cómo estos datos pueden respaldar políticas públicas de conservación, manejo forestal y restauración ecológica.

Marco Teórico: El estudio se basa en teorías de biogeografía de la conservación, deficiencias de conocimiento botánico (shortfalls) y el uso de herbarios digitales como herramientas de gobernanza socioambiental. Destaca las implicaciones de las brechas de datos sobre la distribución de especies para la planificación de la conservación.

Método: Se utilizaron registros del Herbario Virtual JABOT, analizando cronológicamente los primeros registros por estado y las nuevas ocurrencias entre 2005 y 2025. Los datos fueron procesados en hojas de cálculo de Excel y analizados en R 4.3.0 con los paquetes *tidyverse*, *readxl* y *ggplot2*.

Resultados y Discusión: La especie está documentada en 25 de los 27 estados brasileños. Los primeros registros ocurrieron en el Nordeste, seguidos por el Sudeste y el Sur. Las nuevas ocurrencias revelan presencia en ecótonos y áreas perturbadas, lo que respalda su uso en programas de restauración. La ausencia en partes de la Amazonía podría reflejar brechas de muestreo. Estos datos pueden apoyar decisiones sobre uso sostenible, evaluación de riesgo y planificación de corredores ecológicos.

Implicaciones de la investigación: Los resultados destacan el papel estratégico de los herbarios digitales en el desarrollo de políticas ambientales alineadas con los Objetivos de Desarrollo Sostenible (ODS 13 y 15).

Originalidad/Valor: El estudio conecta botánica, política pública y conservación práctica, mostrando cómo los registros históricos de una especie nativa pueden orientar acciones concretas de restauración y gestión de la biodiversidad.

Palabras clave: *Apuleia leiocarpa*, Conservación de la Biodiversidad, Herbarios Digitales, Políticas Ambientales, Restauración Ecológica.

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1 INTRODUCTION

The conservation of native tree species is one of the pillars of ecological sustainability and socio-environmental security in tropical regions, where biodiversity is high and anthropogenic pressure is intense. In Brazil, a country that has one of the greatest floristic diversities on the planet, knowing the geographical distribution of species is not only a scientific need, but a strategic requirement for the implementation of effective public policies for the management, restoration and sustainable use of natural resources. In particular, the absence or precariousness of data on the spatial occurrence of plant species - the so-called *Wallacean shortfall* (Lomolino *et al.*, 2006) - compromises the planning of actions aimed at biodiversity conservation, land use planning and tackling climate change (Hortal *et al.*, 2015).

Among the species of recognised ecological, economic and sociocultural value is *Apuleia leiocarpa* (Vogel) J.F.Macbr., popularly known as grápia. It is a large tree, belonging to the Fabaceae family, whose high density wood is traditionally used in civil construction, naval and fine woodworking (Lorenzi, 2021). In addition to economic use, the species has proven ecological relevance: it is found in seasonal forests, ecotones, secondary fragments and riparian formations, demonstrating tolerance to environmental gradients and adaptive potential to degradation scenarios (Luz, 2022). This versatility has boosted its use in ecological restoration projects in several Brazilian regions (Carvalho, 2003; Reis *et al.*, 2012).

Although there is no specific national plan for the conservation of the species, the species is officially classified as threatened in states such as São Paulo (category "In Danger") and Rio Grande do Sul ("Vulnerable"), which guarantees its inclusion in state red lists and its prioritisation in ecological restoration programmes (Government of the State of São Paulo, 2016). National initiatives such as the Native Vegetation Recovery Plan (Planaveg) and the National Atlantic Forest Policy (Law No. 11,428 / 2006) promote the use of native species with ecological functionality in mixed plantations, especially in the recomposition of permanent preservation areas and legal reserves. Local Payment for Environmental Services projects, such as Conservador das Águas em Extrema (MG), also employ native species in restorative plantations — although they do not directly mention *Apuleia leiocarpa*, its ecological profile and timber value place it among the *recommended candidates for these contexts* (Pagiola *et al.*, 2013). At the same time, institutions such as Embrapa Forests, Federal University of Viçosa (UFV) and Federal University of Santa Catarina (UFSC) have contributed to the advancement of ecological, genetic and phenological knowledge of the species, providing subsidies for its conservation *in situ* and *ex situ* (Reis *et al.*, 2012).



In this context, understanding the historical and recent distribution of graphics in the Brazilian territory becomes fundamental to evaluate knowledge gaps and strengthen the integration between science, public policies and territorial management. In addition to the national scale, regional analyses are of strategic importance, especially in states such as Rio Grande do Norte, where fragments of remaining native vegetation coexist with strong anthropic pressure and are home to several state and federal Conservation Units.

This study aims to analyse the geographical distribution of *Apuleia leiocarpa* in Brazil, based on documentary records available in the JABOT Virtual Herbarium between the years 1939 and 2025. From the systematisation of records by federal unit and the identification of new occurrences in the last two decades, we seek to contribute to the monitoring of biodiversity and the definition of territorial conservation and restoration strategies, focussing on native species of ecological and socioeconomic importance. In addition, this work incorporates a regional cut focused on the state of Rio Grande do Norte, highlighting the occurrence (or absence) of the species in state and federal Conservation Units.

2 METHODOLOGY

The research adopted a descriptive-analytical approach based on secondary data obtained in the JABOT system - Virtual Herbarium of the Botanical Garden of Rio de Janeiro. All available records of the species *Apuleia leiocarpa* were extracted until April 2025. The data included information such as locality, federative unit, date of collection and destination herbarium.

For the analysis, a double cut was applied. First, the oldest record of the species in each state was identified, in order to map the chronology of the documentation and infer patterns of expansion of records over time. Secondly, we analysed the new occurrences documented between January 1, 2005 and 2025, in order to identify recent spatial patterns of distribution of the species.

In addition, a specific regional cut was made for the state of Rio Grande do Norte, with emphasis on verifying the presence of species records in state and federal Conservation Units. This step included the crossing between the specimens location data and the official list of protected areas in the state, obtained from the National Register of Conservation Units (CNUC) and the Institute of Sustainable Development and Environment of RN (IDEMA).

The data were organised in Excel spreadsheets and processed using the R programme for the generation of graphs and/or figures. The qualitative analysis focused on the ecological



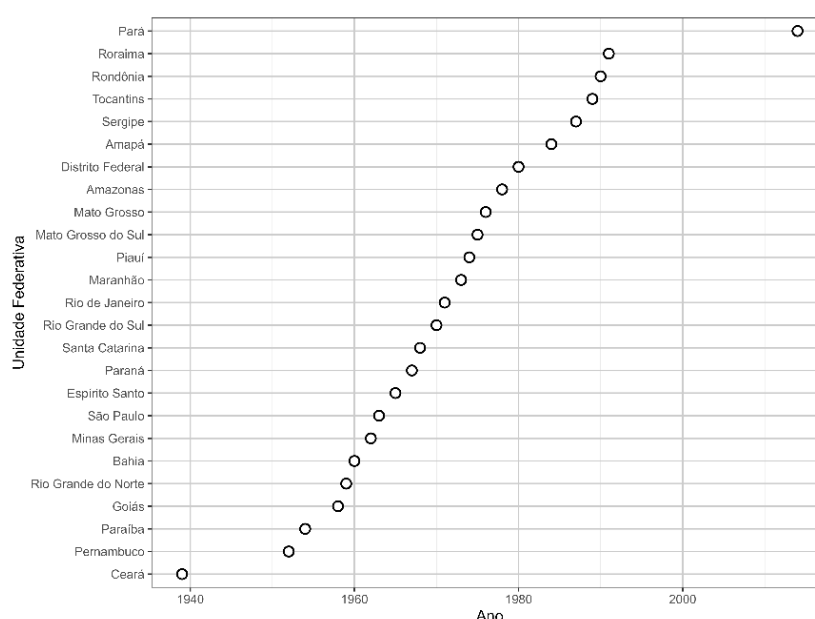
and geopolitical interpretation of the observed patterns, with emphasis on their implications for environmental monitoring and management.

3 RESULTS AND DISCUSSIONS

The analysis of the historical distribution of *Apuleia leiocarpa* based on the records systematised by state presents a documentary trajectory that begins in Ceará, in 1939, and extends over eight decades to reach 25 of the 27 Brazilian federative units. The timeline of the first records by state (Figure 1) shows an initial concentration of collections in the Northeast — including the states of Ceará, Pernambuco, Paraíba and Rio Grande do Norte between 1939 and 1959 and then a gradual expansion to the Southeast, South and Midwest from the 1960s. The last state to present record of the species was Pará, in 2014.

Figure 1

*Year of the first confirmed record of the species *Apuleia leiocarpa* by Brazilian state, based on systematised data from the JABOT Virtual Herbarium and bibliographic validations.*



This pattern of advance in documentation does not exclusively reflect the ecology of the species, but above all the historical dynamics of botanical collections in the country. States with a greater tradition in research, presence of active herbaria and consolidated scientific infrastructure tend to present older records. The Western Amazon states, such as Acre and Roraima, have no known records of *Apuleia leiocarpa* until 2025, which may be associated

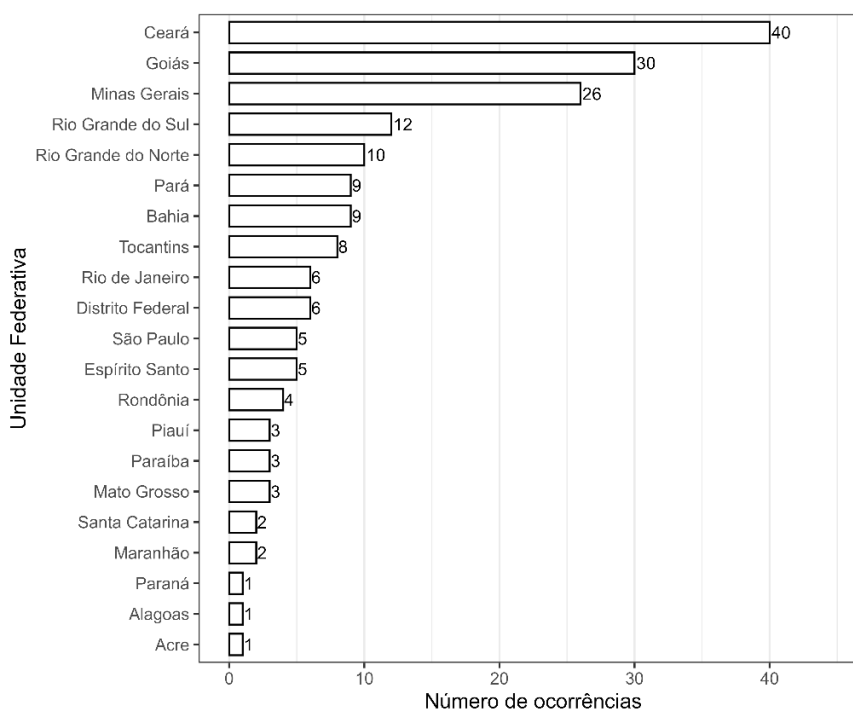


with both ecological restrictions of the species in dense ombrophilous forests and persistent sampling gaps (Hortal *et al.*, 2015).

Between 2005 and 2025, 145 new occurrences of the species were recorded in the JABOT, with emphasis on the states of Ceará (40 records), Goiás (30), Minas Gerais (26), Rio Grande do Sul (12) and Rio Grande do Norte (10) (Figure 2). These new collections occurred mostly in areas of ecological transition — such as ecotones between Cerrado and Atlantic Forest — and in secondary forest fragments. The occurrence in degraded environments, riparian forests and areas with a history of anthropic use reinforces the profile of a resilient and functional species, desirable characteristics for ecological restoration programmes (Luz, 2022; Carvalho, 2003).

Figure 2

New occurrences of Apuleia leiocarpa by UF (2005–2025). Total number of documented records for the species Apuleia leiocarpa by Brazilian state in the last two decades, based on data from the JABOT Virtual Herbarium.



The consolidation of the documented records of *Apuleia leiocarpa* in the Brazilian territory reveals its wide occurrence in the Atlantic Forest, Cerrado and Caatinga biomes, with occasional presence also in areas of the eastern Amazon. This geographically diverse distribution shows a high degree of ecological plasticity, allowing the species to establish itself



under different edaphoclimatic conditions and in various types of vegetation cover, including secondary formations and ecotone zones. This versatility reinforces the strategic value of the plotting for multiple land use programmes, highlighting its potential to integrate agroforestry systems, sustainable forest management plans and enrichment actions of degraded areas with native species of recognised ecological and economic importance.

The consolidated data reinforce the importance of the species as a priority for restoration, including in the context of federal public policies, such as the National Plan for the Recovery of Native Vegetation (Planaveg) and the Atlantic Forest Law (Law No. 11,428 / 2006). In addition, its inclusion in state lists of endangered species, such as in the states of São Paulo and Rio Grande do Sul, makes its conservation a goal legally linked to instruments such as management plans and territorial strategies for forest restoration.

At the international level, the findings dialogue with the Sustainable Development Goals (SDG), especially SDG 15 - Terrestrial Life, by subsidising concrete actions for biodiversity conservation and sustainable management of native forests. The presence of the species in anthropogenic environments and its adaptability to diverse ecological conditions also favour its application in local climate strategies, aligning with SDG 13 - Action against global climate change, through carbon sequestration and restoration of forest stocks. Finally, systematisation and open access to floristic data, such as JABOT, strengthen SDG 12 - Responsible Consumption and Production, by qualifying territorial planning based on scientific evidence.

The absence of records in some states, such as Acre and Roraima, requires interpretative caution. It is not possible to infer ecological absence based only on the absence of documentary data, especially in regions with low historical investment in botanical collections. Therefore, the need to expand regional networks of herbaria, intensify floristic expeditions in undersampled areas and guarantee the digitisation of collections still inaccessible is reinforced.

In summary, the results presented here demonstrate the practical usefulness of digital floristic databases for the formulation of conservation, restoration and forest management policies. By revealing spatial and temporal patterns of the distribution of *Apuleia leiocarpa*, this study contributes to the strengthening of the integration between science, environmental governance and socio-ecological management of Brazilian biodiversity.

In the regional context, the spatial analysis of the distribution of *Apuleia leiocarpa* in the state of Rio Grande do Norte reveals documented records in forest fragments located mainly in areas of ecological transition between Atlantic Forest and open formations. Based on data from the JABOT Virtual Herbarium, occurrences of the species were identified in



municipalities on the east coast and in portions of the interior of the state, including areas under the influence of state and federal Conservation Units.

The species was recorded inside the State Park Dunas de Natal and in areas near the Bonfim-Guaráira Environmental Protection Area. However, there are no documented records until 2025 for the National Forest of Nísia Floresta (FLONA), a federal UC of sustainable use inserted in one of the regions of greatest anthropic pressure in the state. This absence of collections may reflect both sampling limitations and opportunities for further floristic studies.

This cut reinforces the importance of considering regional scales in the analysis of species distribution, especially when linked to legally protected territories. The presence of *Apuleia leiocarpa* in forest fragments near protected areas highlights its potential to integrate management strategies and restoration of native vegetation in RN, contributing to local actions aligned with national guidelines and international conservation commitments.

4 CONCLUSION

From the analysis of documentary records between 1939 and 2025, it was possible to highlight the wide geographical distribution of *Apuleia leiocarpa* in Brazil, including its presence in different biomes and regions of ecological transition. The species shows remarkable versatility, being recorded both in primary forests and in anthropogenic environments, which reinforces its relevance for forest restoration, sustainable management and biodiversity conservation.

The findings presented here reinforce the need for integration between botanical data and socio-environmental management tools, promoting an evidence-based approach to territorial planning, reforestation with native species and the valorisation of ecological knowledge in the formulation of public policies. The distribution of the graph over time and space also highlights the asymmetries in the national botanical collection effort and the importance of strengthening digitisation, curation and collection initiatives in undersampled regions.

In the regional clipping of the state of Rio Grande do Norte, the documented presence of the species in forest fragments under the influence of state Conservation Units, such as the Dunas de Natal State Park and the Bonfim-Guaráira APA, was observed. However, the absence of records in the Nísia Floresta FLONA signals a relevant sampling gap in protected areas that require greater attention in floristic inventories.



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