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CHARACTERIZATION OF A SCIENTIFIC FIELD BASED ON DATA FROM THE LATTES PLATFORM: AN ANALYSIS OF BRAZILIAN PALEONTOLOGY (1945-2024)

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ABSTRACT

The present study analyzed the scientific production in Paleontology in Brazil between 1945 and 2024, using data from the Lattes Platform to map its development. The research is built on scientometric and historiographical perspectives and revealed significant growth in the field, especially from the 1970s onwards, with a peak in publications in 2020. The *Journal of South American Earth Sciences* stood out as the journal with the most publications (1,315), followed by the *Annals of the Brazilian Academy of Sciences* (1,064) and the *Revista Brasileira de Geociências* (943). The analysis of journal dispersion, based on Bradford's law, indicated a high dispersion, with 53.24% of the journals having only one publication. Despite this, most publications were concentrated in core, highly specialized journals, particularly in the fields of Geosciences and Biosciences, reflecting the interdisciplinary nature of Paleontology. The temporal analysis showed a steady increase in production, with a period of high productivity between 2000 and 2020. After 2020, a slight decline can be noted, possibly due to the COVID-19 pandemic. The results indicate that Paleontology in Brazil has consolidated itself as a field of research, with a strong influence from national and international journals. The study underlines the importance of the Lattes Platform as a data source for scientific analyses and highlights the growing maturity of Paleontology in Brazil.

Keywords: Paleontology; Brazil; Brazilian Paleontology; Information Metric Studies; Scientometrics.

RESUMO

CARACTERIZAÇÃO DE UM CAMPO CIENTÍFICO A PARTIR DE DADOS DA PLATAFORMA LATTES: UMA ANÁLISE DA PALEONTOLOGIA BRASILEIRA (1945-2024). O presente estudo analisou a produção científica em Paleontologia no Brasil entre 1945 e 2024, utilizando dados da Plataforma Lattes para mapear seu desenvolvimento. A pesquisa é construída a partir de perspectivas cienciométricas e historiográficas e revelou um crescimento significativo da área, especialmente a partir

da década de 1970, com um pico de publicações em 2020. O *Journal of South American Earth Sciences* se destacou como o periódico com maior número de publicações (1.315), seguido pelos *Anais da Academia Brasileira de Ciências* (1.064) e pela *Revista Brasileira de Geociências* (943). A análise da dispersão dos periódicos, baseada na lei de Bradford, indicou uma alta dispersão, com 53,24% dos periódicos com apenas uma publicação. Apesar disso, a maior parte das publicações concentrou-se em revistas nucleares e altamente especializadas, particularmente em Geociências e Biociências, refletindo a interdisciplinaridade da Paleontologia. A análise temporal revelou um aumento constante da produção, com um período de elevada produtividade entre 2000 e 2020. Após 2020, regista-se um ligeiro declínio, possivelmente devido à pandemia de COVID-19. Os resultados indicam que a Paleontologia no Brasil tem se consolidado como campo de pesquisa, com forte influência de periódicos nacionais e internacionais. O estudo ressalta a importância da Plataforma Lattes como fonte de dados para análises científicas e destaca a crescente maturidade da Paleontologia no Brasil.

Palavras-chave: Paleontologia; Brasil; Paleontologia Brasileira; Estudos Métricos de Informação; Cientometria.

RESUMÉN

CARACTERIZACIÓN DE UN CAMPO CIENTÍFICO A PARTIR DE LOS DATOS DE LA PLATAFORMA LATTES: UN ANÁLISIS DE LA PALEONTOLOGÍA BRASILEÑA (1945-2024). El presente estudio analizó la producción científica en Paleontología en Brasil entre 1945 y 2024, utilizando datos de la Plataforma Lattes para mapear su desarrollo. La investigación se basa en perspectivas cienciométricas e historiográficas y reveló un crecimiento significativo en el campo, especialmente a partir de la década de 1970, con un pico de publicaciones en 2020. El *Journal of South American Earth* Sciences se destacó como la revista con más publicaciones (1.315), seguida por los *Anales de la Academia Brasileña de Ciencias* (1.064) y la *Revista Brasileira de Geociências* (943). El análisis de la dispersión de las revistas, basado en la ley de Bradford, indicó una elevada dispersión, con un 53,24% de las revistas con una sola publicación. A pesar de ello, la mayoría de las publicaciones se concentraron en revistas básicas, altamente especializadas, en particular en Geociencias y Biociencias, lo que refleja la interdisciplinariedad de la Paleontología. El análisis temporal mostró un aumento constante de la producción, con un periodo de alta productividad entre 2000 y 2020. Después de 2020, se observa un ligero descenso, posiblemente debido a la pandemia de COVID-19. Los resultados indican que la Paleontología en Brasil se ha consolidado como campo de investigación, con una fuerte influencia de revistas nacionales e internacionales. El estudio subraya la importancia de la Plataforma Lattes como fuente de datos para análisis científicos y destaca la creciente madurez de la Paleontología en Brasil.

Palabras clave: Paleontología; Brasil; Paleontología brasileña; Estudios métricos de información; Cienciometría.

1 INTRODUCTION

Paleontology is a science that captivates the human imagination because of its mission to narrate the evolution of life in its various forms throughout Earth's history. This study bridges the fields of Information Science and Paleontology by providing one of the first comprehensive bibliometric analyses of Brazilian paleontological research (1945–2024), filling a critical gap in understanding the field's evolution and current trends. Our study aims to analyze scientific outputs published in this field, within the context of scientific communication and academic knowledge production and develop an interpretation of the general characteristics of Paleontology in Brazil, its historical evolution, and its current configuration. In this regard, the research focuses on scientific information resulting from

research activities and the generation of knowledge, providing insight into Paleontology on the national scene.

Paleontology is a field that historically emerged from the intersection of natural history disciplines, including geology, botany, mineralogy, and zoology. This multidisciplinary subject spread from European countries to the Americas (South, Central, and North), influencing paleontological science in Brazil, which developed later. For this study, Brazilian Paleontology is defined as the body of research carried out by Brazilian scholars or researchers with formal links to Brazilian institutions, even if temporary, involving fossil material and the paleontological discipline in various approaches (such as its protagonists, history, applications, and challenges). Production associated with Brazilian Paleontology refers to studies by researchers who, at some point in their career, have published or generated knowledge that results in at least five entries in their Lattes CVs related to Paleontology, regardless of their background. The threshold of five publications was adopted to ensure researchers had a sustained contribution to paleontology, thereby minimizing the impact of occasional contributors. While this may exclude early-career researchers, it aligns with studies on scientific maturity (e.g., Siciliano & Leta, 2020). This criterion may underrepresent interdisciplinary scholars or emerging fields; future studies could use co-authorship networks to complement the analysis.

The information needed to conduct this study – journals and production over time – was obtained from the Lattes Curriculum data of researchers registered on the Lattes Platform, a tool of the National Council for Scientific and Technological Development (CNPq), which is linked to the Ministry of Science, Technology and Innovation (MCTI).

The analysis of studies in databases revealed few studies that apply Information Metrics Studies (ISE) to the field of Paleontology in Brazil. Among them, Siciliano and Leta (2020) and Siciliano (2018) stand out, as they investigate the maturity of the field within the national context. Internationally, other authors, such as Alvarado-Urbizagástegui (2021), Kelley et al. (2013), Miguel et al. (2013), Ortiz-Jaureguizar et al. (2016), Palanivel and Baskaran (2018, 2019), Pascual (1980), Saravanan and Dominic (2013), Suárez Noyola (2019), and Vildoso Morales (2012), are dedicated to exploring Paleontology through metric approaches, although these studies are also scarce. In Brazil, notable works in the field of Geosciences include those by Cândido et al. (2016), Castilhos (2023), and Morandin et al. (2023), which exemplify approaches that use metrics to analyze scientific production in this field.

The Information Science Database (Brapci, in Portuguese acronym) only yields four results for the term "paleontology", excluding the study by Siciliano and Leta (2020), and none of them explore scientific information metrics. Therefore, compared to other scientific areas, there is a scarcity of studies on Scientific Communication and Information Metrics Studies in the field of Paleontology, as well as information associated with its scientists.

This study, therefore, seeks to fill this gap with an approach by connecting Information Science with Paleontology, through a scientometric analysis of data obtained from the Lattes Platform. In addition to contributing to Information Science, our paper aims at providing information on Paleontology, especially regarding the mapping of scientific production in the field.

The main objective of this study is to present the general indicators of scientific production related to Paleontology in Brazil, highlighting its development over time through a longitudinal analysis. The specific objectives include: a) identify the dispersion of scientific journals on Paleontology; b) examine the growth of scientific production in the field of Paleontology and related areas over time. To fulfill our research goals, data obtained from scientific articles registered on the Lattes Curriculum will be analyzed.

2 THE INSTITUTIONALIZATION OF PALEONTOLOGY

Paleontology's interdisciplinary nature justifies our focus on both geosciences and biosciences journals. Paleontology can be divided into different historical phases that are part of its development as a discipline and research area. According to Siciliano (2018), the development of the discipline occurred in three stages: the first, during the 16th and 17th centuries, when it was still part of the studies of naturalists without having a clear definition; the second, in the 18th and 19th centuries, when it was established as a scientific field, driven by the studies of Comparative Anatomy; and the third, in the 20th century, when the discipline gained autonomy with the creation of scientific societies and specialized publications. Faria (2005) also points out that Paleontology was not considered a science for a long period because

religious beliefs and misinterpretations of fossils treated them as curiosities rather than scientific objects.

Alvarado-Urbizagástegui (2021) outlines a chronology similar to that of Siciliano (2018), while Corecco (2022) identifies four great eras of Paleontology: the Era of Myths, the Era of Dawn, the Era of Consolidation, and the Era of Interdisciplinarity. Martinez (2012) connects the emergence of Paleontology to Geology, arguing that both emerged as sciences in the 19th century. He highlights the role of Carl Nilsson Linnaeus (1707-1778), who created a system of morphological classification. Georges Cuvier (1769-1832) played a crucial role in the advancement of Paleontology with the creation of Comparative Anatomy, which facilitated the study of fossils and transformed museums into important research centers. These processes highlight a transdisciplinary characteristic in the formation of Paleontology – both in its conceptual and theoretical universe, and in the constitution of institutions across various areas.

Cuvier, alongside scholars such as Charles Darwin (1809-1882), Nicolaus Steno (1638-1686) and Mary Anning (1799-1847), made significant contributions to the development of Paleontology. Darwin's theory of evolution in the 19th century prompted paleontologists to search for fossils that linked extinct species to living ones, thereby strengthening the theory of natural selection (Apesteguía & Ares, 2010). At the same time, Charles Lyell (1797-1875), with his focus on geology, helped demonstrate that the Earth was undergoing continuous transformations, alongside scientists such as James Hutton (1726-1797) and Abraham Gottlob Werner (1749-1817). Kolbert (2014) states that Cuvier was essential in consolidating Paleontology as a science, especially with his "cabinet science" method, which allowed him to analyze materials from various parts of the world. Faria (2010) recalls that, in 1800, Cuvier organized a network of collaborators to send fossils to France, which facilitated the progress of his research.

Leite and Leite (2016) point out that Cuvier's work, based on comparative anatomy, formalized paleontology as a "biology of the past". In the 20th century, science continued to evolve with the introduction of new technologies, including the use of DNA and computer modeling, which enabled a more detailed analysis of fossils. Subfields of Paleontology include Paleobotany, Vertebrate and Invertebrate Paleontology, and Taphonomy, among others.

Regarding this interdisciplinary aspect, Paleontology has been closely related to both Geosciences and Geology, as well as Biosciences and Biology, since the beginning of its development in fossil studies. The evolution of this science is marked by the influence of both areas, as evident in the growing understanding of species extinction in the 19th century and the acceptance of the Earth´s advanced age by geologists in 1830 (Benton & Harper, 2009). Furthermore, the definition of the stratigraphic record and the understanding of the role of fossils in the history of life reinforced these connections, culminating in Darwin's theory of evolution around 1860.

For this reason, the discipline has historically been interdisciplinary, according to Corecco (2022), and its current phase, in the 20th and 21st centuries, emphasizes collaboration with other areas. Interdisciplinarity, defined as the integration of different types of knowledge to tackle complex problems (Fazenda, 2011; Santos & Rodrigues, 2014), has been fundamental for Paleontology, allowing it to analyze issues such as the evolution of life on Earth (Japiassu, 1994; Trindade, 2008).

In the 18th century, Natural History played a central role in the development of Paleontology, and integration with Geology was essential for its growth (Castañeda, 1995; Fernandes, 2010). Paleontology benefited from geological knowledge and also contributed to the development of this area, especially in subfields such as Geodynamics and Geochronology (Remizova, 2013).

Biology, in turn, began to consolidate as a science at the beginning of the 20th century, with the structuring of evolutionary theory and the incorporation of areas such as Ecology and Genetics (Faria, 2005). Even so, Paleontology's relationship with the Geosciences remains strong, mainly due to the historical influence of Geology on the formation of this science. Today, Paleontology continues to expand its interdisciplinary boundaries, using advanced techniques such as tomography and chemical analysis to reconstruct the Earth's geological and evolutionary past with greater precision (Corecco, 2022).

The field of paleontology in Brazil has specificities regarding its formation and institutionalization. Paleontology in Brazil is closely linked to the development of geology. Manzig (2015) and Cassab and Melo (2016) highlight the scarcity of research on the historiography of national

Paleontology, which is often in conjunction with geology. Figueirôa (2022) divides the history of Geology in Brazil into six phases, which reflect the evolution of the science in the country's political and economic context, which also ends up being related to the history of Paleontology.

When referring specifically to the history of Paleontology, Petri (2001), based on studies by Leinz and Mendes, categorizes Brazilian Paleontology into six phases until 2000, with milestones such as the pioneering phase (1817-1875) and the diversification of micropaleontology (1964-1980). Siciliano (2018) proposes four phases, emphasizing foreign travelers and geological commissions as key moments in the development of Paleontology in Brazil. Regardless of the author used to theoretically support the consolidation of the discipline and research area in Brazil, the influence of Geology can be seen throughout the process of its formation in Brazilian territory.

There is a consensus that paleontological science in Brazil was initially developed by foreign expeditions, renewed by geological commissions and, from the 1930s onwards, consolidated with the creation of the Geological Service of Brazil. According to Petri (2001), the oldest phases are widely accepted, but there are divergent perspectives on the contemporary phases.

Manzig (2015) points out that Brazilian Paleontology gained strength after 1934, with the creation of the first university courses, as Brazil had previously depended on foreign specialists to explore its geological potential. This characteristic demonstrates the importance of consolidating the field in Brazil to train local paleontologists. Fernandes (2020) mentions that even before the arrival of the Portuguese Crown in 1808, indigenous Amazonians collected fossils to adorn funerary urns, and documented records of these early collections date back to the 18th century.

Lozada (2015) notes that the first Brazilian fossils were discovered by European naturalists with diverse backgrounds, including medicine and engineering, underscoring the interdisciplinary nature of Paleontology. Lopes (1999) adds that Brazilian fossils were already being sent to Europe at the end of the 18th century. The arrival of the Portuguese Royal Family in 1808 further stimulated scientific activity in Brazil, leading to the creation of scientific institutions such as the National Museum, which still houses an extensive collection of fossils (Museu Nacional, 2025). This period reflected a growing interest in Natural History in Brazil, amplified by international scientific expeditions, such as the Thayer Expedition (1865) and the Morgan Expeditions (1870-1871), which contributed to the advancement of geological and paleontological sciences in the country (Kunzler, 2018; Martinez, 2012).

The institutionalization of Paleontology in Brazil occurred late, and the science was only consolidated in the 20th century, with contributions from scientists such as Frederico Burlamaqui, director of the National Museum, and through initiatives such as the Geological Commission of the Empire (Fernandes et al., 2010; Guerra, 2010). From the 1950s onwards, the professionalization of Paleontology brought new approaches and diversified research, especially in geologically rich areas such as the Santa Maria and Botucatu formations (Anelli & Nogueira, 2017). These discoveries were driven by Brazil's connection to the ancient supercontinent Gondwana, highlighting the country's significance for global paleontological studies (Anelli & Nogueira, 2017; Bradley, 2011). The following section describes the methodological process of this study.

3 METHODOLOGY

This study adopts a scientometric methodology, as defined by Spinak (1996), which involves the application of bibliometric techniques to measure scientific information. Classified by Glänzel (2003) as a bibliometric/scientometric method, the research focuses on the field of Paleontology, analyzing the field at a national level according to Van Raan's (2003) categorization. It is also one of the methods present in the Information Metrics Studies (IME) method. IME is a set of methods and techniques for measuring information, especially that involved in formal communication processes in science. IME, a discipline focusing on analyzing scientific documents and their associated information, gained notoriety in the 1950s (Santos & Kobashi, 2009) and recognition, as well as consolidation in the 1980s (Grácio & Oliveira, 2017). Derived from bibliometrics, IME encompasses various sub-areas and disciplines, including webometrics, scientometrics, informetrics, and altmetrics, among others, each focused on a distinct element of analysis (Araújo, 2006; Curty & Delbianco, 2020; Milojević & Leydesdorff, 2013).

Bibliometric historiography, in turn, is addressed by authors such as Gabriel Junior et al. (2021); Garfield et al. (2002); Garfield et al. (2010);

Saíz Roca (1989); Santos et al. (2012); Sobral et al. (2023) and Sobral et al. (2024) in applied studies. Despite the lack of conceptual uniformity in the pertinent literature, it is understood that the field is a subdomain of Bibliometrics that makes it possible to analyze the evolution of a theme, research topic, field of knowledge, or production of an author, institution, or research group over time. The approach combines bibliometric analysis with graphic representation, utilizing information retrieval, bibliometric processing and historiographic analysis, to identify production trends, historical milestones, influential authors, collaboration networks and the conceptual evolution of a field based on its scientific production or associated information. Using information metric analysis tools, it is thus possible to highlight the emergence of concepts, the periodicity of publications, and the connections between different areas of knowledge, thereby offering an understanding of the historical and intellectual trajectory of the element studied – in this case, a scientific field.

The diachronic approach, based on time frame, is used to interpret the data, highlighting the characteristics of different periods of Brazilian Paleontology (and biographical information of researchers from Lattes), in line with previous studies by Bufrem and Freitas (2015) and Grácio et al. (2019), for other fields of knowledge.

Characterized as descriptive and exploratory (Gil, 1991), this research aims to describe and examine relationships between variables, providing a comprehensive and detailed view of the phenomenon in question. With a general approach that includes bibliographical, documentary, and field research, using CV data from the Lattes Platform, the study aims to expand knowledge about IMS in the context of Paleontology in Brazil.

According to Wendt (2024), the Lattes platform is a promising source of data because consolidates a database of information on Brazilian science that spans over two decades. Lattes was officially launched in 1999. According to Estácio et al. (2019), Lattes is an Information System (IS) developed to assist in the management of Science, Technology and Innovation (ST&I). It is an electronic government (e-gov) platform comprising information systems, databases, and web portals that integrate the systems of federal agencies, aiming to optimize the management of Science and Technology (S&T) in the country for users, funding agencies, as well as educational and research institutions.

The search for CVs was carried out on March 1, 2024. The search focused on CVs with the term "Paleontology" and the academic title of “doctor” as a filter, resulting in 1,465 CVs, which represent 0.32% of the total number of doctors registered on Lattes (approximately 450,000). The Exact and Earth Sciences area is third in terms of the number of PhDs, with Geosciences accounting for around 13.62% of the area's profiles (Dias, 2016). As Lattes relies on self-reported data, records prior to 2000 may be incomplete. However, its dominance in Brazilian academia makes it the most comprehensive source for national trends. Triangulation with Scopus/WoS could validate trends, especially for international collaborations.

During the collection stage of the CVs and associated publications, we adopted the criterion of the presence of five or more occurrences of the radical “paleo” in the titles, abstracts or keywords of the records. This approach made it possible to gather both publications that are clearly part of the field of Paleontology, as well as works that orbit the theme or dialog with it from different perspectives. Due to the interdisciplinary nature of Paleontology - especially its proximity to Geology - it is expected that some publications relevant to the analysis, as well as journals, are not explicitly linked to Paleontology, but still contribute to the understanding of the field’s interfaces.

Each CV on the Lattes Platform is linked to three unique identifiers. For this study, the 16-digit identifier displayed at the top of each researcher's profile was used. The selected CVs were processed by Brapci Bibliometric Tools, developed in collaboration with Brapci, a database specializing in Brazilian publications in the field of Information Science. The tool, developed by the Federal University of Rio Grande do Sul (UFRGS), enables the initial processing of information from Lattes, organizing it systematically (Wendt, 2024).

The Brapci Bibliometric Tools platform is currently under development (this study was a more extensive attempt to use it). Lattes Extractor can be accessed by requesting it from the CNPQ. The remaining software and tools used in this study are available online.

Based on the unique identifiers of each researcher, Brapci Bibliometric Tools collects XML files from Lattes and converts them into CSV format using Lattes Extractor, a tool provided by CNPq and accessible only to authorized users. After selecting the sections of interest from Lattes, the tool analyzes and extracts the data and metadata from the CVs.

Each CV collected generates an individualized profile that can be updated as the researcher includes new information in Lattes.

This study also employed time frames to conduct a longitudinal analysis. A generation of scientists was defined as having a timespan of up to 30 years, based on the time required for the formation and development of academic careers. Although it is not a rigid definition in the literature, this delimitation reflects the concept of career cycles and the transmission of knowledge between mentors and students. Inspired by Siciliano (2018), who defined three phases in the development of Paleontology in Brazil, three periods of analysis were adopted: 1940-1969, 1970-1999, and 2000-2024.

The data collected was processed using software such as OpenRefine, Excel, Notepad++, and Google Sheets to organize it, eliminate duplicates and identify patterns. Programs such as Table2Net and Gephi helped analyze the relationships between words and frequencies, and graphs were generated with Google Sheets.

Information on full articles published in journals is present in 1,449 profiles (98.90% of the total), totaling 56,799 publications before excluding duplicate data. This segment of Lattes was used to meet both the general and specific objectives of this text. After deduplication, carried out by comparing titles in alphabetical order, 13,421 repeated studies (23.62%) were eliminated, leaving 43,378. Of these, 45 (0.10%) were missing or inconsistent in the "journal" column and were also discarded, resulting in 43,333 valid studies. In addition, both printed and digital versions of the same journal were treated as a single publication, based on manual checks, considering factors such as publication date, authorship, and journal affiliation. This procedure ensured consistency in the data and avoided duplicates that could distort the results.

The analysis focused on the dispersion of journals and the temporal distribution of publications, and the data were treated accordingly. Journal names were processed with lexical proximity algorithms using Open Refine software, with a copy of the original data preserved for future comparisons. The algorithms used included Fingerprint, n-Gram Fingerprint, Metaphone3, Cologne phonetic, Daitch-Mokotoff, Beider-Morse, Levenshtein, and PPM (all available in OpenRefine). The Fingerprint algorithm was used to identify textual similarities and standardize names with subtle spelling variations, while the Levenshtein algorithm calculated the distance between characters, allowing for the unification of terms with slight spelling differences. Journals with 10 or more occurrences were manually reviewed, correcting spelling errors but preserving name changes over time and respecting the original spellings in the languages.

To check for duplicate journals, the titles were sorted alphabetically, and where necessary, information such as publication date, authorship, and journal were compared. A total of 795 journal titles with 10 or more studies were identified.

The columns "Author", "Title of study", "DOI", and "Nature of article" were only used for deduplication. Additionally, an analysis was conducted of the years of creation of the journals and their first publication record in the corpus, with a separate table created for this purpose.

4 RESULTS AND DISCUSSION

First, the most frequently cited journals in the corpus will be presented, followed by an overview of the distribution of research over time. The study analyzed a total of 6,549 journals, encompassing 43,333 publications in the field of Paleontology and associated areas between 1945 and 2024. Of these, 4,457 studies (10.58%) are concentrated in the five leading journals, three of which are published in Brazil, showing the national relevance in the scientific dissemination of this area. In addition, the *Journal of South American Earth Sciences* and *Zootaxa* reinforce production in the Global South, while the other journals have scopes that vary between Geosciences, Biosciences, or both.

Between 1945 and 2024, the *Journal of South American Earth Sciences* stood out as the journal that received the most papers, with a total of 1,315 publications, equivalent to 3.03% of the total analyzed. This international Elsevier journal focuses on studies of South America, Mexico, Central America, the Caribbean, and the Antarctic Peninsula. The *Anais da Academia Brasileira de Ciências*, Brazil's oldest scientific publication (in circulation since 1929), came next with 1,064 studies (2.45%). Third place is occupied by *Revista Brasileira de Geociências*, which registered 943 articles (2.17%). *Zootaxa*, an international journal published by Magnolia Press, ranks fourth with 614 publications (1.41%). Finally, *Revista Brasileira de Paleontologia*, linked to the Brazilian Paleontology Society, received 521 papers (1.20%).

Discrepancies between Lattes records and journal archives may stem from: (1) incomplete

digitization of older issues, (2) broad interdisciplinary classifications in Lattes, or (3) articles citing paleontological data without explicit keywords.

The analysis revealed that 53.24% of the journals had only one publication registered, indicating high dispersion, as predicted by Bradford's Law[1], with the formula 1:n:n^2 (Bradford, 1934). According to this Law, if we organize journals in descending order of relevance to a given topic, we can divide them into three zones, each containing approximately the same number of articles, but distributed unevenly among the journals. The first zone, known as the core, comprises a small number of highly specialized journals that publish the majority of relevant articles. The second zone comprises a larger number of less specialized journals, which still provide significant benefits to the topic, but in smaller quantities than those in the first zone. The third zone comprises a large number of journals that publish only occasional articles relevant to the topic in question. And so on (Bradford, 1934).

The core of the analysis, comprising 33 journals, covers 24.73% of the publications, while journals with fewer than 140 studies account for 75.26% of the total. In addition, the high dispersion observed reflects a challenge in centralizing knowledge, indicating that investments in infrastructure and funding for research are important for reducing regional inequalities and strengthening scientific production.

The distribution according to Bradford Zones organizes the journals into quartiles of 10,833.25 studies each. Zone 1, with 33 journals (0.50% of the total), covers 24.73% of the publications; Zone 2, with 154 journals (2.35%), and Zone 3, with 668 journals (10.20%), account for 25% each. Zone 4, comprising 5,692 journals (86.94%), accounts for 25.26% of publications, indicating a concentration in the core journals, as well as a wide dispersion among the remaining journals (Table 1).

The study analyzed the thematic distribution of the 33 most frequent journals (Bradford upper quartile - Core Zone - Zone 1). It was found that the majority of studies are concentrated in Exact and Earth Sciences journals (27, or 81.8%), followed by Biological Sciences journals (5, or 15.7%), and only one from the Humanities (3%). When examining the categorization of these 33 journals in more detail, the following distribution was observed: Geosciences (20 journals, or 60.6%), Paleontology (6 journals, or 18.2%), Biosciences (6 journals, or 18.2%) and Human Sciences (1 journal, or 3%).

TABLE 1 – Dispersion of the 20 most frequent periodicals in the corpus for the entire interval analyzed.

N.º	*Journal*	*Number of studies*	*%*	*Cumulative total*	*%**
1	Journal of South American Earth Sciences	1,315	3.03	1,315	3.03
2	Anais da Academia Brasileira de Ciências	1,064	2.46	2,379	5.49
3	Revista Brasileira de Geociências	943	2.18	3,322	7.67
4	Zootaxa	614	1.42	3,936	9.08
5	Revista Brasileira de Paleontologia	521	1.20	4,457	10.29
6	Geociências (São Paulo)	471	1.09	4,928	11.37
7	Anuário do Instituto de Geociências (UFRJ)	462	1.07	5,390	12.44
8	Precambrian Research	381	0.88	5,771	13.32
9	Pesquisas em Geociências (UFRGS)	333	0.77	6,104	14.09
10	Palaeogeography, Palaeoclimatology, Palaeoecology	329	0.76	6,433	14.85
11	Revista Brasileira de Geomorfologia	259	0.60	6,692	15.44
12	Geologia USP. Série Científica	254	0.59	6,946	16.03
13	Brazilian Journal of Geology	252	0.58	7,198	16.61
14	Journal of Coastal Research	247	0.57	7,445	17.18
15	Cretaceous Research	226	0.52	7,671	17.70
16	Acta Geológica Leopoldensia	209	0.48	7,880	18.18
17	Gondwana Research	208	0.48	8,088	18.66
18	Ameghiniana	196	0.45	8,284	19.12
19	Journal of Vertebrate Paleontology	193	0.45	8,477	19.56
20	PLoS One	193	0.45	8,670	20.01

*Data rounded to two decimal places. Journals sorted by publication count (1945–2024). (Source: Lattes Platform, 2024)

[1] Principle of bibliometrics that describes how scientific literature is distributed in relation to a specific topic. It states that: relevant articles on a given subject are concentrated in a small number of highly specialized journals. Per the law, as the sources searched expand, the number of journals containing relevant articles increases, but each journal contributes fewer articles.

The existence of scientific journals dedicated to a specific field suggests the recognition of its research interests and needs, as well as the greater independence of this subfield from the broader area that gave rise to it. The data revealed that Brazilian scientific production in Paleontology, including the research associated with it, is predominantly published in journals focused on the areas of Geosciences and Biosciences, which reflects the interdisciplinary nature of Paleontology. In addition, the presence of journals specializing in Paleontology, whether national or international, points to the relative autonomy and maturity of this area of knowledge.

Some journals are exclusively concentrated on paleontological themes, such as *Revista Brasileira de Paleontologia* covering taxonomic studies and various aspects of this science; *Palaeogeography, Palaeoclimatology, Palaeoecology*, which specializes in paleoenvironmental geosciences; the *Journal of Vertebrate Paleontology*, which focuses on vertebrate fossils; and *Ameghiniana*, which focuses on research into the supercontinent Gondwana and the biological history of the Southern Hemisphere. These journals contrast with more general publications that cover both the geosciences, such as the *Journal of South American Earth Sciences* and the *Revista Brasileira de Geociências*, and the biosciences, such as *Zootaxa*, *Herpetological Review*, and *Genetics and Molecular Biology*.

Journals specializing in Paleontology underline specific interests based on temporal and spatial criteria. Examples include *Precambrian Research*, which focuses on the study of the Precambrian period – the longest in Earth's history; *Cretaceous Research*, examining the Cretaceous, the last period of the Mesozoic Era; and *Gondwana Research*, investigating the ancient supercontinent Gondwana, whose remains are mostly found today in the Southern Hemisphere. A preliminary keyword analysis (e.g., 'Cretaceous', 'Gondwana', 'taxonomy') revealed a focus on Mesozoic fossils and South American biomes, aligning with Brazil's geologic record. Future studies could apply NLP tools for more in-depth thematic mapping. On the other hand, *Quaternary International* is dedicated to the Quaternary period, the most recent of the Cenozoic Era. It is understood that the scope of these publications demonstrates the efforts of the scientific community to address the specificities and interdisciplinary intersections in paleontological research. (Table 2)

An analysis of the data in Table 2 reveals a variation in the intervals between the creation of journals and the publication of their first papers linked to Brazil (and which comprise our database). Some journals, such as the *Journal of South*

TABLE 2 – Year of creation of the 20 most frequent journals and year of first publication in the journal according to the corpus.

N.º	*Journal*	*Year of creation*	*Year of registration of the first work in the corpus*
1	Journal of South American Earth Sciences	1988	1988
2	Anais da Academia Brasileira de Ciências	1929	1950
3	Revista Brasileira de Geociências	1971	1971
4	Zootaxa	2001	2002
5	Revista Brasileira de Paleontologia	2001	2001
6	Geociências (São Paulo)	1982	1982
7	Anuário do Instituto de Geociências (UFRJ)	1977	1991
8	Precambrian Research	1974	1976
9	Pesquisas em Geociências (UFRGS)	1972	1981
10	Palaeogeography, Palaeoclimatology, Palaeoecology	1965	1994
11	Revista Brasileira de Geomorfologia	2000	2000
12	Geologia USP. Série Científica	2001	2001
13	Brazilian Journal of Geology	2013	2013
14	Journal of Coastal Research	1985	1985
15	Cretaceous Research	1980	1987
16	Acta Geológica Leopoldensia	1976	1978
17	Gondwana Research	1997	1998
18	Ameghiniana	1957	1963
19	Journal of Vertebrate Paleontology	1981	1984
20	PLoS One	2006	2007

American Earth Sciences, the *Revista Brasileira de Geociências*, and the *Brazilian Journal of Geology*, began publishing Brazilian research immediately after their founding, indicating a rapid acceptance of these journals in the national scientific environment. In contrast, others, such as *Palaeogeography, Palaeoclimatology, Palaeoecology*, took decades to register their first Brazilian paper - in this case, 29 years - possibly reflecting the slower development of specific research areas on these topics in the country.

Some journals took intermediate periods to publish Brazilian work (or for a researcher to have their research published and registered in their Lattes). For example, *Zootaxa* and *PLoS ONE* registered publications within one year of their creation, while *Cretaceous Research* and *Ameghiniana* took between six and seven years. Other older journals, such as *Anais da Academia Brasileira de Ciências* (founded in 1929) and Ameghiniana (1957), despite initially facing challenges in establishing continuous production, consolidated themselves as important vehicles for the dissemination of paleontological knowledge in South America after their first publications.

The creation of specialized journals, such as *Revista Brasileira de Geociências* and *Precambrian Research* in the 1970s and 1980s, reflects a period of expansion and specialization of research in Paleontology on the international stage. This movement also appears to be accompanied by an increase in the number of researchers and a growing need for specialized platforms for scientific dissemination in Brazil. In the 2000s, journals such as *Zootaxa* and *Revista Brasileira de Paleontologia* emerged to serve a growing and consolidated Brazilian scientific community, especially in subdisciplines like species description.

The creation of more recent journals, such as the *Brazilian Journal of Geology* (2013), and the increasing participation of Brazilian researchers in international journals, including *PLoS ONE* (2006), represent a movement towards the internationalization and diversification of Brazilian research. This trend may demonstrate the maturing of Paleontology in Brazil, consolidating its integration with the global scientific community. Graph 1 shows the distribution of publications by year.

Figure 1 illustrates the evolution of scientific production in Paleontology by Brazilian researchers over 80 years, from 1945 to 2024. In the initial years, between 1945 and 1960, production was limited (or barely recorded in Lattes), with an annual average of between 1 and 4 articles, showing the embryonic nature of paleontological research in Brazil during this period. In the 1960s, there was a modest increase, reaching a peak of 57 articles in 1968, suggesting the first steps of a more pronounced development in the area.

Between 1970 and 1980, production grew slowly but steadily, culminating in 211 articles in 1985, which signaled the start of a more pronounced expansion phase. In the following decade, from 1980 to 1990, there was a significant leap, with production exceeding 300 articles per year by the end of this period, reflecting the beginning of the consolidation of Paleontology as a field of research in Brazil. This growth was even more significant between 1990 and 2000, when scientific production exceeded 800 articles per year, possibly influenced by the previous movements in academic training.

The period from 2000 to 2010 was marked by more growth, with production exceeding 1,000 articles per year in the middle of the decade, which is understood to reflect the maturity reached in the area. Between 2010 and 2020, production reached its peak, with more than 2,000 articles published annually between 2018 and 2020, marking the apex of academic productivity in the field up to that point. The peak in vertebrate paleontology post-2000 (Figure 1) coincides with Brazil's fossil discoveries in the Araripe Basin, while the rise of

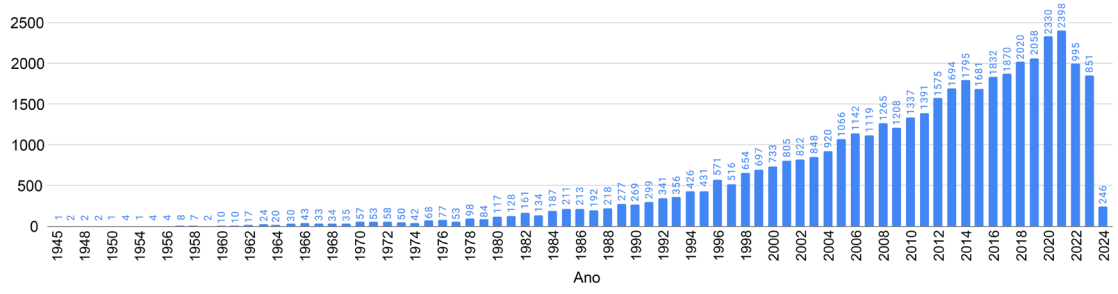

FIGURE 1 – Publication over time (n=43,333).

micropaleontology in the 1990s reflects the demands of the oil industry (Cassab & Melo, 2016).

After 2020, however, there has been a slight downturn in scientific production, although the numbers remain high compared to previous decades. This reduction may be attributed to factors such as the COVID-19 pandemic, which has impacted global academic productivity. The post-2020 decline mirrors global patterns (e.g., a 15% drop in WoS paleontology publications in 2020–2022), likely due to fieldwork restrictions during the pandemic (Nascimento et al., 2021).

Table 3 presents a comparative analysis of journal use across three distinct periods: Period I (1940-1969), Period II (1970-1999), and Period III (2000-2024). The analysis is structured based on the Bradford Zones, providing a view of the distribution and relevance of journals within each zone. The analysis of the Bradford Zones on the frequency of journals in the three periods studied reveals the distribution and impact of scientific publications over time, since the journals in Zone 1 can be considered *core*. In the first period (1940-1969), of the 294 studies analyzed, distributed over 130 journals, Zone 1, with only two journals, was responsible for 23.13% of the studies. The journal *Anais da Academia Brasileira de Ciências* stood out, reflecting its long history and thematic scope. Next, Zone 2 had 10 journals and 25.51% of the studies, while Zones 3 and 4 concentrated a larger number of journals, but with less individual production.

During the second period (1970-1999), scientific production increased, with 7,038 studies distributed evenly across four zones. Zone 1, with 12 journals, was home to 25.16% of the studies, and *Anais da Academia Brasileira de Ciências* continued to lead the way. The creation of new journals in the 1970s, such as *Revista Brasileira de Geociências* and *Acta Geológica Leopoldensia*, showed that researchers were more involved with these publications. Zone 2 had 75 journals, representing 24.95% of the studies, while Zones 3 and 4, with significant numbers of journals, concentrated a greater production, but with less individual impact.

In the third period (2000-2024), scientific production soared, with 36,001 studies published. Zone 1, comprising 32 journals, accounted for 25% of the studies, highlighting specialized and high-impact journals. Zone 2, with 147 journals, and Zones 3 and 4, with a high number of journals, represented a wider range of topics, with the impact concentrated in more specialized journals.

In general, the analysis of the Bradford Zones over the periods showed an increasing concentration of studies in a few specialized journals, while the broader zones reflected the diversity and growth of scientific production. The importance of Zones 1 and 2 stands out, as together they represent a small fraction of the journals but account for half of the studies. Brazilian scientific production in Paleontology, analyzed over 77 years, shows constant grow, except for some early years, such as 1946, 1951, and 1953, where there are no observable and examinable records. The first year with registered publications is 1945, and the average annual growth during the examined period is around 9.75%. During the 1990s, the number of publications increased, culminating in a peak in 2020, the year with the highest number of publications. This growth reflects a trend observed

TABLE 3 – Comparison of journals between Periods I (1940/1969), II (1970/1999), and III (2000/2024).

Period	*Bradford area*	*Number of journals*	*% of all journals*	*Number of studies*	*% of total studies*
Period I (1940-1969)	Zone 1	2	1.54%	68	23.13%
	Zone 2	10	7.69%	75	25.51%
	Zone 3	40	30.77%	73	24.83%
	Zone 4	78	60.00%	78	26.53%
Period II (1970-1999)	Zone 1	12	0.63%	1,771	25.16%
	Zone 2	75	3.96%	1,756	24.95%
	Zone 3	339	17.91%	1,757	24.96%
	Zone 4	1,466	77.48%	1,754	24.92%
Period III (2000-2029)	Zone 1	32	0.60%	9,000	25.00%
	Zone 2	147	2.80%	9,000	25.00%
	Zone 3	575	10.90%	9,000	25.00%
	Zone 4	4,531	85.70%	9,000	25.00%

in various scientific areas. It is associated with the evolution of technological processes and greater support for scientific research, as demonstrated in studies such as that by Nascimento et al. (2021).

Table 4 presents a comparison of growth in scientific production across different periods.

The first period records 294 publications, representing just 0.67% of the total 43,333 publications in the analyzed corpus. This is the period with the most significant number of "missing" years, since the data starts in 1945 and does not include publications from 1946, 1951, and 1953. Therefore, instead of covering 30 years, the period corresponds to 23 years.

In the second period, 7,038 publications were recorded, corresponding to 16.24% of the total, representing an increase of 2,293.88% compared to the first period. This interval encompasses the entire 30-year period proposed for analysis. The increase in scientific production can be attributed to a greater academic and scientific interest, with more researchers dedicating themselves to Paleontology. Additionally, professionals trained during the previous period likely continued to developed the field, alongside the evolution of dating techniques, analytical tools, and other technologies that facilitated research. There was also an expansion of specialized research institutions and programs, which undoubtedly contributed to this growth.

The third period encompasses 36,001 publications, accounting for 83.07% of the total, representing a 41.65% increase over the previous period. This period is the most recent, is still ongoing, and spans 24 years, which helps to justify its greater scientific output. In addition to the advances mentioned in the second period, there has been a diversification of research areas, with the emergence of new subdisciplines and fields in Paleontology.

5 FINAL CONSIDERATIONS

This study investigated scientific production in Paleontology in Brazil, aiming to analyze its development over time using data from the Lattes Platform. The analysis, which spans the period from 1945 to 2024, reveals growth in the field, especially since the 1970s, culminating in a peak in publications in 2020. The study also identified the most relevant journals for publishing Paleontology research in Brazil, demonstrating the importance of both national and international publications for the dissemination of scientific knowledge.

The research confirmed the interdisciplinary nature of Paleontology, which historically developed from the intersection of disciplines such as Natural History, Geology, Botany, Mineralogy, and Zoology. Analysis of the distribution of journals, according to Bradford's Law, showed that the majority of journals are concentrated in the Exact and Earth Sciences, followed by journals in the Biological Sciences, which reflects the strong influence of these areas on Paleontology.

The *Journal of South American Earth Sciences* stood out as the journal with the most significant number of publications, comprising 1,315 articles, which represent 3.03% of the total analyzed. The *Anais da Academia Brasileira de Ciências* and the *Revista Brasileira de Geociências* were also relevant, with 1,064 and 943 articles, respectively. This data highlights the importance of both international and national journals in disseminating Brazilian paleontological research. The analysis also unveiled a high dispersion of journals, with 53.24% of them having only one publication registered.

The temporal analysis of scientific production showed that, after a modest beginning in the 1940s and 1950s, there was a steady increase in production, with growth from the 1970s onwards. The period between 2000 and 2020 saw the highest productivity, with more than 2,000 articles

TABLE 4 – Comparison of scientific production in different periods,

Period	*Number of years covered*	*Total*	*Average number of publications per year*	*%*	*Growth compared to the previous period*
Period I (1940/1969)	23	294	12.78	0.67	-
Period II (1970/19999)	30	7,038	234.60	16.24	2,293.88%
Period III (2000/2024)	24	36,001	1,500.04	83.07	41.65%
Total	77	43,333	562.76	100.00	-

published annually between 2018 and 2020. After 2020, however, a slight downturn in production can be observed, which may be related to external factors such as the COVID-19 pandemic. Paleontology is a science that requires a lot of infrastructure and mobility for its development.

The distribution of journals in the Bradford Zones showed that although scientific production is concentrated in a core of the most relevant journals, there is also a wide dispersion in the other journals. A comparative analysis of three different periods (1940-1969, 1970-1999, and 2000-2024) revealed that, over time, there has been a growth in both the number of journals and scientific production, accompanied by an increase in the importance of specialized journals.

The study thus demonstrated the maturing of Paleontology in Brazil, with the consolidation of its research support infrastructure (journals, for example), the increase in the number of researchers, and the diversification of its areas of study. Despite a recent slight downturn, the field remains productive and in constant development, consolidating its integration with the global scientific community. The analysis also highlighted the importance of the Lattes Platform as a source of data for studies on Brazilian science, which, it is argued, should continue to be utilized for the development of studies in various fields.

In addition to theoretical contributions, this study provides practical recommendations for the field of Paleontology in Brazil. Researchers and academic managers should make efforts to consolidate inter-institutional scientific collaboration networks, especially between national and international institutions. It is recommended that funding for interdisciplinary integrated projects be increased, in order to encourage the diversification of studies and to delve deeper into topics that are still little explored, such as the interface between Paleontology and Computational Sciences. These actions aim to strengthen the field's development and increase its visibility on the global stage.

The results of this study can be helpful for researchers, science managers, and students interested in the area, as well as for the development of public policies that support research in Paleontology in the country. The methodological approach adopted, combining scientometric analysis with bibliometric historiography, can serve as a model for studies in other areas of knowledge.

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